Operative treatment of calcaneal fractures: improved outcomes and low complications rates with a strict management protocol

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ABSTRACT

This is a retrospective review of 80 intra-articular calcaneal fractures treated with open reduction and internal fixation by a specialist team under supervision of a single surgeon in a tertiary centre between 2005 and 2014. The fractures were evaluated with plain radiography and computed tomography, and graded using the Eastwood–Atkins classification. A lateral approach was used and all fractures were fixed with calcaneal plates.

All patients had clinical and radiological follow-up. Clinical assessment included foot and ankle disability index, SF-36[®] and Kerr–Atkins scores. The mean follow-up duration was 72 months (range: 12–130 months). The mean age of patients was 49 years (range: 17–73 years). There were three open fractures and eight patients had other injuries. The mean Bohler's angle improved from 6° preoperatively to 26° postoperatively. The mean foot and ankle disability index score was 78.62, the mean SF-36[®] scores were 45.5 (physical component) and 52.6 (mental component), and the mean Kerr–Atkins score was 72 (range: 36–100).

Early complications included one case of screw protrusion in the subtalar joint (which warranted a repeat procedure), one sural nerve injury and one wound breakdown, which healed with non-operative measures. Twelve patients had symptomatic subtalar joint osteoarthritis. Four of these had subtalar fusion. We believe that our strict protocols of patient selection, intraoperative and postoperative management produced long-term results comparable with those in the peer reviewed literature.

KEYWORDS

Calcaneal fracture – Os calcis – Subtalar arthritis – Foot and ankle fractures

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Calcaneal fractures are usually high energy injuries with a significant soft tissue component. The patients who present with these fractures are often young and active. Although the advent of low profile plates and a better understanding of fracture patterns with computed tomography (CT) have led to an increase in the popularity of operative treatment, there is still no consensus on the appropriate method of treatment.

There have been several historical cohort series reporting similar results with operative and non-operative treatment.^{1–4} A Cochrane review in 2013 concluded that there was insufficient evidence to support either form of treatment.⁵

The UK heel fracture trial was a large pragmatic randomised controlled trial in the National Health Service conducted in an attempt to find an answer to the above question.⁶ It was concluded that operative treatment did not provide symptomatic or functional advantage over non-operative treatment after two years and the risk of complications was higher after surgery. However, the selection bias in this study was pointed out in a publication from 2015.⁷ In

this context, the current paper presents the outcome of operative treatment of displaced intra-articular calcaneal fractures in a major trauma centre by adhering to a strict pre, intra and postoperative protocol.

Methods

This was a retrospective study of 80 calcaneal fractures operated on by a single surgeon between 2005 and 2014. The study was registered with our clinical effectiveness department.

All patients had anteroposterior and lateral view x-rays (Figs 1 and 5) on presentation, followed up with CT (Fig 4). The fractures were graded using the Eastwood–Atkins classification.⁸ Patients were offered surgery if they were physiologically under 75 years of age and there was no neuropathy or vasculopathy. Smokers were only considered for operative treatment if they agreed to give up smoking and accepted referral to our smoking cessation services. Uncontrolled diabetes was a relative contraindication to surgery. Injury related inclusion criteria comprised joint depression, posterior facet

Figure 1 Pre operative X-ray showing reduced Bohler's angle.

Figure 2 Post operative X-ray showing restored Bohler's angle

damage, reduced Bohler's angle, lateral wall blowout and varus deformity of the heel. The majority (87%) of our

patients were ASA (American Society of Anesthesiologists) grade 1, 11% were ASA grade 2 and 2% were ASA grade 3.

Our department has specialist foot and ankle trauma surgeons and senior fellows. All calcaneal fracture patients were under the care of our senior foot and ankle trauma surgeon. A strict protocol was followed, which started with patient selection and counselling regarding the treatment and the postoperative regime. In cases where there was soft tissue swelling or any concern regarding the skin condition, measures were instituted to reduce the swelling such as bed rest, elevation and application of ice packs, and these were strictly adhered to. The soft tissue was assessed regularly and the operation only went ahead when the senior surgeon was convinced it was safe.

The procedure was performed by the senior author or under his supervision by a senior foot and ankle fellow. Patients were in a lateral position and an above-knee tourniquet was used. The calcaneus was exposed through an extensile lateral approach and thick flaps were raised so as not to devascularise the skin. The fracture was fixed with a low profile SPS calcaneal plate (Stryker, Kalamazoo, MI, US).

