CHAPTER **8**

MEDIAL MALLEOLAR FRACTURE FIXATION

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Medial injury to the ankle can occur in any of the Lauge-Hansen fracture classifications. It can present as a deltoid ligament injury, fracture of the medial malleolus, or a combined injury. The medial malleolus fracture can be an isolated injury but is more commonly associated with a fracture of the fibula resulting in a bimalleolar fracture. There can also be an associated fracture of the posterior malleolus producing a trimalleolar fracture. This article will focus on fracture of the medial malleolus.

The medial malleolus is the distal medial extension of the tibia. It is divided into the anterior and posterior colliculus. On the lateral surface is an articular facet that abuts against the corresponding comma-shaped facet on the medial aspect of the talus. The anterior and posterior colliculus are separated by the inter-collicular groove on the lateral aspect. To simplify the ligamentous anatomy, the superficial deltoid ligament is attached to the anterior colliculus and the deep deltoid ligament to the posterior colliculus and inter-collicular groove (1-5).

When the medial malleolus is fractured, its configuration is dependent on the mechanism of injury. In supination-adduction injuries, the medial malleolus fracture is superiorly oriented. It may be obliquely directed upward or become vertical in nature. It is the result of inversion of the ankle so that the talus impacts the medial malleolus resulting in a push-off type fracture. In supination-external rotation, pronation-abduction, and pronation-external rotation fractures, the medial malleolus fracture tends to be transverse in configuration. It is a pull-off type fracture (4-6). Herscovici has described the different medial malleolar fracture patterns (7). Based on AO principles, the medial malleolus fracture is traditionally addressed after reduction and stabilization of the fibular fracture. However, when there is a comminuted facture of the fibula, it is actually advantageous to reduce and fixate the medial malleolus first as this produces a stable medial buttress, which allows more stability when manipulating the fibular fracture.

If the fracture of the medial malleolus is transverse, it can present several variations in configuration. This variation in orientation can require different fixation scenarios. The medial malleolus is easily exposed surgically as it is very superficial. The surgical approach can be anteromedial, directly medial, or posteromedial. The fracture begins at the superomedial aspect of the ankle joint involving the junction of the medial malleolus and distal tibia at the medial bend. It then propagates in a posterior direction. The fracture line may extend directly posteriorly creating a large fracture component that will include both the anterior and posterior colliculus. This represents a significantly sized fracture fragment, which makes reduction and fixation less complicated. It is typically approached through a hockey-sticked shaped incision anterior and inferior to the medial malleolus. This approach allows easy access to evaluate the medial aspect of the ankle joint, removal of osteochondral fracture fragments, debride the fracture site, check the posterior tibial tendon, reduce the fracture, and place internal fixation. It is common for periosteum to be entrapped within the fracture site, which requires removal prior to attempting reduction.

The medial malleolus fracture is then manipulated, anatomically reduced, and held provisionally with pointed reduction forceps. Through this approach, the fracture reduction may be assessed anteriorly, medially, and posteriorly. There are two tricks that can assist in the reduction. The first is to place the leg on a bump so that the heel is off the operating table. This allows the foot to sag posteriorly pulling the medial malleolus fracture fragment closer to the tibia. If this is not done, the foot resting on the operating room table has a tendency to push the medial malleolus forward. The second is to place a drill hole in the tibial metaphysis above the fracture so that one side of the pointed reduction forceps can be placed into it. Otherwise, the reduction forceps many times just slides along the medial aspect of the tibia. Place the forceps so that it is in the middle of the medial malleolus. This frees up space for placing one lag screw in the anterior and a second one in the posterior aspect of the medial malleolus. Guide pins can then be inserted for additional stabilization anterior and posterior to the reduction forceps. They are delivered from the inferior aspect of the medial malleolus and directed superiorly perpendicular to the fracture into the tibial metaphysis. In a patient with good bone density, fixation is normally obtained with two 4.0 mm partially threaded cannulated cancellous screws placed over the guide pins (Figure 1) (8-11).

Figure 1A. Isolated medial malleolus fracture.

