Complex Ankle Fractures

Practical Approach for Surgical Treatment

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KEYWORDS

• Posterior tibial malleolus • Pilon • Tibial plafond • Posterior surgical approach
• Posteromedial approach • Modified posteromedial approach • Trimalleolar fractures
• Cuadrimalleolar fractures

KEY POINTS

- Complex ankle fractures are challenging, especially the surgical planning.
- Preoperative planning with a computed tomography axial view is mandatory to decide the surgical approach and patient positioning.
- Of the posterior tibial plafond, 40%, 64%, and 91% are visualized with the posterolateral, posteromedial, and modified posteromedial approaches, respectively.
- For decision making process, we suggest dividing the ankle into 4 areas: posterior malleolus, medial malleolus, lateral malleolus, and Chaput and/or Wagstafe fragments (supine position).
- Depending on the fracture location we suggest the following surgical approaches: posterolateral approach (posterolateral malleolus and fibula), posteromedial approach (posteromedial malleolus, medial malleolus), modified posteromedial approach (posteromedial and posterolateral malleolus, medial malleolus), medial approach (medial malleolus fracture), and anterolateral approach (Chaput tubercle and anteromedial aspect of the fibula (Wagstaffe fragment).

INTRODUCTION

Since Coppers in 1822 first described trimalleolar fractures, many articles have been published.[1–3] Anatomic reduction in complex ankle fractures is a demanding challenge. High risk of post-traumatic arthritis was observed in complex trimalleolar fractures compared with unimalleolar fractures.[4–6] Lower

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Foot Ankle Clin N Am ■ (2020) ■–■
https://doi.org/10.1016/j.fcl.2020.08.002 foot.theclinics.com

functional outcome was found in trimalleolar fractures when compared with unilateral or bilateral.[3] Patient positioning (supine or prone) and the surgical approach depend on the compromise of anterolateral Chaput tubercle or anterior fibular Wagstaffe fragment.

Compromise of the posterior column in ankle fractures rates are from 7% to 44%.[4] Major concerns about the importance of anatomic reduction of the posterior pilon in complex ankle fractures are increasing in literature. Anatomic reduction of the posterior malleolus is very important to stabilize the inferior tibiofibular syndesmotic complex.[3]

Computed tomography (CT) scanning is mandatory to classify and define the most useful access to the posterior plafond.[7] Bartonicek and colleagues,[8] Mason and colleagues,[9] and Haraguchi and colleagues[10] have described and classified posterior malleolar fractures. Axial CT scans allows us to determine not only the size and number of fragments, but also to define the most useful approach and patient positioning.

PLANNING

Correct preoperative planning is necessary for a good result. AP and lateral views of the ankle mortise are always indicated, but a CT scan (axial view) is mandatory because some posterior fractures may be overlooked.[4,7,11–14] Donohoe and colleagues[7] demonstrated that the use of a preoperative CT scan changed 52% of fracture identifications and in 44%, the surgical approach and patient positioning. Palmanovich and colleagues[15] found that primarily indication change after reviewing previous radiographs with CT scans.

Simple posterior malleolar fractures can be reduced with ligamentotaxis and fixed with anteroposterior screws; however, this method has some limitations. It is technically challenging to achieve anatomic reduction by fluoroscopy, and screw fixation may be difficult in small posterolateral fragments.[16] A large number of publications support direct visualization and anatomic reduction of the posterior malleolus through a posterior approach to obtain a good functional outcome.[4,17]

The posterolateral approach is useful in most cases showing posterior compromise.[18,19] However, when there is a large and split fracture of the posterior fragment, the medial aspect of the fragment is very difficult to access from this incision.[20,21] In this case, the combination of a posterolateral and a posteromedial approach is required. The modified posteromedial (MPM) approach was described to decrease the risk of complications and facilitate the reduction of the posterior malleolus.[4]

Assal and Dalmau Pastor[22] compared the percentage of exposure of the posterior plafond using 3 different approaches: posterolateral, posteromedial, and MPM. With the posterolateral approach, 40% of the surface could be visualized. From a posteromedial approach, 64% could be seen, and 91% of the plafond can be visualized from an MPM approach. Meulenkamp and colleagues[12] demonstrated that 99% of posterior plafond could be exposed using the MPM approach.