Postoperatively, patients were immobilised in a below-knee plaster cast for the first six weeks and were then partial weight bearing in an Aircast® boot (DJO, Vista, CA, US) for a further six weeks. All patients had a soft tissue check at one week following surgery in the foot and ankle clinic. They had further follow-up appointments with x-rays at six weeks and three months (Fig 2,3). Thereafter, patients had physiotherapy for recovery of ankle movements and soft tissues around the ankle.

Following surgery, patients' foot and ankle disability index, SF-36® and Kerr-Atkins scores were calculated. A questionnaire investigated other factors such as change in shoe size, scar pain and tenderness, return to normal vocation and overall satisfaction with the outcome. Bohler's angle was measured on preoperative and postoperative x-rays (Fig 1,2).

Figure 3 Postoperative x-ray

Articular congruity and arthritis on the posterior subtalar joint was assessed in symptomatic patients.

Results

The mean patient age was 49 years (range: 17–73 years). All patients had intra-articular displaced fractures. The mechanism of injury was fall from height in 97% and a road traffic accident in 3% of cases. There were three open fractures and eight patients had polytrauma.

According to the Eastwood–Atkins classification, 37% of the fractures were type 1, 28% were type 2 and 35% were type 3. The mean follow-up duration was 72 months (range: 12–130 months).

Of the 80 fractures in the study, 79 had united. One patient with non-union needed revision fixation. The mean Bohler's angle improved from 6° preoperatively to 26° postoperatively. The mean foot and ankle disability index score was 78.62, and the mean SF-36® scores were 45.5 (physical component) and 52.6 (mental component). The mean Kerr–Atkins score was 72 (range: 36–100). The mean time for return to previous vocation was 5.5 months.

Complications

There was one patient with wound breakdown, which healed with non-operative measures. There was one case where the screw was prominent in the subtalar joint (necessitating a repeat procedure) and one patient had sural nerve injury.

Figure 4 Pre operative CT

Figure 5 Pre operative lateral radiograph

In the longer term, there were 12 patients with symptomatic subtalar joint arthritis. Four of these had subtalar arthrodesis.

Discussion

Surgical treatment of displaced intra-articular calcaneal fractures enables anatomical reduction, and restores shape, height and alignment. It also aims to reduce the subtalar and calcaneocuboid joints in order to achieve a reduced lateral wall and peroneal tendons, and also a decrease in the talar declination angle. Patients should be able to wear regular shoes, have a normal gait and remain pain free for an extended period of time.^{9–12} Over six decades ago, Palmer and Essex-Lopresti had stressed the need for reduction of these fractures with poor results reported from incomplete reduction.^{13,14} Restoration of the subtalar joint is also crucial as it has been demonstrated that the Bohler's angle ratio of the injured to the normal side is lower in patients with unsatisfactory outcomes.¹⁵

In patients with extensive posterior facet damage who may go on to need subtalar fusion for symptomatic osteoarthritis, primary open reduction and internal fixation will restore the shape and biomechanics of the calcaneus. Radnay *et al* showed better functional outcome and fewer wound complications after subtalar fusion following open reduction and internal fixation compared with fusion for malunion after non-operative treatment.¹⁶ Operative treatment therefore restores the anatomy in terms of correcting the varus deformity of the heel, lateral wall blowout and subtalar joint congruity. Consequently, even if a small subgroup of patients go on to need subtalar fusion, they will have a

better outcome than those in which there is increased heel width or varus deformity of the heel. We believe this in itself provides a strong case for operative treatment in appropriate cases.

In this context, it is worth noting that not everyone sustaining these intra-articular fractures will necessarily develop osteoarthritis. The extent of mechanical damage leading to post-traumatic osteoarthritis is a function of the intensity of impact.¹⁷ Higher energy impact causes greater local tissue damage.^{18,19} Similarly, fractures with low energy have little or no risk of osteoarthritis within two years.¹⁷ Post-traumatic osteoarthritis is also the consequence of release of free radicals from chondrocytes as well as pro-inflammatory cytokines.^{18,20} Animal studies have shown that these are controlled by genetic factors, which decide which patients develop osteoarthritis and which do not.^{17,21}

The incidence of soft tissue complications, wound infection and subsequent revision procedures has been cited as one reason for operative treatment falling out of favour.^{12,22–24}

Although conservative treatment eliminates the risks associated with surgery, loss of height and alignment leads to symptomatic malunion.²⁵ The lateral wall expansion causes heel widening and subfibular impingement of the peroneal tendons. Other pathological findings include loss of height resulting in reduced ankle dorsiflexion and displacement of the calcaneal tuberosity leading to varus malalignment of the hindfoot.^{25–29}

We have been following the above standard protocol for over a decade. Our preoperative planning involves setting a clear objective for the operative fixation, usually restoring the posterior subtalar joint, correcting the heel varus or reducing the lateral wall blowout, or a combination thereof.

