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Risk of osteoarthritis secondary to partial or total arthrodesis of the subtalar and midtarsal joints after a minimum follow-up of 10 years

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ABSTRACT

Introduction: The goal of this retrospective, multicentre study was to evaluate the long-term outcomes in patients who have undergone partial or total arthrodesis of the subtalar and midtarsal joints.

Hypothesis: Secondary osteoarthritis of the adjacent joints can negatively affect the outcomes more than 10 years after these fusion procedures.

Material and Methods: The outcomes of 72 fusions (total: 22; partial: 50) performed between 1981 and 2002 were evaluated using the Maryland Foot Score (MFS), self-evaluation questionnaire and three weight-bearing X-ray views (Meary’s with cerclage wire around heel, lateral and dorsoplantar). The average follow-up was 15 ± 5 years (range 10–31).

Results: There were two deep infections that resolved after lavage and antibiotics therapy. There were 21 early complications (10 complex regional pain syndrome, 7 delayed wound healing, 2 superficial infections, 2 venous thrombosis) that all resolved. There were five cases of non-union (6.9%) that healed after being re-operated. After five years, secondary osteoarthritis led to the fusion being extended to the tibotalar joint (1 case) and midtarsal joint (1 case). At the last follow-up, the average MFS was 71.5 (range 25–100). Patient deemed the result as either excellent (10%), very good (9%), good (55%), poor (19%) or bad (7%). Pain at the last follow-up was present in 84% of cases. The rear-foot was normally aligned in 45% of cases, varus aligned in 22% and valgus aligned in 33%. The MFS was significantly better in patients with normal alignment. Patients with neurological foot disorders had significantly more preoperative (80% cavovarus) and postoperative deformity (P<0.05). At the last follow-up, the rate of secondary osteoarthritis in the surrounding joints was elevated: 73% tibotalar, 58.3% subtalar, 65.8% talonavicular, 53.5% calcaneocuboid. The presence of osteoarthritis was not correlated with pain or lower MFS. However there was significantly more pain at last follow-up than at 12 months postoperative and two fusions were required in patients with secondary osteoarthritis.

Conclusion: Although partial or total arthrodesis of the subtalar and midtarsal joints is a reliable procedure, it induces secondary osteoarthritis. Even though it seems to be well tolerated more than 10 years after the initial procedure, this possibility must be discussed with young, active patients.

Level of evidence: IV, retrospective study.

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1. Introduction

Although the outcomes of partial or total arthrodesis of the subtalar and midtarsal joints are now well validated [1–7], overload of the adjacent joints brings about the risk of secondary osteoarthritis (OA) [8–10]. Very few long-term studies have been published that would allow us to evaluate this risk [1,2,6,11–13]. As a consequence, it is difficult for surgeons to provide complete information.

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on the possibility of secondary osteoarthritis to patients who are candidates for this procedure and want to know about their future function.

The Round Table at the Société d’Orthopédie de l’Ouest (Western France Orthopaedic Society) meeting in 2013 sought to evaluate the outcomes at least 10 years after the fusion procedure. The hypothesis was that secondary osteoarthritis in the adjacent joints might negatively affect the long-term functional outcomes of fusion of the three main joints in the midfoot.

2. Material and methods

This was a multicentre retrospective study of 320 cases of partial or full arthrodesis cases performed at five university hospital centres in Western France (Brest, Nantes, Rennes, Rouen and Tours) between 1981 and 2002. Partial arthrodesis was defined as fusion of one or more of the following joints: subtalar (ST), talonavicular (TN) and calcaneocuboid (CC). In complete or triple arthrodesis, all three joints were fused. Patients with a previous tibiotalar (TT) fusion or joint implant were excluded. The main outcome measure was osteoarthritis in joints near the fusion site. The secondary outcomes were complications, functional results, fusion rate and foot architecture.

Sixty-five patients (72 fusions) or 22.5% of the initial cohort agreed to participate in the study. The other patients were either lost to follow-up (59.2%), had died (9.9%) or declined to participate (8.4%). This group of 72 fusion cases formed the basis for the current study. The age, body mass index (BMI), diagnosis, preoperative clinical data available in the patient file (pain, TT mobility labelled as either <15°, 15°–30°, >30°), type of fusion, surgical technique and complications were recorded.

2.1. Functional outcomes

The follow-up for each patient was performed either by telephone (52 cases) or in the surgeon’s clinic (20 cases). Functional outcomes were evaluated using the Maryland Foot Score (MFS), which is specific to foot and ankle function [14]. In the 100-point MFS, >89 points is an excellent result, 75–89 points is a good result, 50–74 is an average result, and <50 points is a bad result. The patients were also asked to complete a self-evaluation questionnaire relative to the result (excellent, very good, good, poor, or bad).

