

Management of Intra-Articular Calcaneal Fractures: Clinical Results of Reduction Technique Using a Bone Spreader



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ABSTRACT

The purpose of the present study was to examine the clinical results of surgery for intra-articular calcaneal fractures using a calcaneal locking plate and a bone spreader as a reduction tool. Ten patients with intra-articular calcaneal fractures were treated. An extended lateral approach was used. The reduction of the intra-articular fragments of the posterior facet was temporarily held using a bone spreader and Kirschner wires. Internal fixation was achieved with a locking calcaneal plate. Böhler's angle and Preiss' angle were assessed on the day of injury and the day of the final follow-up examination. The step off and gap of the posterior facet were assessed on the day of injury and the first week after surgery. The functional outcome was evaluated using the American Orthopaedic Foot and Ankle Society ankle hindfoot scale score. The mean Böhler's angle ranged from $2.1^\circ \pm 11.0^\circ$ to $30.4^\circ \pm 5.0^\circ$ ($p < .0001$), the mean Preiss' angle ranged from $23.5^\circ \pm 4.5^\circ$ to $15.5^\circ \pm 2.9^\circ$ ($p < .0001$), the mean step off ranged from 4.0 ± 1.9 mm to 0.1 ± 0.2 mm ($p = .0002$), and the mean gap ranged from 2.6 ± 1.0 mm to 1.2 ± 0.6 mm ($p = .0035$). The mean American Orthopaedic Foot and Ankle Society Ankle-Hindfoot scale score was 89.2 (range 85 to 100) at a mean of 14.3 months after surgery. Our results suggest that a locking calcaneal plate can be used to restore and reduce an intra-articular calcaneal fracture and achieve good clinical results.

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The management of displaced intra-articular calcaneal fractures remains challenging and controversial (1–7). The key points of treatment for intra-articular calcaneal fractures involves anatomic reduction of the subtalar joint, reduction of the deformity of the lateral wall, reduction of the varus deformity, and rigid internal fixation (8). Reduction methods using a periosteal elevator, osteotomies, or bone spreaders to treat intra-articular calcaneal fractures have been reported (9,10). A bone spreader has been described as a very useful tool for the management of calcaneal fractures, subtalar distraction fusion, and calcaneal osteotomy (9,10). However, few studies have reported the clinical results of reduction techniques using bone spreaders to treat intra-articular calcaneal fractures.

The purpose of the present study was to examine the clinical results of surgery for intra-articular calcaneal fractures using a calcaneal locking plate and bone spreader as reduction tools.

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Patients and Methods

We treated 10 patients (6 males and 4 females) with intra-articular calcaneal fractures consecutively at our hospital from April 2011 to October 2012. None of these patients were treated for bilateral fractures. The mean patient age was 62.9 (range 42 to 76) years. The mean follow-up period was 14.3 (range 7 to 23) months. Of the 10 fractures, 7 were graded as Sanders type 2, 2 as type 3ab, and 1 as type 3ac. Nine fractures were graded as joint depression fractures and one as a tongue fracture using the Essex-Lopresti classification. The mean period from injury to internal fixation was 11.4 (range 7 to 18) days. The inclusion criteria were primary surgery of an intra-articular calcaneal fracture and age >15 years. The exclusion criteria were age <16 years, open fracture, and bilateral calcaneal fractures.

All the patients gave informed consent before inclusion in the study. The local ethical committee authorized the study, which was performed in accordance with the ethical standards of the 1975 Declaration of Helsinki as revised in 2013 (11).

