Conceptrichtlijn traumatisch complexe voetletsels

INITIATIEF
Nederlandse Vereniging voor Heelkunde (NVvH)

IN SAMENWERKING MET
Nederlandse Vereniging voor Radiologie (NVvR)
Nederlandse Vereniging van Spoedeisdende Hulp Artsen (NVSHA)
Nederlandse Orthopaedische Vereniging (NOV)
Koninklijk Nederlands Genootschap Fysiotherapie (KNGF) en stichting LOOP (Landelijk Overkoepelend Orgaan Podologie)
Nederlandse Vereniging van Revalidatieartsen (VRA)

MET ONDERSTEUNING VAN
Kennisinstituut van de Federatie Medisch Specialisten

FINANCIERING
De richtlijnontwikkeling werd gefinancierd uit de Kwaliteitsgelden Medisch Specialisten (SKMS).

Colofon

CONCEPTRICHTLIJN TRAUMATISCH COMPLEXE VOETLETSELS

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Inhoudsopgave

Samenstelling van de werkgroep

Werkgroep

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- Dhr. prof. dr. M. (Martijn) Poeze; traumachirurg, Maastricht UMC, Nederlandse Vereniging voor Heelkunde (NVvH)
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- Dhr. drs. H.H. (Erik) Dol; SEH-arts, Jeroen Bosch Ziekenhuis, Nederlandse Vereniging van Spoedeisdende Hulp Artsen (NVSHA)
- Dhr. drs. M.W. (Menno) Bloembergen; orthopedisch-chirug, Reinier Haga Orthopedisch Centrum en Hagaziekenhuis, Nederlandse Orthopaedische Vereniging (NOV)
- Dhr. drs. J.P.S. (Joris) Hermus; orthopedisch-chirurg, Maastricht UMC, Nederlandse Orthopaedische Vereniging (NOV)
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<u>Met ondersteuning van</u>

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Startpagina – traumatisch complexe voetletsels

Waar gaat deze richtlijn over?

De voet is een complexe structuur, die functioneren door een nauwe samenwerking van 28 botten (25% van alle botten van het skelet), 57 articulaties, 32 spieren en pezen, en een veelvoud (ongeveer 109-132) aan ligamenten. Als een Zwitsers uurwerk zijn al deze delen op elkaar afgestemd, het uit de pas lopen van een der onderdelen heeft een effect op het hele lijf. Tien procent van alle fracturen op de spoedeisende hulp bevindt zich in de voet en het aantal ernstige voetletsels stijgt (deBoer 2014). Daarnaast wordt het aantal gemiste voetletsels geschat op 10-20 procent. Van alle voetletsels is meer dan 80 procent relatief eenvoudig letsel zoals metatarsaal en teen fracturen (Court-Brown 2006). De resterende letsels (calcaneus, talus, midvoet zoals Chopart en Lisfranc) vallen onder de zogenoemde complexe voetletsels. Dit zijn letsels welke vaak intra-articulair verlopen, een uitgebreide behandeling behoeven, met hoger dan gemiddelde kans op complicaties, langdurig herstel hebben en vaak in de toekomst restklachten geven, welke geregeld aanvullende behandeling nodig hebben. Daarnaast zijn complexe voetletsels zeldzaam. Het aantal calcaneus fracturen wordt geschat op 250-300 per jaar in nederland (Zorgproduct - DIS open data (opendisdata.nl)), het aantal talus, Chopart en Lisfranc letsels is significant lager. Dit brengt met zich mee dat het opbouwen van voldoende expertise lastig is. Het hebben van een complex voetletsel heeft een negatieve impact op het welbevinden van een patiënt (Schepers 2017). Deze richtlijn richt zich op wat volgens de huidige maatstaven de beste zorg is voor patiënten met traumatisch complex voetletsel en welke onderwerpen belanghebbenden het belangrijkst vonden om in de richtlijn besproken te hebben. Hierbij moet de kanttekening geplaatst worden dat binnen de verschillende complexe voetsels er vele variaties mogelijk zijn. Er is niet één type calcaneus fractuuur, er is zelfs niet één type intra-articulaire calcaneus fractuur. En los van het ossale letsel moet het weke delen letsel in rekening genomen worden, welke de uitkomst van de behandeling wellicht nog meer bepaald dan het ossale letsel. In de richtlijn komen de volgende onderwerpen aan de orde:

- De aangewezen (acute) diagnostiek van traumatisch complexe voetletsels
- Behandeling van talus fracturen
- Behandeling van calcaneus fracturen
- Behandeling van Chopart letsel
- Behandeling van Lisfranc letsel
- Nabehandeling van traumatisch complexe voetletsels
- Organisatie van zorg rondom traumatisch complexe voetletsels

Voor wie is deze richtlijn bedoeld?

Deze richtlijn is bestemd voor alle zorgverleners die betrokken zijn bij de zorg voor patiënten met een traumatisch complex voetletsel.

Voor patiënten

De botten van beide voeten samen beslaan 25% van alle botten uit het lijf. Gebroken botten binnen de voet komen dan ook vaak voor. De meeste breuken zijn relatief eenvoudig en onschuldig, ondanks het ongemak wat erbij komt kijken. Een klein deel van de breuken van de voet valt onder “complex voetletsel”. Dit zijn onder andere breuken van het hielbeen, sprongbeen en van de middenvoet. De behandeling hiervan is ingewikkeld, het herstel langdurig, de kans dat er restverschijnselen zijn is aannemelijk. In deze richtlijn worden handreikingen gedaan over de behandeling van deze ingewikkelde voetsels.

Hoe is de richtlijn tot stand gekomen?

Het initiatief voor deze richtlijn is afkomstig van Nederlandse Vereniging voor Heelkunde (NVvH). De richtlijn is opgesteld door een multidisciplinaire werkgroep met vertegenwoordigers vanuit de radiologen, SEH-artsen, orthopeden, revalidatieartsen en podologen/fysiotherapeuten.

Referenties

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Schepers T, Rammelt S. Complex Foot Injury: Early and Definite Management. Foot Ankle Clin. 2017 Mar;22(1):193-213. doi: 10.1016/j.fcl.2016.09.014. PMID: 28167063.

Verantwoording

Leeswijzer

Deze verantwoording zal op de Richtlijnendatabase (Richtlijnendatabase.nl) bij elk van de in deze richtlijn opgenomen modules worden geplaatst.

Autorisatie en geldigheid

Autorisatiedatum:	(n.t.b) – volgt na autorisatiefase
Eerstvolgende beoordeling actualiteit	(n.t.b) – volgt na autorisatiefase
Geautoriseerd door:	(n.t.b) – volgt na autorisatiefase
Regiehouder(s):	Nederlandse Vereniging voor Heelkunde (NVvH)

Algemene gegevens

De ontwikkeling van deze richtlijn werd ondersteund door het Kennisinstituut van de Federatie Medisch Specialisten (www.demedischspecialist.nl/kennisinstituut) en werd gefinancierd uit de Kwaliteitsgelden Medisch Specialisten (SKMS). De financier heeft geen enkele invloed gehad op de inhoud van de richtlijnmodule.

Samenstelling werkgroep

Voor het ontwikkelen van de richtlijnmodule is in februari 2022 een multidisciplinaire werkgroep ingesteld, bestaande uit vertegenwoordigers van alle relevante specialismen (zie hiervoor de Samenstelling van de werkgroep) die betrokken zijn bij de zorg voor patiënten met traumatisch complexe voetletsels.

Belangenverklaringen

De Code ter voorkoming van oneigenlijke beïnvloeding door belangenverstrengeling is gevolgd. Alle werkgroepleden hebben schriftelijk verklaard of zij in de laatste drie jaar directe financiële belangen (betrekking bij een commercieel bedrijf, persoonlijke financiële belangen, onderzoeksfinanciering) of indirecte belangen (persoonlijke relaties, reputatiemanagement) hebben gehad. Gedurende de ontwikkeling of herziening van een module worden wijzigingen in belangen aan de voorzitter doorgegeven. De belangenverklaring wordt opnieuw bevestigd tijdens de commentaarfase.
Een overzicht van de belangen van werkgroepleden en het oordeel over het omgaan met eventuele belangen vindt u in onderstaande tabel. De ondertekende belangenverklaringen zijn op te vragen bij het secretariaat van het Kennisinstituut van de Federatie Medisch Specialisten.

Belangentabel richtlijnwerkgroep complexe voetletsels

Werkgroeplid	Functie	Nevenwerkzaamheden	Gemelde Persoonlijke Financiële Belangen	Gemelde Persoonlijke Relaties	Extern gefinancierd onderzoek	Gemelde Intell. belangen en reputatie	Gemelde Overige belangen	Ondernomen actie
Tim Schepers (voorzitter richtlijn complexe voetletsels)	Traumachirurg voltijd Amsterdam UMC	Voet-enkel expert groep van de Arbeitsgemeinschaft für Osteosynthesefragen (AO)	Geen	Geen	Ja: wifi2 studie naar wondinfecties bij voet+enkel operaties (verwijderen schroeven/plaat): https://www.amc.nl/web/research-75/trials-collaborations/wifi-2.htm. De studie richt zich op de effectiviteit van antibiotica op het voorkomen van infecties. Rol als projectleider. Gefinancierd roor ZonMW, direct aan Amsterdam Medical Research	Geschat +/- 200 publicaties over voet- enkelletsel	Geen	Geen restricties; geen van de modules gaat over het onderwerp van de wifi2 studie
Stijn Nelen	Traumachirurg Radboud UMC Nijmegen	ATLS-instructeur	Geen	Geen	Geen	Geen	Geen	Geen restricties
Martijn Poeze	Traumachirurg Maastricht UMC	Geen	Geen	Geen	Geen	Geen	Geen	Geen restricties
Bastiaan Steunenberg	Radioloog Isala Zwolle	Geen	Geen	Geen	Geen	Geen	Geen	Geen restricties

Erik Dol	SEH-arts KNMG	ATLS-instructeur	Geen	Geen	Geen	Geen	Geen	Geen restricties
Menno Bloembergen	Orthopedisch chirurg MTU HagaZiekenhuis Reinier Haga Orthopedisch Centrum	Geen	Geen	Geen	Geen	Geen	Geen	Geen restricties
Joris PS Hermus	Orthopedisch chirurg-traumatoloog Maastricht Universitair Medisch Centrum	Voet-enkel expert groep van de Arbeitsgemeinschaft für Osteosynthesefragen (AO) Council member & honorary secretary European Foot and Ankle Society	Geen	Geen	Geen	Geen	Geen	Geen restricties
Erik Wink	Registerpodoloog podotherapeut bij podologic	Fysiotherapeut bij reyerey, langebaan schaatsploeg	Geen	Geen	Geen	Geen	Geen	Geen restricties
Peter Muitjens	Revalidatiearts 0,8 fte, betaald Werkgever: Adelante Zorggroep	Geen	Geen	Geen	Geen	Geen	Geen	Geen restricties

Inbreng patiëntenperspectief

Er werd aandacht besteed aan het patiëntenperspectief door het uitnodigen van Patiëntenfederatie Nederland (PFN) voor de schriftelijke knelpuntenanalyse. De verkregen input is meegenomen bij het opstellen van de uitgangsvragen, de keuze voor de uitkomstmaten en bij het opstellen van de overwegingen. De conceptrichtlijn is tevens voor commentaar voorgelegd aan Patiëntenfederatie Nederland en de eventueel aangeleverde commentaren zijn bekeken en verwerkt.

Kwalitatieve raming van mogelijke financiële gevolgen in het kader van de Wkkgz

Bij de richtlijnmodule is conform de Wet kwaliteit, klachten en geschillen zorg (Wkkgz) een kwalitatieve raming uitgevoerd om te beoordelen of de aanbevelingen mogelijk leiden tot substantiële financiële gevolgen. Bij het uitvoeren van deze beoordeling is de richtlijnmodule op verschillende domeinen getoetst (zie het stroomschema op de Richtlijnendatabase).

Module	**Uitkomst raming**	**Toelichting**
Module diagnostiek	Geen financiële gevolgen	Uit de toetsing volgt dat de aanbeveling(en) niet breed toepasbaar zijn (<5.000 patiënten) en daarom naar verwachting geen substantiële financiële gevolgen zullen hebben voor de collectieve uitgaven.

Module	**Uitkomst raming**	**Toelichting**
Module talus fracturen	Geen financiële gevolgen	Uit de toetsing volgt dat de aanbeveling(en) niet breed toepasbaar zijn (<5.000 patiënten) en daarom naar verwachting geen substantiële financiële gevolgen zullen hebben voor de collectieve uitgaven.

Module	**Uitkomst raming**	**Toelichting**
Module calcaneus fracturen	Geen financiële gevolgen	Uit de toetsing volgt dat de aanbeveling(en) niet breed toepasbaar zijn (<5.000 patiënten) en daarom naar verwachting geen substantiële financiële gevolgen zullen hebben voor de collectieve uitgaven.

Module	**Uitkomst raming**	**Toelichting**
Module Chopart letsel	Geen financiële gevolgen	Uit de toetsing volgt dat de aanbeveling(en) niet breed toepasbaar zijn (<5.000 patiënten) en daarom naar verwachting geen substantiële financiële gevolgen zullen hebben voor de collectieve uitgaven.

Module	**Uitkomst raming**	**Toelichting**
Module Lisfranc letsel	Geen financiële gevolgen	Uit de toetsing volgt dat de aanbeveling(en) niet breed toepasbaar zijn (<5.000 patiënten) en daarom naar verwachting geen substantiële financiële gevolgen zullen hebben voor de collectieve uitgaven.

Module	**Uitkomst raming**	**Toelichting**
Module Nabehandeling	Geen financiële gevolgen	Uit de toetsing volgt dat de aanbeveling(en) niet breed toepasbaar zijn (<5.000 patiënten) en daarom naar verwachting geen substantiële

		financiële gevolgen zullen hebben voor de collectieve uitgaven.

Module	**Uitkomst raming**	**Toelichting**
Module organisatie van zorg	Geen financiële gevolgen	Uit de toetsing volgt dat de aanbeveling(en) niet breed toepasbaar zijn (<5.000 patiënten) en daarom naar verwachting geen substantiële financiële gevolgen zullen hebben voor de collectieve uitgaven.

Werkwijze

AGREE

Deze richtlijnmodule is opgesteld conform de eisen vermeld in het rapport Medisch Specialistische Richtlijnen 2.0 van de adviescommissie Richtlijnen van de Raad Kwaliteit. Dit rapport is gebaseerd op het AGREE II instrument (Appraisal of Guidelines for Research & Evaluation II; Brouwers, 2010).

Knelpuntenanalyse en uitgangsvragen

Tijdens de voorbereidende fase inventariseerde de werkgroep de knelpunten in de zorg voor patiënten met traumatisch complex voetletsel. Tevens zijn er knelpunten aangedragen door middl van een schriftelijke knelpuntenanalyse. Een verslag hiervan is opgenomen onder aanverwante producten.

Op basis van de uitkomsten van de knelpuntenanalyse zijn door de werkgroep concept-uitgangsvragen opgesteld en definitief vastgesteld.

Uitkomstmaten

Na het opstellen van de zoekvraag behorende bij de uitgangsvraag inventariseerde de werkgroep welke uitkomstmaten voor de patiënt relevant zijn, waarbij zowel naar gewenste als ongewenste effecten werd gekeken. Hierbij werd een maximum van acht uitkomstmaten gehanteerd. De werkgroep waardeerde deze uitkomstmaten volgens hun relatieve belang bij de besluitvorming rondom aanbevelingen, als cruciaal (kritiek voor de besluitvorming), belangrijk (maar niet cruciaal) en onbelangrijk. Tevens definieerde de werkgroep tenminste voor de cruciale uitkomstmaten welke verschillen zij klinisch (patiënt) relevant vonden.

Methode literatuursamenvatting

Een uitgebreide beschrijving van de strategie voor zoeken en selecteren van literatuur is te vinden onder ‘Zoeken en selecteren’ onder Onderbouwing. Indien mogelijk werd de data uit verschillende studies gepoold in een random-effects model (Review Manager 5.4). werd gebruikt voor de statistische analyses. De beoordeling van de kracht van het wetenschappelijke bewijs wordt hieronder toegelicht.

Beoordelen van de kracht van het wetenschappelijke bewijs

De kracht van het wetenschappelijke bewijs werd bepaald volgens de GRADE-methode. GRADE staat voor ‘Grading Recommendations Assessment, Development and Evaluation’ (zie http://www.gradeworkinggroup.org/). De basisprincipes van de GRADE-methodiek zijn: het benoemen en prioriteren van de klinisch (patiënt) relevante uitkomstmaten, een systematische review per uitkomstmaat, en een beoordeling van de bewijskracht per uitkomstmaat op basis van de acht GRADE-domeinen (domeinen voor downgraden: risk of bias, inconsistentie, indirectheid, imprecisie, en publicatiebias; domeinen voor upgraden: dosis-effect relatie, groot effect, en residuele plausibele confounding).

GRADE onderscheidt vier gradaties voor de kwaliteit van het wetenschappelijk bewijs: hoog, redelijk, laag en zeer laag. Deze gradaties verwijzen naar de mate van zekerheid die er bestaat over de literatuurconclusie, in het bijzonder de mate van zekerheid dat de literatuurconclusie de aanbeveling adequaat ondersteunt (Schünemann, 2013; Hultcrantz, 2017).

GRADE	Definitie
Hoog	• er is hoge zekerheid dat het ware effect van behandeling dichtbij het geschatte effect van behandeling ligt; • het is zeer onwaarschijnlijk dat de literatuurconclusie klinisch relevant verandert wanneer er resultaten van nieuw grootschalig onderzoek aan de literatuuranalyse worden toegevoegd.
Redelijk	• er is redelijke zekerheid dat het ware effect van behandeling dichtbij het geschatte effect van behandeling ligt; • het is mogelijk dat de conclusie klinisch relevant verandert wanneer er resultaten van nieuw grootschalig onderzoek aan de literatuuranalyse worden toegevoegd.
Laag	• er is lage zekerheid dat het ware effect van behandeling dichtbij het geschatte effect van behandeling ligt; • er is een reële kans dat de conclusie klinisch relevant verandert wanneer er resultaten van nieuw grootschalig onderzoek aan de literatuuranalyse worden toegevoegd.
Zeer laag	• er is zeer lage zekerheid dat het ware effect van behandeling dichtbij het geschatte effect van behandeling ligt; • de literatuurconclusie is zeer onzeker.

Bij het beoordelen (graderen) van de kracht van het wetenschappelijk bewijs in richtlijnen volgens de GRADE-methodiek spelen grenzen voor klinische besluitvorming een belangrijke rol (Hultcrantz, 2017). Dit zijn de grenzen die bij overschrijding aanleiding zouden geven tot een aanpassing van de aanbeveling. Om de grenzen voor klinische besluitvorming te bepalen moeten alle relevante uitkomstmaten en overwegingen worden meegewogen. De grenzen voor klinische besluitvorming zijn daarmee niet één op één vergelijkbaar met het minimaal klinisch relevant verschil (Minimal Clinically Important Difference, MCID). Met name in situaties waarin een interventie geen belangrijke nadelen heeft en de kosten relatief laag zijn, kan de grens voor klinische besluitvorming met betrekking tot de effectiviteit van de interventie bij een lagere waarde (dichter bij het nuleffect) liggen dan de MCID (Hultcrantz, 2017).

Overwegingen (van bewijs naar aanbeveling)

Om te komen tot een aanbeveling zijn naast (de kwaliteit van) het wetenschappelijke bewijs ook andere aspecten belangrijk en worden meegewogen, zoals aanvullende argumenten uit bijvoorbeeld de biomechanica of fysiologie, waarden en voorkeuren van patiënten, kosten (middelenbeslag), aanvaardbaarheid, haalbaarheid en implementatie. Deze aspecten zijn systematisch vermeld en beoordeeld (gewogen) onder het kopje 'Overwegingen' en kunnen (mede) gebaseerd zijn op expert opinion. Hierbij is gebruik gemaakt van een gestructureerd format gebaseerd op het evidence-to-decision framework van de internationale GRADE Working Group (Alonso-Coello, 2016a; Alonso-Coello 2016b). Dit evidence-to-decision framework is een integraal onderdeel van de GRADE methodiek.

Formuleren van aanbevelingen

De aanbevelingen geven antwoord op de uitgangsvraag en zijn gebaseerd op het beschikbare wetenschappelijke bewijs en de belangrijkste overwegingen, en een weging van de gunstige en ongunstige effecten van de relevante interventies. De kracht van het wetenschappelijk bewijs en het

gewicht dat door de werkgroep wordt toegekend aan de overwegingen, bepalen samen de sterkte van de aanbeveling. Conform de GRADE-methodiek sluit een lage bewijskracht van conclusies in de systematische literatuuranalyse een sterke aanbeveling niet a priori uit, en zijn bij een hoge bewijskracht ook zwakke aanbevelingen mogelijk (Agoritsas, 2017; Neumann, 2016). De sterkte van de aanbeveling wordt altijd bepaald door weging van alle relevante argumenten tezamen. De werkgroep heeft bij elke aanbeveling opgenomen hoe zij tot de richting en sterkte van de aanbeveling zijn gekomen.

In de GRADE-methodiek wordt onderscheid gemaakt tussen sterke en zwakke (of conditionele) aanbevelingen. De sterkte van een aanbeveling verwijst naar de mate van zekerheid dat de voordelen van de interventie opwegen tegen de nadelen (of vice versa), gezien over het hele spectrum van patiënten waarvoor de aanbeveling is bedoeld. De sterkte van een aanbeveling heeft duidelijke implicaties voor patiënten, behandelaars en beleidsmakers (zie onderstaande tabel). Een aanbeveling is geen dictaat, zelfs een sterke aanbeveling gebaseerd op bewijs van hoge kwaliteit (GRADE gradering HOOG) zal niet altijd van toepassing zijn, onder alle mogelijke omstandigheden en voor elke individuele patiënt.

Implicaties van sterke en zwakke aanbevelingen voor verschillende richtlijngebruikers		
	Sterke aanbeveling	*Zwakke (conditionele) aanbeveling*
Voor patiënten	De meeste patiënten zouden de aanbevolen interventie of aanpak kiezen en slechts een klein aantal niet.	Een aanzienlijk deel van de patiënten zouden de aanbevolen interventie of aanpak kiezen, maar veel patiënten ook niet.
Voor behandelaars	De meeste patiënten zouden de aanbevolen interventie of aanpak moeten ontvangen.	Er zijn meerdere geschikte interventies of aanpakken. De patiënt moet worden ondersteund bij de keuze voor de interventie of aanpak die het beste aansluit bij zijn of haar waarden en voorkeuren.
Voor beleidsmakers	De aanbevolen interventie of aanpak kan worden gezien als standaardbeleid.	Beleidsbepaling vereist uitvoerige discussie met betrokkenheid van veel stakeholders. Er is een grotere kans op lokale beleidsverschillen.

<u>Organisatie van zorg</u>

In de knelpuntenanalyse en bij de ontwikkeling van de richtlijnmodule is expliciet aandacht geweest voor de organisatie van zorg: alle aspecten die randvoorwaardelijk zijn voor het verlenen van zorg (zoals coördinatie, communicatie, (financiële) middelen, mankracht en infrastructuur). Randvoorwaarden die relevant zijn voor het beantwoorden van deze specifieke uitgangsvraag zijn genoemd bij de overwegingen. Meer algemene, overkoepelende, of bijkomende aspecten van de organisatie van zorg worden behandeld in de module Organisatie van zorg.

<u>Commentaar- en autorisatiefase</u>

De conceptrichtlijnmodule werd aan de betrokken (wetenschappelijke) verenigingen en (patiënt) organisaties voorgelegd ter commentaar. De commentaren werden verzameld en besproken met de werkgroep. Naar aanleiding van de commentaren werd de conceptrichtlijnmodule aangepast en definitief vastgesteld door de werkgroep. De definitieve richtlijnmodule werd aan de deelnemende (wetenschappelijke) verenigingen en (patiënt) organisaties voorgelegd voor autorisatie en door hen geautoriseerd dan wel geaccordeerd.

Literatuur

Agoritsas T, Merglen A, Heen AF, Kristiansen A, Neumann I, Brito JP, Brignardello-Petersen R, Alexander PE, Rind DM, Vandvik PO, Guyatt GH. UpToDate adherence to GRADE criteria for strong recommendations: an analytical survey. BMJ Open. 2017 Nov 16;7(11):e018593. doi: 10.1136/bmjopen-2017-018593. PubMed PMID: 29150475; PubMed Central PMCID: PMC5701989.

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Brouwers MC, Kho ME, Browman GP, Burgers JS, Cluzeau F, Feder G, Fervers B, Graham ID, Grimshaw J, Hanna SE, Littlejohns P, Makarski J, Zitzelsberger L; AGREE Next Steps Consortium. AGREE II: advancing guideline development, reporting and evaluation in health care. CMAJ. 2010 Dec 14;182(18):E839-42. doi: 10.1503/cmaj.090449. Epub 2010 Jul 5. Review. PubMed PMID: 20603348; PubMed Central PMCID: PMC3001530.

Hultcrantz M, Rind D, Akl EA, Treweek S, Mustafa RA, Iorio A, Alper BS, Meerpohl JJ, Murad MH, Ansari MT, Katikireddi SV, Östlund P, Tranæus S, Christensen R, Gartlehner G, Brozek J, Izcovich A, Schünemann H, Guyatt G. The GRADE Working Group clarifies the construct of certainty of evidence. J Clin Epidemiol. 2017 Jul;87:4-13. doi: 10.1016/j.jclinepi.2017.05.006. Epub 2017 May 18. PubMed PMID: 28529184; PubMed Central PMCID: PMC6542664.

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Neumann I, Santesso N, Akl EA, Rind DM, Vandvik PO, Alonso-Coello P, Agoritsas T, Mustafa RA, Alexander PE, Schünemann H, Guyatt GH. A guide for health professionals to interpret and use recommendations in guidelines developed with the GRADE approach. J Clin Epidemiol. 2016 Apr;72:45-55. doi: 10.1016/j.jclinepi.2015.11.017. Epub 2016 Jan 6. Review. PubMed PMID: 26772609.

Schünemann H, Brożek J, Guyatt G, et al. GRADE handbook for grading quality of evidence and strength of recommendations. Updated October 2013. The GRADE Working Group, 2013. Available from http://gdt.guidelinedevelopment.org/central_prod/_design/client/handbook/handbook.html.

Module 1 Diagnostiek traumatisch complexe voetletsels

De module 'diagnostiek traumatisch complexe voetletsels' bestaat uit de volgende submodules:

- Belaste voetfoto bij complexe voetletsels
- CT of MRI bij complexe voetletsels

Module 1a Belaste voetfoto bij complexe voetletsels

Uitgangsvraag

Wat is de meest aangewezen diagnostiek bij complexe voetletsels (talus, calcaneus, Chopart, Lisfranc) met het oog op het niet missen van letsels en het instellen van de behandeling?

De uitgangsvraag omvat de volgende deelvragen:

1. Wat is de toegevoegde waarde van een belaste voetfoto (x-stress-voet/enkel) bij patiënten verdacht van complex voetletsel (talus, calcaneus, Chopart of Lisfranc)?
2. Wat is de toegevoegde waarde van een CT of MRI bij patiënten verdacht van complex voetletsel (talus, calcaneus, Chopart of Lisfranc)? (zie module 'CT of MRI bij complex voetletsel' [hier wordt een hyperlink ingevoegd zodra de richtlijn wordt gepubliceerd op de richtlijnendatabase])

Inleiding

Complexe voetletsels worden tijdens de acute presentatie vaak gemist met als gevolg uitgestelde behandelingen en slechtere outcome. De mogelijkheden en toepassing van verschillende diagnostische modaliteiten is vaak per ziekenhuis verschillend. Het is onduidelijk wat de beste diagnostiek is om in te zetten en wat de indicaties hiervoor zijn. Hierbij kan men denken aan een CT of MRI maar ook aan een aanvullende belaste voetfoto,

Ernstige letsels zijn vaak het resultaat van hoog energetisch trauma zoals verkeersongelukken, val van grote hoogte of direct crush letsel. Laag energetisch trauma's hebben daarentegen vaak subtiel letsel tot gevolg. Met name de subtiele (ligamentaire) letsels zorgen voor een diagnostische uitdaging vanwege de suggestie dat deze letsels soms enkel op belaste opnames te onderkennen zijn. Op dit moment is er geen consensus wat de beste beeldvorming is voor met name subtiele letsels.

Search and select

A systematic review of the literature was performed to answer the following question:
What is the diagnostic accuracy of an additional weight bearing foot x-ray, compared to a non-weight bearing foot x-ray only in patients with a suspected traumatic foot injury (talus, calcaneus, Chopart or Lisfranc)?

P = Patients with acute traumatic foot injury and suspected of talus, calcaneus, Chopart or Lisfranc injury

I = X-foot/ankle (non-weight bearing) + X-stress-foot/ankle (weight bearing)

C = X-foot/ankle (non-weight bearing)

R = Operative findings or CT (for osseous injuries)/MRI (for ligamentous injuries)

O = 1. Radiodiagnostic accuracy: Sensitivity and specificity of the diagnosis of the injuries (talus, calcaneus, Chopart or Lisfranc), negative predictive value, positive predictive value.

= 2. Clinical management: morbidity, change in clinical management, time saving

Relevant outcome measures

The guideline development group considered change in clinical management, sensitivity and false negatives as critical outcome measures for decision making; and specificity and false positives as important outcome measures for decision making.

A priori, the guideline development group did not define the outcome measures listed above but used the definitions used in the studies.

For the outcome 'change in clinical management' the guideline development group considered a RR <0.80 and RR >1.25 (dichotomous outcomes) and a difference of 25% (continuous outcomes) as a minimal clinically (patient) important difference. For diagnostic accuracy (sensitivity, specificity, negative predictive value and positive predictive value), a difference of 10% was considered clinically relevant.

Search and select (Methods)

The databases Medline (via OVID) and Embase (via Embase.com) were searched with relevant search terms until the 11th of January 2023. The detailed search strategy is depicted under the tab Methods. Relevant search terms were used to search for systematic reviews, RCTs, observational and other studies about diagnosing foot injuries. The search resulted in 1312 unique hits.

Studies were selected based on the following criteria:

- Trials in patients with suspected or diagnosed foot injury
- Trials comparing weight bearing and non-weight bearing radiographs with CT/MRI
- Trials reporting diagnostic accuracy of the diagnostic modalities for detecting fractures or additional injuries

Twenty-eight studies were initially selected based on title and abstract screening. After reading the full text, 27 studies were excluded (see the table with reasons for exclusion under the tab Methods), and one study was included.

Results

One study was included in the analysis of the literature. Important study characteristics and results are summarized in the evidence tables. The assessment of the risk of bias is summarized in the risk of bias tables.

Summary of literature

Description of studies

Almeida (2018) retrospectively reviewed the radiology database to assess the sensitivity of weight bearing (WB) and non-WB radiographs for Chopart fractures, and to assess the sensitivity of radiographs to detect additional fractures. The radiology database was queried for radiology reports on Chopart fractures. Inclusion criteria were: diagnosis of Chopart fracture and imaging work-up including at least one radiograph (WB or non-WB) and subsequent cross-sectional image (CT or MRI). In total, 140 patients were diagnosed with a Chopart fracturen, of which 129 underwent non-WB radiographs and 9 WB-radiographs. The radiographs of 108 patients met the inclusion criteria. Mean age of these patients was 46.4 years, and 67.6% was male. High energy trauma mechanisms were reported in 55.6% of the patients. The indications for either a WB or non-WB radiograph were not reported. Diagnoses that were made based on the WB and non-WB radiographs (index test) were compared to diagnoses based upon the CT or MRI (reference test). A diagnosis of Chopart fracture was based on the following criteria: presence of a radiology report (radiograph, CT, or MR) showing a midfoot fracture extending to the calcaneocuboid or talonavicular joints and documentation of conservative or surgical treatment. The number of correct Chopart fracture diagnoses by radiograph were reported. Additionally, the number of additional fractures detected by either radiography or

CT/MRI were compared. Since only patients with a diagnosis of Chopart injuries were included, it is not possible to calculate specificity.

Results

Diagnostic accuracy - sensitivity

Data on the value of the addition of a weight bearing (WB) radiograph combined with a non-WB radiograph and CT-imaging was only available for two patients. Therefore, also results of non-WB radiograph compared to CT/MRI and WB radiograph compared to CT/MRI were included in the summary of literature. The guideline development group considered this information relevant for answering the search question.

Almeida (2018) reported that, when compared with CT/MRI, the sensitivity of WB radiographs for detecting **Chopart fractures** was 60% (3/5). The sensitivity of non-WB radiography was 68.6% (72/105).

The sensitivity of WB radiographs for detecting additional fractures was 100% (2/2 patients). The sensitivity of non-WB radiographs for detecting additional fractures was 41.6% (15/36).

Data on other diagnostic parameters (specificity, positive predictive value, negative predictive value) was not reported in the included studies.

Clinical management

No study reported the outcome (change in) clinical management after using a weight bearing radiograph in the acute diagnostic phase of traumatic foot injuries.

Level of evidence of the literature

The level of evidence regarding the outcome measure **diagnostic accuracy** was retrieved from observational studies and therefore started high. The level of evidence was downgraded by 3 levels because of study limitations including uncertainties in the patient selection and indications for the diagnostic modalities (-1 risk of bias) and low number of included patients (-2 imprecision). The final level of evidence was graded 'very low'.

The level of evidence regarding the outcome **clinical management** could not be graded as it was not reported in the included studies.

Conclusions

Diagnostic accuracy

Very low GRADE	The evidence is very uncertain about the diagnostic accuracy of a weight bearing radiograph, compared to a non-weight bearing radiograph for detecting traumatic foot injuries in the acute diagnostic phase. *Source: Almeida, 2018*

Clinical management

-GRADE	No evidence was found regarding the effects on clinical management of using a weight bearing radiograph in the acute diagnostic phase, compared to a non-weight bearing radiograph for detecting traumatic foot injuries *Source: -*

Overwegingen – van bewijs naar aanbeveling

Voor- en nadelen van de interventie en de kwaliteit van het bewijs

Er is literatuuronderzoek verricht naar de plaats van een belaste voetfoto in het acute diagnostisch traject bij complexe voetletsels. In dit literatuuronderzoek werd slechts 1 retrospectieve studie gevonden. In deze studie werd de diagnostische accuratesse van een onbelaste voetopname vergeleken met die van een belaste voetopname op zichzelf staand (dus niet additioneel aan een onbelaste voetfoto) bij patiënten met een bewezen Chopart letsel. Vanwege beperkingen in de studie opzet (risico op bias) en de kleine studiepopulatie (maar 5 belaste voetopnames) kan er geen betrouwbaar antwoord worden gegeven op de onderzoeksvraag (GRADE zeer laag). In het literatuuronderzoek zijn er geen studies gevonden die de toegevoegde waarde van een belaste voetopname analyseren bij patiënten met een talusfractuur, calcaneusfractuur of Lisfranc fractuur in het acute stadium.

Op basis van de gevonden literatuur kunnen er dus geen conclusies worden getrokken over de toegevoegde waarde van een belaste voetfoto in de acute diagnostische fase bij complexe voetletsels. Hierover bestaat een kennislacune.

Mogelijk is er een rol weggelegd voor de belaste voetfoto bij patiënten die een klinische verdenking hebben op uitsluitend ligamentair letsel. De **Bruijn (2022)** rapporteerde het gebruik van belaste- en onbelaste voetfoto's bij patiënten met uitsluitend ligamentair Lisfranc letsel. De studie rapporteerde geen diagnostische accuratesse maar gaf wel inzicht in een aantal diagnostische parameters bij zowel de belaste als onbelaste voetfoto. De Bruijn (2022) rapporteerd dat in patiënten met Lisfranc letsel die chirurgie ondergingen (n = 26):

- *"de gemiddelde C1M2 afstand op een belaste foto 3.49 mm ± 1.53 (95% CB: 2.87 tot 4.11) was, vergeleken met, 1.72 mm ± 1.10 (95% BI 1.28 tot 2.16) op een onbelaste foto. De gerapporteerde mean difference was (MD) 1.77 mm (95% BI: 1.26 tot 2.29)".*
- *"de gemiddelde C2M2 alignment op een belaste foto 1.88 mm ± 1.04 (95% BI: 1.46 tot 2.30) was, vergelijken met 0.35 mm ± 0.94 (95% BI -0.20 tot 0.73) bij een onbelaste foto. De gerapporteerdeMD was 1.58 mm (95% BI 1.15 tot 1.91).*

De studie toont aan dat de interval tussen het cuneiforme mediale en de basis van metatarsale 2 toeneemt bij een belaste voetopname. In 13 van de 26 gevallen (50%) is de interval bij een onbelaste opname > 2 mm en dus diagnostisch voor ligamentair Lisfranc letsel. Bij de belaste opname is in 24 van de 26 gevallen (92%) de interval > 2 mm.

Kennely (2019) deed ook retrospectief onderzoek naar belaste en onbelaste voetfoto's voor subtiele Lisfranc letsels. Een selecte groep patiënten werd geïncludeerd (n = 117); patiënten met een dislocatie en patiënten die al met gips behandeld waren, werden geëxcludeerd. Vanwege deze selecte patiëntengroep is deze studie niet geïncludeerd in de literatuursamenvatting. Resultaten van de primaire belaste voetfoto, werden vergeleken met resultaten van de CT-scan. In totaal werd er bij 24 patiënten op de belaste voetfoto een Lisfranc letsel geïdentificeerd. Vervolgens werd bij 54% van deze groep de CT-scan beoordeeld als 'negatief' of 'dubbelzinnig' voor Lisfranc letsel. Van de

patiënten die een negatieve of dubbelzinnige belaste voetfoto hadden, had 12% procent vervolgens een positieve CT. De auteurs concluderen dat wanneer je enkel op basis van CT een diagnose stelt, een groot deel van de letsels gemist wordt en dat een CT weinig additionele informatie geeft bij patiënten met een positieve belaste voetfoto. Echter moeten deze resultaten wel met zorg worden geïnterpreteerd aangezien ze afkomstig zijn uit een selecte patiëntengroep.

Waarden en voorkeuren van patiënten (en evt. hun verzorgers)

De werkgroep is van mening dat het maken van een belaste voetopname in het acute stadium (enkele uren na het trauma) zeer moeilijk praktisch uitvoerbaar is. Vanwege de pijnklachten die de patiënt ervaart door het trauma is het niet vaak mogelijk een goede belaste voetopname te vervaardigen in het acute stadium. De werkgroep ziet wel mogelijkheden voor het maken van een belaste opname enkele dagen, tot 2 weken na het trauma. Deze belaste opname van beide voeten kan instabiliteit in het Lisfranc gewricht aantonen en dus zorgen dat een adequate behandeling sneller wordt ingesteld.

Kosten (middelenbeslag)

De werkgroep is niet op de hoogte van studies die de kosten-effectiviteit van een belaste voetopname analyseren. Naar verwachting spelen kostenoverwegingen geen rol bij de keuze voor het maken van een (on)belaste voetfoto.

Aanvaardbaarheid, haalbaarheid en implementatie

De richtlijnwerkgroep is van mening dat het maken van een belaste voetopname in het acute stadium (enkele uren na het trauma) zeer moeilijk praktisch uitvoerbaar is, mede vanwege de pijnklachten die de patiënt ervaart. Het (standaard) uitvoeren van een belaste voetfoto in de acute fase behoort niet tot de huidige praktijk. De richtlijn werkgroep heeft daarom bedenkingen bij de praktische haalbaarheid en aanvaardbaarheid. De richtlijnwerkgroep ziet wel de mogelijkheid om bij de verdenking op ligamentair letsel in Lisfranc een aanvullende belaste opname van beide voeten te maken. Bij het aanvragen van deze opnames is het van belang om de radioloog te voorzien van adequate klinische gegevens en een eenduidige vraagstelling.

Aanbevelingen

Rationale van de aanbeveling: weging van argumenten voor en tegen de diagnostische procedure

In de literatuur is geen bewijs gevonden voor de toegevoegde waarde van een belaste voetopname bij patiënten met verdenking op complex voetletsel in het acute stadium. De belaste voetfoto kent, met name in het acute stadium, wel nadelen voor de patiënt. Een belaste voetfoto kan namelijk veel pijnklachten geven. Derhalve is de richtlijnwerkgroep van mening dat er op dit moment geen rol is weggelegd voor een belaste voetopname in de acute diagnostische fase.

De richtlijnwerkgroep ziet wel een mogelijk toegevoegde waarde voor de belaste voetopname van beide voeten bij patiënten met een klinische verdenking op geïsoleerd ligamentair Lisfranc letsel. Het vervaardigen van dit onderzoek kan instabiliteit aantonen in het Lisfranc gewricht en zo klinische consequenties hebben voor de patiënt. Hierbij moet worden aangetekend dat het hier gaat om een specifieke kleine patiëntengroep gezien de relatieve zeldzaamheid van geïsoleerd ligamentair Lisfranc letsel.

Maak geen belaste voetopname in de acute diagnostische fase (op de SEH). Overweeg het maken van een belaste voetopname van beide voeten bij de verdenking op geïsoleerd ligamentair Lisfranc letsel, binnen één a twee weken poliklinisch.

Literatuur

Almeida RR, Mansouri M, Tso DK, Johnson AH, Lev MH, Singh AK, Flores EJ. The added value of cross-sectional imaging in the detection of additional radiographically occult fractures in the setting of a Chopart fracture. Emerg Radiol. 2018 Oct;25(5):513-520. doi: 10.1007/s10140-018-1615-x. Epub 2018 Jun 6. PMID: 29876712.

De Bruijn J, Hagemeijer NC, Rikken QGH, Husseini JS, Saengsin J, Kerkhoffs GMMJ, Waryasz G, Guss D, DiGiovanni CW. Lisfranc injury: Refined diagnostic methodology using weight bearing and non-weight bearing radiographs. Injury. 2022 Jun;53(6):2318-2325. doi: 10.1016/j.injury.2022.02.040. Epub 2022 Feb 19. PMID: 35227511.

Kennelly H, Klaassen K, Heitman D, Youngberg R, Platt SR. Utility of weight bearing radiographs compared to computed tomography scan for the diagnosis of subtle Lisfranc injuries in the emergency setting. Emerg Med Australas. 2019 Oct;31(5):741-744. doi: 10.1111/1742-6723.13237. Epub 2019 Feb 19. PMID: 30780193.

Bijlagen bij module diagnostiek

- Stroomschema diagnostiek complexe voetletsels (bijlage)

Evidencetabellen module diagnostiek complexe voetletsel (belaste voetfoto)

Research question: UV1 diagnostiek – toegevoegde waarde van een belaste voetfoto

Study reference	Study characteristics	Patient characteristics	Index test (test of interest)	Reference test	Follow-up	Outcome measures and effect size	Comments
Almeida 2018	Type of study[1]: Retrospective review of database Setting and country: Review of *radiology database*, USA Funding and conflicts of interest: Some of the authors are a consultant for companies delivery medical technology	Inclusion criteria: - Diagnosis of Chopart fracture - At least one radiograph (WB and non-WB) and subsequent CT or MRI Exclusion criteria: - Radiology reports not mentioning fractures or described fractures without extension to the Chopart joints	Describe index test: Weightbearing radiograph N = 5 Comparator test[2]: Non-weight bearing radiograph N = 105	Describe reference test[3]: CT/MRI Cut-off point(s):	Time between the index test en reference test: Unclear For how many participants were no complete outcome data available? Not all patients received radiograph and CT/MRI. These patients were not included in the analysis	Missed diagnoses: *WB x-ray:* 2/5 (40%) *Non-WB X-ray:* 33/105 (31.4%) Additional fractures (missed) *WB x-ray:* 2/2 (100%) *Non-WB X-ray:* 15/36 (42.9%)	The authors concluded that: *"In the setting of a Chopart fracture, CT or MRI can add significant value in the detection of additional ankle or midfoot fractures, irrespective of the energy of trauma"*

[1] In geval van een case-control design moeten de patiëntkarakteristieken per groep (cases en controls) worden uitgewerkt. NB; case control studies zullen de accuratesse overschatten (Lijmer et al., 1999)

[2] Comparator test is vergelijkbaar met de C uit de PICO van een interventievraag. Er kunnen ook meerdere tests worden vergeleken. Voeg die toe als comparator test 2 etc. Let op: de comparator test kan nooit de referentiestandaard zijn.

[3] De referentiestandaard is de test waarmee definitief wordt aangetoond of iemand al dan niet ziek is. Idealiter is de referentiestandaard de Gouden standaard (100% sensitief en 100% specifiek). Let op! dit is niet de "comparison test/index 2".

[4] Beschrijf de statistische parameters voor de vergelijking van de indextest(en) met de referentietest, en voor de vergelijking tussen de indextesten onderling (als er twee of meer indextesten worden vergeleken).

		N= 108 Prevalence: unclear Mean age ± SD: 46.4 Sex: 67.6% M Other important characteristics: High-energy trauma: 55.6%					

Risk of bias assessment diagnostic accuracy studies (QUADAS II, 2011)

Study reference	Patient selection	Index test	Reference standard	Flow and timing	Comments with respect to applicability
Almeida 2018	Was a consecutive or random sample of patients enrolled? Probably yes Was a case-control design avoided? Yes Did the study avoid inappropriate exclusions? Yes Unclear why patients were either assigned to WB or non-WB photo	Were the index test results interpreted without knowledge of the results of the reference standard? Unclear If a threshold was used, was it pre-specified? Not applicable	Is the reference standard likely to correctly classify the target condition? No; CT/MRI probably don't diagnose 100% correctly Were the reference standard results interpreted without knowledge of the results of the index test? Unclear	Was there an appropriate interval between index test(s) and reference standard? Unclear Did all patients receive a reference standard? Yes Did patients receive the same reference standard? Yes, CT or MRI Were all patients included in the analysis? Yes	Are there concerns that the included patients do not match the review question? Since patients with a diagnosis were included, specificity can't be assessed Are there concerns that the index test, its conduct, or interpretation differ from the review question? No Are there concerns that the target condition as defined by the reference standard does not match the review question? No

Study reference	Patient selection	Index test	Reference standard	Flow and timing	Comments with respect to applicability
	CONCLUSION: Could the selection of patients have introduced bias? **RISK: Low**	CONCLUSION: Could the conduct or interpretation of the index test have introduced bias? **RISK: Unclear**	CONCLUSION: Could the reference standard, its conduct, or its interpretation have introduced bias? **RISK: Unclear**	CONCLUSION Could the patient flow have introduced bias? **RISK: Low**	

Table of excluded studies

Reference	Reason for exclusion
Baker JC, Hoover EG, Hillen TJ, Smith MV, Wright RW, Rubin DA. Subradiographic Foot and Ankle Fractures and Bone Contusions Detected by MRI in Elite Ice Hockey Players. Am J Sports Med. 2016 May;44(5):1317-23. doi: 10.1177/0363546515626181. Epub 2016 Feb 17. PMID: 26888876.	wrong population: ankle/hindfoot fractures, wrong outcome
Dale JD, Ha AS, Chew FS. Update on talar fracture patterns: a large level I trauma center study. AJR Am J Roentgenol. 2013 Nov;201(5):1087-92. doi: 10.2214/AJR.12.9918. PMID: 24147480.	Study on CT/MRI
David HG. Value of radiographs in managing common foot injuries. BMJ. 1989 Jun 3;298(6686):1491-2. doi: 10.1136/bmj.298.6686.1492. PMID: 2569334; PMCID: PMC1836682.	Wrong design; descriptive radiograph study
Davis, E. T. (2006). Lisfranc joint injuries. Trauma, 8(4), 225-231.	Wrong design: narrative review (non-systematic)
De Bruijn J, Hagemeijer NC, Rikken QGH, Husseini JS, Saengsin J, Kerkhoffs GMMJ, Waryasz G, Guss D, DiGiovanni CW. Lisfranc injury: Refined diagnostic methodology using weight bearing and non-weight bearing radiographs. Injury. 2022 Jun;53(6):2318-2325. doi: 10.1016/j.injury.2022.02.040. Epub 2022 Feb 19. PMID: 35227511.	Comparison WB with non-WB
Essa A, Levi A, Ron TG, Ner EB, Finestone AS, Tamir E. The role of three dimension computed tomography in Lisfranc injury diagnosis. Injury. 2022 Oct;53(10):3530-3534. doi: 10.1016/j.injury.2022.07.032. Epub 2022 Jul 20. PMID: 35927069.	Study on 2D-CT. This diagnostic modality is not relevant for the research question
Grunz JP, Pennig L, Fieber T, Gietzen CH, Heidenreich JF, Huflage H, Gruschwitz P, Kuhl PJ, Petritsch B, Kosmala A, Bley TA, Gassenmaier T. Twin robotic x-ray system in small bone and joint trauma: impact of cone-beam computed tomography on treatment decisions. Eur Radiol. 2021 Jun;31(6):3600-3609. doi: 10.1007/s00330-020-07563-5. Epub 2020 Dec 5. PMID: 33280057; PMCID: PMC8128787.	Wrong intervention: Cone Beam CT
Gupta RT, Wadhwa RP, Learch TJ, Herwick SM. Lisfranc injury: imaging findings for this important but often-missed diagnosis. Curr Probl Diagn Radiol. 2008 May-Jun;37(3):115-26. doi: 10.1067/j.cpradiol.2007.08.012. PMID: 18436111.	Wrong design: narrative review (non-systematic)
Haapamaki V, Kiuru M, Koskinen S. Lisfranc fracture-dislocation in patients with multiple trauma: diagnosis with multidetector computed tomography. Foot Ankle Int. 2004 Sep;25(9):614-9. doi: 10.1177/107110070402500903. PMID: 15563381. – 2	Study on CT/MRI
Haapamaki VV, Kiuru MJ, Koskinen SK. Ankle and foot injuries: analysis of MDCT findings. AJR Am J Roentgenol. 2004 Sep;183(3):615-22. doi: 10.2214/ajr.183.3.1830615. PMID: 15333345.	Study on CT/MRI
Hirschmann A, Walter WR, Alaia EF, Garwood E, Amsler F, Rosenberg ZS. Acute Fracture of the Anterior Process of Calcaneus: Does It Herald a More Advanced Injury to Chopart Joint? AJR Am J Roentgenol. 2018 May;210(5):1123-1130. doi: 10.2214/AJR.17.18678. Epub 2018 Mar 23. PMID: 29570372.	Study on CT/MRI
Ho K, Connell DG, Janzen DL, Grunfeld A, Clark TW. Using tomography to diagnose occult ankle fractures. Ann Emerg Med. 1996 May;27(5):600-5. doi: 10.1016/s0196-0644(96)70163-4. PMID: 8629781.	Wrong population: ankle fractures
Kennelly H, Klaassen K, Heitman D, Youngberg R, Platt SR. Utility of weight bearing radiographs compared to computed tomography scan for the diagnosis of subtle Lisfranc injuries in the emergency setting. Emerg Med Australas. 2019 Oct;31(5):741-744. doi: 10.1111/1742-6723.13237. Epub 2019 Feb 19. PMID: 30780193.	Only patients with subtle Lisfranc injuries were included. Patients with a frank dislocation and patients treatment with cast immobilisation

	were excluded from the studypopulation.
Kitsukawa K, Hirano T, Niki H, Tachizawa N, Mimura H. The Diagnostic Accuracy of MRI to Evaluate Acute Lisfranc Joint Injuries: Comparison With Direct Operative Observations. Foot Ankle Orthop. 2022 Jan 21;7(1):24730114211069080. doi: 10.1177/24730114211069080. PMID: 35097492; PMCID: PMC8792696.	Wrong comparison: CT/MRI compared to surgical findings
Kumar V, Hameed A, Bhattacharya R, McMurtry I. Role of computerised tomography in management of intra-articular fractures of the os calcis. Int Orthop. 2006 Apr;30(2):110-2. doi: 10.1007/s00264-005-0044-0. Epub 2006 Feb 23. PMID: 16496146; PMCID: PMC2532078.	Study on the clinical decisions that based on CT/Radiograph compared to decisions in the were made in the actual situation
Matuszak SA, Baker EA, Stewart CM, Fortin PT. Missed peritalar injuries: an analysis of factors in cases of known delayed diagnosis and methods for improving identification. Foot Ankle Spec. 2014 Oct;7(5):363-71. doi: 10.1177/1938640014537302. Epub 2014 Jul 17. PMID: 25037956.	wrong outcome: patient characteristics of patients with missed injuries
Miller JR, Dunn KW, Ciliberti LJ Jr, Eldridge SW, Reed LD. Diagnostic Value of Early Magnetic Resonance Imaging After Acute Lateral Ankle Injury. J Foot Ankle Surg. 2017 Nov-Dec;56(6):1143-1146. doi: 10.1053/j.jfas.2017.05.011. PMID: 29079231.	Wrong population: ankle fractures
Ponkilainen VT, Partio N, Salonen EE, Riuttanen A, Luoma EL, Kask G, Laine HJ, Mäenpää H, Päiväniemi O, Mattila VM, Haapasalo HH. Inter- and intraobserver reliability of non-weight bearing foot radiographs compared with CT in Lisfranc injuries. Arch Orthop Trauma Surg. 2020 Oct;140(10):1423-1429. doi: 10.1007/s00402-020-03391-w. Epub 2020 Mar 5. PMID: 32140830; PMCID: PMC7505866.	Study on CT/MRI
Preidler KW, Peicha G, Lajtai G, Seibert FJ, Fock C, Szolar DM, Raith H. Conventional radiography, CT, and MR imaging in patients with hyperflexion injuries of the foot: diagnostic accuracy in the detection of bony and ligamentous changes. AJR Am J Roentgenol. 1999 Dec;173(6):1673-7. doi: 10.2214/ajr.173.6.10584818. PMID: 10584818.	Study on CT/MRI
Rankine JJ, Nicholas CM, Wells G, Barron DA. The diagnostic accuracy of radiographs in Lisfranc injury and the potential value of a craniocaudal projection. AJR Am J Roentgenol. 2012 Apr;198(4):W365-9. doi: 10.2214/AJR.11.7222. PMID: 22451574.	Study on CT/MRI
Rikken QGH, Hagemeijer NC, De Bruijn J, Kaiser P, Kerkhoffs GMMJ, DiGiovanni CW, Guss D. Novel values in the radiographic diagnosis of ligamentous Lisfranc injuries. Injury. 2022 Jun;53(6):2326-2332. doi: 10.1016/j.injury.2022.02.044. Epub 2022 Feb 22. PMID: 35279293.	wrong comparator: patients with hallus valgus deformity
Seo DK, Lee HS, Lee KW, Lee SK, Kim SB. Nonweight bearing Radiographs in Patients With a Subtle Lisfranc Injury. Foot Ankle Int. 2017 Oct;38(10):1120-1125. doi: 10.1177/1071100717717220. Epub 2017 Jul 14. PMID: 28708955.	Wrong comparison: Radiograph compared to surgical findings
Sherief TI, Mucci B, Greiss M. Lisfranc injury: how frequently does it get missed? And how can we improve? Injury. 2007 Jul;38(7):856-60. doi: 10.1016/j.injury.2006.10.002. Epub 2007 Jan 9. PMID: 17214988.	Wrong comparison: Radiograph compared to surgical findings
Shim DW, Choi E, Park YC, Shin SC, Lee JW, Sung SY. Comparing bilateral feet computed tomography scans can improve surgical decision making for subtle Lisfranc injury. Arch Orthop Trauma Surg. 2022 Dec;142(12):3705-3714. doi: 10.1007/s00402-021-04182-7. Epub 2021 Oct 1. PMID: 34599354.	No full tekst available
Walter WR, Hirschmann A, Alaia EF, Garwood ER, Rosenberg ZS. JOURNAL CLUB: MRI Evaluation of Midtarsal (Chopart) Sprain in the Setting of Acute Ankle Injury. AJR Am J Roentgenol. 2018 Feb;210(2):386-395. doi: 10.2214/AJR.17.18503. Epub 2017 Nov 7. PMID: 29112474.	wrong outcome: prevalence of injury and inter-rate reliability

Xi Y, Hu DJ, Yao WW, Li M. [Classification and imaging diagnosis of Lisfranc joint injuries]. Zhonghua Yi Xue Za Zhi. 2016 Jul 5;96(25):1976-81. Chinese. doi: 10.3760/cma.j.issn.0376-2491.2016.25.004. PMID: 27470953.	Article in Chinese
Yammine K, Fathi Y. Ankle "sprains" during sport activities with normal radiographs: Incidence of associated bone and tendon injuries on MRI findings and its clinical impact. Foot (Edinb). 2011 Dec;21(4):176-8. doi: 10.1016/j.foot.2011.05.002. PMID: 21856145.	Wrong population: ankle fractures

Zoekverantwoording bij UV1 diagnostiek

Algemene informatie

Cluster/richtlijn: NVvH Traumatisch Complexe Voetletsels	
Uitgangsvraag/modules: UV1 diagnostiek: Wat is de meest aangewezen diagnostiek bij complexe voetletsels (talus, calcaneus, Chopart, lifranc) met het oog op het niet missen van letsels en het instellen van de behandeling	
Database(s): Ovid/Medline, Embase.com	Datum: 11 januari 2023
Periode: geen restrictie	Talen: geen restrictie
Literatuurspecialist: Alies van der Wal	
BMI-zoekblokken: voor verschillende opdrachten wordt (deels) gebruik gemaakt van de zoekblokken van BMI-Online https://blocks.bmi-online.nl/ Bij gebruikmaking van een volledig zoekblok zal naar de betreffende link op de website worden verwezen.	
Toelichting: Voor deze vraag is gezocht op de elementen: - voetletsels - diagnostiek (beeldvorming) De sleutelartikelen worden gevonden met deze search. Termen m.b.t. de enkel buiten de search gehouden. Vanwege de grote aantallen alleen gezocht met major trefwoorden en in de velden titel en abstract.	

Zoekopbrengst

	EMBASE	**OVID/MEDLINE**	**Ontdubbeld**
SRs	27	30	37
RCT (sensitief filter)	108	87	149
Observationele studies	353	470	573
Overig	360	375	553
Totaal	848	962	**1312**

Zoekstrategie

Embase.com

No.	**Query**	**Results**
#19	#10 NOT (#16 OR #17 OR #18) = overig	360
#18	#10 AND #15 NOT (#16 OR #17) = observationeel	353

#17	#10 AND #12 NOT #16 = RCT	108
#16	#10 AND #11 = SR	27
#15	#13 OR #14	15551918
#14	'case control study'/de OR 'comparative study'/exp OR 'control group'/de OR 'controlled study'/de OR 'controlled clinical trial'/de OR 'crossover procedure'/de OR 'double blind procedure'/de OR 'phase 2 clinical trial'/de OR 'phase 3 clinical trial'/de OR 'phase 4 clinical trial'/de OR 'pretest posttest design'/de OR 'pretest posttest control group design'/de OR 'quasi experimental study'/de OR 'single blind procedure'/de OR 'triple blind procedure'/de OR (((control OR controlled) NEAR/6 trial):ti,ab,kw) OR (((control OR controlled) NEAR/6 (study OR studies)):ti,ab,kw) OR (((control OR controlled) NEAR/1 active):ti,ab,kw) OR 'open label*':ti,ab,kw OR (((double OR two OR three OR multi OR trial) NEAR/1 (arm OR arms)):ti,ab,kw) OR ((allocat* NEAR/10 (arm OR arms)):ti,ab,kw) OR placebo*:ti,ab,kw OR 'sham-control*':ti,ab,kw OR (((single OR double OR triple OR assessor) NEAR/1 (blind* OR masked)):ti,ab,kw) OR nonrandom*:ti,ab,kw OR 'non-random*':ti,ab,kw OR 'quasi-experiment*':ti,ab,kw OR crossover:ti,ab,kw OR 'cross over':ti,ab,kw OR 'parallel group*':ti,ab,kw OR 'factorial trial':ti,ab,kw OR ((phase NEAR/5 (study OR trial)):ti,ab,kw) OR ((case* NEAR/6 (matched OR control*)):ti,ab,kw) OR ((match* NEAR/6 (pair OR pairs OR cohort* OR control* OR group* OR healthy OR age OR sex OR gender OR patient* OR subject* OR participant*)):ti,ab,kw) OR ((propensity NEAR/6 (scor* OR match*)):ti,ab,kw) OR versus:ti OR vs:ti OR compar*:ti OR ((compar* NEAR/1 study):ti,ab,kw) OR (('major clinical study'/de OR 'clinical study'/de OR 'cohort analysis'/de OR 'observational study'/de OR 'cross-sectional study'/de OR 'multicenter study'/de OR 'correlational study'/de OR 'follow up'/de OR cohort*:ti,ab,kw OR 'follow up':ti,ab,kw OR followup:ti,ab,kw OR longitudinal*:ti,ab,kw OR prospective*:ti,ab,kw OR retrospective*:ti,ab,kw OR observational*:ti,ab,kw OR 'cross sectional*':ti,ab,kw OR cross?ectional*:ti,ab,kw OR multicent*:ti,ab,kw OR 'multi-cent*':ti,ab,kw OR consecutive*:ti,ab,kw) AND (group:ti,ab,kw OR groups:ti,ab,kw OR subgroup*:ti,ab,kw OR versus:ti,ab,kw OR vs:ti,ab,kw OR compar*:ti,ab,kw OR 'odds ratio*':ab OR 'relative odds':ab OR 'risk ratio*':ab OR 'relative risk*':ab OR 'rate ratio':ab OR aor:ab OR arr:ab OR rrr:ab OR ((('or' OR 'rr') NEAR/6 ci):ab)))	13761684
#13	'major clinical study'/de OR 'clinical study'/de OR 'case control study'/de OR 'family study'/de OR 'longitudinal study'/de OR 'retrospective study'/de OR 'prospective study'/de OR 'comparative study'/de OR 'cohort analysis'/de OR ((cohort NEAR/1 (study OR studies)):ab,ti) OR (('case control' NEAR/1 (study OR studies)):ab,ti) OR (('follow up' NEAR/1 (study OR studies)):ab,ti) OR (observational NEAR/1 (study OR studies)) OR ((epidemiologic NEAR/1 (study OR studies)):ab,ti) OR (('cross sectional' NEAR/1 (study OR studies)):ab,ti)	6767914
#12	'clinical trial'/exp OR 'randomization'/exp OR 'single blind procedure'/exp OR 'double blind procedure'/exp OR 'crossover procedure'/exp OR 'placebo'/exp OR 'prospective study'/exp OR rct:ab,ti OR random*:ab,ti OR 'single blind':ab,ti OR 'randomised controlled trial':ab,ti OR 'randomized controlled trial'/exp OR placebo*:ab,ti	3302394
#11	'meta analysis'/exp OR 'meta analysis (topic)'/exp OR metaanaly*:ti,ab OR 'meta analy*':ti,ab OR metanaly*:ti,ab OR 'systematic review'/de OR 'cochrane database of systematic reviews'/jt OR prisma:ti,ab OR prospero:ti,ab OR (((systemati* OR scoping OR umbrella OR 'structured literature') NEAR/3 (review* OR overview*)):ti,ab) OR ((systemic* NEAR/1 review*):ti,ab) OR (((systemati* OR literature OR database* OR 'data base*') NEAR/10 search*):ti,ab) OR (((structured OR comprehensive* OR systemic*) NEAR/3 search*):ti,ab) OR (((literature NEAR/3 review*):ti,ab) AND (search*:ti,ab OR database*:ti,ab OR 'data base*':ti,ab)) OR (('data extraction':ti,ab OR 'data source*':ti,ab) AND 'study selection':ti,ab) OR ('search strategy':ti,ab AND 'selection criteria':ti,ab) OR ('data source*':ti,ab AND 'data synthesis':ti,ab) OR medline:ab OR pubmed:ab OR embase:ab OR cochrane:ab OR (((critical OR rapid) NEAR/2 (review* OR overview* OR synthes*)):ti) OR ((((critical* OR rapid*) NEAR/3 (review* OR overview* OR synthes*)):ab) AND (search*:ab OR database*:ab OR 'data base*':ab)) OR metasynthes*:ti,ab OR 'meta synthes*':ti,ab	733409

#10	#8 AND #9	848
#9	'sensitivity and specificity'/de OR sensitivity:ab,ti OR sensitive:ab,ti OR specificity:ab,ti OR 'roc curve':ab,ti OR 'receiver operator':ab,ti OR 'receiver operators':ab,ti OR likelihood:ab,ti OR 'diagnostic error'/exp OR 'diagnostic accuracy'/exp OR 'diagnostic test accuracy study'/exp OR 'inter observer':ab,ti OR 'intra observer':ab,ti OR interobserver:ab,ti OR intraobserver:ab,ti OR validity:ab,ti OR kappa:ab,ti OR reliability:ab,ti OR reproducibility:ab,ti OR ((test NEAR/2 're-test'):ab,ti) OR ((test NEAR/2 'retest'):ab,ti) OR 'reproducibility'/exp OR accuracy:ab,ti OR 'differential diagnosis'/exp OR 'validation study'/de OR 'measurement precision'/exp OR 'diagnostic value'/exp OR 'reliability'/exp OR 'predictive value'/exp OR ppv:ti,ab,kw OR npv:ti,ab,kw OR (((false OR true) NEAR/3 (negative OR positive)):ti,ab)	4631014
#8	#7 NOT ('conference abstract'/it OR 'editorial'/it OR 'letter'/it OR 'note'/it) NOT (('animal'/exp OR 'animal experiment'/exp OR 'animal model'/exp OR 'nonhuman'/exp) NOT 'human'/exp)	4875
#7	#1 AND #6	6027
#6	#2 OR #3 OR #4 OR #5	3957674
#5	'radiodiagnosis'/exp/mj OR 'diagnostic radiology':ti,ab OR 'radio diagnos*':ti,ab OR 'radiodiagnos*':ti,ab OR 'imaging'/exp/mj OR image:ab,ti OR images:ab,ti OR imaging:ab,ti	2433581
#4	'radiography'/exp/mj OR 'x ray*':ti,ab OR xray*:ti,ab OR 'electroradiograph*':ti,ab OR 'radiogram*':ti,ab OR 'radiograph*':ti,ab OR 'radioimaging':ti,ab OR 'radiophotograph*':ti,ab OR 'roentgen*':ti,ab OR rontgen*:ti,ab OR radiotomograph*:ti,ab OR tomograph*:ti,ab OR radiologic*:ti,ab	1804991
#3	'nuclear magnetic resonance imaging'/exp/mj OR 'mri scanner'/exp/mj OR mri:ab,ti OR mris:ab,ti OR nmr:ab,ti OR mra:ab,ti OR mras:ab,ti OR zeugmatograph*:ab,ti OR 'mr tomograph*':ab,ti OR 'proton spin':ab,ti OR ((magneti*:ab,ti OR 'chemical shift':ab,ti) AND (image:ab,ti OR images:ab,ti OR imaging:ab,ti)) OR fmri:ab,ti OR fmris:ab,ti OR 'mr imag*':ab,ti	1075047
#2	'computer assisted tomography'/exp/mj OR 'cat scan*':ti,ab OR ((comput* NEAR/3 tomograph*):ti,ab) OR ct:ti,ab OR ctscan*:ti,ab OR mdct*:ti,ab OR msct:ti,ab	1028806
#1	'foot injury'/exp/mj OR 'tarsometatarsal joint injury'/exp OR 'tarsometatarsal joint dislocation'/exp OR (('foot'/exp/mj OR 'foot bone'/exp/mj OR 'foot joint'/exp/mj OR 'talonavicular joint'/exp/mj OR 'Chopart joint'/exp/mj) AND 'injury'/exp/mj) OR (((foot OR feet OR pedal OR pedis OR hindfoot OR forefoot OR heel OR toe OR toes OR 'digit of the foot' OR hallux OR Lisfranc OR calcan* OR 'os calcis' OR talus OR tarsi OR tarsal OR tarsus OR talare OR tarsometatarsal OR astralagus OR metatars* OR astralagus OR cuboid* OR cuneiform OR navicular* OR talonavicular* OR Chopart) NEAR/4 (trauma* OR injur* OR fractur* OR broken OR break* OR dislocat* OR displac* OR hyperflex* OR damage* OR rupture* OR tear* OR emergenc* OR acute)):ti,ab)	22841

Ovid/Medline

#	Searches	Results
19	10 not (16 or 17 or 18)	375
18	(10 and 15) not (16 or 17)	470
17	(10 and 12) not 16	87
16	10 and 11	30
15	13 or 14	7090773

14	Case-control Studies/ or clinical trial, phase ii/ or clinical trial, phase iii/ or clinical trial, phase iv/ or comparative study/ or control groups/ or controlled before-after studies/ or controlled clinical trial/ or double-blind method/ or historically controlled study/ or matched-pair analysis/ or single-blind method/ or (((control or controlled) adj6 (study or studies or trial)) or (compar* adj (study or studies)) or ((control or controlled) adj1 active) or "open label*" or ((double or two or three or multi or trial) adj (arm or arms)) or (allocat* adj10 (arm or arms)) or placebo* or "sham-control*" or ((single or double or triple or assessor) adj1 (blind* or masked)) or nonrandom* or "non-random*" or "quasi-experiment*" or "parallel group*" or "factorial trial" or "pretest posttest" or (phase adj5 (study or trial)) or (case* adj6 (matched or control*)) or (match* adj6 (pair or pairs or cohort* or control* or group* or healthy or age or sex or gender or patient* or subject* or participant*)) or (propensity adj6 (scor* or match*))).ti,ab,kf. or (confounding adj6 adjust*).ti,ab. or (versus or vs or compar*).ti. or ((exp cohort studies/ or epidemiologic studies/ or multicenter study/ or observational study/ or seroepidemiologic studies/ or (cohort* or 'follow up' or followup or longitudinal* or prospective* or retrospective* or observational* or multicent* or 'multi-cent*' or consecutive*).ti,ab,kf.) and ((group or groups or subgroup* or versus or vs or compar*).ti,ab,kf. or ('odds ratio*' or 'relative odds' or 'risk ratio*' or 'relative risk*' or aor or arr or rrr).ab. or (("OR" or "RR") adj6 CI).ab.))	5330423
13	Epidemiologic studies/ or case control studies/ or exp cohort studies/ or Controlled Before-After Studies/ or Case control.tw. or cohort.tw. or Cohort analy$.tw. or (Follow up adj (study or studies)).tw. or (observational adj (study or studies)).tw. or Longitudinal.tw. or Retrospective*.tw. or prospective*.tw. or consecutive*.tw. or Cross sectional.tw. or Cross-sectional studies/ or historically controlled study/ or interrupted time series analysis/ [Onder exp cohort studies vallen ook longitudinale, prospectieve en retrospectieve studies]	4336620
12	exp clinical trial/ or randomized controlled trial/ or exp clinical trials as topic/ or randomized controlled trials as topic/ or Random Allocation/ or Double-Blind Method/ or Single-Blind Method/ or (clinical trial, phase i or clinical trial, phase ii or clinical trial, phase iii or clinical trial, phase iv or controlled clinical trial or randomized controlled trial or multicenter study or clinical trial).pt. or random*.ti,ab. or (clinic* adj trial*).tw. or ((singl* or doubl* or treb* or tripl*) adj (blind$3 or mask$3)).tw. or Placebos/ or placebo*.tw.	2540677
11	meta-analysis/ or meta-analysis as topic/ or (metaanaly* or meta-analy* or metanaly*).ti,ab,kf. or systematic review/ or cochrane.jw. or (prisma or prospero).ti,ab,kf. or ((systemati* or scoping or umbrella or "structured literature") adj3 (review* or overview*)).ti,ab,kf. or (systemic* adj1 review*).ti,ab,kf. or ((systemati* or literature or database* or data-base*) adj10 search*).ti,ab,kf. or ((structured or comprehensive* or systemic*) adj3 search*).ti,ab,kf. or ((literature adj3 review*) and (search* or database* or data-base*)).ti,ab,kf. or (("data extraction" or "data source*") and "study selection").ti,ab,kf. or ("search strategy" and "selection criteria").ti,ab,kf. or ("data source*" and "data synthesis").ti,ab,kf. or (medline or pubmed or embase or cochrane).ab. or ((critical or rapid) adj2 (review* or overview* or synthes*)).ti. or (((critical* or rapid*) adj3 (review* or overview* or synthes*)) and (search* or database* or data-base*)).ab. or (metasynthes* or meta-synthes*).ti,ab,kf.	641766
10	8 and 9	962
9	exp "Sensitivity and Specificity"/ or (sensitivity or sensitive or specificity).ti,ab. or (ROC-curve or receiver-operator*).ti,ab. or (likelihood or LR*).ti,ab. or exp Diagnostic Errors/ or (inter-observer or intra-observer or interobserver or intraobserver or validity or kappa or reliability).ti,ab. or reproducibility.ti,ab. or (test adj2 (re-test or retest)).ti,ab. or "Reproducibility of Results"/ or accuracy.ti,ab. or Diagnosis, Differential/ or Validation Studies.pt. or exp "Predictive Value of Tests"/ or ppv.ti,ab,kf. or npv.ti,ab,kf. or ((false or true) adj3 (negative or positive)).ti,ab.	3789277
8	7 not (comment/ or editorial/ or letter/) not ((exp animals/ or exp models, animal/) not humans/)	5005
7	1 and 6	5234
6	2 or 3 or 4 or 5	3115542
5	exp *Diagnostic Imaging/ or exp *Diagnostic Tests, Routine/ or 'radio diagnos*'.ti,ab. or 'radiodiagnos*'.ti,ab. or 'image'.ti,ab. or 'images'.ti,ab. or 'imaging'.ti,ab.	1935481

4	exp *Radiography/ or exp *X-Rays/ or 'x ray*'.ti,ab. or xray*.ti,ab. or electroradiograph*'.ti,ab. or 'radiogram'.ti,ab. or 'radiograph*'.ti,ab. or 'radioimaging'.ti,ab. or 'radiophotograph*'.ti,ab. or 'roentgen*'.ti,ab. or 'rontgen*'.ti,ab. or radiotomograph*.ti,ab. or tomograph*.ti,ab. or radiologic*.ti,ab.	1439165
3	exp *magnetic resonance imaging/ or mri.ti,ab. or mris.ti,ab. or nmr.ti,ab. or mra.ti,ab. or mras.ti,ab. or zeugmatograph*.ti,ab. or mr tomograph*.ti,ab. or proton spin.ti,ab. or ((magneti* or chemical shift) and (image or images or imaging)).ti,ab. or fmri.ti,ab. or fmris.ti,ab. or 'mr imag*'.ti,ab.	772566
2	exp *Tomography, X-Ray Computed/ or ct.ti,ab. or cts.ti,ab. or cat scan*.ti,ab. or ctscan*.ti,ab. or mdct*.ti,ab. or msct.ti,ab. or (comput* adj3 tomograph*).ti,ab.	649704
1	exp *Foot Injuries/ or ((exp *Foot/ or exp *Foot Bones/ or exp *Foot Joints/) and (exp *Fractures, Bone/ or exp *Fracture Dislocation/ or exp *Joint Dislocations/ or exp *Crush Injuries/ or exp *Leg Injuries/)) or ((foot or feet or pedal or pedis or hindfoot or forefoot or midfoot or heel or toe or toes or hallux or Lisfranc or calcan* or 'os calcis' or talus or tarsi or tarsal or tarsus or talare or tarsometatarsal or astralagus or metatars* or astralagus or cuboid* or cuneiform or navicular* or talonavicular* or Chopart) adj4 (trauma* or injur* or fracture* or broken or break* or dislocat* or displac* or hyperflex* or damage* or rupture* or tear* or emergenc* or acute)).ti,ab.	19073

Module 1b CT of MRI bij complexe voetletsels

Uitgangsvraag

Wat is de meest aangewezen diagnostiek bij complexe voetletsels (talus, calcaneus, Chopart, Lisfranc) met het oog op het niet missen van letsels en het instellen van de behandeling?

De uitgangsvraag omvat de volgende deelvragen:

1. Wat is de toegevoegde waarde van een belaste voetfoto (x-stress-voet/enkel) bij patiënten verdacht van complex voetletsel (talus, calcaneus, Chopart of Lisfranc)? (zie module 'belaste voetfoto bij complex voetletsel' [hier wordt een hyperlink ingevoegd zodra de richtlijn wordt gepubliceerd op de richtlijnendatabase]
2. Wat is de toegevoegde waarde van een CT of MRI bij patiënten verdacht van complex voetletsel (talus, calcaneus, Chopart of Lisfranc)?

Inleiding

Complexe voetletsels worden tijdens de acute presentatie vaak gemist met als gevolg uitgestelde behandelingen en slechtere uitkomst. De mogelijkheden en toepassing van verschillende diagnostische modaliteiten is vaak per ziekenhuis verschillend. Het is onduidelijk wat de beste diagnostiek is om in te zetten en wat de indicaties hiervoor zijn. Hierbij kan men denken aan een CT of MRI scan maar ook aan een aanvullende belaste voetfoto die niet in alle ziekenhuizen standaard gemaakt worden.

Search and select

A systematic review of the literature was performed to answer the following question:
What is the diagnostic accuracy of an additional imaging with Computer Tomography (CT) or Magnetic Resonance Imaging (MRI), compared to a non-weight bearing foot x-ray only in patients with suspected traumatic foot injuries (talus, calcaneus, Chopart or Lisfranc)?

P = Patients with acute traumatic foot injury and suspected of talus, calcaneus, Chopart or Lisfranc injury
I = X-foot/ankle + CT (Osseous) / MRI (ligamentous)
C = X-foot/ankle
R = Operative findings
O = 1. Radiodiagnostic accuracy: Sensitivity and specificity of the diagnosis of the injury (Chopart, Lisfranc, talus or calcaneus fractures), negative predictive value, positive predictive value.
= 2. Clinical management: morbidity, change in clinical management, time saving

<u>Relevant outcome measures</u>

The guideline development group considered change in clinical management, sensitivity and false negatives as critical outcome measures for decision making; and specificity and false positives as important outcome measures for decision making.

A priori, the working group did not define the outcome measures listed above but used the definitions used in the studies.

For the outcome 'change in clinical management' the guideline development group considered a RR <0.80 and RR >1.25 (dichotomous outcomes) and a difference of 25% (continuous outcomes) as a minimal clinically (patient) important difference. For diagnostic accuracy (sensitivity, specificity,

negative predictive value and positive predictive value), a difference of 10% was considered clinically relevant.

Search and select (Methods)

The databases Medline (via OVID) and Embase (via Embase.com) were searched with relevant search terms until the 11th of January 2023. The detailed search strategy is depicted under the tab Methods. Relevant search terms were used to search for systematic reviews, RCTs, observational and other studies about diagnosing foot injuries. The search resulted in 1312 unique hits.
Studies were selected based on the following criteria:

- Trials in patients with suspected or diagnosed foot injury
- Trials comparing radiographs and CT/MRI with surgical findings
- Trials reporting diagnostic accuracy of the diagnostic modalities for detecting fractures or additional injuries

Twenty-eight studies were initially selected based on title and abstract screening. After reading the full text, twenty-eight studies were excluded (see the table with reasons for exclusion under the tab Methods), and no studies were found that matched the PICO.

