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Talar prosthetic replacement and talus-sacrificing hindfoot arthrodesis for advanced talar avascular necrosis in adults: a systematic review

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Systematic Review

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Abstract

Background

Once avascular necrosis (AVN) has collapsed the talar body, surgeons must choose between prosthetic replacement, which preserves ankle motion, and talus-sacrificing hindfoot arthrodesis, which does not. No previous review has examined both within a single evidence frame. This review aimed to establish outcome benchmarks for each strategy and to pool outcomes where sufficient independent cohorts were available.

Methods

PubMed/MEDLINE, Embase, Scopus, Web of Science and Cochrane CENTRAL were searched from inception to [date], supplemented by a further database search. Studies of at least five adults with advanced talar AVN treated with talar body or total talar prosthesis, or with tibiotalocalcaneal or tibiocalcaneal arthrodesis, with at least 12 months of follow-up were eligible. Serial reports of the same patients were counted once, and studies combining AVN with other indications without separate reporting were treated as non-contributory. Methodological limitations were assessed descriptively. Outcomes reported by at least four independent cohorts were pooled with a random-effects generalised linear mixed model.

Results

Fourteen reports describing 11 studies were eligible but represented seven independent cohorts: three of prosthetic replacement (92 ankles) and four of arthrodesis (58 ankles). All were retrospective and six were uncontrolled case series. The pooled union rate after arthrodesis was 90.4% (95% confidence interval 67.5% to > 99.9%), although leave-one-out estimates ranged from 79.5% to 100% and the 95% prediction interval spanned 2.8% to > 99.9%. Pain and function improved in all three prosthesis cohorts, but only one reported reoperation as an event count. One matched comparative study reported 10-year survivorship of 95.8% with prosthesis and 70.8% with arthrodesis.

Conclusions

The available evidence is too sparse and heterogeneous to establish the superiority of either strategy, and its apparent volume overstates the number of distinct cohorts studied. Treatment selection should be guided by residual bone stock, soft-tissue status and implant availability. Comparative studies reporting reoperation-free survival by diagnosis are needed.

Systematic review registration:

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Background

The talus is unusual among human bones. Approximately three-fifths of its surface is covered by articular cartilage, it has no direct muscular or tendinous insertion, and its blood supply depends on a retrograde extraosseous network dominated by the artery of the tarsal canal [1]. This arrangement leaves the talar body vulnerable to devascularisation after displaced neck fractures and fracture-dislocations, with risk rising according to the Hawkins grade of injury [2, 3]. Trauma is the most frequently reported cause of talar avascular necrosis (AVN); other reported causes include corticosteroid exposure, inflammatory arthropathy, haemoglobinopathy, alcohol use and idiopathic disease [4].

Before subchondral collapse, joint-preserving options remain available, including protected weightbearing, core decompression and vascularised bone grafting [4, 5]. Once the subchondral plate fails and the dome collapses, these approaches lose their rationale, talar height is lost and the adjacent joints degenerate. Where the talar head and neck survive, joint-sparing fusion remains possible; where the body must be sacrificed, the surgeon must choose between fusing across the resulting defect and replacing the bone. Talus-sacrificing arthrodesis takes two forms: tibiotalocalcaneal (TTC) arthrodesis, in which the necrotic body is excised or debrided and the tibia fused to the residual talus and calcaneus, and tibiocalcaneal arthrodesis after complete talectomy [6, 7]. Both relieve pain when they unite but abolish tibiotalar and subtalar motion. Talar prosthetic replacement offers the alternative of preserving motion and talar height, and has evolved from the early talar body prosthesis through customised alumina-ceramic total talar prostheses to three-dimensionally printed metal implants [8–11].

Two features of this literature make it difficult to summarise. Several high-volume centres have published serially on the same growing patient series, so the number of publications exceeds the number of distinct cohorts; and many series combine patients treated for AVN with patients treated for failed arthroplasty, fracture, tumour or bone loss, reporting outcomes by procedure rather than by diagnosis. Both features matter for evidence synthesis: counting the same patients more than once narrows confidence intervals artificially, and pooling mixed indications attributes to AVN results that may belong to other conditions. Previous systematic reviews have addressed talar replacement alone or treatments for talar AVN across all disease stages [5, 12], but none has placed the motion-preserving and motion-sacrificing strategies within a single evidence frame restricted to patients whose talar body must be sacrificed. Only one study has compared the two directly [13].

