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Scoping review for treatment of osteolysis in total ankle arthroplasty

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Abstract

Background Following total ankle replacement (TAR), osteolysis is a known complication. No consensus exists regarding management.

Methods Applying the Arksey and O'Malley framework for scoping studies, a study protocol and a data extraction form was created. The research included all studies until March 2025. Study selection and data extraction were performed by two independent reviewers.

Results Two hundred and eighty-seven studies were identified, of which 54 studies (case series and case reports) were included. 69% of the studies included below 10 cases. The most common reported treatment was bone grafting in $n=36$ (67%) of studies. The conversion of the TAR to an ankle fusion ($n=16$ studies, 30%) was more frequent than the revision to a TAR ($n=15$ studies, 28%). Eleven studies reported multiple treatment options. Long-term follow-up and standardized outcome measurements were infrequently discussed.

Conclusion This scoping review demonstrates that the existing literature is highly heterogeneous and insufficient to recommend standard treatment.

Keywords Total ankle replacement, Osteolysis, Cysts, Treatment, Bone grafting, Fusion, Revision total ankle replacement

Introduction

Total Ankle Replacement (TAR) is an increasingly common alternative to ankle fusion for management of end-stage ankle arthritis, allowing for pain relief with preservation of range of motion [1]. Indications for TAR continue to expand with improved implant longevity and bearing surfaces. While traditionally offered in older, low-demand patients, use in younger and more active patients is increasing [2]. Nevertheless, studies show a higher failure rate of TAR when compared with hip and knee, arthroplasty [1]. Osteolysis is one complication which leads to reoperation and revision surgery [3]. While the underlying etiology remains controversial, several theories have been proposed to explain the elevated rate and early onset of osteolysis in TARs [4, 5].

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A recent systematic review analyzed the incidence of osteolysis and bone cysts in several TAR implants [3]. The average incidence over all implants was reported as 17.7% with a follow up range of 2 to 124 months. The authors discussed various treatment options; however, this was not the focus of the review, and a comprehensive literature synthesis remains lacking. There are no other reviews focused on the treatment options of osteolysis in TAR with little guidance for any definitive management solutions.

Given that most available studies on osteolysis management in TAR are limited by small sample sizes and retrospective designs, a scoping review is proposed. This methodology is appropriate for mapping the breadth of treatment strategies, identifying gaps in the current literature, and informing future research directions in this evolving field.

Methods

A protocol was developed and registered with the Open Science Framework (identifier DOI https://doi.org/10.17605/OSFI.IO/CHZD6). This protocol was added at an appendix.

In summary the following criteria according to the PICO framework were used:

Population: Patients with osteolysis in ankle replacement
Intervention: revision arthroplasty
Comparator(s): bone grafting, arthrodesis etc
Outcome: Radiographic, Functional,
Study designs: All

Inclusion criteria

- Studies reporting treatment of osteolysis in TAR, as primary research question, or as secondary outcome of failure of the TAR
- All study designs
- All TAR implants

Exclusion criteria

- Reviews
- Basic science articles

Literature search

To help inform our comprehensive literature review, an initial limited search was performed in MEDLINE (Ovid) and Cochrane Central Register of Controlled Trials. We then identified key text words contained in titles and abstracts of retrieved papers, and of the index terms used to describe the articles. Following this, with the assistance of an information specialist (RS), we performed a comprehensive electronic search of the medical literature using medical subject headings (MeSH) and text related to surgical management of osteolysis in ankle arthroplasty. Searches were performed using MEDLINE (OVID interface, 1946 – April 2025), EMBASE (1947 – April 2025) and Cochrane Central Register of Controlled Trials (until April 2025). We also performed a search ClinicalTrials.gov to include any relevant trials in progress. References lists of the articles meeting criteria, as well as relevant review articles were scanned to ensure a thorough review. This was then supplemented by a search of grey literature, including conference proceedings from the American Orthopaedic Foot and Ankle Society annual meeting archives (2012–2020).

