Surgical treatment of hindfoot inflammatory diseases: 107 arthrodeses

M.A. Munoz*, R. Augoyard, F. Canovas, The French Association of Foot Surgery (AFCP)

Hip, Knee and Foot Surgery Medical Unit, Lapeyronie University Hospital (Montpellier-1 University), 271, avenue Doyen-Gaston-Giraud, 34000 Montpellier, France

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Summary
Introduction: In rheumatoid diseases, hindfoot arthrodesis abolishes pain and corrects deformity. The choice between selective and double arthrodesis depends on whether the hindfoot malalignment is fixed or not. Indications for surgery are well codified. The various types of arthrodesis have never been assessed together on a large series. We here report a series that is substantial in numbers and in follow-up.

Materials and methods: A continuous single-center retrospective study included patients with native hindfoot inflammatory disease treated by arthrodesis between 1996 and 2009.

Results: Around 80% of patients were followed up, for a mean 7 years. Fifty-four isolated talocalcaneal arthrodeses and 39 double arthrodeses were performed. 96% of patients had rheumatoid arthritis and 4% spondylarthritis. 62% were completely pain-free at follow-up. The satisfaction rate was 91% and mean AOFAS score 70%. 6% of patients showed symptomatic non-union, mainly associated with talonavicular arthrodesis. In 22% of double arthrodeses and 11% of talonavicular arthrodeses, ankle status required surgical revision. In double arthrodeses, there was no correlation between hindfoot deviation and secondary deterioration in ankle status. Talocalcaneal arthrodesis was associated with radiologic hindfoot varus, both preoperatively and at follow-up.

Discussion: Non-union was the main complication in talonavicular arthrodesis. The rate of secondary ankle surgery was significantly elevated in double arthrodesis. These findings support Sacket’s cadaver studies, which, in 2007, reported early deterioration in ankle status in double arthrodesis, due to mechanical overloading. Talocalcaneal arthrodesis proved reliable and simple, free of major complications and with a 100% satisfaction rate.

* Corresponding author. Tel.: +33 06 15 06 95 94.
E-mail address: marieaudemunoz@yahoo.fr (M.A. Munoz).

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Conclusion: Double arthrodesis showed the greatest benefit in terms of restoring foot architecture, but was associated with a higher rate of deterioration in ankle status. Preventive double arthrodesis is not recommended in case of isolated arthritis with reducible hindfoot malalignment.

Level of evidence: Level IV. Retrospective study.
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Introduction

The prevalence of inflammatory rheumatism in the general population is 0.5%; clinical hindfoot involvement is variable [1]. The reference treatment for symptomatic hindfoot inflammatory arthritis is arthrodesis [2]. Indications for surgery are rare in everyday practice; there have therefore been few dedicated reports [3–6], and hindfoot arthrodesis series most often include both inflammatory rheumatism and other etiologies [7–9]. Impact on adjacent joints remains uncertain.

The present continuous single-center retrospective study sought to assess the long-term impact of hindfoot arthrodesis in inflammatory rheumatism.

Material and methods

The series included 96 patients. The inclusion criterion was hindfoot arthrodesis for inflammatory rheumatism. The inclusion period was January 1996 to December 2009. Arthrodeses in a previously operated hindfoot were excluded. Patients were identified retrospectively from databases.

One hundred and seven hindfoot arthrodeses were performed in the 96 patients: 54 talonavicular, 39 double (arthrodesis of all 3 hindfoot joints) and 14 talocalcaneal arthrodeses. Mean age at surgery was 53 years (±12.4), with 78 women and 18 men. A percentage of 50.5 of the feet operated on were right and 49.5% left. Ninety-six percent of cases (92 patients) concerned rheumatoid arthritis and 4% spondylartharthritis (four patients).

Doubles arthrodesis was performed in diffuse arthritic hindfoot joint lesions or fixed hindfoot deformity. Talonavicular arthrodesis was performed in isolated talonavicular joint lesions with well-aligned hindfoot or reducible malalignment. Talocalcaneal arthrodesis was performed in isolated talocalcaneal joint lesion.

All data collection and assessment was performed by a single investigator, independent of the surgeon concerned. Satisfaction was assessed on a self-administered questionnaire, as very satisfied, satisfied, neither satisfied nor dissatisfied, or dissatisfied; patients responding "very satisfied" or "satisfied" were grouped together as "satisfied". Pain was assessed on a 10-point visual analog scale. Functional assessment was based on the AOFAS (American Orthopaedic Foot and Ankle Society) score, assessing the ankle and hindfoot on 100 points [10]. In talonavicular and talocalcaneal arthrodesis, the range of motion of the non-operated hindfoot joints was qualitatively assessed on clinical examination, as normal, stiff or fixed.