The question also has practical implications for health systems. Custom talar prostheses depend on patient-specific imaging, design and manufacture, whereas arthrodesis uses standard implants available in most orthopaedic centres. A clear account of what is known about each strategy, and of how much of the published evidence represents distinct patients, is therefore needed to inform surgical decisions where only one option may be available. This review aimed to establish outcome benchmarks for

prosthetic replacement and talus-sacrificing arthrodesis in adults with advanced talar AVN, to pool outcomes where sufficient independent cohorts permitted, and to assess whether indirect evidence is concordant with the single available direct comparison.

Methods

This systematic review was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement [14]. Because all included studies were observational, reporting additionally followed the Meta-analysis of Observational Studies in Epidemiology (MOOSE) proposal [15], and outcomes that could not be pooled were synthesised following the Synthesis Without Meta-analysis (SWiM) guideline [16].

Eligibility criteria

Studies were eligible if they enrolled adults aged 18 years or older with advanced AVN of the talus, defined as Ficat-Arlet stage III or IV, Hawkins stage III or IV, or radiographic talar dome collapse, in whom the talar body was sacrificed or replaced. The intervention was talar body or total talar prosthetic replacement of any material, performed alone or combined with ankle arthroplasty or adjacent-joint fusion. The comparator was talus-sacrificing hindfoot arthrodesis, comprising TTC arthrodesis and tibiocalcaneal arthrodesis after talectomy, with any fixation or graft. Blair-type tibiotalar fusion, isolated tibiotalar fusion with a retained talar body, isolated subtalar arthrodesis and pantalar arthrodesis were excluded because each retains one or more hindfoot articulations. Eligible designs were comparative studies and case series reporting at least five ankles with a mean or median follow-up of at least 12 months. Case reports, reviews, biomechanical studies and conference abstracts without extractable data were excluded. Records were also excluded where AVN featured only as a complication of a fracture series, an exclusion criterion, a contraindication or a prognostic variable. Studies were grouped for synthesis by intervention arm, and within the arthrodesis arm by fusion construct.

Information sources

PubMed/MEDLINE, Embase, Scopus, Web of Science Core Collection and the Cochrane Central Register of Controlled Trials were searched from inception to [date] without language restriction. ClinicalTrials.gov and the WHO International Clinical Trials Registry Platform were searched for registered studies, and the reference lists of included studies and previous reviews were screened. Because the primary search failed to retrieve several studies later found to be eligible, a supplementary database search was performed on [date] and screened against the same criteria.

Search strategy

Strategies combined concept blocks for the talus, osteonecrosis and the interventions, using controlled vocabulary and free-text terms in database-native syntax. The PubMed strategy was: (talus[tiab] OR talar[tiab] OR astragalus[tiab] OR talectomy[tiab] OR "Talus"[Mesh]) AND ("Osteonecrosis"[Mesh] OR

osteonecro*[tiab] OR "avascular necrosis"[tiab] OR "aseptic necrosis"[tiab] OR AVN[tiab] OR Hawkins[tiab] OR Ficat[tiab] OR collapse[tiab]) AND ("Arthroplasty, Replacement"[Mesh] OR "Prostheses and Implants"[Mesh] OR "Arthrodesis"[Mesh] OR prosthes*[tiab] OR arthroplast*[tiab] OR replacement[tiab] OR implant*[tiab] OR "total talar"[tiab] OR "total talus"[tiab] OR arthrodes*[tiab] OR fusion[tiab] OR tibiotalocalcaneal[tiab] OR tibiocalcaneal[tiab] OR "retrograde nail"[tiab] OR "intramedullary nail"[tiab]). No date, language or publication-type filters were applied. Strategies for the remaining databases are provided as supplementary material.

Selection process

Two reviewers independently screened all records by title and abstract and then assessed potentially eligible reports in full text. Disagreements were resolved by discussion until consensus was reached. Screening decisions were recorded after consensus, so a kappa statistic for inter-reviewer agreement could not be calculated. Study eligibility was adjudicated separately from independent-cohort status: reports were grouped by institution, implant and recruitment window, and within each group the report contributing the largest number of eligible ankles was retained. A study was classified as eligible but non-contributory where AVN was combined with other indications and outcomes were not reported by diagnosis. Where a study used more than one fusion construct, constructs were classified per patient and ineligible patients were removed from the numerator and denominator.

Data items

The primary outcomes were reoperation-free survival and limb salvage, chosen because they are defined identically for both procedures. Secondary outcomes were implant survivorship, pain and function for the prosthesis arm, and radiographic union, pain, function and complications for the arthrodesis arm. Reoperation was defined as any unplanned return to theatre on the index limb for any cause, and limb salvage as freedom from major amputation. Union was recorded as defined by each source study, together with the imaging modality and whether clinical criteria were applied where these were reported. All reported results compatible with each outcome were sought at final follow-up, and where a study reported outcomes at several time points, the latest was extracted. Other data extracted were study design, country, institution, recruitment period, sample size, indication, intervention and construct, fixation, graft and follow-up duration. Corresponding authors were contacted where diagnosis-specific data were not reported, with a second approach after 14 days.

