Direct fixation of fractures of the posterior pilon via a posteromedial approach

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\section*{Abstract}

The treatment of fractures of the posterior pilon is a timely issue. Restoration of the integrity of the incisura fibularis and subsequent anatomic reduction of the fibula are essential for reconstruction of the ankle mortise after trauma, and syndesmotic stability. Inappropriate treatment ultimately will lead to a poor functional outcome and quality of life. Open reduction and direct internal fixation through a posterolateral or posteromedial approach are increasingly preferred over indirect reduction and anteroposterior screw fixation. The posteromedial approach, although elegant, straightforward, and offering an excellent exposure of the fracture site, is used less frequently than the posterolateral approach. In this technical note we describe the posteromedial approach for the treatment of posterior pilon fractures in a step-by-step fashion. We will discuss the indications, its benefits and limitations.

\section*{Introduction}

Ankle fractures comprise approximately 9\% of all fractures [1]. A fracture of the posterior distal tibia occurs in about 46\% of Weber type B or C ankle fracture-dislocations [2]. These posterior fractures are usually referred to as posterior malleolar or posterior pilon fractures [3–6]. The distinction between posterior malleolar fractures and posterior pilon fractures is a matter of convention and it was suggested that fragments comprising more than 50\% of the tibial incisura are considered as posterior pilon fractures [7]. Going back to a small series from 1940 [8], fragments of more than 25\% of the posterior articular surface of the distal tibia in the sagittal plane have been treated operatively [4]. New insights into the anatomy, treatment and outcome of such fractures, however, have questioned this recommendation [5,7].

Recently, the treatment of both posterior malleolus and pilon fractures has gained increasing attention. Small fractures of the posterior tibial rim were frequently ignored or fixed using an anteroposterior lag screw without appropriate reduction with inferior results [9,10]. Fixation of the posterior malleolus is important for the syndesmotic stability; it restores the integrity of the incisura fibularis tibiae and facilitates anatomic reduction of the fibula [3,11]. Moreover, there is increasing evidence for the important role of the posterior malleolus in the development of post-traumatic osteoarthritis [12]. With a displaced posterior malleolus, the center of stress shifts anteriorly and medially at the articular surface [13]. Subsequently, malunited posterior malleolar fractures will lead to a poor functional outcome and poor quality of life [10]. There is no consensus yet regarding the exact size of posterior malleolar fragments that warrant open reduction and internal fixation (ORIF) [5,14,15]. Fragments larger than 5\% of the tibial talar articular surface with an articular step-off of at least 1 mm, more often progress towards osteoarthritis then those without a step-off [16].

Bartonicek et al. [7] introduced a classification of A0 type 44 posterior malleolar fractures based on CT scanning in transverse, sagittal and frontal planes, and 3D CT reconstruction. This classification mainly relates to involvement of the incisura. They recommend ORIF for all large posteroslateral triangular fragments, any displaced intercalary fragments, smaller posteroslateral fragments with displacement of the incisura, and posteroomedial two-part fragments. To achieve this, ORIF through a posteroslateral or posteromedial approach is usually required [17,18].

Since the posteromedial approach is used less frequently but may be very useful especially for posteroomedial fragments, in this technical note we will discuss the indications, technique, benefits, and limitations.
Posteromedial approach

1. Preoperative CT imaging of the fracture configuration, comminution, displacement and impaction is necessary for the planning the surgical approach and technique of fixation (Fig. 1).

2. The patient is put in a prone position while a cushion is placed under the foot to optimize the access to the posteromedial aspect of the ankle (Fig. 2). Before skin incision, a surgical tourniquet is used on the thigh to prevent excessive bleeding and allow for adequate visualization during surgery.

3. The skin incision starts 3 cm above the calcaneal tuberosity, halfway between the Achilles tendon and the posterior edge of the medial malleolus, running approximately 10 cm straight upwards along the posteromedial aspect of the distal tibia (Fig. 3). The proximal end of the incision is determined by the metaphyseal extension of the injury. Care should be taken not to cut too close to the Achilles tendon for the sake of skin devascularization and wound healing problems.

4. A wound retractor is set in place in order to excerpt a constant pull on the subcutaneous tissue. Dissection continues from the superficial posterior compartment towards the deep posterior compartment, longitudinally dissecting the transverse intermuscular septum (Fig. 4). It is of utmost importance to avoid dissection of or damage to the Achilles tendon by limiting dissection to the peritendineal tissue of the Achilles tendon.

5. The interval between the neurovascular bundle, containing the tibialis posterior artery and nerve, and flexor hallucis longus muscle is exposed. The flexor hallucis longus muscle is retracted laterally and the neurovascular bundle medially. The fat tissue envelope surrounding the neurovascular bundle is left intact to avoid damage through pressure or traction (Fig. 5).

6. After incision of the periosteum, the fracture fragments are mobilized. The tibiotalar joint and incisura fibularis tibiae are partially exposed and small intercalary fragments are either reduced or resected, depending on size and cartilage cover. Subsequently, the cortex is reduced using a raspatorium and temporarily fixed with one or two K-wires and the reduction is verified with standard fluoroscopy (Fig. 6).

7. Finally, a buttress plate (2.7 mm VA-LCP, DePuy Synthes, Zuchwil, Switzerland) is applied to the posterior tibial rim and held in place with an additional K-wire. The posterior pilon fracture is then stabilized using cortical screws through the plate. After determining the final reduction, the K-wires are removed and the long (subchondral) lag screws are replaced by shorter locking screws (Fig. 7).

