Long-term results after a triple arthrodesis of the hindfoot: function and satisfaction in 36 patients

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Abstract The long-term functional results of a triple arthrodesis of the hindfoot are not well known. In this retrospective cohort study we therefore investigated pain, function and alignment of the tibiotalar joint, patient satisfaction with the procedure and the prevalence of osteoarthritis (OA) of the tibiotalar joint after a median follow-up of six years. We also aimed to investigate whether there are patient and surgical characteristics associated with the outcome. Patients who underwent a triple arthrodesis for OA between January 1992 and July 2002 were invited to participate. A clinical examination was performed, the Ankle-Hindfoot Scale was completed, and radiographs were taken. Patient characteristics (e.g., age, gender and the indication for operation) and surgical characteristics (e.g., fixation material and use of bone graft) were collected. Sixty-one percent (22 patients) of the patients had a good total score on the Ankle-Hindfoot Scale. Nineteen patients (53%) were satisfied with the result of the operation and 47% of the patients had radiographic OA of the tibiotalar joint. In a univariate regression analysis, male gender and the score on the Ankle-Hindfoot Scale were significantly associated with radiographic OA. Patient satisfaction was significantly associated with a higher score on the Ankle-Hindfoot Scale and better dorsi–flexion of the ankle. Our study shows that 61% of the procedures in 36 patients with a triple arthrodesis for OA had a good score on the Ankle-Hindfoot Scale.

Radiographic OA of the ankle was present in 47% of the cases and was not related to patient satisfaction. No patient characteristics or surgical characteristics were associated with the score on the Ankle-Hindfoot Scale.

Résumé Les résultats fonctionnels à long terme de la triple arthrodèse de l'arrière pied sont maintenant bien connus. Nous avons réalisé une analyse rétrospective d'une cohorte de patients avec étude de la douleur, du fonctionnement et de la position de l'articulation tibiotalienne ainsi que de la satisfaction des patients. Nous avons également évalué la prévalence de l'arthrose (OA) de l'articulation tibiotalienne sur un suivi moyen de 6 ans. Méthode: les patients ayant bénéficié d'une triple arthrodèse ont été analysés. Ces patients ont été opérés entre Janvier 1992 et Juillet 2002. Un examen clinique a été réalisé ainsi que des radiographies. Ont été également analysés, l'âge, l'état général des patients, le sexe, l'indication ainsi que la technique opératoire: matériel de fixation, utilisation de greffes. 61% (22 patients) des patients avaient de bons résultats selon le score Ankle-Hindfoot Scale. Dix-neuf patients (53%) ont été satisfaits du résultat et 47% des patients avaient une radiographie avec une arthrose de l'articulation tibiotalienne. Lors de l'analyse, nous avons mis en évidence pour le sexe masculin que le score Ankle-Hindfoot Scale était de façon significative associé à des signes d'arthrose radiologique, la satisfaction des patients était significativement associée au score élevé de Ankle-Hindfoot Scale et une meilleure flexion de la cheville. Notre étude montre que 61% des procédures chirurgicales sur 36 patients ayant bénéficié d'une triple arthrodèse ont un bon score selon l'échelle Ankle-Indfoot. Une arthrose de la cheville était présente dans 47% des cas mais sans aucune relation avec la satisfaction des patients. Aucune caractéristique des patients ou du traitement chirurgical n'était associé au score Ankle-Hindfoot Scale.

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Introduction

Triple arthrodesis of the hindfoot, a simultaneous fusion of the talonavicular, talocalcaneal, and calcaneocuboid joints, is commonly performed for pain, chronic instability and gross deformity as a result of hindfoot pathology [10, 11]. This pathology includes severe post-traumatic conditions, osteoarthritis (OA), neuromuscular disorders, extensive contractures and longstanding posterior tibial tendon dysfunction [6, 8]. The procedure appears to be effective in relieving pain and improving function [11].

The most common complication of triple arthrodesis is non-union, reported to range from 0% to 40% in different studies [10]. Although some of these non-unions are asymptomatic, a considerable number cause significant disability. Early weight-bearing, insufficient bone apposition and insufficient internal fixation are factors that may contribute to non-unions [10].