Assessment of methodological limitations

Because the evidence consisted predominantly of small retrospective case series, formal risk-of-bias tools and certainty-of-evidence grading were not applied. Methodological limitations relevant to interpretation were instead assessed descriptively for each study by both reviewers, covering sample size, retrospective design, absence of a comparator group, heterogeneity of indications and surgical techniques, completeness of outcome reporting and potential overlap between study populations.

Effect measures

Dichotomous outcomes were summarised as proportions with 95% confidence intervals (CIs). Continuous outcomes were reported as preoperative and postoperative means as given by the source studies. Between-arm relative effects were not calculated, because the arms share no common comparator.

Synthesis methods

Quantitative synthesis was prespecified for any outcome reported by at least four independent cohorts within an arm. Proportions were pooled using a random-effects generalised linear mixed model, a random-intercept logistic regression fitted by maximum likelihood with Gauss-Hermite quadrature, which accommodates studies with event rates of 100% without continuity correction [17]. The CI of the pooled estimate was derived by profile likelihood, and a 95% prediction interval was calculated from a t distribution with k minus 2 degrees of freedom. Heterogeneity was quantified with Cochran Q and I^2 from a Freeman-Tukey double arcsine model with DerSimonian-Laird estimation, which also served as a sensitivity analysis together with leave-one-out analysis. Study-level CIs used the Clopper-Pearson method. Results were displayed in a forest plot. With four cohorts, subgroup analysis and meta-regression were not feasible and tests for small-study effects were not performed. Analyses were conducted in Python 3 with SciPy. Outcomes reported by fewer than four cohorts were tabulated and synthesised narratively without pooling.

Results

Study selection

The primary database search identified 2,184 records, of which 524 were duplicates. Of 1,660 records screened, 95 were assessed in full text and 11 met the eligibility criteria. The supplementary search identified 20 unique records; four duplicated reports already included and five were not primary studies, and of the 11 assessed, three met the criteria. In total, 14 reports describing 11 studies were eligible (Fig. 1). Excluded records from the supplementary search comprised five series that combined AVN with other indications without separate reporting, one probable overlapping cohort, one ineligible construct and one study in which the indication was not AVN.

Study characteristics

Assessment of publication history, patient overlap, indication and construct reduced the 14 reports to seven independent cohorts (Table 1). Two reports from one Bangkok institution described a single talar body prosthesis programme; the earlier was folded into the later, which was non-contributory because its 23 osteonecrosis cases were combined with eight fractures and two tumours [8, 18]. Three reports from one Japanese institution described a continuous programme, and the 55-ankle report was retained as the cohort of record [9, 10, 19]. Two multicentre series combined AVN with failed arthroplasty and bone-

loss indications without diagnosis-specific reporting [20, 21]. One arthrodesis series used five constructs across 11 ankles, only two of which were talus-sacrificing, and three of its ankles were pre-collapse; it was retained for narrative synthesis only [22]. The prosthesis arm of the comparative study was not counted because its institution and recruitment window overlap with the Bangkok programme [13].

Table 1 Cohort adjudication of the 14 eligible reports

Report	Institution	Period	n	Decision
Harnroongroj 1997 [8]	Siriraj, Thailand	1974–1990	16	Lineage; folded into 2014
Harnroongroj 2014 [18]	Siriraj, Thailand	1974–2011	33	Non-contributory
Taniguchi 2012 [9]	Nara, Japan	1999–2006	22	Lineage; superseded design
Taniguchi 2015 [10]	Nara, Japan	2005–2012	55	Cohort, prosthesis
Morita 2022 [19]	Nara, Japan	2005–2011	19	Lineage; long-term subset
Kadakia 2020 [23]	Duke, USA	3 years	27	Cohort, prosthesis
Ouchi 2023 [24]	Fukushima, Japan	2007–2015	10	Cohort, prosthesis
So 2025 [20]	7 centres, USA	2016–2021	36	Non-contributory
Davies 2026 [21]	4 centres, UK	2019–2024	27	Non-contributory
Harnroongroj 2024, prosthesis [13]	Siriraj, Thailand	2005–2012	24	Not counted; overlap
Harnroongroj 2024, arthrodesis [13]	Siriraj, Thailand	2005–2012	24	Cohort, arthrodesis
Dennison 2001 [6]	Chertsey, UK	1994–1999	6	Cohort, arthrodesis
DeVries 2010 [25]	Wisconsin, USA	NR	14	Cohort, arthrodesis
Tenenbaum 2015 [26]	Dallas, USA	NR	14	Cohort, arthrodesis
Urquhart 1996 [22]	Baltimore, USA	1980–1992	11	Excluded from synthesis

n: ankles or patients as reported; NR: not reported. The comparative study appears in two rows because its arms were adjudicated separately but counts as one report.

