Posttraumatic ankle osteoarthritis: How initial cartilage lesions, the deltoid ligament and hindfoot alignment affect the outcome of operatively treated ankle fractures
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CHAPTER 5

THE ROLE OF DELTOID LIGAMENT LESIONS IN SUPINATION EXOROTATION TYPE 4 ANKLE FRACTURES

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Introduction

The fourth stage of the supination-external rotation (SER 4)\(^1\) type of ankle fracture consisting of a fibular fracture at the level of the syndesmosis and a medial malleolar fracture or a rupture of the deltoid ligament, is unstable. It is usually treated operatively.\(^2–6\) A fracture of the medial malleolus can be seen on a plain radiograph of the ankle whereas a ruptured deltoid ligament is difficult to diagnose. The gravity stress test is considered to be the best test for establishing disruption of the medial collateral ligament.\(^7–11\) Arthroscopy, although invasive, MRI and perhaps ultrasonography may be of value.\(^11–13\)

The aim of treatment of a fracture of the medial malleolus by open reduction and internal fixation is to restore the articular surface. Since the medial ligaments are still intact after anatomical reduction of the fracture the ankle is stable on the medial side. We were able to find only one report which compared the results of SER-4 fractures with either a medial malleolar fracture or rupture of the deltoid ligament.\(^14\) This study showed that the Short Musculoskeletal Function Assessment score\(^15\) was worse in patients with a bimalleolar fracture at a maximum of one year postoperatively. In order to clarify the role of the deltoid ligament in the long term in SER-4 fractures, we compared the radiological and clinical results of the bony type with those of the ligamentous type of fracture.

Patients and Methods

After approval of the study by the institutional and cantonal ethical review boards, we undertook a long-term follow-up of a consecutive series of 288 patients who had been treated surgically for a fracture of the ankle between 1993 and 1997 in the hospitals of Liestal and St. Gallen and prospectively evaluated the development of post-traumatic osteoarthritis. There were 66 SER-4 fractures of which 36 were available for follow-up at a mean of 13 years (11 to 14). There were 15 males and 21 females, with a mean age of 46.9 years (16 to 76). The right side was involved in 17 (47%) and the left in 19 (53%). Most (15) of the fractures were the result of a sports injury. Among other causes were road-traffic accidents (eight) and injuries at home (six).
Standard anteroposterior (AP) and lateral radiographs of the ankle had been taken in all patients (Fig. 1). These were independently reviewed to confirm the Lauge-Hansen classification\(^1\) by an expert foot and ankle surgeon (NvD). A medial clear space of 4 mm or more or of 1 mm more of the superior clear space was considered to indicate a rupture of the deltoid ligament.\(^{11}\) In addition to the assessment of the radiographs, arthroscopy had been performed in all patients before reduction and fixation of the fracture, to evaluate the integrity of the medial structures. Radiological assessment showed that there were 25 medial malleolar fractures and 17 ruptures of the deltoid ligament, all of which had been confirmed arthroscopically. In six patients there was a combination of a medial malleolar (avulsion) fracture and a partial rupture of the deltoid ligament. In order to make sound comparisons, we divided the series into two groups, those with an intact deltoid ligament (\(n = 19\)) and those with a partial or completely ruptured deltoid ligament (\(n = 17\)).

All the patients had been treated by a similar surgical protocol, which consisted of restoration of the fibular length and anatomical fixation of the fibular fracture with a tubular plate and screws. The syndesmotic complex had been assessed and found to be damaged in 18 of the 36 patients, but arthroscopic examination before surgery and per-operative hook-testing,\(^{16}\) showed that there were no complete ruptures requiring stabilisation of the syndesmosis. There were no fragments of the posterior malleolus larger than 33% of the articular surface which required fixation.
If a fracture of the medial malleolus was present, it was reduced and stabilised by one or two screws. Post-operative treatment consisted of partial weight-bearing for six weeks in a plaster cast, followed by full weight-bearing with passive and active physiotherapy to the ankle in all patients.

