Functional outcome of operatively treated displaced intra-articular calcaneal fractures using two parallel contoured reconstruction plates

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Abstract

Introduction: The treatment of displaced intra-articular calcaneal fracture is controversial. Conventionally, they were treated non-operatively. However, some surgeons are now operatively treating these fractures because of continuing dissatisfaction with the outcome of conservative treatment of these fractures and improvements that have occurred in surgical techniques and complication rates.

Objective: The aim of this study was to determine the functional outcome of operatively treated displaced intra-articular calcaneal fractures using two parallel contoured reconstruction plates.

Materials and methods: 12 patients with 14 displaced intra-articular calcaneal fractures involving the subtalar joint were included in the study conducted between July 2005 and December 2008. The fracture site was exposed using extended lateral approach. Internal fixation was done by two nearly parallel 3.5mm reconstruction plates and screws contoured to form a gentle curve in all cases with the first plate fixed just below the articular surface. At the end of follow up, the patients’ foot function was assessed by Calcaneal Fracture Scoring System of Kerr et al. Patients were also enquired about their satisfaction with their treatment outcome.

Results: The patients were followed up for duration of 12 to 24 months (mean 15.64 months). The outcome score as measured by Calcaneal Fracture Scoring System ranged from 48 to 94 (mean 83.64). 11 of 12 patients (91.6 %) were satisfied with the treatment.

Conclusion: Displaced intra-articular fractures treated by open reduction and internal fixation, using two nearly parallel, contoured reconstruction plates through an extensile lateral approach and following the principles of treatment of intra-articular fractures, have good functional results with high patient satisfaction rate.

Key words: displaced intra-articular calcaneal fractures, operative treatment.
3. gross displacement of the heel with sub-fibular impingement
4. bony pressure points likely to ulcerate or give mechanical pain.

Exclusion criteria for the patients were as follows.
1. age more than 65 years
2. open calcaneal fractures
3. peripheral vascular disease.

Twelve patients with 14 DIACFs which fitted the criteria were included in the study.

A CT scan of the calcaneum, including a 3D reconstruction image, was done in all patients planned for surgery to better understand the fracture pattern.

**Surgical Technique**
The patients were taken up for surgery after the skin over the heel started wrinkling. They were kept in the lateral position on the operating table with the affected limb up. High thigh pneumatic tourniquet was used and the fracture site was exposed using extended lateral approach. The displaced fragments were reduced and held temporarily with k-wires. Corticocancellous bone graft or modified hydroxyapatite pellets (G-bone) was used to fill the sub-articular void after fracture reduction, if the surgeon thought it was necessary. Internal fixation was done by 3.5mm reconstruction plates and screws. Two plates contoured to form gentle curves and placed in near parallel fashion were used in all cases with the first plate fixed just below the articular surface.

Wound closure was done over 10 G negative suction drain in layers. A below knee plaster slab was applied. The drain was removed in 48 hours and the skin stitches in 2 weeks. Ankle mobilisation was started after the plaster slab was discarded in 3 weeks. The patients were followed up at 6 weeks, 3 months, 6 months, 12 months and 24 months time in the OPD. Partial weight bearing was allowed in six weeks time and full weight bearing on the affected limb was allowed after 3 months post-op. At the end of follow up ranging from 12 to 24 months (mean 15.64 months). The treatment outcome as measured by Calcaneal Fracture Scoring System ranged from 48 to 94 (mean 83.64). 11 of 12 patients (91.6 %) were satisfied with the treatment. None of the patients required sub-talar fusion till the last follow-up.

**Table 1: Calcaneal fracture scoring system**

<table>
<thead>
<tr>
<th>Maximum Points 100</th>
<th>At rest</th>
<th>On activity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pain (36 points)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Slight</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Moderate</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Severe</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Work (25 points)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No change in job</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Modification of job</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Enforced change of job</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Unable to work</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Walking (25 points)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No change in walking ability</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Minimal restriction</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Moderate restriction</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Severe restriction</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Walking aids (14 points)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Occasional stick</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Constant stick</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>1 stick</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Crutches</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

**Results**
The age of the patients ranged from 16 to 62 years (mean: 34.33 years). 11 patients were males and 1 was a female. The right foot was affected in 5 patients, the left in 5 and bilateral feet in 2 patients. Seven of the patients were farmers, 2 were labourers, 1 was a student, 1 was a painter and 1 was a housewife. All the patients had sustained this injury as result of fall from height.