The seven contributing cohorts are summarised in Table 2. All were retrospective; six were uncontrolled case series and one was a matched comparative study. Cohort size ranged from 6 to 55 ankles. The prosthesis cohorts originated from academic centres in Japan and the United States, and the arthrodesis cohorts from the United Kingdom, the United States and Thailand.

Table 2 Characteristics and principal limitations of the seven contributing cohorts

Study	Design	n	Intervention	Follow-up	Principal limitation
Prosthetic replacement					
Taniguchi 2015 [10]	Case series	55	Alumina ceramic total talus	[from full text]	No comparator; reoperation not reported
Kadakia 2020 [23]	Case series	27	3D-printed metal total talus	22.2 months	No comparator; short follow-up
Ouchi 2023 [24]	Case series	10	Total talar replacement	[from full text]	Small sample; reoperation not reported
Talus-sacrificing arthrodesis					
Dennison 2001 [6]	Case series	6	Tibiocalcaneal, Ilizarov frame	32 months*	Very small sample; construct varied
DeVries 2010 [25]	Case series	14	TTC, retrograde nail	[from full text]	No comparator; mixed aetiology
Tenenbaum 2015 [26]	Case series	14	TTC, retrograde nail, no structural graft	26 months	No comparator; construct varied
Harnroongroj 2024 [13]	Matched comparative	24	TTC arthrodesis	10–13 years	Demographic matching only; possible overlap

Follow-up given as mean unless stated. *After frame removal. TTC: tibiotalocalcaneal. Cells marked [from full text] require completion before submission.

Methodological limitations of included studies

All contributing cohorts were observational and retrospective, and only one included a comparator group. Sample sizes were small, and single-digit event counts were typical. Outcome assessors were not blinded in any study. Two of the three prosthesis cohorts did not report reoperation as an event count. In the comparative study, matching was demographic only, without adjustment for extent of bone loss, aetiology, smoking or prior surgery. In two arthrodesis cohorts the construct varied within the series according to talar head viability [6, 26]. These limitations indicate that the findings should be read as descriptive benchmarks rather than as estimates of comparative effectiveness.

Results of individual cohorts

In the prosthesis arm, all three cohorts reported improvement in pain and function (Table 3). In the largest cohort, Japanese Society for Surgery of the Foot (JSSF) scores improved from 43.1 ± 17.0 to 89.4 ± 8.4, with no implant dislocation or migration [10]. In the three-dimensionally printed cohort, visual analogue scale (VAS) pain improved from 7.1 to 3.9 and Foot and Ankle Outcome Scores improved in all subscales, with ankle motion unchanged; three complications required reoperation [23]. In the idiopathic cohort, VAS pain improved from 80 ± 8 to 18 ± 22 and JSSF scores from 53 ± 12 to 89 ± 7 [24].

In the arthrodesis arm, union was achieved in six of six ankles treated with Ilizarov tibiocalcaneal fusion [6], 12 of 14 treated with retrograde-nail TTC fusion, the remaining two forming stable braceable pseudarthroses [25], 14 of 14 treated with retrograde-nail fusion without structural graft [26], and 17 of 24 in the comparative study [13]. In the series without structural graft, VAS pain improved from 6.9 to 1.7 and American Orthopaedic Foot and Ankle Society (AOFAS) scores from 32.7 to 72.1, with one stress fracture, four hardware removals and one superficial infection [26]. All six patients in the Ilizarov series developed pin-site infection [6]. No amputations were reported in any contributing arthrodesis cohort. The comparative study reported 10-year survivorship of 95.8% for the talar body prosthesis and 70.8% for TTC arthrodesis, with pain and function scores favouring the prosthesis [13].

Table 3 Outcomes of individual contributing cohorts

Cohort	Pain	Function	Union, failure or reoperation
Prosthetic replacement			
Taniguchi 2015 [10]	AOS 6.1 → 2.0	JSSF 43.1 → 89.4	No dislocation or migration; reoperation NR
Kadakia 2020 [23]	VAS 7.1 → 3.9	FAOS improved	Reoperation 3/27
Ouchi 2023 [24]	VAS 80 → 18	JSSF 53 → 89	Reoperation NR
Talus-sacrificing arthrodesis			
Dennison 2001 [6]	NR	5 of 6 good or excellent	Union 6/6
DeVries 2010 [25]	NR	8 of 14 walked unaided	Union 12/14
Tenenbaum 2015 [26]	VAS 6.9 → 1.7	AOFAS 32.7 → 72.1	Union 14/14; 4 hardware removals
Harnroongroj 2024 [13]	NRS worse than prosthesis	FAAM worse than prosthesis	Union 17/24; survivorship 70.8%

AOFAS: American Orthopaedic Foot and Ankle Society score; AOS: Ankle Osteoarthritis Scale; FAAM: Foot and Ankle Ability Measure; FAOS: Foot and Ankle Outcome Score; JSSF: Japanese Society for Surgery of the Foot score; NR: not reported; NRS: numerical rating scale; VAS: visual analogue scale.

