



Original article

Comparison of 25 ankle arthrodeses and 25 replacements at 67 months' follow-up

Nazim Mehdi^{a,*}, Alessio Bernasconi^b, Julien Laborde^a, François Lintz^a^a Clinique de l'Union, centre de chirurgie de la cheville et du pied, boulevard de Ratalens, 31240 Saint-Jean, France^b Department of Public Health, Orthopaedic and Traumatology Unit, University of Naples "Federico II", Via S. Pansini 5, Napoli 80131, Italy

ARTICLE INFO

Article history:

Received 24 September 2017

Accepted 18 October 2018

Keywords:

Arthrodesis
Prosthesis
Ankle
Tibiotalar joint
Cysts

ABSTRACT

Introduction: In the treatment of osteoarthritis of the ankle, controversy persists between advocates of arthrodesis and of joint replacement.**Hypothesis:** Results of total ankle replacement (TAR) are equivalent to those of ankle arthrodesis (AA).**Material and methods:** A single-center continuous retrospective series included 50 patients (25 TAR, 25 AA) operated on by a single surgeon. TAR used the standard Salto[®] mobile-bearing prosthesis, and arthrodesis used screws or plates. Results were assessed clinically on AOFAS score, visual analog scale (VAS) and satisfaction questionnaire, and radiologically on X-ray and CT. Survivorship in the 2 procedures was estimated on the Kaplan Meier method.**Results:** At a mean 67 months' follow-up (range, 40–105 months), mean AOFAS and VAS scores were significantly better in the AA group (74.1 and 1.9, respectively) than in the TAR group (67 and 3.5, respectively) ($p < 0.001$). In the AA group, 80% of patients were satisfied or very satisfied, compared to 64% after TAR. Five-year survival without revision for non-union (AA) or implant removal (TAR) was similar between groups: AA, 96%; TAR, 90% ($p = 0.72$). In contrast, survival with no revision procedures was significantly better with AA (96%) than TAR (75%) ($p = 0.03$).**Discussion:** At 5 years, surgical revision rates were significantly greater than after standard Salto[®] mobile-bearing TAR than for arthrodesis, notably due to onset of cysts; we therefore decided to abandon this implant.**Level of evidence:** IV, comparative retrospective study.

© 2018 Published by Elsevier Masson SAS.

1. Introduction

Surgical treatment of ankle osteoarthritis is a subject of controversy between advocates of arthrodesis and joint replacement [1–3]. Arthrodesis is considered to be the gold standard, but for some 40 years has been challenged by the growth of ankle replacement (TAR) [1–4]. Many studies have reported efficacy for both in terms of pain, whereas their respective biomechanics are essential opposed: abolition versus conservation of joint motion [1–3].

Some authors, such as Coester and Fuchs, reported satisfactory outcome beyond 20 years postarthrodesis [5,6], whereas there have been few studies of TAR with more than 10 years' follow-up [7–10]. A few comparative studies have been published, often with contrasting results [11–14]. Over the short term, TAR seems to give better functional results, as it conserves ankle motion [14], but

the 5-year revision rate is much higher than in ankle arthrodesis (AA) (23% vs. 11% for SooHoo [11], and 17% vs. 7% for Daniels [13]), often due to periprosthetic osteolysis, inducing implant component loosening [15]. When cysts show progression, they often require surgical filling or else arthrodesis [15,16].

The present study tested the hypothesis that TAR is equivalent to AA in terms of clinical results and mean 5-year survival. The analysis of periprosthetic cysts is compared to recent literature data.

2. Materials and method

A single-center continuous retrospective study included 25 patients treated by AA and 25 treated by TAR (50 patients; 18 female, 32 male; mean age, 61 years) (Table 1), operated on between May 2007 and February 2013 by a single specialized foot-and-ankle surgeon with 4 years' experience in TAR. The two treatment groups did not significantly differ in terms of BMI or smoking status.

* Corresponding author.