Although most surgeons advocate internal fixation to maintain correction and decrease the incidence of non-union, no consensus regarding the optimal technique of internal fixation has been reached [6, 10]. Moreover, questions persist about the long-term functional results of a triple arthrodesis and whether a painless, plantigrade foot can be maintained in the long-term [12].

Degenerative changes in the ankle and midfoot have been reported in more than 50% of the cases [1, 13, 16].

This clinical retrospective cohort study aimed to investigate the function of the tibiotalar joint, patient satisfaction with the result of the procedure and the prevalence of OA of the tibiotalar joint after a median follow-up of six years. We also aimed to investigate whether there are patient and surgical characteristics associated with the outcome.

Subjects and methods

The files of all patients aged 18 years and older who underwent a primary triple arthrodesis of the hindfoot at the Erasmus Medical Centre in Rotterdam between January 1992 and July 2002 were studied. To obtain a homogenous group of patients we chose to include those patients who had undergone the triple arthrodesis for OA that was either idiopathic or caused by a trauma. The patients were invited by letter to participate in this study. Participating patients visited the outpatient clinic between December 2003 and March 2004; all patients signed an informed consent. At the outpatient clinic of the department of orthopaedics, a clinical examination was performed, a questionnaire was filled in, and radiographs were taken.

Patient characteristics, such as age, gender, indication for operation, smoking habits and medication use and surgical characteristics such as fixation material and the use of bone graft were collected from the operation files. Postoperative

complications and the need for re-operation because of a symptomatic non-union were also noted. The Medical Ethics Committee of the Erasmus Medical Centre approved the study.

Questionnaire

The Ankle-Hindfoot Scale, developed by the American Orthopaedic Foot and Ankle Society (AOFAS), was used to assess pain, function and alignment. This scale has a 100-point clinical rating score. A score of 100 points indicates that the patient is pain-free, has full range of motion, no instability, good alignment and is able to walk more than six blocks (600 meters) on any walking surface without walking aids and without activity limitations. Forty points are assigned to pain, 50 to function, and 10 to alignment. Dorsi-flexion and plantar-flexion were measured with a goniometer and described as sagittal motion. A joint that could be passively dislocated or severely subluxated was graded as unstable in these systems [9]. The maximum score attainable in a population with a triple arthrodesis is 94, because of the loss of subtalar motion [2, 9].

No cut-off points of the Ankle-Hindfoot Scale are mentioned in the literature. However, to perform a regression analysis, we divided patients into patients with a good function (score on the Ankle-Hindfoot Scale of 55–94) and a poor function (score on the Ankle-Hindfoot Scale ≤ 54).

Satisfaction

Patient satisfaction was assessed on a 5-point Likert scale (1 indicating very unsatisfied and 5 indicating very satisfied). Further, patients were asked, “If you could choose and the circumstances were similar, would you like to have the operation again?” (answer options were yes, no or no opinion). In addition patients were divided into a non-satisfied and a satisfied group. Patients who were very unsatisfied, unsatisfied or neither unsatisfied or satisfied were allocated to the non-satisfied group. The satisfied group consisted only of patients who were very satisfied or satisfied with the results of the operation.

Radiographic examination

At follow-up standard radiographs were taken, consisting of weight-bearing anteroposterior and lateral views of the ankle and foot, and an oblique view of the hindfoot. The radiographs were evaluated by one of the authors (H.L.). Radiographic union was evaluated, and in case of uncertainty a second experienced reader (J.V.) was consulted to achieve a final judgement. Radiographic osteoarthritis (ROA) of the tibiotalar joint was quantified by the grading scale of Van Dijk et al. [14] into four grades (range 0–3) (see [Appendix](#)).