Eight studies were found that compared diagnoses based on (primary) radiographs with diagnoses based on CT or MRI. As there was no comparison with surgical findings (reference), these studies did not comply with the PICRO. However, the guideline development group evaluated these studies to be relevant for answering the question: *What is the diagnostic accuracy of an additional CT/MRI, compared to a non-weight bearing foot x-ray only in patients with suspected traumatic foot injuries (talus, calcaneus, Chopart or Lisfranc)?*

Results

A description of the studies that were considered relevant for answering the research question is presented below. As these studies did not comply with the PICO, these studies were not graded. The data of these studies is not incorporated in the Evidence tables and risk of bias tables.

Summary of literature

Description of studies and results

Chopart injuries

Almeida (2018) retrospectively reviewed the radiology database to assess the sensitivity of weight bearing (WB) and non-WB radiographs for Chopart fractures, and to assess the sensitivity of radiographs (WB and non-WB) to detect additional fractures. The radiology database was queried for radiology reports on Chopart fractures. Inclusion criteria were: diagnosis of Chopart fracture and imaging work-up including at least one radiograph (WB or non-WB) and subsequent cross-sectional image (CT or MRI). In total, radiographs of 108 patients met the inclusion criteria. Mean age of these patients was 46.4 years, and 67.6% was male. High energy trauma mechanisms were reported in 55.6% of the patients. Chopart injury diagnoses that were made based on the WB and non-WB radiographs (index test) were compared to diagnoses based upon the CT or MRI (reference test). The indications for either a WB or non-WB radiograph were not reported. A diagnosis of Chopart fracture was based on the following criteria: presence of a radiology report (radiograph, CT, or MRI) showing a midfoot fracture extending to the calcaneocuboid or talonavicular joints and documentation of conservative or surgical treatment. The number of correct Chopart fracture diagnoses by radiography were reported. Additionally, the number of additional fractures detected by either radiography or CT/MRI were compared. Patients were treated conservatively or surgically.

Hirschman (2018) performed a retrospective analysis to assess the frequency of concomitant injuries at the calcaneocuboid and talonavicular joint (indicating advanced Chopart injury) using radiography and MRI and to correlate these findings with radiologic and clinical diagnoses. A hospital database

search was performed to identify adult patients (> 18 years), with both radiographs and MRI of the ankle and foot. Inclusion criteria were: patients with evidence of fractures in the anterior process of calaneus on radiographs, MRI or both; a time interval up to 8 weeks between radiography and MRI and imaging within 8 weeks of acute ankle injury. The study population consisted of 21 patients, mean age 51.7 ± 13 years, 19% male. Radiographs (index test) and MRI (reference test) were compared. Indications for both radiography and MRI were twisting ankle injuries from missing a step (n = 7), nonspecific ankle injury (n = 6), sports-related ankle injury (n = 5) and ankle injury after a fall (n = 3). All radiographs and MRI's were retrospectively reviewed in consensus by two musculoskeletal radiologists. An injury was defined on radiographs as an avulsion fracture and om MR images as bone marrow edema, avulsion fracture or ligamentous sprain. The term 'equivocal' was used when both consensus readers were unsure whether an injury was present. All patients were treated conservatively.

Almeida (2018) and Hirschmann (2018) presented the following data on Chopart injuries detected by (primary) radiographs, when compared with CT and/or MRI, see Table 1. The data should be interpreted carefully due the retrospective nature of the studies and the lack of data on patients not undergoing CT and/or MRI (true negatives and false positives).

Table 1: studies reporting data on Chopart injuries detected by (primary) radiographs, when compared with CT/MRI

	Population (detected by CT/MRI)	**Indication for CT/MRI**	**TP**	**FN**	**TN**	**FP**	**Sensitivity Specificity**	**Comments**
Almeida (2018)	n = 108 **Chopart** injuries	Not clear (radiograph and subsequent **CT or MRI**)	73	35			Sens: 67.6%	CT/MRI identified 37 additional fractures (non-Chopart), compared to 21 additional fractures found with radiograph.
Hirschmann (2018)	n = 21 *Dorsal Calcaneo-cuboid*	**MRI (and radiograph)** Twisting ankle injury, non-specific ankle injury, sports-related ankle-injury, ankle injury after a fall.	10 (+ 5)	6*			Sens: 47.6%	MRI identified 9 additional fractures, compared to 4 additional fractures found with radiograph.
	n = 16 *Dorsal talo-navicular (additional)*		8 (+5)	3*			Sens: 50%	
	n = 16 *Advanced Chopart Joint*		3 (+5)	8*			Sens: 18.8%	

CT = Computer Tomogrpahy, MRI = magnetic resonance imaging, TP = true positives, FN = false negatives, TN = true negatives, FP = false positives, Sens = sensitivity, Spec = specificity

Lisfranc injuries

Haapamaki (2004)-2 performed a retrospective study to assess the acute phase multidetector computed tomography (MDCT) findings of Lisfranc fracture-dislocations. The hospital database of a level-1 trauma centre was reviewed for acute or serious foot or ankle injuries who had MDCT of the foot and ankle. In total, 282 patients were identified, mean age 42 years (range 13 to 89), 73% male. Of these patients, 19 patients had a Lisfranc fracture dislocation. Primary radiographs (index test), when available, were compared with MDCT findings (reference test). Foot and ankle MDCT were requested by emergency room physicians for clinical reasons, mainly to reveal complex fracture anatomy in patients with multiple injuries. In this centre, MDCT was routinely used for screening seriously injured patients. Radiographs of the foot were done routinely on all patients before the foot and ankle MDCT. For two patients a primary film radiograph was not available, as these patients were immediately scanned with MDCT because of multiple injuries to the lower limbs and body. Data of these patients was excluded from the analysis. All patients were treated operatively, except one. This patient was assigned to non-operative treatment because of serious head injury.

Ponkilainen (2019) retrospectively analyzed foot- and ankle scans to assess the diagnostic parameters of non-weight bearing foot radiographs compared with CT in Lisfranc injuries. CT and CBCT scans acquired due to acute foot trauma at a university hospital and a regional hospital were reviewed. Scans with a diagnosis of Lisfranc Injuries were included. Lisfranc injuries were defined as intra-articular fractures and avulsion fractures around the TMT-joint. Patients with extra-articular metatarsal fractures were excluded. A sample of 100 patients was included, of which 34 patients had no Lisfranc injury (some had distal foot fractures), 33 patients with a non-displaced Lisfranc injury, and 33 patients with a displaced Lisfranc. Mean age of the study population was 40.9 ± 18 years, 55 % male. It was not described what the indications were to perform a CT. CT-scans (reference test) were separately evaluated by two experienced foot surgery experts. The anonymized primary non-weight bearing radiographs (index test) were assessed independently by three orthopaedic surgeons, and three orthopaedic surgery residents, twice at three months. They were asked if, based on the radiographs, there was an injury present in the Lisfranc Joint, and if there were other injuries present. False positive rates were calculated by dividing the false negative cases with the CT-positive cases. False negative rates were calculated by dividing the false positive cases with the CT-negative cases.

Preidler (1999) performed a prospective study to compare the diagnostic capabilities of conventional radiography, CT and MRI imaging in depicting ligamentous and bony changes and joint malalignment in patients after hyperflexion injuries. Patients presenting with acute hyperflexion injuries were included in the study (n = 49). Mean age of the study population was 41 years, 55% male. Conventional and weight bearing radiographs were obtained on the day of the injury. All patients underwent CT examination within 48 hours. Additionally, patients underwent MRI, between 18 hours and 5 days after the trauma. All CT- and MRI- scans were masked before being reviewed. Two radiologists independently reviewed the radiographs, CT- and MRI-scans. Eleven patients who presented with joint malalignment on CT and/or MRI underwent surgery (which was considered the gold standard). Five other patients with joint malalignment on CT and/or MRI refused surgery and underwent conservative treatment. All other patients, without signs of instability, were also treated conservatively. As an outcome it was reviewed whether the radiographs, CT and MRI images showed joint malalignment or not.

Rankine (2012) retrospectively analysed hospital data to calculate the diagnostic accuracy of radiographs in the diagnosis of Lisfranc injury using CT and surgical findings as reference standard. A hospital database was searched for patients who underwent CT of the foot for the investigation of acute foot injury. In total, 60 patients were identified, mean age 37 ± 16.7 years, 55% male. Radiographs (index test) and CT (reference test) were compared. If primary radiographs showed evidence of Lisfranc injury or when patients had normal radiographs but with clinical suspicion of

significant foot injury, patients underwent additional CT. The initial presenting radiographs were evaluated independently by two experienced consultant radiologists. One of the observers evaluated the CT examination while blinded to the radiographic evaluation. Malalignment of the tarsal-metatarsal joints (using standard criteria), with particular attention paid to the second metatarsal, was evaluated as evidence for Lisfranc Injury. Presence of intraarticular fractures of the bases of the metatarsals involving the tarsal-metatarsal joint was also taken as evidence of Lisfranc injury. Subtle capsular avulsions involving the tarsal-metatarsal joint were taken as evidence of potential Lisfranc Injury. Patients either received conservative treatment with plaster immobilization, examination under anaesthesia without surgical fixation if no instability was found on stress testing and open reduction and internal fixation in the presence of instability.

Haapamaki (2004)-2, Ponkilainen (2019), Preidler (1999) and Rankine (2012), presented the following data on Lisfranc injuries detected by (primary) radiographs, when compared with CT/MRI, see Table 2. The data should be interpreted carefully due the retrospective nature of the studies and the lack of data on patients not undergoing CT and/or MRI (true negatives and false positives).

Table 2: studies reporting data on Lisfranc injuries detected by (primary) radiographs, when compared with CT/MRI

	Population (detected by CT/MRI)	**Indication for CT/MRI**	**TP**	**FN**	**TN**	**FP**	**Sensitivity Specificity**	**comments**
Haapamaki (2004)-2	n = 17 **Lisfranc** Injuries	MD**CT** used in seriously injured patients	13	4		5	Sens: 76.5%	The five false positive diagnoses that were identified with MDCT, resulted in operative treatment changing to non-operative management in 3 patients. With MDCT 6 additional occult fractures were found in the Lisfranc joint, and 6 occult fractures were found in other parts of the foot. These occult fractures were not diagnosed with radiograph.
Ponkilainen (2019)	n = 66 **Lisfranc** Injuries (100 patients were included)	Not clear	50 Rate: 14.7%	29 Rate: 23.9%			Sens: 76.1% (60.6 – 92.4) Spec: 85.3% (52.9 – 100)	The sensitivity in non-displaced injuries was lower than in displaced injuries (65.4% vs 87.1% p = 0.003). The number of missed cases was higher among non-displaced injuries than in displaced injuries (n = 11 vs 4 p = 0.002).
Preidler (1999)	n = 53 **Metatarsal** fractures (of 49 patients)	All patients underwent radiograph and CT	33				Sens: 62%	MRI revealed 41 metatarsal fractures and 18 metatarsal bone bruises Surgery confirmed tarsal and metatarsal joint malalignment with Lisfranc's ligament disruption in all 11 patients.

	n = 41 **Tarsal** fractures (of 49 patients)	All patients underwent radiograph and CT	20				Sens: 49%	MRI revealed 41 metatarsal fractures and 18 metatarsal bone bruises Surgery confirmed tarsal and metatarsal joint malalignment with Lisfranc's ligament disruption in all 11 patients.
Rankine (2012)	n = 45 **Lisfranc** Inuries (equivocal considered positive)	CT when primary radiograph showed evidence of injury or when injury was suspected	38	7	8	7	Sens: 84.4% Spec: 53.3%	3 of the false positives were doubtfull

CT = Computer Tomogrpahy, MRI = magnetic resonance imaging, TP = true positives, FN = false negatives, TN = true negatives, FP = false positives, Sens = sensitivity, Spec = specificity

Talus fractures

Haapamaki (2004) performed a retrospective study to assess multidetector computed tomography (MDCT) findings and the advantages of MDCT compared with radiography for diagnostic evaluation of acute ankle and foot trauma. The hospital database of a level-1 trauma centre was reviewed for patients with an acute foot or ankle injury and who underwent MDCT. In total, 388 patients with 517 fractures were identified, mean age was 40 years (range 16 – 89), 73% male. Primary radiographs (index test) were compared with MDCT findings (reference test) of the ankle and foot. The diagnosis of acute traumatic ankle or foot fracture was based on MDCT, which was regarded as the gold standard in this study. The ankle and foot MDCT examinations were requested by emergency department physicians mainly to reveal complex fracture anatomy or to rule out a fracture. The radiographs were reevaluated by consensus. Of the 388 eligible patients, primary radiographs and MDCT findings were available for 296 patients with fractures.Based on the MDCT findings, 73 patients were diagnosed with talar fractures and 187 patients were diagnosed with calcaneus fractures. The number of patients treated surgically was 37 (51%) and 107 (57%) respectively. It was reported that 13 patients had luxations of the Chopart joint, however data on the diagnostic accuracy of radiographs for this type of injury was not presented. Data on the diagnostic accuracy of primary radiographs for Lisfranc injury were presented in a separate publication (Haapamaki, 2004-2). There were 44 patients with negative MDCT findings.

Dale (2013) reviewed a level-1 trauma centre database to describe Talar fracture patterns and associated injuries using both radiography and CT. Radiology and clinical data of patients diagnosed with acute talar fractures were retrospectively reviewed. In total, 132 fractures were identified (122 patients, 10 with bilateral injuries), of which 120 were imaged with both CT and radiography. Mean age of the study population was 41 years (range 18 – 81 years), 73% of the patients were male. Mean Injury Severity Score (ISS) was 16 (range 4- 57).

In patients who underwent both radiography and CT, the sensitivity of radiography (index test) compared with CT (reference test) for the detection of talar fractures was calculated, CT was considered the gold standard. In this trauma centre, a CT examination with multiplanar reformats is recommended when a talar fracture is suspected on radiographs.

For each patient, both radiography and CT were reviewed by at least two radiologists. Radiographs were always evaluated before reviewing the CT images to reduce reader bias.

Haapamaki (2004)-2 and Dale (2013), presented the following data on talus fractures detected by (primary) radiographs, when compared with CT, see Table 3. The data should be interpreted carefully due the retrospective nature of the studies and the lack of data on patients not undergoing CT (true negatives and false positives).

Table 3: studies reporting data on talus fractures detected by (primary) radiographs, when compared with CT

	Population (detected by CT/MRI)	Indication	TP	FN	TN	FP	Sensitivity Specificity	Opmerkingen
Dale (2013)	n = 120 **Talar** fractures	**CT** (recommended) when fracture is suspected based on radiograph	89	31			Sens: 74.2%	CT provided 'additional fracture information' not seen on radiography in 112 (93%) cases. This was defined as fractures not seen on radiography, a greater extent of injury not visualized on radiography, bone fragments within the joint space not visualized on radiography, or a subluxation or dislocation of the talar articulations not visualized on radiography
Haapamaki (2004)	n = 67 **Talar** fractures	MD**CT** "to reveal complex fracture anatomy"	52	15			Sens: 77.6%	

CT = Computer Tomogrpahy, MRI = magnetic resonance imaging, TP = true positives, FN = false negatives, TN = true negatives, FP = false positives, Sens = sensitivity, Spec = specificity

Calcaneus fractures

Haapamaki (2004). *For description of study, see paragraph "talus fractures".*
Haapamaki (2004)-2 presented the following data on calcaneus fractures detected by (primary) radiographs, when compared with CT, see Table 4. The data should be interpreted carefully due the retrospective nature of the studies and the lack of data on patients not undergoing CT (true negatives and false positives).

Table 4: studies reporting data on calcaneus fractures detected by (primary) radiographs, when compared with CT

	Population (based on CT/MRI)	Indication	TP	FN	TN	FP	Sensitivity	Opmerkingen
Haapamaki (2004)	n = 149 **calcaneus** fractures	MD**CT** "to reveal complex fracture anatomy"	129	*20*			Sens: 86.5%	

CT = Computer Tomogrpahy, MRI = magnetic resonance imaging, TP = true positives, FN = false negatives, TN = true negatives, FP = false positives, Sens = sensitivity, Spec = specificity

Results

Diagnostic Accuracy

No studies were found reporting the diagnostic accuracy of (primary) radiographs and CT/MRI when compared to surgical findings, in patients with acute traumatic foot injury, suspected of Chopart, Lisfranc, talus or calcaneus fractures.

Clinical management

No studies were found reporting the change in clinical management after a (primary) radiographs or CT/MRI when compared to surgical findings, in patients with acute traumatic foot injury, suspected of Chopart, Lisfranc, talus or calcaneus fractures.

Level of evidence of the literature

The level of evidence for the outcomes **diagnostic accuracy** and **clinical management** was not graded as no studies were found that matched the PICO.

Conclusions

no GRADE	No evidence was found regarding the **diagnostic accuracy** of primary radiographs when compared with CT/MRI and the effects of primary radiographs on **clinical management,** when compared with CT/MRI in patients with acute traumatic foot injury, suspected of Chopart, Lisfranc, talus or calcaneus fractures. *Source: -*

Overwegingen– van bewijs naar aanbeveling

Voor- en nadelen van de interventie en de kwaliteit van het bewijs

De gevonden studies vergeleken de diagnoses die werden gesteld op basis van röntgenfoto's met de diagnoses die werden gesteld met behulp van een CT of MRI. Aan de hand van deze gegevens werd in de meeste studies de sensitiviteit van de röntgenfoto gerapporteerd. Over de sensitiviteit van de CT/MRI werden geen gegevens gerapporteerd.

- Twee studies rapporteerde de sensitiviteit van de röntgenfoto (vergeleken met CT/MRI) voor het diagnosticeren van **Chopartletsel**. Deze varieerde van **47.6% tot 67.6%** (Almeida, 2018; Hirschman, 2018). Beide studies rapporteerden dat de CT/MRI additionele letsel identificeerde, wanneer vergeleken met een röntgenfoto.
- Vier studies rapporteerde de sensitiviteit van een röntgenfoto (vergeleken met CT/MRI) voor het diagnosticeren van **Lisfranc letsel**. Deze varieerde van **49% tot 85.3%.** (Haapamaki, 2004-2; Ponkilainen, 2019; Preidler, 1999; Rankine, 2012)
- Twee studies rapporteerde de sensitiviteit van een röntgenfoto (vergeleken met CT/MRI) voor het diagnosticeren van **talusfracturen**. Deze varieerde van **74.2% tot 77.6%.** (Dale, 2013; Haapamaki, 2004). Dale (2013) rapporteerde daarnaast dat de CT-scans in 112/120 patiënten (93%) additionele informatie over het fractuur lieten zien, die niet zichtbaar was op de röntgenfoto.
- Één studie rapporteerde de sensitivitiet van een röntgenfoto (vergeleken met CT/MRI) voor het diagnosticeren van **calcaneus fracturen**. De gerapporteerde sensitiviteit was **86.5%.** (Haapamaki, 2004). Darabij werd gerapporteerd de comminutie en dislocatie op een CT beter beoordeeld kan worden dan op de gewone rontgenfoto. Er wordt niet aangegeven of dit ook invloed had op het klinisch beleid.

In slechts drie studies werd de **MRI** als aanvullende diagnostiek gebruikt (Almeida, 2018; Hirschman, 2018; Preidler, 1999). Preidler (1999) vergeleek de uitkomsten van een MRI binnen 5 dagen, met de uitkomsten van röntgenfoto's en CT in de dagen daarvoor. De sensitiviteit van CT en MRI was vrijwel gelijk in het opsporen van fracturen, en de MRI had geen invloed op het therapeutisch beleid. In

Almeida en Hirschman (2018) werd tevens MRI als aanvulllende diagnostiek gebruikt (na röntgenfoto), er werd echter geen vergelijking gemaakt met CT. In de meerderheid van de studies ontbraken gegevens over de **terecht negatieve en vals positieve diagnoses of specificiteit**.

Een klein deel van de gevonden studies rapporteerd gegevens over vals positieve diagnoses gemaakt op basis van röntgenfoto's (Haapamaki, 2004; Haapamaki, 2004-2 en Rankine, 2012). Deze studies rapporteerden respectievelijk 29 (7%), 7 (16%) en 5 (29%) vals positieve diagnoses bij röntgenfoto's. Rankine (2012) rapporteerde daarbij een specificteit van 53%

Op basis van de gevonden studies over het gebruik van röntgenfoto en CT en/of MRI voor het opsporen van complex voetletsel is het niet mogelijk om conclusies te trekken met betrekking tot daadwerkelijke sensitiviteit en specificiteit van de röntgenfoto. Reden hiervoor is onder andere dat het overgrote deel van de studies een retrospectief karakter heeft, hierbij is alleen data beschikbaar van patiënten die zowel een röntgenfoto als een CT of MRI hebben ondergaan. Meerdere studies rapporteren dat er alleen een CT wordt gemaakt wanneer er een verdenking is op ernstig letsel. Dit maakt de onderzochte patiëntenpopulaties een sterk afgebakende groep met een hoge à priori kans op letsel, wat een vertekend beeld geeft van de diagnostische accuratesse. Omdat er geen data beschikbaar is betreffende de patiënten die alleen een röntgenfoto ondergaan, kunnen er geen conclusies worden getrokken over de diagnostische accuratesse van een röntgenfoto in een meer algemene populatie, hier ligt een kennislacune. Studies van voldoende kwaliteit waarin de verschillende diagnostische modaliteit worden vergeleken ontbreken. Hierdoor zijn er geen GRADE conclusies geformuleerd. De overwegingen zijn geschreven op basis van de beschrijvende resultaten uit de retrospectieve observationele studies gecombineerd met ervaringen uit de praktijk (expert opinion).

In de gevonden literatuur laat over het algemeen een beperkte sensitiviteit zien van de conventionele röntgenfoto voor complexe voetletsels. Vanuit medisch en patiënten perspectief is dit niet voldoende vanwege het feit dat het hier gaat om complexe voetletsels die onbehandeld tot ernstige invaliditeit kunnen leiden. Uit de diverse studies valt ook op te maken dat een conventionele röntgenfoto onvoldoende de totaliteit van het letsel in beeld brengt. Een aantal studies laat zien dat er in een hoog percentage van de gevallen waarin een afwijking is te zien op een conventionele röntgenfoto, de CT aanvullende informatie geeft. De aanvullende informatie heeft dan betrekking op eventuele bijkomende fracturen en de mate van dislocatie en comminutie van de fractuur. Het is dus aan te raden om bij verdenking op of bij aanwijzingen voor complex voetletsel aanvullende diagnostiek te doen naast de conventionele rontgenfoto. De indicaties om aanvullende diagnostiek te doen worden in het bijgevoegde stroomschema (bijlage module 1) [hier wordt een hyperlink ingevoegd zodra de richtlijn wordt gepubliceerd op de richtlijnendatabase] weergegeven. Hierbij wordt met name gekeken naar het traumamechanisme, de klinische presentatie en de bevindingen op de initiële rontgenfoto's. Het meest aangewezen vervolgonderzoek is een CT scan van de voet. Een CT is laagdrempelig beschikbaar op inmiddels veel spoedeisende hulpen in Nederland in tegenstelling tot de MRI. Bij een lage klinische verdenking op complex voetletsel, is er over het algemeen geen indicatie voor aanvullende diagnostiek. Bij afwijkingen op de röntgenfoto, of verdenkingen op complex letsel op basis van het traumamechanisme of klinisch onderzoek kan aanvullende diagnostiek worden overwogen. Bij evidente, communitieve fracturen (al dan niet intra-articulair, of met dislocatie of
luxatie zoals Lisfranc of Chopart) wordt het maken van een CT op de SEH aanbevolen. Voor een volledig overzicht van de indicaties voor aanvullende diagnostiek, zie ook het stroomschema (bijlage module 1) [hier wordt een hyperlink ingevoegd zodra de richtlijn wordt gepubliceerd op de richtlijnendatabase].

Hoewel dit niet uit de studies als zodanig naar voren komt is het goed mogelijk dat bij vals negatieve onbelaste röntgenfoto's met hoge klinische verdenking het doen van een aanvullende (poliklinische)

CT welke toch letsel laat zien dat het klinisch beleid zou kunnen veranderen. Als er op een CT fracturen of complex voetletsel wordt aangetoond zal dit leiden tot gipsimmobilisatie en/of een operatie terwijl dit zonder aangetoonde fractuur misschien achterwege wordt gelaten met alle gevolgen van dien. Hoeveel “onnodige” CT-scans verricht moeten worden om één complexvoetletsel te vangen is niet duidelijk.Dit komt omdat in alle studies de patiënten die geen aanvullende CT kregen niet onderzocht zijn. Veel van de studies zijn retrospectief waarbij de indicatie om toch een CT te maken niet goed wordt omschreven. De richtlijnwerkgroep heeft gepoogd om een zo goed mogelijk stroomschema te maken met hierbij de indicaties om CT te verrichten.
De invloed van een CT op het klinische beleid bij patiënten die al afwijkingen hadden op de onbelaste röntgenfoto is niet duidelijk, hier ligt een kennislacune. Wel is duidelijk dat de CT, met name bij Lisfrancletsel, veel aanvullende informatie geeft zoals eerder beschreven, welke wel van invloed zou kunnen zijn op de beslissing om wel of niet te opereren.
Uit de weinige studies die er zijn, blijkt dat een MRI ten opzichte van de CT vaak geen extra letsel aantoont wat invloed heeft op het therapeutisch beleid en/of het klinisch beloop. Het lijkt dus voldoende om in het (semi-)acute stadium een CT te verrichten als aanvullende diagnostiek wanneer dit geïndiceerd is (stroomschema (bijlage module 1) [hier wordt een hyperlink ingevoegd zodra de richtlijn wordt gepubliceerd op de richtlijnendatabase]). Een MRI valt in zeldzame gevallen te overwegen als er poliklinisch toch twijfels zijn over eventueel puur ligamentair letsel. Het effect van de, op MRI, extra aangetoonde letsels op het therapeutisch beleid en het klinische beloop is niet bekend.

Waarden en voorkeuren van patiënten (en evt. hun verzorgers)
Patiënten willen goed geïnformeerd een beslissing nemen over hun behandeling. Vooral als men moet besluiten een invasieve ingreep te ondergaan zoals een operatie aan de voet. Een beperkte sensitiviteit van een conventionele röntgenfoto waarbij men weet dat er in een groot gedeelte van de gevallen aanvullende informatie komt uit een CT-scan is dan onvoldoende om een beslissing op te baseren. Een aanvullende CT heeft als nadeel dat het extra stralenbelasting en kosten oplevert. Daarnaast is het effect op het therapeutisch beleid en het klinisch beloop onzeker. Er zijn misschien subgroepen zoals ouderen die geen operatie meer willen en mensen die al rolstoel gebonden zijn waarbij niet meer voor aanvullende diagnostiek wordt gekozen. Dit zal per patiënt overwogen en afgestemd moeten worden.

Kosten (middelenbeslag)
Aan het maken van een aanvullende CT zijn kosten verbonden. Het is onduidelijk hoeveel CT’s er verricht moeten worden om één extra complex voetletsel op te sporen. Echter zijn ook de uiteindelijke kosten die bij een niet-gemist complex voetletsel worden voorkomen, niet goed in te schatten. Deze afweging is dus moeilijk te maken.

Aanvaardbaarheid, haalbaarheid en implementatie
Het is zeker haalbaar en aanvaardbaar om een aanvullende CT-scan te verrichten bij verdenking op complex voetletsel. Een CT-scan is in ieder ziekenhuis in Nederland te verrichten. De timing van de CT-scan zal waarschijnlijk per ziekenhuis verschillen. In het geval van complex voetletsel zou er nog sprake kunnen zijn dat de patiënt geopereerd moet worden. Het is dus aan te bevelen een eventuele aanvullende CT-scan niet te lang uit te stellen en het liefst binnen 2 weken te verrichten. Bij het aanvragen van de CT-scan is het van belang om de radioloog te voorzien van adequate klinische gegevens en een eenduidige vraagstelling.

Aanbeveling
Aanbeveling-1
Rationale van de aanbeveling: weging van argumenten voor en tegen de diagnostische procedure
Onderzoeken naar de toegevoegde waarde van een CT of MRI scan voor de diagnose van complexe voetletsels zijn van lage kwaliteit en ontbreken de relevante informatie die nodig is om conclusies te

trekken over de diagnostische accuratesse. De voornamelijk retrospectieve analyses die zijn gedaan, suggereren echter wel dat CT vaak additionele letsels identificeert, die gemist worden op een röntgenfoto. Gezien het feit dat een onjuist behandelde complexe voetletsels kunnen leiden tot ernstige invaliditeit, is de werkgroep dan ook van mening dat het zinvol is om aanvullende diagnostiek uit te voeren wanneer er op basis van de kliniek en/of röntgenfoto aanwijzingen zijn voor complex voetletsel.

De werkgroep ziet geen rol weggelegd voor MRI (met uitzondering van pure ligamentaire letsels). De beperkte evidence en ervaringen uit de praktijk suggereren dat een MRI ten opzichte van CT vaak geen letsel aantoont wat leidt tot een verandering van het therapeutische beleid.

Overweeg het maken van een aanvullende CT-scan als er op basis van de kliniek en/of gewone röntgenfoto's aanwijzingen zijn voor complex voetletsel.

Voor indicaties en timing zie het stroomschema diagnostiek (bijlage module diagnostiek) [hier wordt een hyperlink ingevoegd zodra de richtlijn wordt gepubliceerd op de richtlijnendatabase])

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Almeida RR, Mansouri M, Tso DK, Johnson AH, Lev MH, Singh AK, Flores EJ. The added value of cross-sectional imaging in the detection of additional radiographically occult fractures in the setting of a Chopart fracture. Emerg Radiol. 2018 Oct;25(5):513-520. doi: 10.1007/s10140-018-1615-x. Epub 2018 Jun 6. PMID: 29876712.

Dale JD, Ha AS, Chew FS. Update on talar fracture patterns: a large level I trauma center study. AJR Am J Roentgenol. 2013 Nov;201(5):1087-92. doi: 10.2214/AJR.12.9918. PMID: 24147480.

Haapamaki VV, Kiuru MJ, Koskinen SK. Ankle and foot injuries: analysis of MDCT findings. AJR Am J Roentgenol. 2004 Sep;183(3):615-22. doi: 10.2214/ajr.183.3.1830615. PMID: 15333345.

Haapamaki V, Kiuru M, Koskinen S. Lisfranc fracture-dislocation in patients with multiple trauma: diagnosis with multidetector computed tomography. Foot Ankle Int. 2004 Sep;25(9):614-9. doi: 10.1177/107110070402500903. PMID: 15563381. – 2

Hirschmann A, Walter WR, Alaia EF, Garwood E, Amsler F, Rosenberg ZS. Acute Fracture of the Anterior Process of Calcaneus: Does It Herald a More Advanced Injury to Chopart Joint? AJR Am J Roentgenol. 2018 May;210(5):1123-1130. doi: 10.2214/AJR.17.18678. Epub 2018 Mar 23. PMID: 29570372.

Ponkilainen VT, Partio N, Salonen EE, Riuttanen A, Luoma EL, Kask G, Laine HJ, Mäenpää H, Päiväniemi O, Mattila VM, Haapasalo HH. Inter- and intraobserver reliability of non-weight bearing foot radiographs compared with CT in Lisfranc injuries. Arch Orthop Trauma Surg. 2020 Oct;140(10):1423-1429. doi: 10.1007/s00402-020-03391-w. Epub 2020 Mar 5. PMID: 32140830; PMCID: PMC7505866.

Preidler KW, Peicha G, Lajtai G, Seibert FJ, Fock C, Szolar DM, Raith H. Conventional radiography, CT, and MR imaging in patients with hyperflexion injuries of the foot: diagnostic accuracy in the detection of bony and ligamentous changes. AJR Am J Roentgenol. 1999 Dec;173(6):1673-7. doi: 10.2214/ajr.173.6.10584818. PMID: 10584818.

Rankine JJ, Nicholas CM, Wells G, Barron DA. The diagnostic accuracy of radiographs in Lisfranc injury and the potential value of a craniocaudal projection. AJR Am J Roentgenol. 2012 Apr;198(4):W365-9. doi: 10.2214/AJR.11.7222. PMID: 22451574.

Bijlagen bij module diagnostiek

- Stroomschema diagnostiek complexe voetletsels (bijlage)

Evidencetabellen

As no studies were included in the summary of literature, no evidence tables were made.

Table of excluded studies

Reference	Reason for exclusion
Almeida RR, Mansouri M, Tso DK, Johnson AH, Lev MH, Singh AK, Flores EJ. The added value of cross-sectional imaging in the detection of additional radiographically occult fractures in the setting of a Chopart fracture. Emerg Radiol. 2018 Oct;25(5):513-520. doi: 10.1007/s10140-018-1615-x. Epub 2018 Jun 6. PMID: 29876712.	CT/MRI findings not compared to a reference test (surgical findings). Descriptive information of this study is provided under 'description of studies'
Baker JC, Hoover EG, Hillen TJ, Smith MV, Wright RW, Rubin DA. Subradiographic Foot and Ankle Fractures and Bone Contusions Detected by MRI in Elite Ice Hockey Players. Am J Sports Med. 2016 May;44(5):1317-23. doi: 10.1177/0363546515626181. Epub 2016 Feb 17. PMID: 26888876.	wrong population: ankle/hindfoot fractures, wrong outcome
Dale JD, Ha AS, Chew FS. Update on talar fracture patterns: a large level I trauma center study. AJR Am J Roentgenol. 2013 Nov;201(5):1087-92. doi: 10.2214/AJR.12.9918. PMID: 24147480.	CT/MRI findings not compared to a reference test (surgical findings). Descriptive information of this study is provided under 'description of studies'
David HG. Value of radiographs in managing common foot injuries. BMJ. 1989 Jun 3;298(6686):1491-2. doi: 10.1136/bmj.298.6686.1492. PMID: 2569334; PMCID: PMC1836682.	Wrong design; descriptive radiograph study
Davis, E. T. (2006). Lisfranc joint injuries. Trauma, 8(4), 225-231.	Wrong design: narrative review (non-systematic)
De Bruijn J, Hagemeijer NC, Rikken QGH, Husseini JS, Saengsin J, Kerkhoffs GMMJ, Waryasz G, Guss D, DiGiovanni CW. Lisfranc injury: Refined diagnostic methodology using weight bearing and non-weight bearing radiographs. Injury. 2022 Jun;53(6):2318-2325. doi: 10.1016/j.injury.2022.02.040. Epub 2022 Feb 19. PMID: 35227511.	Comparison WB with non-WB
Essa A, Levi A, Ron TG, Ner EB, Finestone AS, Tamir E. The role of three dimension computed tomography in Lisfranc injury diagnosis. Injury. 2022 Oct;53(10):3530-3534. doi: 10.1016/j.injury.2022.07.032. Epub 2022 Jul 20. PMID: 35927069.	Study on 2D-CT. This diagnostic modality is not relevant for the research question
Grunz JP, Pennig L, Fieber T, Gietzen CH, Heidenreich JF, Huflage H, Gruschwitz P, Kuhl PJ, Petritsch B, Kosmala A, Bley TA, Gassenmaier T. Twin robotic x-ray system in small bone and joint trauma: impact of cone-beam computed tomography on treatment decisions. Eur Radiol. 2021 Jun;31(6):3600-3609. doi: 10.1007/s00330-020-07563-5. Epub 2020 Dec 5. PMID: 33280057; PMCID: PMC8128787.	Wrong intervention: Cone Beam CT
Gupta RT, Wadhwa RP, Learch TJ, Herwick SM. Lisfranc injury: imaging findings for this important but often-missed diagnosis. Curr Probl Diagn Radiol. 2008 May-Jun;37(3):115-26. doi: 10.1067/j.cpradiol.2007.08.012. PMID: 18436111.	Wrong design: narrative review (non-systematic)
Haapamaki V, Kiuru M, Koskinen S. Lisfranc fracture-dislocation in patients with multiple trauma: diagnosis with multidetector computed tomography. Foot Ankle Int. 2004 Sep;25(9):614-9. doi: 10.1177/107110070402500903. PMID: 15563381. – 2	CT/MRI findings not compared to a reference test (surgical findings). Descriptive information of this study is provided under 'description of studies'
Haapamaki VV, Kiuru MJ, Koskinen SK. Ankle and foot injuries: analysis of MDCT findings. AJR Am J Roentgenol. 2004	CT/MRI findings not compared to a reference test (surgical findings).

Sep;183(3):615-22. doi: 10.2214/ajr.183.3.1830615. PMID: 15333345.	Descriptive information of this study is provided under 'description of studies'
Hirschmann A, Walter WR, Alaia EF, Garwood E, Amsler F, Rosenberg ZS. Acute Fracture of the Anterior Process of Calcaneus: Does It Herald a More Advanced Injury to Chopart Joint? AJR Am J Roentgenol. 2018 May;210(5):1123-1130. doi: 10.2214/AJR.17.18678. Epub 2018 Mar 23. PMID: 29570372.	CT/MRI findings not compared to a reference test (surgical findings). Descriptive information of this study is provided under 'description of studies'
Ho K, Connell DG, Janzen DL, Grunfeld A, Clark TW. Using tomography to diagnose occult ankle fractures. Ann Emerg Med. 1996 May;27(5):600-5. doi: 10.1016/s0196-0644(96)70163-4. PMID: 8629781.	Wrong population: ankle fractures
Kennelly H, Klaassen K, Heitman D, Youngberg R, Platt SR. Utility of weight bearing radiographs compared to computed tomography scan for the diagnosis of subtle Lisfranc injuries in the emergency setting. Emerg Med Australas. 2019 Oct;31(5):741-744. doi: 10.1111/1742-6723.13237. Epub 2019 Feb 19. PMID: 30780193.	Only patients with subtle Lisfranc injuries were included. Patients with a frank dislocation and patients treatment with cast immobilisation were excluded from the studypopulation.
Kitsukawa K, Hirano T, Niki H, Tachizawa N, Mimura H. The Diagnostic Accuracy of MRI to Evaluate Acute Lisfranc Joint Injuries: Comparison With Direct Operative Observations. Foot Ankle Orthop. 2022 Jan 21;7(1):24730114211069080. doi: 10.1177/24730114211069080. PMID: 35097492; PMCID: PMC8792696.	Wrong comparison: CT/MRI compared to surgical findings
Kumar V, Hameed A, Bhattacharya R, McMurtry I. Role of computerised tomography in management of intra-articular fractures of the os calcis. Int Orthop. 2006 Apr;30(2):110-2. doi: 10.1007/s00264-005-0044-0. Epub 2006 Feb 23. PMID: 16496146; PMCID: PMC2532078.	Study on the clinical decisions that based on CT/Radiograph compared to decisions in the were made in the actual situation
Matuszak SA, Baker EA, Stewart CM, Fortin PT. Missed peritalar injuries: an analysis of factors in cases of known delayed diagnosis and methods for improving identification. Foot Ankle Spec. 2014 Oct;7(5):363-71. doi: 10.1177/1938640014537302. Epub 2014 Jul 17. PMID: 25037956.	wrong outcome: patient characteristics of patients with missed injuries
Miller JR, Dunn KW, Ciliberti LJ Jr, Eldridge SW, Reed LD. Diagnostic Value of Early Magnetic Resonance Imaging After Acute Lateral Ankle Injury. J Foot Ankle Surg. 2017 Nov-Dec;56(6):1143-1146. doi: 10.1053/j.jfas.2017.05.011. PMID: 29079231.	Wrong population: ankle fractures
Ponkilainen VT, Partio N, Salonen EE, Riuttanen A, Luoma EL, Kask G, Laine HJ, Mäenpää H, Päiväniemi O, Mattila VM, Haapasalo HH. Inter- and intraobserver reliability of non-weight bearing foot radiographs compared with CT in Lisfranc injuries. Arch Orthop Trauma Surg. 2020 Oct;140(10):1423-1429. doi: 10.1007/s00402-020-03391-w. Epub 2020 Mar 5. PMID: 32140830; PMCID: PMC7505866.	CT/MRI findings not compared to a reference test (surgical findings). Descriptive information of this study is provided under 'description of studies'
Preidler KW, Peicha G, Lajtai G, Seibert FJ, Fock C, Szolar DM, Raith H. Conventional radiography, CT, and MR imaging in patients with hyperflexion injuries of the foot: diagnostic accuracy in the detection of bony and ligamentous changes. AJR Am J Roentgenol. 1999 Dec;173(6):1673-7. doi: 10.2214/ajr.173.6.10584818. PMID: 10584818.	CT/MRI findings not compared to a reference test (surgical findings). Descriptive information of this study is provided under 'description of studies'
Rankine JJ, Nicholas CM, Wells G, Barron DA. The diagnostic accuracy of radiographs in Lisfranc injury and the potential value	CT/MRI findings not compared to a reference test (surgical findings).

of a craniocaudal projection. AJR Am J Roentgenol. 2012 Apr;198(4):W365-9. doi: 10.2214/AJR.11.7222. PMID: 22451574.	Descriptive information of this study is provided under 'description of studies'
Rikken QGH, Hagemeijer NC, De Bruijn J, Kaiser P, Kerkhoffs GMMJ, DiGiovanni CW, Guss D. Novel values in the radiographic diagnosis of ligamentous Lisfranc injuries. Injury. 2022 Jun;53(6):2326-2332. doi: 10.1016/j.injury.2022.02.044. Epub 2022 Feb 22. PMID: 35279293.	wrong comparator: patients with hallus valgus deformity
Seo DK, Lee HS, Lee KW, Lee SK, Kim SB. Nonweight bearing Radiographs in Patients With a Subtle Lisfranc Injury. Foot Ankle Int. 2017 Oct;38(10):1120-1125. doi: 10.1177/1071100717717220. Epub 2017 Jul 14. PMID: 28708955.	Wrong comparison: Radiograph compared to surgical findings
Sherief TI, Mucci B, Greiss M. Lisfranc injury: how frequently does it get missed? And how can we improve? Injury. 2007 Jul;38(7):856-60. doi: 10.1016/j.injury.2006.10.002. Epub 2007 Jan 9. PMID: 17214988.	Wrong comparison: Radiograph compared to surgical findings
Shim DW, Choi E, Park YC, Shin SC, Lee JW, Sung SY. Comparing bilateral feet computed tomography scans can improve surgical decision making for subtle Lisfranc injury. Arch Orthop Trauma Surg. 2022 Dec;142(12):3705-3714. doi: 10.1007/s00402-021-04182-7. Epub 2021 Oct 1. PMID: 34599354.	No full tekst available
Walter WR, Hirschmann A, Alaia EF, Garwood ER, Rosenberg ZS. JOURNAL CLUB: MRI Evaluation of Midtarsal (Chopart) Sprain in the Setting of Acute Ankle Injury. AJR Am J Roentgenol. 2018 Feb;210(2):386-395. doi: 10.2214/AJR.17.18503. Epub 2017 Nov 7. PMID: 29112474.	wrong outcome: prevalence of injury and inter-rate reliability
Xi Y, Hu DJ, Yao WW, Li M. [Classification and imaging diagnosis of Lisfranc joint injuries]. Zhonghua Yi Xue Za Zhi. 2016 Jul 5;96(25):1976-81. Chinese. doi: 10.3760/cma.j.issn.0376-2491.2016.25.004. PMID: 27470953.	Article in Chinese
Yammine K, Fathi Y. Ankle "sprains" during sport activities with normal radiographs: Incidence of associated bone and tendon injuries on MRI findings and its clinical impact. Foot (Edinb). 2011 Dec;21(4):176-8. doi: 10.1016/j.foot.2011.05.002. PMID: 21856145.	Wrong population: ankle fractures

Zoekverantwoording bij UV1 diagnostiek

Algemene informatie

Cluster/richtlijn: NVvH Traumatisch Complexe Voetletsels	
Uitgangsvraag/modules: UV1 diagnostiek: Wat is de meest aangewezen diagnostiek bij complexe voetletsels (talus, calcaneus, Chopart, lifranc) met het oog op het niet missen van letsels en het instellen van de behandeling	
Database(s): Ovid/Medline, Embase.com	Datum: 11 januari 2023
Periode: geen restrictie	Talen: geen restrictie
Literatuurspecialist: Alies van der Wal	
BMI-zoekblokken: voor verschillende opdrachten wordt (deels) gebruik gemaakt van de zoekblokken van BMI-Online https://blocks.bmi-online.nl/ Bij gebruikmaking van een volledig zoekblok zal naar de betreffende link op de website worden verwezen.	
Toelichting: Voor deze vraag is gezocht op de elementen: - voetletsels - diagnostiek (beeldvorming)	

De sleutelartikelen worden gevonden met deze search. Termen m.b.t. de enkel buiten de search gehouden. Vanwege de grote aantallen alleen gezocht met major trefwoorden en in de velden titel en abstract.

Zoekopbrengst

	EMBASE	**OVID/MEDLINE**	**Ontdubbeld**
SRs	27	30	37
RCT (sensitief filter)	108	87	149
Observationele studies	353	470	573
Overig	360	375	553
Totaal	848	962	**1312**

5 *Zoekstrategie*

Embase.com

No.	**Query**	**Results**
#19	#10 NOT (#16 OR #17 OR #18) = overig	360
#18	#10 AND #15 NOT (#16 OR #17) = observationeel	353
#17	#10 AND #12 NOT #16 = RCT	108
#16	#10 AND #11 = SR	27
#15	#13 OR #14	15551918
#14	'case control study'/de OR 'comparative study'/exp OR 'control group'/de OR 'controlled study'/de OR 'controlled clinical trial'/de OR 'crossover procedure'/de OR 'double blind procedure'/de OR 'phase 2 clinical trial'/de OR 'phase 3 clinical trial'/de OR 'phase 4 clinical trial'/de OR 'pretest posttest design'/de OR 'pretest posttest control group design'/de OR 'quasi experimental study'/de OR 'single blind procedure'/de OR 'triple blind procedure'/de OR (((control OR controlled) NEAR/6 trial):ti,ab,kw) OR (((control OR controlled) NEAR/6 (study OR studies)):ti,ab,kw) OR (((control OR controlled) NEAR/1 active):ti,ab,kw) OR 'open label*':ti,ab,kw OR (((double OR two OR three OR multi OR trial) NEAR/1 (arm OR arms)):ti,ab,kw) OR ((allocat* NEAR/10 (arm OR arms)):ti,ab,kw) OR placebo*:ti,ab,kw OR 'sham-control*':ti,ab,kw OR (((single OR double OR triple OR assessor) NEAR/1 (blind* OR masked)):ti,ab,kw) OR nonrandom*:ti,ab,kw OR 'non-random*':ti,ab,kw OR 'quasi-experiment*':ti,ab,kw OR crossover:ti,ab,kw OR 'cross over':ti,ab,kw OR 'parallel group*':ti,ab,kw OR 'factorial trial':ti,ab,kw OR ((phase NEAR/5 (study OR trial)):ti,ab,kw) OR ((case* NEAR/6 (matched OR control*)):ti,ab,kw) OR ((match* NEAR/6 (pair OR pairs OR cohort* OR control* OR group* OR healthy OR age OR sex OR gender OR patient* OR subject* OR participant*)):ti,ab,kw) OR ((propensity NEAR/6 (scor* OR match*)):ti,ab,kw) OR versus:ti OR vs:ti OR compar*:ti OR ((compar* NEAR/1 study):ti,ab,kw) OR (('major clinical study'/de OR 'clinical study'/de OR 'cohort analysis'/de OR 'observational study'/de OR 'cross-sectional study'/de OR 'multicenter study'/de OR 'correlational study'/de OR 'follow up'/de OR cohort*:ti,ab,kw OR 'follow up':ti,ab,kw OR followup:ti,ab,kw OR longitudinal*:ti,ab,kw OR prospective*:ti,ab,kw OR retrospective*:ti,ab,kw OR observational*:ti,ab,kw OR 'cross sectional*':ti,ab,kw OR cross?ectional*:ti,ab,kw OR multicent*:ti,ab,kw OR 'multi-cent*':ti,ab,kw OR consecutive*:ti,ab,kw) AND (group:ti,ab,kw OR groups:ti,ab,kw OR subgroup*:ti,ab,kw OR versus:ti,ab,kw OR vs:ti,ab,kw OR compar*:ti,ab,kw OR 'odds ratio*':ab OR 'relative odds':ab OR 'risk ratio*':ab OR 'relative risk*':ab OR 'rate ratio':ab OR aor:ab OR arr:ab OR rrr:ab OR ((('or' OR 'rr') NEAR/6 ci):ab)))	13761684

#13	'major clinical study'/de OR 'clinical study'/de OR 'case control study'/de OR 'family study'/de OR 'longitudinal study'/de OR 'retrospective study'/de OR 'prospective study'/de OR 'comparative study'/de OR 'cohort analysis'/de OR ((cohort NEAR/1 (study OR studies)):ab,ti) OR (('case control' NEAR/1 (study OR studies)):ab,ti) OR (('follow up' NEAR/1 (study OR studies)):ab,ti) OR (observational NEAR/1 (study OR studies)) OR ((epidemiologic NEAR/1 (study OR studies)):ab,ti) OR (('cross sectional' NEAR/1 (study OR studies)):ab,ti)	6767914
#12	'clinical trial'/exp OR 'randomization'/exp OR 'single blind procedure'/exp OR 'double blind procedure'/exp OR 'crossover procedure'/exp OR 'placebo'/exp OR 'prospective study'/exp OR rct:ab,ti OR random*:ab,ti OR 'single blind':ab,ti OR 'randomised controlled trial':ab,ti OR 'randomized controlled trial'/exp OR placebo*:ab,ti	3302394
#11	'meta analysis'/exp OR 'meta analysis (topic)'/exp OR metaanaly*:ti,ab OR 'meta analy*':ti,ab OR metanaly*:ti,ab OR 'systematic review'/de OR 'cochrane database of systematic reviews'/jt OR prisma:ti,ab OR prospero:ti,ab OR (((systemati* OR scoping OR umbrella OR 'structured literature') NEAR/3 (review* OR overview*)):ti,ab) OR ((systemic* NEAR/1 review*):ti,ab) OR (((systemati* OR literature OR database* OR 'data base*') NEAR/10 search*):ti,ab) OR (((structured OR comprehensive* OR systemic*) NEAR/3 search*):ti,ab) OR (((literature NEAR/3 review*):ti,ab) AND (search*:ti,ab OR database*:ti,ab OR 'data base*':ti,ab)) OR (('data extraction':ti,ab OR 'data source*':ti,ab) AND 'study selection':ti,ab) OR ('search strategy':ti,ab AND 'selection criteria':ti,ab) OR ('data source*':ti,ab AND 'data synthesis':ti,ab) OR medline:ab OR pubmed:ab OR embase:ab OR cochrane:ab OR (((critical OR rapid) NEAR/2 (review* OR overview* OR synthes*)):ti) OR ((((critical* OR rapid*) NEAR/3 (review* OR overview* OR synthes*)):ab) AND (search*:ab OR database*:ab OR 'data base*':ab)) OR metasynthes*:ti,ab OR 'meta synthes*':ti,ab	733409
#10	#8 AND #9	848
#9	'sensitivity and specificity'/de OR sensitivity:ab,ti OR sensitive:ab,ti OR specificity:ab,ti OR 'roc curve':ab,ti OR 'receiver operator':ab,ti OR 'receiver operators':ab,ti OR likelihood:ab,ti OR 'diagnostic error'/exp OR 'diagnostic accuracy'/exp OR 'diagnostic test accuracy study'/exp OR 'inter observer':ab,ti OR 'intra observer':ab,ti OR interobserver:ab,ti OR intraobserver:ab,ti OR validity:ab,ti OR kappa:ab,ti OR reliability:ab,ti OR reproducibility:ab,ti OR ((test NEAR/2 're-test'):ab,ti) OR ((test NEAR/2 'retest'):ab,ti) OR 'reproducibility'/exp OR accuracy:ab,ti OR 'differential diagnosis'/exp OR 'validation study'/de OR 'measurement precision'/exp OR 'diagnostic value'/exp OR 'reliability'/exp OR 'predictive value'/exp OR ppv:ti,ab,kw OR npv:ti,ab,kw OR (((false OR true) NEAR/3 (negative OR positive)):ti,ab)	4631014
#8	#7 NOT ('conference abstract'/it OR 'editorial'/it OR 'letter'/it OR 'note'/it) NOT (('animal'/exp OR 'animal experiment'/exp OR 'animal model'/exp OR 'nonhuman'/exp) NOT 'human'/exp)	4875
#7	#1 AND #6	6027
#6	#2 OR #3 OR #4 OR #5	3957674
#5	'radiodiagnosis'/exp/mj OR 'diagnostic radiology':ti,ab OR 'radio diagnos*':ti,ab OR 'radiodiagnos*':ti,ab OR 'imaging'/exp/mj OR image:ab,ti OR images:ab,ti OR imaging:ab,ti	2433581
#4	'radiography'/exp/mj OR 'x ray*':ti,ab OR xray*:ti,ab OR 'electroradiograph*':ti,ab OR 'radiogram*':ti,ab OR 'radiograph*':ti,ab OR 'radioimaging':ti,ab OR 'radiophotograph*':ti,ab OR 'roentgen*':ti,ab OR rontgen*:ti,ab OR radiotomograph*:ti,ab OR tomograph*:ti,ab OR radiologic*:ti,ab	1804991
#3	'nuclear magnetic resonance imaging'/exp/mj OR 'mri scanner'/exp/mj OR mri:ab,ti OR mris:ab,ti OR nmr:ab,ti OR mra:ab,ti OR mras:ab,ti OR zeugmatograph*:ab,ti OR 'mr tomograph*':ab,ti OR 'proton spin':ab,ti OR ((magneti*:ab,ti OR 'chemical shift':ab,ti) AND (image:ab,ti OR images:ab,ti OR imaging:ab,ti)) OR fmri:ab,ti OR fmris:ab,ti OR 'mr imag*':ab,ti	1075047

#2	'computer assisted tomography'/exp/mj OR 'cat scan*':ti,ab OR ((comput* NEAR/3 tomograph*):ti,ab) OR ct:ti,ab OR ctscan*:ti,ab OR mdct*:ti,ab OR msct:ti,ab	1028806
#1	'foot injury'/exp/mj OR 'tarsometatarsal joint injury'/exp OR 'tarsometatarsal joint dislocation'/exp OR (('foot'/exp/mj OR 'foot bone'/exp/mj OR 'foot joint'/exp/mj OR 'talonavicular joint'/exp/mj OR 'Chopart joint'/exp/mj) AND 'injury'/exp/mj) OR (((foot OR feet OR pedal OR pedis OR hindfoot OR forefoot OR heel OR toe OR toes OR 'digit of the foot' OR hallux OR Lisfranc OR calcan* OR 'os calcis' OR talus OR tarsi OR tarsal OR tarsus OR talare OR tarsometatarsal OR astralagus OR metatars* OR astralagus OR cuboid* OR cuneiform OR navicular* OR talonavicular* OR Chopart) NEAR/4 (trauma* OR injur* OR fractur* OR broken OR break* OR dislocat* OR displac* OR hyperflex* OR damage* OR rupture* OR tear* OR emergenc* OR acute)):ti,ab)	22841

Ovid/Medline

#	Searches	Results
19	10 not (16 or 17 or 18)	375
18	(10 and 15) not (16 or 17)	470
17	(10 and 12) not 16	87
16	10 and 11	30
15	13 or 14	7090773
14	Case-control Studies/ or clinical trial, phase ii/ or clinical trial, phase iii/ or clinical trial, phase iv/ or comparative study/ or control groups/ or controlled before-after studies/ or controlled clinical trial/ or double-blind method/ or historically controlled study/ or matched-pair analysis/ or single-blind method/ or (((control or controlled) adj6 (study or studies or trial)) or (compar* adj (study or studies)) or ((control or controlled) adj1 active) or "open label*" or ((double or two or three or multi or trial) adj (arm or arms)) or (allocat* adj10 (arm or arms)) or placebo* or "sham-control*" or ((single or double or triple or assessor) adj1 (blind* or masked)) or nonrandom* or "non-random*" or "quasi-experiment*" or "parallel group*" or "factorial trial" or "pretest posttest" or (phase adj5 (study or trial)) or (case* adj6 (matched or control*)) or (match* adj6 (pair or pairs or cohort* or control* or group* or healthy or age or sex or gender or patient* or subject* or participant*)) or (propensity adj6 (scor* or match*))).ti,ab,kf. or (confounding adj6 adjust*).ti,ab. or (versus or vs or compar*).ti. or ((exp cohort studies/ or epidemiologic studies/ or multicenter study/ or observational study/ or seroepidemiologic studies/ or (cohort* or 'follow up' or followup or longitudinal* or prospective* or retrospective* or observational* or multicent* or 'multi-cent*' or consecutive*).ti,ab,kf.) and ((group or groups or subgroup* or versus or vs or compar*).ti,ab,kf. or ('odds ratio*' or 'relative odds' or 'risk ratio*' or 'relative risk*' or aor or arr or rrr).ab. or (("OR" or "RR") adj6 CI).ab.))	5330423
13	Epidemiologic studies/ or case control studies/ or exp cohort studies/ or Controlled Before-After Studies/ or Case control.tw. or cohort.tw. or Cohort analy$.tw. or (Follow up adj (study or studies)).tw. or (observational adj (study or studies)).tw. or Longitudinal.tw. or Retrospective*.tw. or prospective*.tw. or consecutive*.tw. or Cross sectional.tw. or Cross-sectional studies/ or historically controlled study/ or interrupted time series analysis/ [Onder exp cohort studies vallen ook longitudinale, prospectieve en retrospectieve studies]	4336620
12	exp clinical trial/ or randomized controlled trial/ or exp clinical trials as topic/ or randomized controlled trials as topic/ or Random Allocation/ or Double-Blind Method/ or Single-Blind Method/ or (clinical trial, phase i or clinical trial, phase ii or clinical trial, phase iii or clinical trial, phase iv or controlled clinical trial or randomized controlled trial or multicenter study or clinical trial).pt. or random*.ti,ab. or (clinic* adj trial*).tw. or ((singl* or doubl* or treb* or tripl*) adj (blind$3 or mask$3)).tw. or Placebos/ or placebo*.tw.	2540677
11	meta-analysis/ or meta-analysis as topic/ or (metaanaly* or meta-analy* or metanaly*).ti,ab,kf. or systematic review/ or cochrane.jw. or (prisma or prospero).ti,ab,kf. or ((systemati* or scoping or umbrella or "structured literature") adj3 (review* or overview*)).ti,ab,kf. or (systemic* adj1 review*).ti,ab,kf. or ((systemati* or literature or database* or data-base*) adj10 search*).ti,ab,kf. or ((structured or comprehensive* or systemic*) adj3 search*).ti,ab,kf. or ((literature adj3	641766

	review*) and (search* or database* or data-base*)).ti,ab,kf. or (("data extraction" or "data source*") and "study selection").ti,ab,kf. or ("search strategy" and "selection criteria").ti,ab,kf. or ("data source*" and "data synthesis").ti,ab,kf. or (medline or pubmed or embase or cochrane).ab. or ((critical or rapid) adj2 (review* or overview* or synthes*)).ti. or (((critical* or rapid*) adj3 (review* or overview* or synthes*)) and (search* or database* or data-base*)).ab. or (metasynthes* or meta-synthes*).ti,ab,kf.	
10	8 and 9	962
9	exp "Sensitivity and Specificity"/ or (sensitivity or sensitive or specificity).ti,ab. or (ROC-curve or receiver-operator*).ti,ab. or (likelihood or LR*).ti,ab. or exp Diagnostic Errors/ or (inter-observer or intra-observer or interobserver or intraobserver or validity or kappa or reliability).ti,ab. or reproducibility.ti,ab. or (test adj2 (re-test or retest)).ti,ab. or "Reproducibility of Results"/ or accuracy.ti,ab. or Diagnosis, Differential/ or Validation Studies.pt. or exp "Predictive Value of Tests"/ or ppv.ti,ab,kf. or npv.ti,ab,kf. or ((false or true) adj3 (negative or positive)).ti,ab.	3789277
8	7 not (comment/ or editorial/ or letter/) not ((exp animals/ or exp models, animal/) not humans/)	5005
7	1 and 6	5234
6	2 or 3 or 4 or 5	3115542
5	exp *Diagnostic Imaging/ or exp *Diagnostic Tests, Routine/ or 'radio diagnos*'.ti,ab. or 'radiodiagnos*'.ti,ab. or 'image'.ti,ab. or 'images'.ti,ab. or 'imaging'.ti,ab.	1935481
4	exp *Radiography/ or exp *X-Rays/ or 'x ray*'.ti,ab. or xray*.ti,ab. or electroradiograph*'.ti,ab. or 'radiogram'.ti,ab. or 'radiograph*'.ti,ab. or 'radioimaging'.ti,ab. or 'radiophotograph*'.ti,ab. or 'roentgen*'.ti,ab. or 'rontgen*'.ti,ab. or radiotomograph*.ti,ab. or tomograph*.ti,ab. or radiologic*.ti,ab.	1439165
3	exp *magnetic resonance imaging/ or mri.ti,ab. or mris.ti,ab. or nmr.ti,ab. or mra.ti,ab. or mras.ti,ab. or zeugmatograph*.ti,ab. or mr tomograph*.ti,ab. or proton spin.ti,ab. or ((magneti* or chemical shift) and (image or images or imaging)).ti,ab. or fmri.ti,ab. or fmris.ti,ab. or 'mr imag*'.ti,ab.	772566
2	exp *Tomography, X-Ray Computed/ or ct.ti,ab. or cts.ti,ab. or cat scan*.ti,ab. or ctscan*.ti,ab. or mdct*.ti,ab. or msct.ti,ab. or (comput* adj3 tomograph*).ti,ab.	649704
1	exp *Foot Injuries/ or ((exp *Foot/ or exp *Foot Bones/ or exp *Foot Joints/) and (exp *Fractures, Bone/ or exp *Fracture Dislocation/ or exp *Joint Dislocations/ or exp *Crush Injuries/ or exp *Leg Injuries/)) or ((foot or feet or pedal or pedis or hindfoot or forefoot or midfoot or heel or toe or toes or hallux or Lisfranc or calcan* or 'os calcis' or talus or tarsi or tarsal or tarsus or talare or tarsometatarsal or astralagus or metatars* or astralagus or cuboid* or cuneiform or navicular* or talonavicular* or Chopart) adj4 (trauma* or injur* or fracture* or broken or break* or dislocat* or displac* or hyperflex* or damage* or rupture* or tear* or emergenc* or acute)).ti,ab.	19073

Module 2 Talus fracturen

Uitgangsvraag

Welk moment van behandelen en welke techniek reduceert de meest voorkomende negatieve (korte-, en lange termijn) gevolgen van talus fracturen?

Inleiding

Talus fracturen zijn zeer zeldzame letsels en zijn onder te verdelen in centrale- en perifere fracturen van de talus. De centrale talus fracturen zijn gelokaliseerd in de nek of in het corpus van de talus. De nek fracturen komen meer frequent voor (ongeveer 70%). Een deel van de talus fracturen heeft een luxatie in het subtalaire gewricht, in het enkel gewricht en/of het talonaviculaire gewricht. De behandeling van deze luxatie-fracturen is enerzijds het opheffen van de luxatie en anderzijds een definitieve stabilisatie in een anatomische stand. Gezien de lage frequentie van voorkomen kan het wenselijk zijn om de definitieve chirurgische behandeling uitgesteld uit te voeren, door een specialist met ervaring in het behandelen van talus fracturen. De vraagstelling is derhalve: is de uitgestelde definitieve behandeling van centrale talus fracturen nadelig voor de uitkomsten en leidt het tot meer complicaties? Daarnaast worden operatie technieken met één of twee incisies beschreven. De tweede vraag luidt: Heeft de één of twee incisie techniek de voorkeur bij de operatieve behandeling van talus fracturen.

Search and select

A systematic review of the literature was performed to answer the following questions:

PICO A: early versus delayed definitive surgery

What are the risks and benefits of early definitive surgery compared to delayed surgery in patients with central talus fractures, after early reduction in case of fracture-dislocation?

P = Patients with a central talus fracture (body and/or neck)

I = Delayed definitive fixation (after early temporal reduction)

C = Early definitive fixation

O = (patient-reported) functional outcome (American Orthopaedic Foot and Ankle Society; AOFAS-score), (osteo)arthritis, arthrodesis, infection, avascular necrosis

PICO B: single (incision) versus dual (incision) approach

What are the risks and benefits of one incision compared to two incisions (antero-lateral and antero-medial) during surgical treatment of patients with central talar fractures?

P = Patients with a central talus fracture (body and/or neck)

I = single incision with screw fixation

C = dual incisions (antero-lateral and antero-medial) with plate and screw fixation

O = (patient-reported) functional outcome (AOFAS-score), (osteo)arthritis, arthrodesis, infection, avascular necrosis

Relevant outcome measures

The guideline development group considered functional outcome (AOFAS-score), occurrence ofosteoarthritis and need for arthrodesis as critical outcome measures for decision making and infection and avascular necrosis as important outcome measures for decision making.

A priori, the guideline development group decided that the American Orthopaedic Foot and Ankle Society (AOFAS) score was the preferred measure for functional outcome. If a study did not include the AOFAS-score but alternative measures for functional outcome were presented (e.g. mobility or

Foot Function Index; FFI-score), these alternative measures were included in the summary of literature. For the other outcome measures listed above, the guideline development group decided to use the definitions used in the studies.

For the predefined outcomes the guideline development group defined the minimal clinically (patient) important differences as follows. For the outcome 'functional outcome' (AOFAS): a difference of 10 points on the AOFAS scale, or a 10% difference on a continuous scale was considered clinically important.

For dichotomous outcomes (osteo)arthritis, need for arthrodesis, infection, avascular necrosis a threshold of (Relative Risk; RR or Odds Ratio; OR) of <0.80 and >1.25 was defined as a minimal clinically (patient) important difference.

Search and select (Methods)

On May 17th 2023, the Embase.com and Ovid/Medline databases were systematically searched for systematic reviews, RCTs and observational studies on acute versus delayed intervention and 1 versus 2 incisions in talus fractures. The detailed search strategy is depicted under the tab Methods. The systematic literature search resulted in 353 unique hits. Studies were selected based on the following criteria: systematic reviews, RCTs and comparative observational studies comparing 1) patients with talus fractures who underwent early definitive fixation with patients undergoing delayed definitive fixation, or 2) comparing patients with talus fractures undergoing surgery with a single approach with patients undergoing surgery with a dual approach. Twenty-one studies were initially selected based on title and abstract screening. After reading the full text, seventeen studies were excluded (see the table with reasons for exclusion under the tab Methods), and four studies were included.

Results

Four studies were included in the analysis of the literature. Important study characteristics and results are summarized in the evidence tables. The assessment of the risk of bias is summarized in the risk of bias tables.

Summary of literature

Description of studies

Lindvall (2004) performed a retrospective study to evaluate the long-term results of surgical treatment of isolated, displaced talar neck and/or body fractures with stable fixation. Patients were selected from a hospital database (USA). Patients with isolated, displaced talar neck and/or body fractures were included. Isolated peripheral fractures of the talus, such as lateral process, talar head, colliculi and osteochondral fractures were excluded. Additionally, the minimum follow-up period had to be 48 months. Patients that were lost to follow-up were excluded from the analysis. The study population consisted of 25 patients, with 26 fractures (mean age: 37.3 years, 40% male). There were 18 talar neck fractures and 8 talar body fractures. According to the Gustilo-Anderson classification, there were 7 open fractures and 19 closed fractures. Closed fractures were treated surgically as soon as medical clearance was obtained, and open fractures were operated within six hours after the injury (except for one fracture). Comparisons were made between fractures treated with surgery within six hours (n = 12; open and closed fractures) and after six hours (n = 14; majority closed fractures), see Table 1. A second comparison was made between patients treated with one anteromedial incision (n = 7), one anterolateral incision (n = 5) and both anteromedial and anterolateral incisions (n = 13), see Table 2. Baseline characteristics were not presented per treatment arm. Outcomes included AOFAS hindfoot score, nonunion rate, osteonecrosis rate and prevalence of posttraumatic arthritis. The mean follow-up duration was 73.6 months (range: 48 to 113).

Parmeshwar (2023) performed a retrospective comparative study to observe and compare the clinical outcomes among three different surgical approaches (anteromedial, anterolateral and combined), in patients with talar neck fractures. Thirty patients with talar neck fractures were included in the analysis. Inclusion criteria were patients with compound fractures up to Gustilo-Anderson Grade 1 and patients aged older than 18 years. Patients with talar body fractures, uncontrolled diabetes mellitus, psychiatric illness and severe cardiac illness were excluded. The patients were divided into three groups, based on the surgical approach method they received, either anteromedial approach (n = 10), anterolateral approach (n =10) or a combined anteromedial and anterolateral approach (n = 10). See Table 2.Outcomes were assessed at 3 months, 6 months, 12 months and 18 months follow-up and included AOFAS-score and complications. The author's stated that "*randomization was done by a person not involving in operation team, by choosing a sealed envelope".* However, it was not clear when and how randomization was executed within the retrospective design. As a consequence, this study was considered an observational study.

Vints (2018) performed a retrospective cohort study to evaluate the long-term outcome after operative management of talus fractures and to identify the factors that affected the outcome. Consecutive adult patients (> 18 years) presenting with talus fracture at a university hospital in Belgium were selected for the cohort. Patients with isolated osteochondral lesions and non-responding patients were excluded. In total 66 patients were included in the population for analysis (mean age: 36.9 ± 33.0, 77.4% male). There were 59 talar body fractures (70.2%), 35 talar neck fractures (41.7%) and 13 talar head fractures (15.5%), and 16 patients had an open fracture (18.8%). All patients were treated surgically with (plate and) screw osteosynthesis, k-wiring, closed reduction and external fixation, primary arthrodesis or total talus transplant with allograft. Patients underwent early surgery (time from trauma to surgery < 24 hours; n = 13) or delayed or delayed-staged surgery (> 24 hours or closed reduction with external fixation before definitive surgery respectively; n = 71), see Table 1. Additionally, for each surgery it was reported whether a single or dual approach was used, see Table 2. Outcomes included the osteoarthritis rates for patients undergoing either early or delayed surgery. The median follow-up duration was 106 months (IQR: 62 – 154).

Wijers (2022) executed a retrospective cohort analysis to describe how surgical treatment of talar neck and body fractures affect functional outcome and quality of life. Adult patients presenting with talar fracture at a level-1 trauma centre in the Netherlands were included. Patients presenting more than one year after the trauma were excluded. In the cohort, 90 patients were included (median age: 32.5 years, 67.8% male), of which 47/90 (52.2% had talar neck fractures and 43/90 (47.7%) and talar body fractures. All fractures were treated with definitive surgery, classified as Open Reduction Internal Fixation (screws only or with plate), primary arthrodesis, external fixator, or partial bones excision. Timing of the definitive treatment was either within 7 days after trauma (early surgery; n = 22) or more than 7 days after trauma (delayed surgery), see Table 1. Outcomes were compared between the early and delayed surgery group and included functional outcome (AOFAS and FFI), avascular necrosis, osteoarthritis and need for secondary arthrodesis. The median follow-up time between trauma and assessment of outcomes was 50.5 months (IQR: 18.3 to 97.3). Patients with a follow-up duration shorter than six months were excluded from the analysis.

Table 1. Overview of the studies included for PICO A: early versus delayed surgery

	Early Surgery	Delayed Surgery
Lindvall 2004	Surgery within six hours after the injury (open fractures) n = 12, 46.2%	Surgery more than six hours after the injury (closed fractures) n = 14, 83.8%
Vints 2018	Surgery within 24 hours after the trauma n = 13, 15.5%	Surgery more than 24 hours after the trauma n = 71, 84.5%

Wijers 2022	Surgery within 7 days after trauma n = 22, 24.4%	Surgery more than 7 days after trauma n = 68, 75.6%

Table 2. Overview of the studies included for PICO B: single (incision) versus dual (incision) approach

	Single approach	Dual approach
Lindvall 2004	Anteromedial (n = 7) or anterolateral (n = 5)	Anteromedial and anterolateral (n = 13)
Parmeshwar 2023	Anteromedial (n = 10) or anterolateral (n = 10)	Anteromedial and anterolateral (n = 10)
Vints 2018 (no results on the predefined outcomes for this comparison)	Anteromedial (n = 44), anterolateral (n = 33), posteromedial (n = 14), posterolateral (n = 10)	Dual Approach n =16

The following studies did not report the predefined outcomes, however, the guideline development group considered both studies relevant for answering the research question. Therefore, a short description of these studies is presented below. The relevant outcomes were summarized under 'results', however as the studies did not comply with the PICO, the GRADE-approach was not applied.

Buckwalter (2017) performed a retrospective study to evaluate the effect of time to surgical reduction of talus fractures and talus fracture dislocations on the development of avascular necrosis and posttraumatic osteoarthritis. Hospital records from a level-1 trauma center (USA) were reviewed for patients with surgically managed talar fractures. Patients with missing documentation and pediatric cases were excluded. In total 106 patients were included in the analysis. Open fracture dislocations were managed with intravenous antibiotics, urgent surgical irrigation, debridement and immediate fixation of temporizing external fixation after reduction. All fractures were definitively managed with standard open reduction and internal fixation (ORIF), and anteromedial, anterolateral or dual approach and mini-fragment implants. After fixation, weight bearing typically was restricted for 6 – 12 weeks. Follow-up was at 6 – 8 weeks. During follow-up radiographs were made which were evaluated for avascular necrosis (AVN) or posttraumatic osteoarthritis (PTOA). Surgical timing (in hours; defined as time from injury to operating room) was compared between patients developing AVN/PTOA (n = 43) and patients who did not develop AVN/PTOA (n = 63).

Vallier (2014) performed a retrospective study to determine the timing of reduction events, versus internal fixation. Hospital records of 81 talar fractures treated at a level-1 trauma centre in the USA were reviewed (mean age: 36.7 year, 50% male). There were 52 talar neck fractures, 29 concurrent talar neck and body fractures and there were 24 open fractures (30%). All fractures were treated surgically. Patients with open fractures underwent urgent surgical debridement and irrigation. Closed reductions were attempted emergently for all dislocations, patients with irreducible dislocations were taken urgently to the operating room for reduction. For closed fractures, attention was directed to the severity of the associated soft tissue swelling to determine surgical timing. In total, 46 patients were treated with urgent ORIF, at a mean of 10.1 hours (range 5-24 hours) and 35 patients were treated with delayed ORIF at a mean of 10.6 days (range 3-19 days). The patients treated with delayed ORIF included 20 patients initially reduced with closed and/or percuatenous method at a mean of 9.5 hours after the injury. Development of osteonecrosis was reported as an outcome. Mean time to fixation was compared between patients developing osteonecrosis (n=16) and patients not developing osteonecrosis (n = 65).

Results

PICO A: early versus delayed definitive surgery

Functional outcome

Two studies reported the outcome functional outcome (Lindvall, 2004; Wijers, 2022). Lindvall (2004) and Wijers (2022) used the AOFAS-score as measure of functional outcome (0-100; with scores < 49 referring to poor functionality, 50-74: fair, 75-89: good and scores > 90 excellent). Due to heterogeneity in reporting it was not possible to pool the results.

Lindvall (2004) did not report data on the AOFAS-score but stated that there was "*no significant difference was seen between early (< 6 hours; n = 12, open and closed fractures) and delayed fixation (> 6 hours; n = 14, majority closed fractures) with regard to average AOFAS hindfoot score.*

Wijers (2022) reported that patients undergoing early surgery (< 7 days; n = 22, 24.4%) had a mean AOFAS-score of 78.9 (range: 53 – 100). The patients undergoing delayed surgery (> 7 days; n = 68, 75.6%) had a mean AOFAS-score of 74.9 (range: 28 – 100). Due to the lack of standard deviations, a mean difference could not be calculated, however the scores appear to be within a similar range.

<u>(Osteo)arthritis</u>

Four studies reported the outcome occurrence of (osteo)arthritis (Buckwalter, 207; Lindvall, 2004; Vints, 2018; Wijers, 2022). Due to heterogeneity in reporting it was not possible to pool the results.

Lindvall (2004) reported that there was "*no significant difference was seen between early (< 6 hours; n = 12, open and closed fractures) and delayed fixation (> 6 hours; n = 14, majority closed fractures) with regard to the prevalence of posttraumatic arthritis.*

Vints (2018) reported 8/13 (64%) of the patients undergoing early surgery (< 24 hours) experienced osteoarthritis, compared to 22/71 (31.7%) of the patients undergoing delayed surgery (> 24 hours). The RR was 1.99 (95% CI: 1.14 to 3.45).

Wijers (2022) reported 4/22 (18.1%) of the patients undergoing early surgery (< 7 days) experienced osteoarthritis, compared to 22/68 (32.4%) of the patients undergoing delayed surgery (> 7 days). The RR was 0.56 (95% CI: 0.22 to 1.45).

Additionally, Buckwalter (2017) reported the mean timing towards surgery (from injury) in patients who developed posttraumatic osteoarthritis (PTOA) or avascular necrosis (AVN), compared to patients who did not develop PTOA or AVN (combined). In the patients who developed PTOA or AVN (n = 43), the mean time towards surgery was 107 hours. In the patients who did not develop PTOA or AVN (n = 63) the mean time towards surgery was 81 hours.

<u>Need for arthrodesis</u>

One study reported secondary arthrodesis rates (Wijers, 2022). Wijers (2022) reported 3/22 (13.6%) of the patients undergoing early surgery (< 7 days) experienced osteoarthritis, compared to 9/68 (13.2%) of the patients undergoing delayed surgery (> 7 days). The RR was 1.03 (95% CI: 0.31 to 3.47).

<u>Infection</u>

None of the studies reported the outcome infection for patients undergoing either early or delayed surgery.

<u>Avascular necrosis</u>

Two studies reported the outcome avascular necrosis (Lindvall, 2004; Wijers, 2022). Due to heterogeneity in reporting it was not possible to pool the results.

Lindvall (2004) did not report data on the avascular necrosis rate after early or delayed definitive surgery. However, it was reported that there was "*no significant difference was seen between early*

(< 6 hours; n = 12, open and closed fractures) and delayed fixation (> 6 hours; n = 14, majority closed fractures) with regard to osteonecrosis rate. (…) Osteonecrosis rate was not related to (…) time to surgery (p = 0.7).

Wijers (2022) reported 3/22 (13.6%) of the patients undergoing early surgery (< 7 days) experienced osteonecrosis, compared to 15/68 (22.1%) of the patients undergoing delayed surgery (> 7 days). The RR was 0.62 (95% CI: 0.20 to 1.94).

Buckwalter (2017) reported the mean timing towards surgery (from injury) in patients who developed posttraumatic osteoarthritis (PTOA) or avascular necrosis (AVN), compared to patients who did not develop PTOA or AVN. In the patients who developed PTOA or AVN (n = 43), the mean time towards surgery was 107 hours. In the patients who did not develop PTOA or AVN (n = 63) the mean time towards surgery was 81 hours.

