Injury 50 (2019) 2312–2317

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Posterior pilon fracture: Epidemiology and surgical technique

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ARTICLE INFO

Article history:
Accepted 3 October 2019

Keywords:
Posterior pilon fracture
Ankle fracture
Posterior malleolar fracture
Syndesmotic injury
Fibular fracture
Posteromedial approach

ABSTRACT

Objectives: To review a case series of patients with posterior pilon variant fracture using a novel approach, focusing on demographic data, injury pattern, surgical results based on computed tomography (CT) scan, and short-term complications.
Design: Consecutive case series.
Setting: Level I trauma center.
Patients/participants: Twenty-five patients with posterior pilon fracture.
Intervention: Posterior pilon fracture open reduction and internal fixation.
Main Outcome Measurements: Parameters measured included age, sex, type of fracture, surgical technique, anatomical reduction, and complications.
Results: Twenty-five patients sustained a posterior pilon fracture, accounting for 13.4% of all operatively treated ankle fractures with median follow-up of 21.7 months. The average age of patients was 42 years (22–62); 19/25 (76%) were female, and 6/25 (24%) were male. A modified posteromedial approach was used in 18/25 (72%) patients. Persistent syndesmotic instability was present in 11/25 (44%) patients after posterior malleolar stabilization. Quality of reduction was assessed under CT scan in 19 patients, with 15/19 (78.9%) having anatomic reduction. We report 2/25 (8%) patients with early wound problems and 7/25 (20%) with short-term complications during follow-up.
Conclusion: Posterior pilon variant fracture appears to be less common than previously reported. Most fractures can be satisfactorily treated through a modified posteromedial approach. Albeit obtaining posterior malleolar fracture rigid fixation, syndesmotic instability was more prevalent than expected. The short-term complication rate was low.
Level of Evidence: Therapeutic level IV.

Introduction

Posterior malleolar fracture in the setting of rotational ankle fractures is a common pattern, with a reported incidence from 7% to 44% [1–4]. However, a subgroup of posterior malleolar fractures, also known as "posterior pilon variant," has recently gained popularity due to its poor prognosis [3]. This fracture pattern is thought to occur by a combination of rotation and axial load and typically occurring on female and elderly patients. Anatomically, a posteromedial fracture line compromises the posterior rim of the tibia and extends to the medial malleolus in some cases [5–7] (Fig. 1). Posterior pilon fracture can be suspected with standard ankle x-rays, by finding a double contour above the medial malleolus, sagittal metaphyseal split, double articular surface, metaphyseal triangle or articular impaction [6,8,9] (Fig. 2). In the presence of any of these signs, computed tomography (CT) scan is useful to confirm fracture pattern and improve surgical planning [10]. A large posteromedial fragment may alter the surgical approach, usually shifting from a posterolateral to a posteromedial or combined approach [8,11–13], changing the implant type to be used, and reconsidering reduction strategies [8,14,15].

Syndesmotic stability may be jeopardized as the posterior tibiofibular ligament is attached to the posterolateral malleolar fragment [16]. Restoring competence of the posterior tibiofibular ligament through rigid internal fixation should re-establish syndesmotic stability and prevent tibiofibular malreduction, both proven factors of poor prognosis. [17] Moreover, it has been described that direct reduction and fixation of the posteromedial fragment prevent chronic talar posteromedial subluxation and decrease the rate of articular surface malreduction [6,8,11].

