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Retrospective case series study

Posterior Malleolus Fractures in Trimalleolar Ankle Fractures: Is Transyndesmotic Fixation Necessary?

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Abstract

Posterior malleolus (PM) fracture in trimalleolar fractures is closely associated with syndesmosis stability and affecting functional outcomes in comparison to bimalleolar fractures of the lateral and medial malleolus. The purpose of this study was to explore the role of posterior malleolus fixation for maintaining of the distal tibiofibular joint stability and intermediate-term outcomes on functional recovery and radiological appearances. In the last 7 years (2015-2022) we did ORIF for 98 consecutive trimalleolar ankle fractures which were evaluated retrospectively in patients with and without transsyndesmotic fixation. Group I consisted of sixty-four patients, in whom transsyndemotic fixation was performed. Thirty-four patients in Group II, no syndesmotic fixation was carried out in trimalleolus fractures. There were 58 male (59%), 40 female (41%) patients who had trimalleolus fractures with mean age 42 years (range 23-75)o

The mean follow up was 14 to 48 months with a mean of 16 months. American Orthopedic Foot and Ankle Society score was not significantly between two groups. Therefore, transyndesmotic screw fixation may not be needed in the cases where the posterior malleolar fracture is appropriately fixed, however, in our series, majority of the triamalleolus fractures were fixed with trans syndesmotic screws based on intra operatively radiological fluoroscopy screening with ankle in forced external rotation (ER) or Hook test after fixation PM fractures. The reduction of lateral malleolus fractures are critical for reduction of the PM fragments including maintaining correct length of the distal fibula, correction of the mal-rotation and centralization of the talus. PM fractures are reduced anatomically in intraoperatively fluoroscopic images, we may either fixing PM or trans syndesmotic fixation to maintain stability distal tibiofibular joint based on intraoperatively fluoroscopic screening assessments. The order of fixation trimalleolus fracture is critical for surgical management. For a trimalleolus fracture, firstly reduction of the lateral malleolus fractures then posterior malleolus, the last for medial malleolus fractures.

Keywords : *Ankle fracture, ankle malleolar fracture, posterior malleolus, syndesmosis, internal fixation.*

INTRODUCTION

Posterior malleolar (PM) fractures are seen in approximately 14%–44% of all ankle fractures [1, 2]. These types of fractures usually include the posterior tubercle of the distal tibia or posteromedial tibial plafond [3].The most common type of posterior malleolar fracture involves the posterior tubercle, resulting in an avulsion of the posterior inferior tibiofibular ligament (PITFL) following a rotational ankle injury [4]. Large posterior malleolar fracture fragments with posteromedial involvement occur along with the axial loading and posterior shearing forces to the ankle mortise [3].

A few studies have demonstrated that functional outcomes are adversely affected in trimalleolar fractures in comparison to bimalleolar fractures of the lateral and medial malleolus [2, 5-9]. Due to the important biomechanical function of the posterior tibial margin in weight-bearing and ankle stability, the affected ankle is thought prone to degenerative ankle arthritis [10].

The treatment of ankle fractures with the involvement of posterior malleolus remains in debates. Most authors recommend fixation when the fracture comprises >25% of the articular surface [2, 5, 7, 8, 11-14]. Surgical treatment with open reduction and internal fixation is the accepted method of treatment for medial and lateral malleolus fractures. Posterior malleolus fractures are frequently left unfixed because they are expected to be reduced spontaneously after open reduction of the lateral malleolus [15]. When a posterior

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fragment is present, surgical technique fails more often in the anatomic reduction of the PM [2]. As the surgical treatment of posterior malleolus fracture requires approaches other than traditional medial or lateral incisions, orthopedic surgeons if not specialized in foot and ankle may have a tendency to neglect the posterior malleolus fractures or underestimate the size of the fragment.

In ankle fractures involving the posterior malleolus, the issue of which type of fractures require posterior malleolus fixation is still controversial [13, 16], suggesting that a transsyndesmotic fixation may be adequate instead of posterior malleolar fixation [17]. Only a few surgical methodologies concerning the ankle for open reduction and internal fixation of posterior malleolar fragments have been described [5,6,15,] whereas a reasonable approach for different fracture patterns and the time of posterior malleolus fixation for trimalleolar fractures have not clearly addressed in the literature.

The present study compares between transsyndesmotic fixation and non transsyndemotic fixation patients who have trimalleolus fractures after fixation of the PM and medial malleolus fractures, to explore the necessity of the syndesmosis fixation in trimalleolus fractured patients.

MATERIALS AND METHODS

A retrospective review conducted between 2015 and 2022 identified 98 patients with trimalleolar fractures, with a component of PM fracture. All patients had immediate pre-reduction radiographs of the ankle including anteroposterior and lateral views. Preoperative computed tomography (CT) was also taken for planning of the surgery.