E-mail address: nazim.mehdi@gmail.com (N. Mehdi).

Table 1
Demographics and score results. Comparison between arthrodesis and TAR groups.

	Ankle arthrodesis group		Total ankle replacement group		<i>p</i>
Demographics					
Number of patients	25		25		
Age ^a	62 ± 9.4 (52–81)		60 ± 11.9 (27–82)		0.650
Gender (M/F) (%)	17/8 (68/32)		15/10 (60/40)		0.710
Side (R/L) (%)	15/10 (60/40)		14/11 (56/44)		0.345
Hindfoot alignment					
Normal (0–7°)	2		3		0.772
Valgus	15		16		
Varus	8		6		
Osteoarthritis					
Post-traumatic	18		17		
Primary	4		5		
Other (infl/neuro/club foot)	3		3		
Mean follow-up ^a	68 ± 11.1 (42–102)		65 ± 10.3 (49–105)		0.433
Clinical results					
AOFAS preop (range)	31(10–46)		32(10–47)		
Pain	7.5		8.2		
Function	15.9		18.1		
Alignment	5.5		7.2		
AOFAS postop (range)	74(29–88)		67(31–100)		<i>p</i> < 0.001
Pain	38.2		30.5		
Function	27.5		28.2		
Alignment	9		9		
AOFAS total pre vs post	<i>p</i> < 0.001		<i>p</i> < 0.001		
Pain VAS preop	8.7(7–10)		9.1(8–10)		
Pain VAS postop	1.9(0–3)		3.5(0–5)		<i>p</i> < 0.001
VAS pre vs post	<i>p</i> < 0.001		<i>p</i> < 0.001		
Satisfaction					
Very satisfied	11(44%)		8(32%)		0.564
Satisfied	9(36%)		8(32%)		
Dissatisfied	5(20%)		9(36%)		
Number of revisions (%)	1/25(4%)		9/25(36%)		<i>p</i> < 0.001

Infl: inflammatory; neuro: neurologic; preop/pre: preoperative; postop/post: postoperative.

^a Mean ± standard deviation [range].

2.1. Inclusion criteria

Candidates for both AA and TAR had severe painful osteoarthritis with major functional impact (Table 1). Clinically, complaints comprised pain and limitation in activities of daily living. Preoperative work-up comprised weight-bearing X-ray views with cerclage quantifying malalignment, and systematic intrajoint imaging on CT or MRI arthrography.

Patients with sagittal range of motion < 5° in dorsiflexion or plantar flexion, frontal varus malalignment exceeding 10° on AP weight-bearing view and/or history of sepsis were managed by ankle arthrodesis; those with sagittal range of motion > 5° in dorsiflexion or plantar flexion, frontal varus malalignment < 10° and no history of sepsis were managed by TAR.

2.2. Surgical technique

Arthrodesis was performed with open surgery, by cross-screwing (OmniLarge™, Biotech, France) in 8 cases and anterior locking plate (Tibiaxys™, Integra LifeSciences, France) in 17 (Fig. 1). Fibular closing-wedge osteotomy was associated systematically [17].

TARs were standard Salto® mobile-bearing models (Tornier SA, Montbonnot, France) (Fig. 2), implanted via an anterior approach. Bone sectioning used cut-guides under fluoroscopy. Non-weight-bearing ankle-cast immobilization, for 7 weeks after AA or 4 weeks after TAR, was followed by 8 weeks' rehabilitation.

2.3. Assessment

Patients were followed up at 4 or 8 weeks, 4 months and 1 year then every 2 years. Clinical assessment and intergroup comparison



Fig. 1. Two examples of arthrodesis, by cross-screwing (left) or locking plate (right).

used AOFAS score and a visual analog scale (VAS); a satisfaction questionnaire was also delivered. Radiographs were taken at each consultation and a CT scan (non-systematically) at 6 months, to check fusion (AA group) or onset of cyst (TAR group).