Vallier (2014) reported the mean timing towards fixation in patients who developed osteonecrosis. In the patients who developed osteonecrosis (n = 16) the mean time towards fixation was 39.8 hours. In the patients who did not develop osteonecrosis (n = 64) the mean time towards surgery was 150.2 hours. Moreover, it was stated that 46/81 (57%) fractures were treated definitely at a mean of 10.1 hours after injury and 35/81 (43%) underwent delayed ORIF at 10.6 days. The delayed surgery group included 10 Hawkins type-IIB and 10 Hawkins type-III fractures initially reduced with closed or percutaneously assisted methods at a mean of 9.5 hours after injury. Only 1 of these patients developed osteonecrosis.

PICO B: single (incision) versus dual (incision) approach

Functional outcome

One study reported the outcome functional outcome (Parmeshwar, 2023). In this study, AOFAS-score was reported at multiple follow-up durations, see Table 3.

Table 3: overview of the AOFAS-scores per treatment arm, reported in Parmeshwar (2023)

	Anteromedial (n = 10)	Anterolateral (n=10)	Combined (n =10)
3 months FU	32	26.6	27.5
6 months FU	45.1	44.1	34.8
12 months FU	65.0	65.2	66.5
18 months FU	75.2	78.3	77.5

Due to the lack of standard deviations, the mean difference could not be calculated.

(Osteo)arthritis

None of the studies reported the outcome occurrence of (osteo)arthritis in patients undergoing either single (incision) or dual (incision) approach surgery.

Need for arthrodesis

None of the studies reported the need for arthrodesis in patients undergoing either single (incision) or dual (incision) approach surgery.

Infection

One study reported the outcome infection (Parmeshwar, 2023). It was reported that 1/10 (10%) patients receiving the anteromedial approach had a superficial wound infection and 1/10 (10%) of the patients receiving the anterolateral approach. Of the patients receiving the combined approach, 2/10 (20%) experienced a deep wound infection and 1/10 (10%) experienced a superficial wound infection.

Avascular necrosis

One study reported the outcome avascular necrosis, at long term follow-up (minimal 48 months; Lindvall, 2004). Lindvall (2004) reported that 4/7 (57.1%) patients receiving the anteromedial approach developed osteonecrosis and 1/5 (20%) patients receiving the anterolateral approach. Of the patients receiving the combined approach, 8/13 (61.5%) developed osteonecrosis.

Level of evidence of the literature

PICO A: early versus delayed definitive surgery

The level of evidence regarding the outcome measure **functional outcome (AOFAS-score)** was retrieved from observational studies and therefore started 'low'. The level of evidence was downgraded by two levels because of study limitations including a lack of adequate correction for confounding variables (-1 risk of bias); and low number of included patients (-1 imprecision). The final level of evidence was graded 'very low'.

The level of evidence regarding the outcome measure **occurence of (oste)oarthritis** was retrieved from observational studies and therefore started 'low'. The level of evidence was downgraded by three levels because of study limitations including a lack of adequate correction for confounding variables (-1 risk of bias); conflicting results (-1 inconsistency) and the 95% confidence intervals crossing the boundaries of clinical decision making (-1 imprecision). The final level of evidence was graded 'very low'.

The level of evidence regarding the outcome measure **need for arthrodesis** was retrieved from observational studies and therefore started 'low'. The level of evidence was downgraded by two levels because of study limitations including a lack of adequate correction for confounding variables (-1 risk of bias); and the 95% confidence intervals crossing the boundaries of clinical decision making (-1 imprecision). The final level of evidence was graded 'very low'.

The level of evidence regarding the outcome measure **infection** could not be graded, as it was not reported in the included studies.

The level of evidence regarding the outcome measure **avascular necrosis** was retrieved from observational studies and therefore started 'low'. The level of evidence was downgraded by three levels because of study limitations including a lack of adequate correction for confounding variables (-1 risk of bias); conflicting results (-1 inconsistency) and the 95% confidence intervals crossing the boundaries of clinical decision making (-1 imprecision). The final level of evidence was graded 'very low'.

PICO B: single (incision) versus dual (incision) approach

The level of evidence regarding the outcome measure **functional outcome** was retrieved from observational studies and therefore started 'low'. The level of evidence was downgraded by two levels because of study limitations including a lack of adequate correction for confounding variables (-1 risk of bias); and low number of included patients (-1 imprecision). The final level of evidence was graded 'very low'.

The level of evidence regarding the outcome measures **occurrence of (osteo)arthritis** and **need for arthrodesis** could not be graded, as it was not reported in the included studies.

The level of evidence regarding the outcome measure **infection** was retrieved from observational studies and therefore started 'low'. The level of evidence was downgraded by two levels because of study limitations including a lack of adequate correction for confounding variables (-1 risk of bias);

and low number of included patients (-1 imprecision). The final level of evidence was graded 'very low'.

The level of evidence regarding the outcome measure **avascular necrosis** was retrieved from observational studies and therefore started 'low'. The level of evidence was downgraded by two levels because of study limitations including a lack of adequate correction for confounding variables (-1 risk of bias); and low number of included patients (-1 imprecision). The final level of evidence was graded 'very low'.

Conclusions

PICO A: early versus delayed definitive surgery

Very low GRADE	The evidence is very uncertain about the effects of early fixation on the outcomes **functional outcome, arthritis, need for arthrodesis and avascular necrosis**, when compared to delayed fixation in patients with talus fractures. *Source:* Lindvall, 2004; Vints, 2018; Wijers, 2022

- GRADE	No evidence was found regarding the effect of early fixation on **infection** when compared to delayed fixation in patients with talus fractures. *Source: -*

PICO B: single (incision) versus dual (incision) approach

Very low GRADE	The evidence is very uncertain about the effects of a single (incision) approach on the outcomes **functional outcome, infection and avascular necrosis**, when compared to a dual (incision) approach in patients with talus fractures. *Source:* Parmeshwar, 2023; Lindvall, 2004

- GRADE	No evidence was found regarding the effect of a single (incision) approach on arthritis and need for arthrodesis when compared to dual (incision) approach in patients with talar fractures. *Source: -*

Overwegingen – van bewijs naar aanbeveling

Voor- en nadelen van de interventie en de kwaliteit van het bewijs

Er is literatuuronderzoek uitgevoerd naar het optimale moment van behandelen en de optimale operatieve behandeltechniek voor talus fracturen. Er werden twee verschillende vergelijkingen uitgewerkt: PICO A vroeg versus vertraagd ingrijpen en PICO B één versus twee incisies. Voor beide vergelijkingen werd er gekeken naar de effecten op functionele uitkomst, de ontwikkeling van artritis/artrose, en de noodzaak tot een secundaire arthrodese (cruciale uitkomstmaten). Infectie en avasculaire necrose werden als belangrijke uitkomstmaten gedefinieerd. Voor beide vergelijkingen werd slechts bewijs met een zeer lage bewijskracht gevonden, waardoor er veel onzekerheid bestaat over de daadwerkelijke effecten van moment van behandelen en behandeltechniek op deze uitkomsten. Redenen voor de lage bewijskracht zijn het feit dat de data afkomstig is van

observationele studies (deze hebben van nature een lage bewijskracht) waarin niet gecorrigeerd is voor de belangrijkste covariaten. Hierdoor bestaat de kans dat de patiëntkarakteristieken van beide studiearmen verschillen, waardoor het onduidelijk is of de gevonden effecten veroorzaakt worden door het verschil in behandeling, of dat het verschil in patiënt karakteristieken de oorzaak is van de gevonden effecten. Daarnaast waren de studiepopulaties klein, waardoor de gevonden 95% betrouwbaarheidsintervallen zowel de effecten ten faveure van de interventiearm (vroeg ingrijpen of een enkele incisie) omvatten, als de effecten ten faveure van de controle arm (vertraagd ingrijpen of een dubbele incisie). Op basis van de gevonden literatuur kunnen dan ook geen conclusies worden getrokken over het optimale moment van behandelen en de optimale behandeltechniek.

Timing van definitieve fixatie (vroeg versus vertraagd ingrijpen)

Naast het vergelijkende onderzoek, zijn er een aantal correlatiestudies uit de search naar voren gekomen. Drie studies keken naar de correlatie tussen vroege en late behandeling met functionele uitkomsten (Vints, 2018; Biz, 2019; Pfuger, 2021), zie Tabel 4. In Biz (2019) en Pfuger (2021) was er geen (statistisch significante) correlatie gevonden tussen moment van behandeling en functionele uitkomst (p-waarde voor correlatie was respectievelijk p = 0.811 en p = 0.43). Vints (2018) rapporteerde wel een associatie tussen moment van behandelen en functionele uitkomst, gemeten met de *Foot Function Index-disability score*, waarbij een hogere score een slechtere functionaliteit betekent (stepwise multiple regression: b = -14.953, SE = 6.256, p = 0.021).

Tabel 4: overzicht van correlatie studies naar de effecten van vroeg ingrijpen vergeleken metvertraagd ingrijpen

	Populatie	Timing	Uitkomst
Biz (2019)	n = 27	Median time between trauma and ORIF: 2 day (range 0-11)	No (statistically significant) correlation between interval of trauma until ORIF in days and AOFAS (p = 0.811; p > 0.05)
Pfuger (2021)	n = 32	Mean time between trauma and surgery: 5.5 ± 5.4 days (range 0 – 19)	No correlation between timing of surgery and FAOS (r = -0.17, p = 0.43)
Vints (2018)	n = 84	Early surgery < 24 hours Delayed surgery > 24 hours	"*delayed surgery was associated with lower FFI-disability scores*" (b = -14.953, SE = 6.256, p = 0.021) (stepwise multiple regression)
Wijers (2022)	n = 90	Early surgery < 7 days Delayed surgery > 7 days	"*no statistically significant association between delayed surgery and postoperative complications*" (multivariate analysis)

ORIF = open reduction and internal fixation; AOFAS = American Orthopaedic Foot and Ankle Society; FAOS = Foot and Ankle Outcome Score

Bellamy (2011) onderzocht de relatie tussen moment van behandelen en de ontwikkeling van post-traumatische artritis en/of avasculaire necrose in patiënten met talus fracturen (n = 17, gemiddelde tijd tot behandelen 13.5 dagen). Er werd zowel voor de uitkomst post-traumatische artritis, als avasculaire necrose geen (statistisch significante) correlatie gevonden met de tijd tot behandelen (p = 0.46 en p = 0.26 respectievelijk)

De literatuur laat dus niet zien dat een uitgestelde definitieve behandeling tot meer complicaties (infecties, avasculaire necrose) of een hoger risico op artritis of artrose leidt.

Een talus fractuur in combinatie met een luxatie is een spoedingreep. Zeker als de huid, vaten, of zenuwen bedreigd zijn, dient binnen 8 uur een repositie verricht te worden, zoals beschreven in de richtlijn beleid rondom spoedoperaties. Hierna kan gekozen worden voor een tijdelijke stabilisatie, bijvoorbeeld middels externe fixatie (indien nodig), of voor directe definitieve fixatie. Aangezien de

literatuur geen uitsluitsel geeft over de optimale timing, is de keuze voor tijdelijke- of directe fixatie voornamelijk afhankelijk van de beschikbare expertise. Indien de benodigde expertise niet aanwezig is, kan besloten worden om een patiënt door te verwijzen voor definitieve behandeling. Indien een onbloedige repositie niet lukt onder sedatie op de spoedeisende hulp, moet de afweging gemaakt worden of de operatieve repositie in het primaire ziekenhuis verricht wordt, of dat er op dat moment overleg en overplaatsing plaatsvindt met een centrum met voldoende expertise. Dit om te voorkomen dat een eventuele open repositie van de luxatie interfereert met de benadering voor de definitieve fixatie.

Manier van behandelen (1 versus 2 incisies)
Over de optimale operatieve techniek voor de behandeling van talus fracturen, konden op basis van de gevonden literatuur ook geen conclusies worden getrokken. De associatie studie van Vints (2018) onderzocht de associatie tussen behandeltechniek en functionele uitkomsten. De multivariabele regressie liet geen associatie zien tussen een enkele incisie (anteromediaal, anterolateraal of posteromediaal) of een dubbele incisie en functionele uitkomst. Daarnaast rapporteerde Vints (2018) dat articulaire incongruente geassocieerd was met slechtere pijn score (FFI). Dit suggereert dat een slechte repositie leidt tot een slechtere uitkomst.

De definitieve behandeling van een talus nek fractuur kan op meerdere manieren. De Arbeitsgemeinschaft fur Osteosynthesefragen adviseert een benadering via twee incisies (anteromediaal en anterolateraal). Dit advies is met name gericht op een optimale visualisatie van de nek van de talus om een as afwijking en/of rotatie te voorkomen.
Mocht er tevens sprake zijn van uitbreiding van de fractuur in het processus lateralis tali, dan kan het nodig zijn de incisie meer lateraal te plaatsen. Zo ook bij een fractuur die uitbreiding heeft in het corpus van de talus, dan kan het noodzakelijk zijn een (mediale) malleolus osteotomie te verrichten.

<u>Waarden en voorkeuren van patiënten (en evt. hun verzorgers)</u>
Patiënten met talus fracturen zijn gebaat bij een behandeling met goede functionele uitkomsten en zo min mogelijk complicaties. Wanneer een patiënt niet de juiste behandeling ontvangt, kan dit het functioneren en de kwaliteit van leven van de patiënt langdurig beperken. Wanneer er bijvoorbeeld een malreductie, malunion, infectie of avasculaire necrose optreedt heeft dit een negatief effect op de uitkomst (Wijers 2022). Tevens is het belangrijk de patiënt voldoende te informeren over de behandeling en de verwachtingen t.a.v. het herstel.

<u>Kosten (middelenbeslag)</u>
De richtlijn werkgroep is niet bekend met kosten-effectiviteitsstudies over de behandeling van talus fracturen. Het primaire doel is de uitkomst van de patiënt te optimaliseren. Vertraagd ingrijpen vereist een eventuele overplaatsing en/of extra operatie, wat hogere kosten met zich meebrengt. Echter, wanneer een patiënt niet de juiste behandeling ontvangt, brengt dit in de nazorg en follow-up ook veel extra kosten met zich mee. In de praktijk spelen deze financiële overwegingen geen rol in de besluitvorming

<u>Aanvaardbaarheid, haalbaarheid en implementatie</u>
De keuze voor het moment van ingrijpen is voornamelijk afhankelijk van de aanwezige expertise in het centrum waar de patiënt met een talus fractuur primair wordt gezien. Indien de benodigde expertise ontbreekt, beveelt de richtlijn werkgroep aan de patiënt laagdrempelig over te plaatsen naar een centrum waar dergelijke expertise wel aanwezig is.
De werkgroep acht het immers aannemelijk dat de uitkomst beïnvloed wordt door de expertise van de operateur maar realiseert zicht dat het wetenschappelijke bewijs hiervoor ontbreekt. Hierover bestaat een kennislacune. Er is echter ook geen bewijs dat uitgestelde definitieve chirurgische behandeling leidt tot een minder goede uitkomst.

Aanbeveling

Aanbeveling-1

Rationale van de aanbeveling: weging van argumenten voor en tegen de interventie

Een talus fractuur in combinatie met een luxatie is een spoedingreep. Zeker als de huid, vaten, of zenuwen bedreigd zijn dient binnen 8 uur een repositie verricht te worden.
Hierna kan gekozen worden voor een tijdelijke stabilisatie, bijvoorbeeld middels externe fixatie, indien nodig. Afhankelijk van de beschikbare expertise kan besloten worden om direct een definitieve fixatie te verrichten, echter is er in de literatuur geen bewijs dat een uitgestelde definitieve behandeling tot meer complicaties (infectie, avasculaire necrose) leidt. Een alternatief is dat patiënt verwezen wordt voor definitieve behandeling bij afwezige expertise. Indien een onbloedige repositie niet lukt, onder sedatie op de spoedeisende hulp, moet de afweging gemaakt worden of de operatieve repositie in het primaire ziekenhuis verricht wordt, of dat er op dat moment al overleg en/of overplaatsing plaatsvindt. Dit om te voorkomen dat een eventuele open repositie van de luxatie interfereert met de benadering voor de definitieve fixatie.

De definitieve behandeling van een talus nek fractuur kan op meerdere manieren. De Arbeitsgemeinschaft fur Osteosynthesefragen (Buckely, 2010) adviseert een benadering via twee incisies (anteromediaal en anterolateraal). Dit advies is met name gericht op een optimale visualisatie van de nek van de talus om een as afwijking, zoals rotatie of varus stand, te voorkomen. Mocht er tevens sprake zijn van uitbreiding van de fractuur in het processus lateralis tali, dan kan het nodig zijn de incisie meer lateraal te plaatsen. Zo ook bij een fractuur die uitbreiding heeft meer proximaal in het corpus van de talus, dan kan het noodzakelijk zijn een (mediale) malleolus osteotomie te verrichten.

Voer, bij voldoende expertise, een spoed reductie van de talus luxatie uit (binnen 8 uur). Voer de repositie bij voorkeur gesloten uit. Stel de definitieve chirurgische behandeling uit indien er geen ervaren voet/enkel trauma-chirurg of orthopedisch chirurg beschikbaar is. Verwijs, bij onvoldoende ervaring met de primaire repositie en definitieve fixatie door naar een ander centrum. Er is geen bewijs dat uitstel van definitieve osteosynthese een negatief effect heeft op de uitkomst. Overweeg bij de definitieve fixatie van een talus fractuur laagdrempelig gebruik te maken van twee incisies om de kans op een anatomische repositie te vergroten en een betere functionele uitkomst te verkrijgen.

Literatuur

Buckley R, Sands A, Schatzker, J. ORIF - Screws fixation [internet]. Arbeitsgemeinschaft für Osteosynthesefragen (AO) Surgery Preference; 2010 [cited 2024 April 09]. Available from: https://surgeryreference.aofoundation.org/orthopedic-trauma/adult-trauma/talus/neck-displaced/orif-screw-fixation

Buckwalter V JA, Westermann R, Mooers B, Karam M, Wolf B. Timing of Surgical Reduction and Stabilization of Talus Fracture-Dislocations. Am J Orthop (Belle Mead NJ). 2017 Nov/Dec;46(6):E408-E413. PMID: 29309454.

Lindvall E, Haidukewych G, DiPasquale T, Herscovici D Jr, Sanders R. Open reduction and stable fixation of isolated, displaced talar neck and body fractures. J Bone Joint Surg Am. 2004 Oct;86(10):2229-34. doi: 10.2106/00004623-200410000-00014. PMID: 15466732.

Vallier HA, Reichard SG, Boyd AJ, Moore TA. A new look at the Hawkins classification for talar neck fractures: which features of injury and treatment are predictive of osteonecrosis? J Bone Joint Surg Am. 2014 Feb 5;96(3):192-7. doi: 10.2106/JBJS.L.01680. PMID: 24500580.

Vints W, Matricali G, Geusens E, Nijs S, Hoekstra H. Long-Term Outcome After Operative Management of Talus Fractures. Foot Ankle Int. 2018 Dec;39(12):1432-1443. doi: 10.1177/1071100718790242. Epub 2018 Aug 22. PMID: 30132701.

Wijers O, Demirci H, Sanders FRK, Halm JA, Schepers T. Functional outcome and quality of life in surgically treated talar neck and body fractures; how is it affected by complications. Injury. 2022 Jun;53(6):2311-2317. doi: 10.1016/j.injury.2022.02.013. Epub 2022 Feb 12. PMID: 35193754.

Bijlagen bij module talus fracturen

Evidence tables bij module talus fracturen

Evidence table for intervention studies (randomized controlled trials and non-randomized observational studies [cohort studies, case-control studies, case series])1

Study reference	Study characteristics	Patient characteristics [2]	Intervention (I)	Comparison / control (C) [3]	Follow-up	Outcome measures and effect size [4]	Comments
Buckwalter 2017	Type of study: Retrospective review Setting and country: Records from a level-1 trauma centre (2003-2013), USA Funding and conflicts of interest: None	Inclusion criteria: - isolated, displaced talar neck and/or talar body fractures Exclusion criteria: - missing documentation - pediatric cases N total at baseline: N = 106 Important prognostic factors[2]: *Age* 81h: 36.21 107h: 38.74 *Polytrauma* 81h: 49% 107h: 51% *Open fracture* 81h: 16% 107h: 35%	PICO1: Early surgery	PICO 1: Delayed surgery	Length of follow-up: 6 to 8 weeks Loss-to-follow-up / incomplete outcome data Patients with missing data or incomplete data were excluded	Outcome measures and effect size (include 95%CI and p-value if available): Avascular necrosis or post-traumatic osteoarthritis Yes: n = 43 / no = 63 Yes: mean time = 107 h No: mean time = 81 h Secondary corrective surgery of arthrodesis	The author's concluded that: "*Our results showed that time from talus fracture- dislocation to surgical reduction had no effect on development of AVN/PTOA*" Open fracture-dislocations were managed with intravenous antibiotics, urgent surgical irrigation, débridement, and immediate fixation or temporiz- ing external fixation after reduction. All fractures were definitively managed with standard ORIF with an anteromedial, anterolateral, or dual ap-proach and mini-fragment implants. After fixation, weight bearing typically was restricted for 6 to 12 weeks.

		Groups comparable at baseline?					
Lindvall 2004	Type of study: Retrospective review Setting and country: Records from a level-1 trauma centre (2003-2013), USA Funding and conflicts of interest: None	<u>Inclusion criteria</u>: - isolated displaced talar neck and/or body fractures <u>Exclusion criteria</u>: - isolated peripheral fractures of the talus such as lateral process, talar head, colliculi and osteochondral fractures - patients that were lost to follow-up <u>N total at baseline</u>: N = 25 (with 26 fractures) <u>Important prognostic factors</u>[2]: *Age:* 37.3 years (range 24 – 83 years), *Male:* 10/25 *Neck fractures:* 18 *Talar body: 8*	PICO 1: surgery within 6 hours (n = 12) PICO 2: anteromedial incision (n = 7) / anterolateral incision (n = 5)	PICO 1: surgery after 6 hours (n = 14) PICO 2: anteromedial and anterolateral incision (n = 13)	<u>Length of follow-up</u>: Minimum of 48 months (mean follow-up duration: 73.6 months – range: 48 to 113 months) <u>Loss-to-follow-up / incomplete outcome data</u> N = 7 (excluded from analysis)	<u>Outcome measures and effect size (include 95%CI and p-value if available):</u> *PICO 1:* "no significant difference was seen between the fractures (open and closed) fixed within 6 hours after the injury and the fractures fixed more than six hours after the injury with respect to": - AOFAS hindfoot score - nonunion rate - osteonecrosis rate - posttraumatic arthritis. *PICO 2:* <u>Osteonecrosis</u> I: 4/7 – 1/5 C: 8/13	The author's concluded that: *"we believe that displaced talar neck and/or body fractures should be treated with open re- duction and internal fixation. Although the time to surgical fix- ation should be minimized, a delay does not appear to adversely affect the outcome, specifically with regard to the development of osteonecrosis"*

		Open fracture n = 7 Groups comparable at baseline?					
Parmeshwar 2023	Type of study: Retrospective study Setting and country: Patients from a level-1 trauma centre between 2018 to 2020 (USA) Funding and conflicts of interest: None	<u>Inclusion criteria</u>: - talus neck fractures - compound fractures up-to grade 1 of Gustilo-Anderson classification - > 18 years - patients with associated fractures like vertebrae, medial malleolus, metatarsals and calcaneus <u>Exclusion criteria</u>: - patients with uncontrolled diabetes, psychiatric illness or severe cardiac illness <u>N total at baseline</u>: N = 30 I1: 10 I2: 10 C: 10 <u>Important prognostic factors</u>[2]:	I1: anteromedial approach (group a) I2: anterolateral approach (group b) PICO 2	Anteromedial and anterolateral approach (group c) PICO 2	<u>Length of follow-up</u>: 3 months, 6 months, 12 months, 18 moths. <u>Loss-to-follow-up / incomplete outcome data</u> N = 4 (excluded from analysis)	<u>Outcome measures and effect size (include 95%CI and p-value if available):</u> <u>AOFAS-score</u> *3 months FU* I1: 32 I2: 26.64 C: 27.52 *6 months FU* I1: 45.08 I2: 44.08 C: 34.80 *12 months FU* I1: 64.96 I2: 65.15 C: 66.48 *18 months FU* I1: 75.23 I2: 78.44 C: 77.52 <u>Infection</u> I1: 1/10 I2: 1/10 C: 3/10 Superficial & deep wound infection	The authors concluded that: "*In the opinion of authors, talar fractures can be managed by different approaches provided operating surgeons have meticulous knowledge about blood supply of talus. There is no significant difference between three different groups in context of AOFAS scoring at final follow-up"* All patients underwent ORIF Time interval between the injury and surgery was ranging from 1 to 30 days, the mean time interval was 7.72 for group A, 8.28 for group B and 8.32 for group C.

		I1: 35.04 I2: 34.88 C: 34.32 *Male:* 73.3% Groups comparable at baseline?				*Complications were also reported, however these were not specified by surgical approach*	
Vallier 2014	Type of study: Retrospective cohort Setting and country: Patients from a level-1 trauma centre between 2001 and 2011 (USA) Funding and conflicts of interest: None	<u>Inclusion criteria</u> - Talus fractures - >18 years <u>Exclusion criteria</u> - patients with other isolated talar body fractures, - lateral or posterior process fractures - osteochondral lesions <u>N total at baseline</u>: N = 80 in cohort, I: n = 46 (57%) C: c= 35 (43%) <u>Important prognostic factors[2]</u>: *Age: 36.7 (17-72 years)* *Male:* 40/80 (50%) *Neck fractures: 52* *Body fractures: 29*	PICO 1: Urgent ORIF – mean duration 10.1 hours (range: 5 – 25 hours)	PICO 1: Delayed ORIF – mean duration 10.6 days (range: 3 – 19 days).	<u>Length of follow-up</u>: Mean follow-up duration: 30.3 months (range: 11 to 120 months) / n = 63 Fourteen patients had less than 11 months of follow-up	<u>Outcome measures and effect size (include 95%CI and p-value if available):</u> PICO 1: Presence of osteonecrosis: Yes: n = 16 / no: n = 64 mean time to fixation Yes =39.8 hours No = 150.2 hours Forty-six (57%) of eighty-one frac- tures were treated definitively at a mean of 10.1 hours after the injury, while thirty-five fractures underwent delayed ORIF at a mean of 10.6 days. The latter group included ten Hawkins type- IIB and ten Hawkins type-III fractures initially reduced with closed or percutaneously assisted methods at a mean of 9.5 hours after the injury, and only one (5%) of these twenty	The author's concluded that: "Delaying reduction and definitive internal fixation does not increase the risk of developing osteonecrosis"

						patients developed osteonecrosis	
Vints 2018	Type of study: Retrospective cohort Setting and country: Patients from a University Hospital (Belgium) between 2000 and 2016 Funding and conflicts of interest: None	Inclusion criteria - Talus fractures - >18 years Exclusion criteria - patients with isolated osteochondral lesions - non-responding patients N total at baseline: N = 84 in cohort, 66 in analysis *PICO 1:* I: 13 C: 71 Important prognostic factors[2]: *Age: 36.9 ± 33.0* *Male:* 10/25	PICO 1: early surgery (time from surgery to trauma < 24 hours)	PICO 1: delayed surgery (time from surgery to trauma > 24 hours) or delayed-staged (closed reduction with external fixation [CREF] before definitive surgery	Length of follow-up: Median Clinical Follow-up time: 106 (IQR 62 – 154) months.	Outcome measures and effect size (include 95%CI and p-value if available): *PICO 1:* FFI – pain Correlation coefficient I: 0.24 C: 0.083 FFI – disability I: 0.020 C: 0.134 Osteoarthritis rates I: 64.0% C: 31.7% *PICO 2:* FFI – pain Correlation coefficient I: 0.24 C: 0.083 FFI – disability I: 0.020 C: 0.134	The author's concluded that: "Delayed surgery after trauma was associated with better outcome measures"
Wijers 2022	Type of study: Retrospective cohort Setting and country:	Inclusion criteria: - patients presenting with talar neck and/body fractures	PICO 1: early surgery (within 7 days after trauma)	PICO 1: delayed surgery (more than 7 days after trauma)	Length of follow-up: Minimum 6 months Mean follow-up duration:	AOFAS-score *Score 90 – 100 = excellent* *Score 75 – 89 = good* *Score 50 – 74 = fair* *Score < 49 = poor* I: 78.9(53-100)	The author's concluded that: "Patients who underwent implant removal and/or secondary arthrodesis had poorer functional

	Patients from a level-1 trauma centre (Netherlands) between 2000 and 2019 Funding and conflicts of interest: None	- at least 6 month follow-up <u>Exclusion criteria:</u> - patients < 18 years on the last day of FU - more than one year delay at presentation <u>N total at baseline</u>: N = 90 in cohort, outcomes available for n = 73 *PICO 1:* I: 22 (24.4%) C: 68 (75.6%) *Median age:* 32.5 (IQR 23.5 – 50) *Male: 61/90* Talar neck: 47/90 Talar body: 43/90				C: 74.9(28-100) <u>FFI – best score = 0 points</u> I: 15.4(4.8-29.5) C: 17.2(3.3-35.4) <u>Avascular necrosis:</u> I: 3/22 (13.6%) C: 15/68 (19.1%) <u>Osteoarthritis:</u> I: 4/22 (18.1%) C: 22/68 (32.4%) <u>Secondary Arthrodesis:</u> I: 3/22 (13.6%) C: 9/68 (13.2%)	outcome compared to patients who did not undergo additional procedures. Careful consideration of re-intervention must be made in combination with patient expectation management." Definitive surgery was classified as Open Reduction Internal Fixation (screws only or with plate), primary arthrodesis, external fixator, partial bones excision)

Risk of bias table for interventions studies (cohort studies based on risk of bias tool by the CLARITY Group at McMaster University)

Author, year	Selection of participants Was selection of exposed and non-exposed cohorts drawn from the same population?	Exposure Can we be confident in the assessment of exposure?	Outcome of interest Can we be confident that the outcome of interest was not present at start of study?	Confounding-assessment Can we be confident in the assessment of confounding factors?	Confounding-analysis Did the study match exposed and unexposed for all variables that are associated with the outcome of interest or did	Assessment of outcome Can we be confident in the assessment of outcome?	Follow up Was the follow up of cohorts adequate? In particular, was outcome data complete or imputed?	Co-interventions Were co-interventions similar between groups?	Overall Risk of bias

					the statistical analysis adjust for these confounding variables?				
	Definitely yes, probably yes, probably no, definitely no	Definitely yes, probably yes, probably no, definitely no	Definitely yes, probably yes, probably no, definitely no	Definitely yes, probably yes, probably no, definitely no	Definitely yes, probably yes, probably no, definitely no	Definitely yes, probably yes, probably no, definitely no	Definitely yes, probably yes, probably no, definitely no	Definitely yes, probably yes, probably no, definitely no	Low, Some concerns, High
Buckwalter 2017	Definitely yes Reason: Participants selected from hospital records from the same hospital	Probably yes Reason: retrieved from hospital records	Definitely yes Reason: outcomes occurred after the intervention (surgery)	Probably yes Reason: retrieved from hospital records.	Definitely no Reason: no multivariate analysis was performed	Probably yes Reason: retrieved from hospital records	Probably yes; Reason: follow-up duration was mentioned. Missings were excluded.	No information	**High for all outcomes; no correction for confounding factors**
Parmeshwar 2023	Definitely yes Reason: Participants selected from hospital records from the same hospital	No information Probably from hospital records	Definitely yes Reason: outcomes occurred after the intervention (surgery)	No information Probably from hospital records	Probably no Reason: it was stated that randomization was performed, but no clear how this was done within the retrospective design	No information Probably from hospital records	Probably yes; There was no loss to follow-up. Missings excluded?	No information	**Some concerns; uncertainties in the design of the study (retrospective design with randomization)**
Lindval 2004	Definitely yes Reason: Participants selected from hospital records from the same hospital	Probably yes Reason: retrieved from hospital records	Definitely yes Reason: outcomes occurred after the intervention (surgery)	Probably yes Reason: retrieved from hospital records.	Definitely no Reason: no multivariate analysis was performed	Probably yes Reason: retrieved from hospital records	Probably yes; Reason: Missings were excluded.	No information	**High for all outcomes; no correction for confounding factors**
Vallier 2014	Definitely yes	Probably yes	Definitely yes	Probably yes	Definitely no	Probably yes	Probably yes;	No information	**High for all outcomes; no**

	Reason: Participants selected from hospital records from the same hospital	Reason: retrieved from hospital records	Reason: outcomes occurred after the intervention (surgery)	Reason: retrieved from hospital records.	Reason: no multivariate analysis was performed	Reason: retrieved from hospital records	Reason: follow-up duration was mentioned. Missings were excluded.		**correction for confounding factors**
Vints 2018	Definitely yes Reason: Consecutive Participants selected from hospital records from the same hospital	Probably yes Reason: retrieved from hospital records	Definitely yes Reason: outcomes (osteoarthritis) occurred after the intervention (surgery)	Probably yes Reason: retrieved from hospital records.	Definitely no Reason: no multivariate analysis was performed → wel voor de risico factoren!	Probably yes Reason: retrieved from hospital records	Probably yes; Reason: Missings were excluded.	No information	**High for outcome osteoarthritis; no correction for confounding factors**
Wijers 2022	Definitely yes Reason: Consecutive Participants selected from hospital records from the same hospital	Probably yes Reason: retrieved from hospital records	Definitely yes Reason: outcomes (functional outcome, complications) occurred after the intervention (surgery)	Probably yes Reason: retrieved from hospital records.	Definitely no Reason: no multivariate analysis was not performed for the predefined outcomes	Probably yes Reason: retrieved from hospital records	Probably yes; Reason: Missings were excluded.	No information	**High for outcome osteoarthritis; no correction for confounding factors**

Table of excluded studies

Reference	Reason for exclusion
Bellamy JL, Keeling JJ, Wenke J, Hsu JR. Does a longer delay in fixation of talus fractures cause osteonecrosis? J Surg Orthop Adv. 2011 Spring;20(1):34-7. PMID: 21477531.	correlation study on factors associated with osteonecrosis or arthritis (not comparative)
Biz C, Golin N, De Cicco M, Maschio N, Fantoni I, Frizziero A, Belluzzi E, Ruggieri P. Long-term radiographic and clinical-functional outcomes of isolated, displaced, closed talar neck and body fractures treated by ORIF: the timing of surgical management. BMC Musculoskelet Disord. 2019 Aug 7;20(1):363. doi: 10.1186/s12891-019-2738-2. PMID: 31391024; PMCID: PMC6686493.	No comparative study (only delayed fixation for predefined outcomes)
Crate G, Robertson A, Martin A, Marlow NJ, Guryel E, Trompeter A. Talar neck and body fracture outcomes: a multicentre retrospective review. Eur J Orthop Surg Traumatol. 2023 Jan;33(1):99-105. doi: 10.1007/s00590-021-03161-3. Epub 2021 Nov 22. PMID: 34807327.	Wrong comparision: operative vs. non-operative management
Daniels TR, Smith JW. Talar neck fractures. Foot Ankle. 1993 May;14(4):225-34. doi: 10.1177/107110079301400409. PMID: 8359770.	wrong design: overview article, non-systematic review
Dodd A, Lefaivre KA. Outcomes of Talar Neck Fractures: A Systematic Review and Meta-analysis. J Orthop Trauma. 2015 May;29(5):210-5. doi: 10.1097/BOT.0000000000000297. PMID: 25635362.	Not clear how 'early' and 'delayed' fixation is defined and which studies reported this comparison
Fournier A, Barba N, Steiger V, Lourdais A, Frin JM, Williams T, Falaise V, Pineau V, Salle de Chou E, Noailles T, Carvalhana G, Ruhlmann F, Huten D. Total talar fracture - long-term results of internal fixation of talar fractures. A multicentric study of 114 cases. Orthop Traumatol Surg Res. 2012 Jun;98(4 Suppl):S48-55. doi: 10.1016/j.otsr.2012.04.012. Epub 2012 May 22. PMID: 22621831.	No comparative study (outcomes presented for dual and single approaches combined)
Halvorson JJ, Winter SB, Teasdall RD, Scott AT. Talar neck fractures: a systematic review of the literature. J Foot Ankle Surg. 2013 Jan-Feb;52(1):56-61. doi: 10.1053/j.jfas.2012.10.008. Epub 2012 Nov 13. PMID: 23153783.	Wrong design: overview of studies on surgical approaches for talar fractures
Lin S, Hak DJ. Management of talar neck fractures. Orthopedics. 2011 Sep;34(9):715-21. doi: 10.3928/01477447-20110714-16. PMID: 21899238.	Wrong design: overview article
Linder A, Steiger V, Hubert L, Rony L. Clinical and radiological outcomes of internal fixation of complex talar neck and body fractures with locking plates through a dual approach. Orthop Traumatol Surg Res. 2022 Nov;108(7):103368. doi: 10.1016/j.otsr.2022.103368. Epub 2022 Jul 16. PMID: 35850424.	No comparative study (all patients underwent internal fixation by dual approach)
Ohl X, Harisboure A, Hemery X, Dehoux E. Long-term follow-up after surgical treatment of talar fractures: Twenty cases with an average follow-up of 7.5 years. Int Orthop. 2011 Jan;35(1):93-9. doi: 10.1007/s00264-009-0930-y. Epub 2009 Dec 22. PMID: 20033158; PMCID: PMC3014484.	no comparative study (all patients underwengt single approache)
Pflüger P, Zyskowski M, Weber A, Gleisenberg K, Kirchhoff C, Biberthaler P, Crönlein M. Patient reported outcome of 33 operatively treated talar fractures. BMC Musculoskelet Disord. 2021 Aug 16;22(1):698. doi: 10.1186/s12891-021-04572-3. PMID: 34399725; PMCID: PMC8369802.	correlation study on factors associated with PROMs (not comparative)
Tyllianakis, M., Karageorgos, A., Papadopoulos, A.X. et al. Surgical Treatment of Talar Neck Fractures. Eur J Trauma 30, 98–103 (2004). https://doi.org/10.1007/s00068-004-1329-5	no comparative study (all patients underwent fixation within 8 hours)
Wijers O, Posthuma JJ, Engelmann EWM, Schepers T. Complications and Functional Outcome Following Operative Treatment of Talus Neck and Body Fractures: A Systematic Review. Foot Ankle Orthop. 2022 Sep 30;7(3):24730114221127201. doi: 10.1177/24730114221127201. PMID: 36199382; PMCID: PMC9528034.	Wrong design: systematic review on any surgical technique (combined) and associated outcomes/comlications (not comparative)
Wu K, Zhou Z, Huang J, Lin J, Wang Q, Tao J. Talar Neck Fractures Treated Using a Highly Selective Incision: A Case-Control Study and Review of the Literature. J Foot Ankle Surg. 2016 May-Jun;55(3):450-5. doi: 10.1053/j.jfas.2016.02.002. Epub 2016 Mar 5. PMID: 26961417.	wrong comparision: dual versus dual approach
Xue Y, Zhang H, Pei F, Tu C, Song Y, Fang Y, Liu L. Treatment of displaced talar neck fractures using delayed procedures of plate fixation through dual approaches. Int Orthop. 2014 Jan;38(1):149-54. doi:	No comparative study (only dual approaches)

10.1007/s00264-013-2164-2. Epub 2013 Dec 3. PMID: 24297608; PMCID: PMC3890131.	

Literature search strategy bij module talus fracturen

Algemene informatie

Cluster/richtlijn: NVvH traumatisch complexe voetletsels	
Uitgangsvraag/modules: UV2 welk moment van behandelen en welke techniek reduceert de meest voorkomende gevolgen (korte en lange termijn) van Talus fracturen?	
Database(s): Embase.com, Ovid/Medline	Datum: 17 mei
Periode: geen restrictie	Talen: geen restrictie
Literatuurspecialist: Alies van der Wal	Rayyan review: https://rayyan.ai/reviews/672889
BMI-zoekblokken: voor verschillende opdrachten wordt (deels) gebruik gemaakt van de zoekblokken van BMI-Online https://blocks.bmi-online.nl/ Bij gebruikmaking van een volledig zoekblok zal naar de betreffende link op de website worden verwezen.	
Toelichting: Voor deze vraag is gezocht op de elementen: PICO A - Talus fracturen - Chirurgie - Timing PICO B - Talus fracturen - 1 versus 2 incisies De sleutelartikelen worden gevonden met deze search	

5 ***Zoekopbrengst***

	EMBASE	**OVID/MEDLINE**	**Ontdubbeld**
SR	16	13	22
RCT	32	25	42
Observationele studies	180	191	289
Totaal	228	229	**353***

in Rayyan

Zoekstrategie

Embase.com

No.	**Query**	**Results**
#15	#8 AND (#11 OR #12) NOT (#13 OR #14) = observationeel	180
#14	#8 AND #10 NOT #13 = RCT	32
#13	#8 AND #9 = SR	16
#12	'case control study'/de OR 'comparative study'/exp OR 'control group'/de OR 'controlled study'/de OR 'controlled clinical trial'/de OR 'crossover procedure'/de OR 'double blind procedure'/de OR 'phase 2 clinical trial'/de OR 'phase 3 clinical trial'/de OR 'phase 4 clinical trial'/de OR 'pretest posttest design'/de OR 'pretest posttest control group design'/de OR 'quasi experimental study'/de OR 'single blind procedure'/de OR 'triple blind procedure'/de OR (((control OR controlled) NEAR/6 trial):ti,ab,kw) OR (((control OR controlled) NEAR/6 (study OR studies)):ti,ab,kw) OR (((control OR controlled) NEAR/1 active):ti,ab,kw) OR 'open label*':ti,ab,kw OR (((double OR two OR three OR multi OR trial) NEAR/1 (arm OR arms)):ti,ab,kw) OR ((allocat* NEAR/10 (arm OR arms)):ti,ab,kw) OR placebo*:ti,ab,kw OR 'sham-control*':ti,ab,kw OR (((single OR double OR triple OR assessor) NEAR/1 (blind* OR masked)):ti,ab,kw) OR nonrandom*:ti,ab,kw OR 'non-random*':ti,ab,kw OR 'quasi-experiment*':ti,ab,kw OR crossover:ti,ab,kw OR 'cross over':ti,ab,kw OR 'parallel group*':ti,ab,kw OR 'factorial trial':ti,ab,kw OR ((phase NEAR/5 (study OR trial)):ti,ab,kw) OR ((case* NEAR/6 (matched OR control*)):ti,ab,kw) OR ((match* NEAR/6 (pair OR pairs OR cohort* OR control* OR group* OR healthy OR age OR sex OR gender OR patient* OR subject* OR participant*)):ti,ab,kw) OR ((propensity NEAR/6 (scor* OR match*)):ti,ab,kw) OR versus:ti OR vs:ti OR compar*:ti OR ((compar* NEAR/1 study):ti,ab,kw) OR (('major clinical study'/de OR 'clinical study'/de OR 'cohort analysis'/de OR 'observational study'/de OR 'cross-sectional study'/de OR 'multicenter study'/de OR 'correlational	14084222

	study'/de OR 'follow up'/de OR cohort*:ti,ab,kw OR 'follow up':ti,ab,kw OR followup:ti,ab,kw OR longitudinal*:ti,ab,kw OR prospective*:ti,ab,kw OR retrospective*:ti,ab,kw OR observational*:ti,ab,kw OR 'cross sectional*':ti,ab,kw OR cross?ectional*:ti,ab,kw OR multicent*:ti,ab,kw OR 'multi-cent*':ti,ab,kw OR consecutive*:ti,ab,kw) AND (group:ti,ab,kw OR groups:ti,ab,kw OR subgroup*:ti,ab,kw OR versus:ti,ab,kw OR vs:ti,ab,kw OR compar*:ti,ab,kw OR 'odds ratio*':ab OR 'relative odds':ab OR 'risk ratio*':ab OR 'relative risk*':ab OR 'rate ratio':ab OR aor:ab OR arr:ab OR rrr:ab OR ((('or' OR 'rr') NEAR/6 ci):ab)))	
#11	'major clinical study'/de OR 'clinical study'/de OR 'case control study'/de OR 'family study'/de OR 'longitudinal study'/de OR 'retrospective study'/de OR 'prospective study'/de OR 'comparative study'/de OR 'cohort analysis'/de OR ((cohort NEAR/1 (study OR studies)):ab,ti) OR (('case control' NEAR/1 (study OR studies)):ab,ti) OR (('follow up' NEAR/1 (study OR studies)):ab,ti) OR (observational NEAR/1 (study OR studies)) OR ((epidemiologic NEAR/1 (study OR studies)):ab,ti) OR (('cross sectional' NEAR/1 (study OR studies)):ab,ti)	7640365
#10	'clinical trial'/exp OR 'randomization'/exp OR 'single blind procedure'/exp OR 'double blind procedure'/exp OR 'crossover procedure'/exp OR 'placebo'/exp OR 'prospective study'/exp OR rct:ab,ti OR random*:ab,ti OR 'single blind':ab,ti OR 'randomised controlled trial':ab,ti OR 'randomized controlled trial'/exp OR placebo*:ab,ti	3789294
#9	'meta analysis'/exp OR 'meta analysis (topic)'/exp OR metaanaly*:ti,ab OR 'meta analy*':ti,ab OR metanaly*:ti,ab OR 'systematic review'/de OR 'cochrane database of systematic reviews'/jt OR prisma:ti,ab OR prospero:ti,ab OR (((systemati* OR scoping OR umbrella OR 'structured literature') NEAR/3 (review* OR overview*)):ti,ab) OR ((systemic* NEAR/1 review*):ti,ab) OR (((systemati* OR literature OR database* OR 'data base*') NEAR/10 search*):ti,ab) OR (((structured OR comprehensive* OR systemic*) NEAR/3 search*):ti,ab) OR (((literature NEAR/3 review*):ti,ab) AND (search*:ti,ab OR database*:ti,ab OR 'data base*':ti,ab)) OR (('data extraction':ti,ab OR 'data source*':ti,ab) AND 'study selection':ti,ab) OR ('search strategy':ti,ab AND 'selection criteria':ti,ab) OR ('data source*':ti,ab AND 'data synthesis':ti,ab) OR medline:ab OR pubmed:ab OR embase:ab OR cochrane:ab OR (((critical OR rapid) NEAR/2 (review* OR overview* OR synthes*)):ti) OR ((((critical* OR rapid*) NEAR/3 (review* OR overview* OR synthes*)):ab) AND (search*:ab OR database*:ab OR 'data base*':ab)) OR metasynthes*:ti,ab OR 'meta synthes*':ti,ab	926537
#8	#7 NOT ('conference abstract'/it OR 'editorial'/it OR 'letter'/it OR 'note'/it) NOT (('animal'/exp OR 'animal experiment'/exp OR 'animal model'/exp OR 'nonhuman'/exp) NOT 'human'/exp)	606
#7	#4 OR #6	695
#6	#1 AND #5	95
#5	'surgical approach'/exp AND (dual:ti,ab,kw OR double:ti,ab,kw OR single:ti,ab,kw) OR (((dual OR double OR single) NEAR/3 (approach* OR incision* OR anterior OR antero* OR lateral* OR medial*)):ti,ab,kw) OR (((anterolateral* OR 'antero lateral*') NEAR/3 (anteromedial* OR 'antero medial*')):ti,ab,kw) OR ((incision* NEAR/3 (1 OR one OR 2 OR two)):ti,ab,kw) OR 'combined approach*':ti,ab,kw OR ((single NEAR/3 (dual OR double)):ti,ab,kw)	121730
#4	#1 AND #2 AND #3	620
#3	'timing'/exp OR 'timing of surgery'/exp OR 'time factor'/exp OR 'time to treatment'/exp OR timing:ti,ab,kw OR timely:ti,ab,kw OR 'time factor*':ti,ab,kw OR early:ti,ab,kw OR immediate*:ti,ab,kw OR urgent:ti,ab,kw OR delay*:ti,ab,kw OR postpon*:ti,ab,kw OR 're intervention*':ti,ab,kw OR reintervention*:ti,ab,kw OR definitive:ti,ab,kw OR definite:ti,ab,kw OR temporary:ti,ab,kw	4342992
#2	'ankle arthrodesis'/exp OR 'subtalar arthrodesis'/exp OR 'arthrodesis'/mj OR 'fracture fixation'/exp OR 'fracture reduction'/exp OR 'open reduction (procedure)'/exp OR 'orthopedic implant'/exp OR 'foot surgery'/de OR 'arthrodes*':ti,ab,kw OR grice:ti,ab,kw OR arthroscop*:ti,ab,kw OR fixat*:ti,ab,kw OR reduction:ti,ab,kw OR stabilization:ti,ab,kw OR screw*:ti,ab,kw OR plate*:ti,ab,kw OR wire*:ti,ab,kw OR kirschner:ti,ab,kw OR pin*:ti,ab,kw OR nail*:ti,ab,kw OR (((talar OR talus OR subtalar* OR ankle) NEAR/3 fusion):ti,ab,kw) OR 'osteo synthes*':ti,ab,kw OR 'osteosynthes*':ti,ab,kw	3050110
#1	'talus fracture'/exp OR (((talar OR talus OR subtalar* OR 'os talare' OR astralagus) NEAR/3 (fractur* OR broken OR dislocat* OR displac* OR trauma* OR injur*)):ti,ab,kw) OR (((talar OR talus) NEAR/3 (neck OR body OR central) NEAR/3 (fractur* OR broken OR dislocat* OR displac* OR luxat* OR trauma* OR injur*)):ti,ab,kw) OR ('talus'/exp AND ('fracture'/exp OR 'dislocation'/exp OR 'bone injury'/exp OR 'injury'/exp))	4374

Ovid/Medline

#	Searches	Results
15	(7 and (11 or 12)) not (13 or 14) = observationeel	191
14	(7 and 10) not 13 = RCT	25

13	8 and 9 = SR	13
12	Case-control Studies/ or clinical trial, phase ii/ or clinical trial, phase iii/ or clinical trial, phase iv/ or comparative study/ or control groups/ or controlled before-after studies/ or controlled clinical trial/ or double-blind method/ or historically controlled study/ or matched-pair analysis/ or single-blind method/ or (((control or controlled) adj6 (study or studies or trial)) or (compar* adj (study or studies)) or ((control or controlled) adj1 active) or "open label*" or ((double or two or three or multi or trial) adj (arm or arms)) or (allocat* adj10 (arm or arms)) or placebo* or "sham-control*" or ((single or double or triple or assessor) adj1 (blind* or masked)) or nonrandom* or "non-random*" or "quasi-experiment*" or "parallel group*" or "factorial trial" or "pretest posttest" or (phase adj5 (study or trial)) or (case* adj6 (matched or control*)) or (match* adj6 (pair or pairs or cohort* or control* or group* or healthy or age or sex or gender or patient* or subject* or participant*)) or (propensity adj6 (scor* or match*))).ti,ab,kf. or (confounding adj6 adjust*).ti,ab. or (versus or vs or compar*).ti. or ((exp cohort studies/ or epidemiologic studies/ or multicenter study/ or observational study/ or seroepidemiologic studies/ or (cohort* or 'follow up' or followup or longitudinal* or prospective* or retrospective* or observational* or multicent* or 'multi-cent*' or consecutive*).ti,ab,kf.) and ((group or groups or subgroup* or versus or vs or compar*).ti,ab,kf. or ('odds ratio*' or 'relative odds' or 'risk ratio*' or 'relative risk*' or aor or arr or rrr).ab. or (("OR" or "RR") adj6 CI).ab.))	5426090
11	Epidemiologic studies/ or case control studies/ or exp cohort studies/ or Controlled Before-After Studies/ or Case control.tw. or cohort.tw. or Cohort analy$.tw. or (Follow up adj (study or studies)).tw. or (observational adj (study or studies)).tw. or Longitudinal.tw. or Retrospective*.tw. or prospective*.tw. or consecutive*.tw. or Cross sectional.tw. or Cross-sectional studies/ or historically controlled study/ or interrupted time series analysis/ [Onder exp cohort studies vallen ook longitudinale, prospectieve en retrospectieve studies]	4440503
10	exp clinical trial/ or randomized controlled trial/ or exp clinical trials as topic/ or randomized controlled trials as topic/ or Random Allocation/ or Double-Blind Method/ or Single-Blind Method/ or (clinical trial, phase i or clinical trial, phase ii or clinical trial, phase iii or clinical trial, phase iv or controlled clinical trial or randomized controlled trial or multicenter study or clinical trial).pt. or random*.ti,ab. or (clinic* adj trial*).tw. or ((singl* or doubl* or treb* or tripl*) adj (blind$3 or mask$3)).tw. or Placebos/ or placebo*.tw.	2589353
9	meta-analysis/ or meta-analysis as topic/ or (metaanaly* or meta-analy* or metanaly*).ti,ab,kf. or systematic review/ or cochrane.jw. or (prisma or prospero).ti,ab,kf. or ((systemati* or scoping or umbrella or "structured literature") adj3 (review* or overview*)).ti,ab,kf. or (systemic* adj1 review*).ti,ab,kf. or ((systemati* or literature or database* or data-base*) adj10 search*).ti,ab,kf. or ((structured or comprehensive* or systemic*) adj3 search*).ti,ab,kf. or ((literature adj3 review*) and (search* or database* or data-base*)).ti,ab,kf. or (("data extraction" or "data source*") and "study selection").ti,ab,kf. or ("search strategy" and "selection criteria").ti,ab,kf. or ("data source*" and "data synthesis").ti,ab,kf. or (medline or pubmed or embase or cochrane).ab. or ((critical or rapid) adj2 (review* or overview* or synthes*)).ti. or (((critical* or rapid*) adj3 (review* or overview* or synthes*)) and (search* or database* or data-base*)).ab. or (metasynthes* or meta-synthes*).ti,ab,kf.	668775
8	7 not (comment/ or editorial/ or letter/) not ((exp animals/ or exp models, animal/) not humans/)	482
7	4 or 6	486
6	1 and 5	61
5	(((dual or double or single) adj3 (approach* or incision* or anterior or antero* or lateral* or medial*)) or ((anterolateral* or 'antero lateral*') adj3 (anteromedial* or 'antero medial*')) or (incision* adj3 (one or two)) or 'combined approach*' or (single adj3 (dual or double))).ti,ab,kf.	71330
4	1 and 2 and 3	437
3	exp Time Factors/ or timing.ti,ab,kf. or timely.ti,ab,kf. or 'time factor*'.ti,ab,kf. or early.ti,ab,kf. or immediate*.ti,ab,kf. or urgent.ti,ab,kf. or delay*.ti,ab,kf. or postpon*.ti,ab,kf. or 're intervention*'.ti,ab,kf. or reintervention*.ti,ab,kf. or definitive.ti,ab,kf. or definite.ti,ab,kf. or temporary.ti,ab,kf.	4130277
2	Arthrodesis/ or exp Fracture Fixation/ or exp Internal Fixators/ or 'arthrodes*'.ti,ab,kf. or grice.ti,ab,kf. or arthroscop*.ti,ab,kf. or fixat*.ti,ab,kf. or reduction.ti,ab,kf. or stabilization.ti,ab,kf. or screw*.ti,ab,kf. or plate*.ti,ab,kf. or wire*.ti,ab,kf. or kirschner.ti,ab,kf. or pin*.ti,ab,kf. or nail*.ti,ab,kf. or ((talar or talus or subtalar* or ankle) adj3 fusion).ti,ab,kf. or 'osteo synthes*'.ti,ab,kf. or 'osteosynthes*'.ti,ab,kf.	2261937
1	(((talar or talus or subtalar* or 'os talare' or astralagus) adj3 (fractur* or broken or dislocat* or displac* or trauma* or injur*)) or ((talar or talus) adj3 (neck or body or central) adj3 (fractur* or broken or dislocat* or displac* or luxat* or trauma* or injur*))).ti,ab,kf. or (exp Talus/ and (exp Fractures, Bone/ or exp "Wounds and Injuries"/))	3012

Module 3 Calcaneus fracturen

Uitgangsvraag: Welke behandeling reduceert de meest voorkomende negatieve gevolgen (korte en lange termijn) van calcaneus fracturen?

Inleiding

Tot dusver laten gerandomiseerde studies wisselende uitkomsten zien ten faveure van operatieve of conservatieve behandeling. Zo geeft een operatieve behandeling wellicht minder kans op post-traumatische artrose, maar wel risico op complicaties van de behandeling (bv. wondgenezingsstoornissen). Naast de vraag wat de meest optimale behandeling is, is er ook onduidelijkheid over hoe de operatieve behandeling het beste uitgevoerd kan worden (extended lateraal,sinus tarsi benadering, of percutane repositie en schroeven).

Search and select

A systematic review of the literature was performed to answer the following question:

PICO A: Operative fixation versus conservative treatment

What are the risks and benefits of operative fixation compared to conservative treatment of displaced intra-articular calcaneal fractures?

P = patients with displaced intra-articular calcaneal fractures
I = operative management
C = conservative management
O = Böhler's Angle, functional outcome (AOFAS), complications (infection, rebleed, nerve damage), malunion, nonunion, (osteo)arthritis

PICO B: Percutaneous and sinus tarsi approach versus extended lateral approach

What are the risks and benefits of surgery via minimal invasive approaches such as percutaneous or sinus tarsi approaches compared to the extend lateral approach in displaced intra-articular calcaneal fractures?

P = patients with displaced intra-articular calcaneal fractures
I = Percutaneous and sinus tarsi approach (operative fixation)
C = extended lateral approach (operative fixation)
O = Böhler's Angle, functional outcome (AOFAS), complications (infection, rebleed, nerve damage), malunion, nonunion, (osteo)arthritis

<u>Relevant outcome measures</u>

The guideline development group considered **functional outcome** and **arthritis** as critical outcome measures for decision making and **complications**, **malunion and nonunion** as important outcome measures for decision making.

A priori, the guideline development group defined functional outcome as measured with the American Orthopaedic Foot and Ankle Society (AOFAS) score. For the other outcome measures listed above, the working group decided to use the definitions used in the studies.

For the predefined outcomes the working group defined the minimal clinically (patient) important differences as follows:

- Bohler's Angle: 15 degrees
- Functional outcome (AOFAS): 10 points

- Dichotomous outcomes (complications, malunion, nonunion of arthritis): Risk Ratio (RR) <0.80 and >1.25 or risk difference (RD) 10%

Search and select (Methods)

The databases Medline (via OVID) and Embase (via Embase.com) were searched with relevant search terms until the 11th of January 2023. The detailed search strategy is depicted under the tab Methods. The systematic literature search resulted in 591 hits. Studies were selected based on the following criteria: systematic reviews and randomized controlled trials comparing A) operative management with conservative management or B) percutaneous and sinus tarsi approach with extended lateral approach. Thirty-five studies were initially selected based on title and abstract screening. After reading the full text, 24 studies were excluded (see the table with reasons for exclusion under the tab Methods), and eleven studies were included.

Results

Three systematic reviews (describing eighteen relevant trials) and eight RCTs were included in the analysis of the literature. Important study characteristics and results are summarized in the evidence tables. The assessment of the risk of bias is summarized in the risk of bias tables.

Summary of literature

Description of studies

PICO A: Operative fixation versus conservative treatment

Selim (2022) performed a systematic review on the management of displaced intra-articular calcaneal fractures. Studies comparing operative management with non-operative management were eligible for inclusion. The databases Medline, Embase and the Cochrane library were searched for relevant articles published until December 2021. Inclusion criteria were: RCTs and prospective comparative studies, comparing non-operative and operative management of displaced intra-articular calcaneal fractures were included. Cadaveric studies, studies published in non-English language and biomechanical studies of treatment options were excluded. In total, thirteen trials were included in the systematic review, of which nine were considered relevant for the purpose of this guideline (**Agren, 2013; Bahari Kashani 2013; Buckley, 2002; Dickenson, 2021; Griffin, 2014; Ibrahim, 2007; Nouraei, 2011; Parmar, 1993; Thordarson, 1996**). The baseline characteristics of these studies are presented in Table 1. Studies that were not considered relevant for this guideline were excluded because the studies did not report any of the predefined outcomes (Sharma, 2011) or because of an observational study design (O'Farell, 1993; Rodriguez-Merchan, 1999; Kamath, 2021). Outcomes that were reported included AOFAS-score, complications (types of complications not further specified) and development of arthritis. Risk of bias in the individual studies was assessed with the Cochrane Risk of Bias tool. There was no blinding of the study participants and personnel in all studies.

Table 1: baseline characteristics of the studies included in Selim (2022) that were considered relevant for the purpose of this guideline.

	Country	Size study population (OF/C)	Mean age, years (OF/C)	% male (total population) *	Follow-up, years (OF/C)
Agren 2013	Sweden	39/37	49/48	not reported	12/12
Bahari Kashani 2013	Iran	84/56	not reported	79	not reported
Buckely 2002	Canada	206/218	41/39	90	3/3
Dickenson 2021	UK	52/66	45	not reported	5/5
Griffin 2014	UK	73/78	45/48	not reported	2/2
Ibrahim 2007	UK	15/11	61/58	91	15/15

Nouraei 2011	Iran	31/30	46/52	Not reported	3/3
Parmar 1993	England	25/31	48/48	86	2/2
Thorardson 1996	USA	15/11	35/36	91	1/1

Abbreviations: OF = operative fixation, C = conservative treatment
*% not specified for intervention/control group

Hussain (2022) performed a randomized controlled trial to make a comparison between functional results in intra-articular calcaneal fractures which are treated conservatively and those which are treated operatively. The study was executed in a hospital in Pakistan. Patients presenting at the hospital with displaced intra-articular calcaneal fractures were randomized by computer-generated random numbers, to operative treatment (n = 16) or conservative treatment (n = 16). All patients had Sander's type II (52%) and type III (48%) calcaneal fractures, that were less than 3 weeks old. Patients with calcaneal fractures connected with spinal injuries, pathological fractures, peripheral vasculopathy or any medical contraindication to surgery were excluded. Bohler's Angle at 1 year follow-up was reported as an outcome.

PICO B: Percutaneous and sinus tarsi approach versus extended lateral approach

This main comparison was subdivided into two sub-comparisons, based on approach that was used for fixation.

- Comparison 1: Percutaneous Fixation (PRF) versus Extended Lateral Approach (ELA)
- Comparison 2: Sinus Tarsi Approach (STA) versus Extended Lateral Approach (ELA)

1. PERCUTANEOUS FIXATION (PRF) VERSUS EXTENDED LATERAL APPROACH (ELA)

*The studies mentioned below were extracted from the systematic review of **Shi (2020).** In this systematic review, a network meta-analysis was performed to evaluate the radiographic characteristics, clinical effectiveness and incision complications of non-operative treatment, open-reduction and internal fixation, minimally invasive reduction and fixation. In this review, a literature search was conducted until 30 December 2019. Studies comparing PRF with ELA were considered relevant for this subcomparison. Since Shi (2020) only reported pooled results, and no data per individual study that was included, it was decided to retrieve the required data from the original papers (Chen, 2011; Sampath Kumar, 2014; Lu, 2015). As the trials from Qi (2009) and Qi (2013) were only published in Chinese, the relevant data could not be extracted.*

Chen (2011; from Shi, 2020) performed a randomized controlled trial to compare the outcome of percutaneous reduction, cannulated screw fixation and calcium sulphate cement (CSC) grafting, with the outcomes of traditional open reduction and internal fixation (ORIF), through an extended lateral approach in patients with displaced intra-articular calcaneus fractures. Patients presenting at a Chinese hospital with displaced intra-articular calcaneal fractures including Sanders Type IIB, Type IIC and some Type III were eligible to participate. Additional inclusion criteria were: operative treatment possible within 7 days of injury (some patients with significant swelling could wait for two weeks), closed fractures and unilateral fractures. Patients with known local or systemic infection, medical contraindications or patients with Sanders Type IV and Sanders Type IIA and open fractures were excluded. Patients were randomly divided to percutaneous reduction + CSC (n = 38) or ORIF trough ELA (n = 40). The average time from trauma to operation was 5 days (range 0 to 7), the mean follow-up duration was 24 months (range 18 – 30). Outcomes included Böhler's angle, AOFAS and infection.

Sampath Kumar (2014; from Shi, 2020) performed a randomized controlled trial to compare minimally invasive percutaneous fixation, with ORIF with an extended lateral approach. Patients with displaced intra-articular fractures of the calcaneus and who presented within 3 weeks after the injury at a hospital in India were included in the trial. Exclusion criteria were: patients with open wound,

peripheral vascular disease, skin infection, signs of compartment syndrome, patients with neurologic deficit following head injury or spinal injury and patients with fractures involving other bones of the other limb. Patients were randomized to minimally invasive percutaneous fixation (n = 22) or ORIF (n = 23), by lottery method. Bilateral fractures were included and randomized by individual fracture. Patients had Sanders Type II, Sanders Type III and Sanders Type IV fractures. Outcomes were assessed at 1.5, three, six- and twelve-months follow-up. One patient from the minimally invasive group, and two patients from the ORIF group were lost to follow-up. Outcomes that were reported included wound complications, including infection. The improvement in Böhler's angle was also reported.

Lu (2015; from Shi 2020) conducted a prospective parallel controlled study to compare ORIF through ELA vs. minimally invasive manipulative reduction with percutaneous k-wire fixation. This trial included 96 patients with closed calcaneal fractures who were admitted to a Chinese hospital. Both groups consisted of 48 patients. Exclusion criteria were: patients of age <18 years or >65 years, simple non-displaced calcaneal fractures, severe collapsed comminuted fractures, patients with severe liver and kidney disorders, psychiatric disorders or accompanied with other severe trauma and open fractures. Patients had Sanders Type II and Type III fractures, consisting of tongue type fractures and compression fractures. Reported outcomes were complications after six months of follow-up (unstable internal fixation, neural and vascular injuries, unfavorable healing).

RCTs published after Shi (2020)

Giray Batıbay (2020) performed a randomized controlled trial to compare closed reduction using dual-point distraction and PRF with ELA. In total, 35 patients with calcaneal fractures who presented to the emergency department (Turkey) between January 2017 and February 2018 were included in the trial. Seventeen patients received PRF treatment and 18 patients received treatment via ELA. Randomization was performed by creating a variable block schedule on a computer system. Patients with diabetes mellitus, osteoporosis and a history of osteoporosis drug therapy, previous ipsilateral foot surgery or fracture, chronic fracture and open fracture were excluded. Patients had Sanders type II, type III and type IV fractures. Outcomes of the study included complication rate (wound complications and postoperative peroneal tendinopathy), AOFAS at 6 months and final follow-up visit, and pre- and postoperative Böhler's angle.

Li (2020) conducted a randomized controlled trial in which the operation techniques percutaneous reduction and hollow screw fixation (group A) was compared with ORIF with L-shaped lateral approach (group B) among patients with displaced intra-articular calcaneal fractures. In total, 71 patients with calcaneal fractures admitted to a Chinese trauma center from July 2015 to December 2018 were recruited. Twelve patients were excluded since they were followed up for shorter than 12 months. Other exclusion criteria were patients with previous history of calcaneal fracture, other fractures in addition to calcaneal fractures, long-term smoking and diabetes which may affect the prognosis. The final analytical sample was composed of 59 patients, with 31 patients in group A and 28 patients in group B. Patients in both groups had Sanders type II, III, and IV calcaneal fractures. Reported outcomes were AOFAS hindfoot score, pre- and postoperative Böhler's angle and soft tissue complications (superficial infection, deep infection, wound edge necrosis, and sural nerve injury).

Vora (2022) conducted a hospital-based, double-blind, prospective, randomized, comparative clinical study at the department of Orthopedics, of a tertiary medical hospital in India. In total, 30 patients with closed displaced intra-articular calcaneal fractures with at least 2 mm displacement, were recruited from December 2017 to September 2019, and either received closed reduction using the Essex Lopresti technique (n=15) or ORIF with plating, using the lateral universal approach of calcaneum (n=15). Exclusion criteria were patients with pathological fractures, Gustilo grade III open fracture, and those with neurological deficits. Follow-ups were done at 6 weeks, 2 months, 3 months,

and 6 months postoperatively. Reported outcomes were AOFAS hindfoot score, pre- and post-operative Böhler's angle (at each follow-up visit), and complications (malunion, infection, wound dehiscence).

A randomized controlled trial was conducted by **Zhai 2021**, in which the effect of closed reduction with cannulated screw internal fixation with plate internal fixation was compared in patients with calcaneal fractures. In total, 60 patients with calcaneal fractures admitted to a Chinese hospital between April 2015 and April 2019 were enrolled in the study and randomly divided in two groups. Thirty patients in group A were operated with closed reduction with hollow screw internal fixation, and 30 patients in group B received open reduction with special-shaped plate internal fixation. Exclusion criteria were patients with open fracture or dated fracture, patients with ankle fracture or tarsal fracture, patients with the history of ankle injury, patients with the ankle dysfunction in the affected limb prior to the fracture, patients with the pathological fracture due to the primary osteogenic tumor, osteoid lesion, cystic pathogenic damage or bone metastases, patients with diseases in nervous system or mental disease. Follow-ups were conducted between three and 15 months after surgery. Reported outcomes were pre- and postoperative Böhler's angle, intraoperative and postoperative complications (nerve damage, wound infection, marginal necrosis of skin, subtalar arthritis).

2. SINUS TARSI APPROACH (STA) VERSUS EXTENDED LATERAL APPROACH (ELA)

Peng (2021) executed a systematic review and meta-analysis on the STA compared with the ELA. A search was performed in the Pubmed, Embase and Cochrane databases on June 2019, for studies comparing STA with ELA in the surgical treatment of calcaneal fractures using internal fixation. Studies in adult calcaneal fracture patients, comparing postoperative outcomes of calcaneal fractures via STA and ELA were included. Eligible study designs were prospective cohort studies, controlled clinical trials and RCTs. Animal or cadaveric studies, and studies from which valid data could not be extracted or converted were excluded from the review. In total, 18 studies were included in the systematic review, of which six were considered relevant for the purpose of this guideline (**Basile, 2016; Bin Jia, 2017; Cheng, 2017; Li, 2016; Xia, 2014; Zhu, 2013**). The baseline characteristics of these studies are presented in Table 2.The other studies included in the review were not considered relevant as these were observational studies, or non-randomized trials. The relevant trials compared STA and plate fixation with ELA and plate fixation. Outcomes that were reported included Bohler's Angle, AOFAS-score and complications (wound infections and nerve injury). Risk of bias of the individual studies was assessed with the Jadad Risk of Bias tool for RCTs. The author's evaluated that most included studies had a low risk of bias. However, after consulting the full text articles of the included studies, there appears to be some inconsistency in the information reported in the review. This introduces some concerns regarding the quality of the systematic review.

Table 2: baseline characteristics of the studies included in Peng (2021) that were considered relevant for the purpose of this guideline.

	Size Study population (STA/ELA)	Mean age, years (STA/ELA)	Female (n) (STA/ELA)	Follow-up, months	fixation type (STA/ELA)
Basile 2016			5/5	24	Plates/plates
Bin Jia 2017	60/60	38.6 / 35.8	20/23	12	Plates/plates
Cheng 2017	33/33	36.2 / 35.1	8/11	Not reported	Plates/plates
Li 2016	32/32	40 / 41	86*	12	Plates/plates
Xia 2014	53/64	38 / 37	38/37	28	Plates/plates
Zhu 2013	18/20	36.6 / 36.4	5/7	15	Plates/plates

Abbreviations: STA = Sinus Tarsi Approach, ELA = Extended Lateral Approach
*not specified for intervention/control group

RCTs published after Peng (2021)

Park (2021) executed a randomized controlled trial to evaluate the hypothesis that a STA would lead to fewer wound complications than ELA in Sanders Type II calcaneal fractures. The study was executed in a South-Korean hospital. Inclusion criteria were: adult patients (>18 years), **Sanders Type 2A and 2B calcaneal fractures**, surgery by a single surgeon and patients followed-up for more than one year. Patients with open or bilateral calcaneal fractures were excluded, as well as patients with concomitant head or neurovascular injury. In total 64 patients met the inclusion criteria and were randomized to either STA (n = 32) or ELA (n = 32). Outcomes were assessed at six and at twelve months follow-up. All patients completed the twelve-month follow-up. The primary outcome was wound complications, including both minor and major complications. Minor complications were defined as superficial infections and superficial marginal wound necroses that could be managed without reoperation or with small procedures (minor injuries). Major wound complications included deep infection and deep marginal wound necrosis involving the implants and the bones requiring reoperation. Additional outcomes that were reported included AOFAS, Böhlers Angle and the presence of sural nerve injury.

Rastegar (2021) performed a randomized controlled trial to compare minimally invasive techniques (STA) with ELA in patients with calcaneus fractures. The study was executed in two hospitals in Iran. Patients aged 18-75 years, with intra-articular fractures of the calcaneus (displacement > 2 mm) were eligible to participate, except for patients with open fractures or Sanders Type 4 fractures. Exclusion criteria were: patients with a history of surgery, osteoarthritis, inflammatory arthritis in the foot and ipsilateral ankle, patients with major comorbidities or patients with fractures due to secondary causes at the operation site. Patients were randomly allocated to the minimally invasive approach (n = 15) or ELA (n =15), according to an allocation sequence that was generated by statistical software. Follow-up was at three, six and twelve months. Patients without adequate follow-up were excluded from the study population. The reported outcomes, at twelve months follow-up, were Bohler's angle and soft tissue complications, including surgical site infection, surgical wound dehiscence, bread union or delayed union, erythema, or cellulitis. Additionally, it was reported that AOFAS was assessed, however, data on this measure were not reported in the article.

Zhang (2020) performed a randomized controlled trial to compare the efficacy of the tarsal sinus approach and the lateral extended approach on intra-articular calcaneal fractures. Patients presenting at a Chinese hospital with closed, Sanders Type II or Type III intra-articular calcaneal fractures were eligible to participate. Patients with extra-articular fractures, bilateral fractures, contra-indications, comorbidities, or foot deformities were excluded. In total 53 patients were randomized to undergo STA, and 53 patients were randomized to ELA. The follow-up duration was six months. Outcomes included AOFAS, Böhler's angle, complications (infection and nerve injury) and delayed union.

Results

PICO A: Operative fixation versus conservative treatment

Functional outcome (AOFAS)

Four studies from the systematic review by Selim (2022) reported the outcome AOFAS (Agren, 2013; Griffin, 2014; Ibrahim, 2007; Thorardson, 1996). The results were pooled in a meta-analysis. The Mean Difference (MD) between the operative group (n = 142) and the conservative group (n = 137) was 6.68 (95% CI: -3.38 to 17.24), see Figure 1. This was not considered clinically relevant.

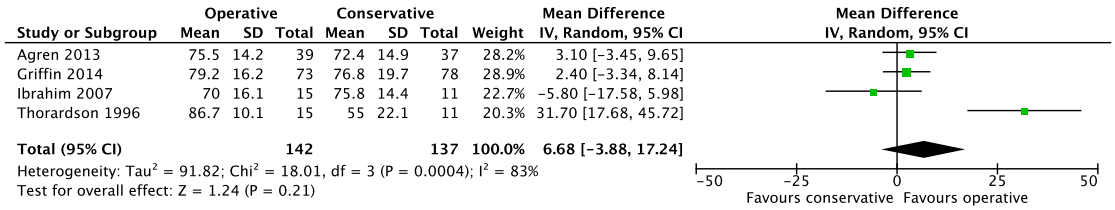

Figure 1. Forest plot showing the comparison of operative fixation with conservative treatment for calcaneal fractures on Functional outcome (AOFAS-score). Pooled relative risk ratio, random effects model. Z: p-value of overall effect; df: degrees of freedom; SD: standard deviation; I^2; statistical heterogeneity; CI: confidence interval.

(Osteo)arthritis

Six studies from the systematic review by Selim (2022) reported the outcome arthritis (Agren, 2013; Bahari Kashani, 2013; Dickenson, 2021; Griffin, 2014; Ibrahim, 2007; Nouraei 2011). The results were pooled in a meta-analysis. The pooled number of patients experiencing arthritis was 81/294 (27.5%) in the operative group, compared to 49/278 (17.6%) in the conservative group. The Risk Ratio (RR) was 1.16 (95% CI 0.54 to 2.50), see figure 2. The pooled Risk Difference (RD) was 0.03 (95% CI -0.11 to 0.16), see figure 3.

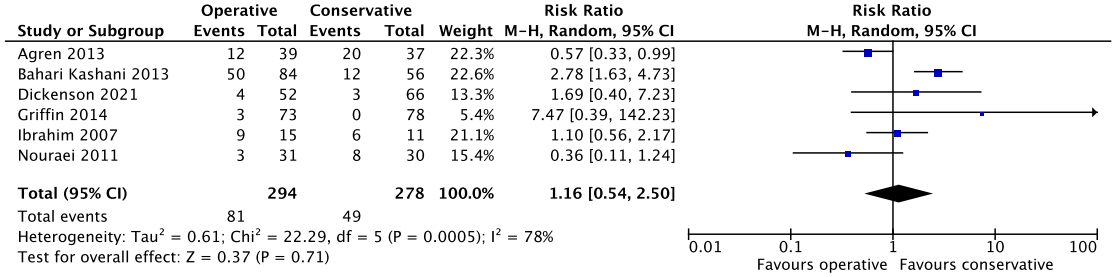

Figure 2. Forest plot showing the comparison of operative with conservative management for calcaneal fractures on the outcome arthritis. Pooled relative risk ratio, random effects model. Z: p-value of overall effect; df: degrees of freedom; SD: standard deviation; I^2; statistical heterogeneity; CI: confidence interval.

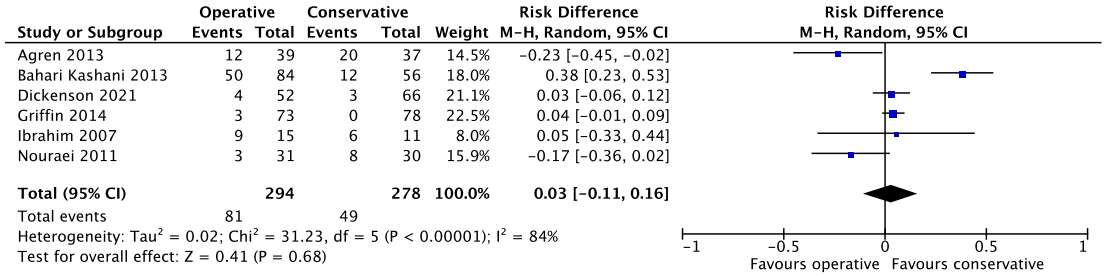

Figure 3. Forest plot showing the comparison of operative with conservative management for calcaneal fractures on the outcome arthritis. Risk difference, random effects model. Z: p-value of overall effect; df: degrees of freedom; SD: standard deviation; I^2; statistical heterogeneity; CI: confidence interval.

Böhler's angle

One study reported the outcome Böhler's angle (Hussain, 2022). It was reported that in the operative treatment group (n = 16), at 1-year follow-up Böhler's angle (mean) was 29.22. In the opposite 'healthy' side Böhler's angle was 31.01. In the conservative treatment group (n= 16), Bohler's angle (mean) was 11.21. In the opposite 'healthy' side, Böhler's angle was 25.