Ninety-eight patients were retrospectively placed in one of the treatment groups. Posterior malleolar fragment was fixed directly by screws alone or plate screws using a posterolateral or/and posteromedial ankle apporach in all patients. The fixation of syndesmosis was done in Group I **[Figure 1]**, non-fixed in Group II **[Figure 2]**. Group I comprised 64 patients and Group II comprised 34 patients. There were 58 male (59%), 40 female (41%) patients with trimalleolus fractures with mean age 42 years (range 23-75).

Figure 1. 47 years old female, slipped on the icy ground, right ankle sprained with swelling, pain and unable to weight bearing. X-rays and CT scans of the ankle was done in emergency.

Figure 1-1. Initial injury radiographs showed talus shifting laterally (an arrow) and PM fracture (B, an arrow).

Figure 1-2. CT scans showed talus shifting medially (an arrow in A) and posteriorly in B (an arrow). Axial view revealed posterolateral and posteromedial fragments with medial translation. 3-D reconstruction image in D clearly displayed a posterolateral fragment (arrow).

Figure 1-3. Postoperative radiographs showed a syndesmotic screw fixation in A and B arrows indicated (intraoperative fluoroscopy screening showed syndesmosis diastasis even after fixation PM and LM and medial malleolus fractures with external rotation force and Hook test). Syndesmosis regained normal anatomy (an arrow in B), and x3 screws for fixation of PM fragment (an arrow in C).

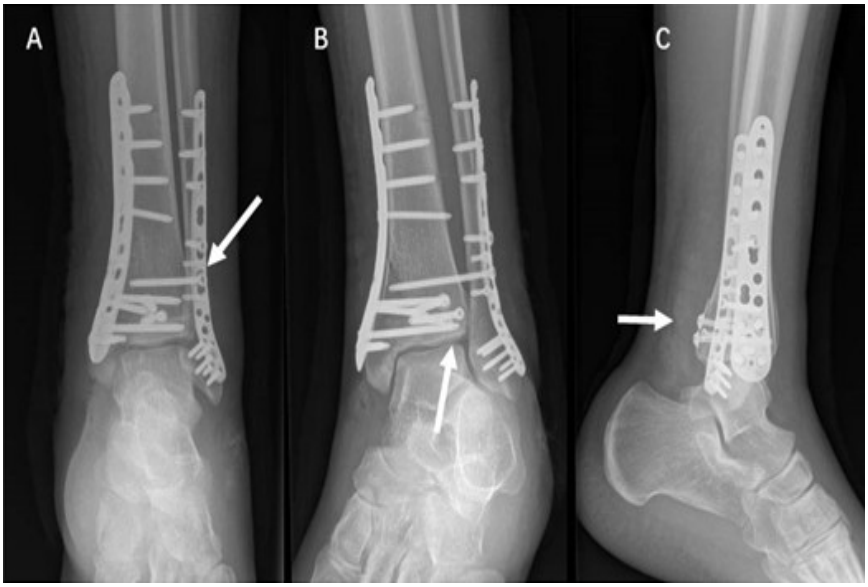


Figure 2. 42 years old man who had been tripped and fell over with right ankle landed awkwardly and immediately painful, unable to Weight bearing and swelling subsequently
On physical examination, his ankle was grossly deformed but neurovascular intact
X-rays and CT scans were done in emergency department. Surgery was arranged in the same day.

Figure 2-1. Radiographs showed trimalleolus fractures of the ankle. High fibular fracture (a red arrow) with medial malleolus vertical shear fracture (a white arrow) on AP view (A). On mortise view of the ankle (B) revealed syndesmosis diastasis with a fracture fragment interposion and talus shifting laterally (an arrow). Lateral view of the radiograph showed a posterior malleolus fracture (an arrow).