Meta-analysis of union

Union in the arthrodesis arm was the only outcome reported by four independent cohorts and was therefore pooled; the contributing cohorts comprised 58 ankles, all retrospective and three uncontrolled. The pooled union rate was 90.4% (95% CI 67.5% to >99.9%), and the 95% prediction interval extended from 2.8% to >99.9% (Fig. 2). The Freeman-Tukey sensitivity model gave a similar estimate of 91.1% (95% CI 72.2% to 99.9%), with moderate heterogeneity ($Q = 8.470$, $P = 0.037$; $I^2 = 65\%$). On leave-one-out analysis the estimate ranged from 79.5%, when the 14-ankle series with complete union was omitted, to 100%, when the series with two pseudarthroses was omitted. No outcome in the prosthesis arm was reported by enough cohorts to pool, and no between-arm comparison was performed.

Discussion

Both reconstructive strategies were associated with substantial improvement in pain and function, and limb loss was rare in the contributing cohorts. Union after talus-sacrificing arthrodesis could be pooled across four cohorts and was high, at approximately nine in ten ankles. However, the evidence base comprises seven small, retrospective and mostly uncontrolled cohorts, and no outcome was reported consistently enough across both arms to permit comparison.

The pooled union estimate must be read alongside its instability. Two of the four cohorts reported complete union in six and 14 ankles, while the only study with a comparator group and 10-year follow-up reported the lowest rate. The estimate shifted by more than 20 percentage points depending on which single study was omitted, and the prediction interval spans almost the entire possible range, indicating that the union rate in a new setting cannot be predicted from these data. This pattern is characteristic of pooling very few small studies, and it shows that a prespecified threshold of four cohorts permits an estimate without ensuring a stable one. The lower rate in the comparative study may reflect its longer follow-up, its inclusion of patients unsuitable for prosthesis, or differences in fixation and graft, none of which can be separated with the available data.

The most consequential finding is methodological. Fourteen eligible reports represented only seven independent cohorts once serial publication, mixed-indication reporting and construct heterogeneity were accounted for. Mixed-indication reporting proved the most costly: three otherwise well-conducted studies, including the two largest multicentre series, could not contribute because outcomes were stratified by procedure rather than by diagnosis [18, 20, 21]. In addition, three eligible studies with talar AVN stated in their titles were not retrieved by the primary search and were identified only through supplementary searching [23, 25, 26]. Counting publications alone would have suggested an evidence base twice its actual size, and relying on a single search would have omitted almost half of the arthrodesis evidence. Reviews in this field should adjudicate at cohort level and verify search sensitivity against known eligible studies before deciding whether pooling is feasible.

The two arms cannot be compared by juxtaposing their results. The prosthesis cohorts derive from academic centres with access to custom implants, and one was restricted to idiopathic disease,

whereas the arthrodesis cohorts include heavily pre-operated post-traumatic patients; one series reported a mean of five previous procedures before fusion [6]. These populations are not exchangeable, and any apparent difference is confounded by indication. Failure also carries different meanings, namely revision or explantation after replacement and nonunion after fusion, which may be asymptomatic and braceable [25]. Reoperation-free survival was chosen as the anchor because it is defined identically for both procedures, yet only one prosthesis cohort reported it as an event count and the arthrodesis cohorts reported reoperations inconsistently. This reporting gap, more than the absolute number of studies, prevents comparison of the two strategies. The direction of the single direct comparison favoured prosthesis [13], but that study shares an institution and recruitment window with an earlier prosthesis series and matched patients on demographic variables alone, so it cannot be regarded as independent confirmation.

These findings are consistent with, but narrower than, those of previous reviews. An earlier systematic review of treatments for talar AVN across all disease stages identified 19 studies comprising 321 ankles, all Level IV, rated the overall quality of evidence as very low, and recommended that arthrodesis be reserved as a salvage procedure [5]. A review of total talus replacement without concomitant arthroplasty or fusion reported favourable functional outcomes [12], and a review of combined total ankle and total talus replacement identified 16 studies comprising 139 ankles with mixed aetiologies, in which revision details were sparsely reported [27]. The present review differs by restricting eligibility to patients in whom the talar body was sacrificed, by placing replacement and fusion in a single evidence frame, and by adjudicating overlapping cohorts before synthesis. The sparse reporting of revision noted in the earlier review mirrors the failure-reporting gap observed here, and suggests that the problem is general to this literature rather than specific to the studies included.

