Prospective Study of Intra-articular Calcaneum Fracture treated with Plating with Bone Grafts in Adults

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ABSTRACT

BACKGROUND In a retrospective–prospective study we analysed calcaneal fractured treated with calcaneal plate with bonegraft

MATERIALS AND METHOD This is a retrospective–prospective study of 30 patients with displaced intraarticular fractures(Type–II Sanders and above) of calcaneum, which were admitted to the hospital and operated with plating and bongrafting through extensile lateral approach, between May 2013 and October 2016. Those admitted and operated for intraarticular fracture of calcaneum in the hospital, with plating and/or bone grafting, through extensile lateral approach, between April 2014 and July 2016, and following up in the outpatient department of the hospital and also those admitted and operated in the hospital with the same protocol between May 2013 and July 2016 were selected for the study. The follow–up ranged from 6 months to 30 months.

RESULTS In the present series the clinical outcome for sixteen (80 percent) of twenty feet was good or excellent. Three feet (15 percent) had a fair result, and one (5 percent) had bad result. Of seven feet that had a type–III fracture, four (57.14 percent) had an anatomical reduction of the posterior facet, and three feet had a nearly anatomical reduction. Clinically, there were three (42.86 percent) good results, two fair results (28.5 percent), and two (28.5 percent) bad results. One patient is having continuous pain and subtalar arthrodesis is being considered for him. Of the three feet that had a type–IV fracture, none had an anatomical reduction, two had a nearly anatomical reduction, one had an approximate reduction. Clinically, one result, were fair, and two were bad for which arthrodesis is being considered in one.

CONCLUSION In the present series, associated injuries were common, especially involving spine and lower limb. In our study, it was possible to restore the Bohler’s angle post–operatively in most of the cases. The average pre–operative Bohler’s angle was 9.6° and it was 26.6° post–operatively.

INTRODUCTION

Intra-articular fractures of calcaneum are not uncommon. Among the tarsal bones calcaneus is most frequently fractured. Calcaneal fractures account for 60% of tarsal bone injuries and 2% of all fractures. Most calcaneal fractures occur in male industrial workers, making the economic importance of this injury substantial.

In the past, many orthopaedic surgeons believed that the natural history of the type of intra-articular calcaneal fracture, determined the final result and not the intervening treatment. The perception was, that these comminuted fractures which appeared as “unintelligible bag of bones” on standard X–rays, were “inoperable”. There were many controversies regarding the management of intra-articular fractures of calcaneum, the major controversy being to treat operatively or non–operatively. If decided to treat operatively, the controversy was whether to do open reduction and internal fixation, primary arthrodesis or percutaneous reduction. Other controversy was regarding the approach, medial, lateral or combined medial and lateral. However, the principal reasons for the prevalence of non-operative treatment were the technical problems associated with operative treatment. Anaesthesia was not always effective, radiography and fluoroscopy were not well developed, antibiotics did not exist, and a sound understanding of the principles of internal fixation was lacking. The resulting complications of infection, malunion, nonunion, and the possible need for amputation, made most surgeons believe that treatment should be non–operative. There was also difference of opinion regarding non–operative treatment; whether to do closed reduction and plaster cast or early motion and non weight bearing without plaster cast.

Conservative treatment of intra-articular fractures of calcaneum however lead to increased morbidity due to incongruency...
Appropriate sized tourniquet was applied on the proximal aspect of the thigh. After anaesthesia was administered by the anaesthesiologist proper position was given to the patient. An image intensifier was kept ready. The patient was given a lateral position. After that scrubbing, draping and painting were done and tourniquet elevated.

The patient was operated by basic approach (Fig. 1), advocated by Sanders using Benirschke and Sangeorzan incision. Accordingly, a right angled skin incision was made on the lateral aspect of the limb. The horizontal limb of the incision was kept at the junction of thick plantar and thin dorsal skin and the vertical limb was extended midway between lower border of fibula and tendoachilles.

- The angle was made curved and not sharp.
- At the distal end, the horizontal limb of incision was turned upwards at the calcaneocuboid joint (Fig. 2).

