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Evaluation of the role of posterior malleolus fixation in trimalleolar ankle fractures: a prospective study

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ABSTRACT

Background: Trimalleolar ankle fractures are relatively rare and complex ankle injuries, the prognosis of which is worse than bimalleolar fracture. The three malleoli are bony restraints of the ankle and all three are fractured in trimalleolar fractures. Hence, there is disruption of the weight bearing portion of the tibial plafond along with talus dislocation/subluxation. Management of such fractures is challenging and confounded by the dilemma of posterior malleolus fixation. Aim: The aim of the present study was to evaluate the radiological and clinical outcome of fixation of large (>25%) posterior malleolus fragment in trimalleolar fractures.
Methods: 25 patients underwent fixation of the three malleoli and evaluated prospectively. Different methods for fixation from plating to lag screws were used for posterior malleolus.
Results: 92% of patients in our series had excellent to good clinical outcome. Radiologically, there was anatomical reduction of the ankle joint and none of the patient had postoperative talus subluxation or arthrosis.
Conclusions: Our study shows that there is consistent and reproducible clinical advantage of fixing the posterior malleolus in trimalleolar ankle fractures.

Keywords: Trimalleolar fracture, Posterior malleolus, Syndesmosis, Subluxation, Arthrosis

INTRODUCTION

Ankle fractures are among the most common injuries treated by orthopaedic surgeons.[1] Most of the rotational ankle fracture mechanisms described by Lauge-Hansen can lead to posterior malleolar fractures by avulsion of the posterior tibial fibular ligament especially the posterior external rotation (PER) injury. Trimalleolar fractures are known to have a worse prognosis than bimalleolar fractures.[2] Displaced trimalleolar ankle fractures often represent a complex injury that results in malalignment of the tibiotalar joint, disruption of the weight bearing portion of the tibial plafond and possible disruption of the distal tibiofibular syndesmosis.

The posterior malleolus acts as the origin of the posterior ankle joint capsule and attachment of the posterior-inferior tibifibular ligament (PITFL), a key stabiliser of the distal tibiofibular syndesmosis. Biomechanical studies have demonstrated that the posterior malleolus and the posterior tibial fibular ligament have a role in stability of the ankle. Fracture of the posterior malleolus causes increased rotation and posterior subluxation of the talus in the mortise. Stability of the ankle mortise in both internal rotation and external rotation in another have

been shown to be affected by disruption of these posterior structures.[3,4] Sectioning the posterior malleolus increases posterior drawer and the tendency for posterior subluxation.[5,6] The amount of posterior instability depends on whether the lateral structures including the fibula and the anterior tibial fibular ligament are intact, because they function as the primary restraints to posterior forces. With intact lateral structures, posterior stability was maintained with fractures of the posterior malleolus of up to 40% to 50% of the tibial plafond.[6,7] One study demonstrated that posterior stability was maintained with a 50% defect in the posterior malleolus but that the remaining distal tibia had increased contact loading.[8] These studies indicate that anatomically reducing and internally fixing the fibula restore most of the posterior stability of the ankle even with large posterior malleolar fractures. However, fractures of the posterior malleolus increase joint contact forces across the remaining distal tibial articular surface.[8] This potentially increases the risk of degenerative arthrosis even if stability is preserved.

Anatomic reduction and rigid fixation of medial and lateral malleolus has routinely been the key of surgical strategy, with posterior malleolus fractures comprising up to 25% of the anterior-posterior dimension of the distal tibia often left untreated. Large posterior malleolar fractures lead to poorer outcomes than small posterior malleolar fractures.[9]

In the literature there is no consensus which fragment size should be internally fixed. Various indications for internally fixing posterior malleolus fractures can be supported from the literature, but most of these indications have been based on the size of the malleolar fragment. Most surgeons have recommended internal fixation for fragments greater than 25% to 30% of the joint surface.[10-12]There are different opinions, however, because some surgeons advise routinely fixing all posterior malleolar fractures, and others believe that unless subluxation is present, fixing the posterior malleolus is not necessary if the fibula is reduced and internally fixed.[13] However, larger posterolateral fragments, transverse-type fractures, and fragments that do not reduce with fibular reduction, should be reduced and fixed.[14,15] Residual posterior subluxation of the talus after reduction of the medial and lateral malleoli is an absolute indication for posterior malleolus fixation.