The patients were operated 10 to 15 days (mean 11.86 days) after injury. Cortico-cancellous bone graft was used in 4 and G-bone in 6 of the operated calcanei. 4 of the calcanei did not require bone graft or G-bone. Two of the heels developed superficial wound infection which healed with dressings and antibiotics. One patient developed deep infection which required rotation flap cover and removal of implant after 3 months. The patients were followed up for duration of 12 to 24 months (mean 15.64 months). The treatment outcome as measured by Calcaneal Fracture Scoring System ranged from 48 to 94 (mean 83.64). 11 of 12 patients (91.6 %) were satisfied with the treatment. None of the patients required sub-talar fusion till the last follow-up.
Discussion

The management of every aspect of intra-articular calcaneal fractures is controversial. There are many systems for classifying DIACF, but there is no consensus amongst surgeons as to which is the most practical one. Opinion is divided as to whether operative treatment is better than conservative treatment. Opinion is also divided as to whether bone graft is required to fill the resultant sub-articular void after fracture reduction. Finally, amongst the many scoring system available to express treatment outcome, there is no consensus among surgeons as to which is the most scientific and practical system.

Essex-lopresti, Rowe and Sanders are the commonly used classification systems for calcaneal fractures. There is varying degrees of agreement among users of these classification systems. Although, classifications show positive correlation with outcome, there is no correlation with choice of treatment\(^1\),\(^2\),\(^3\). Therefore, the indication for surgery was not based on any classification system, but rather on the indications outlined by Barei et al\(^8\).

While some long term retrospective studies of non-operatively treated intra-articular fractures have shown long term symptoms,\(^1\),\(^4\),\(^5\) other studies have reported relatively satisfactory long term results in severely displaced fractures managed conservatively\(^3\),\(^5\),\(^6\).

Historic cohort studies\(^7\),\(^8\),\(^9\) have suggested equal clinical outcomes with operative and conservative treatment of displaced intra-articular calcaneal fractures. While some of the more recent studies\(^10\),\(^21\),\(^22\) have also shown no advantage of operative treatment, many other studies\(^23\),\(^24\),\(^25\),\(^26\),\(^27\),\(^28\) have shown superior results with operative treatment. Earlier, surgical treatment was associated with significant incidence of wound complications, particularly sepsis\(^1\). However, conservative treatment is not without its complications of subtalar joint pain, heel varus and peroneal tendon impingement\(^29\).

Three to six percentage of patients with displaced calcaneal fractures treated operatively undergo sub-talar joint fusion in future\(^23\),\(^30\),\(^31\) whereas non-operatively treated fractures are 5.5 to 6 times more likely to undergo subtalar joint fusion\(^30\),\(^32\). Better functional outcome with decreased wound complication, after sub-talar joint fusion, is seen in operatively treated displaced intra-articular calcaneal fractures\(^33\).

The principle of treating intra-articular fractures especially in a weight bearing joints are anatomical reduction, rigid fixation of intra-articular fractures and early mobilisation for good treatment outcome.\(^34\) Application of these principles to intra-articular calcaneal fractures have been slow because of complex bony and fracture anatomy, tenous soft tissue envelope and difficulty of achieving anatomic reduction and rigid fixation\(^8\). Improvements that have occurred in surgical techniques and complication rates have made many surgeons more operative in the treatment of these fractures.

These were the rationale for us deciding to treat DIACF operatively.

Open calcaneal fracture surgery can be performed using medial, lateral or combined approaches\(^7\),\(^9\),\(^35\),\(^36\),\(^37\),\(^38\),\(^39\). The lateral approach is the most popular approach. A lateral extensile exposure popularised by Benirschke and Sangeorzan\(^7\) was used in all our cases.

