Open Reduction and Internal Fixation of Pilon Fractures with Plating

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Abstract:

The fracture of the tibial plafond or pilon fracture is an uncommon but difficult fracture to manage. The purpose of this study was to present the treatment outcomes of pilon fractures treated with open reduction and internal fixation with plates.

METHOD: *In this retrospective study we identified patients with pilon fractures of the distal tibia who had undergone open reduction and internal fixation at our institute. Between June 2013 and June 2015, 28 patients (mean age, 42.64 years) who had undergone open reduction and internal fixation with plating were selected. All 28 patients were available for follow-up. The clinical outcome was evaluated with the American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot score and the visual analogue scale (VAS). The radiological evaluation was performed using the osteoarthritis-score (OA-score).*

RESULTS: *Satisfactory reduction and stable fixation were accomplished in all patients. At a mean follow-up of 15.5 months, all patients had good radiological results and showed satisfactory clinical recovery. The mean AOFAS sore was 85.10, the mean OA-score was 0.28, and the mean VAS scores during rest, active motion, and weight-bearing walking were 0.28, 0.39, and 1.03, respectively.*

CONCLUSIONS: *Fixation with plating provides stable fixation and allows earlier postoperative exercises without plaster immobilization, thus minimizing the risk of posttraumatic arthritis.*

KEYWORDS: *Pilon fractures, Internal fixation, Bone plates, Staging of treatment*

Introduction

Tibial pilon are distal joint fractures of the tibia, with complete rupture of epiphyseal-diaphyseal continuity. The fracture of the tibial plafond or pilon fracture is an uncommon but difficult fracture to manage. The surgical method of repairing distal tibial fractures remains controversial. Intra-articular fractures with involvement of the tibial plafond usually bear a worse long-term prognosis and pertain a higher risk of degenerative changes [1]. The average age of someone with a pilon fracture is 35 to 40 years old. Pilon fractures are rare in children and elderly people. Men are three times more likely than women to have pilon fractures. They represent 1–5% of lower extremity fractures and 7–10% of all tibial fractures. These injuries generally fall into one of two categories low-energy, rotational type of fracture and high-energy, compression type of fractures [2].

Fracture of the plafond occurs when the talus is driven into the tibia from axial compression. The type of fracture that occurs will depend on the position and rotation of the foot at the time of impact. These result from a major fracture line extending from the fibular incisura and exiting anterior and posterior to the medial malleolus. The comminution commonly distinguishing pilon fractures occurs from secondary fracture lines through the apex of the plafond and in the anterolateral region [3] Historically, these fractures have been treated in a number of manners, but the best results have occurred when stable internal fixation is accomplished using plates and screws [4]

Open reduction and plating is a popular method that can result in good fixation and retention of the achieved position [5] Basic steps in reconstruction are restoration of anatomic length of the fibula with plate fixation, reconstruction of the tibial articular surface, cancellous bone grafting of the metaphyseal defect, and buttress plating either anteriorly or medially of the distal tibia. If anatomic reconstruction of the joint surface can be restored and stable fixation achieved, early motion of the ankle is made possible. This early motion reduces stiffness of the ankle and will yield the most satisfying results.(4) In 2000, Hansen introduced the term posterior pilon to describe severe trimalleolar fractures with the presence of a fourth fragment located deeper than the avulsed posterior fragment [1].

Regarding pilon fracture, specifically the severity of fracture pattern and delay of reduction are important problems to overcome to ensure successful results [6]. Indirect reduction and stabilization of fractures by

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means of distraction using a circular external fixator can be a useful method of achieving satisfactory joint restoration, and employs the principles of closed reduction to realign disrupted bones and joint structures [7]. Locking compression plate (LCP) with minimally invasive technique for pilon fratcure has advantages of less invasion, fewer complications and satisfactory ankle function [8].

Nonunion, malunion, and infection are complications encountered when treating fractures of the distal tibia extending into the joint surface [9]. In this article, through a retrospective study, we present the treatment outcomes of pilon fractures treated with open reduction and internal fixation with plates.

Materials And Methods

During a 2-year period from June 2013 to June 2015, 28 consecutive patients with ankle fractures underwent operative treatment at our institution. There were 22 males and six females with an average age of 42.64 (range, 24 to 64) years. Nineteen patients had been injured in road traffic accidents and nine patients had fall from height. Radiographs of the ankle joint with anteroposterior (AP), mortise and lateral views were taken to evaluate the fractures. Three-dimensional reconstruction of computerized tomography (CT) scan images was also used to identify the fracture patterns both preoperatively and postoperatively in case of external fixation. Two of the 28 patients had associated complete medial malleolar fractures involving both the anterior and the posterior colliculi. Associated lateral malleolar fractures also occurred in 23 cases. In the emergency department, all fractures received closed reduction and fixation with plaster splints. Three cases were applied external fixator because each of these fractures had a concomitant soft-tissue injury. Definitive fixation was delayed in all the cases until the soft tissue swelling had subsided for which skin has to wrinkle, indicating the correct time for surgery. The mean time from injury to operation was 6.5 (range, 4 to 14) days. The patients had signed an informed consent form authorizing the use of their clinical data in this study.