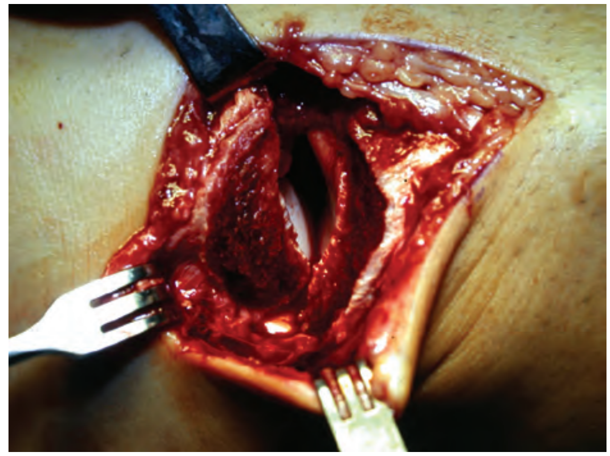

Figure 1B. Exposure of the transverse medial malleolus fracture and visualization of the ankle joint.

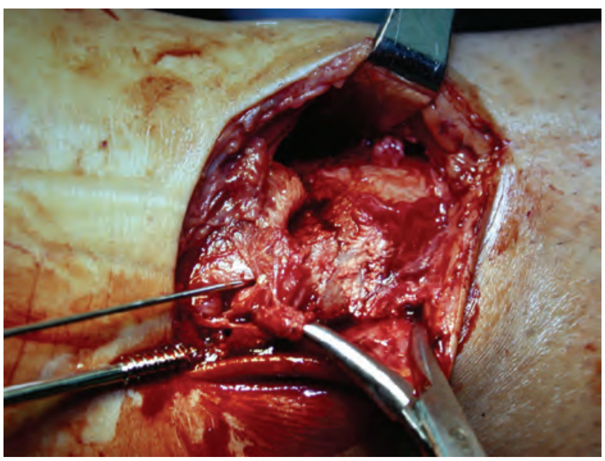

Figure 1C. Reduction of medial malleolus with provisional stabilization by reduction forceps and guide pins allowing for placement of lag screw.

Figure 1D. Figure 1D. Lateral view of anatomically reduced medial malleolus fracture and fixation with two 4.0 mm partially-threaded cancellous screws.

If non-cannulated screws are used, place the initial Kirschner wire (K-wire) in mid aspect of the medial malleolus. Employ the triple drill guide placed over this K-wire to help deliver the screws in a more parallel manner. In a patient with osteoporotic bone, a better fixation choice is a tension band wire construct using a hanging screw (Figure 2). Make sure that the hanging screw engages both the medial and lateral tibial cortex for increased stability. A unicortical screw can pull out while tightening the figure of eight wire. Another tip is to drill the K-wires in to place and then pull them back for several millimeters. This creates a preformed channel that aids in setting the K-wires closer to the bone once the figure-of-eight wire is tightened (8-10).

Sometimes the medial malleolus fracture may vary in configuration from being transverse to a more superiorly oriented oblique fracture. This fracture pattern is also normally fixated with two parallel cancellous lag screws oriented perpendicular to the fracture (Figure 3). However, the stability of fixation can be increased by extending the parallel lag screws so that they engage the lateral tibial cortex (Figure 4). One can employ partially-threaded 4.0 mm screws but it is more common to use 3.5 mm cortical screws.

Another treatment option for the transverse or slightly oblique fracture of the medial malleolus is arthroscopic assisted percutaneous reduction and internal fixation

Figure 1E. Lateral view.

Figure 2A. Trimalleolar fracture dislocation in an older patient.

Figure 2B. Trimalleolar fracture dislocation.

Figure 2C. Fractured medial malleolus.

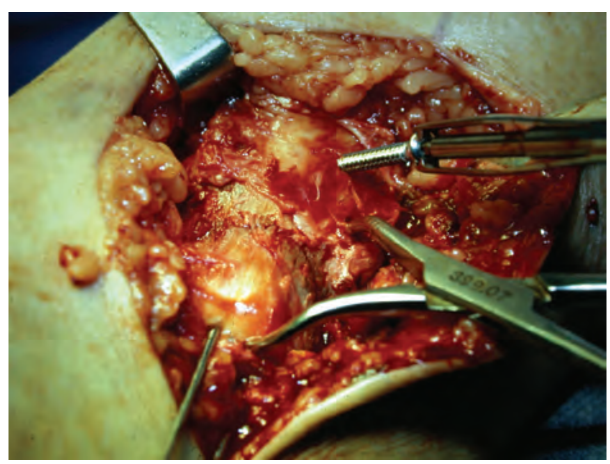

Figure 2D. Reduction of medial malleolus with provisional stabilization and placing bicortical hanging screw.