Some surgeons preferred to combined different approaches changing patient position because there are fewer anesthesia complications,[23] a decreased fluoroscopic exposure, and better visualization of the medial malleolus. However, recent anatomic publications allow the combination of posterolateral and MPM approaches with the patient in prone position to reduce and fixed most of the malleolar fractures diminishing soft tissue complications. In certain cases, when there is an anterolateral Chaput fragment or anteromedial fibula Wagstafe fragment, the patient should be changed to a supine position.

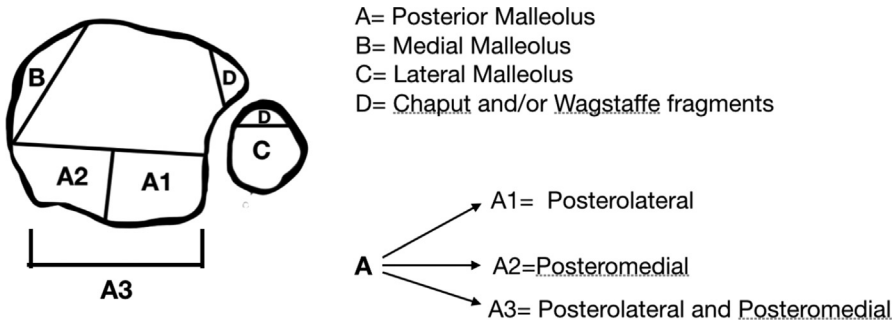

Fig. 1. Ankle CT axial view schematic illustration. Fragments are organized, as shown in the diagram.

In our experience, the ankle is divided into 4 areas on a CT axial view (Fig. 1):

A. Posterior malleolus (A1-A2-A3)
B. Medial malleolus
C. Lateral malleolus
D. Chaput and/or Wagstafe fragments (supine position)

Fractures line splits the posterior malleolus (A) into 3 types: A1 posterolateral, A2 posteromedial, and A3, both posterolateral and posteromedial.

SURGICAL TECHNIQUE

Different approaches are indicated depending on the fracture pattern. The posterior malleolus has to be approached first. If there is a split fracture, the posteromedial fragment has to be debrided and freed of periosteum and fixed in the first place, followed by the posterolateral fragment from a single MPM approach. When the compromise is posterolateral, the fibula can be fixed from the same posterolateral approach. If a medial approach is necessary, it could be done in the same prone position.

We suggest operating in a supine position when there is an anterior component that cannot be addressed from posterior as in Wagstaffe or Chaput type of fractures. As a helpful guideline, we suggest different approaches depending on the fracture pattern (Fig. 2).

Posterolateral Approach

The patient is placed in a prone position, with a bump under the ipsilateral hip, under combined lumbar plexus–sciatic nerve block anesthesia. A pneumatic tourniquet is applied to prevent bleeding. The skin incision is made between the lateral malleolus's posterior edge and the lateral aspect of the Achilles tendon. The sural nerve runs from medial to lateral and crosses the lateral aspect of the Achilles tendon, on average, 9.83 cm proximal to its insertion in the calcaneus.[24] The anatomy of the sural nerve is variable. To avoid nerve injuries, the nerve must be identified and protected throughout the procedure. After fasciotomy, dissection is performed between the peroneal tendons and the flexor hallucis longus. Now, the lateral aspect of the posterior plafond is exposed. When fixing posterolateral malleolus, the peroneal tendons are retracted laterally and flexor hallucis longus muscle medially. When fixing the fibula, the peroneal tendons are retracted medially (Fig. 3).