At follow-up at a mean of 13 (11 to 14) years, the clinical results were assessed by an independent orthopaedic surgeon (MK) with no prior knowledge of the type of trauma, the type of fracture or the radiographs. The American Orthopedic Foot and Ankle Society (AOFAS) hind-foot score was used to quantify the clinical outcome. A validated visual analogue score (VAS) for pain and function was used to assess the subjective outcome. The short-form 36 quality of life score was recorded. Weight-bearing AP and lateral radiographs were evaluated by an orthopaedic foot and ankle surgeon (BH) with no knowledge of the initial type of fracture or the clinical result. We used a modified version of the score of Kannus, Jarvinen and Paakkala to determine the level of osteoarthritis on a 100-point scale. This score takes several aspects of arthritis into account, including the amount of sclerosis visible, the formation of osteophytes, calcification of the ligaments, narrowing of the joint space and the formation of cysts.

Statistical analysis

All data were analysed using the SPSS version 16.0 software (SPSS Inc., Chicago, Illinois). Continuous variables, such as the VAS pain score, the AOFAS hind-foot score, the SF-36 score and the Kannus arthritis score were analysed using the t-test or the Mann-Whitney U test in the case of skewed distributions, to assess differences between the groups. The odds ratio was calculated to assess the increase in risk of having cartilage lesions. A p-value < 0.05 was considered to be statistically significant.

Results

The mean total AOFAS score at follow-up was 86.6 (53 to 100) and the mean modified Kannus radiological score was 88.3 (74 to 100). There was a significant difference (p = 0.015) between the total AOFAS hind-foot score for intact
and damaged (partially or completely ruptured) deltoid ligaments and for the functional element of the score in favour of the damaged ligament group (41.8 (95% CI 38.7 to 45.0) versus 45.5 (95% CI 42.5 to 48.4), Table I). However, there was no significant difference between the two groups for the pain or alignment elements of the score (Table I). With regard to the SF-36 score the only significant difference (p = 0.050) between the two groups was in the bodily pain score (Fig. 2). The subjective VAS score showed no significant differences between the intact and damaged deltoid ligament groups although the intact group tended to score lower (Fig. 3).

The modified Kannus radiological score showed no significant differences between the two groups (87.1 (95% CI 84.2 to 89.9) for the intact group versus 89.8 (95% CI 86.3 to 93.0) for the group with a damaged deltoid). However, arthroscopically, there was a significant difference (p = 0.05) in the intra-articular loose bodies seen between the two groups, with an increased risk in the group with an intact deltoid ligament (Table II). There was no significant difference in lesions of the lateral (p = 0.58) or medial (p = 0.10) deep cartilage between the two groups.

Table 1: Mean (95% confidence interval (CI) details of the American orthopaedic foot and ankle society (AOFAS) hindfoot score in the groups with and without an initial deltoid ligament.

<table>
<thead>
<tr>
<th>AOFAS Score</th>
<th>Deltoid</th>
<th>Mean (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain</td>
<td>Intact</td>
<td>34 (31 - 37)</td>
<td>.167</td>
</tr>
<tr>
<td></td>
<td>Damaged</td>
<td>36 (34 - 39)</td>
<td></td>
</tr>
<tr>
<td>Function</td>
<td>Intact</td>
<td>42 (39 - 45)</td>
<td>.047*</td>
</tr>
<tr>
<td></td>
<td>Damaged</td>
<td>45 (42 - 48)</td>
<td></td>
</tr>
<tr>
<td>Alignment</td>
<td>Intact</td>
<td>07 (06 - 09)</td>
<td>.191</td>
</tr>
<tr>
<td></td>
<td>Damaged</td>
<td>09 (07 - 10)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>Intact</td>
<td>83 (77 - 88)</td>
<td>.015*</td>
</tr>
<tr>
<td></td>
<td>Damaged</td>
<td>91 (86 - 96)</td>
<td></td>
</tr>
</tbody>
</table>

*Significant at p < 0.05.
Figure 2: Bar chart showing that the short-form (SF) 36 score for bodily pain was significantly lower in the group with an intact deltoid ligament than in that with a (partially) ruptured deltoid ligament (error bars indicate 95% confidence intervals).