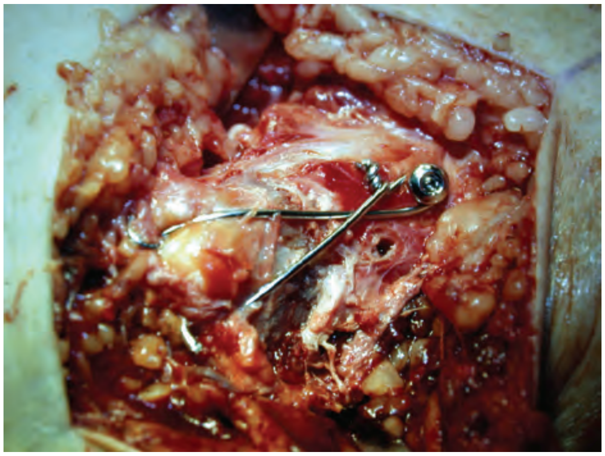

Figure 2E. Tension band wire.

Figure 2F. View of final reduction and internal fixation. The fibula was stabilized with a posterior anti-glide plate and the medial malleolus fixated with tension band.

Figure 2G. Final reduction.

Figure 3A. Variant pronation-abduction injury with oblique medial malleolus fracture.

Figure 3B. Variant pronation-abduction injury with oblique medial malleolus fracture.

Figure 3C. The medial malleolus is fixated with two 4.0 mm partially threaded cannulated cancellous screws.

Figure 3D.

Figure 4A. Weber B fracture with a superiorly oriented oblique fracture of the medial malleolus.

Figure 4B. Reduction and fixation of medial malleolus with bicortical purchase of two 3.5 mm cortical screws to increase stability.

(Figure 5) (12). The arthroscope is placed in the anterolateral portal for visualization. Through an anteromedial portal, the ankle joint is debrided of hemarthrosis. The fracture line is noted at the anterior aspect of the medial bend of the tibia. It is debrided of the hematoma and any entrapped periosteum. The fracture is then manipulated with a percutaneously placed pointed reduction forceps under arthroscopic and fluoroscopic control. Once an anatomic reduction is achieved, it is provisionally held reduced with the reduction forces. The fracture can then be stabilized with two 4.0 mm partially-threaded cancellous screws delivered percutaneously. The percutaneous technique is best reserved for fractures with less displacement. It is easier to perform on the fracture, which is more oblique in configuration because it is easier to apply the reduction forceps. If percutaneous reduction is not achievable, usually because of entrapped periosteum or the configuration of the fracture and the difficulty of applying reduction forceps, then formal open-reduction internal fixation is required.

It is not uncommon for the medial malleolar fracture to be transverse anteriorly but as it propagates posteriorly, it angles inferiorly. This creates a smaller fracture fragment, which is essentially the anterior colliculus (13-15). This smaller fracture sometimes becomes difficult to reduce and tedious to stabilize with internal fixation. This smaller fragment requires different fixation strategies. One option is to utilize a tension band wire as described above (Figure 6). This scenario can also be fixated by utilizing two parallel smaller cancellous screws such as 3.0 mm (Figure 7). A third option is to utilize one 4.0 mm with one parallel K-wire for a second point of fixation to prevent rotation (Figure 8) or instead of the K-wire place a second smaller-sized screw (Figure 9). When there is an anterior colliculus fracture, there is the possibility of having a combined medial lesion with an accompanying deep deltoid ligament rupture. While this fact does not change the fixation of the medial malleolus fracture, it does have an influence on the stability of the ankle mortise. It can produce an unstable ankle even though the medial malleolus is fixated (14). This situation will require syndesmotic stabilization.

