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Management of Valgus Extra-articular Calcaneus Fracture Malunions with a Lateral Opening Wedge Osteotomy

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ABSTRACT

A total of 34 cases of symptomatic valgus deformity of the hindfoot secondary to a malunited extra-articular calcaneal fracture were corrected with laterally based open wedge calcaneal osteotomy. The pre- and postoperative radiographic parameters were compared, and a postoperative clinical evaluation was performed using the American Orthopedic Foot and Ankle Society ankle and hindfoot scoring system. The mean follow-up period was 56.2 (range 24.1 to 97) months. The most significant radiographic changes were improvement in the talonavicular coverage angle (mean 17.3°) on the anteroposterior view. The mean postoperative American Orthopedic Foot and Ankle Society hindfoot and ankle score was 90, with 23 excellent, 8 good, and 3 poor results. Laterally based opening wedge osteotomy of the calcaneus is effective in the management of a valgus heel resulting from malunited extra-articular calcaneal fractures. Lateral decompression of the peroneal tendons and the sural nerve was achieved indirectly through opening wedge lateral calcaneal osteotomy that shifted the weight-bearing axis laterally.

Inadequate or inappropriate primary treatment of a fracture of the calcaneus frequently results in persistent pain in the foot. Painful sequelae, which are common after fractures of the calcaneus, vary. They can be the result of complications related to nerves, subtalar osteoarthrosis, impingement on a tendon or other soft tissue, calcaneofibular abutment, altered mechanics of the tibiotalar joint, an unrecognized compartment syndrome, chronic pain syndrome (e.g., reflex sympathetic dystrophy), and the so-called smashed heel-pad syndrome. The therapeutic approaches to these conditions have included shoe modifications, physiotherapy, operative reconstruction, judicious, sensory denervation of the heel, and, even, amputation (1). Malunion is a common difficulty resulting from the nonoperative treatment of displaced, calcaneal fractures (2). Regardless of the method of treatment selected for calcaneal fractures, mobility can be limited in the presence of a decreased calcaneal body height, calcaneofibular abutment, flattening of the longitudinal arch, and tenosynovitis of the peroneal tendons when they are compressed against the fibula by a widened calcaneal body.

Osteotomy of the calcaneus was advocated by Edwards and Menelaus (3), who described its use in 5 patients who had congenital calcaneovalgus deformity (oblique osteotomy of tuberosity of the calcaneum with medial displacement of the tuberosity of about 1.5 cm). Evans (4) and Pandey et al. (5) also reported its use, mainly for deformities of the foot, rather than for the calcaneus, that develop from paresis of the triceps surae. Mosca (6) used open wedge osteotomy of the cuneform bone to treat flat feet secondary to a variety of causes with very good results. Clinically, it results in a correction of both hind foot and midfoot valgus, with an associated improvement in the medial longitudinal arch (7).

The purpose of the present study was to analyze the clinical and radiographic outcomes of laterally based open wedge osteotomy to realign a valgus calcaneal deformity and subsequently improve the mid-tarsal joint alignment of malunited extra-articular calcaneal fractures.

Patients and Methods

From December 1999 to June 2006, 28 patients (34 feet) with symptomatic feet secondary to malunited extra-articular calcaneal fractures leading to valgus deformity of the heel with no or mild subtalar arthritis underwent lateral opening wedge calcaneal osteotomy. All the patients had pain in the foot or ankle, or both, as a result of the fracture, which had occurred at a mean of 28 (range 9 to 35) months before they were seen by us for treatment. Of the 28 patients, 24 were men and 4 were women. The mean patient age at surgery was 34.7 (range 23.9 to 51.3) years. Of these 28 patients, 6 underwent bilateral procedures. Most of the injuries had been sustained in a fall from a height (23 patients). A motor vehicle accident was the cause of the fracture in 5 patients.