2.2. Radiology outcomes

Three weight-bearing views taken before surgery, immediately after surgery and six months postoperative were evaluated: Meary view with cerclage wire around the heel [15], lateral view and dorsoplantar view. For the last follow-up, the patients sent these same three views to us.

Three parameters were evaluated: foot architecture before and after the fusion procedure; fusion rate; osteoarthritis at the adjacent joints.

2.2.1. Foot architecture

Meary view:

- the TT angle was measured. If the angle deviated from 180°, the foot was characterized as having valgus or varus misalignment;
- the frontal alignment was evaluated using the Djian-Annorier angle: normal alignment (4–8° valgus), valgus misalignment (>8° valgus) or varus misalignment (<4° valgus) [16,17];
- Lateral view: any disruption in the Meary-Toméno line, no matter its magnitude, suggested a cavus or planus foot.

2.2.2. Fusion of the arthrodesis

Fusion was evaluated six months after the procedure and at the last follow-up. Fusion was achieved if the subchondral bone had disappeared and bone trabeculae bridged the joint space. The fusion percentage was categorized as either 0%, >50%, >50%, 100%. An arbitrary threshold of <50% was used to classify a case as having a non-union.

2.2.3. Osteoarthritis of the adjacent joints

The presence of osteoarthritis was evaluated using the Graves classification system [4]: 0: normal joint space; 1: isolated narrowing of the joint space; 2: narrowing with osteophytes and sclerosis; 3: osteoarthritis with joint space no longer present.

2.3. Statistical methods

The statistical analysis was performed by the Department of Public Health and Medical Information at CHU Rennes:

- with qualitative data, the Fisher’s exact, Pearson’s chi-square, Welch Two Sample T-test and Wilcoxon rank sum tests were used;

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• with quantitative data, the Kruskal–Wallis rank sum test and analysis of variance (Anova) were used. Bilateral cases were considered to be independent samples. The risk of Type 1 error was set at 5% when determining if a difference was statistically significant.

3. Results

The 72 fusion cases were performed in 38 men and 27 women; the average patient age was 39.8 years (range 13–74). The average BMI was 25.3 kg/m² (range 14.0–44.1).

In most cases (58.3%), the diagnosis was due to trauma (Table 1). ST fusion was mainly performed after calcaneus fracture and triple arthrodesis performed in patients with deformity due to neurological disorder (Table 2). Patients reported having preoperative ankle pain in 41.6% of cases. The range of motion was normal (>30°) in 78.7% of cases, limited (15° to 30°) in 21.8% of cases and restricted (<15°) in 8.5% of cases.

A lateral sub-malleolar horizontal approach was used in 64% of cases, a dual medial-lateral approach in 27% and medial approach in 7% (TN fusion only). Fixation was performed with staples (28% of cases), screws (29%) or both (31%). In patients where an additional procedure was required (Table 2), bone grafts were required in 56 cases (77.8%) with most grafts taken from the iliac crest (90%), tenotomy and plantar aponeurotomy were performed in 12 cases, and tarsectomy in five cases. The operated limb was immobilized for six to eight weeks.

The average follow-up was 15 ± 5 years (range 10–31 years). It was more than 15 years in 45 cases (62.5%).

3.1. Complications

3.1.1. Early complications

There were early complications in 23 of the arthrodesis cases (32%).

Table 1

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post-traumatic changes</td>
<td>58.3</td>
</tr>
<tr>
<td>Calcaneus</td>
<td>33.3</td>
</tr>
<tr>
<td>Talus</td>
<td>22.2</td>
</tr>
<tr>
<td>Navicular bone</td>
<td>2.8</td>
</tr>
<tr>
<td>Work-related injury</td>
<td>28.6</td>
</tr>
<tr>
<td>Neurologic</td>
<td>25.0</td>
</tr>
<tr>
<td>Inflammatory</td>
<td>11.1</td>
</tr>
<tr>
<td>Congenital</td>
<td>4.2</td>
</tr>
<tr>
<td>Others</td>
<td>1.4</td>
</tr>
</tbody>
</table>

Fig. 2. Foot architecture.
4.5% and valgus. The TT angle was normal in 27% of cases. The foot appeared normal on lateral views in only 33% of cases (Fig. 3). Note that these latter two results only take the direction of the malalignment into account, not its magnitude. Patients with neurological foot disorders had significantly more preoperative (80% cavovarus) and postoperative deformity (P<0.05).