Radiographic assessment at follow-up comprised AP and lateral weight-bearing views and a Méary view [11].

Preoperative and follow-up radiographs were compared for Djian-Annonier angle [12], calcaneal slope [12], Méary-Toméno angle [12], talocalcaneal divergence angle [13] and Djian-Annonier trapeze [12]. In the Djian-Annonier trapeze, a "hindfoot divergence angle" was assessed, as the angle subtended by the line between the middle of the talar dome and the middle of the weight-bearing region, and was considered normal for 7 ± 1° of valgus, and improved when it approximated normal values; positive values exceeding 8° corresponded to hindfoot valgus, and negative values or values less than 6° corresponded to hindfoot varus. Rheumatism-related joint damage was assessed on the 0–5 point Larsen score [14].

Scores were compared by comparison of means tests (Student or Wilcoxon, according to the distribution) for quantitative variables and Chi² (or Fisher exact test, as required) for qualitative variables. Correlations between continuous variables were assessed by Spearman rank correlation coefficient with 95% confidence interval, calculated by Fisher transformation. The significance threshold was set at 5% in all cases. Statistical analysis was performed, with the help of the Medical Information Department of Montpellier University Hospital, using SAS, version 9, software (SAS Institute, Cary, N.C.).

Results

Of the 96 patients, 12 (14 feet) were lost to follow-up and 8 (9 feet) died; 76 (78.5%) (84 feet) were followed up, for a mean 7 years (±3.9). Mean diagnosis-to-surgery interval was 15.7 years (±9.1), without significant difference according to type of arthrodesis.

Complications

Twenty-four complications were found, in 20 patients (Table 1). Non-union was the most frequent (50% of complications, and 14% of cases), and was significantly more frequent in talonavicular arthrodesis (nine out of 42, or 21%; P = 0.039) than in double arthrodesis (three out of 31, or 10%). The five cases of symptomatic non-union (out of 12 cases of non-union) all involved the talonavicular joint; the talocalcaneal joint was never involved, whatever the type of arthrodesis. All the cases of symptomatic non-union required surgical revision of the osteosynthesis with autologous corticocancellous graft, achieving arthrodesis-site consolidation in all cases. Three talonavicular arthrodeses required surgical revision for reasons other than non-union: one case of sepsis, treated by secondary panarthrodesis; and two of persistent hindfoot joint pain, treated by double arthrodesis.
Secondary surgery was performed on 17 of the 84 feet followed up, including ankle surgery in 14 cases (82%) (Table 2). In the talonavicular group, five ankles (11%) required revision surgery, and 7 (22.5%) in the double arthrodesis group; this difference was not statistically significant. The mean interval between primary hindfoot surgery and secondary ankle surgery was 4 ± 3.4 years in the talonavicular group and 1.6 ± 1.45 years in the double arthrodesis group; again, this difference was not statistically significant (NS).

Clinical results

At follow-up, 91% of patients were satisfied with their surgical treatment: 84% in the talonavicular group and 92% in the double arthrodesis group (NS); the satisfaction rate in talocalcaneal arthrodesis was 100%. At end of follow-up, 64% of the operated feet were pain-free. Ten out of the 42 talonavicular arthrodeses (24%) showed residually impaired talocalcaneal range of motion, including two cases of asymptomatic non-union of the talonavicular arthrodesis.

Functional results

Mean AOFAS score was 71.7 ± 19.7. Intermediate scores did not significantly differ according to type of surgery. Everyday activity showed little or no limitation in 70% of patients. "Pain" and "Function" item scores were significantly higher (i.e., improved) (P < 0.05) in the group of satisfied patients (Fig. 1). "Alignment" item scores showed no correlation with satisfaction, whatever the type of surgery.

Radiological results

Table 3 presents the results for Djian-Annionier angle, Méary-Toméno angle, calcaneal slope, talocalcaneal divergence angle and hindfoot deviation angle, according to type of surgery. Mean preoperative Djian-Annionier angle in the double arthrodesis group was significantly greater than in the talonavicular arthrodesis group (135 ± 14° versus 129 ± 12°; P < 0.001) (Table 3). At follow-up, the angle was identical in both groups: i.e., Djian-Annionier angle was significantly improved by double arthrodesis (P < 0.001). In the talocalcaneal arthrodesis group, 30% of patients showed hindfoot varus preoperatively, and 27% at follow-up; 36% showed Djian-Annionier angle ≤120°, and 54% at follow-up. In talonavicular arthrodesis, the hindfoot deviation angle at follow-up was normal in 48% of cases, either in that a normal preoperative angle had been conserved or in that surgery

Table 3 Preoperative and follow-up radiographic values according to type of procedure.