After the surgery, a below knee plaster of paris slab was given over a bulky compressive dressing. Post operative elevation of the operated limb was maintained for 48 hours. Drain was removed at 48 hours after surgery. Knee, hip, and toe movements were encouraged as soon as possible. Ankle and subtalar movement exercises were

### MATERIALS AND METHODS

This is a retrospective prospective study of 30 patients with displaced intra-articular fractures (Type–II Sanders and above) of calcaneum, which were admitted to the hospital and operated with plating and bone grafting through extensile lateral approach, between May 2013 and October 2016. Those admitted and operated for intra-articular fracture of calcaneum in the hospital, with plating and/or bone grafting, through extensile lateral approach, between April 2014 and July 2016, and following up in the outpatient department of the hospital and also those admitted and operated in the hospital with the same protocol between May 2013 and July 2016 were selected for the study. The follow-up ranged from 6 months to 4 years.

The age of the patients ranged from 19 years to 53 years. Twenty-eight were males and two were females. Fractures were classified as per Sanders classification based on coronal images of posterior facet. Patients with type–I Sanders fractures were subjected to conservative line of management, as is the standard protocol according to the prevailing literature. Sanders type–I fractures were not included in the present study. Sanders type–II, type–III, and type–IV underwent operative intervention and were included in the study. There were 20 Sanders type–II, 7 Sanders type–III, and 3 Sanders type–IV fractures. Twenty-seven fractures were due to fall from height, and three fractures were due to road traffic accident.

Sixteen fractures were on the right side, 14 fractures were on the left side. Compound fractures and bilateral fractures were not included in the study.

### OPERATIVE PROCEDURE

We usually operated from seventh to tenth day after injury, when the swelling decreased and there were positive wrinkles on hind foot soft tissues. The patient was taken on a simple radiolucent operation table.
started after 2 weeks if the condition of the wound was satisfactory. Sutures were removed between 14 and 21 days (average of 18 days) depending on the condition of the wound. The patient was kept strict nil weight bearing walking with the help of crutches for at least 8–10 weeks. Regular check X-rays were obtained at 6 to 8 weeks and then at 14 weeks. Gradual weight bearing was started from 8 to 14 weeks and full weight-bearing permitted by the end of 14 weeks depending on consolidation.

The patients were followed up at regular intervals with a minimum follow up of 6 months and maximum follow up of 30 months. The results at follow–up were clinically assessed by applying AOFAS hindfoot scoring system.

Radiological assessment was done by comparing Bohler's angle, lateral wall (heel width), and loss of reduction on follow up X–rays compared with postoperative X–rays (Fig. 4).

RESULTS

In our study, majority of patients were adults belonging to age group 31–40 years. The youngest patient was of 19 years old and the oldest was 53 years and majority of patients involved were young adult males sustaining fall from height. Sanders Type–II fracture was more common than Type–III and Type–IV in our study.

As per the AOFAS hindfoot scoring system, the functional results were classified as Excellent, Good,
Fair, and Bad. Maximum good results were obtained when Bohler’s angle was restored to within 26–35° after surgery. All excellent–good results were seen with post-operative Bohler’s angle between 26 and 35 degree.

All excellent functional results were seen when fracture was Sander’s Type—2.

Good results were not seen with Type—4 fractures. Thus, as the fracture comminution increased the functional results deteriorated.

All excellent–good result were seen when intra-articular step was anatomically reduced to less than 1 mm. Excellent–good results were not seen when intra-articular step was more than 2 mm. Majority of bad results were seen with articular step more than 3 mm. Majority of the patients were able to carry out their daily activities including recreational activities. This was measured as percentage of normal for a patient. Seventy percentage of the patients had regained a near normal hindfoot motion. There were four patients (13.33%) with superficial wound necrosis seen at the angle of the incision and two patients (6.67%) suffered with deep infection. The patients returned to work between 16 and 31 weeks. On careful evaluation, six patients (20%) had heel widening but none of the patient required any change in the size of footwear. All defects healed conservatively; no plastic surgery was needed and no limb amputation was necessary to perform.