Definitions of union also differed across the contributing studies. Union was assessed radiographically in all four arthrodesis cohorts, but the imaging modality and the criteria applied were not reported uniformly, and one series distinguished stable braceable pseudarthrosis from failed fusion [25]. Pooling union therefore combines outcomes that may not be strictly equivalent, which may contribute to the heterogeneity observed. Future studies should report union confirmed on computed tomography where possible, distinguish symptomatic from asymptomatic nonunion, and state whether nonunion led to further surgery.

Construct heterogeneity within the arthrodesis arm further limits interpretation. One series performed tibiocalcaneal fusion after talectomy in four ankles and retained the talar head and neck in ten [26], and another varied its technique according to talar head viability [6]. Arthrodesis therefore represents a family of constructs, and the pooled union rate should be read as an average across techniques rather than the expected result of any one. Similarly, the prosthesis arm combines ceramic and three-dimensionally printed metal designs, and the earlier ceramic talar body design was abandoned by its developers in favour of total talar replacement after four of 22 ankles required revision [9].

Follow-up duration also differed markedly between and within the arms, which complicates any reading of durability. Mean follow-up in the contributing cohorts ranged from approximately two years in the three-dimensionally printed prosthesis series and the fusion series without structural graft to 10 to 13 years in the comparative study, and only one prosthesis report, a long-term subset of a contributing cohort, extended beyond a decade [13, 19, 23, 26]. Because implant loosening, adjacent-joint degeneration and late nonunion may emerge only after several years, short-term series are likely to understate failure in both arms, and survivorship figures from cohorts of very different duration cannot be compared directly.

For practice, the evidence supports framing the decision according to remaining bone stock, soft-tissue condition and implant availability rather than as a binary choice. Where custom implants are available, prosthetic replacement preserves motion, and a long-term subset of the largest cohort showed stable function without subsidence beyond 10 years [19]. Where they are not, TTC or tibiocalcaneal arthrodesis achieves union in most patients using standard implants, at the cost of lost hindfoot motion and, with external fixation, prolonged treatment and pin-site morbidity [6]. This distinction is relevant wherever access to patient-specific implants is limited. For research, the field requires prospective multicentre or registry-based data collection with a common core outcome set, mandatory reporting of indication and construct, and reoperation-free survival reported with Kaplan-Meier estimates and numbers at risk.

This review has limitations at both the evidence and review levels. All evidence is observational and predominantly Level IV. Formal risk-of-bias appraisal and certainty grading were not performed, which is a particular weakness given that a pooled estimate is reported. Only one outcome in one arm could be pooled, and with four cohorts the estimate is unstable and heterogeneity cannot be explored. The primary search failed to retrieve three eligible studies, raising the possibility that others remain unidentified, and data for these three cohorts were extracted from abstracts and require full-text confirmation. Outcome instruments differed across studies, three eligible reports could not contribute because AVN patients were not reported separately, and a kappa statistic for reviewer agreement could not be calculated.

Conclusions

Current evidence does not establish whether talar prosthetic replacement or talus-sacrificing hindfoot arthrodesis provides superior outcomes in adults with advanced AVN of the talus. Both strategies were associated with improvement in pain and function in most reported patients, and arthrodesis achieved union in approximately nine of ten ankles, although this estimate is unstable and its prediction interval is wide. The 14 eligible reports represented only seven independent cohorts, so the apparent volume of evidence overstates the number of distinct patients studied. Treatment selection should therefore be guided by residual talar bone stock, soft-tissue status and implant availability, and prospective registry-based studies reporting reoperation-free survival by diagnosis are required before either strategy can be recommended over the other.

Abbreviations

AOFAS: American Orthopaedic Foot and Ankle Society; AOS: Ankle Osteoarthritis Scale; AVN: Avascular necrosis; CI: Confidence interval; FAAM: Foot and Ankle Ability Measure; FAOS: Foot and Ankle Outcome Score; GLMM: Generalised linear mixed model; JSSF: Japanese Society for Surgery of the Foot; MOOSE: Meta-analysis of Observational Studies in Epidemiology; NRS: Numerical rating scale; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses; SWiM: Synthesis Without Meta-analysis; TTC: Tibiotalocalcaneal; VAS: Visual analogue scale.

Declarations

Ethics approval and consent to participate

Not applicable. This study is a systematic review of previously published data and did not involve human participants.