Surgical technique

At the Erasmus MC a lateral incision is made extending posteriorly from a point over the base of the fourth metatarsal to the inferior tip of the fibula. The articular cartilage is removed from the exposed facets of the talocalcaneal joint down to subchondral bone, the lateral aspect of the talonavicular joint and the calcaneocuboid joint. The medial portion of the talonavicular joint cannot be exposed completely through the lateral incision. Therefore, some surgeons prefer to make a medial incision, centred over the talonavicular joint in order to remove the cartilage of the medial aspect of the talonavicular joint. The calcaneus, talus, navicular and cuboid are placed in their proper positions and, if desired, fixed with screws, pins or staples so that the foot is held in correct alignment. The talocalcaneal joint is fixed first, with correction of the deformity of the hindfoot. The talonavicular and calcaneocuboid joints are then positioned and fixed, so that the forefoot is in a plantigrade position. If joints were fixed, staples, screws and/or threaded wire were used.

The postoperative regimen included immobilisation with a short-leg cast. Patients were not allowed to bear weight for the first six weeks after the operation. Weight-bearing was allowed six weeks postoperatively using a short-leg walking cast for an additional four to six weeks.

Statistical analysis

Logistic regression was performed to assess which patient characteristics and surgical characteristics were associated with the outcome of the triple arthrodesis. Those variables with a (two-sided) P-value of ≤ 0.05 were included in the model. The SPSS version 10.1 (SPSS Inc, Chicago, IL) was used for all analyses.

Results

Fifty-three adult patients who underwent a primary triple arthrodesis of the hindfoot for OA that was either idiopathic or caused by trauma were selected. Of these patients eight were untraceable, two had died and one patient had emigrated. Eventually 40 patients could be invited to participate in this study. Because four patients declined, the final study population consisted of 36 patients (17 women and 19 men). Table 1 presents the baseline characteristics. Table 2 presents the postoperative complications of a primary triple arthrodesis. In this study population 50% had no complications; seven patients (19%) were revised because of symptomatic non-union of the triple arthrodesis.

Table 1 Baseline characteristics of the study population

	Study population (n=36)
Gender, % women	47.2
Age at operation, years $\pm$ SD	43.4 $\pm$ 13.9
Follow-up, years $\pm$ SD	6.1 $\pm$ 2.5
Distribution of arthrodesis left/right (number)	12/24
Smoking, % yes	47.2
Some form of fixation used, % yes	47.2
Exogenous bone graft used, %	25.0
Incision lat/lat and med (number)	25/11
Indication for operation	
Idiopathic OA/trauma (number)	25/11

Idiopathic OA=idiopathic osteoarthritis,
SD=standard deviation

Questionnaire

Pain, function and alignment were assessed by the Ankle-Hindfoot Scale. The median postoperative score of the Ankle-Hindfoot Scale score was 63 points (range 14–94). Sixty-one percent (22 patients) of the patients had a good total score on the Ankle-Hindfoot Scale according to the used definition (≥ 55). Table 3 shows the results on the subscales pain, function and alignment. No patient or surgical characteristics were associated with the score on the Ankle-Hindfoot Scale.

Satisfaction

Of the 36 patients, 19 (53%) were satisfied with the overall result of the operation. In a univariate regression analysis patient satisfaction was significantly associated with a higher score on the Ankle-Hindfoot Scale (P-value of <0.0001), and a better dorsi-flexion of the ankle (P-value of 0.035). Patients with a re-arthrodesis were significantly less satisfied with the result of the operation than patients with a total consolidation at three joints after the primary procedure. Twenty-six patients (72%) would undergo the operation again under similar circumstances, seven (19%)

Table 2 Postoperative complications, numbers (%)

Complications	
None	18 (50.0)
Symptomatic non-union $\rightarrow$ re-operation	7 (19.4)
Superficial wound complication without infection	2 (5.6)
Superficial infection (not admitted, oral AB)	1 (2.8)
Severe wound complication, leading to admission	1 (2.8)
Pulmonary emboli	1 (2.8)
Dystrophy	1 (2.8)
Other	5 (13.9)

Oral AB=oral antibiotics

Table 3 Different outcome measures of the study population

Ankle Hindfoot Scale: median (range)	(n=36)
Pain	20.0 (0.0–40.0)
Function	33.5 (2.0–44.0)
Alignment	3.7 (0.0–10.0)
Total score	63.0 (14.0–94.0)
ROA by van Dijk, number (%)	(n=32)*
grade 0	17 (53.1)
grade I	5 (15.6)
grade II	6 (18.8)
grade III	4 (12.5)
Satisfaction, % yes	(n=36)
	52.8

*Radiographs were not available in four patients

would not undergo the operation again, and three patients had no opinion on this topic.