Studies were eligible for inclusion if they reported treatment of osteolysis in TAR as either primary or secondary research question. We excluded review articles, letters to the editor and basic science articles. When studies reported on the same cohort of patients at different follow-ups (kin studies), we ensured that every patient appeared only once and included data from only the most recent kin study. No languages were excluded in the primary search. A sample search strategy is attached to appendix 1.

Study selection

The first pass of titles and abstracts to identify potentially eligible studies were independently reviewed in duplicate (AS and ML). To ensure reliability between the two reviewers, a series of 20 training studies were used prior to screening. The same two reviewers then conducted the full text 'second pass' review to identify studies meeting the inclusion/exclusion criteria. The reviewers were not blinded to study demographics, including titles, authorship, and center of publication. Reasons for study exclusion were documented in the Covidence database. Study authors were contacted if eligibility criteria remained unclear following article review. Disagreements were resolved via consensus where possible, and by a third reviewer (BM) if necessary. Final study inclusion is presented in a PRISMA flow diagram [6] (Fig. 1).

Data abstraction

A standardized data extraction sheet was created as an excel spreadsheet (Microsoft Corporation, Redmond Washington) (Table 1).

Data extraction was performed in duplicate (AS and ML) with disagreements resolved by consensus, or a third extractor (BM) as needed according to the data extraction table

Statistical analysis

Data analysis was descriptive in nature with summary statistics reported where appropriate.