An extended lateral approach was used, and the peroneal tendons were carefully retracted and dissected from the peroneal tubercle. A lateral wall fragment was identified and separated carefully in 1 piece. A bone spreader was placed underneath the articular fragment of the posterior facet and slowly opened until Böhler's angle was restored to that observed in an uninjured calcaneus. The reduction of the articular fragments was temporarily held with a bone spreader (Fig. 1A–C). For reduction of the varus deformity of the tuberosity, a 3-mm Steinmann pin was used as a joystick to lever the posterior tuberosity into a reduced position. Provisional fixation was undertaken from the posterior inferior corner of the calcaneal tuberosity through the subtalar joint using 2.4-mm Kirschner wires. Anatomic reduction was confirmed using fluoroscopy and intraoperative radiographs (Fig. 1D). Next, the bone spreader was removed, and

β -tricalcium phosphate or calcium phosphate cement was inserted into the fracture void. Internal fixation was performed with a locking calcaneal plate (Synthes GmbH, Oberdorf, Switzerland; Figs. 1E and 2). Nonlocking screws were first inserted through the plate holes just under the subtalar joint and the corners of the tuberosity to compress the plate onto the lateral wall. Next, the locking screws were inserted through the other plate holes. Three experienced orthopedic surgeons (N.T., T.M., N.T.) performed the surgeries. One of us (N.T.) collected the data. The assessors participated in the surgeries. For postoperative rehabilitation, range-of-motion exercises of the ankle joint were allowed 3 days after surgery. Partial weightbearing was allowed 6 weeks after surgery, and full weightbearing was allowed 9 weeks after surgery.

Böhler's angle and Preiss' angle were measured on the day of injury, 1 week after surgery, and at the final follow-up examination using plain radiographs. Preiss' angle was defined as the angle between the lateral wall and the line from the medial tip of the sustentaculum tali to the medial process of the calcaneal tuberosity on the axial view. The step off and gap of the posterior facet were measured on the day of injury and 1 week after surgery using computed tomography scans. Functional outcome was evaluated using the American Orthopaedic Foot and Ankle Society (AOFAS) ankle hindfoot scale score (12,13). All measurements were examined with 1-way analysis of variance, followed by a Tukey-Kramer honest significant difference testing. The JMP computer software program (SAS Institute, Cary, NC) was used for statistical analysis. Values of $p < .05$ were considered to statistically significant.

Results

The results are listed in the Table. Significant differences were found between the Böhler's angle measured on the day of injury and 1 week after surgery ($p < .0001$). The Böhler's angle measured 1 week after surgery and at the final follow-up examination were not significantly different. Significant differences were found between the Preiss' angles measured on the day of injury and 1 week after surgery ($p < .0001$). The Preiss' angles measured 1 week after surgery and at

the final follow-up examination were not significantly different. Significant differences were found between the step off measured on the day of injury and 1 week after surgery ($p = .0002$). Significant differences were found between the gap measured on the day of injury and 1 week after surgery ($p = .0035$). The mean AOFAS Ankle-Hindfoot scale score was 89.2 (range 85 to 100) at the final follow-up examination. No skin necrosis or infection was observed, although delayed wound healing occurred in 1 patient.

Discussion

The results from the present study demonstrated good functional outcomes using a locking calcaneal plate combined with a bone spreader as a reduction tool for treating intra-articular calcaneal fractures.

Several studies have compared the outcomes of operative treatment with those of nonoperative treatment for displaced intra-articular calcaneal fractures (14–25) and reported better functional outcomes for patients who underwent surgery (14–19). However, other studies have reported no significant differences in the functional results between the 2 treatment groups (20–22). Buckley et al (3) showed that females, patients who were not receiving Workers Compensation, younger males, patients with a higher Böhler's angle, patients with a lighter workload, and those with a single, simple, displaced intra-articular fracture had better results after operative treatment those who did not undergo open reduction and internal fixation (ORIF).