Recent studies suggest, that regardless of the size, fixation of the posterior malleolus reduces persistent fragment displacement, increases syndesmotic stability, and improves clinical outcome. Clinical studies: one study showed that treatment by closed reduction led to good or excellent results in the majority of patients with posterior fractures of less than 25% of the articular surface, but the results were less favourable for a larger posterior fragment. Another study showed that even small posterior fragments increased the risk of arthrosis, and the increased risk was proportionate to the size of the fragment. Internally fixing the fragment had a more beneficial effect when the technique was used for large fragments. Another study showed no differences between groups in which the posterior malleolus had been internally fixed and groups in which it had not.[16,17] A prospective study that compared clinical outcome in trimalleolar fractures in two groups of patients in which the posterior malleolus has been fixed and the other group in which it had not been fixed, failed to show any statistically significant difference. No posterior subluxation of the talus occurred in either group.[18] The present study was conducted in this background, to prospectively analyse the advantages if any of fixing the posterior malleolus. The aim of the study was to evaluate clinical and radiological outcome of posterior malleolus fixation in trimalleolar ankle fractures.

METHODS

The study was a prospective study conducted at a tertiary care institute in Mumbai. The study was conducted from 2012-2016 with an average follow up of 2.4 years. 25 patients having trimalleolar ankle fracture were managed operatively. The inclusion criteria of the study were: 1. Trimalleolar fracture i.e. fracture of all the three malleoli. 2. Posterior malleolar fragment greater than 25% of anteroposterior tibial plafond dimension 3. Unilateral involvement. Exclusion criteria were; posterior malleolar fragment less than 25%, any old healed fractures of the leg/ankle, high velocity injury and pre-existing arthrosis of the ankle. Mean age of patients were 37.8 years. 20 patients were male and the remaining were females. Statistically, since the patient study group was relatively small, we used averages, means and percentages as statistical tools in our study. This is because of the rarity of the type of fracture involved.

Figure 1: Showing fracture blister, serous type.

Clinical examination focused on the degree of swelling and the presence of fracture blisters as well as their nature (serous or blood filled) (Figure 1). Surgery was delayed till the time swelling and blisters settled, average delay was 12 days from the date of injury. All the patients were subjected to standard ankle radiographs including the anteroposterior (AP), 15-degree internal rotation AP (mortise), and lateral views. Using these three views the

diagnosis of fracture instability is made. After an initial cursory evaluation of radiographs is completed as a screen for an osseous ankle injury, a more detailed evaluation of each view was than undertaken with quantification of specific radiographic relationships. Radiographically, syndesmosis instability should always be suspected when fibula fractures are above the level of the ankle mortise i.e. Danis-Weber type C injury. The most useful radiographic signs of fibular length were the talocrural angle and the "ball sign." The talocrural angle is measured between a line perpendicular to the tibial plafond and a line connecting the tips of the medial and lateral malleoli. Normal range is 83 ± 4 degrees, reduced talocrural angle shows a proximally displaced fibula fracture with shortening (Figure 2B).

Figure 2: A. Showing posterior malleolus fragment size (50%) with displacement of talus. B. Showing measurement of "Talocrural" angle, reduced in this case (40°).

Figure 3: Showing the "dime sign", the broken ball.

Figure 4: Showing increased medial clear space, indicating lateral shift of talus.