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https://doi.org/10.1016/j.injury.2019.10.007
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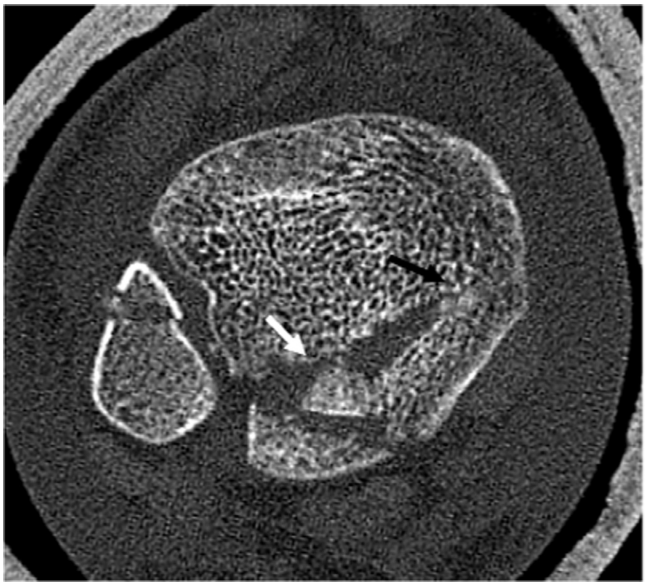

Fig. 1. Axial CT scan showing posteromedial fracture extension (black arrow) and articular comminution (white arrow).

Our objective is to describe a posterior pilon fracture consecutive case series and analyze patient and injury pattern characteristics, surgical technique, radiological results, and complications during follow-up.

Methods

After obtaining IRB approval, a consecutive case series study was conducted. We retrospectively reviewed 187 operatively treated ankle fractures at a level I trauma center from January 2013 to February 2015. We identified 70 trimalleolar fractures, of which 25 presented a fracture pattern compatible with posterior pilon fracture on preoperative 3-view x-rays. This fracture pattern presented a double contour above the medial malleolus, sagittal metaphyseal split, double articular surface or articular impaction. A CT scan demonstrating posterior tibial rim fracture extension from the fibular notch of the tibia to the medial malleolus confirmed the diagnosis. Patients were excluded from our study if they had previous ankle surgery, neuroarthropathic disease, incomplete imaging study or if they refused to participate. A patient chart review was conducted to collect basic demographic data, injury mechanism and fracture status (open vs closed fracture). Using preoperative radiographs, two senior foot and ankle surgeons classified fractures according to Lauge-Hansen and OTA classification. We documented surgical data, namely, surgical approach, posterior malleolar fixation and residual syndesmotic instability after posterior malleolar fixation. At the immediate postoperative period, reduction quality was evaluated by CT scan. Anatomic reduction was defined as any displacement (step or gap) less than 2 mm. If more displacement was observed, the case was classified as insufficiently reduced. We recorded any complication appearing during immediate or short-term follow-up (up to 1 year).

Descriptive analysis was conducted, data is summarized in median and frequency, and range is used as dispersion measurement.

Results

Demographics and classification

Radiographic analysis showed 70/187 (37.4%) trimalleolar fractures, of which 25/187 (13.4%) patients met the inclusion and exclusion criteria, with a mean age of 42 years (22–62). Of the patients, 19/25 (76%) were female and 6/25 (24%) were male. Median follow-up was 21.7 months (12–36). No open fracture was recorded in this study. This subgroup of fractures was analyzed and classified according to the Lauge-Hansen classification, 18/25 (68%) were supination external rotation (OTA 44-B), 4/25 (20%) were pronation external rotation, and 3/25 (12%) were pronation abduction (OTA 44-C). No cases of supination adduction (OTA 44-A) were observed in the study.

Surgical technique

A direct lateral approach over lateral malleolus was made in the first place in order to regain length and anatomically reduce and fix fibula in a standard fashion with an interfragmentary screw in amenable fractures and a posterolateral 1/3 tubular plate.