Fusion was defined as asymptomatic fusion of ≥ 50% of the joint surface.

Cysts were classified following Besse [16], in terms of size and location, with progression assessed at a 6-month interval.



Fig. 2. Standard Salto® mobile-bearing implant.

2.4. Statistical analysis

Distribution normality was checked on Shapiro-Wilk test, and means were compared on Student *t* test. Intergroup differences for categoric variables were assessed on Chi² or Fisher test. For each group, Kaplan-Meier survival curves were drawn, with the event of interest being:

- non-union in the AA group or implant removal in the TAR group;
- any revision surgery, and compared on log-rank test.

Analyses used STATA software, version 12.0 (StataCorp, 2011), with the significance threshold set at *p* < 0.05.

3. Results

Mean follow-up was 67 months (range, 40–105 months), with no loss to follow-up.

3.1. Clinical assessment and complications

Table 1 presents the clinical results. AOFAS and VAS scores were significantly better in AA than in TAR.

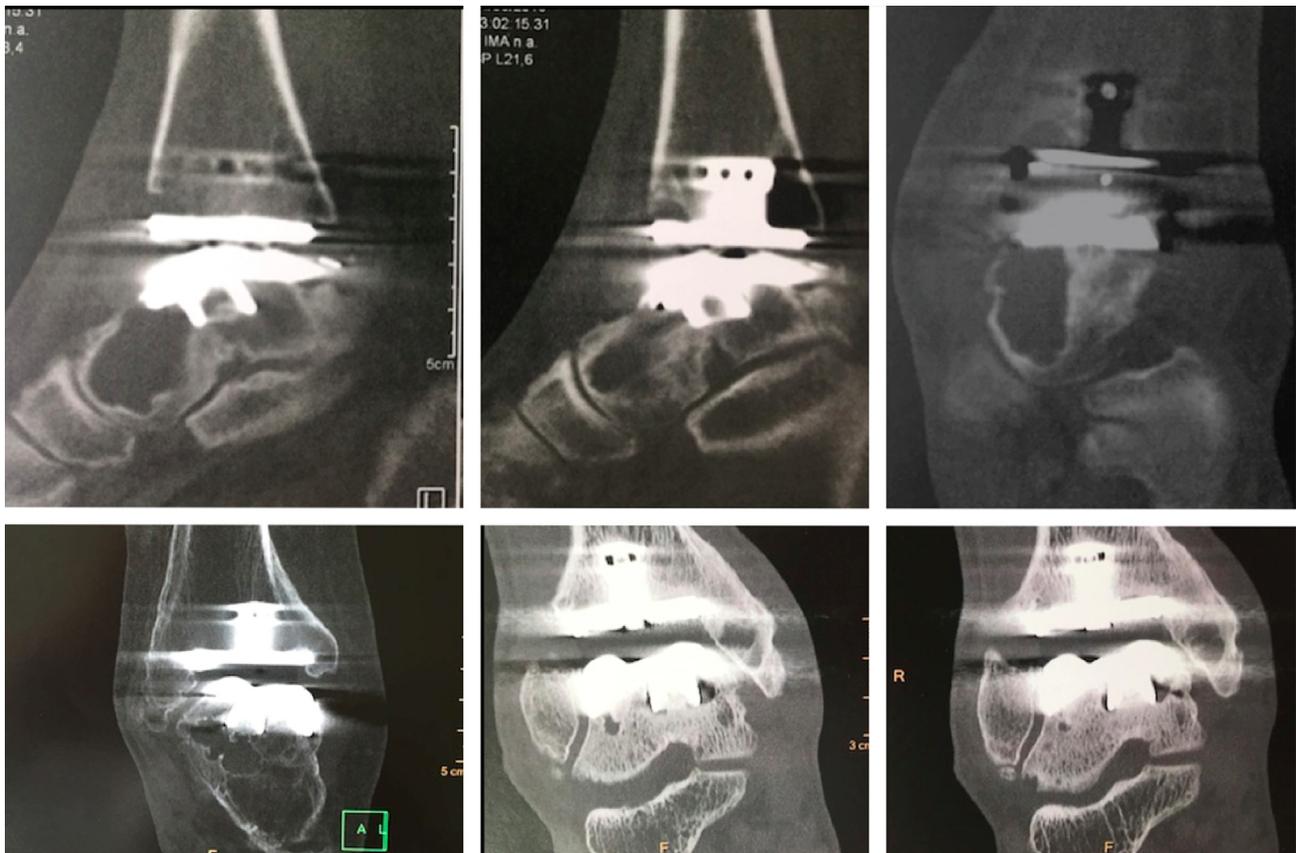


Fig. 3. Several examples of tibial and talar cysts on CT.

There were 2 complications in the AA group: 1 non-union treated by plate and graft, and 1 skin necrosis treated by vacuum-assisted closure.