The "ball" or "dime sign" is described on the AP view as an unbroken curve connecting the recess in the distal tip of the fibula and the lateral process of the talus when the fibula is out to length (Figure 3). Any deviations from the 'normal' in the talocrural angle or the dime/ball sign is an indication of subluxation or instability. The lateral view radiograph is also used to assess the posterior malleolar fragment size vis-a-vis tibial plafond (Figure 2A). An asymmetry of the articulation between the talus and the tibia and fibula on the mortise film, represented by differences in measurements of the medial, superior, and lateral clear spaces indicated ankle instability and subluxation. The distance between the lateral border of the medial malleolus and the medial border of the talus (the medial clear space) should be equal to the superior clear space between the talus and the distal tibia. A space greater than 4 mm is considered abnormal and indicates a lateral shift of the talus (Figure 4).

Since all the patients in the study had large (>25%) posterior malleolus fragment, instability was present in all these cases. All the cases underwent fixation of all the three malleoli. The lateral malleolus was the first one to be fixed. This helped in the indirect reduction of posterior malleolus since the PTFL is attached to distal fibula, also it restored length. A variety of approaches and implant hardware were selected to fix lateral malleolus. In 9 cases a direct lateral approach was chosen for fixing the lateral malleolus. Here, the lateral malleolus was fixed with a laterally placed plate. This approach is most useful while attempting to reduce the syndesmosis, as a syndesmotic screw can be passed through the plate itself. In all such cases the posterior malleolus was fixed 'indirectly' i.e. the fracture line was visualised only under image intensifier. Fixation of the posterior malleolus was done from posterior to anterior using cancellous screws. Syndesmosis instability is most commonly associated with fibula fractures above the level of the distal syndesmotic ligaments. When there is a high fibula fracture (Lauge-Hansen pronation fractures or AO/OTA type C), there is always a syndesmosis injury. Operatively, after a distal fibula fracture has been fixed, the integrity of the syndesmosis was observed directly through the lateral incision by applying a laterally directed force to the distal fibula with a towel clip. Figure 6 Shows example of one such case with a laterally placed locking compression plate (LCP) over lateral malleolus, a syndesmotic screw through the plate and an indirectly fixed posterior malleolus from posterior to anterior with 3 screws. Hence, the lateral approach was chosen where a concurrent syndesmotic injury was suspected. In 16 cases a posterolateral approach was used to fix lateral malleolus. Figure 5 shows management of a case with a posterior plate (LCP) over lateral malleolus acting in antiglide fashion and an indirectly fixed posterior malleolus from posterior to anterior with 2 screws. Figure 7 affords example of another case where an anatomical plate is used to fix lateral malleolus and buttress plate is used to fix posterior malleolus under direct vision.

The medial malleolus was fixed through a direct medial approach using either malleolar screws (Figure 6) or a tension band wiring (Figure 7). Bio-absorbable screws were also used to fix medial malleolus.

All the cases were given a post-operative plaster of Paris slab for 4 weeks and suture removal was done on 14th postoperative day. 4 patients had wound dehiscence, they were managed by secondary suturing, none had surgical site infection (SSI).

Figure 5: Showing anteroposterior and lateral radiographs of management of case in Figure 2.

Figure 6: Showing anteroposterior and lateral radiographs of management of case in Figure 3.

Figure 7: Radiographs showing management of another case of trimalleolar fracture with buttress plate fixation of posterior malleolus and anatomical plate for lateral malleolus.

RESULTS

All the patients were examined at 6 weekly intervals for an average of 28 weeks. At every visit radiographs of the operative site were taken. Anteroposterior (AP), lateral and mortise views were taken. They were observed for bony union, maintenance of the ankle mortise, any subluxation/lateral shift of talus, implant position, arthrosis and integrity of syndesmosis. While radiologically bony union took an average 6.4 months, none of the patient had any signs of talar shift or arthroses and integrity of the syndesmosis was well maintained throughout the follow up period in all the cases. Clinical examination included observations for any local swelling, regional tenderness, joint laxity and range of movement at ankle joint. The average dorsiflexion was 10^{o} and plantarflexion was 35^{o} at an average 12 weeks follow up (Figure 8). None of the patients had laxity of ankle joint tested by drawer test. We used the scoring system for ankle fracture developed by Olerud and Molander.[19] Clinically the patients were rated out of a maximum of 100 points. They were given a set of questionnaire at every visit based on the scoring system and accordingly evaluated. We noted that 19 patients had excellent outcome (score>92), 4 had good (87-91) and 2 had fair outcome (65-86).