Complications

Six studies from the systematic review by Selim (2022) reported the outcome complications, (Agren, 2013; Bahari Kashani, 2013; Buckley, 2002; Griffin, 2014; Parmar, 1993; Thorardson, 1996). Bahari Kashani (2013), reported tenosynovitis as complication. The other studies reported complications including (wound) infections, rebleeding or nerve damage. The results were pooled in a meta-analysis. The pooled number of complications was 93/407 (22.9%) in the operative group, compared

to 63/431 (14.7%) in the conservative group. The RR was 1.91 (95% CI 0.61 to 6.94), see Figure 4. The pooled RD was 0.12 (95% CI: -0.05 to 0.29), see Figure 5.

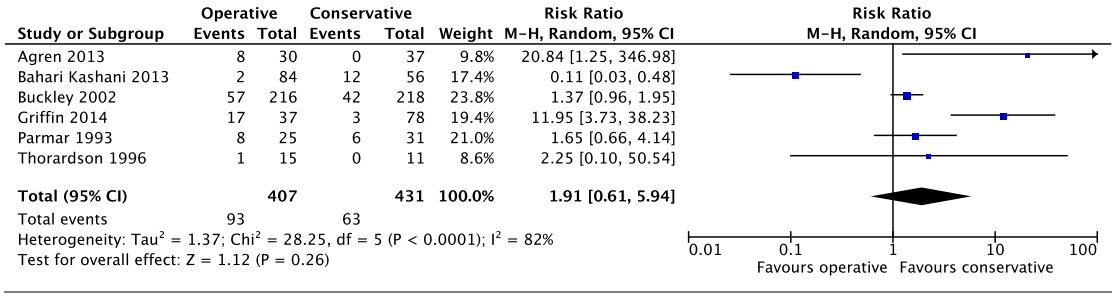

Figure 4. Forest plot showing the comparison of operative with conservative management for calcaneal fractures on the outcome complications. Pooled relative risk ratio, random effects model. Z: p-value of overall effect; df: degrees of freedom; SD: standard deviation; I^2; statistical heterogeneity; CI: confidence interval.

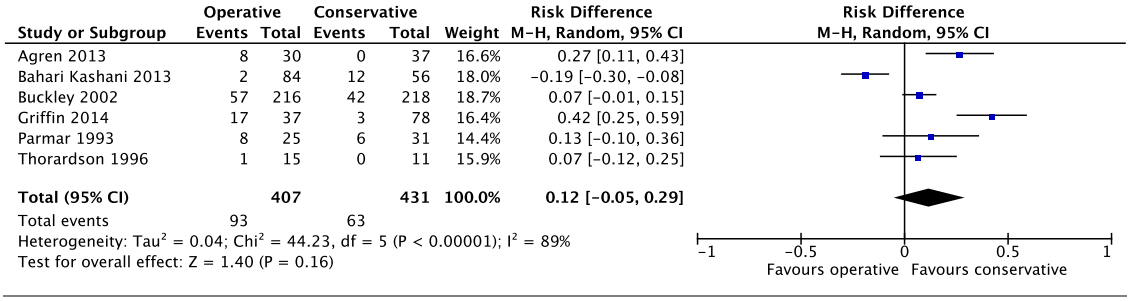

Figure 5. Forest plot showing the comparison of operative with conservative management for calcaneal fractures on the outcome complications. Risk difference, random effects model. Z: p-value of overall effect; df: degrees of freedom; SD: standard deviation; I^2; statistical heterogeneity; CI: confidence interval.

Malunion

None of the included studies reported the outcome malunion after operative fixation compared to conservative treatment in patients with displaced intra-articular calcaneus fractures.

Nonunion

None of the included studies reported the outcome nonunion after operative fixation compared to conservative treatment in patients with displaced intra-articular calcaneus fractures.

PICO B: Percutaneous and sinus tarsi approach versus extended lateral approach

First, results on the predefined outcomes were presented for the subcomparison 1. *percutaneous fixation versus extended lateral approach* were presented. Next the results were presented for the subcomparison 2. *sinus tarsi approach versus extended lateral approach.*

1. PERCUTANEOUS FIXATION (PRF) VERSUS EXTENDED LATERAL APPROACH (ELA)

Functional outcome (AOFAS)

Four studies, of which one was included in the review by Shi (2020), reported functional outcome with the AOFAS (Chen, 2011; Giray Batibay, 2020; Li, 2020; Vora, 2022). Due to heterogeneity in reporting, the result could not be pooled in a meta-analysis. The results of the individual papers are presented in Table 3.

Table 3: AOFAS-scores reported in the studies comparing Percutaneous Fixation and Extended Lateral Approach for patients with calcaneal fractures

	PRF group *Mean AOFAS + SD*	ELA group *Mean AOFAS + SD*	Mean difference (95% CI)

Chen (2011)	91.7 (n = 38)	85.8 (n = 40)	*Can't be assessed due to lack of SD*
Giray Batibay (2020)	90 ± 2.8 (n = 17)	78 ± 6.3 (n = 18)	12.00 (95% CI: 8.80 to 15.20)
Li (2020)	88.3 (n = 31)	86.4 (n = 28)	*Can't be assessed due to lack of SD*
Vora (2022)	78.5 ± 9 (n = 15)	87.7 ± 5.5 (n = 15)	-9.20 (95% CI: -14.52 to -3.88)

Abbreviations: PRF = percutaneous fixation; ELA = extended lateral approach; SD = Standard Deviation; 95% CI = 95% Confidence interval

(Osteo)arthritis

One study reported the outcome subtalar arthritis (Zhai, 2021). In the study of Zhai (2021), 2/32 (6.25%) patients in the PRF group experienced subtalar arthritis, compared to 0/31 (0%) patients in the ELA group. The RD was 0.06 (95% CI: -0.04 to 0.16).

Böhler's angle

Six studies, of which two were included in the review by Shi (2020), reported the outcome postoperative Böhler's angle (Chen, 2011; Sampath Kumar, 2014; Giray Batıbay; Li, 2020; Vora, 2022; Zhai, 2021). After surgery, the mean Böhler's angle in the PRF group ranged between 22 degrees (Vora, 2022) and 33.52 degrees (Zhai, 2021). The mean Böhler's angle in the ELA group ranged between 28.2 degrees (Giray Batibay, 2020) and 33.09 degrees (Zhai, 2021).

The results from four studies were pooled in a meta-analysis. The pooled MD between the PRF group (n = 93) and the ELA group (n = 91) was -1.51 (95% CI: -3.64 to 0.62), (see Figure 6). As in Chen (2011) no SD's were reported, the results could not be pooled.

The study of Sampath Kumar (2014) reported an improvement in Böhler's angle of 18.1 degrees in the PRF group (n = 22) compared to 17.5 degrees in the ELA group (n = 23). Since the mean Böhler's angle in both groups was not presented, the results of this study could not be pooled.

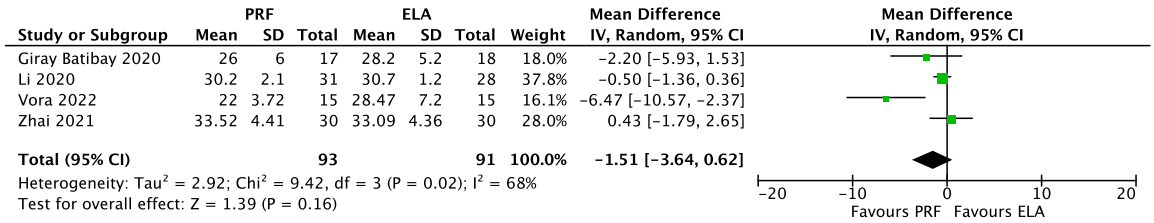

Figure 6. Forest plot showing the comparison percutaneous fixation (PRF) versus extended lateral approach (ELA), for calcaneal fractures on the outcome Böhler's angle. PRF: percutaneous fixation, ELA: Extended Lateral Approach. Z: p-value of overall effect; df: degrees of freedom; SD: standard deviation; I^2; statistical heterogeneity; CI: confidence interval.

Complications

Seven studies, of which three were included in the review by Shi (2020), reported the outcome complications (Chen, 2011; Sampath Kumar, 2014; Lu, 2015; Giray Batibay, 2020; Li, 2020; Vora, 2022; Zhai, 2021). The majority of studies reported the overall number of patients with any complication (i.e. wound healing problems, nerve damage, wound necrosis, unstable internal fixation, and peroneal tendinopathy). One study specified the type of complications (infection). The pooled number of complications was 16/203 (7.9%) in the PRF group, compared to 63/203 (31.0%) in the ELA group. The pooled RR was 0.28 (95% CI: 0.17 to 0.46), see Figure 7. The pooled RD was -0.23 (95% CI: -0.36 to -0.11), see Figure 8.

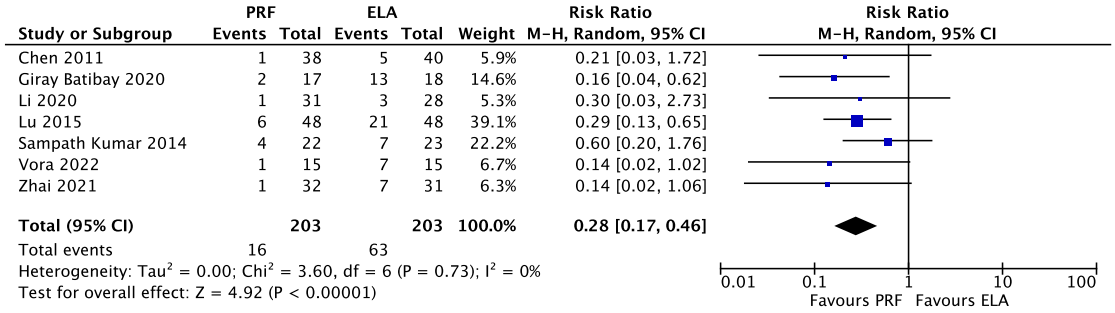

Figure 7. Forest plot showing the comparison percutaneous fixation (PRF) versus extended lateral approach (ELA), for calcaneal fractures on the outcome complications. Pooled Risk Ratio. random effects model. PRF: percutaneous fixation, ELA: Extended Lateral Approach. Z: p-value of overall effect; df: degrees of freedom; I^2; statistical heterogeneity; M-H, Mantel Haenszel; CI: confidence interval.

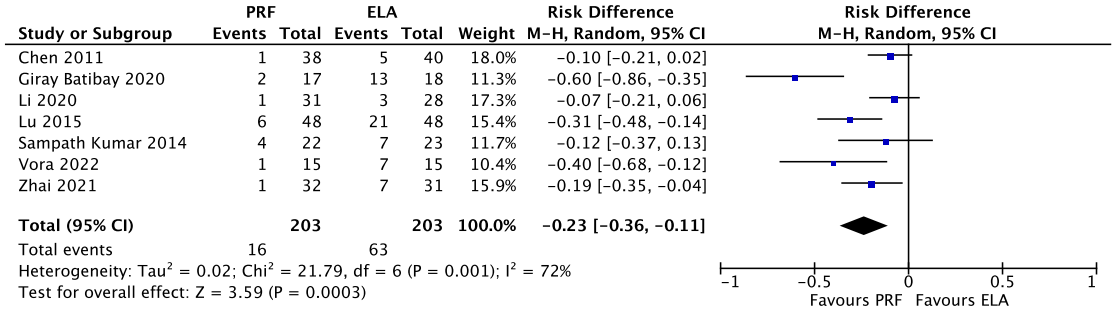

Figure 8. Forest plot showing the comparison percutaneous fixation (PRF) versus extended lateral approach (ELA), for calcaneal fractures on the outcome complications. Pooled Risk Difference. random effects model. PRF: percutaneous fixation, ELA: Extended Lateral Approach. Z: p-value of overall effect; df: degrees of freedom; I^2; statistical heterogeneity; M-H, Mantel Haenszel; CI: confidence interval.

Malunion

One study reported the outcome malunion (Vora, 2022). In the study of Vora (2022), 6/15 (40%) patients in the PRF group experienced malunion, compared to 3/15 (20%) patients in the ELA group. The RR was 2.00 (95% CI 0.61 to 6.55).

Nonunion

None of the included studies reported the outcome nonunion for PRF compared to ELA in patients with displaced intra-articular calcaneus fractures.

2. SINUS TARSI APPROACH (STA) VERSUS EXTENDED LATERAL APPROACH (ELA)

Functional outcome (AOFAS)

Six studies, of which four were included in the review by Peng (2021), reported functional outcome with the AOFAS (Basile, 2016; Cheng, 2017; Li, 2016; Zhu, 2013; Park, 2021; Zhang, 2020). The results of the studies were pooled in a meta-analysis. The pooled MD between the STA group (n = 188) and the ELA group (n = 188) was 0.74 (95% CI: -0.44 to 1.91), see Figure 9.

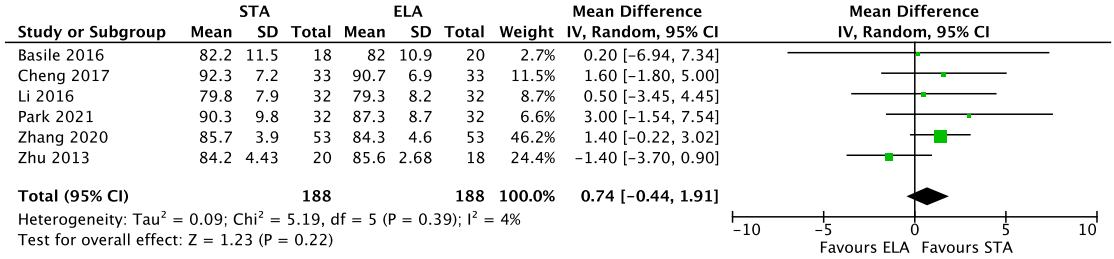

Figure 9. Forest plot showing the comparison Sinus Tarsi Approach (STA) versus extended lateral approach (ELA), for calcaneal fractures on functional outcome (AOFAS). Pooled mean difference, random effects model. STA: Sinus Tarsi Approach, ELA: Extended Lateral Approach. Z: p-value of overall effect; df: degrees of freedom; SD: standard deviation; I^2; statistical heterogeneity; CI: confidence interval.

(Osteo)arthritis

None of the included studies reported the outcome nonunion for STA compared to ELA in patients with displaced intra-articular calcaneus fractures.

Böhler's angle

Eight studies, of which four were included in the review by Peng (2021), reported the outcome postoperative Böhler's angle (Bin Jia, 2017; Cheng, 2017; Li, 2016; Park, 2021; Rastegar, 2021; Xia, 2014; Zhang, 2020; Zhu, 2013). After surgery, the mean Böhler's angle in the STA group ranged between 21 degrees (Park 2021) and 48.7 degrees (Rastegar 2021). The mean Böhler's angle in the ELA group ranged between 21 degrees (Park 2021) and 40.5 degrees (Rastegar 2021).

The results were pooled in a meta-analysis. The pooled MD between the STA group (n = 309) and the ELA group (n = 292) was 1.19 (95% CI: -0.44 to 2.81), see Figure 10.

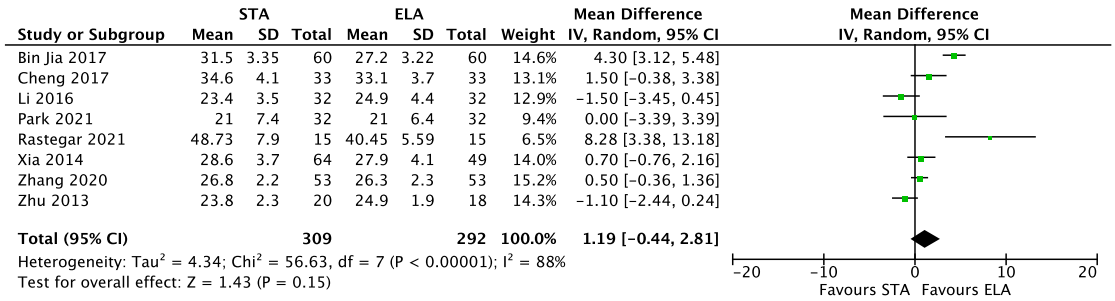

Figure 10. Forest plot showing the comparison Sinus Tarsi Approach (STA) versus extended lateral approach (ELA), for calcaneal fractures on the outcome Böhler's angle. STA: Sinus Tarsi Approach, ELA: Extended Lateral Approach. Z: p-value of overall effect; df: degrees of freedom; SD: standard deviation; I^2; statistical heterogeneity; CI: confidence interval.

Complications

Eight studies, of which four were included in the review by Peng (2021), reported the outcome complications (Basile, 2016; Bin Jia, 2017; Cheng, 2017; Li, 2016; Park, 2021; Rastegar, 2021;; Xia, 2014; Zhang, 2020). Complications that were reported included soft tissue complications, wound infection, flap necrosis or (sural) nervey injury. The pooled number of complications was 10/307 (3.26%) in the STA group, compared to 66/298 (22.1%) in the ELA group. The pooled RR was 0.22 (95% CI: 0.12 to 0.39), see figure 11. The pooled RD was -0.18 (95% CI: -0.23 to -0.12), see figure 12.

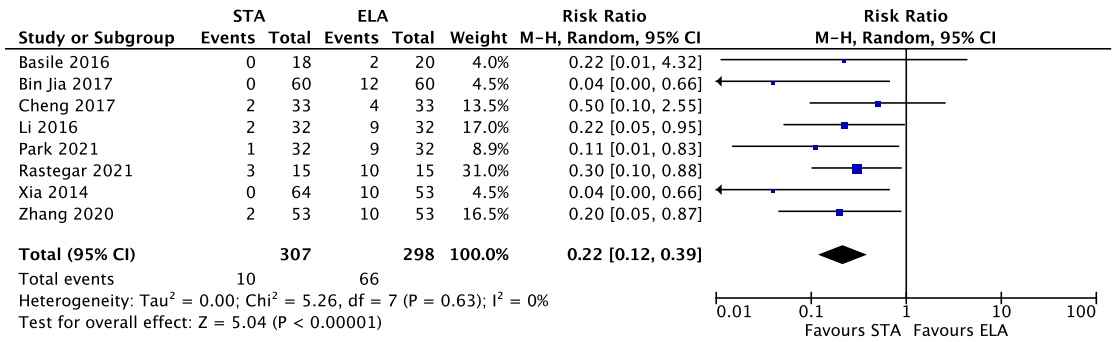

Figure 11. Forest plot showing the comparison Sinus Tarsi Approach (STA) versus extended lateral approach (ELA), for calcaneal fractures on the outcome complications. Pooled risk ratio, random effects model. STA: Sinus Tarsi Approach, ELA: Extended Lateral Approach. Z: p-value of overall effect; df: degrees of freedom; I^2; statistical heterogeneity; M-H, Mantel Haenszel; CI: confidence interval.

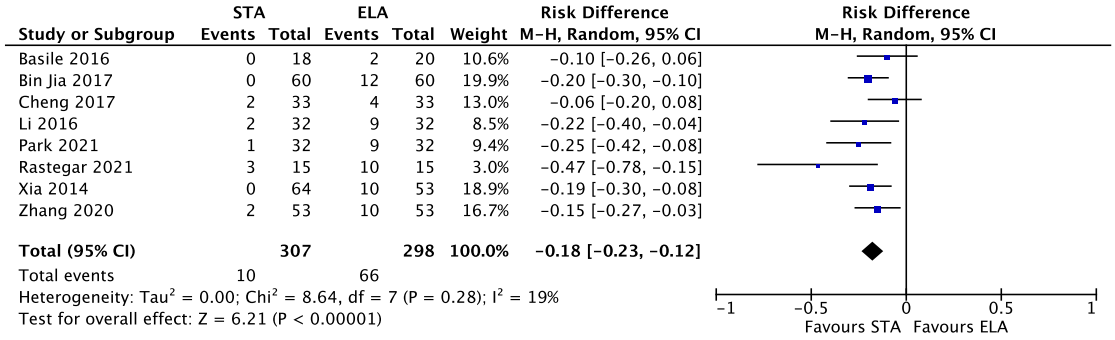

Figure 12. Forest plot showing the comparison Sinus Tarsi Approach (STA) versus extended lateral approach (ELA), for calcaneal fractures on the outcome complications. Pooled risk difference, random effects model. STA: Sinus Tarsi Approach, ELA: Extended Lateral Approach. Z: p-value of overall effect; df: degrees of freedom; I^2; statistical heterogeneity; M-H, Mantel Haenszel; CI: confidence interval.

Malunion

One study reported the outcome delayed union (Zhang, 2020). In the study of Zhang (2020), 1/53 (1.89%) patients in the STA group experienced delayed union, compared to 2/53 (3.77%) patients in the ELA group. The RD was -0.02 (95% CI -0.08 to 0.04).

Nonunion

None of the included studies reported the outcome nonunion for STA compared to ELA in patients with displaced intra-articular calcaneus fractures.

Level of evidence of the literature

PICO A: Operative fixation versus conservative treatment

The level of evidence regarding the outcome measure **functional outcome (AOFAS)** was retrieved from randomized controlled trials and therefore started high. The level of evidence was downgraded by two levels because of study limitations including lack of blinding of the participants (-1 risk of bias); and conflicting results (-1 inconsistency). The final level of evidence was graded 'low'.

The level of evidence regarding the outcome measures **complications** and **arthritis** was retrieved from randomized controlled trials and therefore started high. The level of evidences was downgraded by two levels because of conflicting results (-1 inconsistency) and the 95% confidence intervals crossing the boundaries of clinical decision making (-1 imprecision). The final level of evidence was graded 'low'.

The level of evidence regarding the outcome measure **Böhler's angle** was retrieved from randomized controlled trials and therefore started high. The level of evidence was downgraded by three levels because of study limitations including lack of similarity of baseline characteristics between intervention and control group (-1 risk of bias); and low number of included patients (-2 imprecision). The final level of evidence was graded 'very low'

The level of evidence regarding the outcomes **nonunion and malunion** was not graded as it was not reported in the included studies.

PICO B: Percutaneous and sinus tarsi approach versus extended lateral approach

1. PERCUTANEOUS FIXATION (PRF) VS EXTENDED LATERAL APPROACH (ELA)

The level of evidence regarding the outcome measure **functional outcome (AOFAS)** was retrieved from randomized controlled trials and therefore started high. The level of evidence was downgraded by two levels because of study limitations including lack of blinding of the participants (-1 risk of bias); and conflicting results (-1 inconsistency) The final level of evidence was graded 'low'.

The level of evidence regarding the outcome measure **arthritis** was retrieved from randomized controlled trials and therefore started high. The level of evidence was downgraded by two levels because of study limitations including unclear randomization procedure (-1 risk of bias) and small sample size and low number of cases (-2 imprecision). The final level of evidence was graded 'very low'.

The level of evidence regarding the outcome measure **Böhler's angle** was retrieved from randomized controlled trials and therefore started high. The level of evidence was downgraded by two levels because of study limitations including unclear randomization and allocation procedures (-1 risk of bias); and small sample size (-1 imprecision). The final level of evidence was graded 'low'.

The level of evidence regarding the outcome measure **complications** was retrieved from randomized controlled trials and therefore started high. The level of evidence was downgraded by one levels because of study limitations including unclear randomization procedure (-1 risk of bias); The final level of evidence was graded 'moderate'.

The level of evidence regarding the outcome measure **malunion** was retrieved from randomized controlled trials and therefore started high. The level of evidence was downgraded by three levels because of study limitations including unclear randomization procedure (-1 risk of bias); and the 95% CI crossing both boundaries of clinical decision making (-2 imprecision). The final level of evidence was graded 'very low'.

The level of evidence regarding the outcomes **nonunion** was not graded as it was not reported in the included studies.

2. SINUS TARSI APPROACH (STA) VS EXTENDED LATERAL APPROACH (ELA)

The level of evidence regarding the outcome measure **functional outcome (AOFAS)** was retrieved from randomized controlled trials and therefore started high. The level of evidence was downgraded by one level because of study limitations including lack of blinding of the participants (-1 risk of bias). The final level of evidence was graded 'moderate'.

The level of evidence regarding the outcome measure **Böhler's angle** was retrieved from randomized controlled trials and therefore started high. The level of evidence was downgraded by two levels because of study limitations including unclear randomization and allocation procedures (-1 risk of bias); and large variety in post-operative scores between the individual studies (-1 inconsistency). The final level of evidence was graded 'low'.

The level of evidence regarding the outcome measure **complications** was retrieved from randomized controlled trials and therefore started high. The level of evidence was downgraded by two levels because of study limitations including unclear randomization procedure (-1 risk of bias). The final level of evidence was graded 'moderate'.

The level of evidence regarding the outcome measure **malunion** was retrieved from randomized controlled trials and therefore started high. The level of evidence was downgraded by two levels because of study limitations including unclear randomization procedure (-1 risk of bias), and small sample size and low number of cases (-2 imprecision). The final level of evidence was graded 'very low'.

The level of evidence regarding the outcomes **nonunion and arthritis** was not graded as it was not reported in the included studies.

Conclusions

PICO A: Operative fixation versus conservative treatment

Functional outcome (AOFAS)

Low GRADE	Operative management may result in little to no difference in patient reported functional outcome, compared with conservative treatment in patients with displaced intra-articular calcaneal fractures. *Source: Selim (2022)*

Arthritis

Low GRADE	Operative management may result in little to no difference in arthritis compared with conservative treatment in patients with displaced intra-articular calcaneus fractures. *Source: Selim (2022)*

Bohler's angle

Very Low GRADE	The evidence is very uncertain about the effect of operative treatment on Bohler's angle, when compared with conservative treatment in patients with displaced intra-articular calcaneal fractures. *Source: Hussain (2022)*

Complications

Low GRADE	Operative management may result in an increase in complications (e.g. (wound) infections, rebleeding or nerve damage) compared with conservative treatment in patients with displaced intra-articular calcaneus fractures. *Source: Selim (2022)*

- **GRADE**	No evidence was found regarding the effect of operative fixation on the outcomes **nonunion and malunion** when compared with conservative treatment in patients with displaced intra-articular calcaneus fractures. *Source: -*

PICO B: Percutaneous and sinus tarsi approach versus extended lateral approach

1. PERCUTANEOUS FIXATION (PRF) VS EXTENDED LATERAL APPROACH (ELA)

Functional outcome (AOFAS)

Low GRADE	Percutaneous fixation (PRF) may result in little to no difference in functional outcome (AOFAS) when compared with extended lateral approach (ELA) in patients with displaced intra-articular calcaneus fractures. *Source: Chen, 2011; Giray Batibay, 2020; Li, 2020; Vora, 2022*

Arthritis

Very Low GRADE	The evidence is very uncertain about the effect of percutaneous fixation (PRF) on development of arthritis, when compared with extended lateral approach (ELA) in patients with displaced intra-articular calcaneus fractures.

	Source: Jiao, 2021

Bohler's angle

Low GRADE	Percutaneous fixation (PRF) may result in little to no difference in Bohler's Angle when compared with extended lateral approach (ELA) in patients with displaced intra-articular calcaneus fractures. *Source: Chen, 2011; Sampath Kumar, 2014; Giray Batıbay; Li, 2020; Vora, 2022; Zhai, 2021*

Complications

Moderate GRADE	Percutanous fixation (PRF) likely decreases the risk of complications when compared with extended lateral approach (ELA) in patients with displaced intra-articular calcaneus fractures. *Source: Chen, 2011; Sampath Kumar, 2014; Lu, 2015; Giray Batibay, 2020; Jiao, 2021; Li, 2020; Vora, 2022; Zhai, 2021*

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Malunion

Very low GRADE	The evidence is very uncertain about the effect of PRF on the outcome malunion, when compared with ELA in patients with displaced intra-articular calcaneus fractures. *Source:* Vora, 2022

Nonunion

- GRADE	No evidence was found regarding the effect of PRF on **nonunion** when compared with ELA in patients with displaced intra-articular calcaneus fractures. *Source: -*

10 **2. SINUS TARSI APPROACH (STA) VS EXTENDED LATERAL APPROACH (ELA)**

Functional outcome (AOFAS)

Moderate GRADE	Sinus tarsi approach (STA) likely results in little to no difference in functional outcome AOFAS when compared with ELA in patients with displaced intra-articular calcaneus fractures. *Source: Basile, 2016; Cheng, 2017; Li, 2016; Park, 2021; Zhang, 2020; Zhu, 2013;*

Bohler's angle

Low GRADE	Sinus tarsi approach (STA) may result in little to no difference in Bohler's Angle, when compared with extended lateral approach (ELA) in patients with displaced intra-articular calcaneus fractures. *Source:*

Complications

Moderate GRADE	Sinus tarsi approach (STA) likely decreases the risk of complications, when compared with extended lateral approach (ELA) in patients with displaced intra-articular calcaneus fractures. *Source: Basile, 2016; Bin Jia, 2017; Cheng, 2017; Li, 2016; Xia, 2014; Zhang, 2020; Dai, 2022; Park, 2021; Rastegar, 2021*

Malunion

Very Low GRADE	The evidence is very uncertain about the effect of PRF on the outcome malunion, when compared with ELA in patients with displaced intra-articular calcaneus fractures. *Source: Zhang, 2020*

Nonunion, arthritis

- GRADE	No evidence was found regarding the effect of STA on **nonunion and arthritis** when compared with ELA in patients with displaced intra-articular calcaneus fractures. *Source: -*

Overwegingen – van bewijs naar aanbeveling

<u>Voor- en nadelen van de interventie en de kwaliteit van het bewijs</u>

Er is literatuuronderzoek gedaan naar de optimale behandelstrategie van calcaneus fracturen. Hierbij is gezocht naar studies waarbij een vergelijking werd gemaakt tussen **operatieve en conservatieve behandeling.** Er werd één systematische review gevonden (Selim, 2022), waarin negen relevante RCTs waren geïncludeerd, en 1 additionele RCT (Hussain, 2022). Op basis van dit bewijs lijkt er geen verschil te zijn tussen operatieve en conservatieve behandeling op de patiënt-gerapporteerde functionele uitkomst (AOFAS; cruciale uitkomstmaat). Het gevonden bewijs suggereert echter ook dat operatieve behandeling mogelijk een grotere risico geeft op complicaties (belangrijke uitkomstmaat). Dit verhoogde risico op complicaties is logisch te verklaren gezien de aard van de interventie, waarbij een behandeling met gips van nature een lager risico op complicaties geeft dan een chirurgische behandeling. De resultaten suggereren dat er mogelijk geen verschil is in het risico op artritis/artrose, de resultaten zijn echter niet eenduidig. Ook over de effecten op de hoek van Bohler kunnen geen uitspraken worden gedaan. De bewijskracht voor de gevonden effecten is laag mede vanwege heterogeniteit in de resultaten. Daarnaast doorkruizen de 95% betrouwbaarheidsintervallen (BI) de grenzen voor klinische besluitvorming, waardoor er onzekerheid blijft of het gevonden effect ten faveure van operatief of ten faveure van conservatieve behandeling is. Ondanks de lage bewijskracht, lijkt er een voorzichtig voordeel te zijn voor conservatieve behandeling gezien het mogelijk lagere risico op complicaties en het gelijke effect op functionele uitkomst.

De studie van Selim (2022) includeerde naast gerandomiseerde trials ook prospectieve cohort studies en kwam daarmee tot de conclusie dat er geen verschil in morbiditeit (complicaties) te vinden was tussen de operatief en conservatief behandelde fracturen. Naast de effecten op de vooraf gedefinieerde uitkomstmaten, werd (op basis van zowel het gerandomiseerde onderzoek, als de prospectieve cohort studies) gerapporteerd dat operatief behandelde patiënten minder problemen hadden met de schoeibaarheid van de voet en dat patiënten vaker terugkwamen op hun oude activiteitenniveau (Odds Ratio: 2.87, 95% BI: 1.03 tot 8.00).

De werkgroep is dan ook van mening dat er in specifieke situaties een meerwaarde te verwachten valt van een operatieve interventie. Met name gezonde patiënten waarbij de fractuur significante laterale comminutie/verbreding laat zien, of een verlaagde hoek van Bohler of fibulair impingment kunnen potentieel profijt hebben van een operatieve behandeling. Dit om de kans op schoeibaarheid en terugkomen op het oude activiteitenniveau gunstig te beïnvloeden (Selim, 2022). Hierbij is de werkgroep van mening dat een operatie overwogen dient te worden bij de volgende fractuur kenmerken (Linsenmaier 2003; Selim, 2022; Dickenson 2021)

- Hoogte verlies >5mm
- Laterale communitie of verbreding >5 mm
- Step off posterieure subtalaire gewricht >2mm
- Varus >5 graden
- Valgus > 10 graden
- Bohler < 15 graden
- Fibulair impingement

Vanwege het risico op complicaties, is bij patiënten met een verhoogd risico en/of slechte functionele uitkomst conservatieve behandeling te prefereren. Hierbij moet gedacht worden aan patiënten met diabetes mellitus, perifeer vaatlijden, overgewicht, roken, alcohol misbruik, verlate presentatie al dan niet met slechte toestand van de weke delen of ernstige bijkomende letsels (Selim, 2022). Bij deze patiëntengroep is de kans op complicaties als gevolg van de operatie of post-traumatische artritis/artrose dermate groot, dat er geen meerwaarde van een operatieve interventie te verwachten valt.

Een tweede vergelijking die werd onderzocht in de literatuur was de vergelijking van **percutane (PRF) of sinus tarsi (STA) benadering (ook wel; minimaal invasieve technieken) met een *extended laterale* benadering *(ELA).*** Er werden twee systematische reviews en zeven aanvullende RCTs gevonden. Afzonderlijke vergelijkingen tussen STA en ELA, en tussen PRF en ELA laten vergelijkbare resultaten zien. Zowel voor de STA, als PRF werd er nauwelijks tot geen verschil gevonden in functionele uitkomst (AOFAS; cruciale uitkomstmaat), wanneer vergeleken met ELA (GRADE low en, GRADE moderate, respectievelijk). Daarentegen is het aannemelijk dat met minimaal invasieve technieken (PRF en ELA) het risico op complicaties lager is, dan wanneer er met de ELA benadering wordt behandeld (*absoluut risico verschil:* -0.23, 95% BI: -0.36 tot -0.11, GRADE moderate en *absoluut risico verschil*: -0.18, 95% BI -0.23 tot -0.12, GRADE moderate, respectievelijk). De effecten op de hoek van Bohler (belangrijke uitkomstmaat) lijken vergelijkbaar te zijn voor de minimaal invasieve technieken en ELA. Over de effecten op artritis (cruciale uitkomstmaat), malunion en nonunion (belangrijke uitkomstmaten) werd slechts bewijs met een zeer lage bewijskracht, of zelfs geen bewijs gevonden. Redenen voor de (zeer) lage bewijskracht zijn onder andere beperkingen in de studieopzet, waaronder een gebrek aan blindering of onduidelijkheden ten aanzien van randomisatie en allocatie procedure. Ook werden de studies gekenmerkt door een kleine studiepopulatie en een laag aantal cases met als gevolg brede 95% betrouwbaarheidsintervallen. Hierdoor bestaat er ook voor deze vergelijking onzekerheid over de daadwerkelijke effecten van PRF en STA of ELA. Samenvattend lijkt een minimaal invasieve benadering (PRF en STA) tot dezelfde

functionele uitkomsten te leiden als een ELA. Daar staat tegenover dat het aannemelijk is dat een minimaal invasieve benadering minder post-operatieve complicaties kent.

Waarden en voorkeuren van patiënten (en evt. hun verzorgers)

Primaire voorkeur voor de patiënt ligt in een zo vlot mogelijk functioneel herstel, met zo min mogelijk operatieve behandelingen. Hierbij zijn met name (chronische) pijnklachten van de voet een belangrijke graadmeter, alsmede het kunnen blijven doen van werk en/of sportactiviteiten. Secundair wordt vaak de schoeibaarheid van de voet op prijs gesteld, waarbij mensen de voorkeur geven aan normale confectie schoenen tegenover orthopedisch schoeisel.

Het voordeel van een operatieve behandeling ten aanzien van activiteiten hervatting en schoeibaarheid maakt dat deze behandeling voor patiënten de voorkeur kan genieten. Het merendeel van de calcaneus fracturen ontstaat bij werkzaamheden en sport. Deze groep patiënten is veelal jong en heeft nog veel arbeidsjaren te gaan. Een kleiner deel van de patiënten krijgt een calcaneus fractuur bij minimaal trauma o.b.v. osteoporose en/of diabetes. Bij deze groep dient het wel of niet opereren in samenspraak met de patiënt worden afgewogen te worden tegen het toegenomen risico op post-operatieve complicaties, en het niet aangetoonde functionele verschil of het verschil in post-traumatische artrose. De patiënt moet voldoende worden geïnfomeerd over de behandelopties en verwachting t.a.v. het herstel.

Indien er samen met patiënt gekozen wordt voor een operatieve behandeling is hij of zij gebaat bij een zo laag mogelijk risico op complicaties hetgeen bereikt wordt met een minimaal invasieve behandeling (percutane schroeven of sinus tarsi benadering).

Kosten (middelenbeslag)

Calcaneus fracturen hebben een zeer hoge financiële belasting (Schepers, 2008). Het opereren van calcaneus fracturen leidt tot een significante reductie in kosten (Albin, 2020; Brauer, 2005). Er zijn groepen waarbij de risico's van een operatie te groot zijn (bv diabetische calcaneus fracturen), hierbij dient sterk te worden overwogen om een conservatief beleid te voeren indien mogelijk.

Aanvaardbaarheid, haalbaarheid en implementatie

Hiervoor wordt terugverwezen naar module organisatie van zorg [hier wordt een hyperlink ingevoegd zodra de richtlijn wordt gepubliceerd op de richtlijnendatabase]. In deze module wordt zeer uitvoerig in gegaan op de relatie tussen volume en post-operatieve morbiditeit in operatief behandelde calcaneusfracturen. In deze module komt het precaire evenwicht tussen patiënten die wel of niet baat hebben bij een operatieve interventie. Dit vergt van de behandelaar expertise op het gebied van de operatieve maar ook de conservatieve behandeling. Daar komt bij dat indien een patiënt om wat voor reden dan ook een operatieve behandeling aan gaat dit bij voorkeur gedaan dient te worden middels een minimaal invasieve benadering. Ook hiervoor geldt dat een uitgebreide ervaring nodig is om middels een minimaal invasieve behandeling een goede reductie te bewerkstelligen.

Aanbeveling(en)

Aanbeveling-1

De meta-analyse van deze richtlijn laat potentieel een beperkt voordeel zien voor de niet-operatieve behandeling van calcaneus fracturen. Zeker bij patiënten waarbij de kans op complicaties en/of slechte functionele uitkomst groot is, is een conservatieve behandeling te prefereren. Dit omdat de kans op complicaties als gevolg van de operatie of post-traumatische artritis/artrose dermate groot zijn dat er geen meerwaarde van een operatieve interventie te verwachten valt. De bewijskracht ten faveure van een conservatieve behandeling is laag.

Bij de behandeling van calcaneusfracturen is er ook plaats voor operatieve interventies.

Met name gezonde patiënten waarbij de fractuur significante laterale comminutie/verbreding laat zien, of een verlaagde hoek van Bohler of fibulair impingment kunnen potentieel profijt hebben van een operatieve behandeling. De werkgroep is van mening dat een operatie overwogen dient te worden bij een aantal fractuur kenmerken (Linsenmaier 2003; Selim, 2022; Dickenson 2021)

Overweeg een operatieve behandeling van een calcaneusfractuur enkel indien de patiënt- en fractuurkarakteristieken (hoogte verlies >5mm, verbreding >5 mm, step off posterieure subtalaire gewricht >2mm, varus >5 graden, valgus > 10 graden, Böhler < 15 graden, fibulair impingement) hier aanleiding toe geven.

Aanbeveling-2

Ondanks dat een minimaal invasieve behandeling (PRF of STA) geen meerwaarde heeft voor de functionele uitkomst (AOFAS) bij patiënten met een calcaneusfractuur vergeleken met een extended laterale benadering (ELA), laat het gevonden bewijs zien dat er aanvullende argumenten zijn ten faveure van minimaal invasieve behandeling. Patiënten die een operatieve behadeling moeten ondergaan hebben, met welke techniek dan ook, voor deze fractuur wel een aanmerkelijke kans op complicaties, zoals bijvoorbeeld post-operatieve (fractuur gerelateerde) wondinfectie of perifeer zenuwletsel. Deze kans wordt mogelijk tot 20% verkleind indien er een minimaal invasieve behandelmethode wordt verkozen boven ELA.

Behandel een patiënt met een calcaneusfractuur zo minimaal invasief mogelijk. Denk hierbij aan een operatie met percutane schroefosteosynthese of middels minimaal invasieve plaatosteosynthese (sinus tarsi benadering)

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Bijlagen bij module calcaneus fracturen

Evidence tabellen bij module calcaneus fracturen

Evidence table for systematic review of RCTs and observational studies (intervention studies)

Study reference	Study characteristics	Patient characteristics	Intervention (I)	Comparison / control (C)	Follow-up	Outcome measures and effect size	Comments
Selim 2022 Study characteristics and results are extracted from the SR (unless stated otherwise) **PICO 1**	SR and meta-analysis of RCTs and observational studies *Literature search up to December 2021* a: Agren, 2013 b: Bahari Kashani, 2013 c: Buckley, 2002 d: Dickenson, 2021 e: Griffin, 2014 f: Ibrahim, 2007 g: Nouraei, 2011 h: Parmar, 1993 i: Sharma, 2011 j: Thordarson , 1996 <u>Study design</u>: a t/m j: RCT <u>Setting and Country</u>: a: , Sweden b: , Iran c: , Canada d: , UK e: , UK f: , UK	<u>Inclusion criteria SR</u>: - studies directly comparing nonoperative and operative management of intraarticular calcaneal fractures - RCT and prospective comparative - studies in English - studies in human <u>Exclusion criteria SR:</u> - cadaveric studies - biomechanical studies of treatment options - abstracts, case reports, systematic reviews and retrospective studies *13 studies included in the*	Operative (ORIF)	Conservative	<u>End-point of follow-up</u>: "*The mean follow-up period in the included studies was 4.1 years*" <u>Follow-up (years)</u> a: 12/12 b: not reported c: 3/3 d: 5/5 e: 2/2 f: 15/15 g: 3/3 h: 2/2 i: 2/2 j: 1/1	<u>Outcome measure-1 AOFAS</u> Effect measure: mean difference [95% CI]: a: -3,1 (95% CI: -9.65, 3.45) e: -2.40 (95% CI: -8.14, 3,34) f: 5,8 (95% CI: -5,98, 17,58) j: -31,7 (95% CI: -45,72, -17,68) Pooled effect (random effects model): 6.68 (95% CI: -3.88, 17.24) favoring operative <u>Outcome measure-2 complications</u> Effect measure: RR [95% CI]: a: 20.84 (95% CI: 1.25, 346.98) b: 0.11 (95% CI: 0.03, 0.48) c: 1.37 (95% CI: 0.96, 1.95) e: 11.95 (95% CI: 3.73, 38.23) h: 1.65 (95% CI: 0.66, 4.14) NA j: 2.25 (95% CI: 0.10, 50.54) Pooled effect (random effects model): 1.91 (95% CI: 0.61, 5.94), favouring conservative <u>Outcome measure-3 arthritis</u>	The author's concluded that: "*DIACF management should be individualized, and operative treatment has to be reserved for selected cases with certain patient factors and fracture patterns*. (…)*Fracture patterns with fibular impingement, significant lateral comminution, and large Böhler angle show better outcomes with the operative treatment"* <u>Sensitivity analyses</u> "The **AOFAS-score** favored the ORIF group when Ibrahim et al's study was removed; however, the study was well conducted and demonstrated a low risk of bias in the quality assessment. Therefore, no good reason was noted to exclude it from the results" **"Complications** demonstrated a statistically significant result, favoring the conservative treatment

	g: , Iran h: , England i: , India j: , USA <u>Source of funding and conflicts of interest:</u> Only reported for the systematic review – no conflicts of interest	*review, of which 10 were considered relevant (a t/m j)* <u>Important patient characteristics at baseline</u>: <u>Total population i/c</u> a: 39/37 b: 84/56 c: 206/218 d: 52/66 e: 73/78 f: 15/11 g: 31/30 h: 25/31 i: 15/15 j: 15/11 <u>Mean age i/c (% male)</u> a: 49/48 (not reprted) b: not reported (79) c: 41/39 (90) d: 45 (not reported) e: 45/48 (not reported) f: 61/58 (91) g: 46/52 (not reported) h: 48/48 (86) i: 28/29 (70) j: 35/36 (91) <u>Groups comparable at baseline?</u> Probably yes				Effect measure: RR [95% CI]: a: 0.57 (95% CI: 0.33, 0.99) b: 2.78 (95% CI: 1.63, 4.73) d: 1.69 (95% CI: 0.40, 7.23) e: 7.47 (95% CI: 0.39, 142.23) f: 1.10 (95% CI: 0.56, 2.17) <u>g:</u> 0.36 (95% CI: 0.11, 1.24) Pooled effect (random effects model): 1.16 (0.54 – 2.50) favouring conservative	when Bahari Kashani et al's study was removed" The studies that were not considered relevant for the purpose of this guideline were excluded based on studies design (observational studies). One study did not report any of the predefined outcome measures i - Sharma)
Peng 2021	SR and meta-analysis of RCTs	<u>Inclusion criteria SR</u>:	a: Sinus tarsi approach; plates	a: Extended lateral approach; plates	<u>Duration of follow-up:</u> a: 12 months	<u>Outcome measure 1: Bohler's angle</u>	The author's concluded that:

Study characteristics and results are extracted from the SR (unless stated otherwise) **PICO 2**	and observational studies *Literature search up to June 2019* a: Bin Jia, 2017 b: Cheng, 2017 c: Li, 2016 d: Xia, 2014 e: Zhu, 2013 b + e: full tekst of individual study not available <u>Study design</u>: a t/m e: RCT <u>Setting:</u> not reported <u>Source of funding and conflicts of interest:</u> Only reported for the systematic review – no conflicts of interest	- adult calcaneal fracture patients - studies comparing postoperative functional outcomes of calcaneal fractures via ELA and STA - studies reporting at least 1 of the following outcomes postoperative calcaneal height, postoperative calcaneal width, complications (marginal necrosis, postoperative infection, and nerve injury), operative time, length of hospital stay, postoperative Böhler angle, postoperative Gissane angle, and AOFAS-scores; - Cohort studies, controlled clinical trials and RCTs <u>Exclusion criteria SR:</u> - animal cadaveric studies - studies in which valid data cannot be extracted or converted	b: sinus tarsi approach; plates c: sinus tarsi approach; plates d: sinus tarsi approach; plates e: sinus tarsi approach; plates	b: Extended lateral approach; plates c: Extended lateral approach; plates d: Extended lateral approach; plates e: Extended lateral approach; plates	b: not reported c: 12 months d: 28 months e: 15 months	<u>MD (95% CI)</u> a: 4.30 (95% CI: 3.12, 5.48) b: 1.50 (95% CI: -0.38, 3.38) c: -1.50 (95% CI: -3.45, 0.45) d: 0.70 (95% CI: -0.76, 2.16) e: -1.10 (95% CI: -2.44, 0.24) *pooled effect: 0.82 (95%CI: -1.47, 3.11)* <u>Outcome measure 2: AOFAS MD (95% CI)</u> b: 1.60 (95% CI: -1.80, 5.00) c: 0.50 (95% CI: -3.45, 4.45) e: -1.40 (95% CI: -3.70, 0.90) *pooled effect: -0.21 (95%CI: -2.06, 1.64)* <u>Outcome measure 3 complications</u> <u>RR (95% CI)</u> *Wound infection* a: 0.33 (95% CI: 0.04, 3.11) b: 0.50 (95% CI: 0.10, 2.55) c: 0.40 (95% CI: 0.08, 1.91) d: 0.17 (95% CI: 0.01, 3.39) *Nerve injury* a: 0.11 (95% CI: 0.01, 2.02) *pooled effect:* *0.34 (95% CI: 0.14, 0.84)*	"*compared with ELA, an STA is superior in the treatment of calcaneal fractures, due to effective anatomical reduction of the calcaneus, effective reduction of the incidence of incision complications, and shortened operative time and postoperative hospital stay*" The studies that were not considered relevant for the purpose of this guideline were excluded based on studies design (observational studies). The author's of the review stated that Basile 2016 was a RCT, however after consulting the full text, the trial appeared to be non-randomized. <u>Jadad Quality score for RCT</u> a: 5 b: 4 c: 6 d: 5 e: 3 Some concerns regarding the quality of the systematic review. After consulting some of the full text papers, there appear to be some inconsistencies

		- case reports, systematic reviews and meta-analyses, conference papers without full text. *18 studies included in the review, of which 5 were considered relevant (a t/m e)* <u>Important patient characteristics at baseline:</u> <u>Total population n i/c</u> a: i: 60/ c: 60; b: i: 33/ c:33; c: i: 32/ c:32; d: i: 64/ c:53; e: i: 18/ c:20; <u>Mean age i/c</u> a: i: 38.6 / c: 35.8 b: i: 36.2 / c: 35.1 c: i: 40 / c: 41 d: i: 38 / c: 37 e: i: 36.6 / c: 36.4					

Evidence table for intervention studies (randomized controlled trials and non-randomized *observational* studies [cohort studies, case-control studies, case series])[1]

This table is also suitable for diagnostic studies (screening studies) that compare the effectiveness of two or more tests. This only applies if the test is included as part of a test-and-treat strategy – otherwise the evidence table for studies of diagnostic test accuracy should be used.

Research question: calcaneus fractures

Study reference	Study characteristics	Patient characteristics [2]	Intervention (I)	Comparison / control (C) [3]	Follow-up	Outcome measures and effect size [4]	Comments
PICO A							
Hussain 2022	Type of study: RCT Setting and country: Single Centre, Pakistan 2021 to 2022 Funding and conflicts of interest: none	Inclusion criteria - Patients with displaced intra-articular calcaneal fractures Exclusion criteria - patients with calcaneal fractures connected with spinal injuries, pathological fractures, peripheral vasculopathy or any medical contraindication to surgery N total at baseline: I: n = 16 C: n = 16 Important prognostic factors: All patients had Sander's type II and III closed fractures that were less than 3 weeks old. *Age* i: 40 years c: 42 years *Sex M/F*	Operative treatment Group B	Conservative treatment Group A	Length of follow-up: 1 year Loss-to-follow-up: No loss-to-follow-up was reported	Böhler's angle, mean I: 29.22 (opposite 'healthy' site: 31.1) C: 11.21 (opposite 'healthy' site: 25) → No standard deviations reported di	Author's conclusion: "*operative treatment is a better and more effective method to treat displaced intra-articular calcaneal fractures*"

		In total study population: 11/32 (34%) female Groups comparable at baseline? Probably yes					
PICO B: PRF vs ELA							
Chen 2011 (from Shi 2020)	Type of study: RCT Setting and country: Single Centre, USA 2006 - 2008 Funding and conflicts of interest: None	Inclusion criteria: - Displaced intra-articular calcaneal fracture (more than 2 mm) - operative treatment possible within 7 days of injury - unilateral fracture - closed fracture Exclusion criteria: - Patients with known local or systemic infection, - medical contraindication - Sanders type IV, Sanders type IIA and open fractures N total at baseline: PR + CSC: 38 ORIF, ELA: 40 Important prognostic factors[2]: *age:* PR + CSC: 31.1 ORIF, ELA: 32.7	Percutaneous reduction (PR), cannulated screw fixation and calcium sulphate cement (CSC) grafting PR + CSC In the percutaneous treatment group, we crossed the tuberosity with a 6.5-mm Schanz pin via stab incision to reduce the height and length of calcaneus. Then, we introduced a 6.5-mm Schanz pin into the fragment with the displaced posterior facet and levered the compressed facet under fluoroscopic guidance. In Sanders Type III fractures, another Schanz pin was introduced percutaneously through the lateral cortex of the inferior calcaneus to unlock and push up any remaining depressed parts of the subtalar joint surface of the calcaneus. Once the Böhler's angle and articular	Open Reduction and Internal Fixation (ORIF) through an extensile lateral approach OR(IF) ELA The reduction was accomplished under direct visualization. The fracture was fixed with a combination of screws and a calcaneal plate. The wound was sutured carefully with a suction drain. The intraoperative blood loss and postoperative wound blood loss were calculated.	Length of follow-up: 24 (range 18 – 30) months Loss-to-follow-up: It was stated that 12 patients were lost to follow-up. These patients were excluded from the analysis	Böhler's angle, mean *Postoperative* PR + CSC: 32.1 ORIF, ELA: 30.6 MD: unclear (no SD) AOFAS-score, mean *Postoperative* PR + CSC: 91.7 ORIF, ELA: 85.8 MD: unclear (no SD) Complications *Infection* PR + CSC: 1/38 (2.6%) ORIF, ELA: 5/40 (12.5%) RR: 0.21 (95% CI: 0.03, 1.72)	Author's conclusion: "*compared with ORIF, the percutaneous reduction, fixation and CSC grafting for treatment of DIACF might allow accelerated weight bearing activity, reduce joint stiffness and improve the patients' satisfaction.*"

		Sex: M/F PR + CSC: 20/18 ORIF, ELA: 24/16 *Sanders Type II/III:* PR + CSC: 29/9 ORIF, ELA: 32/8 Groups comparable at baseline? Probably yes	surface were reduced, two Kirschner wires were inserted from the lateral side to the sustentaculum to sustain the reduced joint surface. Then another two Kirschner wires were introduced from the tuberosity to the anterior part of calcaneus in different directions to fix the primary and secondary fracture line. After the closed reduction and provisional fixation were done, the Kirschner wires were replaced by 6.5- and 3.5-mm cannulated screws percutaneously guided by fluoroscopy. The CSC (Wright Medical Technology, Arlington, TN) was placed into the delivery syringe. The delivery needle was advanced through the channel made by the original Schanz pin under fluoroscopic guidance into the bone void in the body created after the reduction. The cement was then slowly and carefully injected into the bone void under fluoroscopic guidance while the needle was gradually withdrawn. If the surgeon felt resistance, the injection was stopped to prevent the cement from entering the subtalar joint through the fracture line.				

Sampath Kumar, 2014 (from Shi 2020)	Type of study: RCT Setting and country: Tertiary care centre, India, 2010-2011 Funding and conflicts of interest: None	Inclusion criteria: - Displaced intra-articular calcaneal fracture – evident on radiographs - reporting within 3 weeks of injury Exclusion criteria: - open wound, peripheral vascular disease, skin infection, signs of compartment syndrome, - patients with neurologic deficit following head injury or spinal injury - patients with fractures involving other bones of the lower limb N total at baseline: MIRPF: 22 ORIF: 23 Important prognostic factors[2]: *age ± SD:* MIRPF: 31.5 ± 11.71 ORIF: 30.7 ± 10.07 *Sex: M/F* MIRPF: 17/5 ORIF: 18/5 *Sanders Type II/III/IV (%)*	**Minimally invasive reduction and percutaneous fixation (MIRPF)** The procedure involved disimpaction of fracture fragments with a Steinmann pin inserted mediolaterally from the posteroinferior part of the medial calcaneal tuberosity. Traction was applied along the long axis of the foot, with alternating varus and valgus stress to disimpact fracture fragments. In joint-depression fractures, a stab incision was made in the sole of the foot, and a bone punch was advanced through the primary fracture line into the body of the calcaneus under image guidance. In cases in which bone punch could not be negotiated through the body, a pilot track was drilled over a guidewire placed beneath the depressed fragment under image guidance. The bone punch was inserted into this tract and the depressed fragment elevated by gentle blows of a mallet. Care was taken to avoid entering the subtalar joint. In tongue-type fractures, a Steinmann pin inserted lateral to the Achilles tendon into the tuberosity fragment was used to lever and elevate the displaced fragment. In complex fractures, both	**Open reduction and internal fixation (ORIF)** Open reduction was performed using a modified lateral approach with an L-shaped incision; skin subcutaneous tissue and periosteum were raised as a single, thick flap. K-wires were placed in lateral malleolus, talus and cuboid positions and bent to act as curved retractors. Peroneal tendons were elevated off the peroneal tubercle and reflected dorsally, while the calcaneofibular ligament was detached from the calcaneus. After subtalar capsulotomy, the entire lateral calcaneus, including the anterior process that forms the calcaneocuboid joint, was exposed, as necessary. The lateral wall of the calcaneus was then opened like a window to allow access to the articular fragment. Any varus/ valgus deformity of the heel was corrected. Calcaneus length was restored to normal by traction. Fragments were reduced carefully and temporarily fixed using K-wires. Immense care was taken to reconstruct the articular surface, especially of the posterior facet. Autologous bone graft from the iliac crest was used when	Length of follow-up: Patients were followed-up at 1.5, 3, 6 and 12 months postoperatively Loss-to-follow-up: MIRPF: n = 1 ORIF: n = 2	Böhler's angle, mean ± SD *Improvement in Böhler's angle* MIRPF: 18.1 ± 5.4 ORIF: 17.5 ± 6.5 P-value 0.734 Complications *Infection* MIRPF: 4/22 (31.8%) ORIF: 0/23 (0%) *Wound healing problems* MIRPF: 0/22 (0%) ORIF: 7/23 (30.4%) P-value 0.005	Author's conclusion: "*minimally invasive reduction and percutaneous fixation is associated with fewer wound-healing problems, better functional outcome and earlier return to work, compared with ORIF*" Bilateral fractures were included and randomization was done separately for each calcaneal fracture

		MIRPF: 8.7 / 43.5 / 47.8 ORIF: 31.8 / 40.9 / 27.3 Groups comparable at baseline? Probably yes	techniques were combined as necessary. If reduction was not anatomical after all possible manoeuvres, the procedure was converted to the open method. If reduction was anatomical, the heelwas compressed manually to lock the reduced fragments in position. Temporary fixation was achieved using K-wires or guidewires. Cannulated cancellous screws (4 mm) were used for fragment fixation. A minimum of three screws was used for fixation: two running in the posteroanterior direction and the third running lateral to medial, lying just below the posterior facet in the lateral view and engaging the sustentaculum tali in the axial view. Care was taken to avoid intra-articular screw placement. Additional screws were placed as necessary.	considered necessary, without adding antibiotics. The lateral wall of the calcaneus was reduced, and a calcaneal locking plate was used for fracture fixation after satisfactory reduction, and locking screws were applied. Additional screws were applied as necessary. Hemostasis was achieved, and the wound was closed over a suction drain.			
Lu 2015 (from Shi 2020)	<u>Type of study:</u> RCT <u>Setting and country:</u> China, July 2012 and July 2014 <u>Funding and conflicts of interest</u>: None	<u>Inclusion criteria:</u> • cases conforming to the diagnostic criteria for calcaneal fracture; • Closed fracture within two weeks; • CT scan and X-ray examination confirmed Sanders	**Minimally invasive manipulative reduction using percutaneous poking K-wire fixation (manipulation group, PRF)** The procedures were performed with the patients being in lateral decubitus position under spinal anesthesia. Guided by fluoroscopy, the first K-wire was inserted from	**ORIF (plate group, ELA)** The surgery was performed with patients being in lateral decubitus position under spinal anesthesia. After sterilization, a lateral L-shaped incision was made on the affected foot followed by fracture reduction. Bone grafting was performed if required.	<u>Length of follow-up</u>: Follow-up at 6 months	<u>Complications, n (%)</u> *Unstable internal fixation* PRF: 4/48 (8.33) ORIF: 0/48 (0) *Neural and vascular injuries* PRF: 0/48 (0) ORIF: 5/48 (10.4) *Unfavorable healing* PRF: 2/48 (4.17) ORIF: 16/48 (33.3)	<u>Author's conclusion</u>: *"lower incidence of adverse reactions and surgical complications was achieved using minimally manipulative reduction with poking k-wire reduction (PRF)."* Manipulative reduction with poking k-wire fixation is suitable for the treatment of Sanders type II tongue type fracture and compression

		II and Sanders III fractures or compression fracture and tongue type fracture classified by Essex-Lopresti system <u>Exclusion criteria:</u> • patients of age <18 or >65 years • simple non-displaced calcaneal fractures • severe collapsed comminuted fractures • patients with severe liver and kidney disorders • psychiatric disorders or accompanied with other severe trauma and open fractures <u>N total at baseline</u>: n = 96 patients PRF: 48 (n=62 feet) ORIF: 48 (n=58 feet) <u>Important prognostic factors[2]</u>: *age ± SD* PRF: 45.12 ± 5.16 years ORIF, ELA: 43.25 ± 4.26 years *Sex:*	the superior external side of the calcaneal tuberosity and advanced to the forefoot without crossing the fracture line. With the forefoot in dorsiflexion position, the K-wire was pulled and poked towards the plantar, and reduction was performed to allow for calcaneal inversion and eversion, as well as flexion and extension of the ankle. Fluoroscopy confirmed that Böhler's angle was restored within the range of 25°-40° and the length and height of the calcaneus were restored. The K-wire was inserted into the talus after restoring the subtalar joint surface. A second K-wire was inserted at 1-2 cm inferior to the first K-wire and in the direction parallel to the inferior of the calcaneus, for fracture fragments stabilization as well as fixation and support between the tarlus and the calcaneus. The heel was squeezed to reduce the calcaneal width. Finally, the fixation was completed by inserting a third K-wire from the posterior of the calcaneus, traversing the fractured fragments of the subtalar joint and reaching the tarsal bones. Lateral fluoroscopic view demonstrated that the three K-wires formed a ≠	Internal fixation was performed using a calcaneal plate (Smith & Nephew, Memphis, TN, USA). Subsequently, a drainage tube was placed, incision was then closed and cast immobilization was performed.			fracture as well as Sanders type III tongue type fracture, with lower cost, rapid recovery and smaller wound. This approach can be employed in clinical practice when surgical indications are met.

		PRF: 75% M ORIF, ELA: 79.2% M *Sanders type II/III fracture* PRF: 37/25 feet ORIF, ELA: 34/24 feet Groups comparable at baseline? Probably yes	structure. The external end of K-wire was trimmed to 1cm.				
Giray Batıbay 2020	<u>Type of study:</u> RCT <u>Setting and country:</u> Turkey, January 2017 and February 2018 <u>Funding and conflicts of interest</u>: None	<u>Inclusion criteria:</u> • Patients aged >18 years with a minimum one-year follow-up • Unilateral and acute calcaneus fractures <u>Exclusion criteria</u>: Patients with • Diabetes mellitus • Osteoporosis (T-score <-2.5) •A history of osteoporosis drug therapy • Previous ipsilateral foot surgery or fracture • Chronic fracture • Open fracture <u>N total at baseline</u>: n = 35 patients PRF: n = 17 ELA: n = 18	**PRF** This procedure was performed using regional anesthesia without using a tourniquet. The patients were placed in the lateral decubitus position with the injured foot placed on a leg holder in an upper and strictly horizontal position. A free approach to the whole foot was essential to mount the distraction device appropriately and position the fluoroscope optimally. Two Kirschner (K)-wires were used for distraction, with the first pin inserted in the anterior process of the talus and second pin inserted in the distal plantar region of the tuber calcaneus. The entry points of the pins were marked using the lateral view. After manual correction of the varus with distraction, distraction was applied using the lateral and axial views until an adequate	**ELA** This approach was used under regional anesthesia using a tourniquet. The patients were placed in the supine position, and an incision was performed starting 2 cm above the lateral malleolus parallel to the Achilles tendon at the posterior sural nerve continuing distally towards the sole of the foot. Then, the incision was turned anteriorly and continued at the junction between the lateral dorsal normal skin and plantar skin until the calcaneocuboid joint; thereafter, a dorsal turn of 1 cm was performed. The whole layer of the skin flap was separated to fully expose the lateral wall of the calcaneus, subtalar joint and calcaneocuboid joint. A K-wire was drilled to restore the articular surface and fracture reduction. An artificial bone was used to fill the	<u>Length of follow-up</u>: PRF: 23.2 months ELA: 25.3 months <u>Loss-to-follow-up</u>: None, patients without at least one year follow-up were excluded	<u>Böhler's angle, mean ± SD</u> *Preoperative* PRF: 11.2 ± 5 ELA: 13.1 ± 6.1 P-value 0.41 *Postoperative* PRF: 26 ± 6 ELA: 28.2 ± 5.2 P-value 0.12 <u>AOFAS, mean ± SD</u> *6 months follow-up* PRF: 90 ± 2.8 ELA: 78 ± 6.3 P-value <0.001 <u>Complications</u> *Peroneal tendinopathy* PRF: 2/17 ELA: 10/18 P-value 0.01 *Wound complications* PRF: 0/17 ELA: 3/18 P-value 0.03	<u>Authors conclusion:</u> *"Closed reduction using dual-point distraction can be preferred owing to many advantages including a considerably decreased risk of wound complications, sickness absence period and length of hospital stay as well as superior postoperative rehabilitation with a low pain score."* <u>Limitations:</u> • Small sample size • Only 24 months of follow-up. Longer follow-up is needed to assess arthritic changes in the subtalar joint, which are the most common complications. • Patient-specific covariates such as smoking habit and medical comorbidities were not evaluated

		Important prognostic factors[2]: *For example age ± SD* PRF: 40.2 ± 10 years ELA: 39.2 ± 9 years *Sex:* 62.9% M *Information not available per treatment group* Groups comparable at baseline? Probably yes	length reduction was achieved. As indicated by the bending of K-wires, significant traction was needed to successfully reduce the fractures. We used an angle-stable, single-point distraction device on the medial side. The tension in the foot ligaments (particularly the plantar fascia) can help raise the longitudinal arch through ligamentotaxis as the calcaneal length is restored. For the fixation of the axis, length and height, two 6.5-mm cannulated fully threaded screws were used (Figure 2b). Parallel screws in the central zone can be considered beams supporting the fractured joint fragments above. Local soft-tissue complications significantly reduced with the use of an entry point above the upper border of the Achilles tendon insertion. Reduction of the central joint fragments of the posterior facet was achieved with the lift. Kirschner wires were inserted for the preparation for the insertion of 4.0-mm sustentaculum screws. All patients were evaluated postoperatively with CT.	bone defects. When the reduction was satisfactory, as observed by fluoroscopy, a steel plate was inserted for ORIF. The fracture end, calcaneal plate and screw location were confirmed using fluoroscopy			

Li 2020	Type of study: RCT Setting and country: China, trauma center, July 2015 to December 2018 Funding and conflicts of interest: No conflicts of interest. Information about funding not reported.	Inclusion criteria: • 18-60 years old • with unilateral, closed intra-articular calcaneal fractures displaced >2 mm • with Sanders type II, III, or IV fractures according to CT scans • Patients accepting the treatment plan designated using a random number table Exclusion criteria: • Patients with previous history of calcaneal fracture • Other fractures in addition to DIACFs • Long-term smoking and diabetes • Patients who were followed up for <12 months N total at baseline: n = 59 patients Group A: n = 31 Group B: n = 28 Important prognostic factors[2]: *age ± SD* Group A: 39.3 ± 9.6 years	**Percutaneous reduction and hollow screw fixation (PRHCF, group A)** One 3.5-mm Steinmann pin was first inserted at the calcaneal tubercle transversely from the medial to lateral sides and was used as the traction pin. The pin was then pulled along the axis of the posterior part of the calcaneus to primarily re-store the height and length. Another 3.5-mm Steinmann pin was introduced from the superoposterior portion of the calcaneus into the fracture fragment along its axis to reduce the posterior facet. The pin tip was placed on the major fracture fragment and not beyond the fracture line. Subsequently, the surgeon performed repeated percutaneous leverage by using the pins inserted sagittally through the calcaneus fragment. The reduction was assessed under fluoroscopic control. If satisfactory reduction could not be achieved after repeated leverage, a 0.3-cm stab incision was made at the bottom side of the calcaneus below the lateral malleolus. The top of the vascular forceps or a 3.5-mm Kirchner wire was placed under the col-lapsed articular bone, which was pulled up to	**ORIF with ELA, group B** A curvilinear, L-shaped incision was made at the affected foot. Once the lateral wall of the calcaneus and the subtalar joints were exposed, the full-thickness flap was held in place with three 2.0-mm Kirschner wires (1 each in the fibula, talar neck, and navicular). A Steinmann pin or traction bow was used for reducing the displaced articular surface to allow restoration of the calcaneal shape. After satisfactory reduction, a lateral plate designed for the calcaneus was generally used for rigid fixation. The rubber drains were then inserted into the incision, and the incision was closed in a layered fashion followed by compression bandaging.	Length of follow-up: Patients were seen for follow-up at one, 3, 6, and 12 months postoperatively and then yearly thereafter. Loss-to-follow-up: No loss-to-follow-up, since patients who were followed-up for <12 months were excluded from the analysis	Böhler's angle, mean ± SD *Preoperative* Group A: 10.1 ± 1.7 Group B: 10.4 ± 1.2 P value 0.428 *Postoperative* Group A: 30.2 ± 2.1 Group B: 30.7 ± 1.2 P value 0.261 AOFAS hindfoot score, mean *Postoperative* Group A: 88.3 Group B: 86.4 P value 0.08 MD unclear, since SDs were not reported Soft tissue complications, n (%) *Total* Group A: 1/31 (3.2) Group B: 3/28 (10.8) P value 0.337 OR=0.28 (95% CI, 0.03;2.84) *Superficial infection* Group A: 1/31 (3.2) Group B: 1/28 (3.6) *Deep infection* Group A: 0/31 (0) Group B: 1/28 (3.6) Wound edge necrosis Group A: 0/31 (0) Group B: 1/28 (3.6) *Sural nerve injury* Group A: 0/31 (0) Group B: 0/28 (0)	Author's conclusion: "*Percutaneous reduction and hollow screw fixation can achieve comparable reduction and functional outcomes to ORIF in treating DIACFs. Percutaneous reduction and hollow screw fixation can minimize damage to the surrounding tissues, which can subsequently result in shorter operative time and hospital stay, and reduced intraoperative blood loss, postoperative pain, and complication rates. Therefore, percutaneous reduction and hollow screw fixation is a safe and effective treatment choice for DIACFs, and a further randomized controlled trial with a larger sample size is warranted"* Limitations • Small sample size • Differences in surgeons' performances might have decreased the ability to extrapolate the results of this study • Validated PROMs were not included in initial study design

		Group B: 39.1 ± 8.6 years *Sex M/F (n):* Group A: 24/7 Group B: 21/7 *Sanders type II/III/IV (n):* Group A: 9/13/9 Group B: 8/11/9 Groups comparable at baseline? Probably yes	correct the angular malformation of the calcaneus and reduce the collapsed articular surface. Thereafter, the calcaneal width was restored by manually squeezing the surface of both sides of the calcaneal bone, and the 2.0-mm Kirchner wire was used for temporary fixation. After satisfactory reduction confirmed using the C-arm fluoroscopy intensifier, a guide pin was inserted adjacent to the lateral edge of the Achilles tendon from the super-oposterior portion of the calcaneal tubercle to the distal part of the fracture. Another guide needle was inserted percutaneously from the site 0.5 cm below the insertion point of the Achilles tendon across the fracture line to the anterior part of the calcaneus. After the satisfactory position of the guide pin was confirmed radiologically, a 6.5-mm diameter hollow screw was inserted to achieve the axial support fixation of the calcaneus. If the fracture of the lateral wall of the calcaneus expanded outwards, 1 to 3 guide pins were inserted percutaneously at the bone block of the lateral side of the calcaneus below the lateral malleolus, and a 4.0-mm hollow screw was inserted				

			to maintain the calcaneal width. Gaskets were used for incomplete bone block.				
Vora 2022	Type of study: RCT Setting and country: Hospital in India, December 2017 to September 2019 Funding and conflicts of interest: No information	Inclusion criteria: • 16-75 years old • Reporting to the Orthopedics OPD/casualty section with closed DICF • with >2 mm displacement, as per Essex Lopresti classification Exclusion criteria: • Patients with pathological fractures • Gustilo grade III open fracture • neurological deficits N total at baseline: n = 30 patients Group P: n = 15 Group O: n = 15 Important prognostic factors[2]: *age ± SD* Group P: 41 ± 11.70 years Group O: 41.4 ± 11.25 years *Sex M/F (n):* Group P: 12/3 Group O: 12/3	**Percutaneous surgery (PS, group P)** The patients were treated with closed reduction (PS) using the Essex Lopresti technique. Patients were placed prone on an operating table with their foot protruding. To achieve reduction, one or two ST pins were inserted from the calcaneal tuberosity towards the subtalar joint, under image intensifier control. Stress over the axis was given onto the pins down the distal side to correct Bohler's angle. Final fixation and stabilization were done using Steinman pins alone or K wires with percutaneous screws.	**ORIF with plating, using the lateral universal approach of calcaneum, group O** The patients were placed in a lateral decubitus position on a radiolucent operating table, with the foot elevated on an appropriate support. A full-thickness, L-shaped, lateral incision was made, with a gentle curve between the two segments. The fracture was reduced and temporarily fixed with K-wires under radiographic guidance. Various types of calcaneal plates like simple reconstruction plates, Y-reconstruction plates, H-plates and anatomical calcaneal plates were used for final stabilization.	Length of follow-up: Patients were seen for follow-up at 6 weeks, 2 months, 3 months and 6 months postoperatively Loss-to-follow-up: Not reported	Böhler's angle, mean ± SD *Preoperative* Group P: 8.73 ± 4.94 Group O: 5.93 ± 4.98 P value 0.1331 *6 months postoperative* Group P: 22 ± 3.72 Group O: 28.47 ± 7.20 P value 0.0056 AOFAS hindfoot score, mean ± SD *6 months postoperative* Group P: 78.53 ± 8.98 Group O: 87.73 ± 5.46 P value 0.0021 Complications, n (%) *Infection* Group P: 1/15 (6.67) Group O: 3/15 (20) P value 0.5957 *Wound dehiscence* Group P: 0/15 (0) Group O: 4/15 (26.67) P value 0.1004 Malunion, n (%) Group P: 6/15 (40) Group O: 3/15 (20) P value 0.4138	Author's conclusion "*ORIF was found to be associated with better functional and radiological outcomes compared to PS"* Limitations Single center approach with small sample size

		Joint depression/tongue type fracture (n): Group P: 7/8 Group O: 8/7 Groups comparable at baseline? Yes, but not for hospitalization duration					
Zhai 2021	Type of study: RCT Setting and country: Hospital in China, April 2015 to April 2019 Funding and conflicts of interest: No information about funding, no conflicts of interest	Inclusion criteria: • Patients with fresh, closed, calcaneus fracture • Patients who underwent the regular X-ray examination, computed tomography (CT) scanning and 3-dimensional reconstruction • Patients who took the symptomatic treatment, including fixation, raising and detumescence of affected limb, and active treatment for the complications of fracture Exclusion criteria: • Patients with open fracture, or dated fracture • Patients with ankle fracture or tarsal fracture	**closed reduction with hollow screw internal fixation, group A** Patients were anesthetized in supine position by the combined spinal and epidural analgesia, followed by the sanitization and draping and surgical treatment under the C-type arm. Punctuating point and direction were selected upon the preoperative X-ray examination and CT examination. From the posterior and lower calcaneal tuberosity, a 4.0 Steinmann pin was drilled vertically and flipped to tract to correct the varus and shortening of calcaneus. Then, under the guidance of C-type arm, a guide pin was inserted percutaneously from the calcaneus tuberosity to fix the site of fracture. Later, in the lateral side of the Achilles tendon, a Steinmann pin was drilled on the top of the calcaneal tuberosity, where the pin tip was	**Surgical open reduction and internal fixation of irregular steel plates, group B** Patients were anesthetized in lateral position of the non-affected side by the combined spinal and epidural analgesia. An L-shape incision was made on the lateral calcaneus and in the middle of Achilles's tendon and fibula and the boundary between the dorsal and pedis of foot skin, a longitudinal and horizontal incision was made respectively. Then, the incision of the calcaneocuboid joint slightly leaned against the dorsal side. During the surgery, incision should reach the surface of bone, where the electrotome was only suggested for hemostasis. To expose the tendon of peroneus longus, the tissues from the skin to the periosteal flap were flicked over, and then 3 kirschner wires were inserted into the astragalus to fix the flaps.	Length of follow-up: All patients were followed up for 3-15 months, average follow-up 10.15 ± 2.67 months Loss-to-follow-up: Not reported	Böhler's angle, mean ± SD *Preoperative* Group A: 14.19 ± 2.47 Group B: 14.08 ± 2.35 P value 0.857 *3 months postoperative* Group A: 33.52 ± 4.41 Group B: 33.09 ± 4.36 P value 0.0056 Complications, n (%) *Nerve damage* Group A: 0/32 (0) Group B: 0/31 (0) *Superficial wound infection* Group A: 1/32 (3.13) Group B: 3/31 10.0) *Deep infection* Group A: 0/32 (0) Group B: 1/31 (3.23) *Marginal necrosis of skin* Group A: 0/32 (0) Group B: 3/31 (10.0) Subtalar arthritis, n (%) Group A: 2/32 (6.25) Group B: 0/31 (0)	Author's conclusion: "*closed replacement and internal fixation of cannulated screw and surgical open reduction and internal fixation of irregular steel plates can both gain promising outcomes in terms of the replacement and postoperative recovery of foot function for calcaneal fracture, while the former is excellent in the mild surgical trauma and low incidence of postoperative complications."* Limitations Small sample size No information about loss-to-follow-up

		• Patients with the history of ankle injury • Patients with the ankle dysfunction in the affected limb prior to the fracture • Patients with the pathological fracture due to the primary osteogenic tumor, osteoid lesion, cystic pathogenic damage, or bone metastases • Patients with diseases in nervous system or mental disease. <u>N total at baseline</u>: n = 60 patients Group A: n = 30 (32 feet) Group B: n = 30 (31 feet) <u>Important prognostic factors</u>[2]: *age ± SD* Group A: 36.85 ± 7.42 years Group B: 37.26 ± 7.38 years *Sex M/F (n):* Group A: 21/9 Group B: 23/7 *Sanders fracture type II/III (n):* Group A: 19/11	advanced to the fracture space and then lifted up to support the bone on the articular surface to correct the Bohler angle and Gissane angle, while the bone at the fracture site was fixed by the 1 or 2 pins drilled beneath the lifted pin. Otherwise, 1 or 2 cannulated screws were inserted along the pin, and the pin was then taken out, followed by suture and plaster external fixation.	Thereafter, paries lateralis was open to expose the lower joint surface which was then turned over by 90°, and then the sclerites in collapse were poked to restore the Gissane angle. The middle to lower joint surface, if necessary, could be exposed by removing the fat in the tarsal canal, while since the anterior to the lower joint surface was hardly to be exposed, a kirschner wire was inserted transversely through the calcaneus tuberosity and dragged downwards to restore the Bohler angle. Thereafter, along the calcaneal axis, a kirschner wire was used to poke to restore the calcaneus height and then inserted directly into the astragalus for restoration and to widen the calcaneus by suppressing longitudinally the paries lateralis of calcaneus. Under the C-shape arm, Bohler angle was adjusted to 30° and after the joint restoration, the artificial bone or iliac bone was inserted in the space of calcaneus according to the defect of subarticular surface bone. A suitable, plastic plate was placed on the paries lateralis of calcaneus, where the screw should be inserted into the sustentaculum tali. Finally, the kirschner wires were taken out, with the			

		Group B: 18/12 Groups comparable at baseline? Yes		thorough hemostasis and a drainage tube was inserted, followed by the suture and compressed dressing.			
PICO B: STA vs ELA							
Park 2021	Type of study: RCT Setting and country: Single centre, South-Korea, 2013 to 2018 Funding and conflicts of interest: None, non-commercial grant.	Inclusion criteria: - adult patients aged > 18 years - Sanders type 2A and 2B calcaneal fracture - surgery by a single surgeon - follow-up of patients > 1year Exclusion criteria: - open calcaneal fracture - bilateral intra-articular calcaneal fracture - Sanders Type 1, 2C, 3 and 4 - concomitant head or neurovascular injury N total at baseline: STA: 32 ELA: 32 Important prognostic factors[2]: *age ± SD:* STA: 50.4 ± 13.9 ELA: 48.8 ± 11.9 *Sex: M/F* STA: 28/4 ELA: 29/3	**Sinus Tarsi Approach (STA)** A 4 cm incision was made from the tip of the lateral malleolus to the level of the calcaneum joint toward the fifth metatarsal. After exposing the fracture site, the impacted posterolateral fragment was elevated using a curette. Calcaneal alignment and height were restored by valgus and downward stress using the Steinmann pin that was inserted into the calcaneal tuberosity. Calcaneal width was restored by compressing the heel by applying force to the lateral aspect. After reducing the posterolateral fragment, Kirschner wires were temporarily fixed to the medial fragment and definite fixation of the posterolateral fragment was performed using two 2.7 mm cortical screws. Fixation between the anterior process and posterior facet fragment was then performed using two or three 7.0 mm cannulated screws.	**Extensile lateral approach (ELA)** A vertical limb incision was made along the lateral edge of the Achilles tendon and a horizontal limb incision was made along the junction of plantar skin and skin of lateral aspect of the foot skin. The lateral wall was retracted inferiorly to expose the fracture site. After reducing the posterolateral fragment, fixation of the posterolateral fragment was performed using two 2.7 mm cortical screws. After restoration of the length and height of the calcaneus, a calcaneal locking plate (DePuy Synthes, West Chester, Pennsylvania, USA) was applied to stabilize the anterior process and posterior facet fragment).	Length of follow-up: Follow-up at 6 and 12 months Loss-to-follow-up: STA: n = 0 ELA: n = 0	Böhler's angle, mean ± SD STA: 21 ± 7.4 ELA: 21 ± 6.4 AOFAS-score, mean ± SD *12 months follow-up* STA: 90.3 ± 9.8 ELA: 87.3 ± 8.7 Complications, n (%) *Wound complications:* STA: 0/32 (0) ELA: 4/32 (12.5) *Sural Nerve injury* STA: 1/32 (3.1) ELA: 3/32 (9.4)	Author's conclusion: "The extensile lateral approach showed higher frequency of wound complications than the sinus tarsi approach for Sanders type 2 calcaneus fractures, even though there was no statistical significance. -- The sinus tarsi approach showed better short-term clinical results and shorter operation time than the extensile lateral approach." Wound complications included minor and major complications. Minor complications: superficial infections and superficial marginal wound necroses that could be managed without reoperation or with small procedures (minor injuries). Major complications: deep infection and deep marginal wound necrosis involving the implants and the bones requiring reoperation.