In 7 patients in the TAR group (28%), progressive tibial and/or talar cysts (Fig. 3) required curettage and bone-graft filling. Systematic specimen pathology found macrophagic cysts with polyethylene debris inclusion. One case of talar component loosening was treated by arthrodesis, and 1 case of talar component malpositioning was treated by early revision.

At 67 months' follow-up, survivorship without revision for non-union in the AA group or implant removal in the TAR group was comparable between groups: 96% (95% CI: 74–99) and 90% (95% CI: 65–97), respectively ($p=0.72$) (Fig. 4). In contrast, survivorship with no surgical revision was significantly better with AA (96%; 95% CI: 74–99) than TAR (75%; 95% CI: 49–88) ($p=0.03$) (Fig. 4).

3.2. Radiologic assessment

Cysts occurred in 12 cases in the TAR group (48%), and were progressive in 7 cases (28%). Two of the 12 patients showed ≤ 2 mm radiolucency, and 10 showed osteolysis. Five of the cysts were tibial and 5 talar (Table 2).

4. Discussion

In the present series of severe ankle osteoarthritis, AA and TAR survival rates were comparable and very satisfactory in terms of revision for non-union in AA or implant removal in TAR at a mean 67

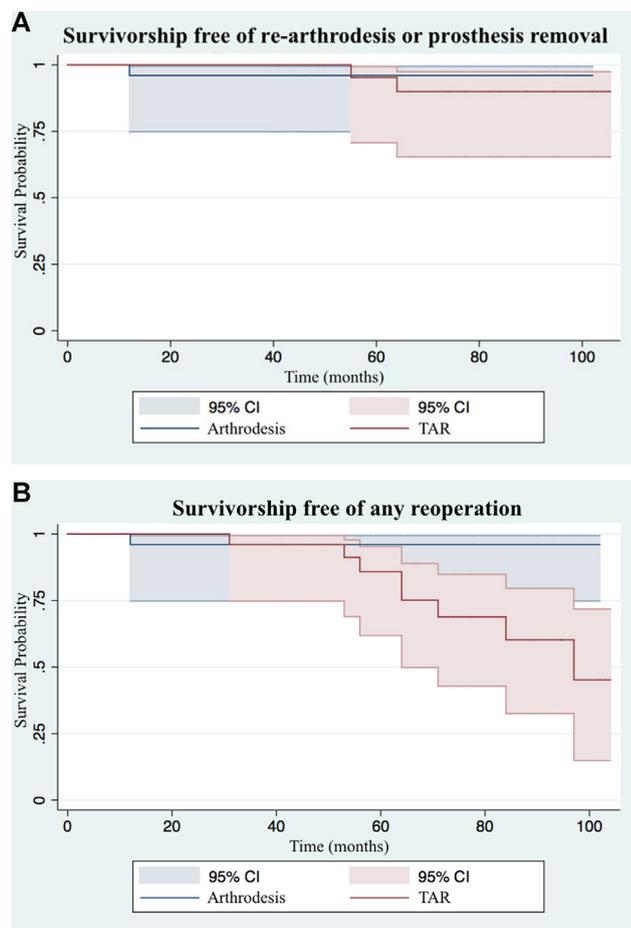


Fig. 4. Kaplan-Meier survival curves in AA and TAR groups. A: with revision for non-union (AA) or implant removal (TAR) as event. B: with surgical revision of any type as event.