Figure 8: Shows postoperative range of movement.

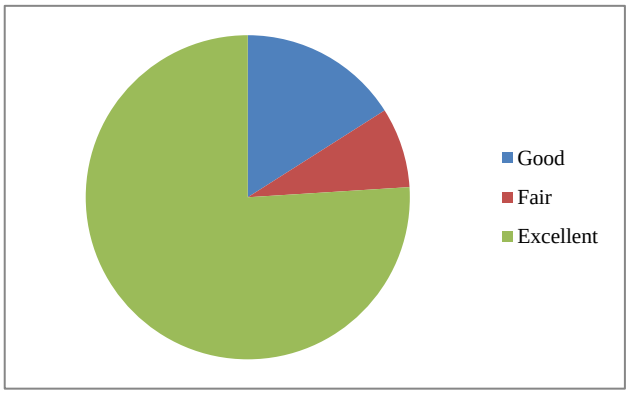

Figure 9: Pie chart distribution of functional outcome based on Olerud and Molander score.

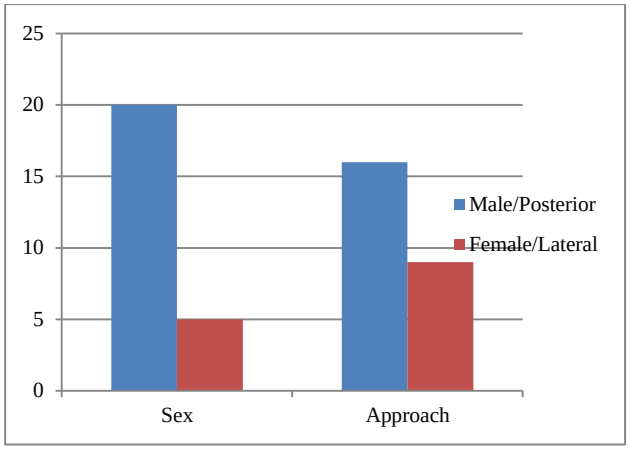

Figure 10: Pie chart showing distribution of sex and approach for lateral malleolus fracture.

DISCUSSION

Trimalleolar ankle fractures are relatively rare and complex injuries of the ankle with a variable posterior malleolar fragment size. Traditionally the criteria for fixing the posterior malleolus fragment had been it's size relative to the anteroposterior tibial plafond dimension, with most authors advocating fixation for fragments greater than 25-30%. However there is no consensus in the literature with divided opinions and studies on both sides. One long term study showed "no significant correlation between outcome and size of unfixated fragments" and "patients in which the posterior malleolar fragment was fixated did not have a statistically significant better outcome than those patients in which the fragments were not fixated".[20] Another study showed "syndesmotic stability may be obtained more effectively by fixation of the posterior malleolus".[21] In our study there is consistent and reproducible clinical advantage of fixing the posterior malleolus as is shown by ankle fracture scoring system. Our study shows that there is definite and incontrovertible benefit of fixing the posterior malleolus in trimalleolar ankle fractures. 92% of patients in our study had excellent to god outcome. This is in line with other such studies.[21] One possible limitation of the study could be observer bias since the operating surgeons were themselves the observers.

CONCLUSION

Posterior malleolus fragment greater than 25% should always be fixed in trimalleolar ankle fractures. Irrespective of the method of fixation of posterior malleolus i.e. direct (plate) or indirect (percutaneous screws) gives comparative results. A posterolateral approach is more time consuming than a direct lateral approach and requires tedious dissection to protect the sural nerve from injury. Preoperative radiographic evaluation should be exhaustive and noted for size of posterior malleolus, syndesmotic injury and talar subluxation/dislocation. Reduction of the posterior malleolus fracture should be 'anatomic' with less than 2 mm intra-articular step. Fixation of the posterior malleolus is not only good for stability of the ankle joint but also prevents development of late stage degenerative changes in the ankle that lead to arthrosis.

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