Falling in the Netherlands: prevention, care, and follow-up of fall-related injury
Boele van Hensbroek, P.

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Chapter 3

Quality of Life and Functional Outcome after Operative Treatment of Calcaneal Fractures

P. Boele van Hensbroek, N.A.M. Heesakkers, M. Maas, J.C. Goslings, J.S.K. Luitse

Submitted
Abstract

Background
Calcaneal fractures comprise 1 to 2% of all fractures and are often seen in patients after a fall from height. The impact on the mobility and functioning of the patients is considerable. Despite conflicting reports in the literature there is a trend towards operative treatment of (dislocated) calcaneal fractures. In our hospital, most dislocated calcaneal fractures are treated by Open Reduction and Internal Fixation (ORIF). However, little information is available on the factors associated with quality of life and functional outcome.

Objective
This study aimed to assess the factors associated with quality of life and functional outcome in patients after ORIF of the calcaneus.

Patients and methods
All consecutive patients with a dislocated calcaneal fracture operated between 1999 and 2007 were included. Medical records were reviewed to obtain demographic data. Fractures were classified (Essex-Lopresti and Sanders) in consensus-meetings by a radiologist and a surgeon. Patients were operated using the extended lateral approach and calcaneal plates. The quality of life and functional outcome were assessed using the EuroQoL-5D (EQ-5D) and Foot and Ankle Outcome Survey (FAOS).

Results
One hundred and ten patients were included of which 73 men (66.4%). The median age was 41.0 years. There were 46 (41.8%) multi trauma patients. Essex-Lopresti Joint depression fractures and Tongue type fractures were equally distributed. The Sanders type II was the most common (46.4%) fracture. Eight patients developed a deep infection. Eleven patients (10.0%) underwent arthrodesis of the PTC joint. Seventy-one patients (64.5%) were available for follow-up. The median EQ-5D score was 0.69 for the study cohort and 0.73 in mono trauma patients. The median FAOS subscores (100=best) were: pain 78, symptoms 57, daily activities 85, sports 55, and quality of life 63. The EQ-5D and FAOS scores were significantly less in patients with multi-trauma and patients with an arthrodesis of the PTC joint.
Conclusion
Multi-trauma and arthrodesis instead of fracture severity are associated with a decreased quality of life and functional outcome after ORIF of the calcaneus.
Introduction

Calcaneal fractures comprise 1 to 2% of all fractures and are often seen in patients after a fall from height. Despite the relative low incidence, the impact on the mobility and functioning of the patients is considerable. The calcaneus is a complex bone with three articular surfaces. Therefore, calcaneal fractures often involve one or more articular surfaces. The reconstruction of the bone and articular surfaces is a challenge to any surgeon. Sometimes the cartilage is largely destroyed so that an arthrodesis is inevitable. In these patients, the reconstruction of the calcaneus is meant to reduce the flattening and widening of the calcaneus and create a basis for the subsequent arthrodesis. Reconstruction of the calcaneus also aims to allow patients to wear the same pair of shoes (instead of a larger shoe on the fractured foot). However, even after the best possible reconstruction, patients may have persistent complains and suffer from early posttraumatic arthritis. The question in patients with a calcaneal fracture is ‘to operate or not to operate’. Previous studies have shown almost equal results in both techniques.\textsuperscript{1-3} Therefore, no consensus has been reached on the optimal treatment of these fractures. Despite the conflicting reports in the literature there is currently a trend towards operative treatment of (dislocated) calcaneal fractures.\textsuperscript{1,3,4} In our hospital, most (displaced) calcaneal fractures are treated by means of Open Reduction and Internal Fixation (ORIF). Over the years, our hospital has become a regional referral center for patients with complex and/or dislocated ankle, calcaneal, and foot fractures. Each year, the number of ORIFs for calcaneal fractures increases. Despite the, to the surgeon, apparent satisfying results of the ORIF technique, little information is available on the quality of life and functional outcome after this type of treatment.\textsuperscript{2} Furthermore, little is known about the factors associated with the quality of life and functional outcome. This study aimed to assess the factors associated with quality of life and functional outcome in patients after ORIF of the calcaneus.

Patients and Methods

All patients with a dislocated calcaneal fracture who underwent ORIF between 1999 and 2007 were included in this study. All patients with extra-articular fractures as well as patients who underwent operative techniques other than ORIF were excluded.
The medical records were reviewed to obtain demographic data as well as data on the trauma mechanism, medical history, hospitalization, Injury Severity Score, operation(s), postoperative complications, consequent operations, and possible hardware removal.