Human Ethics and Consent to Participate declarations

Not applicable.

Consent for publication

Not applicable.

Clinical trial number

Not applicable.

Availability of data and materials

All data analysed during this study are included in this published article and the cited source studies. The data extraction sheet, cohort adjudication matrix and analysis code are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

FNS conceived the study, developed the protocol, performed screening, data extraction, cohort adjudication and statistical analysis, and drafted the manuscript. NH performed independent screening and data extraction, contributed to cohort adjudication, and critically revised the manuscript. Both authors read and approved the final manuscript.

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Not applicable.

Registration and protocol

The review was registered on PROSPERO (CRD420261507894). Two deviations from the registered protocol occurred: the planned meta-analysis was restricted to the single outcome that met the prespecified threshold of four independent cohorts, and formal risk-of-bias and certainty assessment were replaced by descriptive assessment of methodological limitations.

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Table

Table 4 *Design and principal methodological limitations of the contributing cohorts*

Study	Design	n (ankles)	Intervention	Follow-up	Principal limitation
Taniguchi et al. (2015)	Case series	55	Total talar prosthesis	[from full text]	No comparator group; reoperation not reported as an event count
Ouchi et al. (2023)	Case series	10	Total talar replacement	[from full text]	Small sample; no comparator group; reoperation not reported
Dennison et al. (2001)	Case series	6	Tibiocalcaneal fusion with Ilizarov frame	Mean 32 months after frame removal	Very small sample; no comparator group; construct varied within the series
Harnroongroj et al. (2024)	Retrospective comparative study	24 (arthrodesis arm)	TTC arthrodesis vs talar body prosthesis	10–13 years	Retrospective design; demographic matching only; potential population overlap with an earlier series from the same institution

Note. TTC = tibiotalocalcaneal. Cells marked [from full text] require completion before submission.