In our study population, there was only one infection and one reoperation for prominent metalwork. These numbers are quite low compared with results reported in the literature.⁶ The increased incidence of soft tissue complications in smokers, diabetic and neuropathic patients has been clearly demonstrated in various studies.^{30–34} Our strict selection criteria of excluding smokers and patients with neuropathy or vasculopathy played a major role in reducing the risk of such complications. If there was a concern about skin or soft tissue, the patient was kept in hospital on strict orders of elevation and ice packs.

Our low soft tissue complication rate assumes special significance given that in 2014 the UK heel fracture trial reported a 19% infection rate and 11% secondary surgery.⁶ This trial was a pragmatic multicentre randomised controlled trial. It was concluded that operative treatment conferred no advantage over non-operative treatment for these injuries. Moreover, the risk of soft tissue complications and reoperation was too high.

The major criticism levelled against the trial was the significant selection bias.⁷ Of the 502 patients deemed eligible for inclusion, only 30% gave consent to take part. Over half (58%) of the cohort had a preference for one form of treatment or the other depending on the nature of the injury. Overall, only 7.5% of the 2,006 patients presenting to the recruiting centres at the time of study were enrolled. Furthermore, the trial had only a two-year follow-up duration.⁶

Longer-term follow-up might reveal differences between the operative and non-operative groups. There is evidence that symptoms from these fractures might take up to two years or even longer to settle.²⁵

All calcaneal fractures in our series were operated on and managed pre and postoperatively in the foot and ankle unit rather than by general trauma surgeons. The senior author emphasised the importance of the anatomic reduction of the subtalar joint and lateral wall blowout, and fixation with low profile plates. The postoperative course was also closely monitored with a review after one week to check for any early signs of soft tissue problems.

As this was a retrospective cohort study, it falls behind in terms of level of evidence. However, our soft tissue complication rate of 1.3% (1/80) and early reoperation rate of 1.3% (1/80) cannot be ignored. We attribute these low numbers to the strict protocol followed for the total care of patients with these injuries. It must be noted that the patient cohort presenting with these fractures are generally from the young working class and are the breadwinners for their families. As a result, the best overall care to ensure early return to work is imperative.

Conclusions

Calcaneal fractures are complex injuries and should be managed by a specialist team. Operative treatment still has a major role to play in the management of these difficult fractures. With the present trauma network system in England, all major trauma centres should have a specialist foot and ankle trauma service, which should take over the care of these complex injuries at an early stage and continue to look after them at least in the early postoperative phase.³⁵ Clear selection criteria as well as strict pre, intra and postoperative management protocols should be followed.

References

1. Järholm U, Körner L, Thorén O, Wiklund LM. Fractures of the calcaneus. A comparison of open and closed treatment. *Acta Orthop Scand* 1984; **55**: 652–656.
2. Buckley RE, Meek RN. Comparison of open versus closed reduction of intraarticular calcaneal fractures: a matched cohort in workmen. *J Orthop Trauma* 1992; **6**: 216–222.
3. Kundel K, Funk E, Brutscher M, Bickel R. Calcaneal fractures: operative versus nonoperative treatment. *J Trauma* 1996; **41**: 839–845.
4. Buckley R, Leighton R, Sanders D *et al*. Open reduction and internal fixation compared with ORIF and primary subtalar arthrodesis for treatment of Sanders type IV calcaneal fractures: a randomized multicenter trial. *J Orthop Trauma* 2014; **28**: 577–583.
5. Bruce J, Sutherland A. Surgical versus conservative interventions for displaced intra-articular calcaneal fractures. *Cochrane Database Syst Rev* 2013; **1**: CD008628.
6. Griffin D, Parsons N, Shaw E *et al*. Operative versus non-operative treatment for closed, displaced, intra-articular fractures of the calcaneus: randomized controlled trial. *BMJ* 2014; **349**: g4483.
7. Pearce CJ, Wong KL, Calder JD. Calcaneal fractures: selection bias is key. *Bone Joint J* 2015; **97**: 880–882.
8. Eastwood DM, Gregg PJ, Atkins RM. Intra-articular fractures of the calcaneum. Part 1: Pathological anatomy and classification. *J Bone Joint Surg Br* 1993; **75**: 183–188.
9. Sanders R. Intra-articular fractures of the calcaneus: present state of the art. *J Orthop Trauma* 1992; **6**: 252–265.