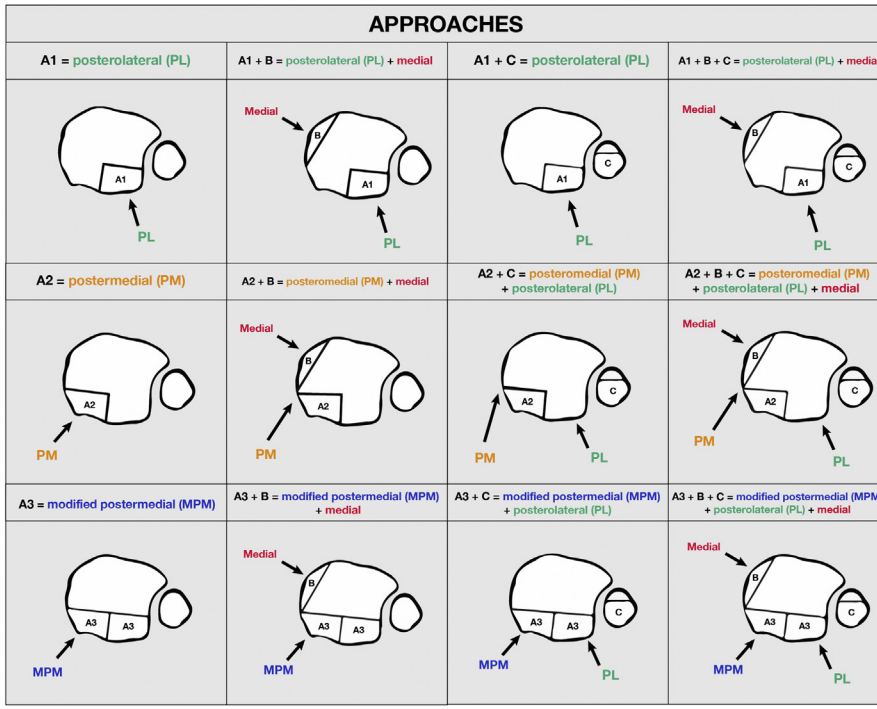

Fig. 2. Based on the fragments involved, a surgical approach proposal is presented.

Posteromedial Approach

With the patient in the prone position, under combined lumbar plexus–sciatic nerve block anesthesia, the incision is made along the posterior tibialis tendon. After the tendon sheaths are incised, the flexor digitorum longus is retracted laterally, protecting the neurovascular bundle, and the posterior tibialis tendon is mobilized and subluxated medially, allowing the visualization of 64% of the posterior plafond.[22] If a medial malleolus fracture is associated, the skin incision is extended distally, the posterior tibial tendon (TP) and flexor hallucis longus are retracted laterally. The fracture is exposed, debrided, and fixed (Fig. 4).

Modified Posteromedial Approach

With the patient in a prone position, under combined lumbar plexus-sciatic nerve block anesthesia, the skin incision is made 1 cm medially to the Achilles tendon, approximately 10 cm in length. The Achilles tendon, flexor hallucis longus, tendon and muscle belly are retracted laterally. The neurovascular bundle is dissected and moved medially, allowing exposure of 91% of the posterior tibial plafond.[22] From this side, platting of the posteromedial and posterolateral fractures is performed. If a medial malleolus fracture is associated, the skin incision is extended distally, and the TP, flexor digitorum longus, neurovascular bundle, and flexor hallucis longus are retracted laterally, allowing good visualization of the medial malleolus (Fig. 5).