3.3.2. Fusion of the arthrodesis

Five of the non-union cases have been described above. In the seven other cases, less than 50% of at least one joint space had fused after six months, but the patients were asymptomatic. At the last follow-up, it was greater than 50%, which suggests that union occurred at six months and continued to progress. Overall, the fusion rate was 93.6%: 90.9% in triple arthrodesis cases, 94.6% in ST fusion cases and 100% in TN fusion cases.

3.3.3. Osteoarthrosis of the adjacent joints

3.3.3.1. TT joint. The TT osteoarthrosis rate at the last follow-up (73%) was higher than preoperatively (Fig. 4). There was no correlation between TT osteoarthrosis and the type of fusion procedure (triple arthrodesis: 73.6%, ST fusion: 73%, TN fusion: 72.5%), pain, the MFS and foot architecture at the review.

3.3. Radiography results

3.3.1. Foot architecture

At the last review, only 45% of cases had normal rear-foot alignment (Fig. 2). The MFS score was higher when the foot was normally aligned (average MFS of 80) than when it was misaligned (average MFS of 68) (P<0.05), with no differences between varus and valgus. 

![Graves 2 TT osteoarthrosis 17 years after triple arthrodesis.](image)

![TT osteoarthrosis.](image)
3.3.3.2. ST, TN and CC joints. By performing partial arthrodesis, 96 joints were spared:

- 12 ST joints (9 isolated TN fusions and 3 TN + CC);
- 38 TN joints (37 ST fusions and 1 ST + CC);
- 46 CC joints (37 ST fusions and 9 TN).

Figs. 5–7 show that the arthritis rate in these joints was higher at the last follow-up than before the procedure. There was no correlation between osteoarthritis (Fig. 8) and pain, the MFS and foot architecture at the review.

4. Discussion

In the current patient cohort, several observations were consistent with published findings:

- the fusion provided significant pain relief; our satisfaction rate was in line with the 81–100% rate reported in various studies [4–6,12,18–20];
- the functional results were not as good, as in several studies that report “fair or reasonable” functional outcomes [3,5,12,18,19];
- pain upon review was very common, which suggests that the results degrade over time [6].

The fusion rate in the current study (90.9% for triple arthrodesis, 94.6% for ST fusion and 100% for TN fusion) is comparable to the one reported in other studies. For triple arthrodesis cases, the fusion rate was 77.5% for Angus et al. [1], 83% for Graves et al. [4], 94% for Sammarco et al. [21] and 100% for Smith et al. [12] and Brillhaut [22]. For ST fusion, the fusion rate ranged from 84% [3] to 100% [23]. For TN fusion, several studies have reported a 100% fusion rate [24,25], contrary to popular belief. These differences can be explained by the challenges of determining whether fusion has occurred [26,27], although this is easier with a CT scan [27]. We found no positive effect of bone grafting, which some studies have stated is indispensable [28,29] and others useless [30,31]. In the Easley et al. Study [3], non-union occurred because a thick layer of avascular subchondral bone (more than 2 mm) existed. Smoking is also a known risk factor that increases the non-union rate by a factor of 2.7 [3,32].

As with most other studies, we found no effect of the diagnosis on the outcomes [1,5,6]. Conversely, Smith et al. [12], reported lower functional scores in patients with inflammatory diseases. The correlation between good rear-foo t-positioning and good functional results is well known [1,3,9]. Studies other than ours have also reported a high number of technical deficits: 56% rate of normal rear-foot alignment after TN + CC fusion [33] and incomplete deformity correction after triple arthrodesis [9].

The primary goal of the current study was to determine the risk of the outcomes worsening beyond 10 years due to secondary osteoarthritis. Only a few other studies have such a long follow-up [1,2,6,11–13]. Nevertheless, our study has its limitations:

- A very large number of patients were lost to follow-up. This can be explained by many patients having moved during a 10+ year period [12].
- The multicentre nature of this study involved multiple surgeons, and the inter-observer reliability during data collection is unknown.
- Because several types of fusion procedures and diagnoses were present, the study cohort was inhomogeneous.

The strongest features of current study were that 72 cases were followed for more than 10 years, and that clinical and radiological assessments were used to determine the frequency of secondary osteoarthritis and its functional impact (Table 3).