		Only Sanders type II included. Groups comparable at baseline? Probably yes					
Rastegar 2021	<u>Type of study:</u> RCT <u>Setting and country:</u> Two centres in Iran, in 2019 <u>Funding and conflicts of interest</u>: None	<u>Inclusion criteria</u>: - patients aged 18 - 75 - intra-articular fracture of the calcaneus with a displacement (more than 2 mm) <u>Exclusion criteria</u>: - previous history of surgery, osteoarthritis, and inflammatory arthritis in the foot and ipsilateral ankle, absence of major comorbidities, smoking - patients with fractures due to secondary causes at the operation site <u>N total at baseline</u>: n = 30 STA: 15 ELA: 15 <u>Important prognostic factors</u>[2]: *age ± SD:* STA: 41.6 ± 7.5 ELA: 35.3 ± 11.7	**STA** **Minimally invasive technique** The patient was placed in a lateral position. The tourniquet was closed above the ankle and left on for up to 2 hours. The incision was given from the site of the lateral malleolus to the base of the fourth metatarsus. With the help of this method, posterior facet and, if necessary, anterior and calcaneocuboid joint facets could be seen and reduced.	**Extensile lateral approach (ELA)** In the second group, the patient was placed in the lateral position. The tourniquet was closed above the ankle and left on for up to 2 hours. The patient underwent surgery using a large L-shaped incision in the lateral ankle according to Benirshcke and Sangeorzan methods. All surgeries were performed by a single orthopedic surgeon and the same surgical team.	<u>Length of follow-up</u>: Follow-up at 3, 6, and 12 months <u>Loss-to-follow-up</u>: None, patients without adequate follow-up at 12 months were excluded	<u>Böhler's angle, mean ± SD</u> STA: 48.73 ± 7.9 ELA: 40.45 ± 5.59 <u>Complications, n (%)</u> *Soft tissue complications* STA: 3/15 (20) ELA: 10/15 (66.7)	<u>Author's conclusion:</u> "*The extensile approach was associated with lower pain, lower Boehler angle and better quality of reduction compared to minimally invasive technique but also higher operation duration and surgical site complication*" The incidence of soft tissue complications such as surgical site infection, surgical wound dehiscence, bread union or delayed union, erythema or cellulitis were recorded by the orthopedic surgeon during 12 months of follow-up.

		Sex: M/F STA: 11/4 ELA: 12/3 Groups comparable at baseline? Probably yes					
Zhang 2020	Type of study: RCT Setting and country: Single Centra, China, 2017 to 2019 Funding and conflicts of interest: None	Inclusion criteria: - patients with Sanders types II and III intra-articular calcaneal fracture - closed fractures - single foot Exclusion criteria: - extra-articular calcaneal fractures, - Sanders type IV - surgical contraindications - foot deformities - congenital diseases - abnormal foot function N total at baseline: n = 106 STA: 53 ELA: 53 Important prognostic factors[2]: *age ± SD* total population: 41.57 ± 2.63, 24-58 years *Sex: M/F* In total: 59/47	**Tarsal sinus approach (group A, STA)** That is, an incision about 3 cm long was cut along the long axis of fibula, 1-2 cm below the ankle in order to expose the tarsal sinus, and then the fracture site was adjusted using a Steinmann pin. After that, the fracture site was fixed temporarily using 2-3 Kirschner wires. The calcaneus was repositioned by manipulation, and after the reposition standard was met, a hollow screw was inserted into the tarsal sinus for fixation.	**Lateral Extended approach (group B, ELA)** That is, the standard surgical method of lateral incision was used, the skin of the foot was cut open to the heel, about 1 cm above the junction between the instep and sole, the periosteum was stripped, the fractured end of calcaneus was opened and repositioned using a medical stripper. The articular surface was observed using X-ray. When the reposition standard was met, the fracture site was fixed with a medical screw and a medical steel plate.	Length of follow-up: Follow-up at 6 months Loss-to-follow-up: None, patients without adequate follow-up at 6 months were excluded	Böhler's angle, mean ± SD STA: 26.8 ± 2.2 ELA: 26.3 ± 2.3 P value 0.316 AOFAS hindfoot score, mean ± SD *6 months follow-up* STA: 85.7 ± 3.9 ELA: 84.3 ± 4.6 P value 0.108 Complications, n (%) *Wound infection:* STA: 1/53 (1.9) ELA: 4/53 (7.6) *Nerve injury* STA: 0/53 (0) ELA: 1/53 (1.9) Delayed union STA: 1/53 (1.9%) ELA: 2/53 (3.8%)	Author's conclusion: *"both surgeries via the tarsal sinus approach and the lateral extended approach have a good efficacy on intra-articular calcaneal fracture. However, compared with the lateral extended approach, the tarsal sinus approach has less intraoperative blood loss, shorter getting out-of-bed time, shorter length of stay and fewer postoperative complications."*

		Sanders type II/III fractures *Total population* 55 cases type II 51 cases type III Groups comparable at baseline? Probably yes					

Risk of bias table for intervention studies (randomized controlled trials; based on Cochrane risk of bias tool and suggestions by the CLARITY Group at McMaster University)

Research question: UV3 calcaneus

Study reference (first author, publication year)	**Was the allocation sequence adequately generated?** Definitely yes Probably yes Probably no Definitely no	**Was the allocation adequately concealed?** Definitely yes Probably yes Probably no Definitely no	**Blinding: Was knowledge of the allocated interventions adequately prevented?** **Were patients blinded?** **Were healthcare providers blinded?** **Were data collectors blinded?** **Were outcome assessors blinded?** **Were data analysts blinded?** Definitely yes Probably yes Probably no Definitely no	**Was loss to follow-up (missing outcome data) infrequent?** Definitely yes Probably yes Probably no Definitely no	**Are reports of the study free of selective outcome reporting?** Definitely yes Probably yes Probably no Definitely no	**Was the study apparently free of other problems that could put it at a risk of bias?** Definitely yes Probably yes Probably no Definitely no	**Overall risk of bias** **If applicable/necessary, per outcome measure** **LOW** **Some concerns** **HIGH**

Hussain 2022 **PICO A**	Probably yes; Reason: it was stated that computer generated random number tables were used	No information on allocation concealment	Probably no; Reason: no information, however due to the nature of the intervention blinding is unlikely	Probably yes Reason: there were no patients reported to be lost to follow-up	Probably yes; Reason: outcomes stated in the method section were reported	Probably no; Reason: it is not clear if the intervention and control group had similar baseline characteristics as Böhlers Angle in the healthy foot was 31.01 versus 25 degrees respectively	Some concerns for the outcomes Bohlers angle
STA vs ELA							
Chen 2011 (from Shi 2020) **PICO B**	No information on allocation sequence generation (but it was stated that patients were randomly assigned)	No information on allocation concealment	Probably no; Reason: it was stated that examinations were blinded as participants were not directly involved with the care of patients in either group. Additional information on blinding procedures was not provided	Probably yes Reason: 12 patients were lost to follow-up, these were excluded from the analysis. Not clear from which group.	Probably yes; Reason: outcomes stated in the method section were reported	Probably yes; Reason: no other sources of bias could be identified	**Some concerns for all outcomes** Unclear randomization and blinding procedure
Sampath Kumar 2014 (from Shi, 2020) **PICO B**	Definitely yes; Reason: randomisation by lottery method	No information	Definitely no Reason: it was stated that blinding methods were not feasible	Probably yes Reason: Loss to follow-up was infrequent in intervention and control group (n =1 and n = 2)	Definitely yes Reason: outcomes stated in the method section were reported	Probably no Reason: bilateral fractures were included. **Infection** occurred in three fractures from two patients	**Some concerns** for functional outcome **High** for infection.

Lu 2015 (from Shi, 2020) **PICO B**	No information on allocation sequence generation (but it was stated that patients were randomly divided into two groups)	No information on allocation concealment	Probably no; Reason: No information, however due the nature of the intervention it is likely that there was no blinding	No information on loss to follow-up	Probably yes; Reason: outcomes stated in the method section were reported	Probably yes; Reason: no other sources of bias could be identified	**High for all outcomes** Problems with blinding, unclear randomization, unclear loss to follow-up
Giray Batıbay 2020 **PICO B**	Definitely yes Reason: A variable block schedule was created on a computer system for randomization	Definitely yes Reason: The list containing the resulting treatment groups was stored in sealed non-transparent envelopes.	Probably no Reason: No information, however, due to the nature of the intervention, it is likely that there was no blinding	Definitely yes Reason: Patients without adequate follow-up were excluded from the study population	Definitely yes Reason: Outcomes stated in the method section were reported	Definitely yes Reason: no other sources of bias could be identified	**Some concerns for AOFAS (patient-reported outcome)** **Low for Böhler's angle and complications (both hard outcomes)** Problems with blinding
Li 2020 **PICO B**	Definitely yes Reason: a random number table was used	No information	Probably yes Reason: outcomes were assessed by an orthopedic surgeon who was blind to the patient grouping. **No information about blinding of patients.**	Probably yes Reason: in total, 12 patients were lost to follow-up and were excluded from the analysis, but not clear from which group. It is likely that 4 patients in group A were excluded and 8 patients in group B (or vice versa), given that 71 patients were enrolled in the study.	Definitely yes Reason: Outcomes stated in the method section were reported	Definitely yes Reason: no other sources of bias could be identified	**Low for Böhler's angle and complications**

Vora 2022 **PICO B**	No information	No information	Probably yes Reason: it was stated that the study was double blind, but given the nature of the intervention, this is questionable.	No information	Definitely yes Reason: Outcomes stated in the method section were reported	Probably no Reason: "… double-blind study", so researcher and patients are blinded, but how is this possible?	**High for all outcomes** **Outcomes AOFAS hindfoot score, Böhler's angle, complications** **Reason:** no information about allocation sequence generation, allocation concealment, loss-to-follow-up
Zhai 2021 **PICO B**	No information, but it was stated that patients were randomized	No information	No information	No information	Definitely yes Reason: Outcomes stated in the method section were reported	Definitely yes Reason: no other sources of bias could be identified	**High for all outcomes** **Reason:** no information about crucial elements to judge RoB (randomization method, allocation concealment, blinding, loss-to-follow-up)
STA vs ELA							
Park 2021, **PICO B**	No information on allocation sequence generation (but it was stated that patients were randomly assigned)	No information on allocation concealment	Probably no; Reason: No information, however due the nature of the intervention it is likely that there was no blinding	Probably yes; Reason: it was stated that no patients were lost to follow-up	Probably yes; Reason: outcomes stated in the method section were reported	Probably yes; Reason: no other sources of bias could be identified	**Some concerns for all outcomes** Unclear randomization and blinding procedure
Rastegar 2021 **PICO B**	Definitely yes; Reason: allocation sequence was generation with random allocation software	No information	Probably no; Reason: No information, however due the nature of the intervention it is likely that there was no blinding	Probably yes; Reason: patients without adequate follow-up were excluded from the study population	Definitely no; Reason: in the method section it is stated that AOFAS and VAS were reported as an outcome, but these were not reported in the result section	Probably yes; Reason: no other sources of bias could be identified	**High for all outcomes** No blinding and selective outcome reporting.
Zhang 2020 **PICO B**	No information on allocation sequence	No information on allocation concealment	Probably no;	Probably yes;	Probably yes;	Probably yes;	**Some concerns outcomes**

	generation (but it was stated that patients were randomly assigned)		Reason: No information, however due the nature of the intervention it is likely that there was no blinding	Reason: patients without adequate follow-up were excluded from the study population	Reason: outcomes stated in the method section were reported	Reason: no other sources of bias could be identified	Unclear randomization and blinding procedure

Table of excluded studies

Reference	Reason for exclusion
Bai L, Hou YL, Lin GH, Zhang X, Liu GQ, Yu B. Sinus tarsi approach (STA) versus extensile lateral approach (ELA) for treatment of closed displaced intra-articular calcaneal fractures (DIACF): A meta-analysis. Orthop Traumatol Surg Res. 2018 Apr;104(2):239-244. doi: 10.1016/j.otsr.2017.12.015. Epub 2018 Feb 2. PMID: 29410159.	More recent + complete SR available (Lv 2021 / Peng 2021), RCTs and comparative retrospective studies
Bruce J, Sutherland A. Surgical versus conservative interventions for displaced intra-articular calcaneal fractures. Cochrane Database Syst Rev. 2013 Jan 31;(1):CD008628. doi: 10.1002/14651858.CD008628.pub2. Update in: Cochrane Database Syst Rev. 2023 Nov 7;11:CD008628. PMID: 23440830.	More recent, and higher quality SR's available (Selim 2022)
Dai F, Xu YF, Yu ZH, Liu JT, Zhang ZG. Percutaneous Prodding Reduction and K-Wire Fixation Via Sinus Tarsi Approach Versus ORIF for Sanders Type III Calcaneal Fractures: A Prospective Case-Controlled Trial. J Foot Ankle Surg. 2022 Jan-Feb;61(1):37-42. doi: 10.1053/j.jfas.2021.06.005. Epub 2021 Jun 18. PMID: 34253433.	Wrong intervention: percutaneous prodding reduction and k-wire fixation versus ORIF
Fan B, Zhou X, Wei Z, Ren Y, Lin W, Hao Y, Shi G, Feng S. Cannulated screw fixation and plate fixation for displaced intra-articular calcaneus fracture: A meta-analysis of randomized controlled trials. Int J Surg. 2016 Oct;34:64-72. doi: 10.1016/j.ijsu.2016.08.234. Epub 2016 Aug 30. PMID: 27565242.	Article in Chinese
Gougoulias N, Khanna A, McBride DJ, Maffulli N. Management of calcaneal fractures: systematic review of randomized trials. Br Med Bull. 2009;92:153-67. doi: 10.1093/bmb/ldp030. PMID: 19734165.	More recent, and higher quality SR's available (Selim 2022)
Jiang N, Lin QR, Diao XC, Wu L, Yu B. Surgical versus nonsurgical treatment of displaced intra-articular calcaneal fracture: a meta-analysis of current evidence base. Int Orthop. 2012 Aug;36(8):1615-22. doi: 10.1007/s00264-012-1563-0. Epub 2012 May 11. PMID: 22576080; PMCID: PMC3535025.	More recent, and higher quality SR's available (Selim 2022)
Jiao L, Li H, Liao T, Han Z, Wu H, Jiang L. Impact of percutaneous poking reduction combined with minimally invasive plate internal fixation on foot function and complications of patients with Sanders type II and III calcaneal fractures. Am J Transl Res. 2021 May 15;13(5):5329-5335. PMID: 34150126; PMCID: PMC8205695.	Wrong intervention: percutaneous poking reduction and minimally invasive plate internal fixation versus
Luo X, Li Q, He S, He S. Operative Versus Nonoperative Treatment for Displaced Intra-Articular Calcaneal Fractures: A Meta-Analysis of Randomized Controlled Trials. J Foot Ankle Surg. 2016 Jul-Aug;55(4):821-8. doi: 10.1053/j.jfas.2016.01.035. Epub 2016 Apr 15. PMID: 27150233.	More recent, and higher quality SR's available (Selim 2022)
Ma D, Huang L, Liu B, Liu Z, Xu X, Liu J, Chu T, Pan L. Efficacy of Sinus Tarsal Approach Compared With Conventional L-Shaped Lateral Approach in the Treatment of Calcaneal Fractures: A Meta-Analysis. Front Surg. 2021 Jan 15;7:602053. doi: 10.3389/fsurg.2020.602053. PMID: 33585545; PMCID: PMC7873930.	Only retrospective studies were included in the analysis.
Majeed H, Barrie J, Munro W, McBride D. Minimally invasive reduction and percutaneous fixation *versus* open reduction and internal fixation for displaced intra-articular calcaneal fractures: A systematic review of the literature. EFORT Open Rev. 2018 Jul 11;3(7):418-425. doi: 10.1302/2058-5241.3.170043. PMID: 30233817; PMCID: PMC6129959.	More recent + complete SR available (Lv 2021 / Peng 2021)
Meena S, Gangary SK, Sharma P. Review Article: Operative versus nonoperative treatment for displaced intra-articular calcaneal fracture: a meta-analysis of randomised controlled trials. J Orthop Surg (Hong Kong). 2016 Dec;24(3):411-416. doi: 10.1177/1602400328. PMID: 28031517.	Duplicate
Meena S, Hooda A, Sharma P, Mittal S, Sharma J, Chowdhury B. Operative versus Non operative treatment of displaced intra-articular fracture of calcaneum: a meta-analysis of randomized controlled trials. Acta Orthop Belg. 2017 Dec;83(1):161-169. PMID: 29322909.	More recent, and higher quality SR's available (Selim 2022)
Mehta CR, An VVG, Phan K, Sivakumar B, Kanawati AJ, Suthersan M. Extensile lateral versus sinus tarsi approach for displaced, intra-articular calcaneal fractures: a meta-analysis. J Orthop Surg Res. 2018 Sep 24;13(1):243. doi: 10.1186/s13018-018-0943-6. PMID: 30249288; PMCID: PMC6154938.	More recent + complete SR available (Lv 2021 / Peng 2021)
Nosewicz TL, Dingemans SA, Backes M, Luitse JSK, Goslings JC, Schepers T. A systematic review and meta-analysis of the sinus tarsi and extended lateral	More recent + complete SR available (Lv 2021 / Peng 2021)

approach in the operative treatment of displaced intra-articular calcaneal fractures. Foot Ankle Surg. 2019 Oct;25(5):580-588. doi: 10.1016/j.fas.2018.08.006. Epub 2018 Aug 28. PMID: 30321924.	
Seat A, Seat C. Lateral Extensile Approach Versus Minimal Incision Approach for Open Reduction and Internal Fixation of Displaced Intra-articular Calcaneal Fractures: A Meta-analysis. J Foot Ankle Surg. 2020 Mar-Apr;59(2):356-366. doi: 10.1053/j.jfas.2019.08.007. PMID: 32131003.	More techniques than only Sinus Tarsi approach / RCT en observational studies
Shi F, Wu S, Cai W, Zhao Y. Comparison of 5 Treatment Approaches for Displaced Intra-articular Calcaneal Fractures: A Systematic Review and Bayesian Network Meta-Analysis. J Foot Ankle Surg. 2020 Nov-Dec;59(6):1254-1264. doi: 10.1053/j.jfas.2020.03.021. Epub 2020 Aug 20. PMID: 32828631.	Only overall effect measures presented, no presentation of data per individual study More recent and higher quality SR available (Selim, 2022)
Wang Q, Zhang N, Guo W, Wang W, Zhang Q. Cannulated screw fixation versus plate fixation in treating displaced intra-articular calcaneus fractures: a systematic review and meta-analysis. Int Orthop. 2021 Sep;45(9):2411-2421. doi: 10.1007/s00264-021-05141-y. Epub 2021 Aug 9. PMID: 34370059.	Comparison of two fixation techniques: cannulated screw fixation versus plate fixation
Wei N, Yuwen P, Liu W, Zhu Y, Chang W, Feng C, Chen W. Operative versus nonoperative treatment of displaced intra-articular calcaneal fractures: A meta-analysis of current evidence base. Medicine (Baltimore). 2017 Dec;96(49):e9027. doi: 10.1097/MD.0000000000009027. PMID: 29245290; PMCID: PMC5728905.	More recent, and higher quality SR's available (Selim 2022)
Wu MH, Sun WC, Yan FF, Hou ZQ, Feng F, Cai L. [Minimally invasive sinus tarsal approach versus conventional L-shaped lateral approach in treating calcaneal fractures: a Meta-analysis]. Zhongguo Gu Shang. 2017 Dec 25;30(12):1118-1126. Chinese. doi: 10.3969/j.issn.1003-0034.2017.12.009. PMID: 29457434.	Article in Chinese
Yao H, Liang T, Xu Y, Hou G, Lv L, Zhang J. Sinus tarsi approach versus extensile lateral approach for displaced intra-articular calcaneal fracture: a meta-analysis of current evidence base. J Orthop Surg Res. 2017 Mar 14;12(1):43. doi: 10.1186/s13018-017-0545-8. PMID: 28288661; PMCID: PMC5348794.	More recent + complete SR available (Lv 2021 / Peng 2021)
Yu T, Xiong Y, Kang A, Zhou H, He W, Zhu H, Yang Y. Comparison of sinus tarsi approach and extensile lateral approach for calcaneal fractures: A systematic review of overlapping meta-analyses. J Orthop Surg (Hong Kong). 2020 Jan-Apr;28(2):2309499020915282. doi: 10.1177/2309499020915282. PMID: 32314645.	Systematic review of overlapping meta-analyses Five reviews included: Yao 2017, Zhang 2017, Bai 2018, Metha 2018, Nosewitcz 2018. No usefull presentation of the results.
Zeng Z, Yuan L, Zheng S, Sun Y, Huang F. Minimally invasive versus extensile lateral approach for sanders type II and III calcaneal fractures: A meta-analysis of randomized controlled trials. Int J Surg. 2018 Feb;50:146-153. doi: 10.1016/j.ijsu.2017.12.034. Epub 2018 Jan 11. PMID: 29337175.	More techniques than only sinus tarsi approach
Zhang F, Tian H, Li S, Liu B, Dong T, Zhu Y, Zhang Y. Meta-analysis of two surgical approaches for calcaneal fractures: sinus tarsi versus extensile lateral approach. ANZ J Surg. 2017 Mar;87(3):126-131. doi: 10.1111/ans.13869. Epub 2017 Jan 25. PMID: 28122417.	More recent + complete SR available (Lv 2021 / Peng 2021)
Zhang W, Lin F, Chen E, Xue D, Pan Z. Operative Versus Nonoperative Treatment of Displaced Intra-Articular Calcaneal Fractures: A Meta-Analysis of Randomized Controlled Trials. J Orthop Trauma. 2016 Mar;30(3):e75-81. doi: 10.1097/BOT.0000000000000446. PMID: 26371619.	More recent, and higher quality SR's available (Selim 2022)

Literature search strategy

Cluster/richtlijn: NVvH Traumatisch complexe voetletsels	
Uitgangsvraag/modules: UV3 Welke behandeling reduceert de meest voorkomende gevolgen (korte en lange termijn) van Calcaneus fracturen?	
Database(s): Ovid/Medline, Embase.com	Datum: 11 januari 2023
Periode: geen restrictie	Talen: geen restrictie
Literatuurspecialist: Alies van der Wal	
BMI-zoekblokken: voor verschillende opdrachten wordt (deels) gebruik gemaakt van de zoekblokken van BMI-Online https://blocks.bmi-online.nl/ Bij gebruikmaking van een volledig zoekblok zal naar de betreffende link op de website worden verwezen.	

Toelichting: Voor deze vraag is gezocht op de elementen: - calcaneus fracturen - chirurgische behandeling Sleutelartikelen worden gevonden met deze search Sensitief filter gebruikt voor RCTs

Zoekopbrengst

	EMBASE	**OVID/MEDLINE**	**Ontdubbeld**
SRs	138	101	149
RCT	411	213	442
Observationele studies	1353	1104	1676
Totaal	549	314	**591***

*Opgenomen in Rayyan

Zoekstrategie

5

Embase.com

No.	**Query**	**Results**
#15	#4 AND #10 NOT (#11 OR #13) = observationeel	1353
#13	#4 AND #7 NOT #11 = RCT	411
#11	#4 AND #5 = SR	138
#10	#8 OR #9	15551918
#9	'case control study'/de OR 'comparative study'/exp OR 'control group'/de OR 'controlled study'/de OR 'controlled clinical trial'/de OR 'crossover procedure'/de OR 'double blind procedure'/de OR 'phase 2 clinical trial'/de OR 'phase 3 clinical trial'/de OR 'phase 4 clinical trial'/de OR 'pretest posttest design'/de OR 'pretest posttest control group design'/de OR 'quasi experimental study'/de OR 'single blind procedure'/de OR 'triple blind procedure'/de OR (((control OR controlled) NEAR/6 trial):ti,ab,kw) OR (((control OR controlled) NEAR/6 (study OR studies)):ti,ab,kw) OR (((control OR controlled) NEAR/1 active):ti,ab,kw) OR 'open label*':ti,ab,kw OR (((double OR two OR three OR multi OR trial) NEAR/1 (arm OR arms)):ti,ab,kw) OR ((allocat* NEAR/10 (arm OR arms)):ti,ab,kw) OR placebo*:ti,ab,kw OR 'sham-control*':ti,ab,kw OR (((single OR double OR triple OR assessor) NEAR/1 (blind* OR masked)):ti,ab,kw) OR nonrandom*:ti,ab,kw OR 'non-random*':ti,ab,kw OR 'quasi-experiment*':ti,ab,kw OR crossover:ti,ab,kw OR 'cross over':ti,ab,kw OR 'parallel group*':ti,ab,kw OR 'factorial trial':ti,ab,kw OR ((phase NEAR/5 (study OR trial)):ti,ab,kw) OR ((case* NEAR/6 (matched OR control*)):ti,ab,kw) OR ((match* NEAR/6 (pair OR pairs OR cohort* OR control* OR group* OR healthy OR age OR sex OR gender OR patient* OR subject* OR participant*)):ti,ab,kw) OR ((propensity NEAR/6 (scor* OR match*)):ti,ab,kw) OR versus:ti OR vs:ti OR compar*:ti OR ((compar* NEAR/1 study):ti,ab,kw) OR (('major clinical study'/de OR 'clinical study'/de OR 'cohort analysis'/de OR 'observational study'/de OR 'cross-sectional study'/de OR 'multicenter study'/de OR 'correlational study'/de OR 'follow up'/de OR cohort*:ti,ab,kw OR 'follow up':ti,ab,kw OR followup:ti,ab,kw OR longitudinal*:ti,ab,kw OR prospective*:ti,ab,kw OR retrospective*:ti,ab,kw OR observational*:ti,ab,kw OR 'cross sectional*':ti,ab,kw OR cross?ectional*:ti,ab,kw OR multicent*:ti,ab,kw OR 'multi-cent*':ti,ab,kw OR consecutive*:ti,ab,kw) AND (group:ti,ab,kw OR groups:ti,ab,kw OR subgroup*:ti,ab,kw OR versus:ti,ab,kw OR vs:ti,ab,kw OR compar*:ti,ab,kw OR 'odds ratio*':ab OR 'relative odds':ab OR 'risk ratio*':ab OR 'relative risk*':ab OR 'rate ratio':ab OR aor:ab OR arr:ab OR rrr:ab OR ((('or' OR 'rr') NEAR/6 ci):ab)))	13761684
#8	'major clinical study'/de OR 'clinical study'/de OR 'case control study'/de OR 'family study'/de OR 'longitudinal study'/de OR 'retrospective study'/de OR 'prospective study'/de OR 'comparative study'/de OR 'cohort analysis'/de OR ((cohort NEAR/1 (study OR studies)):ab,ti) OR (('case control' NEAR/1 (study OR studies)):ab,ti) OR (('follow up' NEAR/1 (study OR studies)):ab,ti) OR (observational NEAR/1 (study OR studies)) OR ((epidemiologic NEAR/1 (study OR studies)):ab,ti) OR (('cross sectional' NEAR/1 (study OR studies)):ab,ti)	6767914
#7	'clinical trial'/exp OR 'randomization'/exp OR 'single blind procedure'/exp OR 'double blind procedure'/exp OR 'crossover procedure'/exp OR 'placebo'/exp OR 'prospective study'/exp OR	3302394

	rct:ab,ti OR random*:ab,ti OR 'single blind':ab,ti OR 'randomised controlled trial':ab,ti OR 'randomized controlled trial'/exp OR placebo*:ab,ti	
#5	'meta analysis'/exp OR 'meta analysis (topic)'/exp OR metaanaly*:ti,ab OR 'meta analy*':ti,ab OR metanaly*:ti,ab OR 'systematic review'/de OR 'cochrane database of systematic reviews'/jt OR prisma:ti,ab OR prospero:ti,ab OR (((systemati* OR scoping OR umbrella OR 'structured literature') NEAR/3 (review* OR overview*)):ti,ab) OR ((systemic* NEAR/1 review*):ti,ab) OR (((systemati* OR literature OR database* OR 'data base*') NEAR/10 search*):ti,ab) OR (((structured OR comprehensive* OR systemic*) NEAR/3 search*):ti,ab) OR (((literature NEAR/3 review*):ti,ab) AND (search*:ti,ab OR database*:ti,ab OR 'data base*':ti,ab)) OR (('data extraction':ti,ab OR 'data source*':ti,ab) AND 'study selection':ti,ab) OR ('search strategy':ti,ab AND 'selection criteria':ti,ab) OR ('data source*':ti,ab AND 'data synthesis':ti,ab) OR medline:ab OR pubmed:ab OR embase:ab OR cochrane:ab OR (((critical OR rapid) NEAR/2 (review* OR overview* OR synthes*)):ti) OR ((((critical* OR rapid*) NEAR/3 (review* OR overview* OR synthes*)):ab) AND (search*:ab OR database*:ab OR 'data base*':ab)) OR metasynthes*:ti,ab OR 'meta synthes*':ti,ab	733409
#4	#3 NOT ('conference abstract'/it OR 'editorial'/it OR 'letter'/it OR 'note'/it) NOT (('animal'/exp OR 'animal experiment'/exp OR 'animal model'/exp OR 'nonhuman'/exp) NOT 'human'/exp)	3796
#3	#1 AND #2	4360
#2	'fracture fixation'/exp OR 'bone implant'/exp OR osteosynthes*:ti,ab,kw OR 'surgery'/exp OR surger*:ti,ab,kw OR surgical*:ti,ab,kw OR operation*:ti,ab,kw OR operative*:ti,ab,kw OR reduction:ti,ab,kw OR orif:ti,ab,kw OR 'mini invasive':ti,ab,kw OR 'minimally invasive':ti,ab,kw OR 'minimal invasive':ti,ab,kw OR mipo:ti,ab,kw OR palmer:ti,ab,kw OR zadravecz:ti,ab,kw OR forgon:ti,ab,kw OR 'sinus tarsi':ti,ab,kw OR 'extended lateral':ti,ab,kw OR 'extensile lateral':ti,ab,kw OR (((screw* OR plate OR plates OR plating OR internal) NEAR/3 (fixat* OR lock* OR percutaneous)):ti,ab,kw)	8346707
#1	'calcaneus fracture'/exp OR diacf:ti,ab,kw OR iacf:ti,ab,kw OR 'tongue type':ti,ab,kw OR sanders*:ti,ab,kw OR ('calcaneus'/exp AND ('fracture'/exp OR 'dislocation'/exp OR 'bone injury'/exp)) OR (((calcan* OR hindfoot OR 'hind foot' OR heel* OR 'os calcis') NEAR/3 (fractur* OR broken OR dislocat* OR displac*)):ti,ab,kw)	7297

Ovid/Medline

#	Searches	Results
12	(4 and 9) not (10 or 11) = observationeel	1104
11	(4 and 5) not 10 = RCT	213
10	4 and 6 = SR	101
9	7 or 8	7090773
8	Case-control Studies/ or clinical trial, phase ii/ or clinical trial, phase iii/ or clinical trial, phase iv/ or comparative study/ or control groups/ or controlled before-after studies/ or controlled clinical trial/ or double-blind method/ or historically controlled study/ or matched-pair analysis/ or single-blind method/ or (((control or controlled) adj6 (study or studies or trial)) or (compar* adj (study or studies)) or ((control or controlled) adj1 active) or "open label*" or ((double or two or three or multi or trial) adj (arm or arms)) or (allocat* adj10 (arm or arms)) or placebo* or "sham-control*" or ((single or double or triple or assessor) adj1 (blind* or masked)) or nonrandom* or "non-random*" or "quasi-experiment*" or "parallel group*" or "factorial trial" or "pretest posttest" or (phase adj5 (study or trial)) or (case* adj6 (matched or control*)) or (match* adj6 (pair or pairs or cohort* or control* or group* or healthy or age or sex or gender or patient* or subject* or participant*)) or (propensity adj6 (scor* or match*))).ti,ab,kf. or (confounding adj6 adjust*).ti,ab. or (versus or vs or compar*).ti. or ((exp cohort studies/ or epidemiologic studies/ or multicenter study/ or observational study/ or seroepidemiologic studies/ or (cohort* or 'follow up' or followup or longitudinal* or prospective* or retrospective* or observational* or multicent* or 'multi-cent*' or consecutive*).ti,ab,kf.) and ((group or groups or subgroup* or versus or vs or compar*).ti,ab,kf. or ('odds ratio*' or 'relative odds' or 'risk ratio*' or 'relative risk*' or aor or arr or rrr).ab. or (("OR" or "RR") adj6 CI).ab.))	5330423
7	Epidemiologic studies/ or case control studies/ or exp cohort studies/ or Controlled Before-After Studies/ or Case control.tw. or cohort.tw. or Cohort analy$.tw. or (Follow up adj (study or studies)).tw. or (observational adj (study or studies)).tw. or Longitudinal.tw. or Retrospective*.tw. or prospective*.tw. or consecutive*.tw. or Cross sectional.tw. or Cross-sectional studies/ or historically controlled study/ or interrupted time series analysis/	4336620
6	meta-analysis/ or meta-analysis as topic/ or (metaanaly* or meta-analy* or metanaly*).ti,ab,kf. or systematic review/ or cochrane.jw. or (prisma or prospero).ti,ab,kf. or ((systemati* or scoping	641766

	or umbrella or "structured literature") adj3 (review* or overview*)).ti,ab,kf. or (systemic* adj1 review*).ti,ab,kf. or ((systemati* or literature or database* or data-base*) adj10 search*).ti,ab,kf. or ((structured or comprehensive* or systemic*) adj3 search*).ti,ab,kf. or ((literature adj3 review*) and (search* or database* or data-base*)).ti,ab,kf. or (("data extraction" or "data source*") and "study selection").ti,ab,kf. or ("search strategy" and "selection criteria").ti,ab,kf. or ("data source*" and "data synthesis").ti,ab,kf. or (medline or pubmed or embase or cochrane).ab. or ((critical or rapid) adj2 (review* or overview* or synthes*)).ti. or (((critical* or rapid*) adj3 (review* or overview* or synthes*)) and (search* or database* or data-base*)).ab. or (metasynthes* or meta-synthes*).ti,ab,kf.	
5	exp clinical trial/ or randomized controlled trial/ or exp clinical trials as topic/ or randomized controlled trials as topic/ or Random Allocation/ or Double-Blind Method/ or Single-Blind Method/ or (clinical trial, phase i or clinical trial, phase ii or clinical trial, phase iii or clinical trial, phase iv or controlled clinical trial or randomized controlled trial or multicenter study or clinical trial).pt. or random*.ti,ab. or (clinic* adj trial*).tw. or ((singl* or doubl* or treb* or tripl*) adj (blind$3 or mask$3)).tw. or Placebos/ or placebo*.tw.	2540677
4	3 not (comment/ or editorial/ or letter/) not ((exp animals/ or exp models, animal/) not humans/)	2575
3	1 and 2	2656
2	exp Fracture Fixation/ or Surgical Procedures, Operative/ or Orthopedic Procedures/ or exp General Surgery/ or exp Orthopedics/ or surger*.ti,ab,kf. or surgical*.ti,ab,kf. or operation*.ti,ab,kf. or operative*.ti,ab,kf. or reduction.ti,ab,kf. or orif.ti,ab,kf. or osteosynthes*.ti,ab,kf. or exp Minimally Invasive Surgical Procedures/ or 'mini invasive'.ti,ab,kf. or 'minimally invasive'.ti,ab,kf. or 'minimal invasive'.ti,ab,kf. or MIPO.ti,ab,kf. or palmer.ti,ab,kf. or zadravecz.ti,ab,kf. or forgon.ti,ab,kf. or 'sinus tarsi'.ti,ab,kf. or 'extended lateral'.ti,ab,kf. or 'extensile lateral'.ti,ab,kf. or ((screw* or plate or plates or plating or internal) adj3 (fixat* or lock* or percutaneous)).ti,ab,kf.	4217287
1	(diacf or iacf or 'tongue type' or sanders*).ti,ab,kf. or (exp Calcaneus/ and (exp Fractures, Bone/ or exp Fracture Dislocation/)) or ((calcan* or hindfoot or 'hind foot' or heel* or 'os calcis') adj3 (fractur* or broken or dislocat* or displac*)).ti,ab,kf.	4934

Module 4 Chopart letsel

Uitgangsvraag

Welke behandeling reduceert de meest voorkomende korte en lange termijn gevolgen van Chopart letsels?

Inleiding

Het Chopart gewricht is een gewrichtscomplex, essentieel voor de loopgang van een mens. Zowel mobiliteit als stabiliteit zijn noodzakelijk voor een goed functioneren hiervan doordat er een translatie van de kracht en beweging van de achtervoet naar de voorvoet ontstaat. Een traumatisch Chopart letsel ontstaat doordat een externe kracht op het talo-naviculare en/of calcaneo-cuboidale gewricht inwerkt, al dan niet met fracturen in het bereik van deze gewrichten, al dan niet met instabiliteit. De huidige behandeling van Chopart letsels richt zich op stabilisatie van de gewrichten in een goede alignment en/of fixatie van fracturen met congruente gewrichtsoppervlakken. Er is een grote variatie aan behandelingen mogelijk van gipsimmobilisatie, open repositie en interne fixatie tot artrodese van het Chopart gewricht. Onduidelijkheid over de uitkomsten van de individuele behandeling maakt dat er ook een grote praktijkvariatie in behandelkeuzes aanwezig is.

Search and select

A systematic review of the literature was performed to answer the following question:
What are the benefits and harms of operative treatment compared with conservative treatment for patients with diagnosed Chopart injuries after an acute trauma?

P = patients with diagnosed Chopart injuries (fracture and/or dislocation) after an acute trauma

I = operative treatment

C = conservative treatment

O = functional outcome, (osteo)arthritis, need for secondary arthrodesis, adverse events, duration of immobilization and signs of chronic instability

<u>Relevant outcome measures</u>

The guideline development group considered functional outcome, arthritis and need for arthrodesis as critical outcome measures for decision making and infection and signs of chronic instability, duration of immobilization/non-weight bearing mobilization as important outcome measures for decision making.

A priori, the guideline development group decided that the American Orthopaedic Foot and Ankle Society (AOFAS) score was the preferred measure for functional outcome. If a study did not include the AOFAS-score but alternative measures for functional outcome were presented (e.g. mobility or Foot Function Index; FFI-score), these alternative measures were included in the summary of literature. For the other outcomes measures listed above, the working group decided to use the definitions used in the studies.

For the predefined outcomes the working group defined the minimal clinically (patient) important differences as follows:

- Functional outcome (AOFAS): 10 points
- Arthritis: Risk Ratio (RR) <0.80 and >1.25
- Need for arthrodesis: Risk Ratio (RR) <0.80 and >1.25
- Signs of chronic instability: Risk Ratio (RR) <0.80 and >1.25
- Duration of immobilization: more or less than 3 months

Search and select (Methods)

The databases Medline (via OVID) and Embase (via Embase.com) were searched with relevant search terms until the 10th of January 2023. The detailed search strategy is depicted under the tab Methods. The systematic literature search resulted in 346 hits. Studies were selected based on the following criteria: systematic reviews, RCTs and observational studies comparing surgical treatment of Chopart injuries with conservative treatment. Studies were selected by three independent reviewers. Discrepancies were solved by consensus. Sixteen studies were initially selected based on title and abstract screening. After reading the full text, thirteen studies were excluded (see the table with reasons for exclusion under the tab Methods), and three studies were included.

Results

Three studies were included in the analysis of the literature. Important study characteristics and results are summarized in the evidence tables. The assessment of the risk of bias is summarized in the risk of bias tables.

Summary of literature

Description of studies

Coulibaly 2015 compared the results of operative treatment and non-operative treatment in navicular fractures, in a retrospective cohort. Patients presented at a level-I trauma centre in the USA with navicular fractures were included (n = 110). Inclusion criteria were radiographically diagnosed navicular fractures, skeletal maturity, and initial treatment at the study institution. Exclusion criteria were stress fractures, unavailable radiographic images at injury and at follow-up and follow-up of less than three months. In total, 41/90 (45.6%) patients received operative treatment and 49/90 (54.4%) non-operative treatment. The specific techniques that were used are presented in table 1. Five fellowship trained orthopaedic surgeons performed all operative procedures. Techniques of fixation and supplemental support varied depending on fracture pattern and surgeon preference. It was stated that operative treatment was related to increasing severity of fracture. Outcomes were assessed at final follow-up at 52 weeks. It was stated that 48 patients were lost to follow-up and 62 patients (with 64 fractures) were included in the full analysis (operative treatment group: n = 35; non-operative treatment group: n = 29). However, data on treatment outcomes was available for 90 patients. Outcomes included functional outcomes (pain and level of activity), secondary osteoarthritis, surgical site infection, non-union, avascular necrosis and time to weight bearing. There was no correction for confounding factors in the analysis, which is considered a limitation of this study.

Van Dorp 2010 retrospectively studied the outcome and morbidity in patients with Chopart joint injuries. All consecutive patients with a joint-dislocation or fracture dislocation of the Chopart joint treated at a Dutch level-2 trauma were included in the analysis (n = 9). Lisfranc fracture dislocations and isolated midfoot fractures were excluded from the analyses. Three patients received operative treatment and six patients were treated non-operatively. The specific techniques that were used are presented in Table 1. The patients being treated operatively on average were younger (mean ± SD: 19 ± 3.6) than the patients receiving non-operative treatment (mean ± SD: 53 ± 23). After a minimum of six months follow-up outcomes were assessed, average follow-up was 31.3 ± 19.2 months. Two patients were excluded because their follow-up was less than six months. Outcomes included the American Orthopaedic Foot & Ankle Society Midfoot Score (AOFAS), measuring pain, function and alignment. Additional outcomes were presence or absence of pain and ability to perform work or hobby. There was no correction for confounding factors in the analysis, which is considered a limitation of this study.

Richter 2004 performed a retrospective study on the injury cause, treatment and long-term results of patients with Chopart joint dislocations or fracture dislocations. Patients presented at a level-I

Trauma Center in Germany with Chopart joint dislocations or Chopart joint fracture-dislocations or combined Chopart-Lisfranc joint fracture-dislocations were included in the study (n = 100). Mean age of the study population was 32 years (range 17-85 years), 68% of the patients were male. Chopart joint dislocations were treated non-operatively with closed reduction without internal fixation. All the patients undergoing closed reduction without internal fixation had pure Chopart joint dislocations, see Table 1. Indications for non-operative treatment were sufficient closed anatomic reduction, sufficient stability after reduction in anatomic position and contra-indications for operative treatment. Patients with Chopart fracture-dislocations or Chopart-Lisfranc fracture dislocations received internal fixation, with open or closed reduction, see Table 1. Demographic data was not presented per treatment group. As a consequence, it is not possible to determine whether the two treatment groups were comparable, which is a limitation of this study. Outcomes were assessed after minimal two years of follow-up. The mean follow-up duration was 9 years (range 2-25 years). Outcome data was available for 58 patients (59 Chopart joint dislocations), 51 were treated operatively and 8 were treated non-operatively. The AOFAS-score was included as an outcome. There was no correction for confounding factors in the analysis, which is considered a limitation of this study.

Table 1: Baseline characteristics of the studies included in the analysis.

	Operative treatment	**Non Operative Treatment**
Coulibaly (2015) **(level 1 trauma center, navicular fractures)**	Open reduction with internal fixation (ORIF; n = 41) Fixation with 2.0 or 2.7 mm spanning plates or screws, if necessary with external fixator.	Toe-touched weight bearing for 10-12 weeks (n = 49) Splint, short leg cast or foot ankle support
Age	39 ± 15.2	36± 12.5
% male	61.8% male	67.9% male
Severity/ injury classification	AO/OTA (2007) A: 16/41 (39.0%) AO/OTA (2007) B: 25/41 (61%)	AO/OTA (2007) A: 42/49 (85.7%) AO/OTA (2007) B: 7/49 (14.3%)
Cause	Road accident (including motor vehicle accident), crush, twist, high-energy fall, low energy fall *	Road accident (including motor vehicle accident) crush, twist, high-energy fall, low energy fall *
Van Dorp 2010 **(Level 2 trauma center)**	Open reduction (n=3) Fixation with screws, K-wires, if necessary, with external fixator	Lower leg cast or external fixator, with/without closed reduction (n=6)
Age	19 ± 3.6	53 ± 23.3
% male	33.3%	33.3%
Severity/classification	*No information*	*No information*
Cause	Motor vehicle accident, sports	Motor vehicle accident, sports, sprain, fall.
Richter 2004 **(level 1 trauma center)**	Internal fixation with open or closed reduction (N=51) Fixation with K-wires, 3.5 cortical screws, if necessary, with external fixator	Closed reduction, no internal fixation (N=8) If necessary, application of a foot cast and rehabilitation with partial weight bearing for 6 weeks.
Age	32 (range: 17-85 years)*	32 (range: 17-85 years)*
% male	68% male*	68% male*
Severity/classification	Chopart fracture-dislocations or Chopart-Lisfranc fracture dislocations	Pure Chopart joint dislocations
Cause	Motor vehicle accident, fall, contusion*	Motor vehicle accident, fall, contusion*

*Of the total study population, not specified per intervention

Results

Functional outcome

AOFAS-score

Two studies reported the American Orthopaedic Foot & Ankle Society Midfoot Score (AOFAS) (van Dorp, 2010; Richter 2004). Higher scores indicate better functioning of the foot, maximum score is 100 points. Van Dorp (2010) reported a higher AOFAS-score in the patients who underwent operative treatment (internal fixation) of the Chopart dislocations than the patients undergoing non-operative treatment, mean difference: 6.90 (95% CI: -32.98 to 46.78, Table 2). Richter (2004) reported a lower AOFAS-score for the patients undergoing operative treatment (internal fixation) for Chopart dislocations, (mean AOFAS: 73) than the patients undergoing non-operative treatment (mean AOFAS: 78, Table 2)

Table 2: Overview of the studies reporting AOFAS-score

	Mean ± SD AOFAS Operative treatment	Mean ± SD AOFAS Non-operative treatment	Mean Difference (95% CI)
Van Dorp 2010 (n = 9)	75.7 ± 24.0 (n = 3)	68.8 ± 29.8 (n = 6)	6.90 (-32.98 to 46.78)
Richter 2004 (n = 58)	73 (n = 51)	78 (n = 9)	Can't be calculated (no SD's)

AOFAS = American Orthopaedic Foot & Ankle Society Midfoot Score; SD = Standard Deviation; 95% CI = 95% confidence intervals

Level of Activity

In Coulibaly (2015) functional outcome was reported by the number of patients who experienced full recovery of work and hobby activities. In the patients who underwent operative treatment (internal fixation) 26/41 (68.4%) experienced full recovery, compared to 38/49 (79.2%) in the patients undergoing non-operative treatment. The Risk Ratio (RR) was: 0.82 (95% CI: 0.62 to 1.08). This was not considered clinically relevant.

<u>(Osteo)arthritis.</u>

One study reported the outcome osteoarthritis (Coulibaly, 2015). It was reported that 35/41 (85.4%) of the patients undergoing operative treatment experienced secondary osteoarthritis, compared to 21/49 (42.9%) of the patients undergoing non-operative treatment. The risk ratio was 1.99 (95% CI: 1.41 to 2.82) in favour of non-operative treatment.

<u>Need for arthrodesis</u>

One study reported the outcome 'need for arthrodesis' (Coulibaly, 2015). It was reported that 7/41 (17.1%) of the patients undergoing operative treatment needed (secondary) arthrodesis, compared to 2/49 patients (4.1%) of the patients undergoing non-operative treatment. The risk ratio was 4.18 (95% CI: 0.92 to 19.04).

<u>Adverse events</u>

Infection

Two studies reported the outcome infection (Coulibaly, 2015; van Dorp 2010). Coulibaly (2015) reported that 3/41 (7.3%) of the patients undergoing operative treatment experienced surgical site infections, compared to 2/49 (4.1%) of the patients undergoing non-operative treatment. The risk ratio was 1.79 (95% CI: 0.31 to 10.22). Van Dorp (2010) reported one infection in the operative treatment group (1/3; 33.2%). There were no infections in the patients undergoing non-operative treatment (0/4; 0%).

Avascular necrosis (AVN)

One study reported the outcome avascular necrosis (Coulibaly, 2015). It was reported that 1/41 (2.4%) of the patients undergoing operative treatment experienced avascular necrosis, compared to 0/49 (0%) of the patients undergoing non-operative treatment.

Duration of immobilization

One study reported the outcome duration of immobilization (Coulibaly, 2015). It was reported that the mean time to weight bearing was 11 ± 4.4 weeks in the patients undergoing operative treatment (n = 41), compared to 9 ± 5.4 weeks in the patients undergoing non-operative treatment (n = 49). Mean difference was 2.00 (95% CI: -0.02 to 4.02).

Signs of chronic instability

One study reported the number of nonunion, which is considered a sign of instability (Coulibaly, 2015). It was reported that 2/41 (4.9%) of the patients undergoing operative treatment experienced nonunion, compared to 1/49 (2.0%) of the patients undergoing non-operative treatment. The risk ratio was 2.39 (95% CI: 0.22 to 25.43).

Level of evidence of the literature

The level of evidence regarding the outcome measure **functional outcome** was retrieved from observational studies and therefore started 'low'. The level of evidence was downgraded by three levels because of study limitations including lack of adequate correction for confounding factors (-1 risk of bias); conflicting results (-1 inconsistency); and the 95% CI's crossing the boundaries of clinical decision making (-1 imprecision). The final level of evidence was 'very low'.

The level of evidence regarding the outcome measure **arthritis** was retrieved from observational studies and therefore started 'low'. The level of evidence was downgraded by one level because of study limitations including lack of adequate correction for confounding factors (-1 risk of bias). The final level of evidence was 'very low'.

The level of evidence regarding the outcome measure **need for arthrodesis** was retrieved from observational studies and therefore started 'low'. The level of evidence was downgraded by two levels because of study limitations including lack of adequate correction for confounding factors (-1 risk of bias) and wide 95% confidence intervals (-1 imprecision) The final level of evidence was 'very low'.

The level of evidence regarding the outcome measure **adverse events** was retrieved from observational studies and therefore started 'low'. The level of evidence was downgraded by two levels because of study limitations including lack of adequate correction for confounding factors (-1 risk of bias) and wide 95% confidence intervals (-1 imprecision). The final level of evidence was 'very low'.

The level of evidence regarding the outcome measure **duration of immobilization** was retrieved from observational studies and therefore started 'low'. The level of evidence was downgraded by two levels because of study limitations including lack of adequate correction for confounding factors (-1 risk of bias) and wide 95% confidence intervals including 0 (-1 imprecision) The final level of evidence was 'very low'.

The level of evidence regarding the outcome measure **signs of chronic instability** was retrieved from observational studies and therefore started 'low'. The level of evidence was downgraded by two levels because of study limitations including lack of adequate correction for confounding factors (-1 risk of bias) and wide 95% confidence intervals (-1 imprecision). The final level of evidence was 'very low'.

Conclusions

Very low GRADE	The evidence is very uncertain about the effect of operative treatment on the outcomes **functional outcome, arthritis, need for arthrodesis, adverse events**

	duration of immobilization and **signs of chronic instability** when compared with non-operative treatment in patients with Chopart injuries. *Source: van Dorp 2010; Richter 2004, Coulibaly 2015*

Overwegingen – van bewijs naar aanbeveling

Voor- en nadelen van de interventie en de kwaliteit van het bewijs

Er is literatuuronderzoek uitgevoerd naar de beste behandeling van Chopart letsels, hierbij werd operatieve behandeling vergeleken met conservatieve behandeling. Er zijn drie observationele studies gevonden waarin deze twee typen behandeling in een directe vergelijking werden geanalyseerd (Coulibaly 2015; van Dorp 2010; Richter 2004). Voor de cruciale uitkomstmaten functionele uitkomst, artrose, noodzaak voor artrose en complicaties werd slechts bewijs met een zeer lage bewijskracht gevonden, waardoor er veel onzekerheid bestaat over het gevonden effect. Ook voor de belangrijke uitkomstmaten duur van immobilisatie en tekenen van chronische instabiliteit werd slechts bewijs met een zeer lage bewijskracht gevonden.

Er zijn geen gerandomiseerde trials gevonden waarin operatieve behandeling vergeleken werd met non-operatieve behandeling. Al het bewijs is afkomstig van observationeel retrospectief onderzoek. Dit heeft van nature een lage bewijskracht. Er was één studie waarin slechts negen patiënten waren geïncludeerd, een dergelijke studiepopulatie is te klein om een betrouwbare conclusie te trekken. Ook was voor een aantal uitkomstmaten een laag aantal cases, wat resulteert in brede 95% betrouwbaarheidsintervallen. In de drie geïncludeerde studies werd niet adequaat gecorrigeerd voor de belangrijkste *confounders*. Hierdoor is het onduidelijk of de gevonden effecten veroorzaakt worden door de verschillende interventies die de operatieve en non-operatieve groep zijn ondergaan, of dat het verschil veroorzaakt wordt door een andere factor (bijvoorbeeld verschillen in de patiëntkarakteristieken van beide studiearmen). Uit de studie van Coulibaly (2015) blijkt dat in de conservatieve groep het aantal patiënten met een ernstig letsel aanzienlijk minder is, dan het aantal patiënten met ernstig letsel in de operatieve groep. Het risico op selectie bias is bij alle drie de studies groot omdat het type letsel en ernst van het letsel bepalend was voor het type behandeling die de patiënt onderging. Dit maakt het lastig om op basis van de gevonden literatuur conclusies te trekken over het effect van de behandeling. De overwegingen zijn dan voornamelijk geschreven vanuit praktijkervaring en expert opinion.

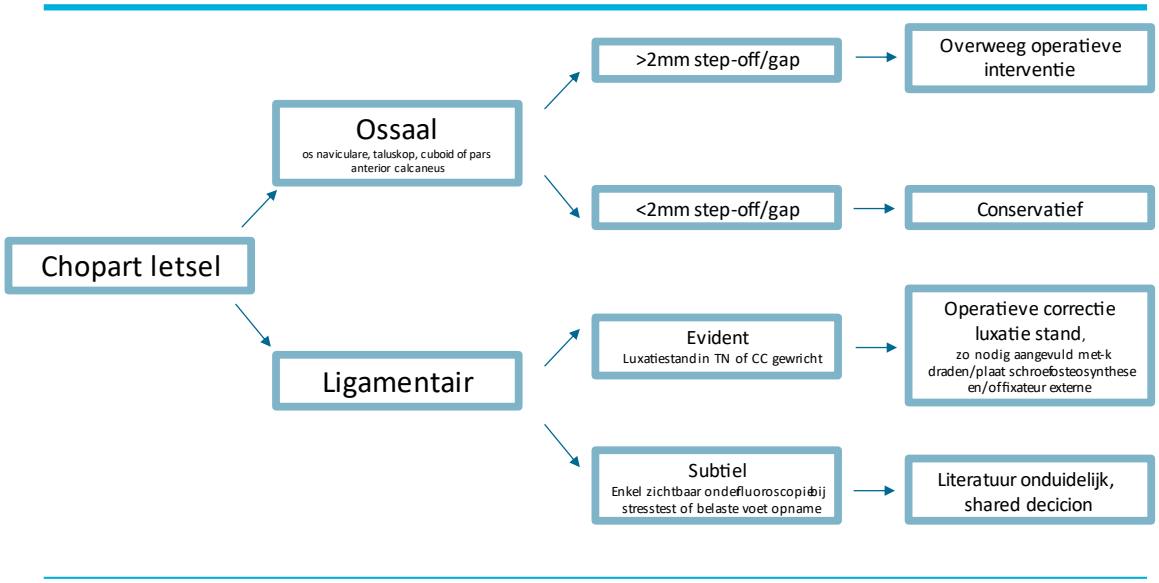
Hoewel er op basis van de gevonden literatuur geen conclusies getrokken kunnen worden over de aangewezen behandelstrategie, laat de literatuur wel zien dat in algemene zin geldt dat bij de behandeling (operatief én non-operatief) van Chopart letsel het risico op volledig herstel 68% tot 79% is. Het risico op artrose is 43% tot 85%, het risico op persisterende instabiliteit is 2% tot 4%, en het risico op complicaties bij de wondgenezing 4% tot 7%.

Open fracturen en luxaties van het Chopart gewricht dienen geopereerd te worden. Hiervoor wordt vaak een externe fixateur gebruikt. Voorheen werd dit letsel dan ook uitbehandeld in de externe fixateur, waar tegenwoordig interne fixatie met plaat-schroeven en K-draden veelvuldig de volgende stap in stabilisatie is.

Het ontstaan van een letsel van het Chopart gewricht door een trauma kan tot een gecompliceerd beloop leiden met verminderde functie van de ledemaat, toegenomen kans op artrose of collaps van de stand van de voet-enkel. Fracturen intra-articulair, in het bereik van het Chopart gewricht, (os naviculare, taluskop, cuboid of pars anterior calcaneus) die tot discongruentie van het gewricht leiden (>2 mm step-off of gap intra-articulair) of tot een afwijkende (stress-belaste) alignment van de voet, verhogen het risico op een dergelijk gecompliceerd beloop. Hierbij is de verwachting dat operatieve correctie van de gewrichtsdiscongruentie/malalignment en stabilisatie van de gewrichten

na een dergelijk letsel het risico op deze late gevolgen kan verminderen (zie Figuur 1). De huidige literatuur maakt geen onderscheid in deze patiënt categorieën, aangezien combinaties.

Onduidelijk is of bij patiënten met intra-articulaire fracturen in het Chopart bereik zonder discongruentie (<2 mm step-off of gap) of gewrichten die alleen bij stresstesten een afwijkende alignment hebben ook beter operatief behandeld kunnen worden of dat gipsimmobilisatie een gelijkwaardige optie is. Hierover bestaat een kennislacune



Figuur 1: behandelopties Chopart letsel. *TN = talonaviculaire; CC = calcaneocuboidale; mm = milimeter.*

Waarden en voorkeuren van patiënten (en evt. hun verzorgers)

Voor de patiënt zijn de belangrijkste doelen van de behandeling een stabiele, functionele en pijnloze voet in het dagelijks leven. Na eerste opvang en initiële behandeling (behandeling evidente luxatiestand gewrichten en behandeling open fracturen), is het wenselijk de behandelopties te bespreken met de betreffende voor- en nadelen van de behandelingen en onzekerheid in de verwachte uitkomst. Hierbij dienen in ieder geval complicaties van operatie, complicaties van non-operatieve zorg en verwachting ten aanzien van functionele uitkomsten besproken te worden.

Kosten (middelenbeslag)

Er is geen data over de kosteneffectiviteit van beide behandelopties. Naar verwachting brengt operatief ingrijpen hogere kosten met zich mee. Secundaire ingrijpen kunnen bij beide behandelingen nodig zijn, het is onduidelijk hoe vaak secundaire ingrepen nodig zijn. Gezien het doel om de patiënt zo goed mogelijk te behandelen, spelen kosten doorgaans geen rol bij deze keuze om een patiënt operatief dan wel niet-operatief te behandelen. Beide behandelopties vallen onder de verzekerde zorg.

Aanvaardbaarheid, haalbaarheid en implementatie

Expertise over- en exposure aan dit letsel is in de meeste ziekenhuizen beperkt. Met name een beperking in de '*index of suspicion*' zal ook meespelen met de problemen met detectie van instabiliteit bij een letsel in het bereik van een Chopart letsel. Ook bij evidente instabiliteit of complexe fracturen in de ossale structuren rondom het Chopart gewricht is de expertise beperkt door de lage frequentie van voorkomen. De expertise op traumatologisch gebied is beperkt, zeker waar het chirurgische interventies betreft, dit is mogelijk een belemmerende factor. Naar verwachting zijn er geen andere belemmerende factoren (bijv. aanwezigheid van apparatuur).

Acute zorg is voor eenieder toegankelijk ongeacht niveau van gezondsheidsvaardigheden, sociale klasse, opleidingsniveau, inkomen of migratie-achtergrond.

Aanbeveling(en)

Aanbeveling-1

Rationale van de aanbeveling: weging van argumenten voor en tegen de interventies

Er is geen bewijs dat operatieve behandeling bij patiënten met een Chopart letsel betere uitkomsten geeft dan conservatieve behandeling. In de geselecteerde retrospectieve studies werden door selectie bias patiënten met een mild letsel conservatief behandeld en patiënten met een ernstig letsel operatief zonder dat er prospectieve vergelijkende studies beschikbaar zijn. De ernst van het letsel werd ook als negatief prognostische factor gevonden. De werkgroep is het, gezien deze resultaten, erover eens dat open fracturen en persisterende luxatiestand in het Chopart gewricht operatief behandeld dienen te worden. Aangezien fracturen die in het bereik van het Chopart gewricht intra-articulair verlopen (os naviculare, taluskop, cuboid of pars anterior calcaneus) tot discongruentie van het gewricht kunnen leiden of tekenen van instabiliteit kunnen hebben, is de werkgroep van mening dat deze groep ook baat kan hebben bij operatieve behandeling om de mogelijke late gevolgen te minimaliseren. Onduidelijk is of intra-articulaire fracturen in het Chopart bereik zonder discongruentie of gewrichten die bij stresstesten een goede alignment behouden ook beter operatief behandeld kunnen worden of dat gipsimmobilisatie dan een gelijkwaardige optie is. Deze keuze zou samen met de patiënt gemaakt kunnen worden.

Behandel patiënten met een open fractuur en/of persisterende luxatiestand van het Chopart gewricht operatief. Overweeg bij patiënten met een incongruent gewricht (fractuur-dislocatie ≥ 2mm) of instabiliteit in het *talonaviculaire (TN) en/of calcaneocuboidale (CC)* gewricht een operatieve behandeling, met als doel congruentie en stabiliteit in het Chopart gewricht.

Literatuur

Coulibaly MO, Jones CB, Sietsema DL, Schildhauer TA. Results and complications of operative and non-operative navicular fracture treatment. Injury. 2015 Aug;46(8):1669-77. doi: 10.1016/j.injury.2015.04.033. Epub 2015 May 7. PMID: 26058352.

Richter M, Thermann H, Huefner T, Schmidt U, Goesling T, Krettek C. Chopart joint fracture-dislocation: initial open reduction provides better outcome than closed reduction. Foot Ankle Int. 2004 May;25(5):340-8. doi: 10.1177/107110070402500512. PMID: 15134617.

van Dorp KB, de Vries MR, van der Elst M, Schepers T. Chopart joint injury: a study of outcome and morbidity. J Foot Ankle Surg. 2010 Nov-Dec;49(6):541-5. doi: 10.1053/j.jfas.2010.08.005. PMID: 21035040.

Bijlagen bij module Chopart letsel

Evidence Tables bij module Chopart letsels

Evidence table for intervention studies studies (randomized controlled trials and non-randomized *observational* studies [cohort studies, case-control studies, case series])

Study reference	Study characteristics	Patient characteristics [2]	Intervention (I)	Comparison / control (C) [3]	Follow-up	Outcome measures and effect size [4]	Comments
Coulibaly 2015	Type of study: Retrospective cohort Setting and country: Patients treated in a Level I trauma centre from March 2002 to June 2007, USA Funding and conflicts of interest: None	Inclusion criteria: - patients with navicular fractures (radiographically diagnosed) - skeletal maturity - initial treatment at the study institution Exclusion criteria: - stress fractures Unavailable radiographic images at injury and at final follow-up - follow-up < 3 months N total: Intervention: 41/90 Control: 49/90 110 patients met inclusion criteria 62 (with 64 NF) were analysed Important prognostic factors[2]: *age ± SD*	Operative Treatment (ORIF) - ORIF (n = 24, 58.5%) - ORIF with external fixator (n = 5, 12.2%) - ORIF with spanning plate (n = 12, 29.3%) proximal – TN joint (n = 0, 0%) distal – NC joint (n = 2, 4.9%) proximal & distal (n = 10, 24.4%) Implants: - 2.0 plate (n = 21, 51.2%) - 2.7 plate (n = 9, 22.0%) - 2.0 plate and external fixation (n = 4, 9.8%) - 2.7 plate and external fixation (n = 1, 2.4%) - Screws (n = 9, 22.0%)	Non-operative treatment (NOT) Patients remained toe-touch weight bearing in a splint, short leg cast, or Foot Ankle Support for ten to twelve weeks. Patients were instructed to begin range-of-motion (ROM) exercises at home and organized physical therapy for weight bearing, gait, ROM, and conditioning	Length of follow-up: Follow up at 2, 6, 12, 26 and 52 weeks Average follow-up time: 23 ± 15.4 months Min. follow-up duration: 3 months Loss-to-follow-up: "22 were excluded because of skeletal immaturity (6), inadequate follow up (34) or incomplete radiographs (8)"	**Functional outcomes:** Pain (Yes) I: 21/41 (51.2%) C: 18/49 (36.7%) Level of activity (full recovery) I: 26/41 (68.4%) C: 38/49 (79.2%) **Secondary osteoarthritis** I: 35/41 (85.4%) C: 21/49 (42.9%) **Need for arthrodesis** I: 7/41 (17.1%) C: 2/49 (4.1%) **Surgical site infection** I: 3/41 (7.3%) C: 2/49 (4.1%) Non-union – signs of instability I: 2/41 (4.9%) C: 1/49 (2.0%) **Time to immobilization** Time to weight bearing (weeks)	The authors concluded that: *"Navicular fractures are uncommon and usually are associated with other injuries. Operative intervention is enhanced with bone grafting to support impacted fracture fragments. Despite alignment and anatomical restoration, secondary arthritis and pain are common. More severe injuries have worse results. Reduction quality relates to pain and return to function"* Baseline data only available for the 62 patients included in the analysis; data in the tables presented for 90 patients. LTFU unclear

		I: 39 ± 15,2 *C: 36± 12,5* *Sex: % male* *I: 61,8% male* *C: 67,9% male* *Comorbidity index:* *I: 1.21 ± 1.7* *C: 1.29 ± 1.3* Groups comparable at baseline? Probably no				I: 11 ± 4.4 C: 9 ± 5.4 <u>Time to healing (weeks)</u> I: 16.1 ± 5.5 C: 16.2 ± 6.8 <u>Avascular necrosis (AVN)</u> I: 1/41 (2.4%) C: 0/49 (0%)	Operative treatment related to increasing severity of fracture 22/41 patients who had ORIF also had secondary surgery for implant removal due to local irritation (16/41), breakage (3/41) and prominence (2/41). No significant difference as found in the rate of plate removal when comparing 2.0 – 2.7 mm plates.
Dorp 2010	<u>Type of study:</u> Retrospective case series <u>Setting and country:</u> Patients treated at a level-2 trauma center between January 2004 and January 2010, NL <u>Funding and conflicts of interest:</u> none	<u>Inclusion criteria</u>: - Patients with joint-dislocation or fracture dislocation of the Chopart joint <u>Exclusion criteria</u>: - Lisfranc fractures dislocations and isolated midfoot fractures <u>N total at baseline</u>: Intervention: 3 Control: 6 n total = 9 <u>Important prognostic factors</u>[2]: *age ± SD:* *I: 19 ± 3.6* *C: 53 ± 23.3*	Open reduction -screw fixation medical cuneiform + K-wire fixation TNJ + external fixator - Screw fixation navicular + K-wire fixation TNJ - Screw fixation navicular + external fixator Patient 2, 4, 5	Lower leg cast or external fixator, with or without closed reduction - Closed reduction + lower leg cast for 8 weeks - lower leg cast - lower leg cast 10 weeks - closed reduction + external fixator - lower leg cast - closed reduction + lower leg cast 8 weeks Patient 1, 3, 6, 7, 8 9	<u>Length of follow-up</u>: Minimum 6 months Average was 31.3 ± 19.2 months <u>Loss-to-follow-up</u>: Total: n = 2 Reasons: follow-up was less than 6 months Both from control population	<u>Functional outcome:</u> <u>AOFAS Mean ± SD</u> I: 75.7 ± 24.0 C: 68.75 ± 29.75 <u>Level of activity – work (unchanged)</u> I: 3/3 (100%) C 2/3 (66.7%) (One patient from control population was retired) <u>Pain (yes)</u> I: 1/3 (33%) C: 2/4 (50%) <u>Level of activity – hobby (unlimited)</u> <u>Patient satisfaction with outcome VAS</u>	The authors concluded that: *Seven patients with an average follow-up of 31.3 ± 19.2 months reported a mean American Orthopaedic Foot & Ankle Society midfoot score of 72 (range, 32-100) points and a mean visual analog scale score of 7.1 (range, 5-10). Four (57.14%) patients still experienced pain or had limitations in daily activities at the time of the final follow-up".* The trauma mechanism was sprain or sports injury in 5 (55.6%), motor vehicle accident in 3

		Sex: % male *I: 33.3%* *C: 33.3%* Groups comparable at baseline? Probably not					(33.33%), and a fall from height in 1 (11.11%) case
Richter 2004	<u>Type of study:</u> Retrospective study <u>Setting and country:</u> Patients treated in a level I trauma center Hannover (Germany) Medical school between January 1972 and December 1997 <u>Funding and conflicts of interest:</u> No information	<u>Inclusion criteria</u>: - Traumatic dislocation or fracture dislocations of the Chopart joint <u>Exclusion criteria</u>: - patients undergoing amputation - less than 2 years follow-up <u>N total at baseline</u>: Intervention: 91 (83%) Control: 19 (17%) n total = 100 58 patients (with 59 fractures) were analysed <u>Important prognostic factors</u>[2]: *Not specified for intervention/control* Age: 32 (range: 17-85 years) Sex % male: 68% male	- Closed reduction with internal fixation - Open with internal fixation ± external fixation Internal fixation with K-wires and/or 3.5 mm cortical screws After operation 2/3 days leg cast, then foot cast for 6 weeks	Closed reduction, no internal fixation Nonoperative treatment included closed reduction, if necessary application of a foot cast and rehabilitation with partial weight bearing for 6 weeks.	<u>Length of follow-up</u>: Average follow-up: 9 years (range 2 – 25 years) <u>Loss-to-follow-up</u>: Total: n = 14 Reason: Amputation, deaths	<u>AOFAS-score</u> I: 73 C: 78	Chopart/Lisfranc fracture dislocations were also included Classification of soft injuries from Tscherne and Oestern.