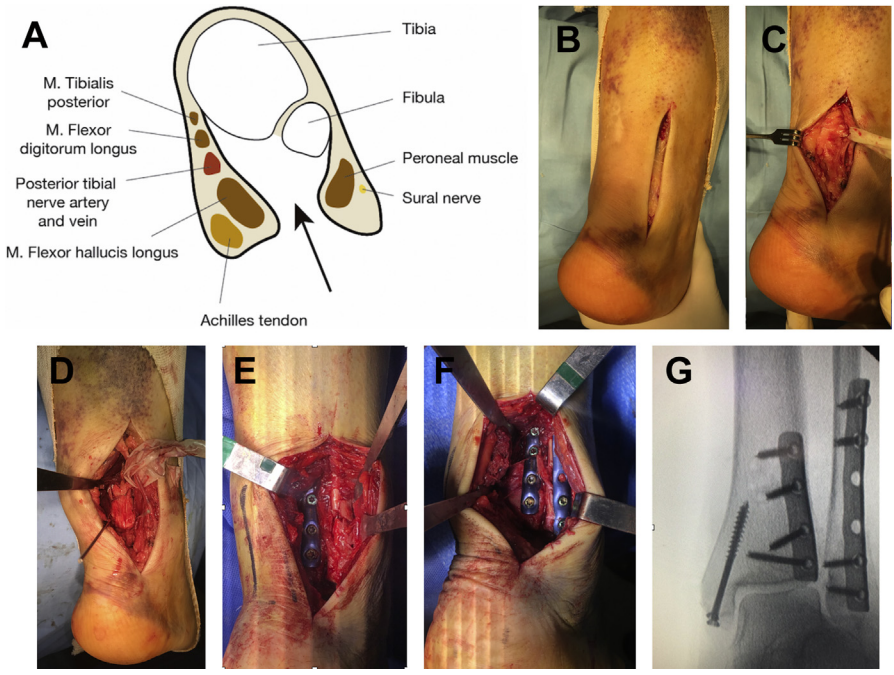

Fig. 3. Posterolateral approach: anatomic considerations. (*A*) A skin incision is made between the posterior edge of the lateral malleolus and the lateral aspect of the Achilles tendon. (*B*) Identify the peroneal tendons fascia and sural nerve. (*C*) Dissection is performed: the flexor hallucis longus medially, Peroneal tendons, and sural nerve laterally. Temporary fixation of the posterolateral fragment. (*D*) The posterolateral malleolar fragment is fixed using screws and buttress plate. (*E*) The posterolateral malleolar fragment and fibula are fixed. (*F*) Postoperative radiographs after open reduction and internal fixation of the posterolateral malleolar fragment and lateral malleolus. In the same patient from a medial approach, we made an open reduction and internal fixation of the medial malleolus with 2 screws (*G*).

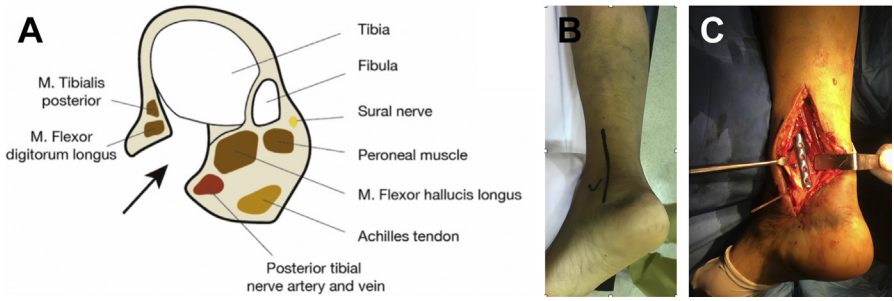

Fig. 4. Posteromedial approach. Anatomic considerations. (*A*) The incision is made along the posterior tibialis tendon. (*B*) The flexor digitorum longus is retracted laterally protecting the neurovascular bundle. Open reduction and internal fixation of the posteromedial malleolar fragment with buttress plate and lag screws (*C*).

