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Review Article

POSTEROLATERAL APPROACH IN TRIMALLEOLAR ANKLE FRACTURE: SURGICAL TECHNIQUE- REVIEW ARTICLE

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ABSTRACT

Ankle fracture involving the lateral malleolar, the medial malleolar and the posterior malleolar (the distal posterior ascent of tibia) is termed as trimalleolar fracture. Population-based studies suggest that the incidence of ankle fractures has increased dramatically since the early 1960s. The highest incidence of ankle fractures occurs in the elderly women, although fractures of the ankle are generally not considered to be "fragility" fractures. There are two treatment options for the trimalleolar fracture, non-surgical and surgical. Many approaches and techniques have been used for the surgical treatment. In this study, posterolateral approach is described. For the posterolateral approach, longitudinal incision is made between the lateral border of the Achilles tendon and the medial border of fibula and lateral and posterior malleolus is fixed. For the medial malleolus, a standard medial incision is made. Given that the posterolateral surgical approach to ankle gives perfect visualization to the posterior malleolus, allowing its good anatomical reduction and stable fixation.

Key words: Trimalleolar ankle fracture, posterior malleolar fracture, Volkmann's fragment, posterolateral approach, anatomical reduction, pilon fracture

INTRODUCTION

Ankle fractures are the fourth most common injuries treated by orthopedic surgeons and have been reported to occur with an overall age and sex adjusted incidence rate of 187 per 100,000 persons-year; this is higher than in earlier population-based studies [1, 2]. Among the surgical treatment of trimalleolar fracture, fixing posterior malleolus among most of the orthopedic surgeons have been debated. The standard indication for fixing a posterior malleolar fracture is a displaced fragments that involves more than 25% - 35% of the articulation surface of the distal tibia[3, 4]. Fixing posterior and lateral malleolus by using posterolateral approach and medial malleolus by standard medial incision is gaining great attention.

Often, the posterior fragment reduces simultaneously when the lateral malleolus is reduced because of their respective attachments to the posteroinferior tibiofibular ligament (PITFL). This fragment is also known as Volkmann's fragment, can be fixed with lag screws inserted from anterior to posterior. This expected reduction is not likely if the ankle is not being fixed acutely because of the interposition of organized hematoma or callus. Many different approaches have been used for the fixation. Among the malleolus fixation, the posterior malleolus fragments have limited visualization which does not facilitate the proper anatomical reduction. An anatomical reduction for unstable ankle is necessary to achieve successful functional outcome. Indirect reduction with stabilization of the posterior malleolus using anteroposterior screws is the most common method of fixation of the posterior malleolus among orthopedic surgeons [5]. Recently interests have been growing in obtaining direct reduction and fixation of posterior malleolus from the posterior surface using a posterolateral approach to the ankle [6-10]. If the direct exposure of the fragment is necessary, the posteromedial approach has been recommended [4, 11]. This allows fixation of the medial and posterior malleoli through the same incision. The limited visualization of the posterior malleolar fragment afforded by this exposure has led other authors to describe different techniques to facilitate anatomical reduction. A medial approach for a typical posterolateral fragment still would seem suboptimal. An extensive posteromedial approach with dislocation of the talus laterally and complete release of the soft tissue attachments to the posterior malleolus has also been described [3]. Other options include arthroscopically assisted reduction [12] and the lateral trans-malleolar approach [13]. It is difficult to get an anatomical reduction of the posterior malleolus fragments using a lateral trans-malleolar approach.

The purpose of this paper is to describe in detail a method of approach and fixation that has been proved very useful: open reduction and internal fixation of trimalleolar ankle fracture using the posterolateral approach.

CLASSIFICATION OF ANKLE FRACTURE

1. Lauge-Hansen classification [14]: The Lauge-Hansen classification is a system of categorizing ankle

fractures based on the foot position and the force applied.

Supination-adduction

- Stage 1: transverse fractures of the lateral malleolus or detachments of the ligaments from the fibula
- Stage 2: vertical fractures of the medial malleolus or detachment of the deltoid ligament.