Table 2
Cyst size and location on Besse's radiologic classification [16].

Size	
Total number	12
Osteolysis (0–2 mm)	2
Type A (2–5 mm)	1
Type B (5–10 mm)	5
Type C (10–20 mm)	3
Type D (20–30 mm)	1
Type E (> 30 mm)	0
Location	
Tibial	^a Zone 1 (lateral tibia): 2 ^a Zone 2 (medial tibia): 0 ^a Zone 4 (tibial malleolus): 2 ^b Zone 6 (posterior tibia): 1 ^b Zone 7 (anterior tibia): 1
Talar	^a Zone 5 (under talar implant): 5 ^b Zone 8 (posterior, under implant): 3 ^b Zone 9 (anterior, under implant): 4 ^b Zone 10 (talar neck and head): 0
Fibular malleolus	^a Zone 3 (fibular malleolus): 1

^a On AP view.

^b On lateral view.

months: respectively, 96% and 90%. However, TAR was associated with much more surgical revision overall, mainly due to progressive periprosthetic cysts, found in 28% of cases and requiring curettage and filling. Clinical scores likewise favored arthrodesis.

In severe ankle osteoarthritis, TAR series with long-term follow-up reported variable results, with 66% to 95% implant survival at 9–10 years [7–10,13]. Arthrodesis, in contrast, ensured lasting results, with 97% satisfaction at 22 years [5,6]. Under- and over-lying joint line deterioration is said to be an argument for arthroplasty, but was not found in the present series. Moreover, according to Coester and Fuchs, radiologic osteoarthritis was not associated with clinical deterioration at more than 20 years' follow-up [5,6].

A recent review of the literature found twice as many complications following TAR as after arthrodesis [2]. TAR failure usually leads to surgical revision, due to cyst progression, as found in the present series [18–20]. Plentiful data from many studies point to onset of periprosthetic cysts after mobile-bearing TAR, but with highly variable incidence (Table 3) [7–10,18–28]. In 2015, with the standard Salto[®] mobile-bearing implant, Roukis found 8 studies (all poor quality) with a mean 55 months' follow-up and 48 cases of TAR revision for 1,209 patients (4%). In 30 cases (62%), however, the reason for revision was not supplied; total incidence of cyst could thus not be estimated [29]. The 75% survival rate for this implant in the present study, at 5.6 years' follow-up, is to be compared with that reported by Bonnin (65% at 10 years), but with a higher rate of >5 mm cysts: 36% versus 15% [7].

The origin of these cysts is poorly understood; the most frequently discussed co-factors are implant design, surface treatment, "excessive" bearing mobility, and implant malpositioning [30–32]. A meta-analysis of periprosthetic cysts in 2430 TARs found increased incidence in case of malpositioning or models without tibial stem, with hydroxyapatite coating, or with mobile bearing [31]. These last 2 factors could account for the high rate of cysts using the implant assessed here.

The retrospective design and lack of randomization are limitations of the study; moreover, indications differed between AA and TAR, introducing a selection bias, as stressed by SooHoo [11].

Table 3

Comparison of results of present series and series since 2010 with various mobile-bearing designs. Survivorship reported with 95% confidence intervals. Series with <25 patients and/or <36 months' follow-up excluded.