Surgical Technique

The surgeries were performed under either general or epidural anesthesia. Patients were positioned supine with a bolster under the distal lower leg as prevision for reduction of the talus. A tourniquet was routinely applied on the thigh. A standard, anteromedial approach in 24 cases, medial approach was used in two cases, posteromedial approach in one case and posterolateral approach in one case. Minimal exposure and careful handling of the periosteum was done to prevent any further vascular damage of the fracture fragments. The tibiotalar joint was opened in the sagittal direction, usually in line with the fracture line between the articular fragments. Transverse incision of the capsule was taken to further expose the joint but was kept short as it risks devascularization of the anterior fragments. A large distractor was used from tibia to medial talus, to pull the talus distally, aiding exposure. A bone spreader was used to separate the anteromedial and the anterolateral articular fragments. This led to exposure of the joint, allowing an excellent approach to the center as well as to the posterior part of the fracture. A 1.5 mm Kirschner wire was used to drill through the central fragment, the anterior cortex of the distal tibia, and the anterior soft-tissue on the opposite side until the tail end of the K-wire was in a position just adequate for temporary fixation of the impacted fragment without affecting reduction.

The fibular fracture was exposed by posterolateral approach by retracting the peroneal tendons laterally and the posterior surface of the distal tibia was reached in case of posterior malleolar fragment by retracting the flexor hallucis longus tendon and the deep posterior compartment medially. We preferred to reduce and fix the fibular fracture first. Prior to fixation, the fracture fragments of the tibia and fibula were mobilized using a periosteal elevator so as to ease reduction and the fracture hematoma was removed. The bone defect was filled with autogenous iliac crest bone grafts in four patients. Large impacted osteochondral fragments were anatomically reduced and inserted press-fit together with the other articular fragments. The nonviable small comminuted ones were removed. It was important to have a detailed appreciation of the fracture morphology and to visualize the malleolar fragments, which served as the principal anatomical reference for anatomical reduction. After satisfactory fracture reduction was achieved and confirmed with intraoperative fluoroscopy, an appropriately sized plate was screwed to the medial surface of the distal tibia. We used locking compression plate in 21 cases and buttres plates in seven cases. Depending on the degree of comminution of the fragment, an additional screw would sometimes be used to achieve better outcome. Medial malleolus fracture were fixed with malleolar screws. In the presence of a posteromedial or posterolateral fragment needing fixation, an additional posteromedial or posterolateral approach was required. After fracture fixation, syndesmotic stability was checked by the Cotton test, and two cases required syndesmotic screw in dorsiflexion where unstable syndesmosis was found. The syndesmotic screw was removed at six weeks. When good reduction and acceptable hardware placement had been confirmed by intraoperative imagery, wound closure was performed in the usual manner.

Postoperative Management

The postoperative rehabilitation protocol was standardized. No external splints were used. Active range of motion exercises, with the extent gradually increased, were begun after 24 hours. The sutures were removed after 2 weeks. Partial weight bearing was begun at 6 weeks. Full weight bearing was allowed at 3 months when advanced signs of union were seen on radiographs.

Postoperative Assessment

The quality of fracture reduction was assessed with the immediate postoperative radiographs. Less than 1 mm articular stepoff was considered as an anatomical reduction. During the period of follow-up, radiographs were taken monthly in the first 3 postoperative months. Thereafter, patients were generally followed every 3 months, which changed to every 6 months one year later. At 12 months of follow-up, the functional outcome was evaluated with the American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot score.(10-12) The visual analogue scale (VAS) (0, pain-free; 10, the most unbearable pain) was used to evaluate pain at fracture site during rest, active movement, and weight-bearing walking.(12, 13) The radiological evaluation was performed using osteoarthritis-score (OA-score).(12, 14) A score of 0 was a normal joint; a score of 1 was assigned to the presence of osteophytes without joint space narrowing; a score of 2 was assigned to joint space narrowing with or without osteophytes; and a score of 3 was assigned with sub or total disappearance or deformation of the joint space.

Results

A standard, anteromedial approach in 24 cases, medial approach was used in two cases and posteromedial approach in one case and posterolateral approach in one case. A syndesmotic screw was used in two cases. Immediate postoperative radiographs was taken for all patients. Anatomical reduction was achieved in 25 patients. Three patients had a 1 mm stepoff of the articular surface. All 28 patients were available for follow-up at an average of 15.5 (range, 12 to 23) months. The wounds of all patients healed uneventfully. All fractures healed within 12 weeks, without loss of reduction and hardware failure. No infections and nerve injuries occurred. At two years postoperatively, the mean OA-score was 0.28 (range, 0 to 2) in all patients. Four patients had an OA-score of 1 and two patient had an OA-score of 2. The mean AOFAS score was 85.10 (range, 72 to 96). The mean VAS score for fracture pain under different conditions was 0.28 (range, 0 to 2) during rest, 0.39 (range, 0 to 3) during active movement, and 1.03 (range, 0 to 5) during weight-bearing walking. Complications included two cases of infection, one case of loss reduction, one case of partial skin necrosis and two cases of delayed union.