Supination-eversion

- Stage 1: anterior tibiofibular ligament (ATFL) injuries.
- Stage 2: Oblique spiral fractures of the distal fibula.
- Stage 3: posterior malleolar fractures or injury to the posterior tibiofibular ligament (PTFL).
- Stage 4: medial malleolar fracture.

Pronation-abduction

- Stage 1: medial malleolar fractures.
- Stage 2: ATFL injuries.
- Stage 3: oblique fractures of the fibula.

Pronation-eversion

- Stage 1: rupture of the deltoid ligament or avulsion fracture of the medial malleolus.
- Stage 2: Injury of the ATFL.
- Stage 3: oblique fracture of the fibula.
- Stage 4: fracture of the posterior malleolus or injury to the PTFL.

2. Danis-Weber classification: The Danis-Weber classification often known as Weber classification is a simple system for classification of lateral malleolar fractures, relating to the level of the fracture in relation to the ankle joint.

Type A

- Below level of the ankle joint
- Tibiofibular syndesmosis intact
- Deltoid ligament intact
- Medial malleolus often fractured
- Usually stable, although occasionally requires open reduction and internal fixation (ORIF)

Type B

- At the level of the ankle joint, extending superiorly and laterally up the fibula

- Tibiofibular syndesmosis intact or only partially torn, but no widening of the distal tibiofibular articulation
- Medial malleolus may be fractured or deltoid ligament may be torn
- Variable stability

Type C

- Above the level of the ankle joint
- Tibiofibular syndesmosis disrupted with widening of the distal tibiofibular articulation
- Medial malleolus fracture or deltoid ligament injury present
- Unstable; requires ORIF

TREATMENT:

There are two treatment options, which comprise of nonsurgical and surgical treatment

1. Nonsurgical treatment (short-leg walking cast/boot): Indications

- In patients who have a high risk for surgery due to existing medical conditions or significant health problems
- Isolated non-displaced medial malleolus fracture or tip avulsion
- Isolated lateral malleolus fracture with <3mm displacement and no talar shift
- Posterior malleolar fracture with <25% joint involvement or <2mm step-off

2. Surgical treatment (ORIF): Indications

- Any talar displacement
- Displaced isolated medial malleolar fracture
- Displaced isolated lateral malleolar fracture
- Bimalleolar fracture and bimalleolar-equivalent fracture
- Posterior malleolar fracture with >25% or >2mm step-off
- Bosworth fracture-dislocation
- Open fracture

TECHNIQUE:

The affected limb is prepped and draped in the usual sterile fashion. Tourniquet is applied over the proximal thigh of the affected limb. The distal part of the affected lower leg is placed on a foam cushion with the knee slightly flexed to allow maximal dorsiflexion of the ankle during reduction. The surgery is performed

in the prone position.

A posterolateral approach is performed. The longitudinal incision is made between the lateral border of the Achilles tendon and the medial border of fibula (Fig.1). Dissection in the subcutaneous plane is performed with great care in order to respect the sural nerve which has a variable anatomy [15, 16]. We find that this gives good access to the Volkmann's fragment and optimal access to the lateral malleolus. The lesser saphenous vein and sural nerve are identified and protected. The sural nerve courses from medial to lateral and crosses the lateral border of the Achilles' tendon on average 9.8 cm proximal to its insertion in the calcaneus [15]. At a point 7 cm proximal to the tip of the lateral malleolus, the nerve is on average 26mm posterior to the edge of fibula [16]. It gives rise to an average of 3 branches in the retromalleolar region, the lateral calcaneal nerve [16]. The surgeon must be aware that the anatomy of the sural nerve is highly variable [15-17] and the best way to protect it and avoid nerve injury and neuromas is to perform meticulous blunt dissection in the subcutaneous tissue. Further entry is made through the interval between peroneal and flexor hallucis longus muscles. Retracting the peroneal tendons medically gives access to the posterior ascent of the lateral malleolus. The fibular fracture is classically fixed with a lag screw and antiglide plate but the fixation construct may vary according to the fracture pattern or communication. In more complex fracture patterns, stacked one-third tubular plates or a limited contact dynamic compression (LC-DC) plate can be used to provide additional stability. The one-third tubular plate is contoured by narrowing the concerns at its distal end to fit closely over the posterior border of the distal fibula. This contour ensures that it will not impinge on the peroneal tendons.