The radiographs were examined and the fractures were classified according to Essex-Lopresti and Sanders. In order to obtain the most reliable fracture classification, the radiographs were reviewed in several consensus-meetings by a team of an experienced trauma radiologist (MM) and an experienced trauma surgeon (JL). In addition to the fracture types, the initial Böhler’s angle, notch depression, articular involvement, and comminution were assessed in all patients. In accordance with literature, a Böhler’s angle between 20 and 40 degrees was considered normal.10

**Operative technique**
The ORIF was performed through an extended lateral approach using calcaneal plates (Synthes®, Solothurn, Switzerland) (Figure 1). All patients underwent the same peri-operative protocol; a single intravenous dose of prophylactic antibiotics administered preoperatively, general or spinal anesthesia, patient positioning on the contralateral side without the use of a pneumatic tourniquet. Postoperative treatment was fully functional; no immobilization was used. Weight bearing was allowed after twelve weeks.

![Figure 1. The extended lateral approach.](image1)

**Figure legend: Above:** The extended lateral approach incision line. **Below:** Calcaneal fracture after open reduction with the calcaneal plate in situ.
Quality of life
Between 10 and 60 months after the operation, patients were contacted by mail. The quality of life (QoL) was assessed using the EuroQoL-5D (EQ-5D) questionnaire. The Foot and Ankle Outcome Survey (FAOS) was used to assess the functional outcome. Both questionnaires were mailed to the patients.

Statistical analysis
Sociodemographic data were expressed as percentages for categorical data, as mean and standard deviation (SD) for normally distributed numerical data, and as median, range, and - where appropriate - inter-quartile range (IQR=25 to 75%) for non-normally distributed numerical data. Differences in dichotomous variables between groups were analysed using the Chi² test and the Fisher’s exact test when small groups were involved. Differences in continuous variables between groups were analysed using the Students T-test for normally distributed variables and the Mann-Whitney U-test for not-normally distributes variables. Correlation between variables was assessed with the Pearson correlation for normally distributed variables and the Spearman correlation for not-normally distributed variables. Data were analyzed using the Statistical Package for the Social Sciences (SPSS®) version 16.0.1 (SPSS Inc., Chicago, IL; USA).

Results
General results
One hundred and ten consecutive patients were included. There were 73 men (66.4%) and the median age was 41.0 years. The patient characteristics are shown in Table 1. Forty-one patients (37.3%) patients had fractured the left calcaneus and 19 patients (17.3%) sustained a bilateral calcaneal fracture. Forty-six patients (41.8%) were classified as multi trauma patients (multiple fractures).

Fracture classification
The Essex-Lopresti Joint depression fractures and Tongue type fractures (Figure 2) were equally distributed (Table 2). However, the Sanders type II fracture (Figure 3) was by far the most common fracture type (Table 2).
### Table 1. Demographic data.

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Male</th>
<th>n (%)</th>
<th></th>
<th>Age (years)</th>
<th>med (IQR)</th>
<th>41.0</th>
<th>(32.0 – 52.0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanism</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>n (%)</td>
<td>68</td>
<td>(61.8)</td>
</tr>
<tr>
<td>• Fall from height</td>
<td></td>
<td>n (%)</td>
<td>22</td>
<td></td>
<td>(20.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Staircase fall</td>
<td></td>
<td>n (%)</td>
<td>10</td>
<td></td>
<td>(9.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• MVC</td>
<td></td>
<td>n (%)</td>
<td>3</td>
<td></td>
<td>(2.7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Kite surfing</td>
<td></td>
<td>n (%)</td>
<td>7</td>
<td></td>
<td>(6.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Other</td>
<td></td>
<td>n (%)</td>
<td>68</td>
<td></td>
<td>(6.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Böhler’s angle (degrees)</td>
<td>med (IQR)</td>
<td>2.0</td>
<td>2.0</td>
<td>(11.0 – 13.0)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Notch depression (mm)</td>
<td>med (IQR)</td>
<td>11</td>
<td>11</td>
<td>(6 – 16)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PTC involvement</td>
<td>n (%)</td>
<td>101</td>
<td>(91.8)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CC involvement</td>
<td>n (%)</td>
<td>64</td>
<td>(58.2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table legend:** n: number; med: median; IQR: inter quartile range; MVC: motor vehicle crash; mm: millimeter; PTC: posterior talocalcaneal joint; CC: calcaneocuboidal joint.

### Table 2. Fracture classification.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Type</th>
<th>Essex-Lopresti</th>
<th>n (%)</th>
<th>54</th>
<th>(49.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Joint depression</td>
<td>Tongue type</td>
<td>n (%)</td>
<td>53</td>
<td>(48.2)</td>
</tr>
<tr>
<td></td>
<td>Unknown</td>
<td>II</td>
<td>n (%)</td>
<td>33</td>
<td>(30.0)</td>
</tr>
<tr>
<td></td>
<td>Sanders</td>
<td>III</td>
<td>n (%)</td>
<td>33</td>
<td>(30.0)</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>IV</td>
<td>n (%)</td>
<td>13</td>
<td>(11.8)</td>
</tr>
</tbody>
</table>

**Table legend:** n: number; med: median; IQR: inter quartile range; MVC: motor vehicle crash;
The median operating time was 130 minutes and ranged from 80 to 199 minutes in patients with one operated fracture (i.e. not patients in whom multiple fractures were operated in the same procedure). Following the ORIF, 14 patients (12.7%) developed a wound infection of which eight (7.3%) had an infection that required operative debridement. Fifty-two patients (47.3%) underwent hardware removal. One patient underwent primary arthrodesis and 10 patients (9.1%) underwent secondary arthrodesis of the PTC joint. Patients with an arthrodesis had the same Essex-Lopresti and Sanders classification as patients without an arthrodesis.