Author (date)	Implants (patients)	Mean follow-up (months)	Survivorship (any revision)	Survivorship (implant removal and arthrodesis or replacement)	Cyst rate and volume	Number of patients with progressive cysts or cysts requiring surgical revision
AES						
Kohonen et al. (2013) ^a	130(123)	48.7	–	–	45/130(34%) (> 10 mm)	ND
Viste et al. (2015)	50(50)	49	76% at 4 years 62% at 7 years	–	Tibia: 36% (X-ray >10 mm) vs 69% (CT) Talus: 30% (X-ray > 10 mm) vs 58% (CT)	19 (38%)
Koivu et al. (2017)	130(123)	96	–	87.7%(80.8–92.8) at 5 years; 78.5%(70.4–85.2) at 10 years	91/130(70%)	50(38%)
Di Iorio et al. (2017)	50(47)	120	57% (44–74) at 10 years	68%(55-85) at 10 years	Tibia 35% - Talus 47% (> 10 mm)	15(30%)
MOBILITY						
Wood et al. (2010)	100(96)	52	93.6%(84.7–97.4) at 4 years	–	3/47(6%) (<2 mm) 6/47(13%) (> 2 mm) 5/47(11%) (> 10 mm) 4/35(11%) (> 2 mm)	0(0%) 0(0%) 1(1%) ND
Choi et al. (2013)	35(35)	34	–	–	4/35(11%) (> 2 mm)	ND
HINTEGRA						
Barg et al. (2013)	722 (684)	75.6	84% at 10 years	–	ND	7(1%)
Choi et al. (2013)	32(32)	53	–	–	4/32(12%) (> 2 mm)	ND
Yoon et al. (2014)	99(90)	40.8	–	–	37/99(37%) (> 2 mm)	10(10%)
Deleu et al. (2015)	50(50)	45	–	94% at 45 months	24/50(48%)	0
STAR						
Mann et al. (2011)	84(80)	109.2	86% at 9.1 years	90%(79.6–95.1) at 10 years	7/84(8%) (<2 mm) 9/84(11%) (mechanical osteolysis ^b) 10/84(12%) (> 2 mm)	0(0%) 0(0%) 6(7%)
Brunner et al. (2013)	77(72)	148.8	–	70.7% at 10 years 45.6% at 14 years	12/77(16%)	5(6%)
Jensen et al. (2014)	42(42)	36	–	–	39/42 (93%)	ND
Kerkhoff et al. (2016)	134(124)	90	–	78%(63–88) at 10.3 years	9/134(7%) (> 2 mm) 61/134 (46%) ^c	0(0%) 7(5%)
SALTO mobile						
Bonnin et al. (2011)	98(96)	120	65%(50–80) at 10 years	85%(75–95) at 10 years	15/98(15%) (> 5 mm)	11(11%)
Rodrigues-Pinto et al. (2013)	103(103)	39.7 42.2 ^d	93.3%(85–100)	–	1/119(0.8%)	ND
Present series	25(25)	67	75%(49–88) at 5.6 years	90%(65–97) at 5.6 years	12/25 (48%)	7(28%)

ND: No data

^a ≥ 1 large cyst (>10 mm).

^b Defined as osteolysis between lateral part of talar component and lateral malleolus.

^c Osteolytic lesion" without specified size.

^d 2 different follow-up periods: < 50 or > 50 years.

5. Conclusion

In the present series, clinical results were less satisfactory after TAR than after AA; surgical revision rates were significantly higher, at 36% versus 4%, mainly due to onset and progression of periprosthetic cysts. We have therefore decided to abandon the Salto mobile-bearing implant, while continuing our experience with other models.

Disclosure of interest

N.M.: consultant for INTEGRA and NOVASTEP.

J.L.: consultant for NOVASTEP and FH.

F.L.: consultant for NEWCLIP TECHNIQUES and CURVEBEAM LLC.

A.B. declares that he has no competing interest.

Funding

None.

Contribution

N.M.: surgery; study promoter; data acquisition and entry; interpretation of results; preparation and revision of manuscript.

A.B.: study promoter; data acquisition and entry; analysis of results; preparation and revision of manuscript.