The vertically-oriented medial malleolus fracture (supination-adduction injuries), starts at the bend of the tibia and extends in a superior direction. Sometimes the fracture is obliquely oriented upward but the majority of times, it is vertical in configuration. The preferred surgical approach is a hockey-stick incision along the anteromedial aspect of the distal tibia extending inferior to the medial malleolus. This allows excellent visualization of the medial ankle joint. If the fracture is oblique, then it can usually be anatomically reduced and fixated with two 4.0 mm partially-threaded cancellous screws as described previously. If vertically oriented, the fracture can be fixated with multiple 4.0 mm cannulated cancellous screws placed perpendicular to the fracture. This means the screws are placed perpendicular to the long axis of the tibia (Figure 10). However, since there is no tibial buttress above the fracture to prevent proximal migration, consideration is usually given to application of a plate to act in an anti-glide function (Figure 11) (8-11). The

Figure 5A. Isolated fracture of medial malleolus.

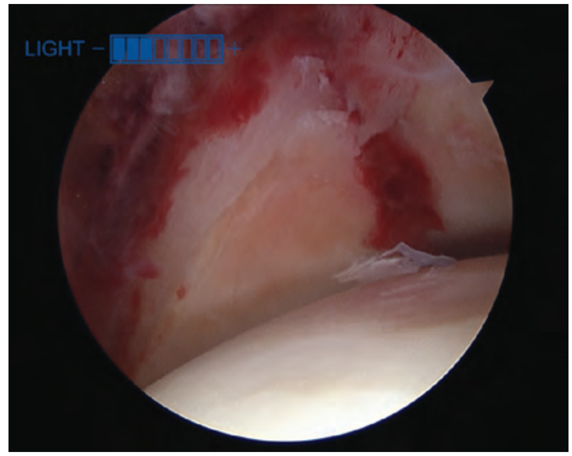

Figure 5B. Arthroscopic view of fracture.

Figure 5C. Fluoroscopic view of arthroscopically assisted reduction and provisional stabilization with reduction forceps.

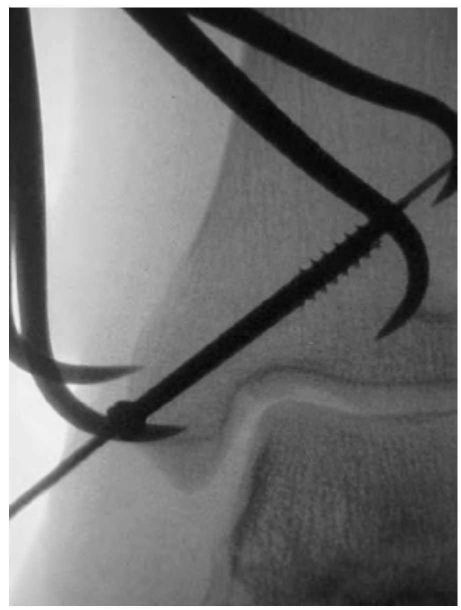

Figure 5D. Percutaneous delivery of screws.

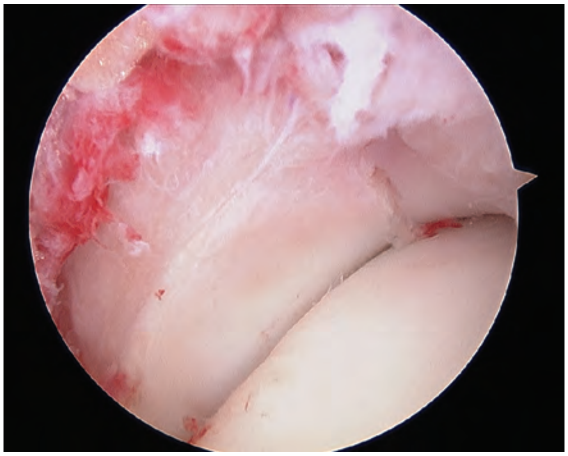

Figure 5E. Arthroscopic view of reduction.

Figure 5F. Reduction appears anatomic with good position of the screws.

distal cancellous screws are placed through the plate, but an additional lag screw can be placed outside the plate if necessary. A screw placed at or just above the apex of the fracture will contour the plate to the distal tibia. When not significantly displaced, this fracture may lend itself to a minimally invasive or percutaneous approach. However, this fracture pattern many times results in osteochondral fracture fragments coming from the tibia. In this situation, the ankle joint must be explored and these fragments excised.