<table>
<thead>
<tr>
<th></th>
<th>Talonavicular arthrodesis</th>
<th>Double arthrodesis</th>
<th>Talocalcaneal arthrodesis</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Djian-Annonier angle</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative</td>
<td>129 (±12)</td>
<td>135 (±14)</td>
<td>121 (±11)</td>
<td>131 (±13)</td>
</tr>
<tr>
<td>Follow-up</td>
<td>129 (±12)</td>
<td>129 (±13)</td>
<td>121 (±11)</td>
<td>128 (±12)</td>
</tr>
<tr>
<td><strong>Méary-Toméno angle</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative</td>
<td>−7.0 (±10.3)</td>
<td>−9.1 (±14.8)</td>
<td>3.2 (±10.2)</td>
<td>−6.7 (±12.9)</td>
</tr>
<tr>
<td>Follow-up</td>
<td>−5.9 (±11.0)</td>
<td>−5.1 (±11.0)</td>
<td>5.6 (±8.2)</td>
<td>−4.1 (±11.0)</td>
</tr>
<tr>
<td><strong>Calcaneal slope</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative</td>
<td>20.2 (±6.8)</td>
<td>17.9 (±6.3)</td>
<td>20.1 (±6.1)</td>
<td>19.2 (±6.6)</td>
</tr>
<tr>
<td>Follow-up</td>
<td>17.2 (±7.8)</td>
<td>14.4 (±6.6)</td>
<td>19.2 (±8.3)</td>
<td>16.5 (±7.6)</td>
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<td><strong>Talocalcaneal divergence angle</strong></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Preoperative</td>
<td>24.9 (±6.1)</td>
<td>25.4 (±8.3)</td>
<td>21.9 (±5.2)</td>
<td>24.7 (±7.1)</td>
</tr>
<tr>
<td>Follow-up</td>
<td>21.3 (±4.5)</td>
<td>20.5 (±2.9)</td>
<td>20.6 (±4.4)</td>
<td>21.0 (±4.0)</td>
</tr>
<tr>
<td><strong>Hindfoot deviation angle</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperative</td>
<td>8.8 (±7.5)</td>
<td>9.1 (±9.8)</td>
<td>5.5 (±5.6)</td>
<td>8.4 (±11.1)</td>
</tr>
<tr>
<td>Follow-up</td>
<td>8.1 (±6.5)</td>
<td>9.0 (±7.5)</td>
<td>5.0 (±7.1)</td>
<td>8.02 (±10.5)</td>
</tr>
</tbody>
</table>

had achieved correction; if cases of partial hindfoot correction are included, the improvement rate was 72%: 28% of feet showed improved hindfoot deviation angles. In double arthrodesis, 41% of cases showed conserved or corrected normal hindfoot deviation angle at follow-up, with a 58% improvement rate including partial corrections: 42% of feet showed improved hindfoot deviation angles.

Preoperative and follow-up Larsen ankle scores did not significantly differ in any of the three surgical procedure groups. Mean preoperative Larsen score in ankles requiring surgical revision was 1.28 ± 1.12, versus 1.27 ± 1.22 in those not requiring surgical revision (NS).

Correlation at follow-up between hindfoot position in terms of hindfoot deviation angle and joint damage in terms of Larsen score was analyzed. In talonavicular arthrodesis, the correlation coefficient with Larsen score was $R = 0.65$ ($P = 0.001$) for hindfoot valgus, and $R = 0.51$ ($P = 0.06$) for hindfoot varus; in double arthrodesis, the coefficients were $R = 0.22$ ($P = 0.46$) and $R = 0.39$ ($P = 0.24$), respectively.

Discussion

Hindfoot arthrodesis in inflammatory rheumatism has a non-negligible impact on neighboring joints. This is especially true of the ankle joint, where functional impact depends on the type of arthrodesis.

All three types of arthrodesis provided subjective and functional satisfaction. The most frequent complication was non-union, which mainly involved the talonavicular joint and was symptomatic in less than 50% of cases. Only symptomatic non-union required surgical revision, which provided consolation in all cases. In the present series, there were no cases of talocalcaneal non-union.

Selective arthrodesis is generally seen as an "early" procedure [15]. In the present series, however, the diagnosis-to-surgery interval was comparable in the three procedural groups: selective arthrodesis thus did not prevent double arthrodesis, but rather was associated with a different pattern of hindfoot evolution.