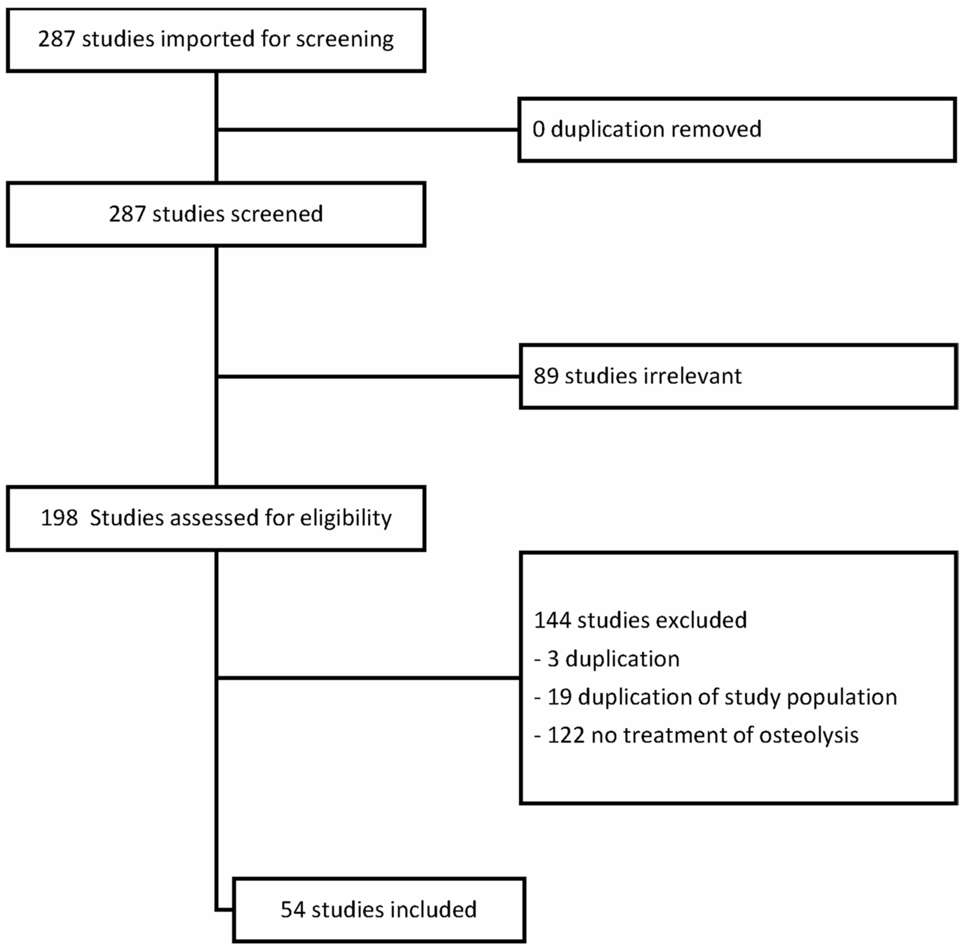

Fig. 1 PRISMA flow diagram

Results

After review, 54 studies met inclusion criteria. The majority of studies were case reports or subgroups of a case series with 10 cases or less (37 studies, 69%), followed by case series and subgroups with more than 10 cases (17 studies, 31%). Those are all studies with level 4 of evidence. The most common reported treatment was bone grafting in 36 (67%) of studies. Conversion of the TAR to ankle fusion ($n = 16$ studies, 30%) was mentioned slightly more frequently than TAR revision ($n = 15$ studies, 28%). Thirteen studies (24%) reported at least two different treatment options.

Treatment of osteolysis with bone grafting

Besse reported on outcomes after bone grafting cysts in 14 ankles with the Ankle Evolution System (AES®) prosthesis at a mean of 55.3 months (range 35–92 months) post implantation. Seven ankles (50%) were grafted with iliac crest autograft, the other seven (50%) with bone cement. After grafting, there was a 72% clinical dissatisfaction rate, and 92% radiological failure. Four of 14 ankles (28%) were converted to an arthrodesis [7].

Another case series by Gross et al. [8] examined bone grafting of osteolytic cysts in 33 procedures in 31 patients with three different primary arthroplasty implants (21 Scandanavian Total Ankle Replacement (STAR®), eight INBONE®, two Salto Tolaris®) at a mean of 65.9 months (range 20–157 months) post primary arthroplasty. Cyst location was in the tibia (22/31, 71.0%), talus (20/31, 64.5%) and fibula (5/31, 16.1%). In 13 cases multiple cysts were found. Graft materials used included fresh-frozen allograft chips (24/31, 76%), calcium phosphate (4/31, 12%), polymethylmetharcrylate (3/31, 9%) and autograft (1/31, 3%). Two patients (6.5%) had a bone grafting procedure twice. Four patients (12.9%) required a revision arthroplasty or fusion. For the remaining 27 patients, the 2-year treatment success was 60%. Calcium phosphate grafting did particularly poorly with a treatment success of only 25%.

Kohonen et al. reported-on bone grafting of cysts in a series of 34 ankles (31 AES®, 3 STAR®) at a mean of 4.5 years (range 2.2–9.2 years) post implantation [9]. Cyst location was in the tibia for 28 ankles (82.4%), and in the talus for 16 ankles (47.1%). Grafting technique included

Table 1 Data extraction

Basic information:
-Author
-Year of publication
-Geographic region of study center
-Language of publication
-Primary outcome
-Study design
-Sample size
-Patient demographics
■ Age
■ gender
■ preexisting diagnosis (raison for primary: posttraumatic, primary osteoarthritis, inflammatory, chronic instability)
length of follow up
Study characteristics
-Time between primary treatment and osteolysis treatment
-TAR factors:
■ Implant Brand
■ Bearing type
■ Alignment
■ Primary adjunct procedures
- Nature of cyst:
■ Radiographic modality for diagnosis of osteolysis (Rx, CT)
■ Location
• Tibia (medial malleolus, tibial metaphysis)
• Fibula
• Talus
■ Size
■ Progression
■ Implant stability
-Treatment/intervention
■ Bone grafting:
• Allograft
• Autograft
• Bone substitute
■ Revision to total ankle
■ Revision to ankle fusion
■ Medical treatments
■ Others
■ Adjunct procedure
-Outcome measurement of treatment
■ Reoperation rate
■ follow up period
■ scores reported
■ radiographic outcome
-Key findings

allograft (29/34, 85%), autograft (4/34, 12%), and combined autograft/allograft (1/34, 3%) Five cases (15%) were augmented with bone morphogenetic protein-7 and bisphosphonate and/or Denosunab treatment was added in 31 cases (91%). At a mean 3.6 year follow up after grafting, nine reoperations were performed and conversion to fusion was performed in four cases. Radiographic outcomes demonstrated a progression of the cyst in 44 of the 65 lesions (68%). Assessing the patients without revision to fusion, 15 of 30 patients (50%) reported a similar or increased pain level compared to the level prior to the grafting procedure. Yet, 26 of the 30 patients (86.6%) state an improved function.

