ORIGINAL ARTICLE

Importance of fixation of posterior malleolus fracture in trimalleolar fractures: A retrospective study

Sinan Karaca, M.D.,[1] Meriç Enercan, M.D.,[2] Güzelali Özdemir, M.D.,[1] Sinan Kahraman, M.D.,[3] Mutlu Çobanoğlu, M.D.,[4] Metin Küçükkaya, M.D.[3]

[1]Department of Orthopedics and Traumatology, Fatih Sultan Mehmet Training and Research Hospital, İstanbul-*Turkey*
[2]Department of Orthopedics and Traumatology, İstanbul Florence Nightingale Hospital, İstanbul-*Turkey*
[3]Department of Orthopedics and Traumatology, Adnan Menderes University Faculty of Medicine, İstanbul-*Turkey*
[4]Department of Orthopedics and Traumatology, İstanbul Bilim University Faculty of Medicine, İstanbul-*Turkey*

ABSTRACT

BACKGROUND: The aim of this retrospective study was to evaluate treatment effect and importance of posterior malleolus (PM) fixation in surgically treated trimalleolar fractures.

METHODS: A total of 57 cases of ankle joint fracture involving PM and treated with open reduction and internal fixation technique between 2004 and 2011 were evaluated. PM fixation was performed with cannulated screws in 46 cases, and in 11 cases, PM plate was used. All patients were assessed using American Orthopaedic Foot and Ankle Society (AOFAS) score, American Academy of Orthopedic Surgeons (AAOS) foot and ankle questionnaire, and Visual Analog Score (VAS) pain scale. Ankle joint mobility was also compared with unaffected side.

RESULTS: Mean follow-up period was 44.6 months (range: 24–108 months). There were 36 female patients and 21 male patients between 23 and 85 years of age (mean: 55.9 years). Average time to surgery was 1.1 day (range: 1–3 days). According to AOFAS assessment, result was excellent in 21 patients and good in 26 patients. AAOS score was 92.4 (range: 32–100). Mean VAS score when resting was 1.1, and mean score was 1.3 when walking (range: 0–10). When compared with uninjured side, there was no significant difference in plantar flexion of ankle (p=0.325) but there was significant difference in dorsiflexion of ankle joint (p<0.001).

CONCLUSION: Anatomical reduction and rigid internal fixation of PM provide satisfactory clinical and functional outcomes even in elderly patients where bone quality may make adequate fixation difficult. Fixation of even small PM fragments can facilitate rehabilitation by creating more stable construction.

Keywords: Ankle fracture; posterior malleolus; syndesmosis injury.

INTRODUCTION

Ankle fractures are relatively common, with an incidence of roughly 187 fractures per 100,000 people each year.[1] Posterior malleolus fracture (PMF) occurs in 7% to 44% of all ankle fractures, most in the setting of rotational ankle fractures,[2,3] and are rarely seen alone.[4]

Address for correspondence: Meriç Enercan, M.D.
İstanbul Florence Nightingale Hastanesi, Ortopedi ve Travmatoloji Kliniği, İstanbul, Turkey
Tel: +90 212 - 375 65 65 E-mail: mdsnn@hotmail.com

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PM fracture may occur as part of any rotational mechanism, and fragment size varies. Large fragments are often associated with posterior fracture dislocation of the ankle and can be difficult to keep in reduced position. PM is significant stabilizer preventing posterior subluxation of the ankle; however, primary restraint to posterior forces is the anterior tibial fibular ligament and the fibula. In general, most PMF tend to be small, laterally based fragments, still connected to the posterior tibiofibular ligament.[5]

Optimal treatment of ankle fractures, including PMF, has not been fully established.[6] While surgical treatment of displaced fractures of the medial and lateral malleolus is common,[7] when PM is also fractured, the trimalleolar pattern, necessity for fixation of that fragment is less clear.

Several biomechanical studies have demonstrated that PM has an important role in transferring load between the distal tibia and the talar dome, as well as in posterior stability, especially when lateral restraints are injured.[8,9] Furthermore, several authors have suggested that arthritis is triggered by change in stress distribution on the articular surface, which is caused by change in the articular surface area at the distal end of the tibia and talar dome after PMF.[2,6,10]

Based on biomechanical, cadaveric, and small population studies, fragment size is frequently cited as one of the main indications for fixation with thresholds for surgery ranging from 25% to 33% of the anteroposterior (AP) dimension of the articular surface.[2,10–13] However, thus far there has not been any strong clinical evidence and no consensus.

Aim of this retrospective, clinical cohort study was to evaluate radiographic osteoarthritis (OA), function, and pain in patients who had operative treatment for trimalleolar ankle fracture.

MATERIALS AND METHODS

Patients and Inclusion Criteria

In all, 65 cases of ankle joint fracture involving PM that were treated with open reduction and internal fixation regardless of the size of fracture between January 2006 and December 2012 at our institution with a minimum follow-up of 2 years were reviewed retrospectively.