		Groups comparable at baseline? Probably not					

Risk of bias table for interventions studies (cohort studies based on risk of bias tool by the CLARITY Group at McMaster University)

Author, year	Selection of participants Was selection of exposed and non-exposed cohorts drawn from the same population?	Exposure Can we be confident in the assessment of exposure?	Outcome of interest Can we be confident that the outcome of interest was not present at start of study?	Confounding-assessment Can we be confident in the assessment of confounding factors?	Confounding-analysis Did the study match exposed and unexposed for all variables that are associated with the outcome of interest or did the statistical analysis adjust for these confounding variables?	Assessment of outcome Can we be confident in the assessment of outcome?	Follow up Was the follow up of cohorts adequate? In particular, was outcome data complete or imputed?	Co-interventions Were co-interventions similar between groups?	Overall Risk of bias
	Definitely yes, probably yes, probably no, definitely no	Definitely yes, probably yes, probably no, definitely no	Definitely yes, probably yes, probably no, definitely no	Definitely yes, probably yes, probably no, definitely no	Definitely yes, probably yes, probably no, definitely no	Definitely yes, probably yes, probably no, definitely no	Definitely yes, probably yes, probably no, definitely no	Definitely yes, probably yes, probably no, definitely no	Low, Some concerns, High
Coulibaly 2015	Definitely yes All consecutive patients presenting with injuries at one trauma centre	Definitely yes Reason: Yes, from hospital data	Definitely yes Reason: Outcomes after treatment and depending on treatment (e.g. infection, complication), functional outcomes	Definitely no; Reason; confounders not taken into account	Definitely no; Reason: Patients receiving ORIF, often had more severe injuries	Probably yes; Reason: some of the outcome measures are subjective (e.g. pain)	Probably yes; Reason: frequent follow-up, not clear which patients were included in the analysis	Probably yes; Reason: intervention and control interventions clearly described	**High** **All outcomes**

			compared to before trauma						
Van Dorp 2010	Definitely yes: All consecutive patients with injuries presenting at one trauma centre	Definitely yes; Reason: patient files, surgical reports and picture archive were used to collect data	Definitely yes: Reason: functional outcomes compared to before the trauma	Definitely no; Reason; confounders not taken into account	Definitely no: Reason: patients receiving operative treatment on average were younger	Probably yes; Reason: some of the outcome measures are subjective (e.g. pain)	Probably yes; Reason: all patients had a min. follow-up for 6 months, missings were excluded	Probably yes; Reason: all interventions were described per patients, appear to be similar	**High** **All outcomes**
Richter 2004	Probably yes: Reason: all consecutive patients with injuries presenting at one trauma centre	Probably yes; Reason: probably based on hospital data but not clearly mentioned	Probably yes: Reason: identification of the situation after treatment	Definitely no; Reason; confounders not taken into account	Definitely no: Reason; patients with more complex dislocations received operative treatment	Probably yes Reason: some of the outcome measures are subjective (e.g. pain)	Probably no; Reason: large proportion was missing, nog clear why. Broad range in FU period (2-25 years)	Probably yes; Reason: intervention and control interventions clearly described	**High** **All outcomes**

Table of excluded studies

Reference	Reason for exclusion
Rammelt S, Missbach T. Chopart Joint Injuries: Assessment, Treatment, and 10-Year Results. J Orthop Trauma. 2023 Jan 1;37(1):e14-e21. doi: 10.1097/BOT.0000000000002465. PMID: 35976798.	Data not presented for operative management and non-operative management separate.
Clements JR, Dijour F, Leong W. Surgical Management Navicular and Cuboid Fractures. Clin Podiatr Med Surg. 2018 Apr;35(2):145-159. doi: 10.1016/j.cpm.2017.12.001. Epub 2018 Feb 1. PMID: 29482786.	No systematic search was performed, search method is lacking
Kutaish H, Stern R, Drittenbass L, Assal M. Injuries to the Chopart joint complex: a current review. Eur J Orthop Surg Traumatol. 2017 May;27(4):425-431. doi: 10.1007/s00590-017-1958-0. Epub 2017 Apr 17. PMID: 28417204.	No systematic search was performed, search method is lacking
Ortega Tapia C, Moreno Fernández L, Martínez Zaragoza J, Arias Baile A, Dalmau Coll A. Fracturas y Luxaciones de Chopart: Nuestro Algoritmo de Tratamiento. Revista del Pie y Tobillo. 2022;36(2).	Article in Spanish
Du X, Qu J, Wang J, Wu J, Ma H, Peng Y, Wang L. [CLASSIFICATION OF ADULT CUBOID FRACTURE AND EFFECTIVENESS ANALYSIS]. Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi. 2016 May 8;30(5):551-554. Chinese. doi: 10.7507/1002-1892.20160111. PMID: 29786293.	Article in Chinese
Engelmann EWM, Wijers O, Posthuma J, Schepers T. Management and Outcome of Hindfoot Trauma With Concomitant Talar Head Injury. Foot Ankle Int. 2021 Jun;42(6):714-722. doi: 10.1177/1071100720980023. Epub 2021 Jan 21. PMID: 33478268; PMCID: PMC8209765.	Patients with talar neck fractures (with concomitant injuries, e.g. Chopart)
Fenton P, Al-Nammari S, Blundell C, Davies M. The patterns of injury and management of cuboid fractures: a retrospective case series. Bone Joint J. 2016 Jul;98-B(7):1003-8. doi: 10.1302/0301-620X.98B7.36639. PMID: 27365481.	Results not presented for operative management versus. Non-operative management
Frink, Michael, et al. "Etiology, treatment and long-term results of isolated midfoot fractures." Foot and ankle surgery 12.3 (2006): 121-125.	Patients with midfoot injuries (Lisfranc + Chopart)
Kotter A, Wieberneit J, Braun W, Rüter A. Die Chopart-Luxation. Eine häufig unterschätzte Verletzung und ihre Folgen. Eine klinische Studie [The Chopart dislocation. A frequently underestimated injury and its sequelae. A clinical study]. Unfallchirurg. 1997 Sep;100(9):737-41. German. doi: 10.1007/s001130050185. PMID: 9411801.	Article in German
Latoo IA, Wani IH, Farooq M, Wali GR, Kamal Y, Gani NU. Midterm functional outcome after operative management of midfoot injuries. Ortop Traumatol Rehabil. 2014 Nov-Dec;16(6):639-44. doi: 10.5604/15093492.1135124. PMID: 25694378.	Patients with midfoot injuries (Lisfranc + Chopart)
Mestdagh H, Butruille Y, Mairesse JL, Gougeon F. Evolution et traitement des fractures du scaphoïde tarsien [Evolution and treatment of tarsal scaphoid fractures]. Acta Orthop Belg. 1984 Sep-Oct;50(5):601-16. French. PMID: 6516816.	Article in French
Richter M, Wippermann B, Krettek C, Schratt HE, Hufner T, Therman H. Fractures and fracture dislocations of the midfoot: occurrence, causes and long-term results. Foot Ankle Int. 2001 May;22(5):392-8. doi: 10.1177/107110070102200506. PMID: 11428757.	Patients with midfoot injuries (Lisfranc + Chopart)
Wallenböck E, Möstl H. Gibt es eine Operationsindikation für die Fraktur des Os naviculare pedis? [Is there a surgical indication for fracture of the os naviculare pedis?]. Zentralbl Chir. 1994;119(8):584-6. German. PMID: 7975949.	Article in German
Main BJ, Jowett RL. Injuries of the midtarsal joint. J Bone Joint Surg Br. 1975 Feb;57(1):89-97. PMID: 234971.	Outdated publication

Literature search strategy bij module Chopart letsels

Cluster/richtlijn: NVvH Traumatisch Complexe Voetletsels	
Uitgangsvraag/modules: UV4 Wat is de beste manier om instabiliteit bij een Chopart Letsel te behandelen?	
Database(s): Ovid/Medline, Embase.com	Datum: 10 januari 2023
Periode: geen restrictie	Talen: geen restrictie

Literatuurspecialist: Alies van der Wal
BMI-zoekblokken: voor verschillende opdrachten wordt (deels) gebruik gemaakt van de zoekblokken van BMI-Online https://blocks.bmi-online.nl/ Bij gebruikmaking van een volledig zoekblok zal naar de betreffende link op de website worden verwezen.
Toelichting: Voor deze vraag is gezocht op de elementen: - Chopart letsel - Chirurgische behandeling Er staan geen sleutelartikelen op het zoekformulier

Zoekopbrengst

	EMBASE	**OVID/MEDLINE**	**Ontdubbeld**
SRs	24	12	25
RCT	8	7	10
Observationele studies	234	163	311
Totaal	266	182	**346***

Zoekstrategie

Embase.com

No.	**Query**	**Results**
#16	#4 AND #10 NOT (#11 OR #12) = observationeel	234
#12	#4 AND #6 NOT #11 = RCT	8
#11	#4 AND #5 = SR	24
#10	#8 OR #9	15551918
#9	'case control study'/de OR 'comparative study'/exp OR 'control group'/de OR 'controlled study'/de OR 'controlled clinical trial'/de OR 'crossover procedure'/de OR 'double blind procedure'/de OR 'phase 2 clinical trial'/de OR 'phase 3 clinical trial'/de OR 'phase 4 clinical trial'/de OR 'pretest posttest design'/de OR 'pretest posttest control group design'/de OR 'quasi experimental study'/de OR 'single blind procedure'/de OR 'triple blind procedure'/de OR (((control OR controlled) NEAR/6 trial):ti,ab,kw) OR (((control OR controlled) NEAR/6 (study OR studies)):ti,ab,kw) OR (((control OR controlled) NEAR/1 active):ti,ab,kw) OR 'open label*':ti,ab,kw OR (((double OR two OR three OR multi OR trial) NEAR/1 (arm OR arms)):ti,ab,kw) OR ((allocat* NEAR/10 (arm OR arms)):ti,ab,kw) OR placebo*:ti,ab,kw OR 'sham-control*':ti,ab,kw OR (((single OR double OR triple OR assessor) NEAR/1 (blind* OR masked)):ti,ab,kw) OR nonrandom*:ti,ab,kw OR 'non-random*':ti,ab,kw OR 'quasi-experiment*':ti,ab,kw OR crossover:ti,ab,kw OR 'cross over':ti,ab,kw OR 'parallel group*':ti,ab,kw OR 'factorial trial':ti,ab,kw OR ((phase NEAR/5 (study OR trial)):ti,ab,kw) OR ((case* NEAR/6 (matched OR control*)):ti,ab,kw) OR ((match* NEAR/6 (pair OR pairs OR cohort* OR control* OR group* OR healthy OR age OR sex OR gender OR patient* OR subject* OR participant*)):ti,ab,kw) OR ((propensity NEAR/6 (scor* OR match*)):ti,ab,kw) OR versus:ti OR vs:ti OR compar*:ti OR ((compar* NEAR/1 study):ti,ab,kw) OR (('major clinical study'/de OR 'clinical study'/de OR 'cohort analysis'/de OR 'observational study'/de OR 'cross-sectional study'/de OR 'multicenter study'/de OR 'correlational study'/de OR 'follow up'/de OR cohort*:ti,ab,kw OR 'follow up':ti,ab,kw OR followup:ti,ab,kw OR longitudinal*:ti,ab,kw OR prospective*:ti,ab,kw OR retrospective*:ti,ab,kw OR observational*:ti,ab,kw OR 'cross sectional*':ti,ab,kw OR cross?ectional*:ti,ab,kw OR multicent*:ti,ab,kw OR 'multi-cent*':ti,ab,kw OR consecutive*:ti,ab,kw) AND (group:ti,ab,kw OR groups:ti,ab,kw OR subgroup*:ti,ab,kw OR versus:ti,ab,kw OR vs:ti,ab,kw OR compar*:ti,ab,kw OR 'odds ratio*':ab OR 'relative odds':ab OR 'risk ratio*':ab OR 'relative risk*':ab OR 'rate ratio':ab OR aor:ab OR arr:ab OR rrr:ab OR ((('or' OR 'rr') NEAR/6 ci):ab)))	13761684
#8	'major clinical study'/de OR 'clinical study'/de OR 'case control study'/de OR 'family study'/de OR 'longitudinal study'/de OR 'retrospective study'/de OR 'prospective study'/de OR 'comparative study'/de OR 'cohort analysis'/de OR ((cohort NEAR/1 (study OR studies)):ab,ti) OR (('case control' NEAR/1 (study OR studies)):ab,ti) OR (('follow up' NEAR/1 (study OR studies)):ab,ti) OR (observational NEAR/1 (study OR studies)) OR ((epidemiologic NEAR/1 (study OR studies)):ab,ti) OR (('cross sectional' NEAR/1 (study OR studies)):ab,ti)	6767914

#6	'randomized controlled trial'/exp OR random*:ti,ab OR (((pragmatic OR practical) NEAR/1 'clinical trial*'):ti,ab) OR (('non inferiority' OR noninferiority OR superiority OR equivalence) NEAR/3 trial*):ti,ab) OR rct:ti,ab,kw	1839814
#5	'meta analysis'/exp OR 'meta analysis (topic)'/exp OR metaanaly*:ti,ab OR 'meta analy*':ti,ab OR metanaly*:ti,ab OR 'systematic review'/de OR 'cochrane database of systematic reviews'/jt OR prisma:ti,ab OR prospero:ti,ab OR (((systemati* OR scoping OR umbrella OR 'structured literature') NEAR/3 (review* OR overview*)):ti,ab) OR ((systemic* NEAR/1 review*):ti,ab) OR (((systemati* OR literature OR database* OR 'data base*') NEAR/10 search*):ti,ab) OR (((structured OR comprehensive* OR systemic*) NEAR/3 search*):ti,ab) OR (((literature NEAR/3 review*):ti,ab) AND (search*:ti,ab OR database*:ti,ab OR 'data base*':ti,ab)) OR (('data extraction':ti,ab OR 'data source*':ti,ab) AND 'study selection':ti,ab) OR ('search strategy':ti,ab AND 'selection criteria':ti,ab) OR ('data source*':ti,ab AND 'data synthesis':ti,ab) OR medline:ab OR pubmed:ab OR embase:ab OR cochrane:ab OR (((critical OR rapid) NEAR/2 (review* OR overview* OR synthes*)):ti) OR ((((critical* OR rapid*) NEAR/3 (review* OR overview* OR synthes*)):ab) AND (search*:ab OR database*:ab OR 'data base*':ab)) OR metasynthes*:ti,ab OR 'meta synthes*':ti,ab	733409
#4	#3 NOT ('conference abstract'/it OR 'editorial'/it OR 'letter'/it OR 'note'/it) NOT (('animal'/exp OR 'animal experiment'/exp OR 'animal model'/exp OR 'nonhuman'/exp) NOT 'human'/exp)	822
#3	#1 AND #2	932
#2	'fracture fixation'/exp OR 'bone implant'/exp OR fixat*:ti,ab,kw OR transfixat*:ti,ab,kw OR screw*:ti,ab,kw OR plate:ti,ab,kw OR plates:ti,ab,kw OR plating:ti,ab,kw OR bridg*:ti,ab,kw OR pin:ti,ab,kw OR pins:ti,ab,kw OR nail*:ti,ab,kw OR wire*:ti,ab,kw OR 'arthrodesis'/exp OR 'arthrodes*':ti,ab,kw OR ((fusion NEAR/3 (primary OR secondary OR late OR joint OR isolated)):ti,ab,kw) OR 'osteosynthes*':ti,ab,kw OR 'open reduction':ti,ab,kw OR orif:ti,ab,kw OR 'fracture reduction':ti,ab,kw OR 'reconstruct*':ti,ab,kw OR 'ligamentoplast*':ti,ab,kw OR 'surgery'/exp OR surger*:ti,ab,kw OR surgical*:ti,ab,kw OR operation*:ti,ab,kw OR operative*:ti,ab,kw OR 'mini invasive':ti,ab,kw OR 'minimally invasive':ti,ab,kw OR 'minimal invasive':ti,ab,kw OR mipo:ti,ab,kw	7722554
#1	'Chopart joint'/exp OR 'navicular bone'/exp OR 'navicular bone fracture'/exp OR 'navicular fracture'/exp OR 'cuboid bone'/exp OR 'cuboid fracture'/exp OR (((Chopart* OR 'transverse tarsal' OR navicular* OR talonavicular* OR cuboid* OR calcaneocuboid*) NEAR/5 (fractur* OR broken OR dislocat* OR displac* OR trauma* OR injur*)):ti,ab,kw)	1563

Ovid/Medline

#	Searches	Results
11	(4 and (7 or 8)) not (9 or 10) = observationeel	163
10	(4 and 5) not 9 = RCT	7
9	4 and 6 = SR	12
8	Case-control Studies/ or clinical trial, phase ii/ or clinical trial, phase iii/ or clinical trial, phase iv/ or comparative study/ or control groups/ or controlled before-after studies/ or controlled clinical trial/ or double-blind method/ or historically controlled study/ or matched-pair analysis/ or single-blind method/ or (((control or controlled) adj6 (study or studies or trial)) or (compar* adj (study or studies)) or ((control or controlled) adj1 active) or "open label*" or ((double or two or three or multi or trial) adj (arm or arms)) or (allocat* adj10 (arm or arms)) or placebo* or "sham-control*" or ((single or double or triple or assessor) adj1 (blind* or masked)) or nonrandom* or "non-random*" or "quasi-experiment*" or "parallel group*" or "factorial trial" or "pretest posttest" or (phase adj5 (study or trial)) or (case* adj6 (matched or control*)) or (match* adj6 (pair or pairs or cohort* or control* or group* or healthy or age or sex or gender or patient* or subject* or participant*)) or (propensity adj6 (scor* or match*))).ti,ab,kf. or (confounding adj6 adjust*).ti,ab. or (versus or vs or compar*).ti. or ((exp cohort studies/ or epidemiologic studies/ or multicenter study/ or observational study/ or seroepidemiologic studies/ or (cohort* or 'follow up' or followup or longitudinal* or prospective* or retrospective* or observational* or multicent* or 'multi-cent*' or consecutive*).ti,ab,kf.) and ((group or groups or subgroup* or versus or vs or compar*).ti,ab,kf. or ('odds ratio*' or 'relative odds' or 'risk ratio*' or 'relative risk*' or aor or arr or rrr).ab. or (("OR" or "RR") adj6 CI).ab.))	5329024
7	Epidemiologic studies/ or case control studies/ or exp cohort studies/ or Controlled Before-After Studies/ or Case control.tw. or cohort.tw. or Cohort analy$.tw. or (Follow up adj (study or studies)).tw. or (observational adj (study or studies)).tw. or Longitudinal.tw. or Retrospective*.tw. or prospective*.tw. or consecutive*.tw. or Cross sectional.tw. or Cross-sectional studies/ or historically controlled study/ or interrupted time series analysis/	4335105

6	meta-analysis/ or meta-analysis as topic/ or (metaanaly* or meta-analy* or metanaly*).ti,ab,kf. or systematic review/ or cochrane.jw. or (prisma or prospero).ti,ab,kf. or ((systemati* or scoping or umbrella or "structured literature") adj3 (review* or overview*)).ti,ab,kf. or (systemic* adj1 review*).ti,ab,kf. or ((systemati* or literature or database* or data-base*) adj10 search*).ti,ab,kf. or ((structured or comprehensive* or systemic*) adj3 search*).ti,ab,kf. or ((literature adj3 review*) and (search* or database* or data-base*)).ti,ab,kf. or (("data extraction" or "data source*") and "study selection").ti,ab,kf. or ("search strategy" and "selection criteria").ti,ab,kf. or ("data source*" and "data synthesis").ti,ab,kf. or (medline or pubmed or embase or cochrane).ab. or ((critical or rapid) adj2 (review* or overview* or synthes*)).ti. or (((critical* or rapid*) adj3 (review* or overview* or synthes*)) and (search* or database* or data-base*)).ab. or (metasynthes* or meta-synthes*).ti,ab,kf.	641346
5	exp randomized controlled trial/ or randomized controlled trials as topic/ or random*.ti,ab. or rct?.ti,ab. or ((pragmatic or practical) adj "clinical trial*").ti,ab,kf. or ((non-inferiority or noninferiority or superiority or equivalence) adj3 trial*).ti,ab,kf.	1576706
4	3 not (comment/ or editorial/ or letter/) not ((exp animals/ or exp models, animal/) not humans/)	502
3	1 and 2	509
2	exp Fracture Fixation/ or exp Internal Fixators/ or fixat*.ti,ab,kf. or transfixat*.ti,ab,kf. or screw*.ti,ab,kf. or plate.ti,ab,kf. or plates.ti,ab,kf. or plating.ti,ab,kf. or bridg*.ti,ab,kf. or pin.ti,ab,kf. or pins.ti,ab,kf. or nail*.ti,ab,kf. or wire*.ti,ab,kf. or exp Arthrodesis/ or 'arthrodes*'.ti,ab,kf. or (fusion adj3 (primary or secondary or late or joint or isolated)).ti,ab,kf. or 'osteosynthes*'.ti,ab,kf. or 'open reduction'.ti,ab,kf. or orif.ti,ab,kf. or 'fracture reduction'.ti,ab,kf. or 'reconstruct*'.ti,ab,kf. or 'ligamentoplast*'.ti,ab,kf. or Surgical Procedures, Operative/ or Orthopedic Procedures/ or exp General Surgery/ or exp Orthopedics/ or surger*.ti,ab,kf. or surgical*.ti,ab,kf. or operation*.ti,ab,kf. or operative*.ti,ab,kf. or exp Minimally Invasive Surgical Procedures/ or 'mini invasive'.ti,ab,kf. or 'minimally invasive'.ti,ab,kf. or 'minimal invasive'.ti,ab,kf. or mipo.ti,ab,kf.	3850847
1	((Chopart* or 'transverse tarsal' or navicular* or talonavicular* or cuboid* or calcaneocuboid*) adj5 (fractur* or broken or dislocat* or displac* or trauma* or injur*)).ti,ab,kf.	900

Module 5 Lisfranc letsel

Uitgangsvraag

Welke behandeling reduceert de meest voorkomende gevolgen (korte en lange termijn) van Lisfranc fracturen?

Introductie

Lisfranc-fracturen zijn met name verwondingen aan de tarsometatarsale gewrichten (TMT's) en het Lisfranc-ligament. Tot 20% van de subtiele ligamenteuze Lisfranc-verwondingen wordt naar verluid ongepast behandeld, hetzij als gevolg van gemiste diagnoses of een onderschatting van de ernst van het letsel. Gevolgen van Lisfranc-fracturen kunnen resulteren in aanhoudende voetpijn, forse standsafwijkingen van de voet, abnormaal lopen en functionele beperkingen, vooral bij sportactiviteiten. Er is behoefte aan consensus met betrekking tot behandelingsmogelijkheden. Momenteel is er nog veel onduidelijkheid over:

- Welke (subtiele) Lisfranc fracturen conservatief behandeld dienen te worden en welke operatief
- Of primaire artrodese leidt tot betere uitkomsten dan primaire fixatie
- Welke invloed de verschillende manieren van ingrijpen hebben op functionaliteit

Er is een grote variatie aan behandelingen mogelijk variërend van gipsimmobilisatie, open repositie en interne fixatie tot artrodese van het Lisfranc gewricht. Onduidelijkheid over de uitkomsten van de individuele behandeling maakt dat er ook een grote praktijkvariatie in behandelkeuzes aanwezig is.

Search and select

A systematic review of the literature was performed to answer the following questions:

PICO A: What is the effectiveness and safety of an operative fixation compared to conservative treatment in patients with a Lisfranc fracture?

P = Patients with Lisfranc fracture
I = Operative fixation
C = Conservative treatment
O = Functional outcomes, infection, bleeding, nerve injury, malunion, nonunion, (osteo)arthritis, hardware removal

PICO B: What is the effectiveness and safety of open reduction and internal fixation (ORIF) compared to primary arthrodesis (PA) in patients with a Lisfranc fracture?

P = Patients with Lisfranc fracture
I = Open reduction internal fixation, with e.g. trans articular screws or bridge plating
C = Primary arthrodesis
O = Functional outcome, infection, bleeding, nerve injury, malunion, nonunion, (osteo)arthritis, hardware removal

<u>Relevant outcome measures</u>

The guideline development group considered functional outcome and (osteo)arthritis as critical outcome measures for decision making; and infection, bleeding, nerve injury, malunion and nonunion and hardware removal as important outcome measures for decision making.

A priori, the guideline development group decided that the American Orthopaedic Foot and Ankle Society (AOFAS) score was the preferred measure for functional outcome. If a study did not include the AOFAS-score but alternative measures for functional outcome were presented (e.g. mobility or

Foot Function Index; FFI-score), these alternative measures were included in the summary of the literature. For the other outcome measures listed above, the working group decided to use the definitions used in the studies.

The working group defined the following thresholds as a minimal clinically (patient) important difference:

- For functional outcome (measured with the AOFAS or FFI) a mean difference (MD) of 10 points was considered clinically relevant.
- For dichotomous outcomes (infection, bleeding, nerve injury, malunion and nonunion, (osteo)arthritis, and hardware removal) a Risk Ratio (RR) < 0.80 or >1.25, or a Risk Difference (RD) of 10% was considered clinically relevant.

Search and select (Methods)

The databases Medline (via OVID) and Embase (via Embase.com) were searched with relevant search terms until January 23rd, 2023. The detailed search strategy is depicted under the tab Methods. The systematic literature search resulted in 802 unique hits. Studies were selected based on the following criteria: systematic reviews and RCTs evaluating operative fixation with conservative treatment (PICO A) and comparing open reduction and internal fixation with primary arthrodesis (PICO B) of Lisfranc injuries. For PICO A (operative fixation compared with conservative treatment), also observational and/or non-randomized studies were screened and included if relevant. Twenty-nine studies were initially selected based on title and abstract screening. After reading the full text, 22 studies were excluded (see the table with reasons for exclusion under the tab Methods). In total, three observational studies (PICO A) and four RCTs (PICO B) were included.

Results

Three observational studies (PICO A) and four RCTs (PICO B) were included in the analysis of the literature. Important study characteristics and results are summarized in the evidence tables. The assessment of the risk of bias is summarized in the risk of bias tables.

Summary of literature

Description of studies

PICO A: operative fixation compared to conservative treatment

The retrospective study of **Ren (2019)** analyzed 61 patients (mean age 39.4 years, 38 males; 62.3%) with undisplaced subtle ligamentous Lisfranc injuries who either had an operation (n=20 patients) or received conservative treatment (n=41 patients) during the period May 2012 to May 2017. Patients were treated in two orthopaedic centres (Beijing United Family Hospital and Tianjin Hospital, China). Patients were followed for on average 12.3 months, and the mean age of the study population was 39.4 (range, 19-64) years. The choice of treatment was done by the patients, which was based on full explanation of pros and cons of both treatments. Outcomes of interest were AOFAS and different types of complications such as infection and arthritis. There is no correction for confounding, which is considered a limitation of the study.

Garriguez-Pérez (2021) performed a retrospective study in which foot function of 42 patients with a subtle Lisfranc injury, who were treated operatively or received conservative treatment between 2009 and 2019 in a hospital (the setting was not further specified), were evaluated by means of the AOFAS Midfoot Score. Apart from AOFAS, other reported outcomes were complications such as nerve injury (however quantitative data was not presented), and (osteo)arthritis Patients with Lisfranc injuries that were displaced between 2 and 5 mm were operatively treated (n=34), whereas Lisfranc injuries that were displaced less than 2 mm received conservative treatment (n=8). The mean age of the total study population was 49 (SD 17.5) years and 35.7% was male. Mean follow-up

was 4.3 (range, 1-8) years. There is no correction for confounding, which is considered a limitation of the study.

The study of **Graef (2021)** retrospectively analyzed treatment decisions (operative or conservative) of Lisfranc injuries treated in a single German level I trauma centre between January 2011 and December 2020. The patients who received operative treatment had subtle or evident instability, whereas patients who received conservative treatment had no instability. In total, 99 patients were included, of which 79 patients (79.8%) were operatively treated and 20 patients (20.2%) received conservative treatment. The median age of the operative group was 45.47 (IQR 15.84) years and 59.5% was male. The median age of the conservative group was 37.95 (IQR 15.13) years and 50.0% was male. This study reported the Foot Function Index (FFI) as clinical outcome. The FFI was only available for 10 patients in the conservative group and 10 patients in the operative treatment group. The mean follow-up time was only reported for the patients with available FFI score. In 10 patients of the operative group with data on FFI, the follow-up duration was 4.50 (SD 2.42) years, and this was 4.20 (SD 2.04) years in 10 patients of the conservative treatment group with data on FFI. Propensity score matching was performed for age, sex, fracture classification, injury mechanisms, total number of collateral fractures of the foot and ankle joint, and follow-up time after the initial treatment.

Table 1: Baseline characteristics of the studies included for PICO A (operative fixation versus conservative treatment)
AOFAS = American Orthopaedic Foot and Ankle Society, FFI = Foot Function index, SD = standard deviation, IQR = inter quartile range, mm = millimeters

Study	Total patient population	Operative treatment	Conservative treatment
Ren, 2019	• N = 61 patients with undisplaced subtle ligamentous Lisfranc injuries • Mean age 39.4 (range, 19-64) years • 62.3% male • Mean follow-up 12.3 months	N = 20 patients	N = 41 patients
Garriguez-Pérez, 2021	• n = 42 patients with a subtle Lisfranc injury • Mean age 49 (SD 17.5) years • 35.7% male • Mean follow-up 4.3 (range, 1-8) years	N = 34 patients displaced 2-5 mm	N= 8 patients displaced <2 mm
Graef, 2021	N = 99 patients with Lisfranc injury	• N = 79 patients **with subtle or evident** instability • Median age: 45.47 [IQR, 15.84] years • 59.5% male • Follow-up time: 4.50 (SD, 2.42) years (n = 10 patients with FFI data)	• N =2 0 patients **without** instability • Median age: 37.95 [IQR, 15.13) years • 50.0% male • Follow-up time: 4.20 (SD, 2.04) years (n = 10 patients with FFI data)

PICO B: open reduction and internal fixation (ORIF) compared to primary arthrodesis (PA)

The RCT by **Sun (2022)** was a multicenter trial, involving 10 foot and ankle centers of nine cities in China (setting not further specified). Sun (2022) evaluated whether ORIF or PA provided more beneficial effects in adult patients with Lisfranc injuries that involved **t**he first tarsometatarsal (TMT) joint dislocation. A total of 88 patients were included in the trial; 44 patients were randomized to the ORIF group (intervention) and 44 patients were randomized to the PA group (control). Patients were on average 40.7 years old (range, 20-78), and 64.1% were male. Patients were followed-up at three weeks, six weeks, three months, six months, and 12 months. Outcomes were AOFAS and arthritis. ORIF and PA operation techniques were exactly similar, with the only difference being that articular

cartilage was not removed from both surfaces of the first TMT joint in the ORIF group, whereas this was the case in the PA group.

*The studies mentioned below were extracted from the systematic review of **Van der Boom (2021).** Since Van der Boom (2021) also included non-randomized studies, and only randomized controlled trials were considered relevant for answering the research question, it was decided to retrieve data from the original papers (*Stødle, 2020; Henning, 2009; Ly, 2006).

Stødle (2020) compared temporary bridge plating (ORIF) with PA of the first TMT joint treatment. In total, 48 patients with low-energy unstable Lisfranc injuries were included in the trial. The trial was performed in a level 1 trauma center of the University Hospital of Oslo, Norway. Twenty-four patients randomized in the ORIF group were on average 34 (IQR, 28-40) years old, and the average age of 24 patients randomized in the PA group was 30 (IQR, 23-40) years. In both groups, 45.8% were males. The AOFAS Midfoot score was the main outcome, which was measured at 12 months and 24 months follow-up. Other outcomes were infection, nonunion, osteoarthritis, and hardware removal.

The RCT of **Henning (2009)** compared ORIF with PA treatment in patients with Lisfranc injuries over a five-year period (March 2000 and August 2005). The setting was not further specified. Thirty-two patients were eligible for this study; 14 patients were randomized to ORIF treatment, and 18 patients were randomized to PA treatment. Patients in the ORIF treatment group were on average 37 (range, 20-58) years old and 64.3% were male. The average age of patients in the PA treatment group was 40 (range, 25-73) years, and 66.7% was male. Outcomes that were studied included infection, nerve injury, nonunion, and hardware removal.

Ly (2006) compared the effect of ORIF with PA for the treatment of primarily ligamentous Lisfranc injuries. The setting was not further specified. Forty-one patients were considered eligible for this RCT and were followed for at least two years. Twenty patients were included in the ORIF group, and were on average 32.4 (range, 19-52) years old. Twenty-one patients constituted the PA group, and this group was on average 32.0 (range, 19-42) years old. The majority of each group was male (65% in the ORIF group and 66.7% in the PA group). AOFAS was measured at 24 months follow-up. Other outcomes were nonunion, delayed union, and hardware removal.

Results

PICO A: operative fixation compared to conservative treatment

Functional outcome

AOFAS-score

Two studies measured functional outcome with the AOFAS-score (Garriguez-Pérez, 2021; Ren, 2019). The study of Garriguez-Pérez (2021) reported a MD of 3.30 (95% CI: -13.05, 6.45) points **lower** in the operative group (N = 34), compared to the conservative group (N= 8), after 4.3 (range 1-8) years follow-up. The study of Ren (2019) reported a MD of 13.70 (95% CI: 9.40, 18.00) points **higher** in the operative group (N= 20) compared to the conservative group (N=41), after 12.3 months follow-up.

FFI score

One study measured functional outcome with the FFI score (Graef, 2021). Graef (2021) reported the FFI score after a mean follow-up time of 4.50 (SD, 2.42) years in the operative treatment and after 4.20 (SD, 2.04) years in the conservative management group. This study reported a MD of 9.06 (95% CI: -15.94, 34.06) points higher in the operative group compared to the conservative group. This was not considered statistically significant, nor clinically relevant.

Infection

Ren (2019) reported the outcome infection In this study, it was reported (in the text) that 1/20 (5.0%) patients had an infection in the surgical group, and 0/41 (0%) patients had an infection in the conservative treatment group. The risk difference (RD) was 0.05 (95% CI: -0.06, 0.16).

Bleeding

None of the included studies reported the outcome *bleeding* for operative fixation compared to conservative treatment.

Nerve injury

None of the included studies reported the outcome *nerve injury* for operative fixation compared to conservative treatment.

Malunion/non-union

None of the included studies reported the outcome *malunion/non-union* for operative fixation compared to conservative treatment.

(Osteo)arthritis

Two studies, Garríguez-Pérez (2021) and Ren (2019) reported the outcome (osteo)arthritis. Garriguez-Pérez (2021) reported 4/34 (11.8%) cases of osteoarthritis in the operative treatment group, compared to 3/8 (37.5%) cases in the conservative treatment group. The RR was 0.31 (95% CI: 0.09 to 1.13). In the study of Ren (2019), 0/20 (0%) cases with arthritis were reported in the operative treatment group and 2/41 (4.88%) cases were reported in the conservative treatment group. The RR was 0.40 (95% CI: 0.02 to 7.96).

Hardware removal

One study (Garríguez-Pérez, 2021) reported the outcome hardware removal. In this study, hardware removal was only done "*if discomfort was referred by the patient or if the follow-up radiographs showed signs of osteolysis*". Hardware was removed because of discomfort in 10/34 (29.4%) patients of the operative group Hardware removal because of asymptomatic osteolysis was performed in 6/34 (17.6%) patients in the operative group Hardware removal was not performed in the patients undergoing conservative treatment, as hardware is not used when applying a conservative management strategy. As hardware removal is not needed in patients undergoing conservative treatment, a comparative analysis could not be made, and the GRADE-approach could not be applied.

PICO B: open reduction and internal fixation (ORIF) compared to primary arthrodesis (PA)

Functional outcome

AOFAS-score

Sun (2022) and Stødle (2020) reported on the outcome AOFAS Midfoot score after **12 months follow-up**. The results were not pooled, as only two studies reported this outcome. The results are shown in Figure 1 below. Stødle (2020) reported a mean AOFAS-score of 79 (SD, 16) points in the ORIF group compared to 85 (SD, 10) points in the PA group. The MD was -6.00 (95% CI, -13.71, 1.71) points, which means that AOFAS was lower in the ORIF vs. PA group. This difference was not considered statistically significant, nor clinically relevant. Sun (2022) reported a mean AOFAS-score of 77.4 (SD, 5.3) points in the ORIF group vs. 84.3 (SD, 7.3) points in the PA group. The MD was -6.90 (95% CI, -9.74, -4.06) points in the ORIF compared to the PA group. This was considered statistically significant, but not clinically relevant.

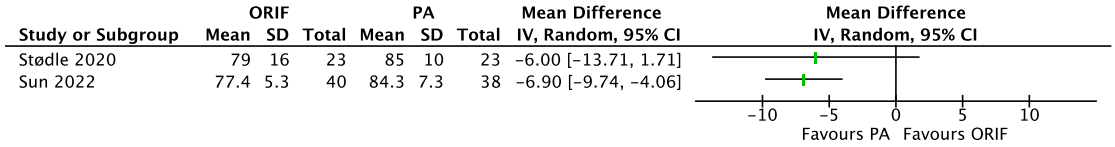


Figure 1 Forest plot that shows the results of individual RCTs on the effect of ORIF vs. PA treatment on the outcome AOFAS after 12 months follow-up in adult patients with all types of Lisfranc injuries (Stødle 2020) and in patients with Lisfranc injuries that involved the first TMT joint dislocation (Sun 2022). *Abbreviations: ORIF, open reduction internal fixation; PA, primary arthrodesis; SD, standard deviation; 95% CI, 95% confidence interval; IV, inverse variance (statistical method);*

Two studies reported AOFAS midfoot score at 24 months follow-up (Stødle, 2020; Ly, 2006)
Stødle (2020) reported AOFAS-score at 24 months follow-up additional to the results at 12 months follow-up. The study reported a mean score of 85 (SD, 15) points in the ORIF group compared to 89 (SD, 9) points in the PA group, which resulted in a MD of -4.00 (95% CI, -11.15, 3.15) points. Ly (2006) reported a mean AOFAS of 68.6 (range, 16-100) points in the ORIF group vs. 88.0 (range, 63-100) points in the PA group. A MD could not be calculated for this study, because the SD was not reported. The GRADE-approach could not be applied.

Infection

Tabular data on infection rates were not presented in the included studies. However, two studies reported the following on infections. Henning (2009) described that "*no infection […] was noted*" in the ORIF group (0/14, 0%) whereas in the PA group, one patient had "*presumed superficial cellulitis*" also called a superficial wound infection *and "no deep infection" was noted (1/18, 5.6%)".* The RD was -0.06 (95% CI, -0.21, 0.10), which was not statistically significant. Stødle (2020) reported in the text that "*one patient had a superficial wound infection in the ORIF group (1/24, 4.2%)*" but data on infection were not reported for the PA group. Therefore, the GRADE assessment could not be applied for the article of Stødle (2020).

Bleeding

None of the included studies reported the outcome *bleeding* for the for ORIF compared to PA.

Nerve injury

Information about nerve injury was reported by Henning (2009), stating in the text that "*no neural injury […] was noted*" in both the ORIF (0/14) and PA group (0/18). This resulted in a risk difference of 0.00 (95% CI, -0.12, 0.12).

Nonunion, delayed union

In total, three studies reported on the outcomes nonunion and delayed union (Stødle, 2020; Henning, 2009; Ly, 2006). Stødle (2020) reported that the rate of nonunion was low in both groups, with two patients in the ORIF group (2/23, 8.7%) and one patient in the PA group (1/22, 4.5%). This resulted in a RD of 0.04 (95% CI, -0.10, 0.19). Henning (2009) reported in the text that "*one delayed union associated with a broken first TMT joint screw healed at the 6-month mark, and one nonunion of a first TMT joint was treated nonoperatively*" in the PA group. This information was not provided for the ORIF group. Finally, Ly (2006) reported no information about nonunion/delayed union in the ORIF group, but "*one patient had a delayed union*" and "*one patient with a nonunion […]*" in the PA group. As the studies of Henning (2009) and Ly (2006) only reported data on nonunion/malunion rates for one of the treatment groups, a comparative analysis could not be made and the GRADE-approach could not be applied.

(Osteo)arthritis

Sun (2022) and Stødle (2020) reported the outcome osteo(arthritis) after ORIF or PA treatment in adult patients with all types of Lisfranc injuries (Stødle, 2020) and Lisfranc injuries that involved the

first TMT joint dislocation (Sun, 2022). Sun (2022) reported 8/40 (20%) (osteo)arthritis events in the ORIF group compared to 0/38 (0%) events in the PA group. This resulted in a RD of 0.20 (95% CI 0.07, 0.33). The study of Stødle (2020) reported 11/24 (45.9%) (osteo)arthritis events in the ORIF group and did not report any data for the PA group.

Hardware removal surgery

Stødle (2020), Henning (2009), and Ly (2006) reported the outcome hardware removal surgery as potential risk of complication after ORIF or PA treatment for Lisfranc injuries. The results of the individual RCTs were pooled, see Figure 2. In the ORIF group, the pooled number of patients undergoing hardware removal was 32/58 (55.2%) compared to 14/62 (22.6%) patients in the PA group. The pooled RR was 2.38 (95% CI 0.70, 8.06).

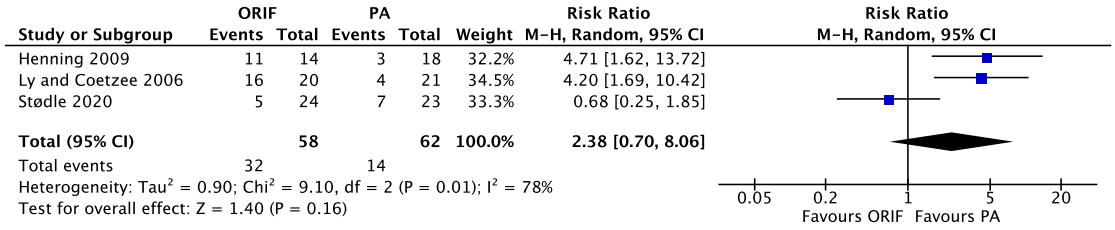


Figure 2 Forest plot that shows the results of individual RCTs on the effect of ORIF vs. PA treatment on the outcome hardware removal surgery in adult patients with all types of Lisfranc injuries *Abbreviations: ORIF, open reduction internal fixation; PA, primary arthrodesis; SD, standard deviation; 95% CI, 95% confidence interval; IV, inverse variance (statistical method);*

Level of evidence of the literature

PICO A: operative fixation compared to conservative treatment

The level of evidence regarding the outcome measures **AOFAS** and **(osteo)arthritis** was derived from observational studies and therefore started low. The level of evidence for each outcome measure was downgraded by two levels because of study limitations including lack of adequate correction for confounding factors (-1 risk of bias) and the 95% CI of both studies crossing the threshold for clinical decision making (-1 imprecision). For both outcome measures, the final level of evidence was graded 'very low'.

The level of evidence regarding the outcome measure **FFI** was derived from observational studies and therefore started low. The level of evidence was downgraded by three levels because of study limitations including problems with the selection of Lisfranc Injuries (-1 risk of bias) and the 95% CI crossing both thresholds for clinical decision making (-2 imprecision). The final level of evidence was graded 'very low'.

The level of evidence regarding the outcome measure **infection** was derived from observational studies and therefore started low. The level of evidence was downgraded by two levels because of study limitations including lack of adequate correction for confounding factors (-1 risk of bias) and small study population (-1 imprecision). The final level of evidence was graded 'very low'.

The level of evidence regarding the outcome measures **bleeding, nerve injury** and **malunion/nonunion** could not be graded since no studies were found that reported these outcomes.

PICO B: open reduction and internal fixation (ORIF) compared to primary arthrodesis (PA)

The level of evidence regarding the outcome measure **AOFAS** was derived from RCTs and therefore started high. The level of evidence was downgraded by two levels because of study limitations including lack of blinding (-1 risk of bias) and the 95% CI crossing the thresholds of clinical decision making (-1 imprecision). The final level of evidence was graded 'low'.

The level of evidence regarding the outcome measures **infection** and **nerve injury** were derived from RCTs and therefore started high. The level of evidence for each outcome measure was downgraded by three levels because of study limitations including lack of blinding and premature discontinuation of one trial (-2 risk of bias) and small study population (-1 imprecision). For both outcome measures, the final level of evidence was graded 'very low'.

The level of evidence regarding the outcome measures **bleeding** could not be graded as none of the studies reported the outcome 'bleeding'.

The level of evidence regarding the outcome measure **malunion/non-union** was derived from RCTs and therefore started high. The level of evidence was downgraded by three levels because of study limitations including lack of blinding and lack of external validity (-2 risk of bias); and 95% CI crossing the threshold of clinical decision making (-1 imprecision). The final level of evidence was graded 'very low'.

The level of evidence regarding the outcome measure **(osteo)arthritis** was derived from RCTs and therefore started high. The level of evidence was downgraded by two levels because of study limitations including lack of blinding (-1 risk of bias); and 95% CI crossing the threshold of clinical decision making (-1 imprecision). The final level of evidence was graded 'low'.

The level of evidence regarding the outcome measure **hardware removal** was derived from RCTs and therefore started high. The level of evidence was downgraded by three levels because of study limitations including lack of blinding, lack of external validity, and one trial discontinued prematurely (-1 risk of bias); conflicting results (-1 inconsistency); and 95% CI crossing the threshold of clinical decision making (-1 imprecision). The final level of evidence was graded 'very low'.

Conclusions

PICO A: operative fixation compared to conservative treatment

Functional outcome (AOFAS and FFI score), (osteo)arthritis

Very low GRADE	The evidence is very uncertain about the effect of operative fixation on **functional outcome (AOFAS; FFI)** and **(osteo)arthritis** when compared to conservative treatment in patients with subtle Lisfranc injury. *Source: Garriguez-Pérez, 2021; Ren, 2019; Graef 2021*

Infection

Very low GRADE	The evidence is very uncertain about the effect of operative fixation on **infection** when compared to conservative treatment in patients with subtle Lisfranc injury. *Source: Ren, 2019*

Bleeding, nerve injury, malunion/non-union

No GRADE	No evidence was found regarding the effect of operative fixation on **bleeding, nerve injury** and **malunion/non-union** when compared to conservative treatment in patients with subtle Lisfranc injury.

PICO B: open reduction and internal fixation (ORIF) compared to primary arthrodesis (PA)

Functional outcome: AOFAS-score

Low GRADE	ORIF may result in little to no difference in **functional outcome (AOFAS)** when compared to PA in patients with Lisfranc injury. *Source: Sun, 2022; Stødle, 2020*

Infection, nerve injury

Very low GRADE	The evidence is very uncertain about the effect of ORIF on **infection**, and **nerve injury**, when compared to PA in patients with Lisfranc injury. *Source: Henning, 2009*

Malunion/nonunion

Very Low GRADE	The evidence is very uncertain about the effect of ORIF on **malunion/nonunion** when compared to PA in patients with Lisfranc injury. *Source: Sun, 2022; Stødle, 2020*

Arthrosis

Low GRADE	ORIF may result in little in an increased risk for developing **(osteo)arthritis** when compared to PA in patients with Lisfranc injury. *Source: Sun, 2022*

Hardware removal

Very low GRADE	The evidence is very uncertain about the effect of ORIF on **hardware removal**, when compared to PA in patients with Lisfranc injury. *Source: Stødle, 2020; Henning, 2009; Ly and Coetzee, 2006*

Bleeding

No GRADE	No evidence was found regarding the effect of ORIF on bleeding when compared to PA in patients with Lisfranc injury. *Source: -*

Overwegingen – van bewijs naar aanbeveling

Voor- en nadelen van de interventie en de kwaliteit van het bewijs

Er is literatuuronderzoek gedaan naar de optimale behandelstrategie van Lisfranc fracturen. Hierbij is gezocht naar studies die een operatieve behandeling vergeleken met een conservatieve behandeling en naar studies die een primaire open reductie en interne fixatie (ORIF) vergeleken met een primaire arthrodese (PA). Deze vraag betreft met name de minder ernstig gedisluxeerde Lisfranc fracturen (< 2 mm dislocatie, in deze module: subtiel Lisfranc letsel), aangezien bij duidelijk gedisluxeerde Lisfranc fracturen (2 – 5 mm, in deze module: evident Lisfranc letsel) operatieve behandeling de voorkeur geniet. Voor de vergelijking tussen **operatief ingrijpen en conservatieve behandeling** werden geen RCTs gevonden, maar wel drie relevante retrospectieve observationele studies (Ren, 2019; Garriguez-Pérez, 2021; Graef, 2021). Observationeel onderzoek heeft van nature een lage bewijskracht. Daarbij was er in de studies van Ren (2019) en Garriguez-Pérez (2021) een gebrek aan correctie voor confounders, waardoor het aannemelijk is dat verschillen in de karakteristieken van de patiëntenpopulaties een effect hebben gehad op de resultaten. Bijvoorbeeld in de studie van Garriguez-Pérez (2021), werden patiënten met een dislocatie kleiner dan 2 mm conservatief

behandeld, en patiënten met een dislocatie van 2 tot 5 mm operatief behandeld. In de studie van Graef (2021) is wel rekening gehouden met confounders, middels *'propensity score matching'* in de statistische analyse. De bewijskracht voor effecten op de uitkomstmaten functionele uitkomst (AOFAS en FFI score, cruciale uitkomstmaat) en risico op artrose of infectie (belangrijke uitkomstmaten) is zeer laag. Voor de belangrijke uitkomstmaten bloeding, zenuwschade en slechte/geen genezing werd geen bewijs gevonden. Samenvattend is er op basis van dit bewijs niet te zeggen welke behandeling (operatief of conservatief) leidt tot betere uitkomsten.

Wel is in zowel de studie van Garriguez-Perez (2021) als Graef (2021) te zien dat patiënten met een minimale tot geen instabiliteit (<2 mm dislocatie) conservatief werden behandeld. Patiënten met een duidelijke dislocatie (2-5 mm) werden operatief behandeld. Zoals beschreven in de module diagnostiek (zie stroomschema diagnostiek hier wordt een hyperlink ingevoegd zodra de richtlijn wordt gepubliceerd op de richtlijnendatabase]) is de werkgroep van mening dat bij subtiele afwijkingen immobilisatie en aanvullende beeldvorming d.m.v. CT overwogen dient te worden. Er dient binnen twee weken een klinische herbeoordeling te worden gedaan, met zo nodig additionele CT of belaste voetfoto. Indien additionele diagnostiek laat zien dat het letsel stabiel is, kan er gekozen worden voor conservatieve behandeling. Mogelijk zal de RCT van Ponkilainen (2018; *study protocol*) meer sturing kunnen geven in de toekomst in de beste keuze van behandeling in dit soort letsels.

Voor de vergelijking tussen **ORIF en PA** werden vier RCTs gevonden (Sun, 2022; Stødle, 2020; Henning, 2009; Ly, 2006). Het gevonden bewijs suggereert dat er nauwelijks tot geen verschil is tussen ORIF en PA op functionele uitkomst (AOFAS/FFI-score na 12 maanden en na 24 maanden; cruciale uitkomstmaat). Ten aanzien van het risico op artrose (belangrijke uitkomstmaat) werd een absoluut risico verschil van 0.20 gevonden (95% BI 0,07 tot 0,33), in het voordeel van PA. De bewijskracht voor deze gevonden effecten is laag, mede vanwege kleine studie populaties en een laag aantal cases (n = 78 en n = 54). Voor de effecten op het risico op infectie, zenuwschade, malunion/nonunion, en chirurgisch verwijderen van bijvoorbeeld schroeven (belangrijke uitkomstmaten) werd slechts bewijs met een zeer lage bewijskracht gevonden. Zo waren de uitkomsten over het risico op verwijderen van materiaal erg tegenstrijdig. Mogelijk kan dit worden verklaard door het feit dat in Stødle (2020) alleen *low-energy* Lisfranc letsels waren geïncludeerd. Geen van de studies rapporteerden data over het risico op een bloeding. Redenen voor de (zeer) lage bewijskracht zijn o.a. een gebrek aan blindering en brede 95% BI's die de grenzen van klinische besluitvorming doorkruizen. Er is geen sterk bewijs over welke behandeling de beste is, een primaire arthrodese of primaire fixatie (ORIF).

Bij een primaire fixatie tracht men het gewricht te behouden en niet op te offeren, maar de vraag is of het opweegt om 1-4 graden beweeglijkheid van het Lisfranc gewricht op te offeren met als doelmeer stabiliteit te geven door een primaire artrodese. Dit sluit aan bij de gevonden resultaten ten aanzien van functionele uitkomst, die laten zien dat de functionele uitkomst na PA en ORIF vergelijkbaar zijn. Hoewel het verschil niet klinisch relevant was, laten zowel Sun (2022) als Stødle (2020) zien dat de AOFAS-score enigszins hoger was in de patiënten die met primaire artrodese werden behandeld. Om deze beweeglijkheid postoperatief na een primaire fixatie enigszins te verwezenlijken zal een tweede operatie noodzakelijk zijn om het materiaal te verwijderen. Garriguez-Pérez (2021) adviseert om het materiaal alleen te verwijderen bij osteolyse en klachten, terwijl in de praktijk veelal de eerste keuze is om osteosynthese materiaal te verwijderen na een ORIF. Over de noodzaak tot het routinematig verwijderen van osteosynthese materiaal bestaat een kennislacune.

Een ander veel genoemd argument ten faveure van behandeling met primaire arthrodese s dat het risico op artrose lager is. Dit komt mede doordat bij een primaire arthrodese het gewricht wordt opgeofferd en gefixeerd. De gevonden literatuur (Sun, 2022), laat een risico verschil van 0.20 (95% 0.07 tot 0.22) zien, wat suggereert dat de kans op artrose 20% groter is in de groep patiënten die

ORIF ondergaat. Het mogelijk lagere risico op artrose dient meegenomen te worden in de behandelkeuze.

Een complicatie van een artrodese die kan optreden is een nonunion. Daarentegen suggereert de gevonden literatuur over Lisfranc letsels geen verhoogd risico op nonunion bij primaire arthrodese, al is de bewijskracht laag.

Het succes van de ingreep hangt sterk samen met de nabehandeling (zie ook module nabehandeling, [hier wordt een hyperlink ingevoegd zodra de richtlijn wordt gepubliceerd op de richtlijnendatabase]),de fysieke toestand van de patiënt,weke delen van de voet na het letsel,comorbiditeiten (o.a. diabetes mellitus; perifeer vaatlijden) en andere leefstijlfactoren (bijv. roken).

Wanneer je kiest voor primaire fixatie, is de richtlijnwerkgroep van mening dat een plaatfixatie de aangewezen keuze is. Dit wordt ook ondersteund in de retrospectieve studie van Lau (2016) waarin 62 patiënten gedurende 6 jaar behandeld zijn voor hun Lisfranc fracturen. Patiënten ondergingen fixatie met transarticulaire schroeven (14/62, 22.5%), *dorsal locking plates (17/62, 27.4%)* of een combinatie van schroeven en platen (29/62, 46.8%). De fracturen die werden behandeld met een combinatie van schroeven en platen hadden een 3.01 (95% CI: 1.4-8.74) keer verhoogd risico op het ontwikkelen van stadium III of IV-osteoartritis vergeleken met een behandeling van alleen platen. Er werden geen verschillen in risico op osteoartritis gevonden wanneer een behandeling van platen werd vergeleken met schroeven.

Waarden en voorkeuren van patiënten (en evt. hun verzorgers)

Wanneer er geen duidelijke instabiliteit is door een Lisfranc letsel, kan de keuze voor een conservatieve of operatieve behandeling in overleg met de patiënt worden gemaakt. Een conservatieve behandeling middels gips is minder ingrijpend voor de patiënt, maar heeft als nadeel dat je een lange periode in het gips zit wat het dagelijks functioneren beperkt.

Ook de keuze voor primaire arthrodese, danwel primaire fixatie kan in overleg met de patiënt worden gemaakt. De voor- en nadelen van beide ingrepen dienen te worden besproken en de patiënt moet worden geïnformeerd over de verwachtingen t.a.v. het herstel. Voor de patiënt is primaire arthrodese mogelijk minder belastend omdat er niet het risico is dat zij een tweede ingreep moeten ondergaan voor verwijdering van materiaal en de kans op artrose mogelijk hoger is bij een primaire fixatie.

Kosten-effectiviteit (middelenbeslag)

Albright (2018) is de enige studie die ons beeld geeft dat primaire artrodese een meer kosten-effectievere techniek is dan ORIF. De primaire artrodese zou $1429/QALY kosten, terwijl de primaire fixatie $3958/QALY zou kosten. Dit is met name door de afname in re-operaties bij primaire artrodese.

Aanvaardbaarheid, haalbaarheid en implementatie

Expertise over- en exposure aan dit letsel is in de meeste ziekenhuizen beperkt. Met name een beperking in de '*index of suspicion'* zal meespelen met de problemen met detectie van instabiliteit bij een letsel in het bereik van een Lisfranc letsel. Ook bij evidente instabiliteit of complexe fracturen in de ossale structuren rondom het Lisfranc gewricht is de expertise beperkt door de lage frequentie van voorkomen. De expertise op traumatologisch gebied is beperkt, zeker waar het chirurgische interventies betreft, dit is mogelijk een belemmerende factor. Naar verwachting zijn er geen andere belemmerende factoren (bijv. aanwezigheid van apparatuur).

Acute zorg is voor eenieder toegankelijk ongeacht niveau van gezondsheidsvaardigheden, sociale klasse, opleidingsniveau, inkomen of migratie-achtergrond.

Aanbeveling(en)

Aanbeveling-1

Er is geen bewijs dat operatieve behandeling bij patiënten met een subtiel Lisfranc letsel betere uitkomsten geeft dan conservatieve behandeling. In de geselecteerde retrospectieve studies werden patiënten met een minimaal tot geen verplaatst Lisfranc letsel (subtiel letsel) conservatief behandeld en patiënten met een duidelijke verplaatsing/instabiliteit operatief behandeld.
Er zijn geen prospectieve vergelijkende studies beschikbaar. De werkgroep is het, gezien deze resultaten, erover eens dat open fracturen en persisterende luxatiestand in het Lisfranc gewricht operatief behandeld dienen te worden. Aangezien intra-articulaire fracturen en ligamentair letsel van het Lisfranc gewricht kunnen leiden tot discongruentie van het gewricht of persisterende instabiliteit kunnen hebben, is de werkgroep van mening dat deze groep ook baat kan hebben bij operatieve behandeling om de mogelijke late gevolgen te minimaliseren. Onduidelijk is of intra-articulaire fracturen in het Lisfranc bereik zonder discongruentie of gewrichten die bij stresstesten een goede alignment behouden ook beter operatief behandeld kunnen worden of dat gipsimmobilisatie dan een gelijkwaardige optie is. Deze keuze zou samen met de patiënt gemaakt kunnen worden.

Aanbeveling-2

De primaire artrodese lijkt mogelijk iets beter te doen dan de primaire fixatie van een Lisfranc letsel, maar de verschillen waren niet signifcant. Mogelijk dat de verschillen kleiner worden als het osteosynthese materiaal na een primaire fixatie alleen verwijderd wordt op indicatie. Aangezien we op dit moment vooral alleen osteosynthese verwijderen bij primaire fixatie. Het gevonden bewijs suggereert dat artrose komt mogelijk vaker voor postoperatief voorkomt in de primaire fixatie groep vergeleken met de primaire artrodese groep. Hierdoor lijkt een lichte voorkeur te zijn voor de primaire artrodese.

Behandel patiënten met een open fractuur en/of persisterende luxatiestand van het Lisfranc gewricht operatief. Behandel operatief als er een evidente instabiliteit dan wel discongruentie van het Lisfranc gewricht bestaat (>5 mm).

Beslis bij subtiele Lisfranc letsels, waarbij er geen duidelijke dislocatie is (2-5 mm) samen met de patiënt of er operatief of conservatief behandeld wordt. Behandel conservatief indien aanvullend onderzoek laat zien dat het letsel stabiel is (<2 mm; zie ook het stroomschema diagnostiek (bijlage module diagnostiek) [hier wordt een hyperlink ingevoegd zodra de richtlijn wordt gepubliceerd op de richtlijnendatabase])

Geef bij de operatieve behandeling van Lisfranc letsel een lichte voorkeur aan behandeling middels primaire artrodese.

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Bijlagen bij module Lisfranc letsel

Evidence tables module Lisfranc letsel (PICO A)

Evidence table for intervention studies (randomized controlled trials and non-randomized observational studies [cohort studies, case-control studies, case series])

Study reference	Study characteristics	Patient characteristics [2]	Intervention (I)	Comparison / control (C) [3]	Follow-up	Outcome measures and effect size [4]	Comments
Ren, 2019	Type of study: retrospective cohort study Setting and country: Beijing United Family Hospital and Tianjin Hospital, China Funding and conflicts of interest: The authors declared that there are no conflicts of interest. No funding received.	Inclusion criteria: no fractures in initial radio graphs; the radiographic Images showed that the first and second metatarsal had no diastasis (less than 2 mm in gap), but only weight bearing view showed the diastasis more than 3 mm; further images from CT showed some abnormality including 'fleck sign' or MRI showed plantar and interosseous branches of Lisfranc ligament rupture. 'Fleck sign' is a 'small chip of bone found in the space between the first and second metatarsal bases, which indicates avulsion of	Describe intervention (treatment/procedure/test): **Operative** For the surgical treatment, a reduction clamp was used to hold the position of the first and second metatarsal, one or two position screw/screws (depending on whether there is a diastasis between first and second cuneiform) were inserted. A posterior plaster splint was used for two weeks after the wound was well healed, followed by a walking boot with a foot arch supporter for the followed four weeks.	Describe control (treatment/procedure/test): **Conservative** For the conservative management of the undisplaced subtle ligamentous Lisfranc injury, a posterior plaster splint was used for initial three to five days, followed by a full cast to fix the ankle in 90 with foot arch remolding without weight bearing for totally six weeks. After the cast was removed, a walking boot with foot arch supporter was used to allow patient to fully weight bear for another six weeks.	Length of follow-up: 12.3 months Loss-to-follow-up: Not applicable	Outcome measures and effect size (include 95%CI and p-value if available): AOFAS, mean (SD) Operative: 90.0 (3.7) Conservative: 76.3 (13.0) P-value: <0.05 *Interpretation: higher scores is better outcome* Infection, n (%) Operative: 1 (5.0) Conservative: 0 (0) P-value: not reported Arthrosis, n (%) Operative: 4 (11.8) Conservative: 3 (37.5) P-value: not reported	Authors' conclusions Although surgical intervention for treating ligamentous injuries to Lisfranc joint is still controversial, we can learn a lesson and inform patients to give an appropriate warning to consider conservative and surgical management for undisplaced subtle Ligamentous Lisfranc injuries. Remarks Unclear whether groups are comparable in terms of age and sex

		the Lisfranc ligament. <u>Exclusion criteria:</u> not applicable <u>N total at baseline</u>: 61 patients with subtle ligamentous Lisfranc injuries *Operative: n=20 (32.8%)* *Conservative: n=41 (67.2%)* <u>Important prognostic factors</u>[2]: *Mean age total study group: 39 (range, 19-64) years* *Sex:* *Total study group: 62.2% Male* <u>Groups comparable at baseline?</u> Unclear.					
Garriguez-Pérez, 2021	<u>Type of study</u>: retrospective cohort study <u>Setting and country:</u> hospital, country not reported <u>Funding and conflicts of</u>	<u>Inclusion criteria</u>: (a) traumatic widening of the first intermetatarsal or intercuneal space, (b) complete clinical and radiographic history, and (c) minimum 1-year follow-up.	Describe intervention (treatment/procedure/test): **Operative** for injuries displaced between 2 and 5 mm (stage II and III). A limited approach over the C1-M2 space was used to remove fat and scar tissue that might prevent proper reduction. The space was reduced using a clamp, and	Describe control (treatment/procedure/test): **Conservative** for injuries displaced less than 2 mm (stage I). Use of posterior ankle splint for the first week until initial swelling has subsided and then replaced for a full ankle cast, which was kept for 6-8 weeks. Nonweight bearing	<u>Length of follow-up</u>: 4.3 (range, 1-8) years <u>Loss-to-follow-up</u>: Not applicable	Outcome measures and effect size (include 95%CI and p-value if available): <u>AOFAS, mean (SD)</u> Operative: 86.8 (6.6) Conservative: 90.1 (13.7) P-value: not reported *Interpretation: higher scores is better outcome* <u>Arthrosis, n (%)</u>	<u>Authors' conclusions</u> Foot function does not seem diminished after sustaining injuries <u>Remarks</u> Groups are not comparable in types of complications Relatively small sample size

	interest: The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. ICMJE forms for all authors are available online. The author(s) received no financial support for the research, authorship, and/or publication of this article.	Exclusion criteria:(a) complete dislocation or fracture-dislocation of the tarsometatarsal joint, (b) displaced fracture of the base of the metatarsals, (c) open or crush injuries, (d) associated injuries in the ipsilateral limb, and (e) associated comorbidities that made operative risk too high to propose operative treatment. N total at baseline: 42 patients with subtle Lisfranc injuries *Operative: n=34 (81.0%)* *Conservative: n=8 (19.0%)* Important prognostic factors[2]: *Mean age total study group: 49 (SD 17.5) years* *Sex:*	K-wires, screws, or dorsal plating were used for definitive fixation of at least 2 of the 3 possible elements (C1-M2, M1-M2, or C1-C2), according to surgeon's preference (Figure 3). After operative treatment, an ankle splint was used for 1 week to allow healing of soft tissues. When the splint was removed, active ankle range of motion was promoted but weight bearing was not allowed for 6 weeks. Hardware removal was not done routinely, performing it only if discomfort was referred by the patient or if the follow-up radiographs showed signs of osteolysis.	was indicated until the 12th week after the beginning of treatment.		Operative: 4 (11.8) Conservative: 3 (37.5) P-value: not reported	Retrospective study and including different treatment modalities with different injury stages No adjustment for confounding in statistical analyses

		Total study group: 35.7% Male <u>Groups comparable at baseline?</u> Unclear. Characteristics such as age, sex and BMI only provided for the whole study population.					
Graef, 2021	<u>Type of study</u>: retrospective cohort study <u>Setting and country:</u> level I trauma centre, Germany <u>Funding and conflicts of interest:</u> Open Access funding enabled and organized by Projekt DEAL. Authors declare no competing interests.	<u>Inclusion criteria:</u> All patients who were treated due to an injury of the Lisfranc joint in a single German level I trauma centre from January 2011 until December 2020 were included in this Study <u>Exclusion criteria:</u> not reported <u>N total at baseline</u>: 99 patients with Lisfranc injuries *Operative: n=79 (79.8%)* *Conservative: n=20 (20.2%)* <u>Important prognostic factors</u>[2]:	Describe intervention (treatment/procedure/test): **Operative** not clear / no information	Describe control (treatment/procedure/test): **Conservative** not clear / no information	<u>Length of follow-up</u>: Operative: 4.50 (SD 2.42) years *using n=10 patients with FFI data Conservative: 4.20 (SD 2.04) years *using n=10 patients with FFI data <u>Loss-to-follow-up</u>: Not applicable	Outcome measures and effect size (include 95%CI and p-value if available): <u>FFI, mean (SD)</u> Operative: 30.09 (28.59) Conservative: 21.03 (28.46) P-value: 0.487 *Interpretation: higher scores is worse outcome*	<u>Authors' conclusions</u> the decision to treat Lisfranc injuries operatively or conservatively should always include qualitative parameters such as the grade of displacement (Buehren criteria A and C) and quantitative variables like the M1-M2 distance (Buehren criterion B) but also take into account the trauma mechanism. If conservative treatment is chosen, regular checkups are required to not miss secondary displacements. <u>Remarks</u> Propensity score matching applied to evenly match groups A and B. groups were matched for age, sex, fracture classification, injury mechanism, total number of collateral fractures of the foot and ankle joint, and follow-up time after treatment.

		Mean age operative: 45.47 [IQR, 15.84] years *Mean age conservative: 37.95 [IQR, 15.13)* *Sex:* *Operative: 50% male* *Conservative: 59.5% male* <u>Groups comparable at baseline?</u> Baseline characteristics in terms of age, sex, trauma mechanisms etc not evenly distributed.					Bonferroni correction was applied to account for multiple testing Possibility of selection bias due to design. Operative group consisted mainly of homolateral dislocations and partial or complete divergent dislocations. Conservative group particularly consisted of isolated partial displacement.

Evidence tables bij module Lisfranc letsel (PICO B)

Evidence table for intervention studies (randomized controlled trials and non-randomized observational studies [cohort studies, case-control studies, case series])

Study reference	Study characteristics	Patient characteristics [2]	Intervention (I)	Comparison / control (C) [3]	Follow-up	Outcome measures and effect size [4]	Comments
Sun, 2022	<u>Type of study</u>: RCT <u>Setting and country:</u> hospital, China <u>Funding and conflicts of interest:</u> This work was supported by the	<u>Inclusion criteria</u>: (1) age more than sixteen (closed osteoepiphysis), (2) purely ligamentous and fracture dislocation, and (3) with or without	Describe intervention (treatment/procedure/test): **ORIF** For open reduction and internal fixation, because dislocation of the first TMT joints may potentially loss some essential anatomical landmarks which influenced precise reduction and alignment, the second ray	Describe control (treatment/procedure/test): **PA** The exact same approach and principles were used as that in performing open reduction and internal fixation. The first TMT joint was fused only, and	<u>Length of follow-up</u>: 37.8 (range, 24-48) months <u>Loss-to-follow-up</u>: Intervention: 0 (0%) N (%) Reasons (describe): not applicable Control: 1 / 44	Outcome measures and effect size (include 95%CI and p-value if available): <u>AOFAS, mean ± SD</u> *Note, this outcome is measured at 12 months* ORIF: 77.4 ± 5.3 PA: 84.3 ± 7.3 P value: <0.01	<u>Authors' conclusions:</u> PA of the first TMT joint provided a better medium-term outcome than ORIF for Lisfranc injuries with the first TMT dislocation. PA prevented redislocation, pain, and revision as well. Therefore, PA of the first TMT joint was indicated

	Natural Science Foundation of Beijing (No. 7212020), the Science and Technology Planning Project of Beijing Municipal Education commission (No. KM202110025013), and the Beijing Thousand Talents Project (No. 2020A43). The authors declare no competing interests	other TMT joint injuries. Exclusion criteria: (1) previous Lisfranc injuries or foot abnormalities, (2) pathological fracture, (3) with neurovascular or head injury, and (4) with cognitive impairment N total at baseline: 88 Intervention: 44 Control: 44 Important prognostic factors[2]: *For example age ± SD:* *I: 41.9 ± 7.8* *C: 39.4 ± 8.4* *Sex:* *I: 65.0% M* *C: 63.2% M* *Diabetes:* *I: 8.0%* *C: 10.0%* *Smoker:* *I: 20.0%* *C: 16.0%* Groups comparable at	should be reduced first. Then, the first ray was reduced regarding the second ray as an anatomical template and fixed temporarily by K-wires. The other TMT joints were reduced finally. A large point reduction clamp was used to maintain the reduction between the second metatarsal base and the medial cuneiform. The homerun screw was inserted to fix the joint using solid 2.7-mm cortical screws. The anatomic reduction and alignment of joints were confirmed visually and under fluoroscopy. Bridging plates (DePuy Synthes, Warsaw, IN, USA) between joints were used for the medial three rays. If the lateral column was unstable or dislocated, it was assessed under fluoroscopy after treatment of the medial three rays. When without satisfactory reduction, the lateral column was reduced and stabilized by temporary K-wires but not fused. The K-wires were removed at six weeks post-operatively. If the lateral column could not be closed reduced, then the second incision along the fourth metatarsal was made for reduction and fixation.	ORIF was completed for the second and third TMT joints. And the joints were also fused by the same bridging plates. The only additional step was that the articular cartilage was removed from both the surfaces of the first TMT joint. The lateral column was also reduced and stabilized by temporary K-wires but not fused. No additional bone graft was needed. The joint alignment and implant position were checked under fluoroscopy during surgery, and then, the wound was irrigated, closed, and dressed.	N (%) Reasons (describe): not reported Incomplete outcome data: Intervention: 4 (10%) N (%) Reasons (describe): not reported Control: 5 (11.4%) N (%) Reasons (describe): not reported	Arthrosis, n (%) ORIF: 8 (20) PA: 0 P value: <0.05	for Lisfranc injuries with the first TMT joint dislocation. Remarks During follow-up visits, neither patients nor the surgeons were blinded. Small sample size Relatively high drop-out rate

		baseline? More men than women in both groups. More smokers in the ORIF group, but both not statistically significant.					
Stødle, 2020	Type of study: RCT Setting and country: Level 1 trauma center, country not reported Funding and conflicts of interest: Are H. Stødle, MD, reports grants from Sofies Mindes Ortopedi AS, Oslo, Norway, during the conduct of the study. The authors disclosed receipt of financial support from Sophies Minde Ortopedi.	Inclusion criteria: Lisfranc injuries with instability of the medial 3 TMT joints and no fractures in relation to the first TMT joint, in patients between 18 and 65 years old. Minor capsular avulsions in relation to the first TMT joint was accepted as a primarily ligamentous injury. Exclusion criteria: concomitant other major lower extremity injuries / polytrauma, open injuries, previous foot pathology, diabetes mellitus, neuropathy, and	Describe intervention (treatment/procedure/test): **ORIF** A 2-incision technique was used, with one longitudinal dorsomedial incision over the first TMT joint and a second incision over the third TMT joint. A skin bridge of at least 4 cm between the incisions was preserved to reduce the risk of wound complications. The 3 medial TMT joints were exposed. In the patients randomized to dorsal bridge plating, the cartilage of the first TMT joint was left intact. In the BP group, the first TMT joint was bridged with 2.7-mm locking plate.	Describe control (treatment/procedure/test): **PA** As all of the patients were treated with a primary arthrodesis of the second and third TMT joint, the cartilage was removed from these joints and the subchondral bone was multiperforated using a 2-mm drill bit to enhance fusion. No bone graft was used. In the PA group, the arthrodesis of the first TMT joint was fixed with two 2.7- or 3.5-mm fully threaded screws with interfragmentary compression. The primary arthrodesis of the second and third TMT joints was either fixed using 2.7- or 3.5-mm fully threaded screws or, in case of a severely comminuted joint, a locking plate was used. A “homerun-screw” was then placed from the medial cuneiform to the base of the second	Length of follow-up: 24 months Loss-to-follow-up: Intervention: not reported N (%) Reasons (describe): not reported Control: not reported N (%) Reasons (describe): not reported Incomplete outcome data: Intervention: not reported N (%) Reasons (describe): not reported Control: not reported N (%) Reasons (describe): not reported	Outcome measures and effect size (include 95%CI and p-value if available): AOFAS, mean ± SD *12 months follow-up* ORIF: 79 ± 16 PA: 85 ± 10 P-value: 0.12 *24 months follow-up* ORIF: 85 ± 15 PA: 89 ± 9 P-value: 0.32 Nonunion, n (%) ORIF: 2 (8.70) PA: 1 (4.55) P-value: >0.99 Arthrosis, n (%) ORIF: 11 (45.8) PA: 0 (0) P-value: not reported Hardware removal, n (%) ORIF: 5 (20.8) PA: 7 (30.4) P-value: 0.45 Infection *“One patient had a superficial wound infection in the BP group”(only in the text)* Information not provided for PA group.	Authors’ conclusions Both the temporary bridge plate (BP) group and the primary arthrodesis (PA) group yielded good outcome scores when treating Lisfranc injuries. We did not find superiority of the BP group compared to the PA group according to the AOFAS midfoot score. The first metatarsal was better aligned in the BP group. Despite avoiding transarticular screw damage by bridge plating the first TMT joints, there was a high rate of radiologically detected osteoarthritis in the first TMT joint. The long-term effects of post-traumatic osteoarthritis is still unknown and longer follow-up is required. Remarks Lack of external validity, since only ‘low-energy’ injuries were included, which are known to have better results than high-energy injuries. Possibility to have missed patients with minor

		peripheral vascular disease. N total at baseline: 48 ORIF: 24 PA: 24 Important prognostic factors[2]: *For example age ± SD:* *I: 34 (IQR 28-40)* *C: 30 (IQR 23-40)* *Sex:* *I: 45.8% M* *C: 45.8% M* Groups comparable at baseline? Mostly yes, but a higher rate of ligamentous injuries in the PA group was observed		metatarsal securing the Lisfranc mortise. After reduction and fixation of the 3 medial TMT joints, the reduction of the fourth and fifth TMT joints was assessed. If displaced, the 2 lateral TMT joints were reduced and stabilized using 1.6-mm Kirschner wires.			symptoms for nonunion, because only patients with clinically suspected nonunion were evaluated. Patients and examiner were not blinded for the treatment.
Henning, 2009	Type of study: RCT Setting and country: not reported Funding and conflicts of interest: not reported	Inclusion criteria: Acute Lisfranc injury of less than 3 months duration and closed physes/skeletal maturity. Exclusion criteria Major intra-articular fracture	Describe intervention (treatment/procedure/test): **ORIF** primary ORIF consisted of a 9- to 10-cm, dorsal longitudinal incision over the interval at the base of the first and second TMT joints. This approach allowed visualization and reduction of the first, second, and medial half of the third TMT joints. The first TMT was reduced with a tenaculum clamp and flexion force avoided plantar gapping or malreduction. Crossed 0.062 Kirschner wires	Describe control (treatment/procedure/test): **PA** For PA, the same dorsal access was provided with the two longitudinal incisions. Since the first, second, and third TMT joints are “non-essential” or relatively immobile, the TMT joints were fused. Since the fourth and fifth TMT “essential” or more mobile, the fourth and fifth TMT joints were not fused.	Length of follow-up: 24 months Loss-to-follow-up: 3 patients dropped out postoperatively and 5 patients were lost to follow-up early in the study. At the time of the final phone survey, an additional 9 patients were unable to be contacted after an exhaustive search.	Outcome measures and effect size (include 95%CI and p-value if available): Hardware removal, n (%) ORIF: 11 (79) PA: 3 (17) P-value: <0.05 Infection, n (%) ORIF: 0 (0) PA: 1/18 (5.56) → superficial cellulitis P-value: not reported	Authors conclusion: PA resulted in a statistically significant decrease in the number of follow-up surgeries performed compared to ORIF if hardware removal is routinely performed. Remarks Small sample size High drop out rate during follow-up

		pattern, prior foot trauma, prior foot infection, prior foot surgery, prior foot pathology, chronic injury of greater than three months duration, or associated medical comorbidities such as diabetes mellitus, peripheral vascular disease, peripheral neuropathy, or autoimmune disease. <u>N total at baseline</u>: 32 ORIF: 14 PA: 18 <u>Important prognostic factors</u>[2]: For example age ± SD: ORIF: 37 (range, 20-58) years PA: 40 (range, 25-73) years *Sex:* *ORIF: 64.3% M* *PA: 66.7% M* <u>Groups comparable at</u>	secured the reduction. With a tenaculum clamp compressing the joint, a retrograde 0.062 Kirschner wire secured the joint. The medial aspect of the third TMT was visualized through the same incision. When necessary, the lateral 8 cm longitudinal, universal incision over the fourth metatarsal allowed access to the lateral aspect of the third and entire visualization of the fourth and fifth TMT joints. After the third TMT was reduced with a tenaculum clamp, a 0.062 Kirschner wire was percutaneously inserted retrograde to stabilize the third TMT joint. If the Kirschner wires were inserted close to the TMT, the wire would not interfere with retrograde drilling and screw insertion. The fourth and fifth TMTs were reduced with dental picks and tenaculum clamps. Retrograde percutaneous 0.062 Kirschner wires were inserted perpendicular to the TMT joint and into the subchondral bone of the cuboid. Temporary reduction was confirmed with anterior-posterior (AP), lateral (Lat), and oblique (Obl) intraoperative fluoroscopic views. Final stabilization was performed in a medial to lateral direction. A step was created on the mid anterior first MT cortical surface with a perpendicular drill through the first cortex only. A 2.5-mm drill with drill sleeve was used to cross the joint about 30 degrees from the anterior cortical surface.17 Periarticular screws (Zimmer, Warsaw, IN) with a 3.5-mm shaft and a 2.7-mm head size	The reduction and fixation sequence was similar to PORIF, i.e. medial to lateral. The articular surface was removed with one-quarter inch osteotomes and small curettes. Final subchondral preparation required 2.0 mm drill perforation through the subchondral bone into cancellous bone. The temporary stabilization of the joints was similar to the PORIF group. Screws were inserted via a lag technique to compress the subchondral surfaces with the same screw configuration as PORIF. No additional bone graft or allograft was necessary.	*Note: drop out rate and reasons were not reported per treatment group.* <u>Incomplete outcome data</u>: ORIF: not reported N (%) Reasons (describe): not reported PA: not reported N (%) Reasons (describe): not reported	<u>Neural injury</u> *No neural injury was noted in both ORIF and PA group (only in text)* <u>Nonunion</u> *"one delayed union associated with a broken first TMT joint screw healed at the 6-month mark, and one nonunion of a first TMT joint was treated nonoperatively" in the PA group" (only in the text).* This information was not provided for the ORIF group.	Non-blinding of the surgeon who directed examinations and grading of radiographs may have resulted in bias The study was discontinued prematurely, because patients undergoing PA were doing clinically as well as the ORIF patients with significantly fewer follow-up surgical procedures and without adverse outcomes.

		baseline? Yes, sex, age, mechanism of injury, and smoking rate was similar between groups (p >0.05)	increased joint stability and screw longevity with lessened cortical splitting. Two crossed 3.5-mm cortical screws were inserted at the first TMT joint. The retrograde screw was inserted along the medial half of the first TMT perpendicular to the joint. The antegrade screw was inserted from the lateral half of the medial cuneiform into the base of the first MT. A single retrograde 3.5-mm periarticular screw was inserted perpendicularly across the second TMT joint on the AP view. A percutaneous incision over the mid portion of the third metatarsal was used for insertion of a single retrograde 2.7-mm or 3.5-mm periarticular cortical screw across the third TMT joint. All screws were inserted in a neutral, not lag technique. The final screw position and TMT reductions were confirmed with fluoroscopy. The fourth and fifth TMT Kirschner wires were cut below the skin. A posterior splint in neutral position was applied. When present, an associated cuboid fracture was reduced and stabilized via the lateral longitudinal incision. A 2.5-mm external fixator (Synthes, Paoli, PA) was inserted across the cuboid from the calcaneus to the fifth MT shaft. The impacted articular surface was carefully elevated with an osteotome or elevator followed by insertion of allograft bone in the void. A mini “T” plate (Synthes, Paoli, PA) stabilized the cuboid fracture and allowed for insertion of “raft” screws into the subchondral bone. Because anatomical fixation of the				

			cuboid articular surface determined TMT reduction and restoration of the lateral column length, the cuboid fracture fixation was performed before fourth and fifth TMT reduction and stabilization with Kirschner wires.				
Ly, 2006	Type of study: RCT Setting and country: not reported Funding and conflicts of interest: The authors did not receive grants *or outside funding in support of their research for or preparation of this manuscript. They did not receive payments or other benefits or a commitment or* agreement to provide such benefits from a commercial entity. No commercial entity paid or directed, or agreed to pay or direct, any benefits to any research fund, foundation, educational institution, or other charitable or nonprofit organization with which the authors are affiliated or	Inclusion criteria: the Lisfranc injury had to be primarily ligamentous, with no major fractures present. Lisfranc injuries with a fleck sign were considered to be primarily ligamentous. Exclusion criteria: commuted intra-articular fracture at the base of the first or second metatarsal; any other substantial foot, ankle, or leg injury; a previous attempt at surgical management of the same injury; insulin-dependent diabetes mellitus; ipsilateral ankle	Describe intervention (treatment/procedure/test): **ORIF** Two dorsal longitudinal incisions—one between the first and second metatarsals and the second centered between the fourth and fifth metatarsals—were made. Open reduction and screw fixation of the first, second, and third metatarsal-cuneiform joints was performed. Then, if necessary, Kirschner wires were pla*ced in* each of the lateral two rays, but the rays were not fused. Seven patients in the open-reduction group required Kirschner-wire fixation of the lateral rays. The Kirschner wires were removed between six and eight weeks postoperatively. The screws were not routinely removed unless they caused symptoms, and they were never removed before three months.	Describe control (treatment/procedure/test): **PA** Standard incisions were made as described for the open-reduction group. Open reduction was performed, cartilage and fibrous tissue were resected, and the joints were decorticated. Reduction and screw fixation was then performed. If the third metatarsal-cuneiform joint was seen to be displaced on the computed tomography scan or was clearly unstable on direct examination, it was fused in the same fashion. The rationale for treatment of the lateral two rays was exactly the same as the rationale in the open-reduction group. Nine patients in the arthrodesis group underwent temporary Kirschner-wire fixation of the lateral two rays.	Length of follow-up: 42.5 months Loss-to-follow-up: ORIF: not reported N (%) Reasons (describe): not reported PA: not reported N (%) Reasons (describe): not reported Incomplete outcome data: ORIF: not reported N (%) Reasons (describe): not reported PA: not reported N (%) Reasons (describe): not reported	Outcome measures and effect size (include 95%CI and p-value if available): AOFAS, mean (range) *Measured at 24 months follow-up* ORIF: 68.6 (16-100) PA: 88.0 (63-100) P-value: 0.005 *Measured at final follow-up* ORIF: 57.1 (16-100) PA: 86.9 (63-100) P-value: 0.0001 Hardware removal, n (%) ORIF: 16 (80) PA: 4 (19) P-value: not reported Nonunion, delayed union *"One patient had a delayed union"* and *"one patient with a nonunion […]"* in the PA group (only in the text). No such information was provided for the ORIF group.	Authors conclusion: Because of the poor healing potential of the ligament-osseous interface and the trend toward a higher rate of correction loss, increasing deformity, and degenerative arthritic changes, we believe that primarily ligamentous injuries are a subset of Lisfranc joint injuries that are not as amenable to internal fixation. We believe that **stable arthrodesis is a better primary treatment for these injuries,** with superior short and medium-term outcomes than those following open reduction and internal fixation. Remarks The allocation of treatment with an open-randomization, odd-or-even format could have introduced selection bias. Using a random-numbers table or computerized randomization would have been a better way to allocate our patients.

	associated.	fusion; peripheral vascular disease; peripheral neuropathy; and rheumatoid arthritis. N total at baseline: 41 Intervention: 20 Control: 21 Important prognostic factors[2]: *For example age ± SD:* *I: 32.4 (range, 19-52) years* *C: 32 (range, 19-42) years* *Sex:* *I: 65% M* *C: 66.7% M* Groups comparable at baseline? Yes					The attending surgeon performed the follow-up clinical examination and gathered the questionnaires, which raises concern about bias. Hardware removal could have contributed to the poor results observed in the ORIF group.