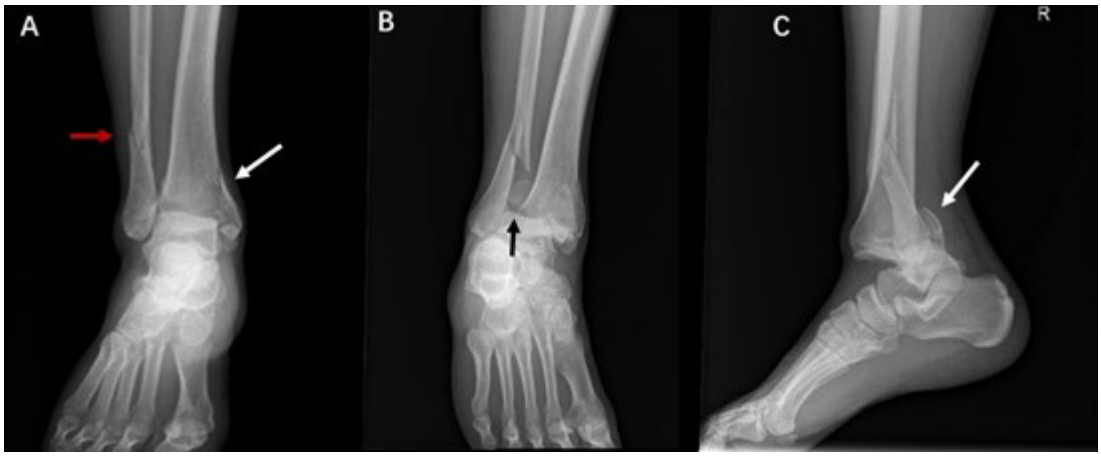


Figure 2-2. CT scans showed syndesmosis separation (A, an arrow indicated) and medial malleolus fracture with posterior medial extension (B and C arrows indicated). 3-D reconstruction CT images clearly showed posterior medial and posterior lateral fractured fragments with syndesmosis diastasis purely due to PM fragment shifting laterally (arrows in D) with PITF ligament intact.

Figure 2-3. Post-operative radiographs showed internal fixation of the PM fragments with a T plate without syndesmosis trans fixation and no syndesmosis widening in A and B. and ankle posterior dislocation was well reduced (C).

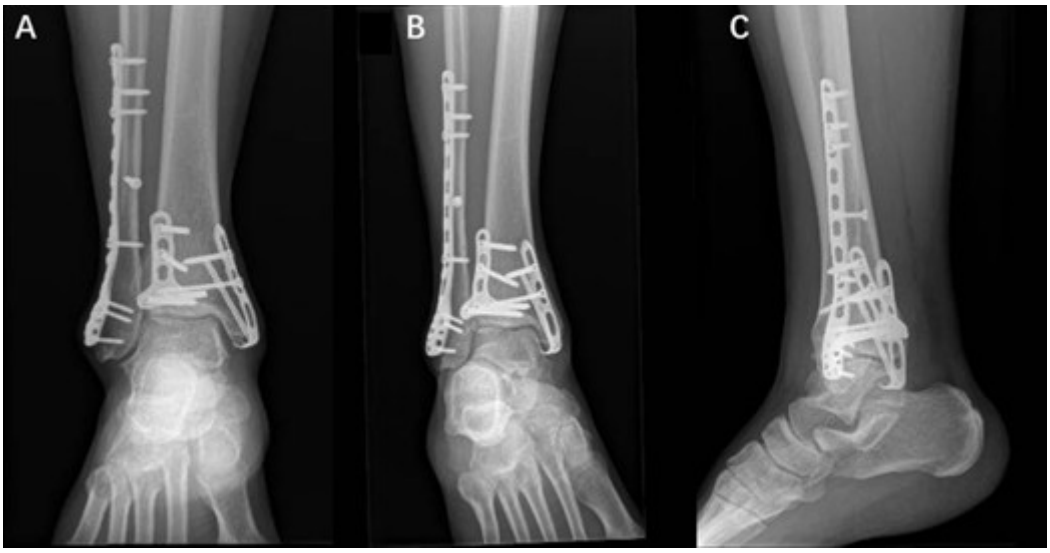


Figure 2-4. One and a half years postoperatively, all metal implants were removed due to irritation locally. No osteoarthritis either clinically or radiologically.

Posterior malleolar fragment was fixed according to fragment size and surgeons' preference in the earlier cases. Then, afterward, posterior malleolus fracture was fixed regardless of the size of the fracture fragment.

Conventional lateral and medial approaches to the ankle were used in Group I to reduce and fix the lateral and medial malleolar fractures. A transsyndesmotic fixation was determined based on intraoperative lateral translation stress test (Hook test) and an external rotation stress mortis fluoroscopic view (stable distal tibiofibular joint at least 1 mm overlapping on mortise view). The transsyndesmotic fixation was not used when the rotational stability was achieved with fracture fixation alone. Specifically, 3.5 mm cortical or 4.5 mm malleolar screw was inserted tricortically from fibular plate to the tibia just one inch above ankle joint with 10-20 degrees anteversion. In Group II, we used a posterolateral approach to the ankle to reduction and fixation of the posterior malleolar fracture and associated fibular fractures in one incision. Fixation of medial malleolus was performed using a mini medial approach. At the end, we performed Hook test and external rotation stress tests to determine if syndesmosis screws were required.

Follow up radiographs were obtained at 3, 6 months and 1 year postoperatively. At each follow up, patients were assessed for syndesmotic reduction, loss of fixation, and implant failure. The reduction in quality was evaluated on immediate postoperative radiography. Functional score and degenerative changes were assessed on the last follow up records by one author (JL). Postoperatively, an air boot was worn with touching down weight bearing for Group I and Group II patients for 6 weeks to facilitate healing of PM fractures. Assisted passive range of motion exercises of the ankle was applied to all patients immediately after surgery. The patients were mobilized with weight-bearing as tolerated in Cam walker 6–12 weeks after surgery.