On occasion, the distal tibial metaphysis is impacted upwards. This must be recognized on the initial radiographs. Once the fracture is exposed, the distal tibial metaphysis needs to be dis-impacted with an osteotome and levered back into position using the superior aspect of the talus as a template. The osteotomy is now back-filled with a local cancellous bone graft taken more proximally from the exposed metaphyseal fracture site. The medial malleolus fracture is then reduced and fixated with plate and screws (6,9).This situation requires a longer period of post-operative non-weightbearing approaching 3 months.

On occasion, the medial malleolus fracture may involve extension into the posteromedial aspect of the distal tibia. This is usually associated with fracture dislocations that produce a somewhat large posterior malleolus fracture fragment. Variations of this fracture pattern can produce one large posterior malleolus component that exists on the medial aspect of the medial malleolus. It can produce a posterior malleolus fracture that has two fragments. One occurs posterolaterally and the other posteromedially. They are normally still connected by soft tissue and essentially function as one segment when considering reduction. Sometimes the medial malleolus also has a fracture of the anterior colliculus dividing it into an anterior and posterior fragment (Figure 12). The surgical approach to this fracture is usually a curved posteromedial incision. It follows the posterior cortex of the distal tibia curving inferior to the medial mallelous essentially following the course of the posterior tibial tendon. This incision allows exposure to the ankle joint for debridement as well as the delivery of internal fixation for the posteromedial fragment. The internal fixation can be multiple cancellous lag screws depending on the size of the fragment. A screw with a large washer can be placed at the apex of the fracture for an anti-glide function for smaller fractures. For a larger fracture, a plate may be more appropriate.

Figure 6A. Weber B fracture with anterior colliculus fracture.

Figure 6B. Weber B fracture with anterior colliculus fracture.

Figure 6C. Reduction and fixation of the medial malleolus fracture with tension band wire.

Figure 7A. Weber B injury with anterior colliculus fracture.

Figure 7B. Reduction and medial malleolus fixation with two 3.0 mm partially-threaded cancellous screws because of the smaller size of the fracture.

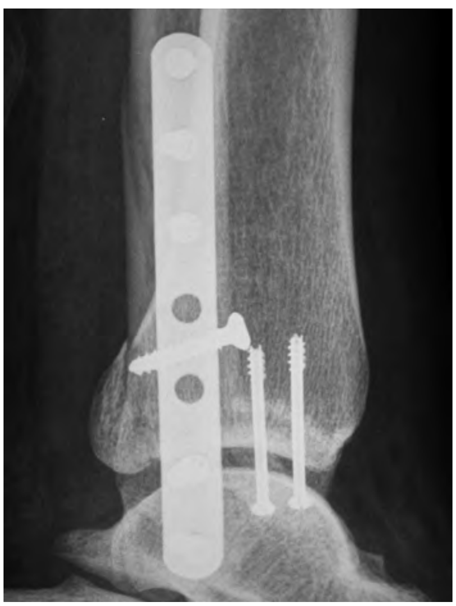

Figure 7C.

Figure 8A. Weber B injury with small anterior colliculus fracture.

Figure 8B. Fixation of medial malleolus with one 4.0 mm cancellous screw and a K-wire for a second point of fixation.

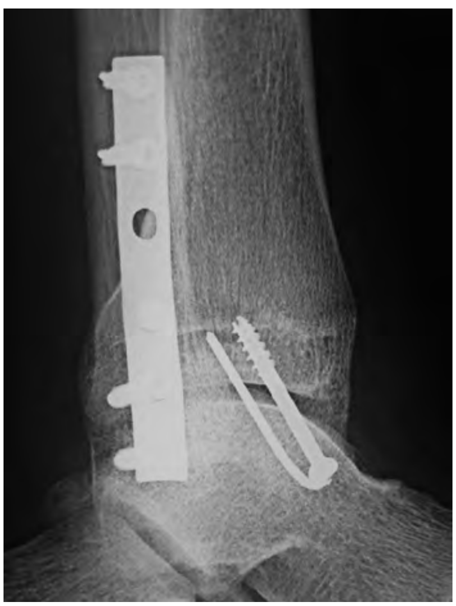

Figure 8C. Fixation of medial malleolus.