DISCUSSION

Fractures of the calcaneum account for 2% of all human body fractures. They present a strong social importance and a great economical impact, because they affect economically active individuals. Calcaneal fractures are the most common fracture of the tarsal bones, yet controversy existed on the best treatment for these disabling injuries. Methods have been proposed during the last century for treating calcaneal fractures. Conservative therapy has been used since Hipocrates era. In 1850, Clark introduced the surgical treatment with pin fixation and, in 1882, Charles Bell described the open reduction. Frederick Cotton and Lewis Wilson, in 1908, described a treatment method that consisted of a closed reduction or with minimal opening and immobilization with cast. Historically, most calcaneal fractures have been treated closed because open reduction and internal fixation (ORIF) did not result in improved outcomes and had high complication rates. The open reduction of intra-articular fractures of calcaneus has gained a strong impulse after the publication of studies by Palmer performing an open reduction through lateral approach, fragments reduction, repair of the subtal joint surface depression, bone gap filling with bone graft and immobilisation with cast. Subsequently, Palmer’s technique was modified employing fracture fixation with screws and using both approaches, medial and lateral. In the 1990 decade, many surgeons started using the extensive lateral approach and the possibility to use the Y plate and 3.5 mm AO (Arbeitsgemeinschaft für Osteosynthese) screws was added. With a better understanding of fracture patterns with computed tomography (CT) scans and modern surgical techniques and implants, outcomes have improved and morbidity lowered. A trend has developed toward open reduction and internal fixation for displaced, intra-articular calcaneus fracture.

Calcaneal fracture often results in a varus deformity with heel widening, loss of calcaneal height, and subtalar articular incongruency. Open reduction and internal fixation can be used to address these deformities, restoring the anatomic morphology of the calcaneus and thereby the biomechanics and function of the hindfoot. Restoring heel width prevents chronic peroneal tendinitis secondary to impingement from lateral wall blow out of the calcaneus and restoring the length and alignment of the Achilles tendon maintains plantarflexion strength. Normal subtalar motion is integral to the foot’s ability to adapt to uneven surfaces with inversion and eversion. In addition, subtalar eversion unlocks Chopart’s joint, creating a supple foot to absorb the force of heel strike, and subtalar inversion locks Chopart’s joint, creating a rigid foot for toe off. Open reduction and internal fixation provides the opportunity for anatomic reduction and rigid internal fixation of the subtalar joint so as to preserve the subtalar joint motion.

This study seeks to study the management of closed intra-articular fractures of calcaneum, primarily treated with plating and bone grafting through extensile lateral approach. A series of 30 patients admitted to the hospital with intra-articular fractures of calcaneum were selected.

AGE GROUPS

The ages of the patient varied from 19 to 53 years. The maximum age group being 31 to 40 years of age. The average age group was 33.67 years. The average age group in other series is compared below:

<table>
<thead>
<tr>
<th>Series</th>
<th>Average Age (years)</th>
<th>Range (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myerson M et al. (1986–1988)</td>
<td>36</td>
<td>23–65</td>
</tr>
<tr>
<td>Present series</td>
<td>33.67</td>
<td>19–53</td>
</tr>
</tbody>
</table>

Most patients were young adults, probably because of frequent involvement in fall from height.

SEX

There were 28 males and 2 females patients again probably due to more involvement in fall from height.
Calcanum fracture treated with plating in adults

Compression without any neurodeficit and did well with hyperextension brace. One developed paraparesis and was treated with methyl prednisolone and decompression in the form of pedicular screw and rod fixation. He managed to develop enough power later on to ambulate freely. Five patients had associated fractures of the lower limb 2 Tibia, 2 lateral malleolus and one femur. Other fractures such as of distal end radius and Bennets were also seen. Two had head injury which were managed by the surgeons on a priority basis.

<table>
<thead>
<tr>
<th>Series</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>John R Stephenson (1979–1984)</td>
<td>20</td>
<td>2</td>
<td>22</td>
</tr>
<tr>
<td>Myerson M et al. (1986–1988)</td>
<td>36</td>
<td>6</td>
<td>42</td>
</tr>
<tr>
<td>Sidney Silva de Paula et al. (2000–2003)</td>
<td>63</td>
<td>8</td>
<td>71</td>
</tr>
<tr>
<td>Present series</td>
<td>28</td>
<td>2</td>
<td>30</td>
</tr>
</tbody>
</table>

**Side**

Sixteen fractures were on the right side and 14 fractures were on the left side.

**Mechanism of injuries**

In the present series, majority (90%) were due to fall from height, such as involving construction work or fall from trees and rooftops. A patient from tribal area had fallen from mountain. Three fractures were due to road traffic accidents involving four wheelers like trucks and cars.