The mean follow up was 14 to 48 months with a mean of 16 months. The quality of reduction was assessed according to the scoring criteria of Ovadia and Beals [18], functional outcomes including the American Orthopaedic Foot and Ankle Society (AOFAS), and the severity of osteoarthritis of the ankle using the grading system of van Dijk et al [19].

The size of the posterior malleolar fragment was defined as the percentage of the distal tibial articular surface on the most involved section, as measured on the preoperative sagittal plane CT scans. The length of the articular surface of the fragment was divided by the length of the distal tibial articular surface, including the articular surface of the fragment, and multiplied by 100.

Chi-square test was used to evaluate the statistical significance of discrete variables. $P < 0.05$ was considered statistically significant.

RESULTS

In all patients, the fracture healed within 3 months after the surgical fixation. No loss of reduction/fixation occurred on radiographic follow up, and there was hardware irritation especially medial malleolus implants in 9 patients, but no loosening was seen. One patient in Group I and one patient in Group II developed a wound erythema. Two patients in group I and one patient in Group II developed deep vein thrombosis postoperatively who were treated by subcutaneous injection of low molecular heprins.

Trans-syndesmotic fixation was required in 64 patients of Group I. In Group II (34 patients), no trans-syndesmotic fixation was performed after fixation of the PM fractures.

Probably due to short or mid-term follow up, we did not see any differences of posttraumatic osteoarthritis either radiologically or clinically between group I and group II **(Fig 3 and 4)**.

The median of AOFAS score of the patients was 89 (80–94) in Group I and 92 (85–96) in Group II. AOFAS score was no difference between Group I compared to Group II (P > 0.05).

Figure 3. 47 years old male, slipped on a snow ground accidently, twisted ankle with trimalleolus fractures.

Figure 3-1. Initial injury radiographs showed a trimalleolus fractured ankle, an arrow indicated posterior malleolus fracture fragment in B.

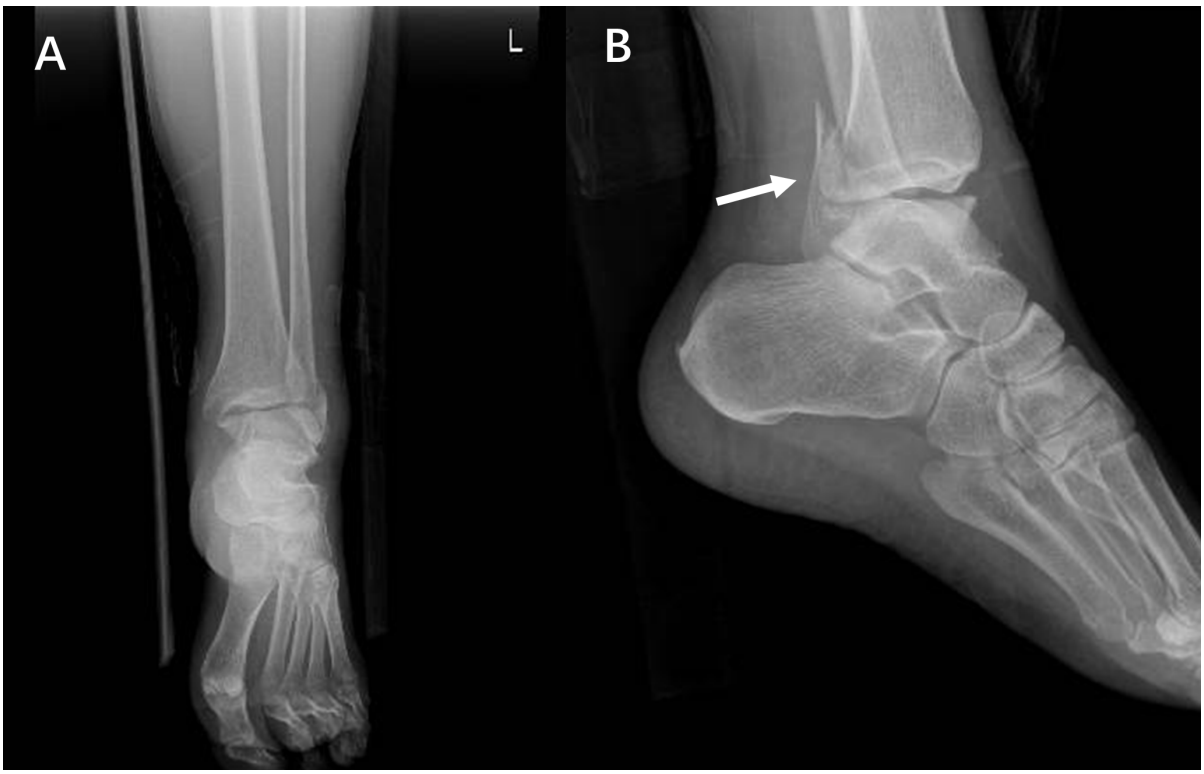


Figure 3-2. CT scans showed posterolateral malleolus fragment (arrows) that was shifting laterally causing syndesmotic diastasis. Anterior tibiotalus joint "V" sign indicated anterior capsule torn which was repaired with x2 suture anchors.