All patients had undergone a trial of nonoperative treatment that included orthotics, shoe modification, activity modification, and nonsteroidal anti-inflammatory medication. Despite these treatments, they continued to be symptomatic to the degree that it was interfering with their ability to participate in activities of daily living. The

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subtalar joint range of movement was restricted in 27 feet. The pain was most commonly in the region of the peroneal tendons and the medial longitudinal arch.

The indications for surgery included calcaneal valgus deformity interfering with patient daily life activities without subtalar arthritis. The operation was done within 1 year of the original injury.

Clinical Evaluation

All patients were evaluated before and after surgery using the American Orthopedic Foot and Ankle Society (AOFAS) hindfoot and ankle scoring system (8). This is a 100-point scale, with 40 points for pain, 50 for function, and 10 for alignment. A score of 90 to 100 was considered excellent, 80 to 89 good, 70 to 79 fair, and less than 70 poor. Examination of the foot and ankle included measurement of the range of dorsiflexion-plantar flexion and inversion-eversion of the ankle, hindfoot, and forefoot. The site or sites of maximum tenderness were evaluated by palpation of the soft tissues and through assessment of pain on attempted active range of motion of the ankle and the subtalar and transverse tarsal joints. The physical examination was supplemented with selective blocks of joints and soft tissue using xylocaine and bupivacaine. This was done to better localize the exact source of pain when it had been difficult to determine.

Radiologic Evaluation

Weight-bearing anteroposterior, lateral, and axial radiographs of the foot were obtained for all patients preoperatively and at every postoperative follow-up visit at 6 weeks and 3 months and then every 6 months. The measurements were performed in a similar manner on all radiographs according to the method of Sangeorzan et al. (9). On the anteroposterior film, we measured the talocalcaneal angle and the talonavicular coverage angle, which measure the amount of subluxation of the navicular. A line was drawn connecting the border of the articular surface of the talus and a perpendicular line was made at the midpoint. A second line was drawn connecting the border of the articular surface of the navicular and a perpendicular drawn to it. The angle between the perpendicular lines was defined as the talonavicular coverage angle. On the lateral view, 2 measurements were made. First, the talocalcaneal angle was measured between the long axis of the talus and calcaneus. The angle between the long axis of the talus and the lateral border of the calcaneus. The angle decreases when varus angulation of the hindfoot is present or when the foot is in dorsiflexion. The talocalcaneal angle increases with valgus or plantar flexion (10, 11). Second, the calcaneal length was measured from the most posterior point of the tuberosity to the calcaneocuboid joint. The height of the posterior facet is measured by a line perpendicular on the calcaneal axis to the highest point of the posterior facet (12). The hindfoot alignment view provides a coronal plane evaluation of the hindfoot in relation to the distal tibia. A special roentgenogram of the hind part of the foot, modified from that described by Cobey, was made with the patient standing upright with the knees extended and away from the x-ray beam, which was directed downward at a 20° angle from the horizontal to a vertically oriented x-ray cassette. This roentgenogram allowed accurate delineation of the angle that was formed by the long axis of the tibia and the vertical axis of the calcaneus (13).

The radiographs were useful for the diagnosis and delineation of the severity of the osteoarthrosis (subtalar or transverse tarsal). All radiographic measurements were assessed by myself and 1 radiologist using a computerized digitizer.

Surgical Technique

The lateral opening wedge calcaneal osteotomy is approached through an oblique lateral incision. Superficial branches of the peroneal nerve are protected and retracted. The middle facet of the subtalar joint (the sustentaculum tali) is identified by probing over the dorsum of the exposed calcaneus.

The lateral border of the widened calcaneus is shaved. The periosteum is incised in line with the planned osteotomy, starting laterally approximately 2.5 cm proximal to the calcaneocuboid joint in the interval between the middle and posterior facets of the subtalar joint.