<table>
<thead>
<tr>
<th>Series</th>
<th>Fall</th>
<th>RTA</th>
<th>Iatrogenic</th>
<th>Total patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sidney Silva De Paula et al. (2000–2003)</td>
<td>70</td>
<td>1</td>
<td>–</td>
<td>71</td>
</tr>
<tr>
<td>Present series</td>
<td>27</td>
<td>3</td>
<td>–</td>
<td>30</td>
</tr>
</tbody>
</table>

**Associated injuries**

<table>
<thead>
<tr>
<th>Series</th>
<th>Associated injuries (No)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stulik J et al. (1994–2003)</td>
<td>75</td>
<td>30.36%</td>
</tr>
<tr>
<td>Present series</td>
<td>11</td>
<td>36.6%</td>
</tr>
</tbody>
</table>

Eleven out of 30 patients had an associated injury. Three patients had injury to the thoraco–lumbar spine in the form of wedge compression fractures. Two of the fractures involving the upper lumbar vertebra were Type 1 compression without any neurodeficit and did well with hyperextension brace. One developed paraparesis and was treated with methyl prednisolone and decompression in the form of pedicular screw and rod fixation. He managed to develop enough power later on to ambulate freely. Five patients had associated fractures of the lower limb 2 Tibia, 2 lateral malleolus and one femur. Other fractures such as of distal end radius and Bennets were also seen. Two had head injury which were managed by the surgeons on a priority basis.

**Type of fracture (Sander’s classification)**

<table>
<thead>
<tr>
<th>Series</th>
<th>Type 2</th>
<th>Type 3</th>
<th>Type 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sanders et al. (1987–1990)</td>
<td>79</td>
<td>30</td>
<td>11</td>
</tr>
<tr>
<td>Laughlin et al. (1992–1993)</td>
<td>21</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>Present series</td>
<td>20</td>
<td>7</td>
<td>3</td>
</tr>
</tbody>
</table>

**Injury–Surgery–Interval**

The interval between injury and surgery in this series was between 6 days and 14 days average, 9.36 days. In the absence of facilities like anti swell pumps, we waited till appearance of wrinkling of the skin to decide the time of surgery.

<table>
<thead>
<tr>
<th>Series</th>
<th>Interval</th>
<th>Mean Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sidney Silva De Paula et al. (2000–2003)</td>
<td>1–20 days</td>
<td>2–7 days</td>
</tr>
<tr>
<td>Stelhlik et al. (1994–2001)</td>
<td>6 hours–3 weeks</td>
<td>18.5 hours</td>
</tr>
<tr>
<td>Kocis et al. (2001–2003)</td>
<td>1–16 days</td>
<td>7.3 days</td>
</tr>
<tr>
<td>Present series</td>
<td>6–14 days</td>
<td>9.36 days</td>
</tr>
</tbody>
</table>

**Pre–operative Bohler’s angle**

Average preoperative Bohlers angle in this series was 9.67 degrees.

<table>
<thead>
<tr>
<th>Series</th>
<th>Preop. Bohler’s angle (average)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marcos Emilio et al. (1995–2001)</td>
<td>6.9°</td>
</tr>
<tr>
<td>Present series</td>
<td>9.67°</td>
</tr>
</tbody>
</table>

**Post–operative Bohler’s Angle**

The average post–operative Bohler’s angle in this series was 26.63°.
Bohler’s Angle and Functional Outcome

The Bohler’s angle, considered as normal within measurements ranging from 20° to 40°, is used for indicating changes on the posterior joint facet. Loucks and Buckley (1999) performed a prospective and randomised study to evaluate the Bohler’s angle and its correlation with fracture treatment outcomes. They observed that surgical treatment improved angle graduation as well as the functional status. They stated that fractures with a Bohler’s angle markedly reduced at the immediate post-trauma period provided bad outcomes and they suggested that the high energy of trauma produces angle flattening, with a more extensive bone and soft parts injury. Sidney Silva de Paula et al. (2000–2003) in their study found variations between 0° and 40°, with an average of 22.08° ± 8.95°, with no significant difference regarding the kind of fractures. The value of this angle showed a correlation with the quality of outcome. So that 70.21% of the reductions with an angle above 20° presented good and excellent outcomes, while only 37.50% of the reductions below 20° showed a similar result.

Angle restoration is directly correlated to the quality of fragments reduction. And 80% of patients with successful reductions had satisfactory results in a series by Essex–Lopresti. In another series of Hutchinson et al., 76% of patients attained satisfactory results based on CT assessment of the fracture reduction. Unsatisfactory results were associated with failure to obtain or to maintain a satisfactory reduction. In the present series, maximum good results were obtained when Bohler’s angle was restored to within 26–30 degree after surgery. All excellent results were seen with post-operative Bohler’s angle between 26 and 35°. All bad results were seen with post-operative Bohler’s angle below 20°.

REFERENCES

Calcanœum fracture treated with plating in adults


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