Grafting technique

Autograft

Fourteen studies (84 ankles) reported on cyst management with autograft (Table 2). The primary ankle prosthesis was Hintegra® (34 cases), STAR® (26 cases), Salto Tolaris® (11 cases), AES® (7 cases) and Mobility® (1 case). Prosthesis type was not specified in the remaining 5 cases. Only half of the studies reported on graft location. In 27 cases (32%), osteolysis was tibial sided, and in 21 cases (25.9%) the cyst was in the talus. The iliac crest was used in 57 patients (68%) and in two patients the graft was harvested from the proximal tibia. For 25 patients (302%) the donor side was not mentioned.

Allograft

Twelve studies (120 ankles) reported on patients treated with allograft bone grafting (Table 2). The primary prosthesis was unknown in 60 cases, Hintegra® (51 cases), STAR® (three cases), Salto Tolaris® (three cases), AES® (two cases), and Beuchel-Pappas® (two cases). Detailed information of the location of osteolysis could be found in 50% of studies, with 42 ankles having tibial cysts and 29 ankles having cysts localized to the talus. Little information was provided about the allograft source or technique.

Bone substitute and biologics

Five studies (28 ankles) reported on the use of a bone substitute for cyst management [7–9, 15] (Table 2). Calcium phosphate cement was used in fourteen cases and polymethylmethacrylate cement was used in six cases. In one study five bone grafts were augmented with bone morphogenetic protein 7 (BMP-7).

Revision total ankle replacement

Fourteen studies reported on 105 ankles that underwent revision arthroplasty as part of osteolysis management (Table 3). The primary implant was an Agility® (41 cases), Hintegra® (36 cases), STAR® (seven cases), Inbone® (two cases), AES®, Buechel-Pappas® and Salto Tolaris® (one case each). A further sixtheen ankles did not report the implant type.

Williams et al. reported on 11 ankle revision arthroplasty procedures. In their series, authors used the remnants of the tibial cut from the plafond, augmented with calcium phosphate and calcium sulfate synthetic biomaterial and allograft chips as needed. In four of the

Table 2. Grafting techniques

Author	Year	Number ankles	Primary total ankle	Mean time to revision surgery (in month)	Cyst localisation (tibia/talus)	Technique	Outcome of all treated osteolysis	Follow-up after grafting (in month)	Follow-up after grafting
Autograft									
Yoon[10]	2022	33	Hintegra	68.2	NR	iliac crest	Radiographic: No loosening, healed	NR	NR
Naude[11]	2022	1	Hintegra	87.6	0/1	proximal tibia with demineralized bone matrix	88% incooperation	38.4	No
Mehdi[12]	2019	7	Salto	NR	NR	iliac crest	radiographic: "many of the cyst reoccur"	NR	NR
Gramlich[13]	2018	12	Salto	27.4 (all revision cases)	NR	spongiosa	NR	NR	NR
Koo[14]	2018	1	Salto talaris	50.0	NR	proximal tibia	NR	NR	NR
Kohonen[9]	2017	4	NR	54.0	NR	NR	clinical: 86.6 cases improved function; radiographic: 68% of lesions continue to progress;	NR	NR
Gross[8]	2016	1	NR	51.3	NR	NR	succes rate: 60.6%	48	NR
Hamel[15]	2013	6	STAR	23.3	3/3	spongosia	NR	23.3	NR
Besse[7]	2013	7	AES	55.3	7/7	iliac crest	Clinical: AOFAS score 65.5; Radiographic: 5 bone cysts reoccured	32	28% fusion
Brunner[16]	2013	1	STAR	NR	1/0	NR	Clinical "no sysmptoms"	18	No
Rodrigues-Pinto[17]	2013	1	Salto	21.0	1/0	Iliac crest	AOFAS 95, ROM35 degree	NR	NR
Bonin[18]	2011	8	Salto	7.8	8/4	iliac crest	Clinical: AFOAS 73.5; Radiographic 50% residual cysts	NR	NR
Wood[19]	2010	1	Mobiity	NR	0/1	NR	NR	NR	NR
Harris[20]	2009	1	STAR	48.0	NR	iliac crest	Clinical: "symptoms improved"; Radiographic: "cyst reduced in size"	3	no
Allograft									
Lee[21]	2022	29	Hintegra	60.7	NR	cancellous bone chips (Lifenet Health)	2 fusion, 1 revision TA, 3 repeated bone grafting	60.2	3 regarfting, 1 TAR, 2 TTC
Naude[11]	2022	7	Hintegra	87.6	2/5	allograft bone chips mixed with demineralized bone matrix	88% incooperation	38.4	No
Ruiz[22]	2020	14	Hintegra	46.8	8/5	NR	NR	NR	NR
Mehdi[12]	2019	2	Salto	67.0	NR	NR	radiographic: "many of the cyst reoccur"	NR	NR
Wan[23]	2018	1	Salto	35.9	NR	NR	NR	NR	NR
Kohonen[9]	2017	29	3 STAR, 21AES	NR	28/16	NR	clinical: 86.6 cases improved function; radiographic: 68% of lesions continue to progress;	NR	NR
Gross[8]	2016	25	NR	65.9	NR	9.1 % cement; 12.1% calcium phospahte	succes rate: 60.6%	48	1 regrafting, 1 fusion
Weme[24]	2015	6	BP or CCI (wright)	60.0	NR	NR	2 of 6 ankle fusion	NR	33% fusion