Discussion

Pilon fractures are caused by high-energy or, more rarely, low-energy trauma [15, 16]. These fractures result from a combination of axial compressive forces and torsional forces. In high energy fracture patterns axial forces predominate, while torsional forces account for low energy pilon fractures.

In accordance with the evolving principles of AO, anatomical restoration of the articular surface was paramount to achieving a satisfactory functional outcome. There are four key principles: the restoration of the length and axis of the fibula or tibia; the reconstruction of the distal end of the tibia; the filling of the defect resulting from impaction, using cancellous autografts; and the support of the medial side of the tibia by plating to prevent a late varus deformity [17].

Staging the treatment of the patient can minimize development of soft tissue complications [2]. Sirkin [18] suggested that definitive reconstruction through open approaches should be delayed until soft-tissue swelling has decreased, as the tissues are tenuous and cannot withstand surgical trauma. Surgery should be delayed for at least 10 days to allow wrinkles to return, blisters to re-epithelialize, and wounds to heal. In decisions regarding which plating technique to use for fractures of the distal tibia, several components must be understood for successful treatment. We must take into account the different fracture patterns that include fibula as well as the distal tibia. We must also understand the common articular fragments and their relationships to the rest of the joint.

Chen et al [6] studied 39 ankles of 38 patients treated with open reduction and internal fixation for pilon fractures with an average age of 38.6 years and mean follow up of 31.7 months. They suggested that anatomic reduction, rigid fixation and early motion exercise are important to successful treatment of ankle fractures. Regarding pilon fracture, specifically the severity of fracture pattern and delay of reduction are important problems to overcome to ensure successful results.

Gupta et al [19] treated 79 patients with locking plates for distal tibial fractures and concluded that, minimally invasive osteosynthesis, if possible, offers the best possible option as it permits adequate fixation in a biological manner. Peri-operative docking of fracture ends may be a good option in severely impacted fractures with gap. They observed that precontoured distal medial tibial LCP was better tolerated implant in comparison to the 4.5-mm Limited Contact-LCP or metaphyseal LCP with respect to complications of soft tissues, bone healing and functional outcome, though its contour needs to be modified.

Pugh et al [20] External fixation offers advantages in the treatment of the soft-tissue injury associated with pilon fractures, but malunion continues to be a problem with this method of fixation.

Blauth et al [21] examined 51 patients clinically and radiologically at an average of 68 months after injury. The patients were treated in three different ways: primary internal fixation with a plate for patients with closed fractures without severe soft tissue trauma; one-stage minimally invasive osteosynthesis for reconstruction of the articular surface with long-term transarticular external fixation of the ankle for at least four weeks and a two-stage procedure entailing primary reduction and reconstruction of the articular surface with minimally invasive osteosynthesis and short-term transarticular external fixation of the ankle joint followed by secondary medial stabilization with a plate using a technique requiring only limited skin incisions. They recommended a two-step procedure for the treatment of severe tibial pilon fractures with extensive soft tissue damage. In the first stage, primary reduction and internal fixation of the articular surface is performed using stab incisions, screws, and K-wires. Temporary external fixation is applied across the ankle joint. After recovery of the soft tissues, the second stage entails internal fixation with a medial plate using a reduced invasive technique.

Moreover, no external splints were used and active range of motion exercises were started 24 hours postoperatively. In our opinion, because the injury mechanism of a pilon fractures contains the component of axial forces and shearing forces, application of distal tibia medial plate provides stable fixation and allows earlier motion of the ankle joint, thus helping recovery of the articular cartilage [22] At two-year follow-up, the functional results were favorable with a mean AOFAS score of 85.10. The VAS scores were low on rest and active movements but was annoying on weight bearing in a few cases. Severe ankle pain and swelling or articular stiffness was not found in our cases.

Limitations of this study include that although we chose the AOFAS score, the OA-score and the VAS score to assess the outcomes, we could not thoroughly compare the results with other reports. Although some other limitations might exist in this study, we believe that our patients gained proper management and the clinical outcomes were favorable.

Conclusion

The pilon fractures are more commonly due to high-energy trauma. CT scanning is helpful for evaluating these fractures. Definitive reconstruction through open approaches should be delayed until soft-tissue swelling has decreased. Anatomical reduction and stable fixation of a pilon fracture can be realized by direct manipulation through various approaches depending upon the fracture fragment configuration. Fixation with plating provides stable fixation and allows earlier postoperative exercises without plaster immobilization, thus minimizing the risk of posttraumatic arthritis, although rigorous studies supporting this claim are pending.

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