Radiographic examination

Union or non-union

In 20 (59%) patients total union in all three joints was found. In ten patients (29%) two joints were consolidated and in four patients (12%) one joint was consolidated. The calcaneocuboid joint was consolidated in 91%, the talonavicular joint in 82% and the talocalcaneal joint in 74%. Radiographs of two patients were missing.

ROA

Graded according to Van Dijk et al. 15 patients (47%) showed radiological OA of the tibiotalar joint at the X-ray follow-up. The majority of patients had radiographic OA grade II (see Table 3). In a univariate regression analysis, male gender and the score on the Ankle-Hindfoot Scale were significantly associated with radiological OA (P-value of 0.002 and 0.015, respectively).

Discussion

This clinical retrospective cohort study aimed to investigate pain, function and alignment of the tibiotalar joint, patient satisfaction with the procedure and the prevalence of osteoarthritis (OA) of the tibiotalar joint after a median follow-up of six years. Sixty-one percent of the patients had a good score on the Ankle-Hindfoot Scale. Of all patients, 53% were satisfied with the results of the operation between two to 11 years of follow-up, and 47% had radiological OA grade I, II or III of the tibiotalar joint.

We also aimed to investigate whether there are patient and surgical characteristics associated with the outcome. No

characteristics were associated with the score on the Ankle-Hindfoot Scale. Patient satisfaction was significantly associated with a higher score on the Ankle-Hindfoot Scale and better dorsi–flexion of the ankle. Male gender and score on the Ankle-Hindfoot Scale were significantly associated with radiological OA.

In this study the median Ankle-Hindfoot Scale score was 63.0, similar to the score of 60.7 found by Pell et al. [11]. Because each patient in the latter study had an arthrodesis in which fixation material was used, we additionally divided our study population into a fixation group and a non-fixation group. The group without fixation material had a higher OAFAS score (median 65.0) than the group with fixation material (median 46.0). This difference was significant (P-value of 0.042).

Although in our study group 53% of the patients claimed to be (absolutely) satisfied with the result of the operation, other studies have reported satisfaction rates between 69–95% [2, 9, 12]. In spite of this low satisfaction rate, 73% of patients would undergo the operation again under the same conditions.

We found union of all three joints in 59% of the patients. Wulker et al. [16] found in a group of 52 patients that 47% had a complete bony union, whereas Salzman et al. reported 81% [12]. In both studies determination of non-union was measured by radiographic evaluation, in the same way we measured the presence of non-union. Although we found that smoking was not related to the presence of a union or non-union, Bernarz et al. found that smokers had a significantly higher rate of non-union than non-smokers, with a relative risk for smokers of 2.7 [7]. Similarly, Cobb et al. found that the relative risk of non-union was 3.75 higher in active smokers [4].

Our finding with regard to degenerative changes are supported by those of other long-term studies. Similar to some long-term follow-up studies we found degenerative changes of the ankle and hindfoot after triple arthrodesis [2]. The reported incidence of such changes after a triple arthrodesis ranges from 39–77% [11]. The review by de Heus et al. of the outcomes of 37 triple arthrodesis after an average duration of ten years showed that OA of the tibiotalar joint did not occur with great frequency after triple arthrodesis [5]. According to Pell et al., patients were satisfied despite clinical and radiographic evidence of degenerative joint disease of the ankle [11]. Beisher et al. showed that the presence of radiological OA of the ankle did not correlate with the level of the patient's pain or functional disability [3]. These findings are confirmed by our study.

A limitation of this study is the retrospective design, whereby we missed information of the preoperative scores of the Ankle-Hindfoot Scale. Moreover, because we could not retrieve preoperative radiographs of some ankle joints, it was not possible to evaluate radiological OA before the operation. We used radiographs for evaluating the consol-

idation of the arthrodesis, while CT scanning may be more precise. However, the radiation exposure and the costs of this techniques did not allow us to use this technique in our study. It is possible that the rates of union or non-union might be flawed, in our study.