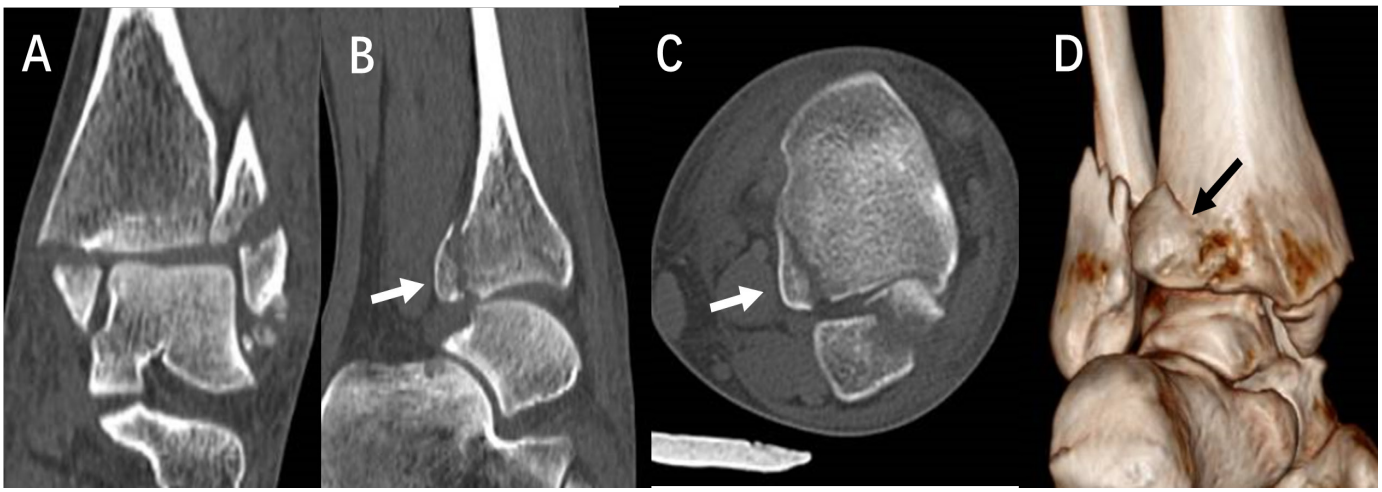


Figure 3-3. Postoperative radiographs showed anatomic reduction of all fractures and secured fixations including a trans syndesmotic screw fixation.

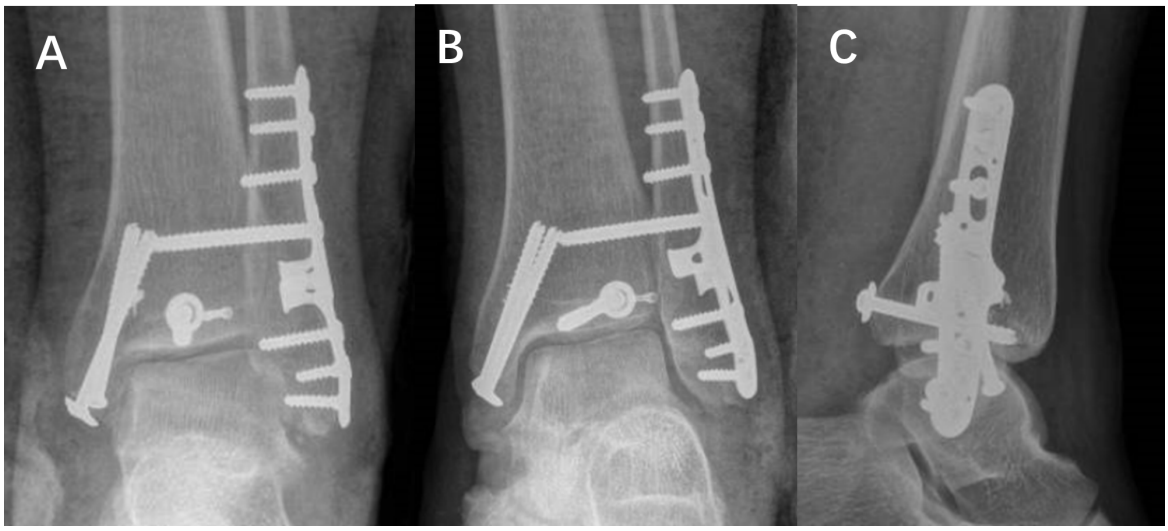


Figure 3-4. Two years postop, all implants were taken out due to local skin irritation but no osteoarthritis changes in ankle joint either clinically or radiologically.

Figure 4. 49 years old female, fell over on icing gourd, twisted her right ankle causing ankle fracture subluxation.