The study provided a radiological description of the three types of arthrodesis at follow-up. Radiographically, talonavicular arthrodesis showed no change with surgery; the internal arch remained slightly broken. In 28% of cases, there was some malalignment of the hindfoot with respect to the preoperative findings; the exact origin of this deformity could not be determined, as no immediate postoperative X-ray views were taken. Twenty-four percent of talonavicular arthrodeses showed talocalcaneal mobility; this abnormal conservation of mobility may be inherent to inflammatory rheumatism and the capsule distension associated with this kind of pathology. No arthrodeses required surgical revision for hindfoot malalignment; the present results suggest that the postoperative mobility and malalignment were not a sign of failure or a risk-factor for surgical revision of the talonavicular arthrodesis.

Double arthrodesis corrected the plantar footprint, by correcting the Djian-Annonier angle and reducing talocalcaneal divergence, but did not reduce hindfoot malalignment. Preoperatively, ankle status in the double arthrodesis group was not worse than in the other two procedural groups; nevertheless, the surgical revision rate was 22.5% in double arthrodesis, compared to 11% in talonavicular arthrodesis. This secondary surgery was required for a deterioration in ankle status that could be said to be "pathological" in the rapidity of its evolution: the mean interval between primary hindfoot surgery and secondary ankle surgery was 1.6 ± 1.43 years in double arthrodesis, compared to 4 ± 3.4 years in talonavicular arthrodesis, and seemed very short in view of the mean hindfoot diagnosis-to-surgery interval of 15 years. Taken together, these findings suggest that double arthrodesis leads to early deterioration in ankle status. A correlation between ankle deterioration and hindfoot malalignment was found for valgus deviation in the talonavicular group, but not in the double arthrodesis group, where hindfoot malalignment and ankle status...
seemed to evolve independently. Talocalcaneal arthrodesis showed a trend for preoperative pes cavus, and the same aspect persisted postoperatively; this finding has not been reported elsewhere in the literature.

The present study involved a limitation in radiological assessment: the preoperative assessment was not available in every case. On the other hand, the number of arthrodeses (n = 107) and the excellent rate of follow-up (78.5%) represent strong points.

The satisfaction rate (91%) was comparable to literature reports, which range from 85 to 100% [3,4,8,15–18]. The mean AOFAS was also in agreement with the literature [15,17]. The symptomatic non-union rate was 6%, in agreement with other reports (3 to 18%) [4,7,19]. In the present series, talocalcaneal arthrodesis was systematically free of non-union, in contrast to other series reporting rates of 5 to 7% [4,20].

According to Steinhauser [21], followed by Elbar et al. [19], talonavicular arthrodesis induces an "arthrodesis-like" effect on the talocalcaneal joint [19,21]. In a series of 50 talonavicular arthrodeses, Asencio et al. [7] reported one case of talonavicular arthrodesis with persistent partial talocalcaneal mobility, in an inflammatory foot with talonavicular non-union. Other authors [22] suspected talocalcaneal micromobility as being implicated in residual hindfoot pain.

Some authors, describing overall hindfoot arthritic pathology, report concomitant ankle involvement [23,24]; this was not found in the present series. In the literature, the rate of ankle arthropathy secondary to hindfoot arthrodesis ranges from 2 to 39% [3,6,9,16,17,25,26]. Rammelt et al. [26] reported a rate of 30% neighboring joint degeneration following talonavicular arthrodesis, without, however, specifying rates per joint. In inflammatory rheumatism, Mäenpää et al. [6] and Figgie et al. [16] reported respectively 2% and 8% rates of secondary ankle surgery following double arthrodesis; both implicated hindfoot malalignment. The clinical hypothesis of secondary ankle deterioration following double arthrodesis is in agreement with Suckel et al.’s cadaver studies [27], which found significantly less pressure on the ankle following talonavicular as compared to double arthrodesis, with significantly more even pressure distribution. Could this difference in pressure distribution account for the more rapid deterioration in ankle status? And, if so, how may this be avoided? The present study failed to identify predictive factors for rapid ankle deterioration; a prospective study would be needed to assess precisely the chronology of ankle deterioration following double arthrodesis, but would be difficult to set up, due to the sample-size required to achieve statistical power.

In conclusion, there are two distinct forms of inflammatory hindfoot: painful hindfoot with isolated arthritis, and malaligned hindfoot with diffuse arthritic involvement. Double arthrodesis achieves better architectural restoration, but with a greater risk of ankle deterioration. Preventive double arthrodesis is not to be recommended in isolated arthritis of the foot with reducible hindfoot malalignment.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.