J.L. and F.L.: study promoters; interpretation of results; critical revision of content; manuscript preparation.

All authors read and approved the final submitted version of the manuscript.

References

- [1] Haddad SL, Coetzee JC, Estok R, Fahrbach K, Banel D, Nalysnyk L. Intermediate and long-term outcomes of total ankle arthroplasty and ankle arthrodesis. A systematic review of the literature. *J Bone Joint Surg Am* 2007;89:1899–905.
- [2] Maffulli N, Longo UC, Locher J, Romeo G, Salvatore G, Denaro V. Outcome of ankle arthrodesis and ankle prosthesis: a review of the current status. *Br Med Bull* 2017;1–22.
- [3] Lawton CD, Butler BA, Dekker RG, Prescott A, Kadakia AR. Total ankle arthroplasty versus ankle arthrodesis—a comparison of outcomes over the last decade. *J Orthop Surg Res* 2017;12:76.
- [4] Besse J-L, Colombier J-A, Asencio J, Bonnin M, Gaudot F, Jarde O, et al. Total ankle arthroplasty in France. *Orthop Traumatol Surg Res* 2010;96:291–303.
- [5] Coester LM, Saltzman CL, Leupold J, Pontarelli W. Long-term results following ankle arthrodesis for posttraumatic arthritis. *J Bone Joint Surg Am* 2001;83-A:219–28.
- [6] Fuchs S, Sandmann C, Skwara A, Chylarecki C. Quality of life 20 years after arthrodesis of the ankle. A study of adjacent joints. *J Bone Joint Surg Br* 2003;85:994–8.
- [7] Bonnin M, Gaudot F, Laurent J-R, Ellis S, Colombier J-A, Judet T. The SALTO total ankle arthroplasty: survivorship and analysis of failures at 7 to 11 years. *Clin Orthop Relat Res* 2011;469:225–36.
- [8] Mann JA, Mann RA, Horton E. STAR™ ankle: long-term results. *Foot Ankle Int* 2011;32:S473–84.
- [9] Brunner S, Barg A, Knupp M, Zwicky L, Kapron AL, Valderrabano V, et al. The Scandinavian total ankle replacement: long-term, eleven to fifteen-year, survivorship analysis of the prosthesis in seventy-two consecutive patients. *J Bone Joint Surg Am* 2013;95:711–8.
- [10] Kerkhoff YRA, Kosse NM, Metsaars WP, Louwerens JWK. Long-term functional and radiographic outcome of a mobile bearing ankle prosthesis. *Foot Ankle Int* 2016;37:1292–302.
- [11] SooHoo NF, Zingmond DS, Ko CY. Comparison of reoperation rates following ankle arthrodesis and total ankle arthroplasty. *J Bone Joint Surg Am* 2007;89:2143.
- [12] Dalat F, Trouillet F, Fessy MH, Bourdin M, Besse J-L. Comparison of quality of life following total ankle arthroplasty and ankle arthrodesis: Retrospective study of 54 cases. *Orthop Traumatol Surg Res* 2014;100:761–6.
- [13] Daniels TR, Younger AS, Penner M, Wing K, Dryden PJ, Wong H, et al. Intermediate-term results of total ankle replacement and ankle arthrodesis. *J Bone Joint Surg Am* 2014;96:135–42.
- [14] Benich MR, Ledoux WR, Orendurff MS, Shofer JB, Hansen ST, Davitt J, et al. Comparison of treatment outcomes of arthrodesis and two generations of ankle replacement implants. *J Bone Joint Surg Am* 2017;99:1792–800.
- [15] Preyssas P, Toullec É, Henry M, Neron J-B, Mabit C, Brilhault J. Total ankle arthroplasty - three-component total ankle arthroplasty in western France: a radiographic study. *Orthop Traumatol Surg Res* 2012;98:S31–40.
- [16] Besse J-L, Brito N, Lienhart C. Clinical evaluation and radiographic assessment of bone lysis of the aes total ankle replacement. *Foot Ankle Int* 2009;30:964–75.