Figure 1: Incision mark

A second interval is then exploited between the peroneal tendons and Achilles' tendon more medially within the wound. Access to the posterior malleolus is achieved by lifting off the flexor hallucis longus from posterior tibia. Meanwhile great care is taken to preserve the posteroinferior tibiofibular ligament (PITFL) attachment to the fragment and the joint capsule. Blood is supplied to the posterior tibia by the perimalleolar arterial ring from which fine arterial branches penetrate the bone 2.5-5 cm proximal to the joint line [18]. Care should be taken not to devascularize the fragments. An anatomical reduction is almost always achieved

and is held temporarily by krischner wires (k-wires). When anatomical reduction is conformed on image intensification, fixation is undertaken using either lag screws or a small buttress plate. Alternatively, both the posterior and lateral malleolus can be accessed through the same intramuscular plane between the peroneal tendon and the posterior border of the fibula.

The medial malleolus can be addressed through a standard medial incision. The fixation of the medial malleolus is more complicated in the prone position because of the leg's propensity to rotate externally but could be performed correctly when the knee is flexed and rotated internally or else bent at 110 degree. Fixation of the medial side is carried out classically with two 3.5 lag screws but again may vary according to fracture pattern.

The accurate lateral c-arm image of the ankle is achieved by internal rotation of the leg which can be accompanied by rotating the leg by gripping the knee proximally or by rotating the bed (5-10) degree. An image intensifier is used to assess fracture reduction and position of the implant. Alternatively, c-arm imaging can be omitted and radiographs can be taken after fixation. Figure 2 and Figure 3 show typical preoperative and postoperative radiographs respectively. Incision is closed in the usual manner.