Table 2 (continued)

Author	Year	Number ankles	Primary total ankle	Mean time to revision surgery (in month)	Cyst localisation (tibia/talus)	Technique	Outcome of all treated osteolysis	Follow-up after grafting (in month)	Follow-up after grafting
Kraal[25]	2013	2	BP (Beuchel-Pappas)	14.8	0/2	NR	NR	NR	NR
Kokkonen[26]	2011	1	AES	28.0	NR	NR	NR	NR	NR
Rodriguez[27]	2010	1	AES	39.4	1/1	NR	clinical: AOFAS 85, radiographic: graft integrated	NR	No
Valderrabano[28]	2004	3	STAR	44.4	3/0	NR	NR	NR	NR
Bone substitute and biologics									
Clifton[29]	2021	6	Hintegra	NR	NR	iliac bone graft or calcium phosphat/calcium sulfat	radiographic: no further osteolysis	24	NR
Kohonen[9]	2017	5	NR	54.0	NR	5 BMP-7	clinical: 86.6 cases improved function; radiographic: 68% of lesions continue to progress;	NR	NR
Gross[8]	2016	7	NR	51.3	NR	3 cement; 4 calcium phosphate cement	succes rate: 60.6%	48	1 regrafting, 3 Revision TAR
Hamel[15]	2013	3	STAR	23.3	NR	3 cement	Clinical: AOFAS score 85.3	23.3	1 regrafting
Besse[7]	2013	7	AES	55.3	7/7	1 corticocancellous–calcium phosphate cement;, 4 calcium phosphate cement; 2 poly-methylmethacrylate antibiotic impregnated cement	Clinical: AOFAS score 65.5; Radiographic: 5 bone cysts reoccured	32	28% fusion
not specified									
Fram[30]	2023	1	Cadance	16	0/1	NR	NR	NR	NR
Henricson[31]	2020	2	Rebalance	NR	NR	NR	radiographic: no further osteolysis	NR	NR
Yang[32]	2019	19	Hintegra	NR	NR	NR	NR	NR	NR
Koivu[33]	2017	10	AES	NR	NR	NR	NR	NR	NR
Koivu[34]	2017	5	STAR	110.0	NR	NR	NR	NR	NR
Kerkhoff[35]	2016	7	STAR	NR	1/6	NR	NR	NR	NR
Jung[36]	2015	2	Mobility	42.0	1/1	NR	NR	NR	NR
Lee[37]	2013	6	NR	NR	NR	NR	NR	NR	NR
Barg[38]	2011	1	Hintegra	36.0	NR	NR	NR	NR	NR
Mann[39]	2011	2	STAR	81.6	NR	NR	radiographic: no furhter osteolysis	60	No
Besse[40]	2010	12	NR	NR	12/NR	NR	NR	NR	NR
Claridrge[41]	2010	1	BP	84.0	0/1	NR	NR	NR	NR
Knecht[42]	2004	4	Agility	35.0	4/0	NR	NR	NR	NR