Figure 4-1. Initial injury radiographs showed malleolus fractures of the ankle (arrows in A) and PM fractures were hardly visualized on the lateral view radiograph (an arrow in B). Sagittal CT reconstruction image demonstrated that ankle joint was subluxed posteriorly with anterior "V" sign (an arrow in C).

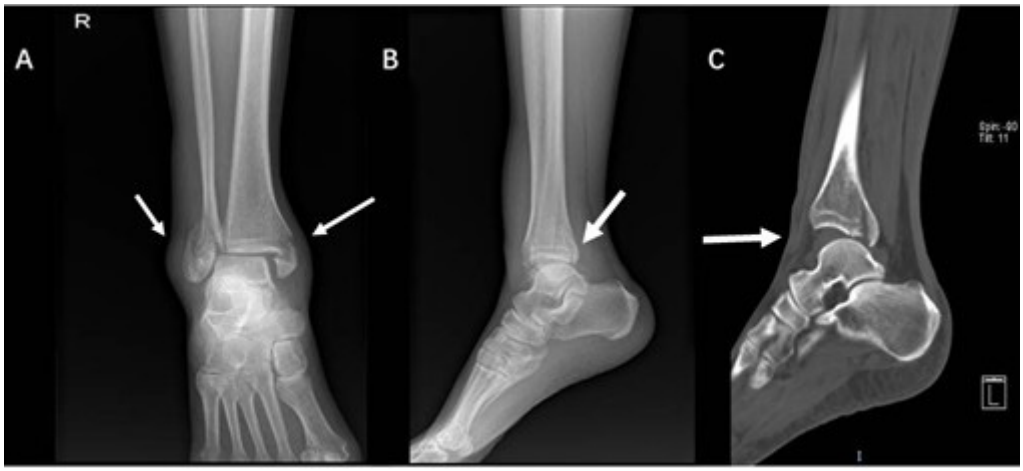


Figure 4-2. CT coronal, sagittal images clearly demonstrated a trimalleolus fractures of the right ankle (arrows in A and B). 3-D reconstruction images showed PM fracture which is connecting PITFL shifting laterally with lateral malleolus fractured fragment (black arrows in C and D indicated PM fragment).

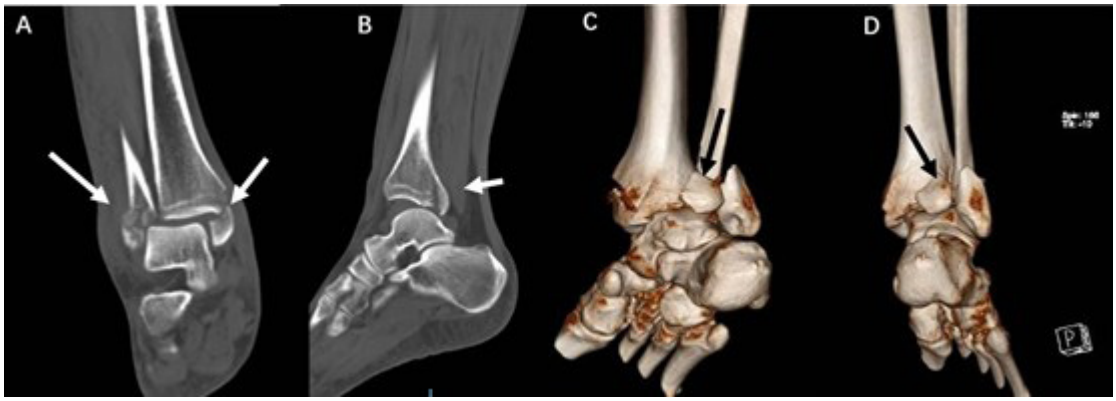


Figure 4-3. A year postoperatively, radiographs showing PM fragment was fixed with large cortical screw with a washer, indicated with arrows in A B and C, spared transsyndemotic fixation