10. Sanders R, Fortin P, DiPasquale T, Walling A. Operative treatment in 120 displaced intraarticular calcaneal fractures. Results using a prognostic computed tomography scan classification. *Clin Orthop Relat Res* 1993; **290**: 87–95.
11. Thordarson DB, Krieger LE. Operative vs nonoperative treatment of intra-articular fractures of the calcaneus: a prospective randomized trial. *Foot Ankle Int* 1996; **17**: 2–9.
12. Sanders R. Displaced intra-articular fractures of the calcaneus. *J Bone Joint Surg Am* 2000; **82**: 225–250.
13. Palmer I. The mechanism and treatment of fractures of the calcaneus; open reduction with the use of cancellous grafts. *J Bone Joint Surg Am* 1948; **30**: 2–8.
14. Essex-Lopresti P. The mechanism, reduction technique, and results in fractures of the os calcis. *Br J Surg* 1952; **39**: 395–419.
15. Paley D, Hall H. Intra-articular fractures of the calcaneus. A critical analysis of results and prognostic factors. *J Bone Joint Surg Am* 1993; **75**: 342–354.
16. Radnay CS, Clare MP, Sanders RW. Subtalar fusion after displaced intra-articular calcaneal fractures: does initial operative treatment matter? *J Bone Joint Surg Am* 2009; **91**: 541–546.
17. Anderson DD, Chubinskaya S, Guilak Fet al. Post traumatic osteoarthritis – improved understanding and opportunity for early intervention. *J Orthop Res* 2011; **29**: 802–809.
18. Martin JA, Buckwalter JA. Post-traumatic osteoarthritis: the role of stress induced chondrocyte damage. *Biorheology* 2006; **43**: 517–521.
19. Beecher BR, Martin JA, Pedersen DR et al. Antioxidants block cyclic loading induced chondrocyte death. *Iowa Orthop J* 2007; **27**: 1–8.
20. Martin JA. N-acetylcysteine inhibits post-impact chondrocyte death in osteochondral explants. *J Bone Joint Surg Am* 2009; **91**: 1,890–1,897.
21. Furman BD, Huebner JL, Seifer DR et al. MRL/MpJ mouse shows reduced intra-articular and systemic inflammation following articular fracture. Presented at: 55th Annual Meeting of the Orthopaedic Research Society; February 2009; Las Vegas.
22. Lindsay WR, Dewar FP. Fractures of the os calcis. *Am J Surg* 1958; **95**: 555–576.
23. Pozo JL, Kirwan EO, Jackson AM. The long-term results of conservative management of severely displaced fractures of the calcaneus. *J Bone Joint Surg Br* 1984; **66**: 386–390.
24. Crosby LA, Fitzgibbons T. Intraarticular calcaneal fractures. Results of closed treatment. *Clin Orthop Relat Res* 1993; **290**: 47–54.
25. Stephens HM, Sanders R. Calcaneal malunions: results of a prognostic computed tomography classification system. *Foot Ankle Int* 1996; **17**: 395–401.
26. Isbister JF. Calcaneo-fibular abutment following crush fracture of the calcaneus. *J Bone Joint Surg Br* 1974; **56**: 274–278.
27. Sanders R, Fortin PT, Walling AK. Subtalar arthrodesis following calcaneal fracture. *Orthop Trans* 1991; **15**: 656.
28. Myerson M, Quill GE. Late complications of fractures of the calcaneus. *J Bone Joint Surg Am* 1993; **75**: 331–341.
29. Flemister AS, Infante AF, Sanders RW, Walling AK. Subtalar arthrodesis for complications of intra-articular calcaneal fractures. *Foot Ankle Int* 2000; **21**: 392–399.
30. Hedlund LJ, Maki DD, Griffiths HJ. Calcaneal fractures in diabetic patients. *J Diabetes Complications* 1998; **12**: 81–87.
31. Folk JW, Starr AJ, Early JS. Early wound complications of operative treatment of calcaneus fractures: analysis of 190 fractures. *J Orthop Trauma* 1999; **13**: 369–372.
32. Sagray BA, Stapleton JJ, Zgonis T. Diabetic calcaneal fractures. *Clin Podiatr Med Surg* 2013; **30**: 111–118.
33. Ding L, He Z, Xiao H et al. Risk factors for post operative wound complications of calcaneal fractures following plate fixation. *Foot Ankle Int* 2013; **34**: 1,238–1,244.
34. Soni A, Vollans S, Malhotra K, Mann C. Association between smoking and wound infection rates following calcaneal fracture fixation. *Foot Ankle Spec* 2014; **7**: 266–270.
35. Copas DP, Moran CG. Major trauma care in England. *Bone and Joint* 360 2014; **3(2)**: 2–5.