Conclusion

Our study shows that 61% of the procedures in 36 patients with a triple arthrodesis caused by idiopathic or secondary OA had a good score on the Ankle-Hindfoot Scale. The patients who needed a revision-operation after a triple arthrodesis still have a significantly more impaired function of the ankle than those in whom a re-operation was unnecessary. Radiological OA of the ankle was present in 47% of the cases and was not related to patient satisfaction. No patient characteristics or surgical characteristics were associated with the score on the Ankle-Hindfoot Scale. Patient satisfaction was significantly associated with a higher score on the Ankle-Hindfoot Scale and a better dorsi–flexion of the ankle. Male gender and the score on the Ankle-Hindfoot Scale were significantly associated with radiological OA.

Appendix

Table 4 The grading of radiological evidence of osteoarthritis of the ankle according to Van Dijk et al. [11]

Grade	Description
0	No abnormality or subchondral sclerosis
I	Signs of cartilage damage with or without osteophytes
II	Cartilage destruction, subchondral necrosis, cysts and collapse of bone
III	Cartilage destruction accompanied by a partial or complete disappearance of the joint space and bony necrosis with deformation or subluxation

References

- Angus PD, Cowell HR (1986) Triple arthrodesis. A critical long-term review. *J Bone Joint Surg Br* 68:260–265
- Bednarz PA, Monroe MT, Manoli A 2nd (1999) Triple arthrodesis in adults using rigid internal fixation: an assessment of outcome. *Foot Ankle Int* 20:356–363
- Beischer AD, Brodsky JW, Pollo FE, Peereboom J (1999) Functional outcome and gait analysis after triple or double arthrodesis. *Foot Ankle Int* 20:545–553
- Cobb TK, Gabrielsen TA, Campbell DC 2nd, Wallrichs SL, Ilstrup DM (1994) Cigarette smoking and nonunion after ankle arthrodesis. *Foot Ankle Int* 15:64–67
- de Heus JA, Marti RK, Besselaar PP, Albers GH (1997) The influence of subtalar and triple arthrodesis on the tibiotalar joint. A long-term follow-up study. *J Bone Joint Surg Br* 79:644–647
- Donatto KC (1998) Arthritis and arthrodesis of the hindfoot. *Clin Orthop* 81–92
- Ishikawa SN, Murphy GA, Richardson EG (2002) The effect of cigarette smoking on hindfoot fusions. *Foot Ankle Int* 23:996–998
- Kann JN, Parks BG, Schon LC (1999) Biomechanical evaluation of two different screw positions for fusion of the calcaneocuboid joint. *Foot Ankle Int* 20:33–36
- Kitaoka HB, Alexander IJ, Adelaar RS, Nunley JA, Myerson MS, Sanders M (1994) Clinical rating systems for the ankle-hindfoot, midfoot, hallux, and lesser toes. *Foot Ankle Int* 15:349–353
- Meyer MS, Alvarez BE, Njus GO, Bennett GL (1996) Triple arthrodesis: a biomechanical evaluation of screw versus staple fixation. *Foot Ankle Int* 17:764–767
- Pell RF 4th, Myerson MS, Schon LC (2000) Clinical outcome after primary triple arthrodesis. *J Bone Joint Surg Am* 82:47–57
- Saltzman CL, Fehrle MJ, Cooper RR, Spencer EC, Ponseti IV (1999) Triple arthrodesis: twenty-five and forty-four-year average follow-up of the same patients. *J Bone Joint Surg Am* 81:1391–1402
- Southwell RB, Sherman FC (1981) Triple arthrodesis: a long-term study with force plate analysis. *Foot Ankle* 2:15–24
- van Dijk CN, Lim LS, Poortman A, Strubbe EH, Marti RK (1995) Degenerative joint disease in female ballet dancers. *Am J Sports Med* 23:295–300
- Wetmore RS, Drennan JC (1989) Long-term results of triple arthrodesis in Charcot-Marie-Tooth disease. *J Bone Joint Surg Am* 71:417–422
- Wulker N, Flamme C (1996) Hindfoot arthrodesis. *Orthopade* 25:177–186