Figure 3: Bar chart showing that the subjective visual analogue scale (VAS) did not show a significant difference between the two groups although the group with an intact deltoid ligament had a lower score (error bars indicate 95% confidence intervals).
Discussion

The results of our study suggest that at a mean follow-up of 13 years (11 to 14) an SER-4 fracture with a fracture of the medial malleolus has a worse prognosis than that with a partial or complete rupture of the deltoid ligament. Significant differences were seen in the total AOFAS hind-foot score and function score (Table I). The SF-36 subscore for bodily pain was significantly lower in the group with an intact deltoid ligament (Fig. 2). The subjective VAS score was also lower in the intact deltoid group, but this did not reach significance (Fig. 3). Radiologically, there were no significant differences detectable between the groups. Tejwani et al.\textsuperscript{14} described a series of similar patients with a maximum follow-up of one year. They found that bimalleolar fractures had a worse prognosis than fibular fractures associated with a lesion of the deltoid ligament. They suggested that the difference between the two groups might even out with longer follow-up. However, the results of our study after 13 years suggest that this may not be the case. This does not mean that the combination of a lesion of the deltoid ligament and a lateral malleolar fracture should be underestimated. In order to obtain a good clinical result, the lateral malleolus must be anatomically reduced and open reduction and internal fixation are commonly used.\textsuperscript{2–5,10,22–24} The deltoid ligament should heal with no residual laxity when the ankle mortise is intact. Good results can be obtained by conservative treatment as shown by Wei et al.\textsuperscript{25} if anatomical reduction can be obtained and maintained. They recorded a mean AOFAS score of 98 (87 to 100) after a mean follow-up of 20 years in bi- and trimalleolar fractures treated by closed reduction and with a non-weight-bearing long-leg cast for six weeks followed by a short-leg cast for six weeks.

There are other factors which could influence the development of post-traumatic osteoarthritis. The medial malleolar fracture could represent a more serious injury than its ligamentous equivalent because of the energy transferred into intra-articular lesions. Several authors point out the possibility of these cartilage lesions having a significant influence on the long-term outcome.\textsuperscript{26–31} In our study there was a significant difference (p < 0.05) between the two groups with regard to loose bodies seen at arthroscopy when the deltoid ligament was intact (Table II). The odds ratio of having loose bodies was 5.5. Of the 36 patients, ten were found to have a cartilage lesion of a depth
of > 50% on the medial side and nine on the lateral side. Analysis of the data showed a positive correlation between deep cartilage damage and an intact deltoid ligament, but this was not significant.

The limitations of our study include the lack of pre-operative functional data and the relatively small number of patients who could be followed up. Only 36 of the 66 SER-4 fractures were seen at a mean of 13 years after injury. Further limitations include the use of the Lauge-Hansen classification, since the reproducibility of this classification is quite modest according to Thomsen et al.\textsuperscript{32} The original fractures consisted of the AO/ASIF types\textsuperscript{33} 44-B2.1, 44-B2.2, 44-B3.1 and 44-B3.2. The AOFAS hind-foot score and the Kannus arthritis score have not yet been fully validated, although the subjective part of the AOFAS hind-foot score has shown some validity in a recent review\textsuperscript{34} and has been widely used in foot and ankle studies.\textsuperscript{35} The Kannus arthritis score is more sensitive than for example the Takakura\textsuperscript{36} osteoarthritis score or the Kellgren-Lawrence score.\textsuperscript{37} Since there was no severe end-stage arthritis in our patients at follow-up we chose a radiological scoring system which still has discriminating power in a patient group with little signs of osteoarthritis.

The results of our study suggest that 13 years after operative management of a SER-4 ankle fracture patients with a partial or complete rupture of the deltoid ligament tend to have better results than those with a fracture of the medial malleolus.

Table 2: Free bodies present in the joint as shown by arthroscopy, by number and percentage.

<table>
<thead>
<tr>
<th>Free bodies</th>
<th>Intact</th>
<th>(Partially) Ruptured</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>11</td>
<td>58%</td>
<td>15</td>
</tr>
<tr>
<td>Yes</td>
<td>8</td>
<td>42%</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>19</td>
<td>100%</td>
<td>17</td>
</tr>
</tbody>
</table>

*Significant at \( p < 0.05 \).


References


CHAPTER 5 - DELTOID LIGAMENT IN SER-4 FRACTURES

33. No authors listed. AO foundation. https://c5ezou06l8jye58i-gh8rmg.sec.amc.nl (date last accessed 5 October 2009).