A lateral to medial oblique osteotomy is accomplished using power-driven instrumentation (Fig. 1). The osteotomy line is taken slightly oblique from proximally and laterally to distally and medially. Preoperatively, the required depth of the osteotomy is estimated from the calcaneal axial radiographs. A large osteotome is then used to open the osteotomy. The periosteum of the medial calcaneus should be preserved to prevent medial displacement of the posterior fragment. Once the determined width of the opening is achieved, a suitable tricortical bone graft taken from the posterior iliac crest is placed in the osteotomy site plus the bone that was taken from the lateral calcaneal shaving (Fig. 2). Fixation is obtained with one cannulated screw through the posterior approach along the long axis of the calcneus.

Postoperatively, non–weight-bearing in a cast was advised for 6 weeks, followed by a walking cast for another 6 weeks before the patients were allowed to wear normal shoes.

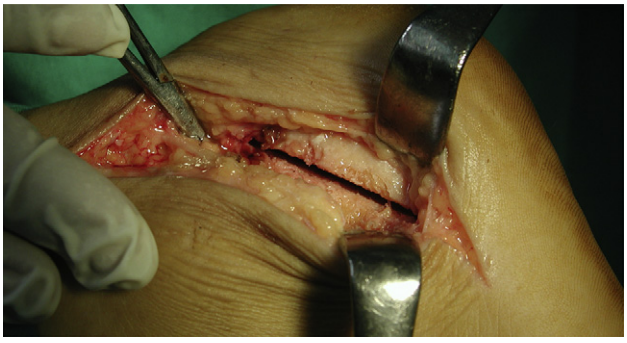

Fig. 1. Photograph showing osteotomy site, with posterior aspect of heel pointing up.

Statistical Evaluation

The statistical comparison was made using the paired Student's t test to compare the pre- and postoperative values. The tests that yielded $p < .05$ were considered to demonstrate statistically significant differences.

Results

All patients were available for radiographic and clinical evaluation at the final follow-up visit. The mean follow-up period was 56.2 (range 27 to 97) months. The results of the operation were evaluated using the AOFAS score. The ability to return to the previous occupation or to the preinjury level of activity was carefully assessed.

Radiographic Evaluation

Postoperative radiographs showed the following improvements compared with preoperative values. On the anteroposterior view, the talocalcaneal angle improved from a mean of 21.4° (range 16.6° to 24.5°) preoperatively to 38.3° (range 29° to 41.3°) postoperatively. The talonavicular coverage angle improved from 24.5° (range 19.2° to 27.4°) preoperatively to 7.2° (range 6.5° to 10.6°) postoperatively. On the lateral view, similar improvement was seen. The lateral talocalcaneal angle improved from 23° (range 16.4° to 27.8°) preoperatively to 34.4° (range 32.7° to 45.8°) postoperatively. The length of the calcaneus increased 73.6 mm preoperatively to 80.9 mm postoperatively, and the calcaneal height improved from 44 mm preoperatively to 49 mm postoperatively (Figs. 3 and 4). The tibiocalcaneal angle (measured in the hindfoot view) improved from 32.4° preoperatively (range 23.8° to 45.7°) to 6.2° (range 7.3° valgus to 5.4° varus) postoperatively. All differences in the angles between the preoperative measurements and at follow-up were significant, except for the

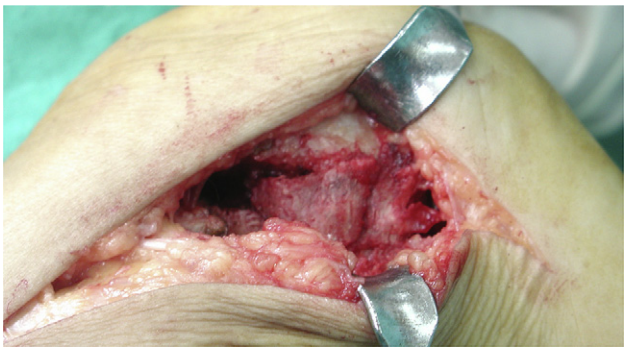

Fig. 2. Trapezoidal iliac bone graft placed in osteotomy site, which was filled with bone taken from lateral calcaneal shaving, with posterior aspect of heel pointing up.