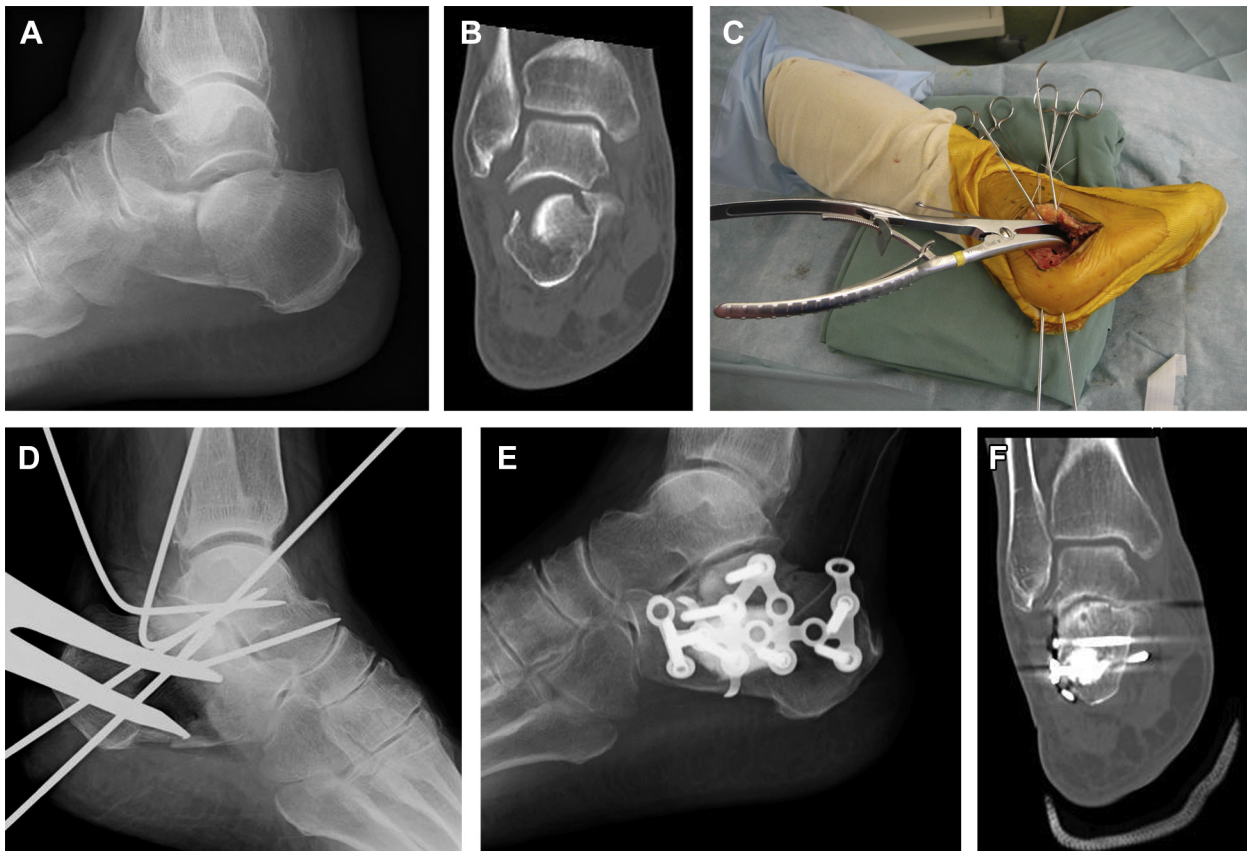


Fig. 1. (A) Radiograph of the left calcaneus on the day of injury. (B) Computed tomography scan of the left calcaneus on the day of injury. A 76-year-old female had sustained an injury to her left calcaneus. The fracture type was graded as Sanders 2c and a joint depression fracture using the Essex-Lopresti classification (Böhler's angle -1° , Preiss' angle 19° , step off 6 mm, gap 3 mm). (C) Intraoperative photograph showing the reduction of the articular fragments temporarily held with a bone spreader. (D) Intraoperative radiograph showing Böhler's angle reduced anatomically. (E) Radiograph of the left calcaneus after surgery. (F) Computed tomography scan of the left calcaneus after surgery. The fracture was reduced and fixed anatomically (Böhler's angle 33° , Preiss' angle 15.7° , step off 0 mm, gap 1.3 mm).

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