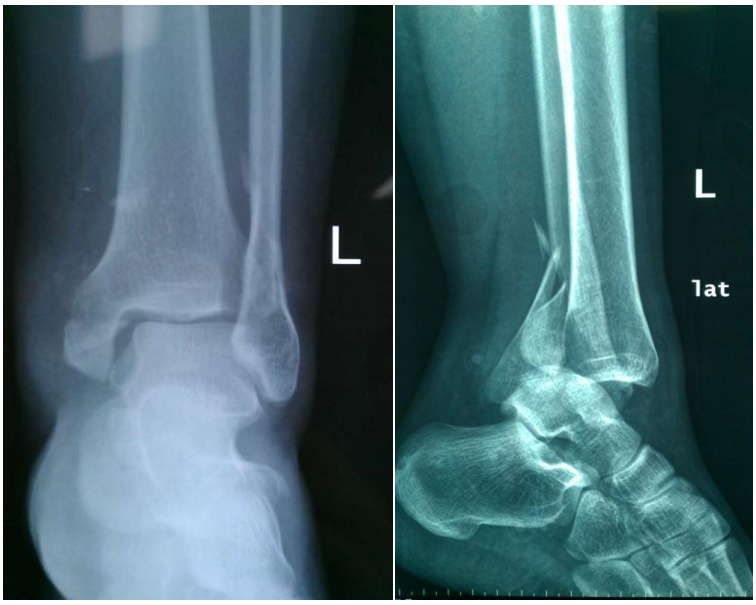

Figure 2: pre-operative

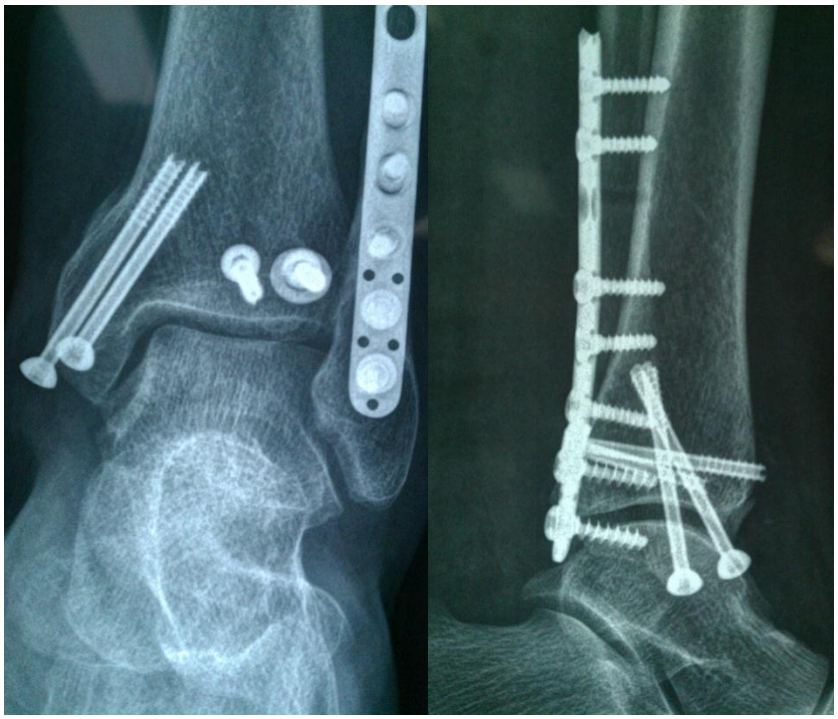

Figure 3: post-operative

OUTCOME:

Evaluation uses the American Orthopedic Foot and Ankle Joint Association (American Orthopedics Food ankle Society, AOFAS) score, the score level includes 4 aspects, a total of 100 points (excellent: > 92; good: 87-91; Poor:65-86, bad: < 65).

In the study of our senior authors, a total of 20 patients, mean age 46.5 years, of trimalleolar fracture were treated with this approach from January 2011 to December 2012. Except 1 case of patients with delayed wound healing, others none of them had postoperative complications such as infection, mal-union and screw breakage .The group of patients underwent the postoperative follow-up of 12 to 20 months, an average of 15 months and all fracture healed taking average time of 12 weeks. AOFAS score is adopted to evaluate the curative effect. 11 cases score as excellent, 4 cases score as good, 4 cases score as poor, 1 case score as bad. The cases scoring to excellent and good were 75%.

COMPLICATIONS:

Chances of developing complications increase with age, diabetes, and smoking.

- Mal-union and reflex sympathetic dystrophy is commonly associated with lateral malleolus fracture

- Non-union is rare but commonly associated with conservative treatment of medial malleolus fracture
- Post traumatic Arthritis
- Skin edge necrosis (3%) may occur. Fractures that are operated on in the presence of fracture blisters or abrasions have more than twice the complication rate.
- Delayed healing of the wound/bones
- Compartment syndrome of the leg and foot occur rarely.
- Tibiofibular synostosis is associated with the use of a syndesmotic screw
- Loss of reduction is reported in 25% of unstable ankle injuries treated non-operatively
- Loss of ankle range of motion may occur
- Deep infection is the most important complication following ankle fracture surgery.

DISCUSSION

Ankle fractures including a posterior fragment have a worse prognosis than bimalleolar fractures [19-25]. Among trimalleolar fracture fragments, posterior larger fragment imply a worse clinical outcome than smaller ones but the quality of reduction also influences the final outcome, with better result bring obtained if a good reduction is achieved regardless of size [19, 26]. Many surgical approaches to the malleolar fractures have been described. A long medial incision with dislocation ankle was used to reach the posterior fragment [27]. This method requires extensive soft tissue stripping of the fracture fragments [27]. Kao et al [28] described a posterior-medial-anterior approach to pilon fractures that uses a larger J-type incision that starts posteriorly proximally and then curves around the medial malleolus and distally is located over the dorsomedial foot. A posteromedial incision has been described that allows fixation of the posterior and medial malleoli from the same incision [7]. This approach has limited visualization of the posterior malleolus fragment. Holt [12] described an arthroscopically assisted reduction of the posterior malleolus. Weber [29] described a case series of 9 patients who were treated with a combined posteromedial and posterolateral approach. All the previous approaches either involved excessive dissection or had limited visualization of the posterior malleolus. Recently, interest has been growing in fixing the posterior malleolus using a posterolateral approach [7-10]. Despite the recent interest in the approach, the studies describing its results have been very few [8, 30].There are reports of this approach in the peer-reviewed literature. Miller in 1974 reported on 5 cases of ORIF of the posterior malleolus using this exposure but gave scant details regarding the technique used and patient's outcome [31]. Heim reported on 60 trimalleolar fractures treated surgically, 16 of which were treated with this approach. He found it especially useful for the patients with smaller, posterior fragments [24] but did not give details regarding the approach technique and results of this subset of patients. Talbot et al [9] provided a detailed description of the technique of the posterolateral approach in a surgical technique report but without presenting their own results. Also, Carmont and Davies [10] in a