Figure 9A. Weber C injury with anterior colliculus fracture.

Figure 9B. Medial malleolus fixated with one 4.0 and one 3.0 mm partially-threaded cancellous screws.

Figure 10A. Supination-adduction fracture.

Figure 10B. The medial malleolus fracture is fixated with multiple partially threaded cancellous screws. A screw with washer is placed at the apex of the fracture for an anti-glide fuction.

Figure 10C.

Figure 11A. Supination-adduction fracture dislocation with superiorly impacted medial aspect of the tibial plafond.

Figure 11B. CT scan.

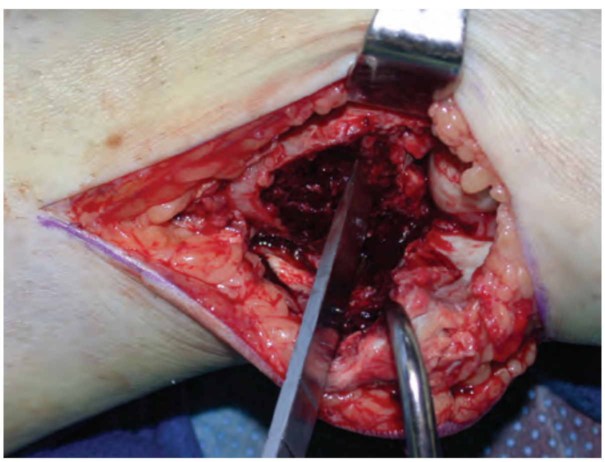

Figure 11C. Tibial osteotomy employing osteotome to disimpact the tibial plafond.

Figure 11D. Fluoroscopic view of reduction the tibial plafond.

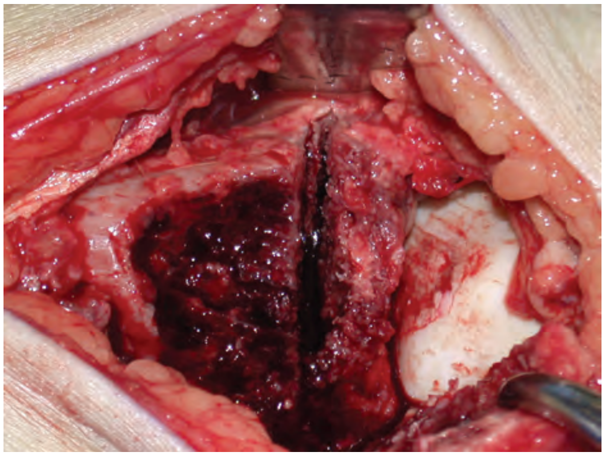

Figure 11E. Reduction of articular surface but observe the severe damage to the talar dome. The osteotomy with be back-filled with local cancellous bone graft.

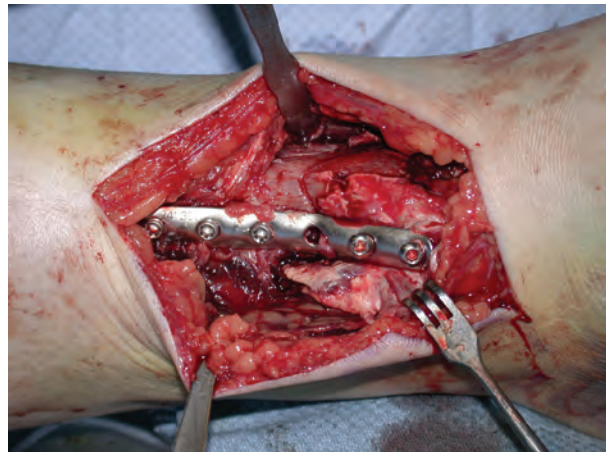

Figure 11F. Application of buttress plate.

Figure 11G. Medial malleolus is fixated with plate and screws.