Risk of Bias table module Lisfranc letsel (PICO A)

Author, year	Selection of participants Was selection of exposed and non-exposed cohorts drawn from the same population?	Exposure Can we be confident in the assessment of exposure?	Outcome of interest Can we be confident that the outcome of interest was not present at start of study?	Confounding-assessment Can we be confident in the assessment of confounding factors?	Confounding-analysis Did the study match exposed and unexposed for all variables that are associated with the outcome of interest or did the statistical analysis adjust for these confounding variables?	Assessment of outcome Can we be confident in the assessment of outcome?	Follow up Was the follow up of cohorts adequate? In particular, was outcome data complete or imputed?	Co-interventions Were co-interventions similar between groups?	Overall Risk of bias

	Definitely yes, probably yes, probably no, definitely no	Definitely yes, probably yes, probably no, definitely no	Definitely yes, probably yes, probably no, definitely no	Definitely yes, probably yes, probably no, definitely no	Definitely yes, probably yes, probably no, definitely no	Definitely yes, probably yes, probably no, definitely no	Definitely yes, probably yes, probably no, definitely no	Definitely yes, probably yes, probably no, definitely no	Low, Some concerns, High
Ren, 2019	**Definitely yes** Reason: all patients had undisplaced subtle ligamentous Lisfranc injury	**Definitely yes** Reason: surgeons performed the procedures (i.e. exposures)	**Definitely yes** Reason: all outcomes were assessed after treatment	**Definitely no** Reason: confounding factors are not assessed.	**Definitely no** Reason: no adjustment for confounding in statistical analyses, because confounders were not defined a priori.	**Probably yes** Reason: not clearly described, but no reason to believe that this was not well performed.	**Definitely yes** Reason: Outcome data were complete.	No information	Some concerns for all outcomes Reason: no adjustment for confounding
Garriguez-Pérez, 2021	**Definitely no** Reason: different types of Lisfranc injuries (stage I, II and III) constituted the cohort and were differently treated.	**Definitely yes** Reason: Stage I injuries received conservative treatment, stage II and III injuries received operative treatment. The treatments were well performed.	**Definitely yes** Reason: all outcomes were assessed after treatment.	**Definitely no** Reason: confounding factors are not assessed.	**Definitely no** Reason: no adjustment for confounding in statistical analyses, because confounders were not defined a priori.	**No information**	**No information**	**No information**	Some concerns for all outcomes Reason: patients not comparable, no adjustment for confounding
Graef, 2021	**Definitely no** Reason: different types of Lisfranc fractures were differently treated.	**Definitely yes** Reason: treatments were well performed.	**Definitely yes** Reason: all outcomes were assessed after treatment.	**Definitely yes** Reason: the authors of the study thought a priori about potential confounders, such as age, sex, and trauma mechanism.	**Definitely yes** Reason: propensity score matching was applied.	**Probably yes** Reason: the FFI-F is a valid scale to assess foot function	**No information**	**No information**	Some concerns for all outcomes (FFI) Reason: concerns related to study population

Risk of Bias table Lisfranc letsel (PICO B)

Study reference (first author, publication year)	**Was the allocation sequence adequately generated?** Definitely yes Probably yes Probably no Definitely no	**Was the allocation adequately concealed?** Definitely yes Probably yes Probably no Definitely no	**Blinding: Was knowledge of the allocated interventions adequately prevented?** **Were patients blinded?** **Were healthcare providers blinded?** **Were data collectors blinded?** **Were outcome assessors blinded?** **Were data analysts blinded?** Definitely yes Probably yes Probably no Definitely no	**Was loss to follow-up (missing outcome data) infrequent?** Definitely yes Probably yes Probably no Definitely no	**Are reports of the study free of selective outcome reporting?** Definitely yes Probably yes Probably no Definitely no	**Was the study apparently free of other problems that could put it at a risk of bias?** Definitely yes Probably yes Probably no Definitely no	**Overall risk of bias** **If applicable/necessary, per outcome measure** **LOW** **Some concerns** **HIGH**
Sun, 2022	Definitely yes Reason: a random number generated system was used for the blinded process.	Probably yes Reason: numbered envelopes were used.	Definitely no Reason: Patients and healthcare providers were not blinded Data analysts were blinded.	Probably yes Reason: it was stated that 1 patient was lost to follow-up and 9 patients had missing data. Missing data were not imputed	Probably yes Reason: the protocol is not on clinical trials.gov. However, all outcomes that have been described are presented in tables	Definitely yes Reason: authors have no conflicts of interest. No reason to believe that the funders of this project influenced study outcomes.	Some concerns for all outcomes. Reason: lack of blinding and potential problem with loss to follow-up.
Stødle, 2020	Definitely yes Reason: A random allocation rule was used.	Definitely yes Reason: Allocations were kept in sealed, opaque envelopes and were manually shuffled.	Definitely no Reason: healthcare provider and patients were not blinded.	Definitely no Reason: there was no loss to follow-up	Probably yes Reason: more outcomes reported in article than in protocol	Definitely no Reason: potential of selection bias due to inclusion of only low-energy injuries that are known to have better results than high-energy injuries. And	Some concerns for all outcomes Reason: lack of blinding and problem with selection bias

						main reports a grant from Sofies Mindes Ortopedi, but no reason to believe that this institution influenced study results.	
Henning, 2009	Definitely yes Reason: A random number generating system was used.	Probably yes Reason: envelopes were used, but not clear whether envelopes were sealed and opaque.	Definitely no Reason: healthcare providers were not blinded. Not clear whether patients were blinded.	Probably yes Reason: three patients dropped out postoperatively and five patients were lost to follow-up early in the study. At the time of the final phone survey, an additional nine patients were unable to be contacted.	Probably yes Reason: all outcomes that have been described in the article are presented in tables	Definitely no Reason: three different surgeons performed the procedures and the trial was discontinued prematurely	Some concerns Reason: lack of blinding and trial was discontinued prematurely.
Ly, 2006	Definitely no Reason: An odd-or-even process was used.	No information	Definitely no Reason: healthcare providers were not blinded.	No information	Probably yes Reason: all outcomes that have been described in methods are presented in tables or in text.	Definitely yes Reason: the authors did not receive grants or outside funding in support of their research. They did not get payments from commercial entities	Some concerns for all outcomes Reason: randomization process and lack of blinding.

Table of excluded studies

Reference	Reason for exclusion
Ahluwalia R, Yip G, Richter M, Maffulli N. Surgical controversies and current concepts in Lisfranc injuries. Br Med Bull. 2022 Dec 12;144(1):57-75. doi: 10.1093/bmb/ldac020. PMID: 36151742.	Wrong design: narrative review
Attia AK, Mahmoud K, Alhammoud A, d'Hooghe P, Farber D. Return to Play After Low-Energy Lisfranc Injuries in High-Demand Individuals: A Systematic Review and Meta-Analysis of Athletes and Active Military Personnel. Orthop J Sports Med. 2021 Mar 8;9(3):2325967120988158. doi: 10.1177/2325967120988158. PMID: 33763497; PMCID: PMC7944543.	Wrong outcome: return to play / evt achtergrond, goed uitgevoerde review
Cosculluela, Pedro E., Andrew M. Ebert, and Kevin E. Varner. "Dorsomedial bridge plating of Lisfranc injuries." *Techniques in Foot & Ankle Surgery* 8.4 (2009): 215-220.	Wrong design: description of a technique
Crates JM, Barber FA, Sanders EJ. Subtle Lisfranc subluxation: results of operative and nonoperative treatment. J Foot Ankle Surg. 2015 May-Jun;54(3):350-5. doi: 10.1053/j.jfas.2014.07.015. Epub 2015 Mar 4. PMID: 25746769.	wrong population: all patients underwent initially non-operative management, those who failed underwent surgery
Ettinger S, Altemeier A, Stukenborg-Colsman C, Yao D, Plaass C, Lerch M, Claassen L. Comparison of Isolated Screw to Plate and Screw Fixation for Tarsometatarsal Arthrodesis Including Clinical Outcome Predictors. Foot Ankle Int. 2021 Jun;42(6):734-743. doi: 10.1177/1071100720980014. Epub 2021 Feb 6. PMID: 33550860.	Wrong comparison: comparison of two surgical techniques
Gentchos, Christopher. "Lisfranc Injuries." *Techniques in Foot & Ankle Surgery* 20.2 (2021): 66-74.	Narrative review
Grewal US, Onubogu K, Southgate C, Dhinsa BS. Lisfranc injury: A review and simplified treatment algorithm. Foot (Edinb). 2020 Dec;45:101719. doi: 10.1016/j.foot.2020.101719. Epub 2020 Jul 6. PMID: 33038662.	Non-systematic review
van Hoeve S, Stollenwerck G, Willems P, Witlox MA, Meijer K, Poeze M. Gait analysis and functional outcome in patients after Lisfranc injury treatment. Foot Ankle Surg. 2018 Dec;24(6):535-541. doi: 10.1016/j.fas.2017.07.003. Epub 2017 Jul 18. PMID: 29409269.	Patient characteristics of Lisfranc injuries are compared with healthy controls and only 5 patients in the conservative treatment group
Kushare I, Wunderlich N, Elabd A, Attia E. Pediatric and adolescent Lisfranc injuries - Presentation, treatment and outcomes. Foot (Edinb). 2021 Mar;46:101737. doi: 10.1016/j.foot.2020.101737. Epub 2020 Sep 9. PMID: 33853714.	wrong population: paediatric patients
Lau S, Howells N, Millar M, De Villiers D, Joseph S, Oppy A. Plates, Screws, or Combination? Radiologic Outcomes After Lisfranc Fracture Dislocation. J Foot Ankle Surg. 2016 Jul-Aug;55(4):799-802. doi: 10.1053/j.jfas.2016.03.002. Epub 2016 Apr 12. PMID: 27079306.	Comparison of four groups (rather than two), and only two patients in the conservative treatment group. Comparison is therefore not possible.
Levy CJ, Yatsonsky D 2nd, Moral MZ, Liu J, Ebraheim NA. Arthrodesis or Open Reduction Internal Fixation for Lisfranc Injuries: A Meta-analysis. Foot Ankle Spec. 2022 Apr;15(2):179-184. doi: 10.1177/1938640020971419. Epub 2020 Dec 3. PMID: 33269645.	Higher quality SR available (van den Boom, 2021)
McHale KJ, Rozell JC, Milby AH, Carey JL, Sennett BJ. Outcomes of Lisfranc Injuries in the National Football League. Am J Sports Med. 2016 Jul;44(7):1810-7. doi: 10.1177/0363546516645082. Epub 2016 May 10. PMID: 27166291.	Unclear if all patients have a dislocation at start of the study
Nunley JA, Vertullo CJ. Classification, investigation, and management of midfoot sprains: Lisfranc injuries in the athlete. Am J Sports Med. 2002 Nov-Dec;30(6):871-8. doi: 10.1177/03635465020300061901. PMID: 12435655.	Comparison of different types of Lisfranc fractures (stage I, II and III) and wrong population (n = 15 athletes)
Prakash, Mukara, et al. "A Prospective Study on the Surgical Management of Closed Lisfranc Injury by Various Modalities." *European Journal of Molecular & Clinical Medicine (EJMCM)* 8.04 (2021): 2021	wrong comparison: comparison of different fixation techniques
Richter M, Thermann H, Huefner T, Schmidt U, Krettek C. Aetiology, treatment and outcome in Lisfranc joint dislocations and fracture dislocations. Foot and Ankle Surgery. 2002;8:21-32. https://doi.org/10.1046/j.1460-9584.2002.00294.x	Wrong population; patients who were treated operatively may have different types of Lisfranc injuries than patients who were treated non-operatively.
Robertson GAJ, Ang KK, Maffulli N, Keenan G, Wood AM. Return to sport following Lisfranc injuries: A systematic review and meta-analysis. Foot	Non-comparative studies included, only studies reporting return to sports included

Ankle Surg. 2019 Oct;25(5):654-664. doi: 10.1016/j.fas.2018.07.008. Epub 2018 Aug 8. PMID: 30321929.	
Shakked RJ. Lisfranc Injury in the Athlete. JBJS Rev. 2017 Sep;5(9):e4. doi: 10.2106/JBJS.RVW.17.00025. PMID: 28902660.	Non-systematic review
So E, Lee J, Pershing ML, Chu AK, Wilson M, Halaharvi C, Mandas V, Hyer CF. A Comparison of Complications and Reoperations Between Open Reduction and Internal Fixation Versus Primary Arthrodesis Following Lisfranc Injury. Foot Ankle Spec. 2021 Nov 28:19386400211058264. doi: 10.1177/19386400211058264. Epub ahead of print. PMID: 34841938.	Wrong design; retrospective cohort.
Stavrakakis IM, Magarakis GE, Christoforakis Z. Percutaneous fixation of Lisfranc joint injuries: A systematic review of the literature. Acta Orthop Traumatol Turc. 2019 Nov;53(6):457-462. doi: 10.1016/j.aott.2019.08.005. Epub 2019 Sep 28. PMID: 31575479; PMCID: PMC6939019.	Wrong intervention: study on screw percutaneous fixation
Ter Laak Bolk CS, Dahmen J, Lambers KTA, Blankevoort L, Kerkhoffs GMMJ. Adequate return to sports and sports activities after treatment of Lisfranc injury: a meta-analysis. J ISAKOS. 2021 Jul;6(4):212-219. doi: 10.1136/jisakos-2020-000477. Epub 2020 Dec 10. PMID: 34272297.	Wrong outcome: return to play
Yu, Xiao, et al. "Cannulated compressive screw compared with cortical screw for fixation of simple first tarsometatarsal joint fracture-dislocation: a finite element analysis." *INTERNATIONAL JOURNAL OF CLINICAL AND EXPERIMENTAL MEDICINE* 10.4 (2017): 6475-6481.	Wrong comparison: comparison of two fixation techniques

Literature search strategy

Cluster/richtlijn: NVvH Traumatisch Complexe Voetletsels	
Uitgangsvraag/modules: UV5 Welke behandeling reduceert de meest voorkomende gevolgen (korte en lange termijn) van Lisfranc fracturen?	
Database(s): Embase.com, Ovid/Medline	Datum: 23 januari 2023
Periode: vanaf 2000	Talen: geen restrictie
Literatuurspecialist: Alies van der Wal	
BMI-zoekblokken: voor verschillende opdrachten wordt (deels) gebruik gemaakt van de zoekblokken van BMI-Online https://blocks.bmi-online.nl/ Bij gebruikmaking van een volledig zoekblok zal naar de betreffende link op de website worden verwezen.	
Toelichting: Voor deze vraag is gezocht op de elementen: - Lisfranc fractuur - Operatieve fixatie De sleutelartikelen worden gevonden met deze search	

Zoekopbrengst

	EMBASE	**OVID/MEDLINE**	**Ontdubbeld**
SRs	67	37	72
RCT	38	19	39
Observationele studies	590	329	691
Totaal	695	385	**802**

5

Zoekstrategie

Embase.com

No.	Query	Results
#11	#5 AND #8 NOT (#9 OR #10) = observationeel	590
#10	#5 AND #7 NOT #9 = RCT	38
#9	#5 AND #6 = SR	67
#8	'clinical trial'/exp OR 'randomization'/exp OR 'single blind procedure'/exp OR 'double blind procedure'/exp OR 'crossover procedure'/exp OR 'placebo'/exp OR 'prospective study'/exp OR rct:ab,ti OR random*:ab,ti OR 'single blind':ab,ti OR 'randomised controlled trial':ab,ti OR 'randomized controlled trial'/exp OR placebo*:ab,ti OR 'major clinical study'/de OR 'clinical study'/de OR 'family study'/de OR 'longitudinal study'/de OR 'retrospective study'/de OR 'prospective study'/de OR 'comparative study'/de OR 'cohort analysis'/de OR ((cohort NEAR/1 (study OR studies)):ab,ti) OR (('case control' NEAR/1 (study OR studies)):ab,ti) OR (('follow up' NEAR/1 (study OR studies)):ab,ti) OR (observational NEAR/1 (study OR studies)) OR ((epidemiologic NEAR/1 (study OR studies)):ab,ti) OR (('cross sectional' NEAR/1 (study OR studies)):ab,ti) OR 'case control study'/de OR 'comparative study'/exp OR 'control group'/de OR 'controlled study'/de OR 'controlled clinical trial'/de OR 'crossover procedure'/de OR 'double blind procedure'/de OR 'phase 2 clinical trial'/de OR 'phase 3 clinical trial'/de OR 'phase 4 clinical trial'/de OR 'pretest posttest design'/de OR 'pretest posttest control group design'/de OR 'quasi experimental study'/de OR 'single blind procedure'/de OR 'triple blind procedure'/de OR (((control OR controlled) NEAR/6 trial):ti,ab,kw) OR (((control OR controlled) NEAR/6 (study OR studies)):ti,ab,kw) OR (((control OR controlled) NEAR/1 active):ti,ab,kw) OR 'open label*':ti,ab,kw OR (((double OR two OR three OR multi OR trial) NEAR/1 (arm OR arms)):ti,ab,kw) OR ((allocat* NEAR/10 (arm OR arms)):ti,ab,kw) OR placebo*:ti,ab,kw OR 'sham-control*':ti,ab,kw OR (((single OR double OR triple OR assessor) NEAR/1 (blind* OR masked)):ti,ab,kw) OR nonrandom*:ti,ab,kw OR 'non-random*':ti,ab,kw OR 'quasi-experiment*':ti,ab,kw OR crossover:ti,ab,kw OR 'cross over':ti,ab,kw OR 'parallel group*':ti,ab,kw OR 'factorial trial':ti,ab,kw OR ((phase NEAR/5 (study OR trial)):ti,ab,kw) OR ((case* NEAR/6 (matched OR control*)):ti,ab,kw) OR ((match* NEAR/6 (pair OR pairs OR cohort* OR control* OR group* OR healthy OR age OR sex OR gender OR patient* OR subject* OR participant*)):ti,ab,kw) OR ((propensity NEAR/6 (scor* OR match*)):ti,ab,kw) OR versus:ti OR vs:ti OR compar*:ti OR ((compar* NEAR/1 study):ti,ab,kw) OR (('major clinical study'/de OR 'clinical study'/de OR 'cohort analysis'/de OR 'observational study'/de OR 'cross-sectional study'/de OR 'multicenter study'/de OR 'correlational study'/de OR 'follow up'/de OR cohort*:ti,ab,kw OR 'follow up':ti,ab,kw OR followup:ti,ab,kw OR longitudinal*:ti,ab,kw OR prospective*:ti,ab,kw OR retrospective*:ti,ab,kw OR observational*:ti,ab,kw OR 'cross sectional*':ti,ab,kw OR cross?ectional*:ti,ab,kw OR	16316741

	multicent*:ti,ab,kw OR 'multi-cent*':ti,ab,kw OR consecutive*:ti,ab,kw) AND (group:ti,ab,kw OR groups:ti,ab,kw OR subgroup*:ti,ab,kw OR versus:ti,ab,kw OR vs:ti,ab,kw OR compar*:ti,ab,kw OR 'odds ratio*':ab OR 'relative odds':ab OR 'risk ratio*':ab OR 'relative risk*':ab OR 'rate ratio':ab OR aor:ab OR arr:ab OR rrr:ab OR ((('or' OR 'rr') NEAR/6 ci):ab)))	
#7	'randomized controlled trial'/exp OR random*:ti,ab OR (((pragmatic OR practical) NEAR/1 'clinical trial*'):ti,ab) OR ((('non inferiority' OR noninferiority OR superiority OR equivalence) NEAR/3 trial*):ti,ab) OR rct:ti,ab,kw	1839814
#6	'meta analysis'/exp OR 'meta analysis (topic)'/exp OR metaanaly*:ti,ab OR 'meta analy*':ti,ab OR metanaly*:ti,ab OR 'systematic review'/de OR 'cochrane database of systematic reviews'/jt OR prisma:ti,ab OR prospero:ti,ab OR (((systemati* OR scoping OR umbrella OR 'structured literature') NEAR/3 (review* OR overview*)):ti,ab) OR ((systemic* NEAR/1 review*):ti,ab) OR (((systemati* OR literature OR database* OR 'data base*') NEAR/10 search*):ti,ab) OR (((structured OR comprehensive* OR systemic*) NEAR/3 search*):ti,ab) OR (((literature NEAR/3 review*):ti,ab) AND (search*:ti,ab OR database*:ti,ab OR 'data base*':ti,ab)) OR (('data extraction':ti,ab OR 'data source*':ti,ab) AND 'study selection':ti,ab) OR ('search strategy':ti,ab AND 'selection criteria':ti,ab) OR ('data source*':ti,ab AND 'data synthesis':ti,ab) OR medline:ab OR pubmed:ab OR embase:ab OR cochrane:ab OR (((critical OR rapid) NEAR/2 (review* OR overview* OR synthes*)):ti) OR ((((critical* OR rapid*) NEAR/3 (review* OR overview* OR synthes*)):ab) AND (search*:ab OR database*:ab OR 'data base*':ab)) OR metasynthes*:ti,ab OR 'meta synthes*':ti,ab	733409
#5	#4 AND [2000-2023]/py	1483
#4	#3 NOT ('conference abstract'/it OR 'editorial'/it OR 'letter'/it OR 'note'/it) NOT (('animal'/exp OR 'animal experiment'/exp OR 'animal model'/exp OR 'nonhuman'/exp) NOT 'human'/exp)	1771
#3	#1 AND #2	2247
#2	'fracture fixation'/exp OR 'bone implant'/exp OR fixat*:ti,ab,kw OR transfixat*:ti,ab,kw OR screw*:ti,ab,kw OR plate:ti,ab,kw OR plates:ti,ab,kw OR plating:ti,ab,kw OR bridg*:ti,ab,kw OR pin:ti,ab,kw OR pins:ti,ab,kw OR nail*:ti,ab,kw OR wire*:ti,ab,kw OR kirschner:ti,ab,kw OR 'arthrodesis'/exp OR 'arthrodes*':ti,ab,kw OR fusion:ti,ab,kw OR 'osteosynthesis'/exp OR 'osteo synthes*':ti,ab,kw OR 'osteosynthes*':ti,ab,kw OR reduction:ti,ab,kw OR orif:ti,ab,kw OR 'forefoot surgery'/exp OR 'foot surgery'/exp OR 'surgery'/exp OR surger*:ti,ab,kw OR surgical*:ti,ab,kw OR operation*:ti,ab,kw OR operative*:ti,ab,kw OR 'mini invasive':ti,ab,kw OR 'minimally invasive':ti,ab,kw OR 'minimal invasive':ti,ab,kw OR mipo:ti,ab,kw	9023862
#1	'Lisfranc fracture'/exp OR Lisfranc:ti,ab,kw OR (((forefoot OR 'fore foot' OR midfoot OR 'mid foot' OR tarsometatarsal) NEAR/3 (fractur* OR broken OR injur* OR trauma OR dislocat* OR displac*)):ti,ab,kw) OR (('forefoot'/exp OR 'tarsometatarsal joint'/exp) AND ('fracture'/exp OR 'dislocation'/exp OR 'bone injury'/exp OR 'injury'/exp))	3134

Ovid/Medline

#	Searches	Results
11	(5 and 8) not (9 or 10) = observationeel	329
10	(5 and 6) not 9 = RCT	19
9	5 and 7 = SR	37
8	Case-control Studies/ or clinical trial, phase ii/ or clinical trial, phase iii/ or clinical trial, phase iv/ or comparative study/ or control groups/ or controlled before-after studies/ or controlled clinical trial/ or double-blind method/ or historically controlled study/ or matched-pair analysis/ or single-blind method/ or (((control or controlled) adj6 (study or studies or trial)) or (compar* adj (study or studies)) or ((control or controlled) adj1 active) or "open label*" or ((double or two or three or multi or trial) adj (arm or arms)) or (allocat* adj10 (arm or arms)) or placebo* or "sham-control*" or ((single or double or triple or assessor) adj1 (blind* or masked)) or nonrandom* or "non-random*" or "quasi-experiment*" or "parallel group*" or "factorial trial" or "pretest posttest" or (phase adj5 (study or trial)) or (case* adj6 (matched or control*)) or (match* adj6 (pair or pairs or cohort* or control* or group* or healthy or age or sex or gender or patient* or subject* or participant*)) or (propensity adj6 (scor* or match*))).ti,ab,kf. or (confounding adj6 adjust*).ti,ab. or (versus or vs or compar*).ti. or ((exp cohort studies/ or epidemiologic studies/ or multicenter study/ or observational study/ or seroepidemiologic studies/ or (cohort* or 'follow up' or followup or longitudinal* or prospective* or retrospective* or observational* or multicent* or 'multi-cent*' or consecutive*).ti,ab,kf.) and ((group or groups or subgroup* or versus or vs or compar*).ti,ab,kf. or ('odds ratio*' or 'relative odds' or 'risk ratio*' or 'relative risk*' or aor or arr or rrr).ab. or (("OR" or "RR") adj6 CI).ab.)) or Epidemiologic studies/ or case control studies/ or exp cohort studies/ or Controlled Before-After Studies/ or Case control.tw. or cohort.tw. or Cohort analy$.tw. or (Follow up adj (study or studies)).tw. or (observational adj (study or studies)).tw. or Longitudinal.tw. or Retrospective*.tw. or prospective*.tw. or consecutive*.tw. or Cross sectional.tw. or Cross-sectional studies/ or historically controlled study/ or interrupted time series analysis/ or exp clinical trial/ or randomized controlled trial/ or exp clinical trials as topic/ or randomized controlled trials as topic/ or Random Allocation/ or Double-Blind Method/ or Single-Blind Method/ or (clinical trial, phase i or clinical trial, phase ii or clinical trial, phase iii or clinical trial, phase iv or controlled clinical trial or randomized controlled trial or multicenter study or clinical trial).pt. or random*.ti,ab. or (clinic* adj trial*).tw. or ((singl* or doubl* or treb* or tripl*) adj (blind$3 or mask$3)).tw. or Placebos/ or placebo*.tw.	8098384
7	meta-analysis/ or meta-analysis as topic/ or (metaanaly* or meta-analy* or metanaly*).ti,ab,kf. or systematic review/ or cochrane.jw. or (prisma or prospero).ti,ab,kf. or ((systemati* or scoping or umbrella or "structured literature") adj3 (review* or overview*)).ti,ab,kf. or (systemic* adj1 review*).ti,ab,kf. or ((systemati* or literature or database* or data-base*) adj10 search*).ti,ab,kf. or ((structured or comprehensive* or systemic*) adj3 search*).ti,ab,kf. or ((literature adj3 review*) and	644750

	(search* or database* or data-base*)).ti,ab,kf. or (("data extraction" or "data source*") and "study selection").ti,ab,kf. or ("search strategy" and "selection criteria").ti,ab,kf. or ("data source*" and "data synthesis").ti,ab,kf. or (medline or pubmed or embase or cochrane).ab. or ((critical or rapid) adj2 (review* or overview* or synthes*)).ti. or (((critical* or rapid*) adj3 (review* or overview* or synthes*)) and (search* or database* or data-base*)).ab. or (metasynthes* or meta-synthes*).ti,ab,kf.	
6	exp randomized controlled trial/ or randomized controlled trials as topic/ or random*.ti,ab. or rct?.ti,ab. or ((pragmatic or practical) adj "clinical trial*").ti,ab,kf. or ((non-inferiority or noninferiority or superiority or equivalence) adj3 trial*).ti,ab,kf.	1580951
5	limit 4 to yr="2000 -Current"	771
4	3 not (comment/ or editorial/ or letter/) not ((exp animals/ or exp models, animal/) not humans/)	1077
3	1 and 2	1139
2	exp Fracture Fixation/ or Surgical Procedures, Operative/ or Orthopedic Procedures/ or exp General Surgery/ or exp Orthopedics/ or surger*.ti,ab,kf. or surgical*.ti,ab,kf. or operation*.ti,ab,kf. or operative*.ti,ab,kf. or reduction.ti,ab,kf. or orif.ti,ab,kf. or exp Minimally Invasive Surgical Procedures/ or 'mini invasive'.ti,ab,kf. or 'minimally invasive'.ti,ab,kf. or 'minimal invasive'.ti,ab,kf. or MIPO.ti,ab,kf. or fixat*.ti,ab,kf. or transfixat*.ti,ab,kf. or screw*.ti,ab,kf. or plate.ti,ab,kf. or plates.ti,ab,kf. or plating.ti,ab,kf. or bridg*.ti,ab,kf. or pin.ti,ab,kf. or pins.ti,ab,kf. or nail*.ti,ab,kf. or wire*.ti,ab,kf. or kirschner.ti,ab,kw. or exp Arthrodesis/ or 'arthrodes*'.ti,ab,kf. or fusion.ti,ab,kw. or 'osteo synthes*'.ti,ab,kf. or 'osteosynthes*'.ti,ab,kf.	4862636
1	(Lisfranc or ((forefoot or 'fore foot' or midfoot or 'mid foot' or tarsometatarsal) adj3 (fractur* or broken or injur* or trauma or dislocat* or displac*))).ti,ab,kf. or (exp Forefoot, Human/ and (exp Fractures, Bone/ or exp Fracture Dislocation/))	1953

Module 6 Nabehandeling traumatisch complexe voetletsels

Uitgangsvraag

Hoe dient de nabehandeling van patiënten met traumatisch complexe voetletsels er uit te zien?

De uitgangsvraag omvat de volgende deelvraag:

Wat is de aanbevolen strategie ten aanzien van gipsimmoblisatie en mate van belasting na een complex voetletsel?

Inleiding

In de huidige situatie is er veel variatie in de nabehandeling van patiënten met traumatisch complexe voetletsels, met name in verschil in duur van de immobilisatie en de mate van belasting. De hoofdbehandelaar (operateur of chirurg) bepaalt doorgaans de mate van belasting in de eerste fase van de nazorg. Er heerst echter onduidelijkheid en/of grote variatie in de praktijk omtrent duur en mogelijke start van belasting.

Search and select

A systematic review of the literature was performed to answer the following questions:

PICO A: cast immobilization vs. no cast immobilization

What are the benefits and harms of cast immobilization compared to no cast immobilization in patients with traumatic foot injury who were surgically treated?

P = Patients with traumatic foot injury who were surgically treated

I = Cast immobilization

C = **No** cast immobilization

O = Function, pain, return to performance (sport/work/exercise/leisure), adverse events and quality of life.

PICO B: early weight bearing vs. non-weight bearing

What are the benefits and harms of (partial) early weight bearing compared to no or delayed weight bearing in patients with traumatic foot injury who were surgically treated?

P = Patients with traumatic foot injury who were surgically treated

I = (Partial) weight bearing, early weight bearing, early exercise, permissive weight bearing

C = No weight bearing, delayed weight bearing

O = Function, pain, return to performance (sport/work/exercise/leisure), adverse events and quality of life.

<u>Relevant outcome measures</u>

The guideline development group considered the outcomes function and pain as critical outcome measures for decision making; and return to performance, adverse events and quality of life as important outcome measures for decision making.

A priori, the working group did not define the outcome measures listed above but used the definitions used in the studies.

For the predefined outcomes the working group defined the minimal clinically (patient) important differences as follows:

- Functional outcome (AOFAS): 10 points
- Pain: a difference of 20% (on a visual analogue scale)
- Return to performance: Risk Ratio (RR) <0.80 and >1.25

- Adverse events: Risk Ratio (RR) <0.80 and >1.25
- Quality of life: a difference of 10%

Search and select (Methods)

The databases Medline (via OVID) and Embase (via Embase.com) were searched with relevant search terms until 5th of June 2023. The detailed search strategy is depicted under the tab Methods. The systematic literature search resulted in 842 unique hits. Studies were selected based on the following criteria systematic reviews (of RCTs) or RCTs on cast immobilization and/or early weight bearing in patients with traumatic foot injury. Eight studies were initially selected based on title and abstract screening. After reading the full text, seven studies were excluded (see the table with reasons for exclusion under the tab Methods), and one study was included.

Results

One study was included in the analysis of the literature. Important study characteristics and results are summarized in the evidence tables. The assessment of the risk of bias is summarized in the risk of bias tables.

Summary of literature

Description of studies

PICO A: cast immoblization vs. no cast immobilization

No studies were included that compared immobilization with no cast immobilization in patients with complex foot injury treated surgically.

PICO B: early weight bearing vs. non-weight bearing

The RCT by **Li (2021)** evaluated the effect of early partial weight bearing vs delayed weight bearing on postoperative foot function in adult patients with Sanders IV calcaneal fractures. A total of 86 Chinese patients with Sanders IV calcaneal fracture were included in the trial. In total, 44 patients were randomized in the early partial weight bearing group (intervention), and 42 patients were randomized in the delayed weight bearing group (control). All patients had undergone open reduction with internal fixation (ORIF) with steel plate. Patients aged 18 – 60 were eligible to participate. The intervention group underwent early partial weight bearing rehabilitative exercise, starting from the 4th week postoperatively. From the 13th week, the patients started to stand or walk with full weight. The control group performed the conventional rehabilitative exercises, which included partial weight bearing standing or walking in 13 to 24 weeks after surgery. The control group gradually increased the exercise intensity to full weight bearing. After 24 weeks, the Maryland foot function and AOFAS were reported.

Results

PICO A: cast immoblization vs. no cast immobilization

No studies reported one of the predefined outcomes (functional outcome, pain, return to performance, adverse events or quality of life) for the comparison cast immobilization versus no cast immobilization.

PICO B: early weight bearing vs. non-weight bearing

Functional outcome (AOFAS)

Li (2021) reported functional outcome AOFAS after early partial weight bearing compared to delayed weight bearing at 6 months follow-up. The mean AOFAS-score in the early weight bearing group was 83.42 ± 8.54 (n = 44). In the delayed weight bearing group, the mean AOFAS-score was 76.42 ± 7.03 (n = 42). The mean difference in AOFAS-score was 7.00 (95% CI: 3.70 to 10.30), in favor of the early weight bearing group.

Pain

None of the studies reported the outcome 'pain' for the comparison early weight bearing versus delayed weight bearing.

Return to performance

None of the studies reported the outcome 'return to performance' for the comparison early weight bearing versus delayed weight bearing.

Adverse events

None of the studies reported the outcome 'adverse events' for the comparison early weight bearing versus delayed weight bearing.

Quality of life

None of the studies reported the outcome 'quality of life for the comparison early weight bearing versus delayed weight bearing.

Level of evidence of the literature

PICO A: cast immoblization vs. no cast immobilization

The level of evidence for the comparison cast immobilization versus no cast immobilization could not be graded, as no studies were found in which these modalities were compared.

PICO B: early weight bearing vs. non-weight bearing

The level of evidence regarding the outcome measure **functional outcome (AOFAS)** was downgraded by two levels because of study limitations including lack of blinding of patients (-1 risk of bias) and a low number of included patients (-1 imprecision). The final level of evidence was graded 'low'.

The level of evidence for the outcomes **pain, return to performance, adverse events and quality of life** after early- or non-weight bearing could not be graded, as no studies were found that reported this outcome.

Conclusions

PICO A: castimmoblization vs. no castimmobilization

No GRADE	No evidence was found regarding the effect of cast immobilization on functional outcome, pain, return to performance, adverse events or quality of life, compared to no cast immobilization in patients with traumatic foot injury who were surgically treated. *Source: -*

PICO B: early weight bearing vs. non-weight bearing

Functional outcome (AOFAS)

Low GRADE	The evidence suggests that early weight bearing may result in little to no difference in **functional outcome,** compared with delayed weight bearing in patients with traumatic foot injury who were surgically treated.

	Source: Li, 2021

Pain, return to performance, adverse events, quality of life

No GRADE	No evidence was found regarding the effect of early weight bearing on the outcomes **pain**, **return to performance, adverse events** and **quality of life**, compared to no weight bearing, in patients with traumatic foot injury who were surgically treated. *Source: -*

Overwegingen – van bewijs naar aanbeveling

Voor- en nadelen van de interventie en de kwaliteit van het bewijs

Ten aanzien van de **nabehandeling** van (chirurgisch behandeld) complex voetletsel dient de behandelaar (operateur) verschillende keuzes te maken, onder andere ten aanzien van gebruik en duur van gipsimmobilisatie en mate van belasting.

Gipsimmobilisatie

Er is literatuuronderzoek gedaan naar de rol van gipsimmobilisatie bij de nabehandeling van complexe voetletsels. Er zijn geen gerandomiseerde studies of systematische reviews gevonden waarin de effecten van gipsimmobilisatie werden vergeleken met de effecten van **geen** gipsimmobilisatie. Bewijs over de effecten van gipsimmobilisatie op functionele uitkomst of herstel van complex voetletsel ontbreekt. Er zijn echter wel een aantal nadelen van gipsimmobilisatie bekend (Lievens, 2019; Monajemi, 2017):

- Drukplekken en wonden t.g.v. verkeerd aanleggen en/of zwelling
- Compressie neuropathie
- Ischaemie en compartimentsyndroom
- Stijfheid van gewrichten
- Spieratrofie t.g.v. disuse
- Diepe veneuze trombose, risico bij onderbeen gips is 1,8%

Voordelen van gipsimmobilisatie zijn bescherming van de osteosynthese, met name bij moeilijk instrueerbare patiënten, een mogelijk vlottere genezing van wonden en weke delen en preventie van spitsvoet. Als alternatief voor gipsimmobilisatie kan ook gekozen worden voor een orthese bijvoorbeeld in de vorm van een walker.

Mate van belasting

Naast een zoekvraag naar de gipsimmobilisatie is er literatuuronderzoek gedaan naar voor- en nadelen van vroegtijdig belasten vergeleken met laat/restrictief belasten.
Als cruciale uitkomstmaten werden functionele uitkomst en pijn gedefinieerd. Terugkeer naar werk of sport, complicaties en kwaliteit van leven werden als belangrijke uitkomstmaten gedefinieerd.
Over de rol van vroegtijdig belasten werd één gerandomiseerde trial gevonden (Li 2021). Deze studie suggereert dat vroegtijdig belasten niet leidt tot een betere of slechtere functionele uitkomst (AOFAS-score), dan laat/restrictief belasten in patiënten met calcaneus fracturen. De bewijskracht voor dit gevonden effect is laag. Redenen hiervoor zijn beperkingen in de studieopzet (waaronder een gebrek aan blindering) en een kleine patiëntenpopulatie (n = 86). Over de effecten van vroegtijdig belasten op de andere gedefinieerde uitkomstmaten werd geen bewijs gevonden. Er lijkt dus voorzichtig bewijs te zijn dat vroegtijdig belasten mogelijk leidt tot een vergelijkbare functionele uitkomst als laat /restrictief belasten (bij calcaneus- en talusfracturen). Echter gezien de lage bewijskracht kunnen hier geen harde conclusies over worden getrokken.

In de internationale AO-richtlijn wordt beschreven dat belasten van de complexe voetletsels kan gaan starten na 6 tot 12 weken (Buckley, 2010). In de dagelijkse praktijk blijkt echter dat eerder wordt gestart met belasten op basis van ervaring van de operateur en door matige compliance van patiënten (Hustedt, 2012; Kalmet, 2023; Raaben, 2018;).

De laatste jaren komt er steeds meer aandacht voor *permissive weight bearing*. Bij permissive weight bearing vindt er een graduele opbouw van functionele activiteiten plaats, geleidt door de subjectieve ervaringen (o.a. pijn, vertrouwen om te belasten) van de patiënt en door objectieve klinische symptomen (o.a. ontsteking, neurovasculaire status, reactie van gewrichten etc.) gedurende de revalidatie, geëvalueerd door de fysiotherapeut bij iedere therapiesessie. De voortgang van de therapie wordt niet bepaald door een vooraf bepaalde of vaste belastingsgraad van de aangedane zijde in kg, of in percentage van het lichaamsgewicht. Dit proces stelt patiënten in staat om de activiteiten met normale/optimale motorische vaardigheden te hervatten. De aanpak wordt geleid door de kwaliteit en veiligheid van het bewegen (Kalmet, 2023).

De rol van *permissive weight bearing* bij de nabehandeling van complexe voetletsels is nog niet onderzocht. Observationele studies in enkel- (Smeeing, 2020) of onderste extremiteiten letsel (Consigliere, 2019; Kubiak, 2013) suggereren echter positieve resultaten van *permissive weight bearing* bij o.a. calcaneusfracturen. In de studie van Kalmet zijn er 17 calcaneusfracturen geincludeerd (Kalmet, 2023). Er zijn aanwijzingen dat vroege belasting leidt tot een sneller herstel van loopfunctie en deelname aan de normale dagelijkse activiteiten (Kalmet, 2019)

De **revalidatie** na complexe voetletsels vindt meestal plaats bij de eerstelijnsrevalidatie (fysiotherapie) of in tweedelijns medisch specialistische revalidatie

<u>*Eerstelijns revalidatiefase (fysiotherapie)*</u>
Er is geen eenduidige aanpak in of richtlijn voor de fysiotherapeutische nabehandeling van complexe voetletsels. Het is onduidelijk voor welke specifieke patiëntengroepen verwijzing naar de fysiotherapie na complex voetletsel zinvol is. Hierover bestaat een kennislacune.

Indien een patiënt een hulpvraag heeft richting bewegend functioneren, heeft het volgens de werkgroep de voorkeur om de patiënt, gericht te verwijzen naar een fysiotherapeut.

Verwijzing voor fysiotherapie en verslaglegging
Verwijzing naar de fysiotherapeut: de arts stuurt een verwijzing naar de fysiotherapeut en na afronding van de behandeling stuurt de fysiotherapeut een eindverslag naar de arts.
Als het verloop en/of het karakter van de behandeling substantieel afwijkt van wat was verwacht, stuurt de fysiotherapeut een tussentijds voortgangsverslag. Het kan ook zijn dat de fysiotherapeut tijdens zijn behandeling een interventie van de arts nodig acht of extra informatie nodig heeft. Ook dit is aanleiding voor een extra informatie-uitwisseling (KNGF, 2016).

Bij een verwijzing naar een fysiotherapeut zijn, behalve de algemene verwijsgegevens, minimaal de volgende verwijsgegevens van belang:

- De lokalisatie van de fractuur;
- De gebruikte operatietechniek;
- Andere pathologie (bijvoorbeeld degeneratieve verschijnselen, bandletsel, passieve stabiliteit);
- Gegevens van aanvullend onderzoek;
- Gebruik van medicatie die het bewegend functioneren beïnvloeden;
- Gebruik van loophulpmiddelen;
- Belastingadvies.

De fysiotherapeut beoordeelt de aangrijpingspunten die behandeld kunnen worden. Denk hierbij aan mobiliteit, stabiliteit, belastbaarheid, spierfunctie, pijn, littekens, wonden, oedeem en bewegingsangst. In een latere fase van de revalidatie zal de behandeling zich meer richten op veranderen en handhaven van houding, lopen en verplaatsen, verbeteren van mogelijkheden tot arbeidsintegratie en hervatten van intensieve bewegingsvormen.

Bij terugrapportage van een fysiotherapeut aan de operateur wordt de volgende informatie beschreven:

- De fysiotherapeutische conclusies;
- Het behandelresultaat en eventueel verloop;
- Eventuele aanbevelingen aan de arts richting vervolg en aanbevelingen gedaan aan de patiënt (bijvoorbeeld continueren oefeninstructies).

Tweedelijns medisch specialistische revalidatie

De betrokkenheid van de revalidatiearts en het medisch specialistisch revalidatieteam kan geïndiceerd zijn bij:

- Complexe samenhangende problematiek op meerdere *International Classification of Functioning* (ICF) domeinen waardoor een interdisciplinaire behandeling noodzakelijk is.
- Indien er sprake is van complex voetletsel als onderdeel van een multitrauma
- Bij complexe loopproblemen en of restklachten verdient het aanbeveling om orthopedische aanpassingen aan schoenen of orthesen te beoordelen middels een (gezamenlijk) spreekuur van medisch specialist, fysiotherapeut en of orthopedisch technicus, registerpodoloog of podotherapeut.

Waarden en voorkeuren van patiënten (en evt. hun verzorgers)

Snellere mobilisatie en weer kunnen participeren in de dagelijkse activiteiten zijn voor de patiënt de belangrijkste doelen van de nabehandeling. In het gesprek met de patiënt over de opties ten aanzien van nabehandeling is samen beslissen altijd van belang. Er dient een goede voorlichting te worden gegeven over de voor- en nadelen (van gipsimmobilisatie en *early* of *permissive weight bearing*). Over het algemeen zal een patiënt meer voordeel zien in vroege belasting. Het blijkt dat de compliance aan een lange onbelaste periode niet optimaal is.

Kosten (middelenbeslag)

De werkgroep is niet op de hoogte van kosten-effectiviteitstudies over de nabehandeling van complexe voetletsels. Gipsimmobilisatie en fysiotherapeutische nabehandeling brengen kosten met zich mee, maar daar tegenover staan de (maatschappelijke) kosten van een onvolledig of traag herstel (bijvoorbeeld ziekteverzuim, hulp in huishouding). De keuze voor wel of geen fysiotherapie dient samen met de patiënt te worden gemaakt. Fysiotherapeutische behandeling wordt niet standaard vergoed vanuit de zorgverzekering, mogelijk kan dit voor de patiënt een argument zijn om de fysiotherapeut niet te gaan bezoeken.

Aanvaardbaarheid, haalbaarheid en implementatie

Een argument dat ten faveure van gipsimmobilisatie of late belasting wordt gebruikt is dat de kans op falen van osteosynthese, of migratie van fractuurdelen groter is zonder gipsimmobilisatie of bij vroege belasting. Echter ervaringen uit de praktijk en de (beperkte) evidence laat zien dat het risico op complicaties niet groter is. Daarnaast is de compliance van veel patiënten niet optimaal waardoor ze al sneller en meer belasten dan volgens de huidige AO-richtlijnen wordt geadviseerd (zonder bewijs dat dit leidt tot meer complicaties). Tenslotte is het voor patiënten, voor de gezondheidszorg en de maatschappij van belang om sneller te herstellen en weer te kunnen participeren. Ondersteuning vanuit de internationale richtlijnen over vroege belasting, en de literatuur omtrent

voetletsels is nog zeer beperkt, dit kan een adequate implementatie belemmeren. Het is noodzakelijk dat meer onderzoek wordt gedaan en de opgedane de kennis hierover wordt verspreid.

Aanbeveling(en)

Aanbeveling-1

Rationale van de aanbeveling: weging van argumenten voor en tegen de interventies

Er is geen bewijs dat wel of geen gipsimmobilisatie leidt tot een betere genezing van een complex voetletsel. De keuze voor gipsimmobilisatie dient te worden gemaakt door de operateur. Vanwege de nadelen die gipsimmobilisatie kent, is het advies van de werkgroep om gipsimmobilisatie zo kort mogelijk te doen. Er is geen bewijs dat een vroege of *permissive weight bearing* leidt tot een snellere genezing van een complex voetletsel, echter er is ook geen bewijs dat het leidt tot meer complicaties. Er zijn voorzichtige aanwijzingen dat vroege belasting leidt tot een sneller herstel van loopfunctie en deelname aan de normale dagelijkse activiteiten.

Maak per individuele patiënt een plan voor de nabehandeling. Indien de operateur dat noodzakelijk vindt kan een (onbelaste) gipsimmobilisatie plaatsvinden maar overweeg dat zo kort mogelijk te doen. Indien er voldoende wondgenezing bereikt is kan gestart worden met belasten, eventueel tijdelijk in gips of met een orthese. Houdt hierbij rekening met de risico's op complicaties en de voorkeur van patiënten. Hierbij spelen fysieke aspecten van het letsel en de gezondheidstoestand een rol. Maar ook psychosociale aspecten zoals mentale belastbaarheid, instrueerbaarheid, leefomgeving en werksituatie kunnen van invloed zijn

Literatuur

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Bijlagen bij module nabehandeling

Evidence Tables bij module nabehandeling

Evidence table for intervention studies studies (randomized controlled trials and non-randomized *observational* studies [cohort studies, case-control studies, case series])

Study reference	Study characteristics	Patient characteristics [2]	Intervention (I)	Comparison / control (C) [3]	Follow-up	Outcome measures and effect size [4]	Comments
Li, 2021	Type of study: RCT Setting and country: Hospitals in China Funding and conflicts of interest: The authors reported no conflict of interest.	Inclusion criteria: (1) The diagnostic criteria of patients were in accordance with Sanders IV calcaneal fracture in *Bone and Joint Injury*, and the type was fresh simple fracture; (2) All patients had under-gone open reduction and internal fixation (ORIF) with steel plate; (3) Patients aged between 18-60 years; (4) Patients had voluntarily signed informed consent.	Describe intervention (treatment/procedure/test): The rehabilitative trainings for joint activity, muscle strength and proprioception were the same as those conducted by the control group. While starting from the 4th week postoperatively, these patients received partial weight bearing training as well. The patients held the parallel rod with both hands and put the mass measuring instrument under feet to experience the loading weight they can tolerate. The patient's initial loading weight was 25% of his body mass, which ranged from 10 to 20 kg, and then increased progressively. The patients looked straight and walked with crutches in a three-point manner and started to stand or walk with full weight 13 weeks after surgery.	Describe control (treatment/procedure/test): 1) the patient raised the injured foot and began to perform passive toe movements 24 hours after surgery. The exercise was required to perform in maximum range, 3-5 times/group and 6 groups a day. (2) In the 3rd to 6th week after the operation, the patients continued the above exercises and conducted gentle active and passive ex-ercises of ankle and subtalar joints. The patients were asked to extend their back or plantar flexion as long as they can tolerate, and maintained for 20 seconds. The exercise was set by 3 to 5 times/group, and 6 groups per day. (3) The patients continued to expand the range of motion in ankle joint for 2-7 weeks postoperation. They	Length of follow-up: 24 weeks Loss-to-follow-up: not reported / unclear Incomplete outcome data: not reported / unclear Intervention:	Outcome measures and effect size (include 95%CI and p-value if available): Maryland foot function **Intervention** Before: 14.28 ± 3.11, p=0.638 6 weeks: 41.26 ± 5.49*, p<0.001 12 weeks: 61.73 ± 8.11*, p<0.001 24 weeks: 89.74 ± 10.23*, p<0.001 *Statistically significant (P<0.05) compared with the same group before treatment **Control** Before: 13.97 ± 2.98, p=0.638 6 weeks: 36.58 ± 4.85*, p<0.001 12 weeks: 53.03 ± 7.52*, p<0.001 24 weeks: 81.29 ± 9.52*, p<0.001	Conclusion authors: the early partial weight bearing rehabilitative exercise can effectively promote the postoperative functional recovery of patients with Sander IV calcaneal fractures, and at the same time has no impact on internal fixa-tion and calcaneus shape of patients. Remarks: Loss to follow-up and incomplete outcome data not reported.

		Exclusion criteria: (1) Patients with Sanders I, II, III calcaneal fractures; (2) Patients with injuries of vital nerves, blood vessels or ligaments; (3) Patients with immune system diseases, endocrine system diseases, etc.; (4) Patients with dysfunctions of heart, brain, liver or kidney; or (5) Patients with mental disorders. N total at baseline: 86 Intervention: 44 Control: 42 Important prognostic factors[2]: *For example age ± SD:*		underwent joint mobilization of subtalar joint, calcaneocubic joint, and talar navicular joint, and passively moved the subtalar joint to gradually restore the range of motion for the three joints. Meanwhile, we adopted the unarmed resistant technique to perform isometric exercises on patients' posterior tibial muscle, tibial anterior muscle, and tibial long brevis muscle to strengthen the patients' muscles strength around their ankle joints. (4) According to fracture degree, the patients performed the partial weight bearing standing or walking in the 13th to 24th weeks after surgery, and gradually increased the exercise intensity to full weight bearing. The proprioceptive training of patients was carried out by shaking board, so that the patients' proprioceptive system of ankle and foot can be recovered; For gait training, it started by shifting the center of gravity left/right and front/back between the legs; For walking practice, the patients were required to reach the equal support of both feet and same		*Statistically significant (P<0.05) compared with the same group before treatment AOFAS (points +/-SD) **Intervention** Before: 10.25 ± 2.17, p=0.17 6 weeks: 37.69 ± 5.47, p<0.001 12 weeks: 57.84 ± 8.95, p<0.001 24 weeks: 83.42 ± 8.54, p<0.001 **Control** Before: 10.96 ± 2.58, p=0.17 6 weeks: 33.21 ± 4.36, p<0.001 12 weeks: 51.06 ± 6.08, p<0.001 24 weeks: 76.42 ± 7.03, p<0.001	

		I: 39.19 ± 7.30y *C: 38.75±8.33y* *Sex:* *I: 56.8% M* *C: 52.4% M* *BMI:* *I: 23.27 ± 3.10 kg/m²* *C: 23.49 ±2.71 kg/m²* Groups comparable at baseline? Yes		extent in swing phase, until the normal walking gait can be restored.			

Risk of bias table for intervention studies (randomized controlled trials; based on Cochrane risk of bias tool and suggestions by the CLARITY Group at McMaster University)

Study reference (first author, publication year)	**Was the allocation sequence adequately generated?** Definitely yes Probably yes Probably no Definitely no	**Was the allocation adequately concealed?** Definitely yes Probably yes Probably no Definitely no	**Blinding: Was knowledge of the allocated interventions adequately prevented?** - **Were patients blinded?** - **Were healthcare providers blinded?** - **Were data collectors blinded?** - **Were outcome assessors blinded?** - **Were data analysts blinded?** Definitely yes Probably yes Probably no Definitely no	**Was loss to follow-up (missing outcome data) infrequent?** Definitely yes Probably yes Probably no Definitely no	**Are reports of the study free of selective outcome reporting?** Definitely yes Probably yes Probably no Definitely no	**Was the study apparently free of other problems that could put it at a risk of bias?** Definitely yes Probably yes Probably no Definitely no	**Overall risk of bias** **If applicable/necessary, per outcome measure** **LOW** **Some concerns** **HIGH**

Li, 2021	No information	No information	Definitely no; *Reason:* due to the nature of the intervention, blinding of patients and healthcare providers is not possible. Not clear if outcome assessors were blinded	Probably yes; *Reason:* No information on loss to follow-up described. Seemingly no loss to follow-up.	Definitely no; *Reason*: protocol registered after study end. Follow-up time of 1 year is noted. No secondary outcomes described in protocol.	Probably yes *Reason:* no other sources of bias could be identified	**Some concerns** - Unclear randomization and allocation concealment - No blinding (observer bias), might have influenced AOFAS (patient reported)

Table of excluded studies

Reference	Reason for exclusion
De Boer AS, Van Lieshout EMM, Van Moolenbroek G, Den Hartog D, Verhofstad MHJ. The effect of time to post-operative weight bearing on functional and clinical outcomes in adults with a displaced intra-articular calcaneal fracture; A systematic review and pooled analysis. Injury. 2018 Apr;49(4):743-752. doi: 10.1016/j.injury.2018.02.021. Epub 2018 Feb 21. PMID: 29496317.	Low quality systematic review: not clear from which studies the data was retrieved. Also observational studies included.
Song M, Li S, Yang S, Dong Q, Lu M. Is Early or Delayed Weightbearing the Better Choice After Microfracture for Osteochondral Lesions of the Talus? A Meta-analysis and Systematic Review. J Foot Ankle Surg. 2021 Nov-Dec;60(6):1232-1240. doi: 10.1053/j.jfas.2021.04.022. Epub 2021 May 10. PMID: 34215515.	Wrong population: patients with osteochondral lesions of the talus
Ter Laak Bolk CS, Dahmen J, Lambers KTA, Blankevoort L, Kerkhoffs GMMJ. Adequate return to sports and sports activities after treatment of Lisfranc injury: a meta-analysis. J ISAKOS. 2021 Jul;6(4):212-219. doi: 10.1136/jisakos-2020-000477. Epub 2020 Dec 10. PMID: 34272297.	Wrong intervention: conservative treatment, surgical fixation and primary arthrodesis
Lee DH, Lee KB, Jung ST, Seon JK, Kim MS, Sung IH. Comparison of early versus delayed weight bearing outcomes after microfracture for small to midsized osteochondral lesions of the talus. Am J Sports Med. 2012 Sep;40(9):2023-8. doi: 10.1177/0363546512455316. Epub 2012 Aug 9. Erratum in: Am J Sports Med. 2012 Oct;40(10):NP28. PMID: 22879399.	Wrong population: patients with osteochondral lesions of the talus
Kagami Y, Tokutake K, Takegami Y, Okui N, Sakai T, Inoue H, Kanemura T, Hanabayashi M, Ito O, Kanayama Y, Maruyama K, Yoshida H, Ando T, Sugimoto R, Sugimoto T, Imagama S. Do heel-unloading orthoses improve clinical outcomes in patients after surgical treatment of calcaneal fracture? A propensity-matched, multicenter analysis of the TRON database. Prosthet Orthot Int. 2022 Dec 1;46(6):569-575. doi: 10.1097/PXR.0000000000000168. Epub 2022 Jul 1. PMID: 36515902.	Wrong intervention: graffin orthrosis versus splint or cast
Yoo CH, Kang C, Hwang DS, Hwang JM, Lee GS, Park YC. Radiological and Clinical Effectiveness of a Novel Calcaneal Fracture Brace after Intra-articular Calcaneal Fracture Surgery. Clin Orthop Surg. 2018 Sep;10(3):374-379. doi: 10.4055/cios.2018.10.3.374. Epub 2018 Aug 22. PMID: 30174815; PMCID: PMC6107817.	Wrong intervention: study on novel calcaneal fracture brace
Chen W, Liu B, Lv H, Su Y, Chen X, Zhu Y, Du C, Zhang X, Zhang Y. Radiological study of the secondary reduction effect of early functional exercise on displaced intra-articular calcaneal fractures after internal compression fixation. Int Orthop. 2017 Sep;41(9):1953-1961. doi: 10.1007/s00264-017-3533-z. Epub 2017 Jun 28. PMID: 28660328.	Wrong study design observational study

Literature search strategy

Cluster/richtlijn: NVvH Traumatisch Complexe voetletsels	
Uitgangsvraag/modules: Wat is de plaats van gipsimmobilisatie bij de nabehandeling van traumatisch complexe voetletsels?	
Database(s): Embase.com, Ovid/Medline	Datum: 5 juni 2023
Periode: geen restrictie	Talen: geen restrictie
Literatuurspecialist: Alies van der Wal	Rayyan review: https://rayyan.ai/reviews/688862
BMI-zoekblokken: voor verschillende opdrachten wordt (deels) gebruik gemaakt van de zoekblokken van BMI-Online https://blocks.bmi-online.nl/ Bij gebruikmaking van een volledig zoekblok zal naar de betreffende link op de website worden verwezen.	
Toelichting: Voor deze vraag is gezocht op de elementen: - chirurgie traumatisch complex voetletsel - (gips)immobilisatie/ belasting	

5

Zoekopbrengst

	EMBASE	OVID/MEDLINE	Ontdubbeld

SR	41	26	48
RCT	128	61	139
Observationele studies	511	471	655
Overig	888	525	1064
Totaal	680	558	**842***

in Rayyan

Embase.com

No.	Query	Results
#12	#4 NOT (#9 OR #10 OR #11) = overig	888
#11	#4 AND (#7 OR #8) NOT (#9 OR #10) = observationeel	511
#10	#4 AND #6 NOT #9 = RCT	128
#9	#4 AND #5 = SR	41
#8	'case control study'/de OR 'comparative study'/exp OR 'control group'/de OR 'controlled study'/de OR 'controlled clinical trial'/de OR 'crossover procedure'/de OR 'double blind procedure'/de OR 'phase 2 clinical trial'/de OR 'phase 3 clinical trial'/de OR 'phase 4 clinical trial'/de OR 'pretest posttest design'/de OR 'pretest posttest control group design'/de OR 'quasi experimental study'/de OR 'single blind procedure'/de OR 'triple blind procedure'/de OR (((control OR controlled) NEAR/6 trial):ti,ab,kw) OR (((control OR controlled) NEAR/6 (study OR studies)):ti,ab,kw) OR (((control OR controlled) NEAR/1 active):ti,ab,kw) OR 'open label*':ti,ab,kw OR (((double OR two OR three OR multi OR trial) NEAR/1 (arm OR arms)):ti,ab,kw) OR ((allocat* NEAR/10 (arm OR arms)):ti,ab,kw) OR placebo*:ti,ab,kw OR 'sham-control*':ti,ab,kw OR (((single OR double OR triple OR assessor) NEAR/1 (blind* OR masked)):ti,ab,kw) OR nonrandom*:ti,ab,kw OR 'non-random*':ti,ab,kw OR 'quasi-experiment*':ti,ab,kw OR crossover:ti,ab,kw OR 'cross over':ti,ab,kw OR 'parallel group*':ti,ab,kw OR 'factorial trial':ti,ab,kw OR ((phase NEAR/5 (study OR trial)):ti,ab,kw) OR ((case* NEAR/6 (matched OR control*)):ti,ab,kw) OR ((match* NEAR/6 (pair OR pairs OR cohort* OR control* OR group* OR healthy OR age OR sex OR gender OR patient* OR subject* OR participant*)):ti,ab,kw) OR ((propensity NEAR/6 (scor* OR match*)):ti,ab,kw) OR versus:ti OR vs:ti OR compar*:ti OR ((compar* NEAR/1 study):ti,ab,kw) OR (('major clinical study'/de OR 'clinical study'/de OR 'cohort analysis'/de OR 'observational study'/de OR 'cross-sectional study'/de OR 'multicenter study'/de OR 'correlational study'/de OR 'follow up'/de OR cohort*:ti,ab,kw OR 'follow up':ti,ab,kw OR followup:ti,ab,kw OR longitudinal*:ti,ab,kw OR prospective*:ti,ab,kw OR retrospective*:ti,ab,kw OR observational*:ti,ab,kw OR 'cross sectional*':ti,ab,kw OR cross?ectional*:ti,ab,kw OR multicent*:ti,ab,kw OR 'multi-cent*':ti,ab,kw OR consecutive*:ti,ab,kw) AND (group:ti,ab,kw OR groups:ti,ab,kw OR subgroup*:ti,ab,kw OR versus:ti,ab,kw OR vs:ti,ab,kw OR compar*:ti,ab,kw OR 'odds ratio*':ab OR 'relative odds':ab OR 'risk ratio*':ab OR 'relative risk*':ab OR 'rate ratio':ab OR aor:ab OR arr:ab OR rrr:ab OR ((('or' OR 'rr') NEAR/6 ci):ab)))	14138616
#7	'major clinical study'/de OR 'clinical study'/de OR 'case control study'/de OR 'family study'/de OR 'longitudinal study'/de OR 'retrospective study'/de OR 'prospective study'/de OR 'comparative study'/de OR 'cohort analysis'/de OR ((cohort NEAR/1 (study OR studies)):ab,ti) OR (('case control' NEAR/1 (study OR studies)):ab,ti) OR (('follow up' NEAR/1 (study OR studies)):ab,ti) OR (observational NEAR/1 (study OR studies)) OR ((epidemiologic NEAR/1 (study OR studies)):ab,ti) OR (('cross sectional' NEAR/1 (study OR studies)):ab,ti)	6767914
#6	'clinical trial'/exp OR 'randomization'/exp OR 'single blind procedure'/exp OR 'double blind procedure'/exp OR 'crossover procedure'/exp OR 'placebo'/exp OR 'prospective study'/exp	3302394

	OR rct:ab,ti OR random*:ab,ti OR 'single blind':ab,ti OR 'randomised controlled trial':ab,ti OR 'randomized controlled trial'/exp OR placebo*:ab,ti	
#5	'meta analysis'/exp OR 'meta analysis (topic)'/exp OR metaanaly*:ti,ab OR 'meta analy*':ti,ab OR metanaly*:ti,ab OR 'systematic review'/de OR 'cochrane database of systematic reviews'/jt OR prisma:ti,ab OR prospero:ti,ab OR (((systemati* OR scoping OR umbrella OR 'structured literature') NEAR/3 (review* OR overview*)):ti,ab) OR ((systemic* NEAR/1 review*):ti,ab) OR (((systemati* OR literature OR database* OR 'data base*') NEAR/10 search*):ti,ab) OR (((structured OR comprehensive* OR systemic*) NEAR/3 search*):ti,ab) OR (((literature NEAR/3 review*):ti,ab) AND (search*:ti,ab OR database*:ti,ab OR 'data base*':ti,ab)) OR (('data extraction':ti,ab OR 'data source*':ti,ab) AND 'study selection':ti,ab) OR ('search strategy':ti,ab AND 'selection criteria':ti,ab) OR ('data source*':ti,ab AND 'data synthesis':ti,ab) OR medline:ab OR pubmed:ab OR embase:ab OR cochrane:ab OR (((critical OR rapid) NEAR/2 (review* OR overview* OR synthes*)):ti) OR ((((critical* OR rapid*) NEAR/3 (review* OR overview* OR synthes*)):ab) AND (search*:ab OR database*:ab OR 'data base*':ab)) OR metasynthes*:ti,ab OR 'meta synthes*':ti,ab	733409
#4	#3 NOT ('conference abstract'/it OR 'editorial'/it OR 'letter'/it OR 'note'/it) NOT (('animal'/exp OR 'animal experiment'/exp OR 'animal model'/exp OR 'nonhuman'/exp) NOT 'human'/exp)	1978
#3	#1 AND #2	2139
#2	'orthopedic cast'/exp OR 'casting'/exp OR 'cast'/exp OR 'immobilization'/exp/mj OR 'mobilization'/exp/mj OR immobilisat*:ti,ab,kw OR immobilizat*:ti,ab,kw OR mobilisat*:ti,ab,kw OR mobilizat*:ti,ab,kw OR cast*:ti,ab,kw OR plaster*:ti,ab,kw OR splint*:ti,ab,kw OR brac*:ti,ab,kw OR ((walk* NEAR/3 boot*):ti,ab,kw) OR 'weight bearing'/exp/mj OR (((weight OR nonweight OR fullweight OR partialweight) NEAR/3 bear*):ti,ab,kw) OR 'weightbear*':ti,ab,kw OR 'nonweightbear*':ti,ab,kw OR 'fullweightbear*':ti,ab,kw OR 'partialweightbear*':ti,ab,kw OR (((postoperative OR 'post operative') NEAR/3 (exercis* OR ambulation)):ti,ab,kw) OR ((earl* NEAR/3 (exercis* OR rehabilitat* OR ambulation)):ti,ab,kw)	552552
#1	('surgery'/exp OR surger*:ti,ab,kw OR surgical*:ti,ab,kw OR operation*:ti,ab,kw OR operative*:ti,ab,kw OR 'mini invasive':ti,ab,kw OR 'minimally invasive':ti,ab,kw OR 'minimal invasive':ti,ab,kw OR mipo:ti,ab,kw OR 'orthopedic implant'/exp OR fixat*:ti,ab,kw OR transfixat*:ti,ab,kw OR screw*:ti,ab,kw OR plate:ti,ab,kw OR plates:ti,ab,kw OR plating:ti,ab,kw OR bridg*:ti,ab,kw OR pin:ti,ab,kw OR pins:ti,ab,kw OR nail*:ti,ab,kw OR wire*:ti,ab,kw OR kirschner:ti,ab,kw OR 'arthrodes*':ti,ab,kw OR arthroscop*:ti,ab,kw OR fusion:ti,ab,kw OR 'osteo synthes*':ti,ab,kw OR 'osteosynthes*':ti,ab,kw OR reduction:ti,ab,kw OR orif:ti,ab,kw OR 'reconstruct*':ti,ab,kw OR 'ligamentoplast*':ti,ab,kw OR grice:ti,ab,kw OR palmer:ti,ab,kw OR zadravecz:ti,ab,kw OR forgon:ti,ab,kw) AND ('Lisfranc fracture'/exp OR Lisfranc:ti,ab,kw OR (((forefoot OR 'fore foot' OR midfoot OR 'mid foot' OR tarsometatarsal) NEAR/3 (fractur* OR broken OR injur* OR trauma OR dislocat* OR displac*)):ti,ab,kw) OR (('forefoot'/exp OR 'tarsometatarsal joint'/exp) AND ('fracture'/exp OR 'dislocation'/exp OR 'bone injury'/exp OR 'injury'/exp)) OR 'Chopart joint'/exp OR 'navicular bone'/exp OR 'navicular bone fracture'/exp OR 'navicular fracture'/exp OR 'cuboid bone'/exp OR 'cuboid fracture'/exp OR (((Chopart* OR 'transverse tarsal' OR navicular* OR talonavicular* OR cuboid* OR calcaneocuboid*) NEAR/5 (fractur* OR broken OR dislocat* OR displac* OR trauma* OR injur*)):ti,ab,kw) OR 'calcaneus fracture'/exp OR diacf:ti,ab,kw OR iacf:ti,ab,kw OR 'tongue type':ti,ab,kw OR sanders*:ti,ab,kw OR ('calcaneus'/exp AND ('fracture'/exp OR 'dislocation'/exp OR 'bone injury'/exp)) OR (((calcan* OR hindfoot OR 'hind foot' OR heel* OR 'os calcis') NEAR/3 (fractur* OR broken OR dislocat* OR displac*)):ti,ab,kw) OR 'talus fracture'/exp OR (((talar OR talus OR subtalar* OR 'os talare' OR astralagus) NEAR/3 (fractur* OR broken OR dislocat* OR displac* OR trauma* OR injur*)):ti,ab,kw) OR (((talar OR talus) NEAR/3 (neck OR body OR central) NEAR/3 (fractur* OR broken OR dislocat* OR displac* OR luxat* OR trauma* OR injur*)):ti,ab,kw) OR ('talus'/exp AND ('fracture'/exp OR 'dislocation'/exp OR 'bone injury'/exp OR 'injury'/exp)))	10056

Ovid/Medline

#	Searches	Results
12	4 not (9 or 10 or 11) = overig	525
11	(4 and (7 or 8)) not (9 or 10) = observationeel	471
10	(4 and 6) not 9 = RCT	61
9	4 and 5 = SR	26
8	Case-control Studies/ or clinical trial, phase ii/ or clinical trial, phase iii/ or clinical trial, phase iv/ or comparative study/ or control groups/ or controlled before-after studies/ or controlled clinical trial/ or double-blind method/ or historically controlled study/ or matched-pair analysis/ or single-blind method/ or (((control or controlled) adj6 (study or studies or trial)) or (compar* adj (study or studies)) or ((control or controlled) adj1 active) or "open label*" or ((double or two or three or multi or trial) adj (arm or arms)) or (allocat* adj10 (arm or arms)) or placebo* or "sham-control*" or ((single or double or triple or assessor) adj1 (blind* or masked)) or nonrandom* or "non-random*" or "quasi-experiment*" or "parallel group*" or "factorial trial" or "pretest posttest" or (phase adj5 (study or trial)) or (case* adj6 (matched or control*)) or (match* adj6 (pair or pairs or cohort* or control* or group* or healthy or age or sex or gender or patient* or subject* or participant*)) or (propensity adj6 (scor* or match*))).ti,ab,kf. or (confounding adj6 adjust*).ti,ab. or (versus or vs or compar*).ti. or ((exp cohort studies/ or epidemiologic studies/ or multicenter study/ or observational study/ or seroepidemiologic studies/ or (cohort* or 'follow up' or followup or longitudinal* or prospective* or retrospective* or observational* or multicent* or 'multi-cent*' or consecutive*).ti,ab,kf.) and ((group or groups or subgroup* or versus or vs or compar*).ti,ab,kf. or ('odds ratio*' or 'relative odds' or 'risk ratio*' or 'relative risk*' or aor or arr or rrr).ab. or (("OR" or "RR") adj6 CI).ab.))	5436642
7	Epidemiologic studies/ or case control studies/ or exp cohort studies/ or Controlled Before-After Studies/ or Case control.tw. or cohort.tw. or Cohort analy$.tw. or (Follow up adj (study or studies)).tw. or (observational adj (study or studies)).tw. or Longitudinal.tw. or Retrospective*.tw. or prospective*.tw. or consecutive*.tw. or Cross sectional.tw. or Cross-sectional studies/ or historically controlled study/ or interrupted time series analysis/ [Onder exp cohort studies vallen ook longitudinale, prospectieve en retrospectieve studies]	4452022
6	exp clinical trial/ or randomized controlled trial/ or exp clinical trials as topic/ or randomized controlled trials as topic/ or Random Allocation/ or Double-Blind Method/ or Single-Blind Method/ or (clinical trial, phase i or clinical trial, phase ii or clinical trial, phase iii or clinical trial, phase iv or controlled clinical trial or randomized controlled trial or multicenter study or clinical trial).pt. or random*.ti,ab. or (clinic* adj trial*).tw. or ((singl* or doubl* or treb* or tripl*) adj (blind$3 or mask$3)).tw. or Placebos/ or placebo*.tw.	2594592
5	meta-analysis/ or meta-analysis as topic/ or (metaanaly* or meta-analy* or metanaly*).ti,ab,kf. or systematic review/ or cochrane.jw. or (prisma or prospero).ti,ab,kf. or ((systemati* or scoping or umbrella or "structured literature") adj3 (review* or overview*)).ti,ab,kf. or (systemic* adj1 review*).ti,ab,kf. or ((systemati* or literature or database* or data-base*) adj10 search*).ti,ab,kf. or ((structured or comprehensive* or systemic*) adj3 search*).ti,ab,kf. or ((literature adj3 review*) and (search* or database* or data-base*)).ti,ab,kf. or (("data extraction" or "data source*") and "study selection").ti,ab,kf. or ("search strategy" and "selection criteria").ti,ab,kf. or ("data source*" and "data synthesis").ti,ab,kf. or (medline or pubmed or embase or cochrane).ab. or ((critical or rapid) adj2 (review* or overview* or synthes*)).ti. or (((critical* or rapid*) adj3 (review* or overview* or synthes*)) and (search* or database* or data-base*)).ab. or (metasynthes* or meta-synthes*).ti,ab,kf.	671830
4	3 not (comment/ or editorial/ or letter/) not ((exp animals/ or exp models, animal/) not humans/)	1083
3	1 and 2	1108
2	exp Casts, Surgical/ or exp Braces/ or exp Splints/ or Immobilization/ or exp Early Ambulation/ or immobilisat*.ti,ab,kf. or immobilizat*.ti,ab,kf. or mobilisat*.ti,ab,kf. or mobilizat*.ti,ab,kf. or cast*.ti,ab,kf. or plaster*.ti,ab,kf. or splint*.ti,ab,kf. or brac*.ti,ab,kf. or (walk* adj3	443447

	boot*).ti,ab,kf. or exp Weight-Bearing/ or ((weight or nonweight or fullweight or partialweight) adj3 bear*).ti,ab,kf. or 'weightbear*'.ti,ab,kf. or 'nonweightbear*'.ti,ab,kf. or 'fullweightbear*'.ti,ab,kf. or 'partialweightbear*'.ti,ab,kf. or ((postoperative or 'post operative') adj3 (exercis* or ambulation)).ti,ab,kf. or (earl* adj3 (exercis* or rehabilitat* or ambulation)).ti,ab,kf.	
1	(Surgical Procedures, Operative/ or exp General Surgery/ or exp Orthopedics/ or exp "Prostheses and Implants"/ or surger*.ti,ab,kf. or surgical*.ti,ab,kf. or operation*.ti,ab,kf. or operative*.ti,ab,kf. or 'mini invasive'.ti,ab,kf. or 'minimally invasive'.ti,ab,kf. or 'minimal invasive'.ti,ab,kf. or mipo.ti,ab,kf. or fixat*.ti,ab,kf. or transfixat*.ti,ab,kf. or screw*.ti,ab,kf. or plate.ti,ab,kf. or plates.ti,ab,kf. or plating.ti,ab,kf. or bridg*.ti,ab,kf. or pin.ti,ab,kf. or pins.ti,ab,kf. or nail*.ti,ab,kf. or wire*.ti,ab,kf. or kirschner.ti,ab,kf. or 'arthrodes*'.ti,ab,kf. or arthroscop*.ti,ab,kf. or fusion.ti,ab,kf. or 'osteo synthes*'.ti,ab,kf. or 'osteosynthes*'.ti,ab,kf. or reduction.ti,ab,kf. or orif.ti,ab,kf. or 'reconstruct*'.ti,ab,kf. or 'ligamentoplast*'.ti,ab,kf. or grice.ti,ab,kf. or palmer.ti,ab,kf. or zadravecz.ti,ab,kf. or forgon.ti,ab,kf.) and ((Lisfranc or ((forefoot or 'fore foot' or midfoot or 'mid foot' or tarsometatarsal) adj3 (fractur* or broken or injur* or trauma or dislocat* or displac*))).ti,ab,kf. or (exp Forefoot, Human/ and (exp Fractures, Bone/ or exp Fracture Dislocation/)) or ((Chopart* or 'transverse tarsal' or navicular* or talonavicular* or cuboid* or calcaneocuboid*) adj5 (fractur* or broken or dislocat* or displac* or trauma* or injur*)).ti,ab,kf. or (diacf or iacf or 'tongue type' or sanders*).ti,ab,kf. or (exp Calcaneus/ and (exp Fractures, Bone/ or exp Fracture Dislocation/)) or ((calcan* or hindfoot or 'hind foot' or heel* or 'os calcis') adj3 (fractur* or broken or dislocat* or displac*)).ti,ab,kf. or (((talar or talus or subtalar* or 'os talare' or astralagus) adj3 (fractur* or broken or dislocat* or displac* or trauma* or injur*)) or ((talar or talus) adj3 (neck or body or central) adj3 (fractur* or broken or dislocat* or displac* or luxat* or trauma* or injur*))).ti,ab,kf. or (exp Talus/ and (exp Fractures, Bone/ or exp "Wounds and Injuries"/)))	5635

Module 7 Organisatie van zorg

Uitgangsvraag

Hoe zou de zorg voor patiënten met traumatisch complex voetletsel georganiseerd moeten worden?