Figures

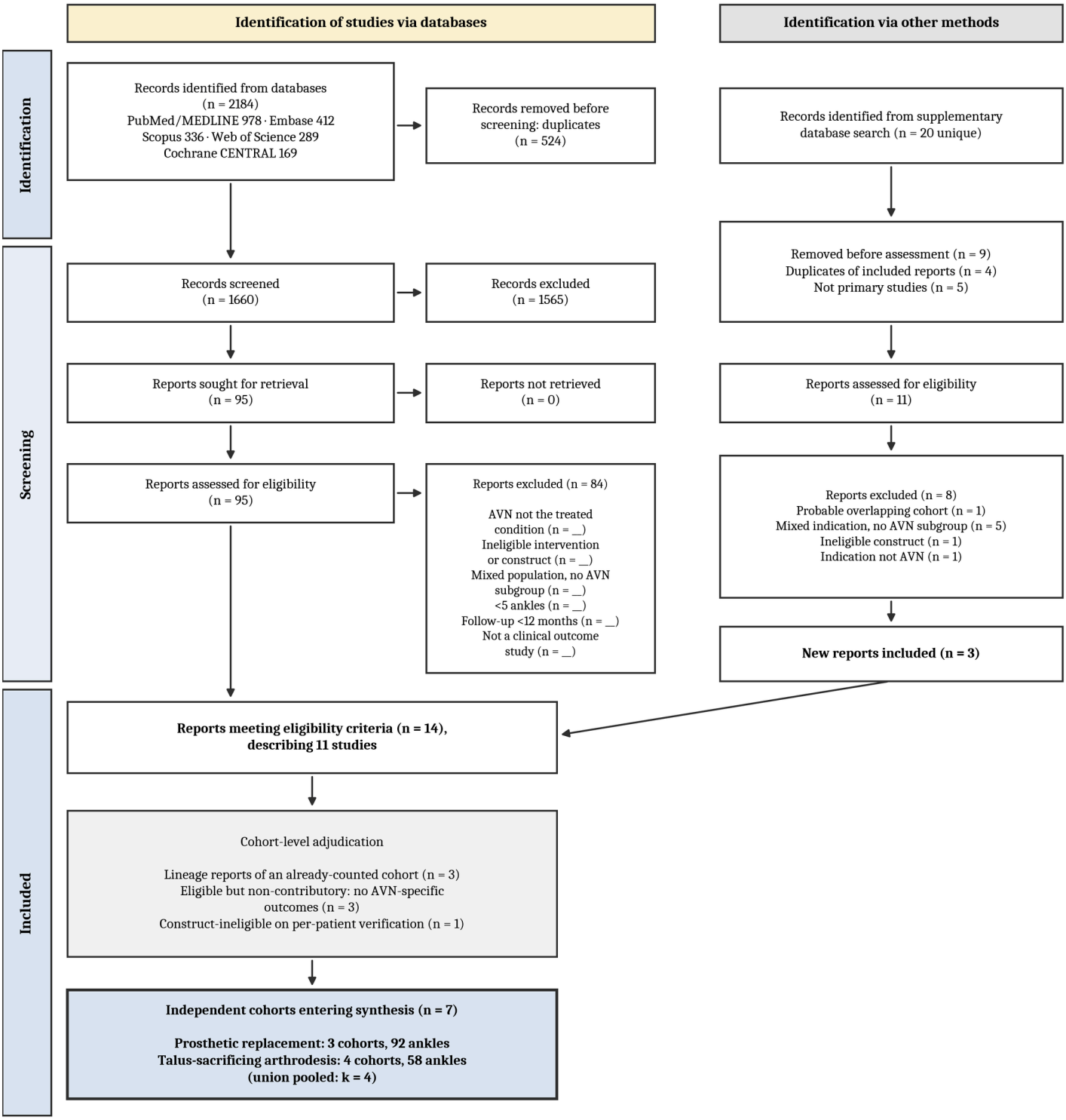
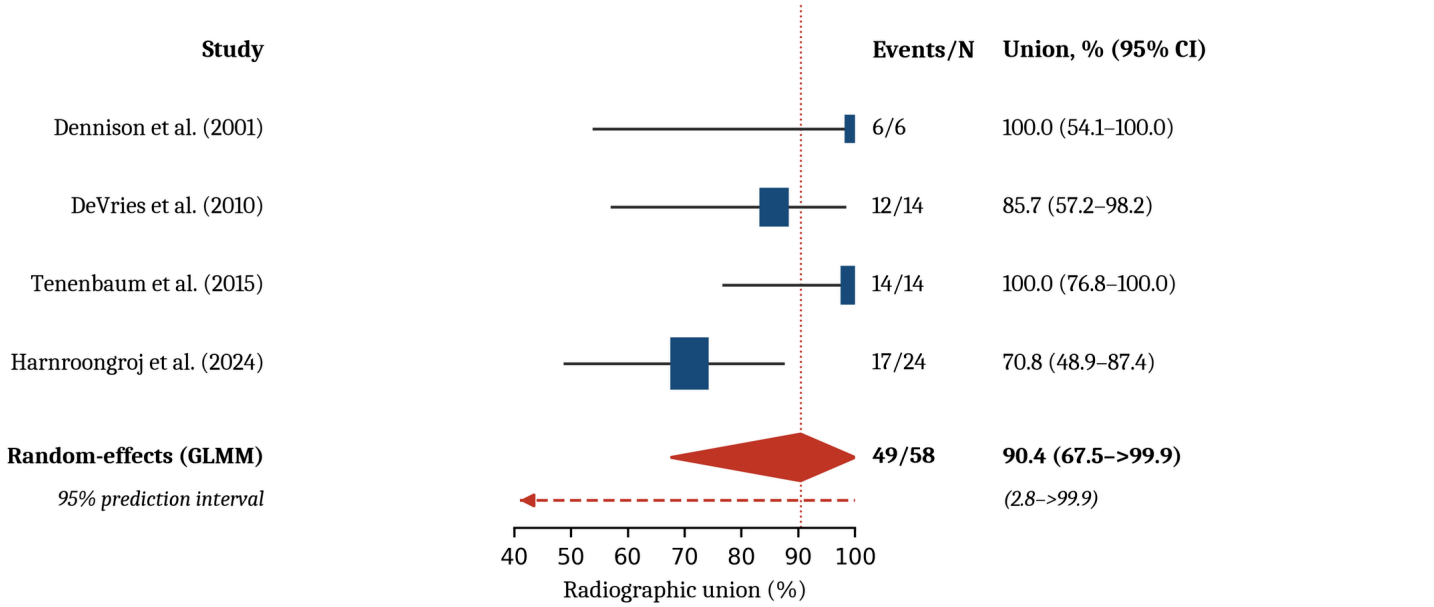


Figure 1

PRISMA 2020 flow diagram showing the primary and supplementary identification routes and the cohort-level adjudication step. AVN: avascular necrosis.



Heterogeneity (Freeman–Tukey, DerSimonian–Laird sensitivity model): Q = 8.47, df = 3, P = 0.037; I^2 = 65%. GLMM between-study variance (logit scale) = 1.00.

Figure 2

Forest plot of radiographic union after talus-sacrificing hindfoot arthrodesis. Squares are proportional to sample size and horizontal lines show Clopper-Pearson 95% confidence intervals. The diamond shows the random-effects generalised linear mixed model estimate and the dashed line its 95% prediction interval, truncated at 40% for display. GLMM: generalised linear mixed model.