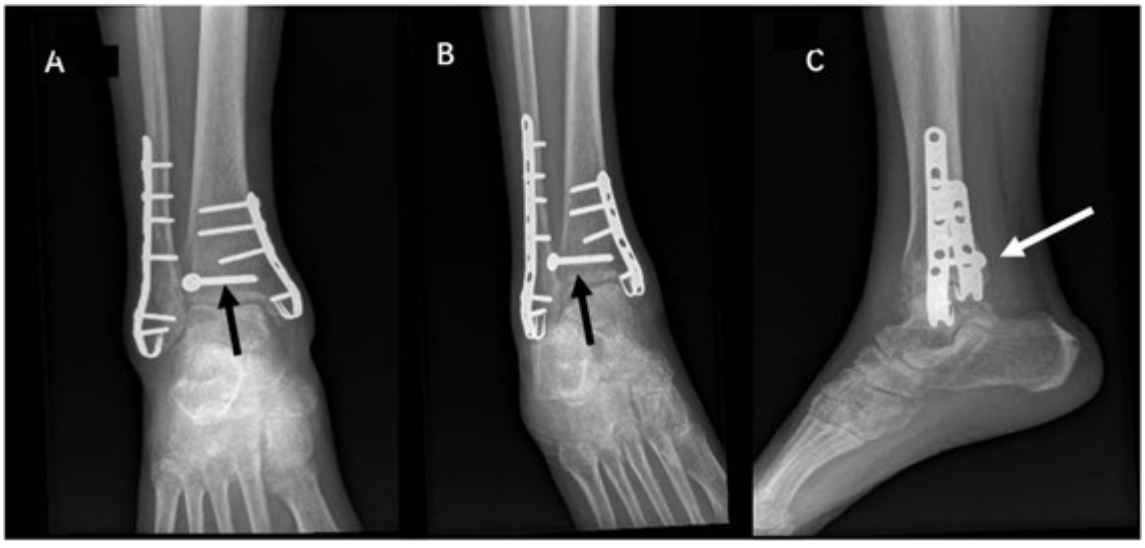
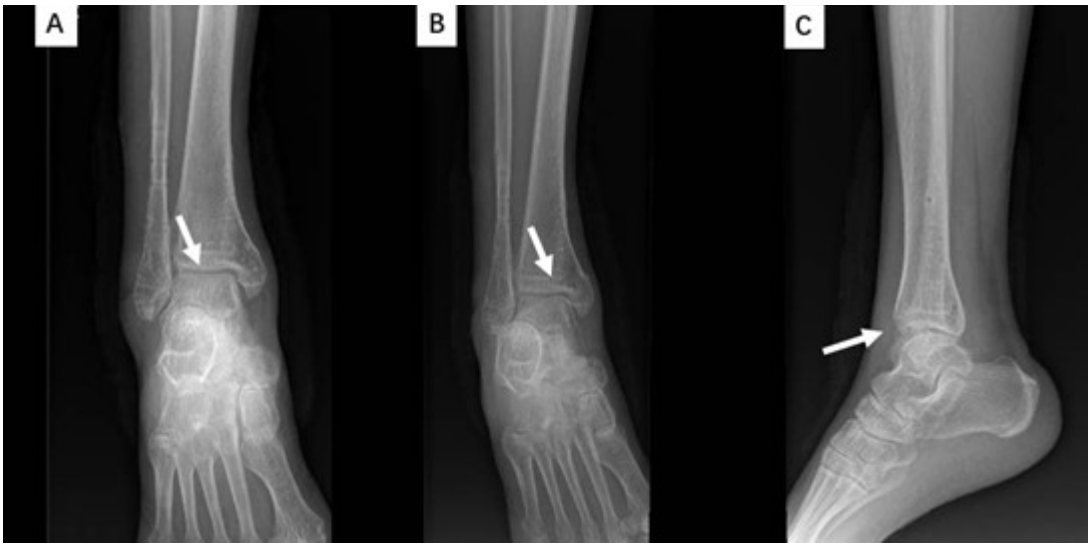


Figure 4-4. Two years after index surgery, all implants were taken out completely and there is no osteoarthritis changes in ankle joint in orthogonal views (arrows in A, B and C).



DISCUSSION

Ankle fractures are common and account for close to four percent of all fractures in the entire body [20]. Posterior malleolus fractures accompany about 7%–44% of ankle fractures [21, 22]. The injury is thought to be secondary to external rotation of the talus under the tibial plafond with the foot in a pronated or supinated position [23-25]. In ankle fractures, due to the simplicity of the procedure, both malleoli stay just underneath the skin, much easier for internal fixation unlike PM fracture fragment deep under posterior compartment, usually is left unfixed in early literature.

The PITFL complex is regarded as core for the stability of the ankle syndesmosis [26-29]. Posterior malleolus fractures alter the tibiofibular syndesmotic stability [30]. When the posterior malleolus is fractured, the posterior syndesmotic ligaments are remaining intact and attached to the PM fragment. Failure through the PM usually suggests the integrity of the PITFL (31). Rigid fixation of the fibula followed by reduction and fixation of the posterior malleolar fracture may restore the ligamentotaxis of the PITFL adequately and stabilize the syndesmosis without trans-syndesmotic fixation [31]. In a biomechanical study of Gardner et al., 70% stiffness of the distal tibiofibular articulation was restored by reducing and stabilizing the posterior malleolus compared to 40% through the use of a syndesmotic screw [31].

Numerous authors prescribe resorting to posterior malleolar stabilization with internal fixation when the fragment involves >25% of the articular surface [2, 8 11, 13, 17, 28, 32-34]. This recommendation is based on the biomechanical evidence of decreased joint surface contact area assuming from the posterior tibial fragment size and resulting in tibiotalar instability rather than on the presumed goal of restoring rotator ankle stability [11, 13, and 32]. Van den Bekerom et al [35] detected a shift in the location of the contact stresses to a more anterior and medial location after a displaced posterior malleolar fracture using biomechanical model.