List of all studies treating osteolysis with different grafting techniques

NR Not reported, *AOFAS* American orthopedic foot and ankle sore

Table 3. Treatment ankle replacement/fusion

Author	Year	Number ankles	Primary total ankle	Mean time to revision surgery (in month)	Cyst localisation (tibia/talus)	Technique	Outcome	Follow-up after revision (in month)	Complication/Reintervention after revision
Revision to total ankle replacement									
Wu[43]	2024	5	NR	73.0	NR	to Inbone II	3 year suvivorship 90.4%	NR	NR
Clifton[29]	2021	5	Hintegra	56.0	NR	to Inbone TAR	good outcome and return to function	NR	NR
Eggelstone[44]	2020	6	NR	27.0	NR	to Inbone	VAS 1, AOS 12, at 2 years	NR	NR
Yang[32]	2019	31	Hintegra	N/A	NR	component revision	NR	24	No
Li[45]	2017	1	Agility	24.0	NR	to Salto talaris	radiographic: stable implant	NR	NR
Koivu[46]	2017	1	AES	NR	0/1	tibial component to Mobility	NR	NR	NR
Roukis[47]	2016	20	19 Agility, 1 Inbone	33.0	NR	14 Agility to Agility, 3 Agility to Inbone II, 2 Agility to Salto talaris,1 Inbone I to Inbone II	NR	NR	NR
Williams[48]	2015	11	Agility	49.6	NR	to Inbone II	Radiographic: 3 with subsidence of talar component	NR	NR
Horisberger[49]	2015	6	NR	72.0	NR	to revision Hintegra or primary components	clinical: AOFAS 84 (72–97), VAS 0.9; radiopgraphic: stable implant	NR	NR
Brunner[16]	2013	5	STAR	102.7	NR	one to regular and 4 to revision component	NR	NR	NR
Ketz[50]	2012	10	Agility	NR	NR	to custom made implant	NR	NR	NR
Mann[39]	2011	2	STAR	81.6	NR	one component revision	Radiographic: no further osteolysis	72	No
Lampert[51]	2011	1	Salto	60.0	0/1	to total talus with hintegra tibia component	NR	NR	NR
Di Dommenico[52]	2008	1	BP	24.0	NR	to Agility	radiographic: bone graft incoporated	40	no
Revision to arthrodesis									
ankle fusion:									
Aubret[53]	2018	1	NR	82.8	NR	2 plates	NR	19.3	no
Koivu[34]	2017	1	STAR	NR	NR	NR	NR	NR	NR
Koivu[33]	2017	12	AES	MR	NR	NR	NR	NR	NR
Weme[24]	2015	7	BP or CCI (wright)	NR	NR	NR	NR	NR	NR
Kraal[25]	2013	1	BP	189.0	1/0	plate	NR	NR	NR
Mann[39]	2011	2	STAR	6.8	NR	NR	Radiographic: no further osteolysis	72	NR
Bonnin[18]	2011	3	Salto	7.0	2/2	NR	NR	NR	NR
Besse[40]	2009	7	NR	NR	NR	NR	NR	NR	NR
Culpan[54]	2007	1	Custom made	12.0	NR	NR	Clinical: AOFAS 64	NR	no
TTC fusion									
Lee[21]	2022	5	Hintegra	60.7	talus	NR	NR	NR	NR

Table 3 (continued)