In order to access the posterior malleolar fragment, a modified posteromedial approach was used in 18/25 (72%) patients, through which the entire posterior plafond was visualized. The patient is positioned supine with hip flexed and abducted, knee fully flexed. A posteromedial incision is made curved anteriorly at the posterior third of the medial malleolus extending proximally 1 cm behind the posteromedial tibial border (Fig. 3). The flexor retinaculum is incised, avoiding damage to the posterior tibial tendon (PTT) sheath. The PTT is retracted anteriorly, and the flexor digitorum longus (FDL) along with the neurovascular bundle is retracted posterolaterally, protecting it. Fracture fragments are directly visualized, and the fracture hematoma is removed along with small osteocartilaginous fragments which could prevent reduction. This approach allows adequate exposure of both posteromedial and posterolateral fragments at the metaphyseal level, which is the key to get a precise reduction and fixation. After a K-wire provisional fixation, a definitive posteromedial fixation is made with an anterior-to-posterior (AP) position screw to prevent fragment sliding, adding a posteromedial buttress small fragment plate. An additional buttress plate or AP screw to the posterolateral fragment was used when a sagittal split was found (Fig. 4).

Syndesmotic stability was tested after osseous fixation via Cotton test [18] and direct syndesmotic visualization [12] of fibular abnormal displacement in lateral and/or anteroposterior direction. More than 2 mm displacement under stress test was considered abnormal and fixation guaranteed. After osseous fixation, syndesmotic instability remained in 11/25 patients requiring rigid syndesmotic fixation.

Reduction and follow-up

Reduction quality was assessed under CT scan in 19/25 (76%) patients. In this subgroup, 15/19 (78.9%) patients were anatomically reduced, while in 4/19 (21.1%), reduction was considered to be non-anatomic (Fig. 5). In these patients, posterolateral fragment step-off and rotation were responsible for fracture malreduction.

Overall, our complication rate was 28% (7/25). Superficial infection developed in 2/25 (8%) patients, healing uneventfully with oral antibiotics and dressing changes. In the short term, 5/25 (20%) patients presented with complications: two patients developed osteoarthritis, with one of them undergoing ankle arthrodesis. We observed two cases of posterior pilon nonunion, one of them was the patient who required an ankle arthrodesis and the other underwent revision surgery due to persistent pain. One patient presented with syndesmotic malreduction requiring syndesmotic fusion. One patient presented with complex regional pain syndrome.

Discussion

Posterior malleolar fracture frequency varies from 7% to 44% among all ankle fractures [1–4], and the posterior pilon variant

Fig. 2. Preoperative x-rays showing signs suggestive of posterior pilon fracture. (a) Double contour medially (white arrow) and metaphyseal triangle (black arrow). (b) Sagittal split. (c) Articular impaction. (d) Double articular surface.

subgroup is estimated to be between 6 and 20% [8,9,15]. This high variability can be partially explained by underestimation in the past [7]. Currently, we constantly perform an exhaustive examination of this fracture pattern, taking into consideration radiographic signs and patient risk factors like gender or age [9]. In our series, 13.3% of our operatively treated ankle fractures corresponded to posterior pilon fracture. In agreement with previous studies, female gender was more prevalent.

Posterior pilon fracture is hard to recognize on conventional radiographs. Surgeons must keep a high index of suspicion in the presence of a medial double contour [8], sagittal split [9], or double articular surface on the AP view and/or in the presence of articular impaction on the lateral view [19,20]. Also a metaphyseal triangle can be seen in the AP view, representative of a Volkmann fragment. Irwin et al. and others [21,22] recommended that all ankle fractures with posterior malleolus fracture must undergo CT scan examination. Concordantly, we believe that a CT scan should be obtained if any of the described signs are present to better understand the fracture pattern and perform an adequate surgical planning.

There is limited evidence describing the relationship between ankle fracture patterns and posterior malleolar fracture occurrence. Switaj et al. [9] did not encounter any association to a specific Lauge-Hansen or AO/OTA classification. However, like in this series, no patient presented a supination adduction pattern. We found that supination external rotation was the most frequent pattern in our study, probably explained by the fact that this pattern is the most frequent mechanism in developing ankle fractures. Pronation