Many authors addressed the ankle fractures with posterior malleolus. Rigid fixation of lateral malleolus could yield a near anatomic reduction of the posterior malleolus [15, 36]. Although the posterior malleolus reduces with a closed reduction, maintaining the reduction may be difficult without a rigid fixation. The decision about surgical fixation of the posterior malleolus is traditionally made based on its size, and small avulsion fractures are usually left unfixed [2, 11]. Larger fragments involving >25% of the tibial plafond require surgical reduction and fixation [2, 5, 7-14]. However, newer literature does not rely on size of post malleolus for fixation. Heim claimed that all posterior fragments, except for the avulsion lip fractures, should be fixed internally [33].

Studies of posterior malleolus fractures have analyzed relatively small patient group sizes [30]. Classification of these fractures, indications for surgical intervention, surgical approach, and operative technique remain subject of debate. Bois and Dust [3] found radiographic osteoarthritis of Grades II or III in 67% of their series at an average of 9.4 years after ankle fracture. They concluded that radiographic changes consistent with ankle osteoarthritis might be well tolerated early in the disease process.

Park et al [37] treated 29 ankle fractures with a posterior malleolar fragment. Syndesmotic screw fixation was used in 15 cases, whereas 14 cases were treated using posterior malleolar fixation. They found no statistical difference in the quality of reduction, grade of ankle arthrosis, and clinical scores between groups [37]. Chung et al. treated 15 cases of posterior malleolus fracture, yielding 5 excellent and 7 good outcomes [38]. Lee et al. investigated ten cases of trimalleolar fractures, all patients in their series received excellent AOFAS

score following open reduction and internal fixation of posterior malleolar fragment [39]. Xu et al. found no statistical difference in the treatment effect between 42 cases of fixed and 60 cases of unfixed posterior malleolus fragment groups [21].

Gardner et al. treated syndesmotic instability with traditional trans-syndesmotic fixation methods that have been found to have a 52% rate of malreduction, as evaluated by CT compared to plain radiographs that show well-reduced fractures [40]. Miller et al. suggested that fixation of posterior malleolus fracture is more likely to restore stability to the syndesmosis compared to trans-syndesmotic fixation alone [16]. Ogilvie-Harris et al showed that the PITFL alone makes up 42% of the strength of the syndesmosis [41]. Gardner et al. evaluated the integrity of PITFL after ankle fractures associated with posterior malleolar fracture and suggested that this kind of fracture has an intact PITFL [31]. Based on these studies, it may be concluded that, in most ankle fractures involving a posterior fragment, PITFL can be functioned by reduction and fixation of posterior malleolus, thereby providing fixation of the syndesmosis and eliminating the need for syndesmotic transfixation.

In our earlier cases, posterior malleolar fixation was decided according to fragment size and surgeons' preference. Our preferred method of fixation for ankle fractures with posterior malleolus fracture is fixation of the posterior malleolus with the lateral malleolus through a posterolateral approach, regardless of the size of the fracture fragment and the fixation of medial malleolus fracture from a separate medial incision. We believe that the stabilization of the syndesmosis through the intact PITFL by direct reduction of posterior malleolar fragment results in more anatomic reduction of the tibiofibular articulation.

The posterolateral ankle approach provides a clear internervous plane between the flexor hallucis longus and peroneal muscles. However, the sural nerve, which passes directly just beneath the skin, is potentially at risk of iatrogenic injury over the whole length of the incision during the posterolateral approach. The course of the sural nerve passes at the midportion of the posterolateral incision at midway between the lateral malleolus and the Achilles tendon [42]. When performing a posterolateral approach to the ankle, particular care should be taken at the midpoint of the incision.

Our surgical preferences of the orders of trimalleolus fracture fixation is critical for surgical management. For trimalleolus fracture fixation, firstly reduction of the lateral malleolus fractures then posterior malleolus, the last medial malleolus fractures. Reduction and fixation of lateral malleolus fracture anatomically can facilitate ligamentotaxis of PITF ligament for maintaining reduction of the PM fragment anatomically for easier fixation of the posterolateral fragment and posterior medial fragment, and then, last medial malleolus fractures.

In present study, the benefits for internal fixation of the trimalleolus fractures without transsyndemotic screws are cost effective and avoid screw breakage and second surgery for screw removals (most Asians would like it to be out at 10-12 weeks postoperatively). However, intraoperatively fluoroscopy screening with external rotation stress tests or a Hook test are critical for necessity of the transsyndesmotic screw fixation. The degenerative changes in our patients were not obvious in between group I and group II. As we knew that radiographic changes of ankle osteoarthritis may be well tolerated early in the disease process nevertheless, long-term follow-up may help to elucidate whether no transsyndesmotic fixation for patients who have trimalleolar fractures is valid for surgical management of syndesmosis diastasis.

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