- [17] Mehdi N, Bernasconi A, Laborde J, Lintz F. An original fibular shortening osteotomy technique in tibiotalar arthrodesis. *Orthop Traumatol Surg Res* 2017;103:717–20.
- [18] Jensen J, Frøkjær J, Gerke O, Ludvigsen L, Torfing T. Evaluation of periprosthetic bone cysts in patients with a Scandinavian total ankle replacement: weight-bearing conventional digital radiographs versus weight-bearing multiplanar reconstructed fluoroscopic imaging. *AJR Am J Roentgenol* 2014;203:863–8.
- [19] Yoon HS, Lee J, Choi WJ, Lee JW. Periprosthetic osteolysis after total ankle arthroplasty. *Foot Ankle Int* 2014;35:14–21.
- [20] Wood PL, Karski MT, Watmough P. Total ankle replacement: the results of 100 mobility total ankle replacements. *J Bone Joint Surg Br* 2010;92:958–62.
- [21] Choi GW, Kim HJ, Yeo ED, Song SY. Comparison of the HINTEGRA and mobility total ankle replacements. Short- to intermediate-term outcomes. *Bone Joint J* 2013;95-B:1075–82.
- [22] Kohonen I, Koivu H, Pudas T, Tiusanen H, Vahlberg T, Mattila K. Does computed tomography add information on radiographic analysis in detecting periprosthetic osteolysis after total ankle arthroplasty? *Foot Ankle Int* 2013;34:180–8.
- [23] Rodrigues-Pinto R, Muras J, Martín Oliva X, Amado P. Total ankle replacement in patients under the age of 50. Should the indications be revised? *Foot Ankle Surg* 2013;19:229–33.
- [24] Barg A, Zwicky L, Knupp M, Henninger HB, Hintermann B. HINTEGRA total ankle replacement: survivorship analysis in 684 patients. *J Bone Joint Surg Am* 2013;95:1175–83.
- [25] Deleu PA, Devos Bevernage B, Gombault V, Maldague P, Leemrijse T. Intermediate-term results of mobile-bearing total ankle replacement. *Foot Ankle Int* 2015;36:518–30.
- [26] Viste A, Zahrani AL, Brito N, Lienhart C, Fessy MH, Besse J-L. Periprosthetic osteolysis after AES total ankle replacement: conventional radiography versus CT-scan. *Foot Ankle Surg* 2015;21:164–70.
- [27] Di Iorio A, Viste A, Fessy MH, Besse JL. The AES total ankle arthroplasty analysis of failures and survivorship at ten years. *Int Orthop* 2017;41:2525–33.
- [28] Koivu H, Kohonen I, Mattila K, Loytyniemi E, Tiusanen H. Medium to long-term results of 130 Ankle Evolutive System total ankle replacements—Inferior survival due to peri-implant osteolysis. *Foot Ankle Surg* 2017;23:108–15.
- [29] Roukis TS, Elliott AD. Incidence of revision after primary implantation of the SALTO® mobile version and SALTO TALARIS™ total ankle prostheses: a systematic review. *J Foot Ankle Surg* 2015;54:311–9.
- [30] Besse J-L. Osteolytic cysts with total ankle replacement: frequency and causes? *Foot Ankle Surg* 2015;21:75–6.
- [31] Arcângelo J, Guerra-Pinto F, Pinto A, Grenho A, Navarro A, Martín Oliva X. Periprosthetic bone cysts after total ankle replacement. A systematic review and meta-analysis. *Foot Ankle Surg* 2017 [pii: S1268-7731(17)31347-4].
- [32] Barg A, Elsner A, Anderson AE, Hintermann B. The effect of three-component total ankle replacement malalignment on clinical outcome: pain relief and functional outcome in 317 consecutive patients. *J Bone Joint Surg* 2011;93-A:1969–78.