recent report described the similarity between the posterolateral approach of the ankle and volar approach of the wrist with no presentation of the patients' results. Amorosa et al [7] reported on only 2 cases of posterior malleolus fracture treated with the posterolateral approach. Only a few previous reports have described the results of this approach when treating a relatively large number of patients [6, 8, 30]. Miller et al [30], they found that posterior malleolar stabilization of the syndesmotic injuries was equivalent to screw fixation and recommended that when a posterior malleolar fracture is present, regardless of the size of the fracture fragment, an anatomic reconstruction should be performed by fixation of the fragment using a posterolateral approach. Forberger et al [6] retrospectively described their results in treating 45 consecutive patients with the posterolateral approach. They used the posterolateral approach to surgically fix the posterior malleolus if it involved more than 25% of the articular surface or in young patients (<50 years old) and those with subluxation of the ankle if more than 10% of the articular surface was involved. They concluded that the posterolateral approach allowed good exposure and stable fixation of a displaced posterior malleolar fragment with few local complications.

It is found that posterolateral approach have several advantages. The main advantage is that it allows direct inspection and reduction of the posterior fragment, gives good visualization, gain good anatomical articular reduction and strong fixation. The approach allows one to address the fragment in a manner consistent with the classic fracture pattern that is parallel to the transmalleolar axis and thus posterolateral [20]. Anatomical reduction of the articular surface is a basic principle in the fracture surgery and this approach certainly promotes that goal. This was shown in a study by Huber et al [8]. They found that anatomical reduction of the posterior malleolus was more frequent with direct reduction (83% of cases) when compared with the standard indirect reduction and anteroposterior screws (27% of cases). Even in delayed surgery better anatomical articular reduction and better fixation is obtained as it can be cleaned out directly, removing interposed callus or periosteum.

These are other advantages as well. Wound dehiscence in the posterolateral approach will not lead to the same disastrous complications as with other approaches to the ankle. In the case of major soft tissue contusion, bruising often does not involve the posterior aspect of the leg; thus, the posterolateral approach could be used without increased risk [9]. The hardware with the posterolateral approach is deep in the ankle, with good soft tissue coverage and causes no irritation to the patients. In the case of fracture dislocations, the surgeon can choose to supplement fixation of the posterior malleolus with a buttress plate, also a basic fixation principle in a weight bearing joint that will experience axial load or shearing forces during weight bearing. It is also believed that fixation of even small posterior malleolus fragments can facilitate rehabilitation by creating a more stable construct. This might prevent subluxation of the talus and stabilize the syndesmosis, conceivably making early range of motion easier on the patients. This is also the exposure of choice for the use of an antiglide plate for fibular fixation.

There are also some drawbacks to this approach. Another incision is made for reduction and fixation of medial malleolus fracture. It is not extensile distally. Furthermore in a case with associated forefoot or talus fractures or anterior syndesmotic injuries, moving the patient to a supine position will be necessary as these injuries cannot be addressed through this incision or in the prone position.

CONCLUSION

This approach is believed that it provides the good exposure to achieve good reduction, good soft tissue coverage, strong fixation and minimal complications. Even in delayed surgery better anatomical articular reduction and better fixation is obtained. As bruising often does not involve the posterior aspect of the leg thus the posterolateral approach could be used without increased risk. When using this approach, fixation of the medial malleolus might be more difficult than usual because of the patient's position. Surgeons could benefit from using this approach.

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