Author	Year	Number ankles	Primary total ankle	Mean time to revision surgery (in month)	Cyst localisation (tibia/talus)	Technique	Outcome	Follow-up after revision (in month)	Complication/Reintervention after revision
Ali[55]	2018	23	AES	NR	NR	hindfoot nail	Radiographic: fusion rate: ankle (95.5%), subtalar joint (91.3%); total 87% fusion	13.9	1 nail fracture, 1 prox stress fracture
Wan[23]	2018	2	Salto	NR	NR	hindfoot nail	NR	NR	NR
Aubret[53]	2018	10	NR	82.8	NR	hindfoot nail	Clinical: AOFAS 56 (21–78), SF36 score 60.4 (19–84); radiographic: fusion rate: ankle 8/10, subtalar 5/9;	19.3	30% hardware removal without symptom improvement
Yoon[56]	2014	1	Hintegra	53.5	NR	NR	Radiopgraphic: fusion	NR	NR
Besse[7]	2013	11	AES	NR	NR	NR	NR	NR	NR
Moor[57]	2008	2	NR	NR	NR	hindfoot nail	Radiopgraphic: fusion	12	no
Johl[58]	2006	1	BP	84.0	NR	hindfoot nail	Clinical: returned to to normal activities; Radiographic: fusion	12	no

List of all studies treating osteolysis with replacement or fusion

NR Not reported, *AOFAS* American orthopedic foot and ankle sore, *AOS* Ankle osteoarthritis score, *SF* Short form, *VAS* Visual analog scale

11 ankles, femoral head allograft was applied. On the last follow up radiographs after revision two of the four patients (50%) had asymptomatic subsidence of the talar component [48]. In contrast, Roukis et al. used a metal reinforced polymethylmethacrylate cement in most of their 20 revision cases. At a mean 1.3 year follow up there were no subsequent revisions in their series [47].

Horrisberger et al. revised six ankles filling cysts with bone graft. Two ankles subsequently failed and were converted to tibiotalocalcaneal arthrodesis at 30 and 35 months, respectively. ¨Larger defects were filled with mono- or bicortical iliac crest bone blocks [49]. For cases of very large talar osteolysis, Ketz et al. reported revision to custom made talar component [50], while Lampert reported on revision to a total talus with a tibial component in one case [51].

Revision to arthrodesis

Salvage ankle arthrodesis was discussed in 16 studies for a total of 90 ankles (Table 3.). From those reporting implants, revised prostheses included the AES® (46 cases), Salto Talaris® (five cases), STAR® (three cases), Buechel-Pappas® (two cases), Hintegra® (five cases) and one custom prosthesis. Nine of 26 cases were fused as a secondary intervention after grafting [7, 18, 46]. Tibiotalocalcaneal fusion was the most commonly reported method with 55 cases with a nail being the most commonly reported implant used (38 cases). Iliac crest autograft was used to fill the defect in 24 cases, with a femoral head allograft used in two cases [57]. The use of trabecular metal was not recommended by Aubret et al. after a case series of 10 patients with poor outcome and a fusion rate of 80% for the ankle and 55.6% for the subtalar joint [53]. In contrast Ali et al. reported a fusion rate of 95% for the ankle and 91% for the subtalar joint, but with an average 2.4 cm limb shortening [55].

Discussion

This study addresses an important knowledge gap of treating osteolysis in ankle replacement surgery. There is one recently published systematic review and meta-analysis which address the incidence of osteolysis in different total ankle arthroplasty [3], however the review does not discuss revision procedures or techniques. This review sought to fill that gap by providing a broad overview of the literature related to management approaches for osteolysis in the setting of TAR.

There is an increasing incidence of publications discussing treatment of osteolysis in recent literature. This might reflect the increasing incidence of osteolysis and the increasing need for treatment options. All included studies were performed between 2004 and 2025 with an increasing number in the last years. Analyzing the country of the study population, most of the study centers were located in Europe (32 studies), followed by North America with 12 studies and Asia with eight studies. One study center was located in South America and one in Africa. This might be due to different uses of total ankle arthroplasty in different countries.

With the increasing use of TAR there is an increasing prevalence of complications. Osteolysis and aseptic loosening are known as one of the more common complications and does occur in up to 77% depending on the TAR implant [27], and length of follow-up. It is not surprisingly the most common cause of failure and is responsible for 10% to 38% of revisions [16, 59].