Inleiding

Traumatisch complex voetletsel is een verzamelterm voor diverse letsels waarbij verschillende behandelmogelijkheden per type letsel zijn. Hierdoor is behandeling van complex voetletsel niet uniform. Landelijk bestaat een grote variatie in behandeling. De afzonderlijke modules over behandeling geven richting aan de optimale behandeling van deze typen letsels. Desalniettemin, is het letsel zo divers dat het moeilijk is om voldoende (behandel)ervaring op te doen. De vraag is of met name de ervaring van de chirurg, en wellicht het behandelvolume in een centrum van invloed is op het behandelsucces bij traumatisch complex voetletsel.

Search and select

A systematic review of the literature was performed to answer the following question: What is the association of surgeon and/or hospital volume with outcomes related to surgical procedures in patients with an acute traumatic foot injury?

P = Patients with an acute traumatic foot injury (talus, calcaneus, Chopart or Lisfranc injury) with indication for surgery.
I = Low surgeon/hospital volume.
C = High surgeon/hospital volume.
O = complications, functional outcomes (AOFAS midfoot, LEFS, PROMIS), arthrodesis rate.

<u>Relevant outcome measures</u>

The guideline development group considered surgical site infections and functional outcomes as critical outcomes for decision making; and the arthrodesis rate as an important outcome for decision making.

The working group defined a threshold of 10% for continuous outcomes and a relative risk (RR) or odds ratio (OR) for dichotomous outcomes of <0.80 and >1.25 as a minimal clinically (patient) important difference.

<u>Search and select (Methods)</u>

The databases Medline (via OVID) and Embase (via Embase.com) were searched with relevant search terms until the 9th of October 2023. The detailed search strategy is depicted under the tab Methods. The systematic literature search resulted in 308 hits. Studies were selected based on the following criteria: systematic reviews, randomized controlled trials, and observational studies on surgeon/hospital case volume and traumatic foot injuries in which a multivariate analysis to adjust for important covariates was described. The search did not result in randomized controlled trials comparing low volume with high volume surgery. Therefore, the working group decided to include multivariate cohort studies to investigate the association between volume and outcomes related to surgical procedures.
Nine studies were initially selected based on title and abstract screening. After reading the full text, five studies were excluded (see the table with reasons for exclusion under the tab Methods) and four studies were included.

<u>Results</u>

Four studies were included in the analysis of the literature. These studies investigated the association between surgeon / hospital volume and outcome / complications and used a multivariate analysis to adjust for important covariates. Studies that did determine univariate associations were described in

the evidence to decision framework. Important study characteristics and results are summarized in the evidence tables. The assessment of the risk of bias is summarized in the risk of bias tables.

Summary of literature

Description of studies

Systematic review(s)

The systematic review of **Poeze (2008)** investigated whether a relationship exists between fracture load and the rates of serious infection and subtalar arthrodesis following the treatment of displaced intra-articular calcaneal fractures. Fracture load was calculated by dividing the number of calcaneal fractures that were treated operatively by the inclusion time of the reported studies in months for each institution. For the uniformity of this guideline, the term fracture load is replaced by volume. Poeze (2008) searched Medline and Embase databases between 2000 to 2006, searched personal files and communications to find additional citations to search for recently published studies, and searched reference lists of the articles found with use of the above-mentioned methods for additional articles. Studies describing adult patients (defined as those with an age of at least eighteen years) who were managed with open reduction and internal fixation through a lateral approach for the treatment of a unilateral or bilateral fracture were included. Patients with open fractures and patients who were managed with percutaneous and/or external fixation procedures were excluded. Studies that included a subgroup of patients from other studies, those in which more than 30% of the patients had been lost to follow-up, and those in which primary parameters (inclusion time and the rates of deep infection and arthrodesis) were also excluded. Twenty-one observational studies were included in the final analysis, of which five with a prospective- and sixteen with a retrospective design (Aktuglu, 2002; Al-Mudhaffar, 2000; Asik, 2002; Assous, 2001; Benirschke, 2004; Bibbo, 2006; Buckley, 2003; Elsner, 2005; Geel, 2001; Harvey, 2001; Herscovici, 2005; Huang, 2002; Koski, 2005; Naovaratanophas, 2001; Sarkar, 2002; Schildhauer, 2000; Shuler, 2001; Tennent, 2001; Westpal, 2004; Wiley, 2005; Zmurko, 2002). The total number of fractures included in the studies was 1656. Fracture load was defined as the number of open reduction and internal fixation procedures per month. Nine of the 21 studies included in Poeze (2008) had an institutional fracture load of more than one open reduction and internal fixation procedure per month. Twelve of the 21 studies included in Poeze (2008) had an individual fracture load of less than one open reduction and internal fixation procedure per month. Poeze (2008) performed a multiple regression analysis to investigate the association between institutional volume and deep infections, adjusted for time to surgery, time of surgery, percentage of patients with Sander type-IV fractures, percentage of patients with bilateral fractures, percentage of patients with diabetes, percentage of patients who smoke, and the postoperative Bohler angle.

The retrospective study of **Stewart (2019)** investigated whether increased surgeon and hospital volume is associated with lower rates of complications after tarsal fractures. Volume was calculated as the total number of tarsal fracture fixations performed during the year of index operation, including those procedures excluded from the cohort. The study included patients who underwent open reduction and internal fixation, closed reduction and internal fixation, or primary arthrodesis of tarsal fractures. Stewart (2019) used data from several state inpatient databases of the Health Cost and Utilization Project maintained by the Agency for Healthcare Research and Quality. These databases contain nearly all discharges from a participating state, regardless of payer and all information is deidentified. Stewart (2019) selected Florida (2005 through 2014) and New York (2006 through 2010) databases. In total, 4132 tarsal fractures that underwent fixation by 1223 surgeons at 299 hospitals were included. The mean (SD) age was 44 (15) years. The mean (SD) surgeon volume per year was 3.8 (5.1). The mean (SD) hospital volume was 7.9 (12.0). Stewart reported the association between complications (amputation, infection, wound dehiscence, avascular necrosis, nonunion, malunion) and surgeon volume (per five procedures) and hospital volume (per five procedures), adjusted for patient-level factors, comorbidities, and injury characteristics including

age, sex, race, insurance status, geographic income quartile, Charlson comorbidities, and open fracture.

The retrospective study of **Qin (2022)** investigated the relationship between surgeon volume and the risk of deep surgical site infections. Qin (2022) included patients aged eighteen years and older who underwent open reduction and internal fixation of acute calcaneal fractures. The study was a single-centre, retrospective secondary analysis of data extracted from a prospected maintained and updated database of Surgical Site Infection in Orthopaedic Surgery in the Third Hospital of Hebei Medical University, a 2000-bed tertiary and teaching hospital. The database was initiated on the 1st of October 2014. In total, 883 patients with a discharge diagnosis of calcaneal fracture were included. The mean (SD) case volume for one surgeon in a calendar year was 16.3 (10.5) years. Qin (2022) reported the association of surgeon volume with postoperative deep surgical site infections, adjusted for the surgeon volume category (the surgeons were dichotomized into high-volume (≥6 per year) or low-volume (<6 per year) categories), gender, and age.

The retrospective study of **Yin (2022)** investigated the relationship between surgeon volume and the risk of overall complications following open reduction and internal fixation to treat displaced, intra-articular calcaneal fractures. Yin (2022) included patients from a single-institution, aged eighteen years and older who presented with acute displaced intra-articular calcaneal fractures and underwent surgery and had complete one-year follow-up. In total, 585 patients were included in the final analysis. The median (IQR) case volume was 15 (1 to 40). Yin (2022) reported the association between volume and the risk of complications, adjusted for age, gender, living place, occupation, lifestyles, BMI, comorbidities, medical history, injury- and surgery-related variables, and laboratory indexes on admission.

Results

1. Complications

1.1. Surgeon volume

The association between surgeon volume and complications was reported in three studies (Stewart, 2019; Qin, 2022; Yin, 2022). However, In the study of Poeze (2008) this association was not adjusted for confounding covariates. Therefore, we only presented the results on institutional volume with multivariate models (see 1.2 hospital volume).

Stewart (2019) performed a multiple logistic regression analysis and reported the association between complications and surgeon volume (per five procedures), adjusted for patient-level factors, comorbidities, and injury characteristics including age, sex, race, insurance status, geographic income quartile, Charlson comorbidities, and open fractures. Volume was calculated as the total number of tarsal fracture fixations performed during the year of index operation.
The odds-ratio for the association of surgeon volume (per five procedures) and complications, adjusted for all aforementioned confounders, was 0.91 (95% CI 0.82 to 0.99). This means that for every five procedures, the odds for the risk of complications decreases by 0.91. Infection and wound dehiscence were the most common complications, with the majority occurring within the first 90 days.

Qin (2022) performed a multivariate logistic regression analysis and reported the association between surgeon volume (less than six open reductions and internal fixation procedures per month) and deep surgical site infections, adjusted for the residence place, diabetes mellitus, incision level, injury mechanism, age, sex, and bone grafting.
The odds-ratio for the association of surgeon volume and deep surgical site infections, adjusted for all aforementioned confounders, was 5.8 (95% CI 2.1 to 15.7). This means that a surgeon volume of

less than six open reduction and internal fixation procedures per months increases the odds for deep surgical infections by 5.8.

Yin (2022) constructed four multivariate logistic regression models to investigate the relationship between surgeon volume and the risk of overall complications. The optimal cut-off value for surgeon volume was five procedures in the past twelve months.
Model 1 was adjusted for age, gender, living place, and occupation. Model 2 was additionally adjusted for lifestyles, BMI, comorbidities, and medical history. Model 3 was additionally adjusted for injury- and surgery-related variables. Model 4, the full adjusted model, further adjusted for laboratory indexes on admission. For the purpose of this guideline, only the fully adjusted model (model 4) was used since this model was the most inclusive and fully adjusted for confounding covariates.

Fully adjusted model (model 4)
The odds-ratio for the association of low surgeon -volume and complications for the fully adjusted model (model 4), adjusted for age, gender, living place, and occupation, lifestyles, BMI, comorbidities, medical history, injury- and surgery-related variables, and laboratory indexes on admission, was 4.4 (95% CI 2.2 to 8.8). This means that low-surgeon volume (less than five open reduction and internal fixation operations per year) increases the odds for the risk of complications with 4.4.

1.2. Hospital volume

The association between hospital volume and complications was reported in two studies (Poeze, 2008; Stewart, 2019).

Poeze (2008) investigated the relationship between hospital volume and serious infections. Volume was defined as the number of open reduction and internal fixation procedures **per institution** per month. Poeze (2008) performed a multiple regression analysis and reported significant associations between **hospital volume** and the development of serious infection after surgery adjusted for confounding factors as time to surgery, time of surgery, percentage of patients with Sander type-IV fractures, percentage of patients with bilateral fractures, percentage of patients with diabetes, percentage of patients who smoke, and the postoperative Bohler angle. The complete model explained 51% of the observed variance, whereas volume accounted for 23% of this variance.

Poeze (2008) also reported the rate of deep infections. The deep infection rate for studies with a **hospital volume** of more than one open reduction and internal fixation operation per month was 1.8%, compared to 8.9% for studies with a hospital volume less than one operation per month. With use of these cut-off points, Poeze (2008) divided the included studies in studies with a hospital volume of more or less than one operation per month. The odds-ratio for the development of a deep infection was 24.0 (95% CI 2.1 to 279.0), in favor of a hospital volume of more than one operation per month.

Stewart (2019) performed a multiple logistic regression analysis and reported the association between complications and **hospital volume** (per five procedures), adjusted for patient-level factors, comorbidities, and injury characteristics including age, gender, race, insurance status, geographic income quartile, Charlson comorbidities, and open fractures. Volume was calculated as the total number of tarsal fracture fixations performed during the year of index operation.
The odds-ratio for the association of hospital volume (per five procedures) and complications, adjusted for all aforementioned confounders, was 1.00 (95% CI 0.96 to 1.04).

2. Functional outcomes (AOFAS midfoot, LEFS, PROMIS)

None of the studies reported associations between surgeon or hospital volume and functional outcomes, with adjustment for confounding covariates.

3. Arthrodesis rate

One study reported the association between hospital volume and the arthrodesis rate (Poeze, 2008). However, the results were not adjusted for possible confounding. Poeze (2008) reported the mean (95% CI) arthrodesis rate for studies with a hospital volume below or above the cut-off point of 0.75 procedures per month. Hospital volume was defined as the number of open reduction and internal fixation procedures per hospital per month. Poeze (2008) did not adjust for possible confounding. The mean (SD) arthrodesis rate in studies with a hospital volume below the cut-off point of 0.75 was 6.4 (95% CI 2.4 to 10.5), compared to 1.9 (95% CI 0.2 to 3.5) in studies with a hospital volume above the cut-off point of 0.75, in favor of a hospital volume above 0.75 procedures per months. As the model that was used was not adjusted for possible confounding, the GRADE approach was not applied.

Table 1: Summary of findings association between surgeon volume and complications

Author	Association	Adjusted confounders	Odds-ratio (95% CI)	Descriptives
Poeze (2008)	Hospital volume (less than one operation per month) & deep infections	- Time to surgery; - Time of surgery; - Percentage of patients with Sander type-IV fractures; - Percentage of patients with bilateral fractures; - Percentage of patients with diabetes; - Percentage of patients who smoke; - Postoperative Bohler angle.	Hospital volume & risk for deep infections 24.0 (95% CI 2.1 to 279.0) N=1656 fractures	A hospital volume of less than one procedure per month increases the odds for the risk of serious infections with 24.0.
Stewart (2019)	Surgeon volume (per five procedures) & complications Hospital volume (per five procedures) & complications	- Patient-level factors; - Comorbidities and injury characteristics; - Age; - Sex; - Ethnicity; - Insurance status; - Geographic income quartile; - Charlson comorbidities; - Open fractures.	Surgeon volume & risk for **complications** 0.91 (95% CI 0.82 to 0.99) Hospital volume & risk for **complications** 1.00 (95% CI 0.96 to 1.04) N=4132 fractures	Surgeon volume & risk for complications For every five procedures, the odds for the risk of complications decreases with 0.91. Hospital volume & risk for complications For every five procedures, the odds for the risk of complications are 1.00
Qin (2022)	Surgeon volume (less than six open reduction and internal fixation procedures per month) & deep infections	- Residence place; - Diabetes mellitus; - Incision level; - Injury mechanism; - Age; - Sex; - Bone grafting.	Surgeon volume & **risk for deep infections** 5.8 (95% CI 2.1 to 15.7) N=883 patients	Surgeon volume & deep infections Surgeon volume of less than six procedures per month increases the odds for the risk of serious infections with 5.8.
Yin (2022)	Surgeon volume (less than five procedures per month) & overall complications	Model 4 (full adjusted model) - Age; - Gender; - Living place; - Occupation; - Lifestyles; - BMI; - Comorbidities; - Medical history; - Injury- and surgery-related variables; - Laboratory indexes on admission.	Surgeon volume & **overall complications** model 4 4.4 (95% CI 2.2 to 8.8). N=585 patients	Surgeon volume & overall complications model 4 Surgeon volume of less than five procedures per month increases the odds for the risk of serious infections with 4.4

Level of evidence of the literature

Surgeon volume

1. Complications

The level of evidence regarding complications was derived from observational (prospective and retrospective) studies and therefore started high. The level of evidence was downgraded because of study limitations including concerns on the analysis methods and confounding variables that were included in the models and hetereogeneity between studies including the type of complications that were reported (-2 risk of bias). The final level of evidence was graded **low.**

2. Functional outcomes (AOFAS midfoot, LEFS, PROMIS)

None of the studies reported associations between surgeon volume and functional outcomes, with adjustment for confounding covariatess.

3. Arthrodesis rate

None of the studies reported associations between surgeon volume and arthrodesis rate with adjustment for confounding covariates.

Hospital volume

1. Complications

The level of evidence regarding complications was derived from observational (prospective and retrospective) studies and therefore started high. The level of evidence was downgraded because of study limitations including concerns on the analysis methods and confounding variables that were included in the models and hetereogeneity between studies including the type of complications that were reported (-2 risk of bias) and conflincting results (-1 inconsistency). The final level of evidence was graded **very low.**

2. Functional outcomes (AOFAS midfoot, LEFS, PROMIS)

None of the studies reported associations between hospital volume and functional outcomes, with adjustment for confounding covariates.

3. Arthrodesis rate

As no multivariate analysis was performed on the association between hospital volume and complications, the GRADE-approach was not applied and no GRADE conclusions were formulated.

Conclusions

Surgeon volume

1. Complications

Low GRADE	Prognostic models correcting for factors including age, gender, geographic location, lifestyle, BMI, comorbidities, medical history and Injury- and surgery-related variables suggest that surgeon volume may be associated with the risk of complications in patients with acute traumatic foot injury (calcaneal or tarsal fractures) undergoing open reduction and internal fixation procedures. *Sources: Stewart (2019); Qin (2022); Yin (2022).*

2. Functional outcomes (AOFAS midfoot, LEFS, PROMIS)

No GRADE	None of the studies reported associations between surgeon volume and functional outcomes with adjustment for confounding covariates. *Sources: -*

3. Arthrodesis rate

No GRADE	None of the studies reported associations between surgeon volume and the arthrodesis rate with adjustment for confounding covariates in patients with an acute traumatic foot injury undergoing open reduction and internal fixation procedures . *Sources: -*

Hospital volume

4. Complications

Very Low GRADE	Prognostic models correcting for factors including age, gender, geographic location, lifestyle, BMI, comorbidities, medical history and Injury- and surgery-related variables are very uncertain about the association between hospital volume and the risk of complications in patients with acute traumatic foot injury (calcaneal or tarsal fractures) undergoing open reduction and internal fixation procedures. *Sources: Poeze (2008); Stewart (2019)*

5. Functional outcomes (AOFAS midfoot, LEFS, PROMIS)

No GRADE	None of the studies reported associations between hospital volume and functional outcomes with adjustment for confounding covariates. *Sources: -*

6. Arthrodesis rate

No GRADE	None of the studies reported associations between hospital volume and functional outcomes with adjustment for confounding covariates. *Sources: -*

Overwegingen – van bewijs naar aanbeveling

Voor- en nadelen van de interventie en de kwaliteit van het bewijs

Er is literatuuronderzoek uitgevoerd naar het effect van chirurgisch volume en de uitkomst op verschillende klinische uitkomsten, zoals complicaties, functionele uitkomsten, noodzaak tot arthrodese, bij patiënten met acute, traumatische voetletsels die een open reductie en interne fixatie procedure ondergaan. Complicaties en functionele uitkomsten werden als cruciale uitkomstmaten gedefinieerd.

Uit het literatuuronderzoek kwamen vier prognostische studies naar voren met modellen die de associatie onderzochten tussen het volume en klinische uitkomsten. Drie studies includeerden patiënten met calcaneus fracturen (Poeze, 2008; Qin, 2022; Yin, 2022) en 1 studie includeerde patiënten met tarsale fracturen (Stewart 2019). Vier studies beschreven de associatie tussen chirurgisch volume en complicaties. De overige uitkomstmaten (functionele uitkomst en noodzaak tot arthrodese) werden niet geraporteerd in de geïncludeerde studies. De geïncludeerde studies rapporteerden zowel de associatie tussen het volume van de chirurg en klinische uitkomsten als de associatie tussen het volume van de instelling en klinische uitkomsten. De systematische review van Poeze (2008) liet zien dat een chirurgisch volume van de instelling lager dan één procedure per maand het risico op het oplopen van diepe infecties doet toenemen (OR 24.0; 95% CI 2.1 to 279). Het

artikel van Stewart (2019) liet geen verschil zien bij een hoger volume op ziekenhuis niveau OR 1.00 (95% CI 0.96 to 1.04). De bewijskracht hiervoor werd gegradeerd op 'zeer laag GRADE' doordat deze resultaten niet eenduidig zijn.
De drie andere geïncludeerde studies (Stewart, 2019; Qin, 2022; Yin, 2022) rapporteerden alleen de associatie tussen het volume van de chirurg en het optreden van complicaties. De analyses van al deze studies liet zien dat een lager chirurgisch volume geassocieerd lijkt met een verhoogd risico op complicaties, zoals (diepe) infecties. Hier werd de bewijskracht gegradeerd op 'laag GRADE'.

Naast de vier geïncludeerde studies werden er nog vier studies gevonden die de associatie tussen chirurgisch volume en klinische uitkomsten onderzochten, echter werden de resultaten gebaseerd op univariate analyses zonder te corrigeren voor eventuele confounders. Een andere reden voor exclusie was het feit dat de studies niet aan de PICO voldeden, omdat ze bijvoorbeeld de associatie tussen de ervaring van de chirurg en het risico op complicaties onderzochten. Omdat deze studies alsnog nuttige informatie bevatten die bij kunnen dragen aan de uiteindelijke aanbeveling, heeft de werkgroep besloten om deze te excluderen uit de literatuuranalyse en op beschrijvende wijze op te nemen in de overwegingen.

De retrospectieve observationele studie van Court-Brown (2009) onderzocht primair in hoeverre uitstel voorafgaand aan een chirurgische behandeling van een gesloten intra-articulaire calcaneus fractuur geassocieerd is met de prevalentie van postoperatieve diepe infectie. Court-Brown (2009) includeerde 178 patiënten. Er werd geen associatie gevonden in het aantal oppervlakkige of diepe infecties met betrekking tot uitstel van chirurgische behandeling. De studie bekeek eveneens de associatie tussen de ervaring van de chirurg en infecties. Groep A bestond uit twee ervaren orthopedische chirurgen. Groep B bestond uit een groep van 15 orthopedische traumachirurgen, klinische fellows of senior stagiaires die samen 35 operaties uitvoerden in de periode van 1995 en 2006. De resultaten lieten zien dat de ervaren chirurg, die 60,7% van de operaties uitvoerde, het laagste percentage diepe infecties had (2,8% versus 14.3%). Dit verschil was significant verschillend. Er werden geen verschillen gevonden tussen ervaring van de chirurg en oppervlakkige infecties.

Fischer (2021) voerde een retrospectieve studie uit en includeerde de data van patiënten met een calcaneus fractuur die tussen 2014 en 2017 in een kliniek werden behandeld. In totaal werd de data van 192 patiënten geïncludeerd. Fischer (2021) onderzocht de associatie tussen de ervaring van de behandelend chirurg bij de behandeling van een intra-articulaire calcaneus fractuur en klinische uitkomsten. De studie rapporteerde het verschil in AOFAS-score, VAS-score, en Kiel-score tussen ervaren en minder ervaren chirurgen. De resultaten lieten zien dat de ervaren chirurgen significant betere resultaten lieten zien in alle bovengenoemde scores. Eén patiënt die werd behandeld door een ervaren chirurg had een complicatie, tegenover vier patiënten met een complicatie die door een minder ervaren chirurg werden behandeld.

De studie van Joseph (2023) analyseerde de relatie tussen de ervaring van de chirurg met de 'sinus tarsi benadering' van intra-articulaire calcaneus fracturen. Er werden 66 patiënten geïncludeerd. Logistische regressie liet zien dat voor elk extra jaar aan ervaring van de chirurgen met de 'sinus tarsi benadering', de kans op een chirurgische complicatie met 29,3% afneemt. In een multiple lineaire regressieanalyse kwam tevens naar voren dat de kans op het verkrijgen van een goede of uitstekende articulaire reductie respectievelijk 1,8 en 2,3 keer groter was dan het verkrijgen van een redelijke reductie voor elk jaar toename in chirurgische ervaring. Joseph (2023) concludeerde daarmee dat de ervaring van de chirurg een cruciale rol speelt in de klinische uitkomsten van patiënten met intra-articulaire calcaneus fracturen.

Schepers (2013) onderzocht de subcuticulaire sluitingstechniek met één laag en onderzocht daarnaast de associaties tussen de patiënt-, fractuur- en chirurgische factoren met betrekking tot de ontwikkeling van wondcomplicaties. In totaal werden er 46 patiënten (49 calcaneus fracturen)

geïncludeerd, waarbij de calcaneus fractuur werd gesloten middels de bovengenoemde sluitingstechniek. In vier gevallen werd een postoperatieve infectie gerapporteerd, waarvan drie patiënten rokers waren. Twee patiënten ontwikkelden een diepe wondinfectie, waarvoor een chirurgische debridement en het verwijderen van implantaten noodzakelijk was. De operaties werden door vijftien chirurgen uitgevoerd. Er werd gewerkt in tweetallen, waarbij één van de vier ervaren chirurgen bij iedere operatie aanwezig was. Er werd geen associatie gevonden tussen de chirurg en het optreden van wondcomplicaties, noch kon er een leercurve worden ontdekt bij het vergelijken van de eerste helft van de behandelde patiënten met de tweede helft van de behandelde patiënten. Er werd echter wel een statistisch significante associatie gevonden tussen het totale aantal procedures dat door het chirurgische team werd uitgevoerd en het aantal complicaties. In de groep patiënten waarin wondcomplicaties optraden was het gemiddelde aantal eerder behandelde calcaneus fracturen 13 (SD 8) fracturen vergeleken met 22 (SD 9) behandelde fracturen in de groep patiënten zonder wondcomplicaties.

De meerderheid van de studies includeerde patiënten met een calcaneusfractuur. Alleen de studie van Stewart (2019) includeerde patiënten met een tarsale fractuur. De reden hiervoor is naar alle waarschijnlijkheid dat er jaarlijks meer patiënten met een calcaneusfractuur worden behandeld dan de overige letsels (tarsale frcaturen, Chopart letsels en Lisfranc letsels). Voor deze type letsels is het dus nog moeilijker om voldoende behandelervaring op te doen.

In de studies werden verschillende volumes gerapporteerd die een positieve associatie lieten zien met behandeluitkomst of lager complicatierisico. Waar Poeze (2008) rapporteerde dat de kans op het oplopen van diepe infecties toeneemt bij een chirurgisch volume van de instelling kleiner dan één procedure per maand, rapporteerde Qin (2022) een associatie bij minder dan 6 procedures per maand en Yin (2022) over minder dan 5 per maand. Stewart (2019) spreekt over een lagere kans op complicaties bij iedere 5 operaties extra per chirurg.

Bovengenoemde studies keken naar het effect van volume en complicaties. Dit staat los van de leercurve. Studies welke nu niet meegenomen zijn in de analyse zijn van Ahn (2019) en Sanders (1993). Op basis van o.a. operatieduur en mate van repositie deduceerde zij een leercurve voor calcaneus fracturen tussen de 20 (Ahn) en 35-50 (Sanders) ingrepen per chirurg.

De meerderheid van de studies die zijn gedaan rond complexe voetletsels betreffen Calcaneusfracturen. Aangezien over dit type letsel het meeste literatuur beschikbaar is, zijn argumenten voor het schrijven van de overwegingen voornamelijk ontleend aan deze literatuur. De hoeveelheid beschikbare literatuur lijkt geassocieerd met de frequentie waarmee een letsel voorkomt. Een aanzienlijk deel van de hierna volgende tekst is tevens toepasbaar op talus fracturen, Lisfranc letsel en Chopart letsels. Hetzij met enkele nuances.

<u>Waarden en voorkeuren van patiënten (en evt. hun verzorgers)</u>
De behandeling van calcaneus fracturen is voornamelijk gericht op herstel met behoud van zo veel mogelijk functie bij een zo'n laag mogelijk complicatie percentage. De effecten van een calcaneus fractuur zijn vooral verlies van hoogte, met daarbij beperkingen in beweeglijkheid, verbreding van de hiel, waarbij er problemen ontstaan met schoeisel, en oneffenheden in het subtalaire gewricht, welke tot vroege artrose leidt met verhoogde kans op pijnklachten en secundaire arthrodese. De operatieve behandeling, in patiënten met een geschikt risicoprofiel, zijn vooral gericht op herstel van deze anatomie met voorkomen van de bovengenoemde klachten.

De gemiddelde leeftijd van patiënten met een calcaneus fractuur ligt rond de 40 jaar, dit zijn veelal actieve mensen qua sport en/of werk. Het zoveel mogelijk weer terugkomen op oude niveau is derhalve erg belangrijk. Complicaties, zoals wondinfectie, verlagen de patiënttevredenheid significant en verhogen de kans op een secundaire arthrodese (Backes 2015). Het is derhalve van

groot belang om een zo'n goed mogelijk herstel van de anatomie te verkrijgen met een zo'n laag mogelijk complicatie percentage.

Het merendeel van de calcaneus fracturen ontstaat bij werkzaamheden en sport. Deze groep patiënten zijn veelal jong en hebben nog veel arbeidsjaren te gaan. Een kleiner deel van de patiënten krijgt een calcaneus fractuur bij minimaal trauma o.b.v. osteoporose en/of diabetes. Bij deze groep dient het wel of niet opereren goed afgewogen te worden tegen de hogere risico's.

Kosten (middelenbeslag)

Zoals ook beschreven in de module calcaneus fracturen, [hier wordt een hyperlink ingevoegd zodra de richtlijn wordt gepubliceerd op de richtlijnendatabase], hebben calcaneus fracturen een zeer hoge financiële belasting (Schepers, 2008). Het opereren van calcaneus fracturen leidt tot een significante reductie in kosten (Albin, 2020; Brauer, 2005).

Over de kosten-effecitiviteit van andere type letsel is geen literatuur beschikbaar.

Aanvaardbaarheid, haalbaarheid en implementatie

Op de website Zorgproduct - DIS open data (opendisdata.nl) is het aantal calcaneus fracturen wat operatief behandeld wordt berekend op 250 tot 300 per jaar. Met een voorzichtige schatting op basis van bovengenoemde literatuur lijkt het wenselijk om per maand minimaal twee patiënten met een calcaneus fractuur te opereren. In dat geval kan de zorg voor de operatief behandelde calcaneus fracturen geconcentreerd worden in tien ziekenhuizen. Bij een grens van het opereren van één patiënt met een calcaneus fractuur per maand zal dit in 25 ziekenhuizen plaatsvinden. De werkgroep stelt voor dat er afspraken gemaakt dienen te worden over het verwijzen van patiënten in de regio. Dit zal betekenen dat er enkele patiënten per jaar verwezen zullen worden indien er onvoldoende expertise aanwezig is. Het is wellicht wenselijk om ander letsel "in ruil" elders te concentreren. Met betrekking tot morele en ethische bezwaren is het niet verwijzen van een patiënt bij onvoldoende expertise potentieel erger dan wel verwijzen.

Een operatie of een conservatief beleid voor verschillende voetletsels dient zorgvuldig afgewogen te worden. Dit hangt deels af van de hogere kans op complicaties bij de operatieve behandelingen van de beschikbare expertise.
Bij een regionale concentratie van zorg van deze complexe letsels is de verwachting dat er weinig problemen zullen ontstaat qua beschikbare tijd. Overwogen kan worden om afspraken te maken over andere letsels als ware een "uitruil". Bij elke patiënt moet op basis van patiëntkarakteristieken en letsel karakteristieken overwogen worden of een operatie de beste keuze is. Uiteraard in goed overleg met de patiënt, waarbij de gene met kennis en ervaring aan kan geven wat de gevolgen zijn van deze keuzes. Zoals eerder gesteld kan het zijn dat het letsel geen operatie behoeft, maar ook dat de conditie van de patiënt een operatie minder wenselijk maakt. Dit dient in goed overleg met patiënt en familie plaats te vinden.

Rationale van de aanbeveling: weging van argumenten voor en tegen de interventies

Het letsel bij traumatisch complexe voetletsels is zo divers dat het moeilijk is om voldoende (behandel)ervaring op te doen. Er is literatuuronderzoek verricht of de ervaring van de chirurg, en het behandelvolume in een centrum van invloed is op het behandelsucces bij traumatisch complex voetletsel. Er zijn meerdere observationele studies die een positieve associatie laten zien tussen minder complicaties en een betere behandeluitkomst bij een hoger volume van het centrum of meer ervaring van de chirurg. De bewijskracht hiervoor is echter zeer laag door het design van de studies en de brede betrouwbaarheidsintervallen die werden gevonden. Logischerwijs heeft het voor patiënten meerwaarde om in een centrum geholpen te worden waar expertise over het specifieke letsel in huis is. In de meerderheid van de studies werden patiënten geïncludeerd met calcaneus fracturen. Aangezien overig complex voetletsel in volume nog minder voorkomt dan

calcaneusfracturen is het voor deze letsels nog moeilijker om voldoende behandelervaring op te doen. De werkgroep is het erover eens dat juist ook voor overig complex voetletsels het meerwaarde heeft om voldoende behandelervaring op te doen en door te verwijzen indien deze expertise niet in huis is. Hierover kunnen afspraken in de regio worden gemaakt.

Aanbeveling(en)

Organiseer, indien mogelijk in de eigen regio, of en naar wie de complexe voet-letsels verwezen worden.

Verwijs patiënten met een calcaneus fractuur naar een centrum met meer expertise en volume (minder dan één a twee calcaneus operaties per maand) indien die in het ziekenhuis waar de patiënt zich presenteert niet beschikbaar is.

Overweeg verwijzing bij overige complexe voetletsels ook naar een centrum met meer expertise en volume indien die in het ziekenhuis waar de patiënt zich presenteert niet beschikbaar is.

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Bijlagen bij module organisatie van zorg

Evidence tables bij module organisatie van zorg

5 *Evidence tables for Systematic review(s)*

Study reference	Study characteristics	Patient characteristics	Intervention (I)	Comparison / control (C)	Follow-up	Outcome measures and effect size	Comments
Poeze (2008)	SR and meta-analysis of prospective and retrospective observational studies. *Literature search up to 2006.* A: Schildhauer (2000) B: Al-Mudhaffar (2000) C: Geel (2001) D: Assous (2001) E: Tennent (2001) F: Harvey (2001) G: Naovaratanophas (2001) H: Shuler (2001) I: Huang (2002) J: Asik (2002) K: Aktuglu (2002) L: Sarkar (2002) M: Zmurko (2002) N: Buckley (2003) O: Benirschke (2004) P: Westphal (2004) Q: Elsner (2005) R: Herscovici (2005) S: Wiley (2005) T: Koski (2005) U: Bibbo (2006) Study design: A: Prospective B: Retrospective C: Retrospective D: Retrospective	Inclusion criteria SR: - Adult patients who were managed with open reduction and internal fixation through a lateral approach for the treatment of a unilateral or bilateral fracture. Exclusion criteria - Patients with open fractures and patients who were managed with percutaneous and/or external fixation procedure. *Twenty-one studies included* Important patient characteristics at baseline: N, mean age Not reported. *Sex:* Not reported.	Describe intervention: All studies ORIF.	Describe control: No control.	Study time: A: 22 months B: 48 months C: 84 months D: 60 months E: 96 months F: 84 months G: 145 months H: 36 months I: 48 months J: 30 months K: 76 months L: 8 months M: 84 months N: 106 months O: 72 months P: 85 months Q: 34 months R: 156 months S: 72 months T: 50 months U: 29 months Follow-up time A: 21.0 months B: 16.1 months C: 52.0 months D: 27.0 months E: 44.0 months F: 24.0 months G: 81.0 months H: Not reported. I: 36.3 months	Institutional fracture load (number of open reduction and internal fixations per month) A: 1.64 B: 0.65 C: 0.54 D: 0.67 E: 0.53 F: 2.45 G: 0.79 H: 1.75 I: 0.67 J: 0.87 K: 0.18 L: 1.50 M: 0.31 N: 2.13 O: 4.74 P: 0.84 Q: 0.56 R: 0.26 S: 1.07 T: 2.96 U: 1.07 Individual fracture load (number of open reduction and internal fixations per month) A: Not reported. B: 0.11 C: 0.54	Author's conclusion A significant relationship between the deep infection rate, traumatic subtalar arthritis, and the fracture load may indicate a need for specialized institutional trauma care to improve outcomes associated with the operative treatment of calcaneal fractures.

	E: Retrospective F: Retrospective G: Retrospective H: Retrospective I: Retrospective J: Retrospective K: Retrospective L: Prospective M: Retrospective N: Prospective O: Retrospective P: Retrospective Q: Prospective R: Retrospective S: Retrospective T: Retrospective U: Prospective <u>Setting and Country</u>: A: Not reported. B: Not reported. C: Not reported. D: Not reported. E: Not reported. F: Not reported. G: Not reported. H: Not reported. I: Not reported. J: Not reported. K: Not reported. L: Not reported. M: Not reported. N: Not reported. O: Not reported. P: Not reported. Q: Not reported. R: Not reported. S: Not reported. T: Not reported. U: Not reported. <u>Source of funding and conflicts of interest:</u> The authors did not receive any outside funding or grants in support of their research for or				J: 38.2 months K: 42.0 months L: Not reported. M: Not reported. N: 60.0 months O: 21.6 months P: 32.0 months Q: 22.3 months R: 43.9 months S: 24.0 months T: 10.7 months U: 22.4 months	D: 0.67 E: 0.53 F: 1.23 G: Not reported. H: Not reported. I: Not reported. J: 0.43 K: 0.09 L: Not reported. M: Not reported. N: 0.36 O: 4.74 P: 0.28 Q: 0.11 R: Not reported. S: 0.53 T: 0.09 U: 0.44 <u>Serious infection</u> A: 11.0% B: 16.1% C: 3.0% D: 20.0% E: 7.8% F: 1.4% G: 2.6% H: 3.2% I: 3.1% J: 19.2% K: 14.3% L: 0% M: 7.7% N: 4.4% O: 1.8% P: 7.1% Q: 10.5% R: 10.0% S: 1.3% T: 5.0% U: 0% <u>Arthrodesis rate</u> A: Not reported. B: Not reported. C: 2.2%	

	preparation of this work. Neither they nor a member of their immediate families received payments or other benefits or a commitment or agreement to provide such benefits from a commercial entity. No commercial entity paid or directed, or agreed to pay or direct, any benefits to any research fund, foundation, division, center, clinical practice, or other charitable or nonprofit organization with which the authors, or a member of their immediate families, are affiliated or associated.					D: 2.5% E: 5.9% F: 2.4% G: 0.9% H: Not reported. I: 6.3% J: Not reported. K: Not reported. L: Not reported. M: 15.4% N: 2.2% O: 0% P: 2.5% Q: 5.3% R: 7.5% S: Not reported. T: 5.0% U: 0%	

Individual studies

Study reference	Study characteristics	Patient characteristics	Prognostic factor(s)	Follow-up	Estimates of prognostic effect	Comments
Qin (2022)	Type of study: Retrospective study. Setting and country: 2000-bed tertiary teaching hospital. Funding and conflicts of interest: The authors declared no potential conflict of interest with respect to the research, authorship, and/or publication of this	Inclusion criteria: • Patients aged 18 years or above who underwent ORIF of acute closed calcaneal fractures between January 2016 and December 2019 with complete 1-year follow-up data Exclusion criteria: • Open calcaneal fracture;	Describe prognostic factor(s) and method of measurement: Multivariate analysis - Surgeon volume - Residence place (urban vs rural) - Diabetes mellitus (yes or no) - Incision level II (II vs I) - Injury mechanism (low- to medium- vs high-impact trauma) - Age (increment in each year) - Sex (male vs female) - Bone grafting (yes or no)	Duration or endpoint of follow-up: One year. For how many participants were no complete outcome data available? N (%): none.	(Adjusted) Factor-outcome associations (include SEs or 95%CI and p-value if available): **Complications** Surgeon volume - Beta 1.76 - SE 0.51 - OR 5.8 - 95% CI 2.1 to 15.7 - P=0.001 Residence place (urban vs rural) - Beta 0.57 - SE 0.48 - OR 1.8 - 95% CI 0.7 to 4.5 - P=0.235	

	article. ICMJE forms for all authors are available online.	• Bilateral calcaneal fractures; • Pathological (metastatic) fractures; • Old fractures (>28 days from injury); • Polytrauma; • Treatments other than ORIF; • Presence of infections or signs before index admission; • Wound-related issues other than DSSIs (eg superficial infection, wound edge necrosis); • Missing information for variables of interest; • Insufficient 1-year follow-ups. N=883 <u>Mean age ± SD:</u> *High volume: 42.0 (11.0)* *Low volume: 43.7 (11.9)* <u>Sex: % M / % F</u> *High volume: 657/728 (90.2%)* *Low volume: 138/155 (89.0%)*			Diabetes mellitus (yes or no) - Beta -0.14 - SE 1.07 - OR 0.9 - 95% CI 0.1 to 7.1 - P=0.896 Incision level (II vs I) - Beta 1.19 - SE 0.82 - OR 3.3 - 95% CI 0.7 to 16.4 - P=0.144 Injury mechanism - Beta -0.65 - SE 0.58 - OR 0.5 - 95% CI 0.2 to 1.6 - P=0.263 Age - Beta -0.02 - SE 0.02 - OR 1.0 - 95% CI 0.9 to 1.0 - P=0.422 Sex - Beta -0.15 - SE 0.78 - OR 0.9 - 95% CI 0.2 to 4.0 - P=0.852 Bone grafting - Beta 1.02 - SE 0.61 - OR 2.8 - 95% CI 0.8 to 9.2 - P=0.096 <u>Incremental predictive value[1]:</u> No information.	

Stewart (2019)	Type of study: Retrospective study. Setting and country: Healthcare Cost and Utilization Project maintained by the Agency for Healthcare Research and Quality database. Florida and New York databases were selected. Funding and conflicts of interest: S. Morshed is a consultant for DePuy Synthes. The remaining authors report no conflict of interest.	Inclusion criteria: • Patients who underwent open reduction and internal fixation, closed reduction and internal fixation, or primary arthrodesis of tarsal fractures. Exclusion criteria: • Patients who had other lower extremity operative fractures; • Expiration during the index hospitalization or receiving fixation at more than one institution. N=4132 Mean age ± SD: 44.5 (15.3) Sex: Female (%) 1245 (30.0%)	Describe prognostic factor(s) and method of measurement: Multivariate analysis - Surgeon volume - Hospital volume - Age (per 10 years) - Male sex - Race/ethnicity - Insurance - Median income quartile - Charlson comorbidities - Open fracture	Duration or endpoint of follow-up: At least 2 years. For how many participants were no complete outcome data available? N (%): none	(Adjusted) Factor-outcome associations (include SEs or 95%CI and p-value if available): **Complications** Surgeon volume (per 5 operations) - OR 0.91 - 95% CI 0.82 to 0.99 - P=0.045 Hospital volume (per 5 operations) - OR 1.00 - 95% CI 0.96 to 1.04 - P=0.985 Age (per 10 years) - OR 1.23 - 95% CI 1.10 to 1.36 - P<0.001 Male sex - OR 1.56 - 95% CI 1.12 to 2.17 - P=0.009 Race/ethnicity *Black* - OR 0.90 - 95% CI 0.52 to 1.55 - P=0.712 *Hispanic* - OR 0.97 - 95% CI 0.66 to 1.41 - P=0.860 *Other* - OR 1.02 - 95% CI 0.61 to 1.70 - P=0.946 Insurance *Medicare* - OR 1.06 - 95% CI 0.65 to 1.72 - P=0.812	

					Medicaid - OR 1.48 - 95% CI 0.89 to 2.47 - P=0.132 *Self-pay* - OR 1.24 - 95% CI 0.77 to 1.99 - P=0.370 *Uninsured* - OR 2.47 - 95% CI 1.39 to 4.39 - P=0.002 *Other* - OR 1.52 - 95% CI 1.06 to 2.18 - P=0.023 Median income quartile *First* - OR 1.24 - 95% CI 0.81 to 1.88 - P=0.319 *Second* - OR 1.48 - 95% CI 1.00 to 2.17 - P=0.049 *Third* - oR 1.23 - 95% CI 0.83 to 1.84 - P=0.306 Charlson comorbidities - OR 1.23 - 95% CI 1.02 to 1.48 - P=0.032 Open fracture - OR 2.84 - 95% CI 1.92 to 4.19 - P<0.001	

					Incremental predictive value[1]: Not reported.	
Yin (2022)	Type of study: Retrospective study. Setting and country: No information. Funding and conflicts of interest: The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.	Inclusion criteria: • patients aged 18 years or older who presented with acute displaced intra-articular calcaneal fracture and underwent surgery with ORIF and had complete 1-year follow-up data. Exclusion criteria: • Open calcaneal fracture; • Old fracture (>21 days from injury); • Bilateral calcaneal fractures; • Pathological (metastatic) fracture; • Polytrauma or multiple fractures; • Treatments other than ORIF; • Missing data for variables of interest; • Incomplete 1-year follow-up data. N=585	Describe prognostic factor(s) and method of measurement: Multivariate logistic regression - Age - Gender - Living place - Occupation - Lifestyles - BMI - Comorbidities - Medical history - Injury- and surgery-related variables - Laboratory indexes on admission.	Duration or endpoint of follow-up: 1 year. For how many participants were no complete outcome data available? N (%): None	(Adjusted) Factor-outcome associations (include SEs or 95%CI and p-value if available): *Model 1* OR 3.8 (95% CI 2.0 to 7.1) adjusted for: - Age - Gender - Living place - Occupation *Model 2* OR 3.9 (95% CI 2.1 to 7.5) adjusted for: - Age - Gender - Living place - Occupation - Lifestyles - BMI - Comorbidities - Medical history *Model 3* OR 4.4 (95% CI 2.3 to 8.7) adjusted for: - Age - Gender - Living place - Occupation - Lifestyles - BMI - Comorbidities - Medical history - Injury- and surgery-related variables *Model 4* OR 4.4 (95% CI 2.2 to 8.8) adjusted for: - Age	

		<u>Age <45 years</u> High volume: 264/474 (55.7%) Low volume: 51/111 (45.9%) <u>Age >45 years</u> High volume: 210/474 (44.3%) Low volume: 60/111 (54.1%) <u>Sex: M (%)</u> High volume: 426/474 (89.9%) Low volume: 97/111 (87.4%)			- Gender - Living place - Occupation - Lifestyles - BMI - Comorbidities - Medical history - Injury- and surgery-related variables - Laboratory indexes on admission. <u>Incremental predictive value[1]:</u> No information.	

Quality assessment

Table of quality assessment – prediction modelling studies (based on PROBAST version 15/05/2019)

Study reference (first author, year of publication) Classification[1]	**Participant selection** 1) Appropriate data sources?[2] 2) Appropriate in- and exclusion? Risk of bias: low/high/unclear	**Predictors** 1) Assessed similar for all participants? 2) Assessed without knowledge of outcome? 3) Available at time the model is intended to be used? Risk of bias: low/high/unclear	**Outcome** 1) Pre-specified or standard outcome definition? 2) Predictors excluded from definition? 3) Assessed similar for all participants? 4) Assessed without knowledge of predictors? 5) Time interval between predictor and outcome measurement appropriate? Risk of bias: low/high/unclear	**Analysis** 1) Reasonable number of participants with event/outcome? 2) All enrolled participants included in analysis? 3) Missing data handled appropriately? 4) No selection of predictors based on univariate analysis? 5) Relevant model performance measures evaluated appropriately?[3] 6) Accounted for model overfitting[4] and optimism? 7) Predictors and weights correspond to results from multivariate analysis? Risk of bias: low/high/unclear	**Overall judgment** *High risk of bias: at least one domain judged to be at high risk of bias.* *Model development only: high risk of bias.* Risk of bias: low/high/unclear
Poeze (2008) *Model development*	1) systematic review of cohorts limited information of baseline characteristics of included studies 2) limited information on baseline characteristics of included studies *Some concerns*	No information (systematic review) *unclear*	1) standard outcome 2) yes 3) no information (systematic review) 4) no information (systematic review) 5) no information (systematic review) *unclear*	1) probably yes 2) no information 3) missing data were replaced with series mean 4) probably yes 5) no information 6) no information 7) probably yes *High risk of bias*	*High risk of bias* • Model development • Concerns regarding analysis Serious and deep infection

Stewart (2019) *Model development*	1) patient data from state inpatient databases (USA) 2) probably yes *Low*	1) probably yes; extracted from database 2) yes; information is deidentified 3) not clear *Low*	1) standard outcome definition (any outcome) 2) yes 3) probably yes; extracted from database 4) probably yes; extracted from database 5) yes, 2 years *Low*	1) probably yes 2) no, missings were excluded 3) missing data was not included in the model 4) bivariate and multivariate 5) no information 6) no 7) probably yes *High risk of bias*	High risk of bias • Model development • Concerns regarding analysis Outcome: any complication
Qin (2022) *model development*	1) patient data from surgical site infection database from single institution (china) 2) probably yes *High → surgical site infection database might be biased – single institution China*	1) probably yes; extracted from database 2) no information 3) not clear *Low*	1) pre-specified (only deep surgical site infections) 2) yes 3) probably yes; extracted from database 4) probably yes; extracted from database 5) 1 year *Low*	1) probably yes 2) no, missings were excluded 3) missing data was not included in the model 4) selection of variables, were significant or approximately significant in the univariate analysis 5) no information 6) yes 7) probably yes *Some concerns*	High risk of bias • Model development • Participant selections • Concerns regarding analysis Outcome: deep surgical site infections
Yin (2022)	1) patient selection from database from single institution (China) 2) probably yes *Some concerns → single institution China*	1) probably yes; extracted from medical records 2) yes; information is deidentified 3) not clear *Low*	1) standard outcome (overall complications) 2) probably yes 3) yes; extracted from medical records 4) probably yes; extracted from medical records 5) yes, 1 year *Low*	1) probably yes 2) missings were excluded 3) missings were excluded 4) probably yes 5) no information 6) yes 7) probably yes *Some concerns*	Some concerns • Patient selection (single institution, China) • Concerns regarding analysis

Table of excluded studies

Author and year	Reason for exclusion
Anh (2019)	Wrong study design.
Court-Brown (2009)	Wrong study design.
Fischer (2021)	Wrong study design.
Joseph (2023)	Wrong study design.
Schepers (2013)	Wrong study design.

Literature search strategy

Algemene informatie

Cluster/richtlijn: NVvH traumatisch compexe voetletsels	
Uitgangsvraag/modules: What are the effects of surgeon case volume on outcome in patients with acute traumatic foot injury?	
Database(s): Embase.com, Ovid/Medline	Datum: 9 oktober 2023
Periode: vanaf 2000	Talen: geen restrictie
Literatuurspecialist: Alies van der Wal	Rayyan review: https://rayyan.ai/reviews/789388
BMI-zoekblokken: voor verschillende opdrachten wordt (deels) gebruik gemaakt van de zoekblokken van BMI-Online https://blocks.bmi-online.nl/ Bij gebruikmaking van een volledig zoekblok zal naar de betreffende link op de website worden verwezen.	
Toelichting: Voor deze vraag is gezocht op de elementen: - traumatic foot injury (talus, calcaneus, Chopart or Lisfranc injury) - surgeon/ hospital case volume De sleutelartikelen worden gevonden met deze search	
Te gebruiken voor richtlijntekst: In de databases Embase.com en Ovid/Medline is op 9 oktober 2023 systematisch gezocht naar systematische reviews, RCTs en observationele studies over surgeon/ hospital case volume en traumatische voetletsels. De literatuurzoekactie leverde 308 unieke treffers op.	

Zoekopbrengst

	EMBASE	OVID/MEDLINE	Ontdubbeld
SR	14	16	22
RCT	43	27	50
Observationele studies	149	166	236
Totaal	206	209	**308***

***in Rayyan**

Zoekstrategie

Embase.com

No.	Query	Results
#1	'Lisfranc fracture'/exp OR Lisfranc:ti,ab,kw OR (((forefoot OR 'fore foot' OR midfoot OR 'mid foot' OR tarsometatarsal) NEAR/3 (fractur* OR broken OR injur* OR trauma OR dislocat* OR displac*)):ti,ab,kw) OR (('forefoot'/exp OR 'tarsometatarsal joint'/exp) AND ('fracture'/exp OR 'dislocation'/exp OR 'bone injury'/exp OR 'injury'/exp))	3311
#2	'Chopart joint'/exp OR 'navicular bone'/exp OR 'navicular bone fracture'/exp OR 'navicular fracture'/exp OR 'cuboid bone'/exp OR 'cuboid fracture'/exp OR (((Chopart* OR 'transverse tarsal' OR navicular* OR talonavicular* OR cuboid* OR calcaneocuboid*) NEAR/5 (fractur* OR broken OR dislocat* OR displac* OR trauma* OR injur*)):ti,ab,kw)	1778
#3	'calcaneus fracture'/exp OR diacf:ti,ab,kw OR iacf:ti,ab,kw OR 'tongue type':ti,ab,kw OR sanders*:ti,ab,kw OR ('calcaneus'/exp AND ('fracture'/exp OR 'dislocation'/exp OR 'bone injury'/exp)) OR (((calcan* OR hindfoot OR 'hind foot' OR heel* OR 'os calcis') NEAR/3 (fractur* OR broken OR dislocat* OR displac*)):ti,ab,kw)	7595

#4	'talus fracture'/exp OR (((talar OR talus OR subtalar* OR 'os talare' OR astralagus) NEAR/3 (fractur* OR broken OR dislocat* OR displac* OR trauma* OR injur*)):ti,ab,kw) OR (((talar OR talus) NEAR/3 (neck OR body OR central) NEAR/3 (fractur* OR broken OR dislocat* OR displac* OR luxat* OR trauma* OR injur*)):ti,ab,kw) OR ('talus'/exp AND ('fracture'/exp OR 'dislocation'/exp OR 'bone injury'/exp OR 'injury'/exp))	4454
#5	'foot fracture'/de OR 'tarsal fracture'/exp OR 'foot surgery'/exp OR 'forefoot surgery'/exp OR (((foot OR feet OR forefoot OR forefeet OR midfoot OR hindfoot OR heel*) NEAR/3 (surg* OR operat* OR broke* OR fractur* OR injur* OR trauma OR dislocat* OR displac* OR luxat*)):ti,ab,kw)	20476
#6	'surgeon volume'/exp OR 'surgical volume'/exp OR 'high volume surgeon'/exp OR 'low volume surgeon'/exp OR 'hospital volume'/exp OR 'high volume hospital'/exp OR 'low volume hospital'/exp OR (((surg* OR case* OR consult* OR high* OR low* OR hospital* OR institution*) NEAR/3 volume):ti,ab,kw) OR 'case load':ti,ab,kw OR ((outcome* NEAR/2 volume):ti,ab,kw) OR (('surgeon'/exp OR surgeon*:ti,ab,kw OR 'orthopedic surgery'/exp OR 'hospital'/exp OR hospital*:ti,ab,kw) AND ('experience'/exp OR 'work experience'/exp OR 'job performance'/exp OR 'job experience'/exp)) OR (((surgeon* OR surgical OR orthoped* OR orthopaed* OR hospital* OR institution* OR department*) NEAR/3 (experience* OR performance)):ti,ab,kw)	229765
#7	(#1 OR #2 OR #3 OR #4 OR #5) AND #6	446
#8	#7 NOT ('conference abstract'/it OR 'editorial'/it OR 'letter'/it OR 'note'/it) NOT (('animal'/exp OR 'animal experiment'/exp OR 'animal model'/exp OR 'nonhuman'/exp) NOT 'human'/exp) NOT (('adolescent'/exp OR 'child'/exp OR adolescent*:ti,ab,kw OR child*:ti,ab,kw OR schoolchild*:ti,ab,kw OR infant*:ti,ab,kw OR girl*:ti,ab,kw OR boy*:ti,ab,kw OR teen:ti,ab,kw OR teens:ti,ab,kw OR teenager*:ti,ab,kw OR youth*:ti,ab,kw OR pediatr*:ti,ab,kw OR paediatr*:ti,ab,kw OR puber*:ti,ab,kw) NOT ('adult'/exp OR 'aged'/exp OR 'middle aged'/exp OR adult*:ti,ab,kw OR man:ti,ab,kw OR men:ti,ab,kw OR woman:ti,ab,kw OR women:ti,ab,kw))	350
#9	#8 AND [2000-2023]/py	322
#10	'meta analysis'/exp OR 'meta analysis (topic)'/exp OR metaanaly*:ti,ab OR 'meta analy*':ti,ab OR metanaly*:ti,ab OR 'systematic review'/de OR 'cochrane database of systematic reviews'/jt OR prisma:ti,ab OR prospero:ti,ab OR (((systemati* OR scoping OR umbrella OR 'structured literature') NEAR/3 (review* OR overview*)):ti,ab) OR ((systemic* NEAR/1 review*):ti,ab) OR (((systemati* OR literature OR database* OR 'data base*') NEAR/10 search*):ti,ab) OR (((structured OR comprehensive* OR systemic*) NEAR/3 search*):ti,ab) OR (((literature NEAR/3 review*):ti,ab) AND (search*:ti,ab OR database*:ti,ab OR 'data base*':ti,ab)) OR (('data extraction':ti,ab OR 'data source*':ti,ab) AND 'study selection':ti,ab) OR ('search strategy':ti,ab AND 'selection criteria':ti,ab) OR ('data source*':ti,ab AND 'data synthesis':ti,ab) OR medline:ab OR pubmed:ab OR embase:ab OR cochrane:ab OR (((critical OR rapid) NEAR/2 (review* OR overview* OR synthes*)):ti) OR ((((critical* OR rapid*) NEAR/3 (review* OR overview* OR synthes*)):ab) AND (search*:ab OR database*:ab OR 'data base*':ab)) OR metasynthes*:ti,ab OR 'meta synthes*':ti,ab	968218
#11	'clinical trial'/exp OR 'randomization'/exp OR 'single blind procedure'/exp OR 'double blind procedure'/exp OR 'crossover procedure'/exp OR 'placebo'/exp OR 'prospective study'/exp OR rct:ab,ti OR random*:ab,ti OR 'single blind':ab,ti OR 'randomised controlled trial':ab,ti OR 'randomized controlled trial'/exp OR placebo*:ab,ti	3889356
#12	'major clinical study'/de OR 'clinical study'/de OR 'case control study'/de OR 'family study'/de OR 'longitudinal study'/de OR 'retrospective study'/de OR 'prospective study'/de OR 'comparative study'/de OR 'cohort analysis'/de OR ((cohort NEAR/1 (study OR studies)):ab,ti) OR (('case control' NEAR/1 (study OR studies)):ab,ti) OR (('follow up' NEAR/1 (study OR studies)):ab,ti) OR (observational NEAR/1 (study OR studies)) OR ((epidemiologic NEAR/1 (study OR studies)):ab,ti) OR (('cross sectional' NEAR/1 (study OR studies)):ab,ti)	7873010
#13	'case control study'/de OR 'comparative study'/exp OR 'control group'/de OR 'controlled study'/de OR 'controlled clinical trial'/de OR 'crossover	14481278

	procedure'/de OR 'double blind procedure'/de OR 'phase 2 clinical trial'/de OR 'phase 3 clinical trial'/de OR 'phase 4 clinical trial'/de OR 'pretest posttest design'/de OR 'pretest posttest control group design'/de OR 'quasi experimental study'/de OR 'single blind procedure'/de OR 'triple blind procedure'/de OR (((control OR controlled) NEAR/6 trial):ti,ab,kw) OR (((control OR controlled) NEAR/6 (study OR studies)):ti,ab,kw) OR (((control OR controlled) NEAR/1 active):ti,ab,kw) OR 'open label*':ti,ab,kw OR (((double OR two OR three OR multi OR trial) NEAR/1 (arm OR arms)):ti,ab,kw) OR ((allocat* NEAR/10 (arm OR arms)):ti,ab,kw) OR placebo*:ti,ab,kw OR 'sham-control*':ti,ab,kw OR (((single OR double OR triple OR assessor) NEAR/1 (blind* OR masked)):ti,ab,kw) OR nonrandom*:ti,ab,kw OR 'non-random*':ti,ab,kw OR 'quasi-experiment*':ti,ab,kw OR crossover:ti,ab,kw OR 'cross over':ti,ab,kw OR 'parallel group*':ti,ab,kw OR 'factorial trial':ti,ab,kw OR ((phase NEAR/5 (study OR trial)):ti,ab,kw) OR ((case* NEAR/6 (matched OR control*)):ti,ab,kw) OR ((match* NEAR/6 (pair OR pairs OR cohort* OR control* OR group* OR healthy OR age OR sex OR gender OR patient* OR subject* OR participant*)):ti,ab,kw) OR ((propensity NEAR/6 (scor* OR match*)):ti,ab,kw) OR versus:ti OR vs:ti OR compar*:ti OR ((compar* NEAR/1 study):ti,ab,kw) OR (('major clinical study'/de OR 'clinical study'/de OR 'cohort analysis'/de OR 'observational study'/de OR 'cross-sectional study'/de OR 'multicenter study'/de OR 'correlational study'/de OR 'follow up'/de OR cohort*:ti,ab,kw OR 'follow up':ti,ab,kw OR followup:ti,ab,kw OR longitudinal*:ti,ab,kw OR prospective*:ti,ab,kw OR retrospective*:ti,ab,kw OR observational*:ti,ab,kw OR 'cross sectional*':ti,ab,kw OR cross?ectional*:ti,ab,kw OR multicent*:ti,ab,kw OR 'multi-cent*':ti,ab,kw OR consecutive*:ti,ab,kw) AND (group:ti,ab,kw OR groups:ti,ab,kw OR subgroup*:ti,ab,kw OR versus:ti,ab,kw OR vs:ti,ab,kw OR compar*:ti,ab,kw OR 'odds ratio*':ab OR 'relative odds':ab OR 'risk ratio*':ab OR 'relative risk*':ab OR 'rate ratio':ab OR aor:ab OR arr:ab OR rrr:ab OR ((('or' OR 'rr') NEAR/6 ci):ab)))	
#14	#9 AND #10 = SR	14
#15	#9 AND #11 NOT #14 = RCT	43
#16	#9 AND (#12 OR #13) NOT (#14 OR #15) = observationeel	149
#17	#14 OR #15 OR #16	206

Ovid/Medline

#	Searches	Results
1	(Lisfranc or ((forefoot or 'fore foot' or midfoot or 'mid foot' or tarsometatarsal) adj3 (fractur* or broken or injur* or trauma or dislocat* or displac*))).ti,ab,kf. or (exp Forefoot, Human/ and (exp Fractures, Bone/ or exp Fracture Dislocation/))	2012
2	((Chopart* or 'transverse tarsal' or navicular* or talonavicular* or cuboid* or calcaneocuboid*) adj5 (fractur* or broken or dislocat* or displac* or trauma* or injur*)).ti,ab,kf.	923
3	(diacf or iacf or 'tongue type' or sanders*).ti,ab,kf. or (exp Calcaneus/ and (exp Fractures, Bone/ or exp Fracture Dislocation/)) or ((calcan* or hindfoot or 'hind foot' or heel* or 'os calcis') adj3 (fractur* or broken or dislocat* or displac*)).ti,ab,kf.	5090
4	(((talar or talus or subtalar* or 'os talare' or astralagus) adj3 (fractur* or broken or dislocat* or displac* or trauma* or injur*)) or ((talar or talus) adj3 (neck or body or central) adj3 (fractur* or broken or dislocat* or displac* or luxat* or trauma* or injur*))).ti,ab,kf. or (exp Talus/ and (exp Fractures, Bone/ or exp "Wounds and Injuries"/))	3049
5	exp Foot Injuries/ or ((exp Fractures, Bone/ or exp "Wounds and Injuries"/ or exp Surgical Procedures, Operative/) and (exp Foot/ or exp Foot Bones/ or exp Foot Joints/)) or ((foot or feet or forefoot or forefeet or midfoot or hindfoot or heel*) adj3 (surg* or operat* or broke* or fractur* or injur* or trauma or dislocat* or displac* or luxat*)).ti,ab,kf.	43421
6	exp Hospitals, High-Volume/ or exp Hospitals, Low-Volume/ or ((surg* or case* or consult* or high* or low* or hospital* or institution*) adj3 volume).ti,ab,kf. or 'case load'.ti,ab,kf. or (outcome* adj2 volume).ti,ab,kf. or ((exp Surgeons/ or surgeon*.ti,ab,kf.) and exp Work Performance/) or ((surgeon* or surgical or orthoped* or orthopaed* or hospital* or institution* or department*) adj3 (experience* or performance)).ti,ab,kf.	138939
7	(1 or 2 or 3 or 4 or 5) and 6	415

8	7 not (comment/ or editorial/ or letter/) not ((exp animals/ or exp models, animal/) not humans/) not ((Adolescent/ or Child/ or Infant/ or adolescen*.ti,ab,kf. or child*.ti,ab,kf. or schoolchild*.ti,ab,kf. or infant*.ti,ab,kf. or girl*.ti,ab,kf. or boy*.ti,ab,kf. or teen.ti,ab,kf. or teens.ti,ab,kf. or teenager*.ti,ab,kf. or youth*.ti,ab,kf. or pediatr*.ti,ab,kf. or paediatr*.ti,ab,kf. or puber*.ti,ab,kf.) not (Adult/ or adult*.ti,ab,kf. or man.ti,ab,kf. or men.ti,ab,kf. or woman.ti,ab,kf. or women.ti,ab,kf.))	391
9	limit 8 to yr="2000 -Current"	342
10	meta-analysis/ or meta-analysis as topic/ or (metaanaly* or meta-analy* or metanaly*).ti,ab,kf. or systematic review/ or cochrane.jw. or (prisma or prospero).ti,ab,kf. or ((systemati* or scoping or umbrella or "structured literature") adj3 (review* or overview*)).ti,ab,kf. or (systemic* adj1 review*).ti,ab,kf. or ((systemati* or literature or database* or data-base*) adj10 search*).ti,ab,kf. or ((structured or comprehensive* or systemic*) adj3 search*).ti,ab,kf. or ((literature adj3 review*) and (search* or database* or data-base*)).ti,ab,kf. or (("data extraction" or "data source*") and "study selection").ti,ab,kf. or ("search strategy" and "selection criteria").ti,ab,kf. or ("data source*" and "data synthesis").ti,ab,kf. or (medline or pubmed or embase or cochrane).ab. or ((critical or rapid) adj2 (review* or overview* or synthes*)).ti. or (((critical* or rapid*) adj3 (review* or overview* or synthes*)) and (search* or database* or data-base*)).ab. or (metasynthes* or meta-synthes*).ti,ab,kf.	698254
11	exp clinical trial/ or randomized controlled trial/ or exp clinical trials as topic/ or randomized controlled trials as topic/ or Random Allocation/ or Double-Blind Method/ or Single-Blind Method/ or (clinical trial, phase i or clinical trial, phase ii or clinical trial, phase iii or clinical trial, phase iv or controlled clinical trial or randomized controlled trial or multicenter study or clinical trial).pt. or random*.ti,ab. or (clinic* adj trial*).tw. or ((singl* or doubl* or treb* or tripl*) adj (blind$3 or mask$3)).tw. or Placebos/ or placebo*.tw.	2641262
12	Epidemiologic studies/ or case control studies/ or exp cohort studies/ or Controlled Before-After Studies/ or Case control.tw. or cohort.tw. or Cohort analy$.tw. or (Follow up adj (study or studies)).tw. or (observational adj (study or studies)).tw. or Longitudinal.tw. or Retrospective*.tw. or prospective*.tw. or consecutive*.tw. or Cross sectional.tw. or Cross-sectional studies/ or historically controlled study/ or interrupted time series analysis/ [Onder exp cohort studies vallen ook longitudinale, prospectieve en retrospectieve studies]	4549432
13	Case-control Studies/ or clinical trial, phase ii/ or clinical trial, phase iii/ or clinical trial, phase iv/ or comparative study/ or control groups/ or controlled before-after studies/ or controlled clinical trial/ or double-blind method/ or historically controlled study/ or matched-pair analysis/ or single-blind method/ or (((control or controlled) adj6 (study or studies or trial)) or (compar* adj (study or studies)) or ((control or controlled) adj1 active) or "open label*" or ((double or two or three or multi or trial) adj (arm or arms)) or (allocat* adj10 (arm or arms)) or placebo* or "sham-control*" or ((single or double or triple or assessor) adj1 (blind* or masked)) or nonrandom* or "non-random*" or "quasi-experiment*" or "parallel group*" or "factorial trial" or "pretest posttest" or (phase adj5 (study or trial)) or (case* adj6 (matched or control*)) or (match* adj6 (pair or pairs or cohort* or control* or group* or healthy or age or sex or gender or patient* or subject* or participant*)) or (propensity adj6 (scor* or match*))).ti,ab,kf. or (confounding adj6 adjust*).ti,ab. or (versus or vs or compar*).ti. or ((exp cohort studies/ or epidemiologic studies/ or multicenter study/ or observational study/ or seroepidemiologic studies/ or (cohort* or 'follow up' or followup or longitudinal* or prospective* or retrospective* or observational* or multicent* or 'multi-cent*' or consecutive*).ti,ab,kf.) and ((group or groups or subgroup* or versus or vs or compar*).ti,ab,kf. or ('odds ratio*' or 'relative odds' or 'risk ratio*' or 'relative risk*' or aor or arr or rrr).ab. or (("OR" or "RR") adj6 CI).ab.))	5527263
14	9 and 10 = SR	16
15	(9 and 11) not 14 = RCT	27
16	(9 and (12 or 13)) not (14 or 15) = observationeel	166
17	14 or 15 or 16	209

Kennislacunes

Module 1a: Belaste voetfoto bij complexe voetletsels

- Wat is de toegevoegde waarde van een belaste voetfoto in de acute diagnostische fase bij complexe voetletsel?

Module 1b: CT of MRI bij complexe voetletsels

- Bij hoeveel patiënten die naast een eventuele röntgenfoto géén aanvullende diagnostiek ondergaan, is er complex voetletsel aanwezig?
- Wat is de invloed van bevindingen op CT/MRI op therapeutisch beleid en klinisch beloop?
- Wat is de waarde van een aanvullende X-voet (röntgenfoto) in 3 richtingen?

Moduel 2: Talus fracturen

- Wat zijn de effecten van een uitgestelde definitieve behaneling van een talus fractuur op (functionele) uitkomst?
- Wat is het effect van expertise van de operateur ten aanzien van behandeling van talusfracturen, op de (functionele) uitkomst?

Module 3: Calcaneus fracutren
Er zijn bij deze module geen kennislacunes geformuleerd

Module 4: Chopart letsel

- Wat zijn de voor- en nadelen van een uitgestelde behandeling van Chopart letsel (met gips), gecombineerd met een schoenaanpassing of artrodese indien instabiliteit/artrose optreed?
- Wat is de juiste behandeling (operatief of gipsimmobilisatie) bij patiënten met intra-articulaire fracturen in het Chopart bereik zonder discongruentie (<2 mm step-off of gap) of gewrichten die alleen bij stresstesten een afwijkende alignment hebben?

Module 5: Lisfranc letsel

- Wat zijn de voor- en nadelen van het routinematig verwijderen van osteosynthese materiaal na een ORIF?
  Achtergrond: van Pelt (2019) suggests that routine hardware removal following ORIF of TMTJ fractures may not be necessary as retained hardware appears to be well tolerated in our patient series. Adverse events were significantly more likely if the patient was older, female gender, BMI greater than 30, history of diabetes, or tobacco use.
  Because the the Lisfranc midfoot joint complex has very litle motion, the importance of removal as a standard procedure can be debatable.

Module 6: Nabehandeling

- Leidt gipsimmobilisatie na een operatief behandeld complex voetletsel tot een beter behandelresultaat in de zin van fractuur genezing, functie van de voet en activiteiten en participatie? En wat is hierbij de optimale duur van gipsimmobilisatie?
- Leidt early of permissive weight bearing na een operatief behandeld complex voetletsel tot een beter behandelresultaat in de zin van fractuur genezing, functie van de voet en hervatten van activiteiten en participatie?
- Wat is de plaats van fysiotherapie bij de nabehandeling van complex voetletsel?

Module 7: Organisatie van zorg:
Er zijn bij deze module geen kennislacunes geformuleerd

Implementatieplan

Aanbeveling	Tijdspad voor implementatie: <1 jaar, 1-3 jaar of >3 jaar	Verwacht effect op kosten	Randvoorwaarden voor implementatie (binnen aangegeven tijdspad)	Mogelijke barrières voor implementatie[1]	Te ondernemen acties voor implementatie[2]	Verantwoordelijken voor acties[3]	Overige opmerkingen
Diagnostiek: belaste foto *1e: Belaste opname SEH* *2e: Belaste opname bij Lisfranc letsel*	1-3 jaar	Waarschijnlijk nihil	Kennis over correcte uitvoer belaste foto Communicatie binnen ziekenhuizen tussen radiologie en traumatologie. Logistiek mogelijk maken van extra opname. Kennis over correcte uitvoering belaste opname	Gebrek aan capaciteit radiologie	Verspreiding van de richtlijn Communicatie binnen ziekenhuizen	Betrokken wetenschappelijke verenigingen Ziekenhuisbestuurders	Incidentie complex voetletsel is laag, waardoor de impact op kosten en middelen naar verwachting beperkt is
Diagnostiek: CT/MRI *Aanvullende CT*	1-3 jaar	Onduidelijk	Aanwezigheid/capaciteit van CT-scan/MRI	Gebrek aan capaciteit radiologie Kostenoverwegingen personeel	Verspreiding van de richtlijn Communicatie binnen ziekenhuizen	Betrokken wetenschappelijke verenigingen	
Talus *1e: spoedreductie binnen 8 uur* *2e: uitstellen chirurgische behandeling bij afwezigheid expertise*	1-3 jaar	Geen	Goede afspraken en communicatie binnen de regio t.a.v. spoedzorg en behandeling van patiënten met trauma	Geen goede communicatie en/of afspraken tussen de ziekenhuizen binnen een regio	Communicatie tussen ziekenhuizen, overleg binnen regio	Betrokken wetenschappelijke verenigingen Behandelend trauma/orthopedisch chirurgen	Incidentie talusfracturen is laag (+/- 100) Sluit grotendeels aan bij huidige beleid

3e: 1 of 2 incisies bij talus fractuur			Expertise t.a.v. het uitvoeren van operatieve behandeling van het talus gewricht	Gebrek aan traumatologische/chirurgische expertise binnen een centrum	Educatie, verspreiding van de richtlijn.		
Calcaneus *1e: operatieve of conservatieve behandeling* *2e: minimaal invasieve techniek versus operatief*	1-3 jaar	Geen	Expertise t.a.v. het uitvoeren van operatieve behandeling van het calcaneus gewricht	Gebrek aan traumatologische/chirurgische expertise binnen een centrum	Educatie, verspreiding van de richtlijn.	Betrokken wetenschappelijke verenigingen Behandelend trauma/orthopedisch chirurgen	Incidentie calcaneus fracturen is laag (+/- 300) Sluit grotendeels aan bij huidige beleid
Chopart *Operatieve of conservatieve behandeling*	1 tot 3 jaar	Geen	Expertise t.a.v. het uitvoeren van operatieve behandeling van het Chopart gewricht	Gebrek aan traumatologische expertise t.a.v. behandeling chopartletsel	Educatie, verspreiding van de richtlijn.	Betrokken wetenschappelijke verenigingen Behandelend trauma/orthopedisch chirurgen	Incidentie Chopart fracturen is laag (+/- 100) Sluit grotendeels aan bij huidige beleid
Lisfranc *1e: operatieve of conservatieve behandeling* *2e: primaire arthrodese of ORIF*	1 tot 3 jaar	Geen	Expertise t.a.v. het uitvoeren van operatieve behandeling van het Chopart gewricht	Gebrek aan traumatologische expertise t.a.v. behandeling chopartletsel	Educatie, verspreiding van de richtlijn.	Betrokken wetenschappelijke verenigingen Behandelend trauma/orthopedisch chirurgen	Incidentie Chopart fracturen is laag (< 400) Sluit grotendeels aan bij huidige beleid
Nabehandeling	1 tot 3 jaar	Geen	Kennis over nabehandeling complex voetletsel.	Gebrek aan kennis over de nabehandeling.	Communicatie tussen ziekenhuizen, overleg binnen regio	Betrokken wetenschappelijke verenigingen	

1e: gipsimmobilisatie bij de nabehandeling 2e: mate van belasting bij nabehandeling kunnen van invloed zijn				Geen goede communicatie en/of afspraken tussen ziekenhuizen, fysiotherapie en revalidatiecentra	Educatie, verspreiding van de richtlijn.	Behandelend trauma/orthopedisch chirurgen	
Organisatie van zorg: *Regel bij voorkeur binnen de regio wie de complexe voet letsels behandeld*	1-3 jaar	Door een daling van complicaties zal er een reductie in kosten ontstaan	Beschikbare middelen en operatie-tijd Afspraken tussen ziekenhuizen in de regio over doorverwijzing en behandeling.	Patiënt niet door willen of kunnen sturen Onvoldoende aandacht voor het belang van de patiënt Te weinig operatietijd in één centrum	Communicatie tussen ziekenhuizen, overleg binnen regio Educatie, verspreiding van de richtlijn.	Betrokken wetenschappelijke verenigingen Behandelend trauma/orthopedisch chirurgen binnen de regio (ROAZ)	

[1] Barrières kunnen zich bevinden op het niveau van de professional, op het niveau van de organisatie (het ziekenhuis) of op het niveau van het systeem (buiten het ziekenhuis). Denk bijvoorbeeld aan onenigheid in het land met betrekking tot de aanbeveling, onvoldoende motivatie of kennis bij de specialist, onvoldoende faciliteiten of personeel, nodige concentratie van zorg, kosten, slechte samenwerking tussen disciplines, nodige taakherschikking, etc.

[2] Denk aan acties die noodzakelijk zijn voor implementatie, maar ook acties die mogelijk zijn om de implementatie te bevorderen. Denk bijvoorbeeld aan controleren aanbeveling tijdens kwaliteitsvisitatie, publicatie van de richtlijn, ontwikkelen van implementatietools, informeren van ziekenhuisbestuurders, regelen van goede vergoeding voor een bepaald type behandeling, maken van samenwerkingsafspraken.

[3] Wie de verantwoordelijkheden draagt voor implementatie van de aanbevelingen, zal tevens afhankelijk zijn van het niveau waarop zich barrières bevinden. Barrières op het niveau van de professional zullen vaak opgelost moeten worden door de beroepsvereniging. Barrières op het niveau van de organisatie zullen vaak onder verantwoordelijkheid van de ziekenhuisbestuurders vallen. Bij het oplossen van barrières op het niveau van het systeem zijn ook andere partijen, zoals de NZA en zorgverzekeraars, van belang.