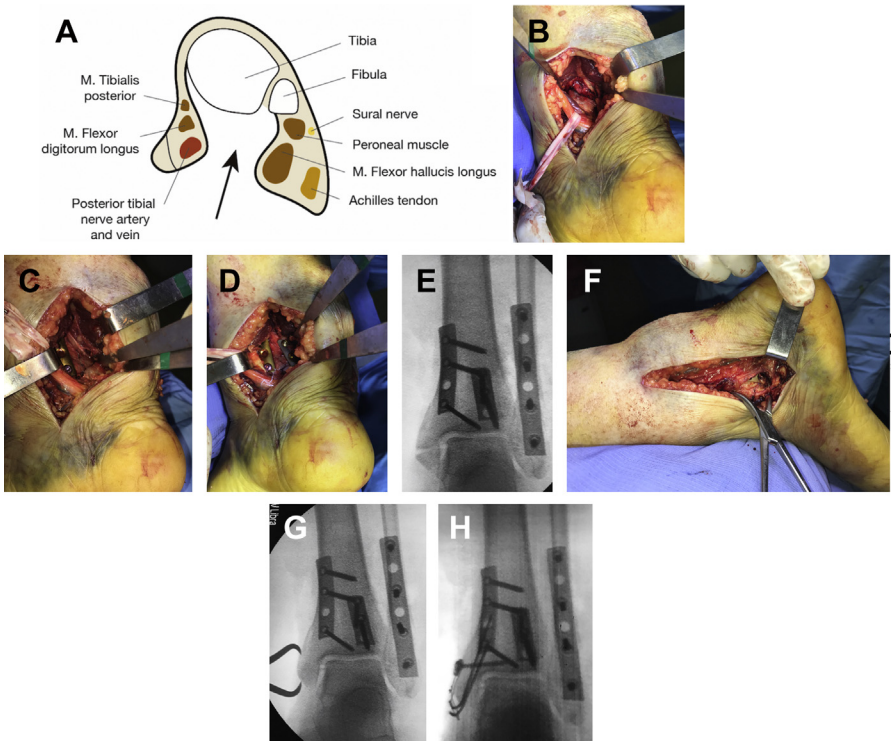

Fig. 5. MPM approach. Anatomic considerations. (*A*) Skin incision between the medial malleolus and the Achilles tendon. The neurovascular bundle is moved medially and the flexor hallucis longus laterally. (*B*) Open reduction and internal fixation of the posteromedial malleolar fragment and visualization of the posterolateral malleolar fragment. (*C*) After fixing the posteromedial malleolar fragment, we fixed the posterolateral malleolar fragment. (*D*) Fluoroscopy showing an accurate reduction of the posteromedial malleolar fragment, posterolateral malleolar fragment, and fibula. Associated medial malleolus fracture. (*E*) Same approach (MPM approach); the TP, flexor digitorum longus, neurovascular bundle, and flexor hallucis longus are retracted laterally. Reduction of the medial malleolus with a clamp (*F*). Fluoroscopy showing reduction of medial malleolus (*G*). Fluoroscopy showing a tension band for medial malleolus fracture (*H*).

Medial Approach

The patient is placed in the prone position. Although the prone position can make open reduction and internal fixation of the medial malleolus more challenging, the medial malleolus is generally the easier of the malleoli to reduce and fix.

A 4- to 5-cm long skin incision is made. Care should be taken not to damage the saphenous vein, which is retracted anteriorly. Periosteum and hematoma should be removed from the fracture site. Internal fixation of the medial malleolus is made after anatomic reduction of the articular surface is obtained (Fig. 6).

Anterolateral Approach

The patient is placed in a supine position. An anterolateral incision is made following the anterior border of the fibula. The superficial peroneal nerve is dissected and retracted laterally and peroneus tertius tendon medially. This incision allows excellent

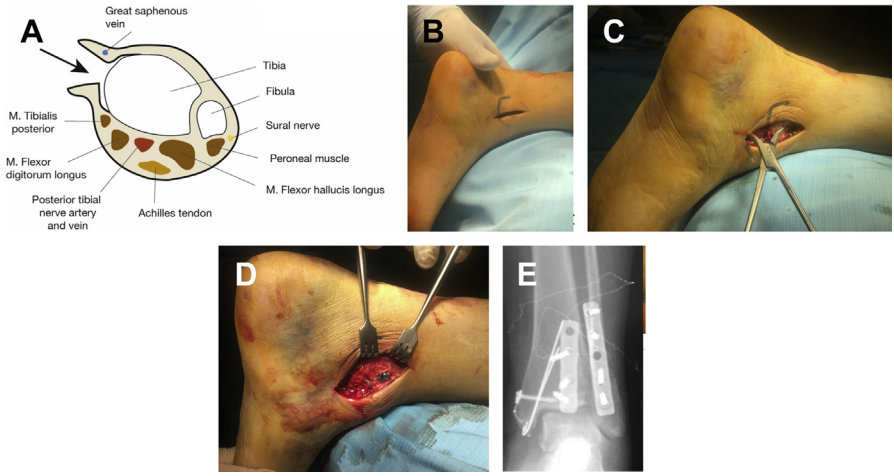

Fig. 6. Medial approach. Anatomic considerations. (*A*) A 5-cm skin incision (prone position) is made. (*B*) Reduction of the medial malleolus with a clamp. (*C*) Tension band for medial malleolus fracture. (*D*) Postoperative radiographs after open reduction and internal fixation of the posterior and lateral malleolus (*E*).