**Operative characteristics**

**Follow-up**

Seventy-one patients (64.5%) were available for follow-up. The median EQ-5D score was 0.69 for the study cohort and 0.73 in mono trauma patients. The quality of life was significantly worse in patients with multi trauma (p=0.002), a bilateral calcaneal fracture (p=0.017), or an arthrodesis (p=0.022) compared with the other patients. The quality of life - Visual Analogue Scale.

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**Figure 2.** Essex-Lopresti classification.

**Figure 3.** Sanders type II fracture.

**Figure legend:** Conventional radiographs. **Above:** Tongue type: Note the lengthwise fracture. The articular surface (between arrows) and tuber are not separated. **Below:** Joint depression: the articular surface in punched into the calcaneus.

**Figure legend:** CAT scan: coronal picture. Note that there is one fracture line through the posterior talocalcaneal joint (arrow).
did not correlate with gender, age, fracture type or severity of injury. The median FAOS sub-scores (100=best) were: pain 78, symptoms 57, daily activities 85, sports 55, and quality of life 63. Multi trauma patients had lower pain (p=0.018) and quality of life (p=0.021) sub-scores than the other patients. A longer operating time was associated with a lower Symptoms sub-score (p=0.043). Finally, patients with an arthrodesis had significantly lower daily activities (p=0.024), sports (p=0.022), and quality of life (p=0.002) sub-scores than the other patients.

**Discussion**

In this study we showed that the quality of life after operative treatment of a calcaneal fracture is associated with the extent of the injuries and arthrodesis of the PTC joint. After open reduction and internal fixation, the type of calcaneal fracture is not associated with quality of life or functional outcome.

Calcaneal fractures are relatively rare fractures. However, over the last years, our hospital has become a regional referral centre for dislocated calcaneal fractures. The number of operative treatments for calcaneal fractures increases each year. This allowed us to build this relatively large series. We also eliminated the dilemma of which of the two classification systems to use. The inter-observer agreement of calcaneal fracture classifications is known to be moderate at best. Therefore we classified the fractures during consensus-meetings. In doing so we tried to establish the most reliable and repeatable classification.

Although the number of bilateral fractures in this series was comparable with other series in literature, this series has slightly more multi trauma patients. The latter can be explained by the Level-1 Trauma Center status of our hospital. The median Böhler’s angle before the operation was the same as another report in literature. However, the Böhler’s angle reported by another study was much steeper (less depression). This may indicate that the patients in our series sustained higher energy trauma compared with the other series.

The deep infection rate in this series (7.3%) is comparable to other series. However, the number of patients with hardware removal was higher than in other series. Possible explanations for this are the long period of follow-up and the fact that we counted all calcaneal hardware removal (i.e. not just complete hardware removal).

The follow-up rate in our series (64.5%) was comparable to another large
series.\textsuperscript{2} Still roughly one third of the patients was lost to follow-up. This is even after additional attempts to contact them by mail and telephone. These patients were either living abroad, did not have a permanent address, moved without notification or suffered from a psychiatric illness, all known problems in the trauma population.

The results of the EQ-5D show that the quality of life is indeed affected by the calcaneal fracture. However, given the severity of the calcaneal fractures, there is only a minimal difference with the general Dutch population.\textsuperscript{9} The results of the FAOS indicate that many patients suffer from symptoms other than pain. They further indicate that, although daily activities are little affected, participation in sports and recreation is diminished.

In this study there was no association between fracture type and quality of life. Surprisingly, other than multi-trauma, none of the variables that we measured before the operation were associated with quality of life or functional outcome. In other words, despite the severity of a fracture, operative treatment can lead to quality of life and functional outcome as good as in less severe fractures. A control group would be necessary to truly determine the correlation between classification, treatment, and outcome.

We believe that the high volume of calcaneal fractures operated at our hospital contributed to the quality of the postoperative results. However, these findings question the value of the classification systems to predict quality of life and functional outcome in daily practice.

This study has several limitations. First, the radiographs were reviewed retrospectively. The radiographs were not made in a standard fashion. This was especially true for the patients who were referred from other centers. Second, follow-up and quality of life in trauma patients can be difficult and the response rate is often unsatisfactory. Whether the results would have been different if non-responders had answered and returned the questionnaires remains unknown.

**Conclusion**

Based on the results of this study we conclude that fracture severity and classification are not associated with quality of life and functional outcome after ORIF of the calcaneus. Multi-trauma and arthrodesis are associated with a reduction in quality of life and functional outcome.
References


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