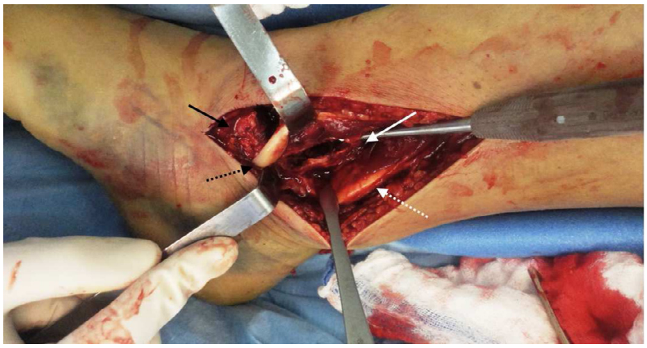

Fig. 3. Posteromedial approach. Key anatomic elements are visualized. Medial malleolar fragment (black arrow), posterior tibialis tendon (dotted black arrow), posterior malleolar fragment (white arrow), and flexor digitorum longus (dotted white arrow).

with external rotation or abduction exhibited an equal distribution in this investigation.

Several approaches for posterior pilon fracture fixation can be attempted [22]. According to our results, most posterior pilon fractures can be anatomically reduced using a modified posteromedial approach. There were 7 cases on which a different approach was preferred (posterolateral), election based at the surgeon's discretion, mainly when a posteromedial fragment was considered unfixable (size or comminution). Klammer et al. [6] proposed a posterolateral approach, arguing that both posterolateral and posteromedial tibial fragments can be safely fixed under this view. In contrast, we propose a modified posteromedial approach [14], because an adequate exposure to the medial posterior tibial rim can be obtained and directly reduce the posteromedial fragment, which is the key morphologic element of this fracture pattern [13]. From this same approach, the posterolateral fragment can be reached as well, and reduction is guided by metaphyseal fracture lines of this triangle. One limitation of these surgical strategies is that direct articular surface visualization is not possible after reduction. Moreover, we believe that, if fibular fixation is

Fig. 5. Mal-reduced posterior pilon fragment due to fragment sliding.

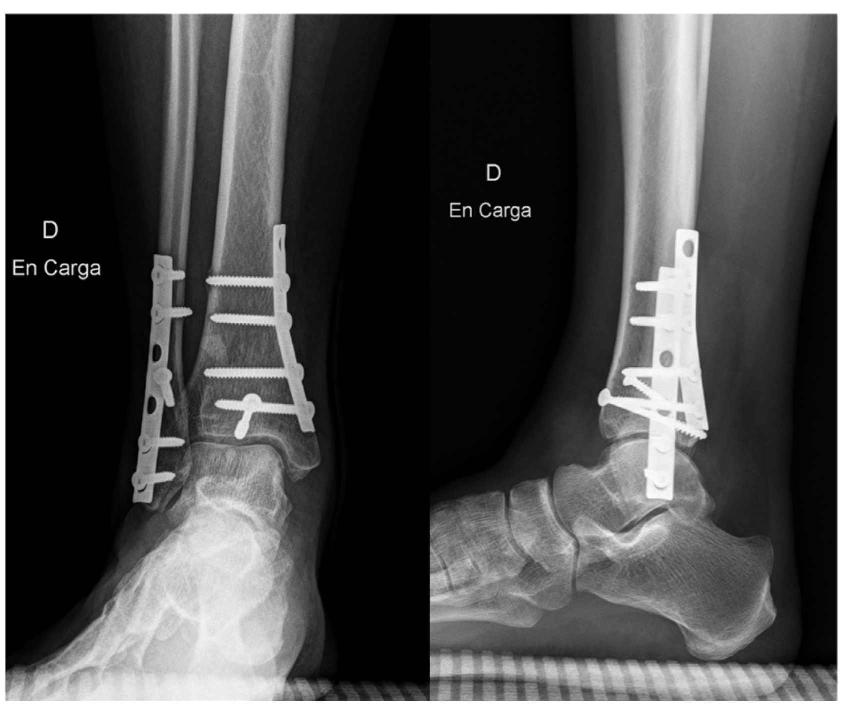

Fig. 4. Posteromedial fragment plate fixation plus an AP screw for posterolateral fragment.

warranted, limited dissection through an additional lateral approach can be easily performed in the supine position in contrast to the extended posterolateral approach dissection. Careful posterolateral fragment positioning cannot be overemphasized when reducing it from a posteromedial approach, which is a frequent source of malreduction. Chances of achieving anatomic reduction are greatly influenced by adequate fracture cleaning and fibular reduction due to their attachment through syndesmotic ligaments.