Various fixation devices like pelvic reconstruction plates\(^8\), calcaneal plates\(^4\),\(^40\), K-wires\(^40\) or a combination...
of k-wires and screws\textsuperscript{41} can be used for fixing these fractures. We used a combination of two 3.5 mm reconstruction plates and screws to fix these fractures. The two 3.5 mm reconstruction plates were contoured to form gentle curves and placed in near parallel fashion with the first plate fixed just below the articular surface. The "blow out" of the lateral wall, when present, could be well reduced and held in place with a combination of these two plates. The first contoured plate kept just below the articular surface fixed the fracture and supported the fractured articular surface whereas the second plate contoured and applied almost parallel to the first strengthened the fracture fixation of the first plate. The fixation afforded by the combination of these two nearly parallel plates is more surgeon friendly in terms of application and versatility as compared to the calcaneal plate. It also gives a better fracture fixation as compared to plain K-wires or a combination of K-wires and screws. To the best of our knowledge, this method of fixation has not been described in literature.

The indication for using bone graft is controversial\textsuperscript{42}. As with other intra-articular fractures, bone graft should be used when the area beneath the posterior facet is vacant and non-supportive or whenever enough bone is missing or impacted that a buttress is needed\textsuperscript{7}. However, various authors\textsuperscript{43,44}, in recent studies have found no objective radiographic or functional benefits to the case of bone graft supplementation in the operative treatment of these fractures. We filled the resultant sub-articular void which occurred after fracture reduction, if it was substantial, with bone graft in the initial 4 cases and G-bone in the subsequent 6 cases. In 4 cases, it did not require any filling up. This is following the principles of bone grafting in articular fractures when there is a bony defect in the sub-articular region after fracture reduction. We changed from bone grafting the sub-articular void in the earlier cases to filling it up with G-bone in the later cases to avoid donor site morbidity.

Outcome measurements can be expressed by various scoring systems\textsuperscript{18,45,46,47,48} or its modifications based on the author’s experience of important symptoms and functional abilities. Kerr et al\textsuperscript{10} designed his scoring system by selecting the most relevant variables derived from other authors’ judgement and experience of previous systems\textsuperscript{18,45,46,47,48}. We chose the scoring system of Kerr et al\textsuperscript{10} for our study because it has been devised by scientific means and subjected to critical statistical analysis. Thus, the tendency of overestimation of outcome or inability to utilise the available range of scores and inability to distinguish between the patients at the most severe end of the range could be overcome increasing the overall sensitivity of the score using this scoring system. The ideal scoring system should span the full range of available scores and should have an approximately linear relationship with the ranked patient. The median score should be close to 50% of the available score. Kerr's calcaneal fracture scoring system comes closest to this amongst all the scoring systems available. We have chosen this system because it is concise, simple, scientific and easily reproducible.

Calcaneal Fracture Scoring System has been used by various other authors in recent publications for outcome measurements of treatment of calcaneal fractures. In a study conducted by Tennet et al\textsuperscript{23} a mean calcaneal fracture score of 87.7 for unilateral calcaneal fractures and 70.5 for those with bilateral calcaneal fractures or a contralateral foot/ankle injuries was achieved for operative treatment. Ibrahim et al\textsuperscript{20} achieved a mean score of 70.1 with conservative treatment and 63.5 with operative treatment. The difference in the scores was not statically significant (p=0.41). Potter et al\textsuperscript{31} reported operatively treated fractures with a mean score outcome of 70.0 in those who had sustained the injury as a result of fall and 61.3 in those with road traffic accident.

At the end of a mean of 15.64 months follow-up, we observed a mean Calcaneal Fracture Scoring System score of 83.64 in our patients. Our average score of 83.64 is comparable to that of Tennent et al and slightly higher than that of Ibrahim et al and Potter et al. We believe we were able to achieve a good mean Calcaneal fracture Score 83.64 because of our surgical technique and treatment protocol.

One patient developed deep wound infection which required rotation flap cover and implant removal. At the end of one year follow-up, her score was 48. She will probably require sub-talar joint fusion sometime in the future. 11 of 12 patients (91.6%) were satisfied with the outcome of treatment.

There were certain limitations to our study. 12 patients with 14 calcanei were operated and their functional outcome score was measured at a mean follow-up of 15.64 months (range: 12-24 months). A study involving more patients followed up for a longer period of time can more accurately define the functional outcome of DIACF treated by this method.

Conclusion

Displaced intra-articular fractures treated by open reduction and internal fixation, using two nearly parallel, contoured reconstruction plates through an extensile lateral approach and following the principles of treatment of intra-articular fractures, have good functional results with high patient satisfaction rate.
References