8. After fixation of the posterior pilon, stability of the tibiofibular syndesmosis is tested with external rotation or the hook test. In most instances, bony fixation of the strong posterior syndesmosis will lead to syndesmotic stability [3,11,20]. If instability persists due to rupture of the anterior and

Fig. 1. Preoperative CT images of a patient with a posterior pilon fracture: intercalary fragment and incongruence of the incisura fibularis tibiae. axial view (A), sagittal view (S), coronal view (C).
Fig. 2. The Patient is positioned prone (A). An asymmetrical cushion (B) is placed under the injured ankle in order to facilitate intraoperative fluoroscopy. Optimal access is assured by slight outward rotation of the leg.

Fig. 3. (A) Skin incision. Surgical anatomy of the posteromedial ankle [19].
intersosseous tibiofibular ligaments, a syndesmotic screw is placed. Anatomic reduction and implant position are controlled fluoroscopically (Fig. 8).

9. The wound is closed in a single-layer using skin staples (Fig. 9).

Fig. 4. Dissection of the subcutaneous tissue exposing the transverse intermuscular septum.

Fig. 5. (A) The neurovascular bundle (arrowheads) the posterior tibial artery and tibial nerve embedded in fat tissue is running along the medial board of the flexor hallucis longus (FHL) muscle and tendon. (B) The FHL is retracted laterally while the neurovascular bundle is retracted medially thus exposing the posterior malleolar fracture.

Fig. 6. (A) Direct exposition of the fracture site with the intercalary fragment. (B, C) Temporary fixation of the reduced posterior pilon fragments with K-wires.

Fig. 7. (A, B) Fixation of the posterior pilon with a variable angle locking compression plate.
Discussion

Over the last decades, treatment of posterior pilon fractures has evolved with the development of different surgical strategies and approaches [3,5,7,11,14,17,21]. The approach is mainly determined by the individual pathoanatomy of the articular injury, options for stable internal fixation and injuries accompanying the ankle fracture (i.e. ruptures of the deltoid ligament, the anterior or posterior tibiofibular ligament, and fibular fracture). The more complex the fracture pattern, the greater the need for an approach that visualizes more than one column (i.e. lateral, posterior and medial). Two main posterior approaches are described in the literature: the posteromedial and posterolateral approach [3,22–25].

The posterolateral approach is a relatively common approach and allows a surgeon to treat fractures of the posterior pilon simultaneously with distal fibular fractures through a single incision [25]. Especially in case of a small posterolateral fragment of the posterior pilon, this approach has proven to be very useful. Postoperative wound complications are rare due to the extensive overlying soft tissue envelope consisting of the FHL and peroneal muscles. However, attention should be paid to the sural nerve when performing dissection of the subcutaneous tissue [11,17,25]. One study reported a 4% rate of stage 1 complex regional pain syndrome using a posterolateral approach [26]. The major drawback however is the inability to obtain a complete overview over the posteromedial pilon and adequate reduction and fixation of posteromedial fractures or fractures with an extension into the medial malleolus (Bartonicek & Rammelt type 3 [7]).

Fig. 8. Immediate postoperative lateral (A) and anteroposterior radiographs (B).

Fig. 9. Wound closure with skin staples.

Fig. 10. Schematic overview of the vascularization of the soft tissue envelope surrounding the ankle modified from Aubry and Fieve [30]. 1, perfusion area of the anterior tibial artery; 2, perfusion area of the posterior tibial artery; 3, perfusion area of the peroneal artery; 4, anterior peroneal artery; 5, posterior peroneal artery; 6, posterior tibial artery; 7, anterior tibial artery.
The posteromedial approach provides a good overview of both smaller and larger posterior pilon fracture fragments with medial extension. A direct access to the joint surface of the posterior pilon and adjacent incisura fibularis tibiae is obtained, which facilitates direct reduction of intercalary fragments [27,28]. The posteromedial approach has also been described for the treatment of fractures of the posterior talar body and posterior process of the talus [19]. In contrast to the posterolateral approach, when using the posteromedial approach care has to be taken to spare the deep neurovascular bundle containing the posterior tibial artery and tibial nerve (Fig. 10) to prevent neurovascular damage and postoperative complications [29,30]. Although the posteromedial approach is fairly straightforward, Cronier et al. [22] cautioned against soft tissue problems resulting from comprised tendons and neurovascular bundle by scar tissue. The major limitation of the posteromedial approach, however, is the inability to treat fractures of the lateral malleolus or the distal fibula through the same incision in the presence of bimalleolar and trimalleolar fractures.

Assal et al. [31] proposed a modified posteromedial approach for the treatment of complex pilon tibial fractures, which provides visualization from medial to lateral and allows access to the entire posterior pilon and distal fibula. As the authors state, extensive soft tissue damage is prevented through this approach since it runs through intermuscular planes instead of the standard internervous approach [31].

There are multiple applications for the posteromedial approach in posterior pilon fractures. In the first place, the posteromedial approach is a very elegant approach for the treatment of small posteromedial or medially extended posterior pilon fractures. It should be particularly considered in the absence of fibular fractures and for posterior malleolar fractures accompanied by excessive ligamentous injury with substantial lateral talus shift and laterally displaced fibular fractures, which require additional lateral buttressing. It is furthermore useful for revision surgery in cases of inadequately reduced or secondary displaced posterior pilon fractures resulting in malunion and nonunion; and patients with severely comprised soft-tissues around the lateral aspect of the ankle.

In summary, the posteromedial approach is elegant and straightforward in the treatment of posteromedial pilon fractures, posterior malleolar fractures with medial extension and/or intercalary fragments. Moreover, the postoperative complications are limited provided that the posteromedial neurovascular bundle is respected.

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References
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