Posterior fragment fixation in trimalleolar ankle fractures can be accomplished with buttress plates or lag screws. Indirect reduction and fixation with an AP screw is not always feasible due to periosteal or hematoma interposition and/or fracture callus formation on delayed treatment [23] frequently producing mal-reduction. On the other hand, posterior direct reduction and buttress plate fixation are attractive alternatives to attempting anatomic reduction. Results of comparing both techniques concluded that no differences were observed in articular range of movement or AOFAS score at 38 months' follow-up [24]. We utilized standard small fragment plates and screws for posterior fragment fixation. An additional posterolateral fragment buttress plate or AP lag screw was used when a posterior fragment sagittal split was found. It is interesting to note that 1/3 of posterior pilon fractures in our series did not exhibit dissociation between both fragments, making them amenable to unilateral fixation after reduction.

The posterolateral fragment is attached to the posterior tibiofibular ligament. Therefore, reduction and rigid fixation should indirectly result in syndesmotic stabilization [15,16]. Even though posterior malleolar fixation was accomplished, syndesmotic instability still remained in 11/25 patients. This is an interesting finding that could be explained by several reasons. First of all, operatively treated ankle fractures are, by definition, less stable and associated with a higher rate of syndesmotic injury, with reports as high as 39% to 45% [25–27]. Then, considering posterior pilon fracture as a different entity than a typical rotational ankle fracture, with presumably more extensive damage due to higher involved energy, could help explain that our study group resulted with a higher syndesmotic instability, reaching the higher documented values. Another interesting issue is diagnosis method. Classically, diagnosis of syndesmotic instability is made by intraoperative fluoroscopic imaging, which has poor sensitivity [28] and could make many syndesmotic injuries go unnoticed. With direct syndesmotic visualization [12] there is a higher probability of finding residual instability. Finally, another aspect that could be influencing residual syndesmotic instability is the high rate of posterior fragment malreduction, mainly dependent on Volkmann fragment in our series, which could have negatively influenced syndesmotic fibular reduction and consequently contributed to our high syndesmotic instability rate.

The major limitations of this study include the retrospective and descriptive nature of our study, which prevent us to draw any definitive conclusion. There were also multiple surgeons involved in patient care, wherein the surgical strategy was at the surgeon's discretion. Functional outcomes were not assessed, and a longer follow-up is needed to seek for post-traumatic degenerative changes.

The strengths of this study is that it is one of the largest posterior pilon series published, with a detailed demographic and fracture type analysis, didactic surgical procedure description and postoperative CT-scan in a large group of patients which allowed us to recognize mal-reduction and most typical fragments responsible for it.

Conclusion

In conclusion, posterior pilon variant represents a distinct entity when compared to ankle fractures. We found a relative frequency of 13.3%, lower than was previously described. Surgeons must keep a high index of suspicion in the presence of suggestive radiographic signs or female patients. Most fractures can be anatomically reduced thorough a modified posteromedial approach. Attention must be paid to anatomic posterolateral fragment reduction and syndesmotic residual instability, which are intimately related and we found to be elements frequently found during this type of fracture management. We believe surgical strategies must attempt direct visualization, reduction, and fixation of posteromedial fragment due to absence of ligamentous attachments, making ligamentotaxis impossible. Significant short-term complications are to be expected, but longer follow-up is needed to better understand posterior pilon prognosis.

Declaration of Competing Interest

None of the authors received payments or services, either directly or indirectly (i.e., via his or her institution), from a third party in support of any aspect of this work

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