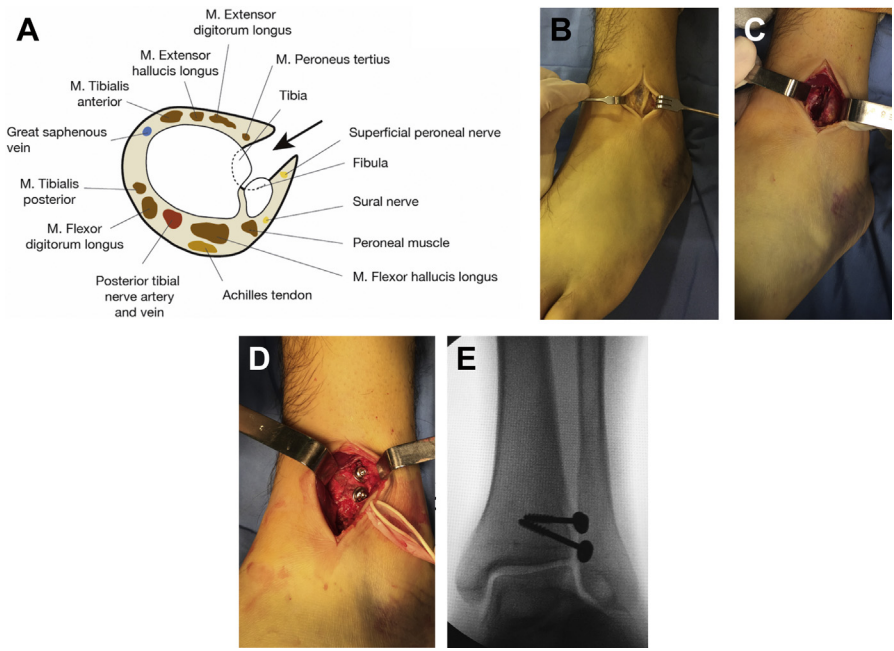

Fig. 7. Anterolateral approach. Anatomic considerations. (*A*) Anterolateral skin incision following the anterior border of the fibula. Retracted superficial peroneal nerve laterally. (*B*) Identification of a Chaput fracture. (*C*) Anatomic reduction with anteroposterior screws fixation (*D*). Postoperative mortise radiographs (*E*).

visualization of either the Chaput tubercle and anteromedial aspect of the fibula (Wagstaffe fragment) (Fig. 7).

Postoperative Care

It is important to protect the fracture with a nonweightbearing splint for 2 weeks owing to tendon retraction in plantar flexion. Patients are encouraged for early mobilization, and partial weightbearing is authorized at 6 weeks. Full weightbearing is allowed at 8 weeks.

SUMMARY

Anatomic reduction of the posterior malleolus is mandatory for a good functional outcome. Preoperative planning with a CT scan's axial view helps to decide which approach and surgical position we should choose. Based on posterior malleolus fracture anatomy, a guideline is suggested to facilitate decision making on which approach seems to provide the best exposure with the fewest complications.

CLINICS CARE POINTS

- The posterolateral approach is useful when there is a posterolateral compromise of the tibia and most of the fibula fractures.
- An MPM approach allows the visualization of more than 90% of the posterior malleolus.
- The supine position is indicated when there is an anterior compromise of the tibia or fibula.

DISCLOSURE

The authors do not have any relationship with a commercial company that has a direct financial interest in subject matter or materials discussed in this article or with a company making a competing product.

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