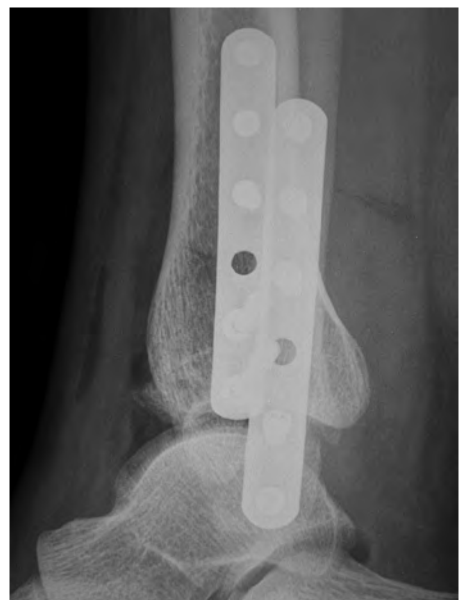

Figure 11H.

Figure 12A. Complex ankle fracture dislocation.

Figure 12B. Complex ankle fracture dislocation.

Figure 12C. Closed reduction resulting in re-articulation of the talus within the ankle mortise.

Figure 12D. Closed reduction.

Figure 12E. 3D CT scan demonstrates a large two piece posterior malleolus fracture which exits through the medial malleolus. There is also an anterior colliculus fracture.

Figure 12F. 3D CT scan.

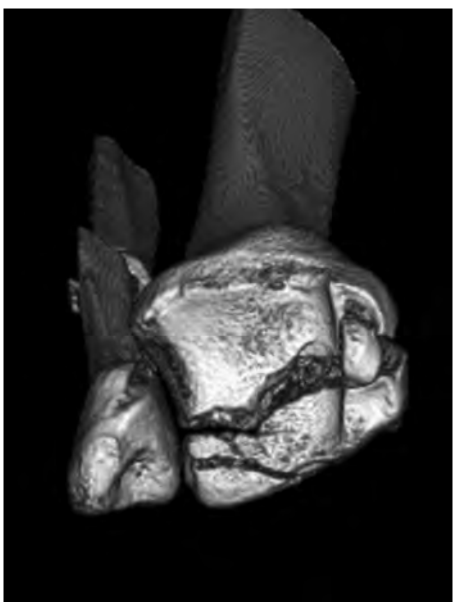

Figure 12G. 3D CT scan.

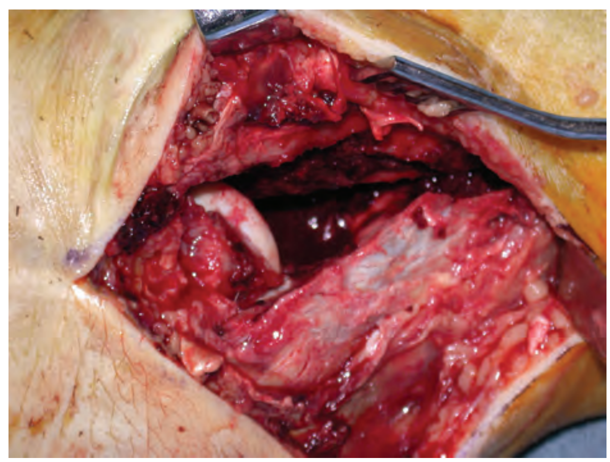

Figure 12H. Posteromedial incisional approach allows exposure of the ankle joint through retraction of the posteromedial fragment.

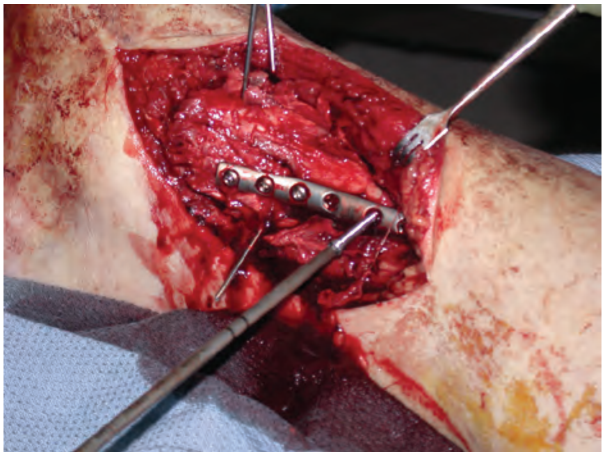

Figure 12I. Application of a plate along posteromedial aspect of the tibia.

Figure 12J. Final reduction with interal fixation.

Figure 12K. Final reduction and internal fixation.

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