The development of osteoarthritis can be attributed to the non-fused joints being overloaded [29,10]. It is most common at the ankle [8,10]. After triple arthrodesis, the rate of TT osteoarthritis ranges from 39 to 77% [1,5–7,13,20,29]. The OA rate in the current study (73%) is similar to the one reported by Wetmore et al. [13], after 21 years of follow-up in patients with Charcot-Marie-Tooth disease. De Heus et al. [2] have reported an OA rate of only 34% after an average follow-up of 10 years. We are unable to explain these differences. After ST fusion, the rate of TT osteoarthritis was
Table 3

<table>
<thead>
<tr>
<th>Study</th>
<th>Avg. follow-up (years) and % LTFU</th>
<th>Type of arthrodesis</th>
<th>Rate of TT osteoarthrosis</th>
<th>Rate of rear-foot osteoarthrosis</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angus PD et al. [1]</td>
<td>13 (80% LTFU)</td>
<td>Triple: 80</td>
<td>39%</td>
<td>Unknown</td>
<td></td>
</tr>
<tr>
<td>Wetmore RS et al. [13]</td>
<td>21 (46% LTFU)</td>
<td>Triple: 30</td>
<td>76%</td>
<td>Unknown</td>
<td></td>
</tr>
<tr>
<td>Haritidis JH et al. [11]</td>
<td>25 (poliomyelitis)</td>
<td>Triple: 42</td>
<td>28.6%</td>
<td>No correlation</td>
<td></td>
</tr>
<tr>
<td>Clain MR et al. [33]</td>
<td>7</td>
<td>TN + CC: 16</td>
<td>37.5%</td>
<td>ST: “a few cases”</td>
<td>None</td>
</tr>
<tr>
<td>Fogel GR &amp; al. [36]</td>
<td>9.5</td>
<td>TN: 11</td>
<td>Unknown</td>
<td>ST: 28%</td>
<td>Unknown</td>
</tr>
<tr>
<td>Saltzman CL et al. [6]</td>
<td>25 and 44 (69% LTFU)</td>
<td>Triple: 184</td>
<td>25 years: 69%</td>
<td>Unknown</td>
<td>No correlation</td>
</tr>
<tr>
<td>De Heus JA et al. [2]</td>
<td>10 (22% LTFU)</td>
<td>ST: 17</td>
<td>44 years: 100%</td>
<td>Unknown</td>
<td>No correlation</td>
</tr>
<tr>
<td>Smith RW et al. [12]</td>
<td>14 (48% LTFU)</td>
<td>ST: 31</td>
<td>27%</td>
<td>Secondary arthrodesis of ankle: 4%</td>
<td>No correlation</td>
</tr>
<tr>
<td>Sammarco VJ et al. [21]</td>
<td>1.5 to 7</td>
<td>ST + TN: 16</td>
<td>37.5%</td>
<td>CC: 37.5%</td>
<td>Unknown</td>
</tr>
<tr>
<td>Current study</td>
<td>15 (77.5% LTFU)</td>
<td>TN: 16</td>
<td>74%</td>
<td>ST: 58.3%</td>
<td>CC: 53.5%</td>
</tr>
</tbody>
</table>

LTFU: lost to follow-up; CMT: Charcot-Marie-Tooth disease; TN: talonavicular joint; CC: calcaneocuboid joint; ST: subtalar joint; NC: naviculo-cuneiform joint.

reported as 14% after four years [3] and 36% after five years [34]. Our rate was higher (73%), likely because of the longer follow-up. There was no relationship between TT osteoarthritis and pain or the MFS at the last follow-up. Other studies found no correlation between osteoarthritis and pain in the TT joint [5,28,33]. As with other studies, we did not find any correlation between TT osteoarthritis and diagnosis or residual architectural defects [2,4,5,18,19,36]. We were able to determine the rate of secondary OA in non-fused joints after partial arthrodesis, information rarely reported in previous published studies (Table 3). The rate of secondary OA was very high in all of the joints that had been spared. Nevertheless, secondary ST, TN and CC osteoarthritis was not correlated to pain or lower MFS scores at review. After ST fusion, it is easy to imagine that the spared midtarsal joint (CC + TN) would deteriorate due to excessive mechanical loading. But it is harder to understand why secondary ST or CC osteoarthritis occurs after TN fusion, which theoretically restricts ST and CC motion. This suggests that the restriction is functional but not complete.

There was no statistical relationship between secondary osteoarthritis (no matter its location) and symptoms. But we found significantly more pain at the last follow-up than at 12 months post-operative. This can likely be explained by secondary osteoarthritis in the TT joint or rear-foot.

5. Conclusion

Partial or complete fusion of the subtalar and midtarsal joints bring about satisfactory functional results, but the morbidity is by no means insignificant. Correct rear-foot positioning must be achieved. The arthritic degradation of the non-fused subtibial, subtalar and midtarsal joints cannot be ignored. Although few patients are asymptomatic after more than 10 years of follow-up, the high percentage of patients with pain upon review suggests that the OA will eventually bring out pain. We found no effect of residual architectural deformity on the occurrence of secondary osteoarthritis. As a consequence, other studies are needed.

Disclosure of interest

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

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