Diagnostic of osteolysis can been done with radiographs or CT. Radiographs have the advantage of being used as standard control in follow up of TAR. But small osteolysis (less than 200 mm^2) is only detected in about 50% on plane radiographs [10, 56, 60]. Especially talar lesions can be more often detected by CT [3]. In our scoping review the incidence of cyst location ratio talus versus tibia was 2/3. aligning with findings in prior systematic reviews [3].

Periprosthetic osteolysis after TAR are often asymptomatic [12]. Despite this close follow- up is recommended [61]. The literature suggested that rapidly progressive warrant intervention due to their risk of causing fracture, implant loosening and so failure [27, 62]. If the implant is stable with low risk of implant failure different grafting techniques are proposed. The autograft techniques included in the review were mainly performed with iliac crest and had over 50% persistence of cysts in radiographic follow up [8, 12, 18]. Grafting with allografts had a similar clinical and radiographic outcome [9, 24]. This low success rate questions the treatment of asymptomatic cysts.

For symptomatic cysts, literature is more conclusive [61, 62]. There are two manly treatment options: revision of the implant or an ankle fusion. For both techniques osteolysis carries the challenges of managing the massive bone loss and attaining rigid fixation [62]. Often a revision total ankle implant like Inbone II® [47, 48] are used. Due to massive bone loss custom-made implants or other options like a total talus might be discussed [50, 51]. For this option, only case reports are available, and the outcome is not clear. In contrast the revision of a loose implant to the TTC have a more predictive result. The ankle fusion rate in the case series included in this scoping review was between 80 and 95% and the subtalar fusion rate 55–85% [53, 55]. Most studies of this scooping review had no outcome reported for exclusive ankle fusion [7, 46].

Based on the available literature the most promising grafting technique seemed to be autograft. If grafting techniques of the cysts are not possible anymore, an ankle or TTC fusion is the most predictable option.

The primary limitation to this study is the presence of incomplete data within many cited publications. In cases of missing data, we did contact the authors to provide us with more detailed information, getting responses in 3 out of 12. Given the lack of high-quality data, only a qualitative analysis was feasible. This does not reflect the quality of the existing data which is one disadvantage of a scoping review [63]. This scoping review reiterates the lack of quality evidence for guiding management of osteolysis in ankle replacement surgery. To provide further management guidelines, higher-level data and studies are needed. Given the low number of ankle replacements, national registry data advocated as a feasible option to improve data and outcome quality, allowing for more consistent follow up and more homogeneous outcome measurements including patient reported outcome measures.

Conclusion

This scoping review reveals that the current body of literature is highly varied and lacks the depth necessary to guide management strategies, as few studies specifically address the treatment of osteolysis. As a result, treatment approaches are inconsistent in the same study and across studies, and there is a significant lack of data on treatment outcomes. Consequently, the existing evidence base is insufficient to support informed clinical decision-making. To bridge this gap, future research should focus on generating higher-quality evidence or establishing national registry databases that systematically track treatment outcomes.

Abbreviations

AES	Ankle Evolution System
AOFAS	American Orthopaedic Foot and Ankle Score
AOS	Ankle Osteoarthritis Scale (assumed; please confirm if different)
BMP	Bone Morphogenetic Protein
BP	Beuchel–Pappas
CT	Computed Tomography
MeSH	Medical Subject Headings
NR	Not Reported
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta–Analyses
Rx	Radiograph
STAR	Scandinavian Total Ankle Replacement
TAR	Total Ankle Replacement
TTC	Tibiotalocalcaneal
VAS	Visual Analogue Scale

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12891-025-09278-4.

Supplementary Material 1. Appendix : Detailed search strategy.

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Not applicable

Authors' contributions

Angela Seidel, MD: Data collection, manuscript writingMichael Li, MD : Data collectionKarl-Andre Lalonde, MD : research concept, review of the manuscriptRisa Shorr: establishing the research strategy, providing article, review of the literatureBradley Meulenkamp, MD: idea of research, research concept, review of the manuscript, supervision.

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Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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