Inclusion criteria were (1) definitive diagnosis of unilateral ankle joint fracture based on clinical and imaging technologies, (2) open reduction internal fixation surgery performed by the same senior author, (3) involvement of PM, and (4) presence of complete clinical follow-up data.

Total of 57 of the 65 patients who met criteria for the study agreed to participate and were seen at outpatient clinic. Physical examination was performed, X-rays (mortise, AP, and lateral radiographs) were taken, questionnaires were discussed, and medical history and general patient characteristics were evaluated.

Mean follow-up period was 44.6 months (range: 24 to 108 months). Right ankle fractures accounted for 36 of those studied and 21 were left ankle.

At time of hospital admission, each patient's demographic information, medical history (including any diagnosis of diabetes mellitus), and smoking history were recorded (Table 1). Operative details (including tourniquet time) were recorded in database at time of surgery. Each patient's postoperative course, including incidence of postoperative complications (e.g., medical, surgical, thromboembolic, or genitourinary complications) and length of hospital stay, was also recorded. Postoperatively, all ankles were splinted and kept immobilized for 3 weeks. At that time, active-assisted ankle range of motion (ROM) exercise was initiated with referral to a physiotherapist. As general protocol, all patients did not bear weight on the injured extremity for 6 weeks and then advanced to weight bearing as tolerated.

Table 1. Demographic details of the patient population

Demographic	
n	57
Male/Female	21/36
Age (y)	55.9
Diabetes	3
Smoking	6
AO 44B	38
AO 44C	19
Body mass index (Mean±SD)	29.1±4.7

AO: Müller AO Classification; SD: Standard deviation.

Measurement and Evaluation Indices

Size of PM fragment was calculated as percentage of total distal tibial articular surface as measured in a straight line from anterior to posterior margins of articular surface on computed tomography (CT) scan (Fig. 1). All patients had been evaluated preoperatively with AP, lateral, and mortise X-rays, as well as 3-dimensional CT. To describe fractures, Müller AO Classification of fractures system was used (Table 1).

Fracture union was defined as loss of fracture lines in PM.

Figure 1. Distance between c and d divided by distance between a and b seen in lateral computed tomography scan is equal to percentage of fragment.

Post-traumatic arthritis imaging score on X-ray of ankle joint during follow-up was recorded and classified using the following scores:

0 indicated normal joint, 1 indicated osteophytes but no joint space narrowing, 2 indicated joint space narrowing with or without osteophytes, and 3 indicated disappearance or deformation of joint space.[14]

Ankle-Hindfoot Scale of American Orthopaedic Foot and Ankle Society (AOFAS)[15] and American Academy of Orthopedic Surgeons (AAOS) foot and ankle questionnaire[16] were used to asses functional outcome. Both scores range from 0 to 100 points, where 0 is the worst result possible. AOFAS consists of questionnaire examining pain (40 points), function in daily living (28 points), ROM (22 points), and ankle alignment (10 points). AAOS questionnaire is comprised of 25 questions regarding experience of ankle disability in the past week. Visual Analog Scale (VAS) was used to quantify pain at time of survey when resting and walking (score 0–10 where 0 represents no pain and 10 indicates unbearable pain). Finally, general physical examination of the ankle was performed and ROM of the affected ankle was evaluated.

Restriction in dorsiflexion was compared with contralateral, uninjured side; difference was noted as dorsiflexion restriction. Greater dorsiflexion restriction reflects worse outcome.

Statistical analysis included mean value of ROM of ankle joint on affected and unaffected side. Paired samples t-test was used to compare ROM value between ankles. P value of <0.05 represented statistical significance.

RESULTS

Fifty-seven patients were evaluated. There were 36 females and 21 males, from 23 to 85 years of age (mean: 55.9 years). None of the patients had pre-existing ankle arthritis. Etiology was motor vehicle accident for 16 (28.1%) patients, fall from height for 18 (31.5%), and ground-level fall for 23 (40.3%).

In 46 cases, after anatomical reduction of lateral and medial malleolus, PM fixation was performed with 1 or 2 3.5 mm cannulated screws, from anterior to posterior in 35 cases (Figure 2), and from posterior to anterior in 11 cases (Figure 3). In remaining 11 cases, PM plate was used for fixation (Figure 4).

Average time to surgery was 1.1 day (range: 1–3 days). Mean tourniquet time was 96 minutes (range: 78–109 minutes). Mean fragment size was 21.06±6.24% (range: 13–36%). In 38 cases, fragment size was <25%, while in 19 cases, fragment size was ≥25%. Mean fragment size and percentage of involved distal tibial articular surface was 18.65±3.83% (range: 13–25%) in PMF fixed with cannulated screws and 31.22±3.56% (range: 25–36%) when plate was used.

Average length of hospital stay was 6.3 days (range: 3–21 days). There was 1 superficial wound infection, which resolved with use of oral antibiotics after index surgery. No

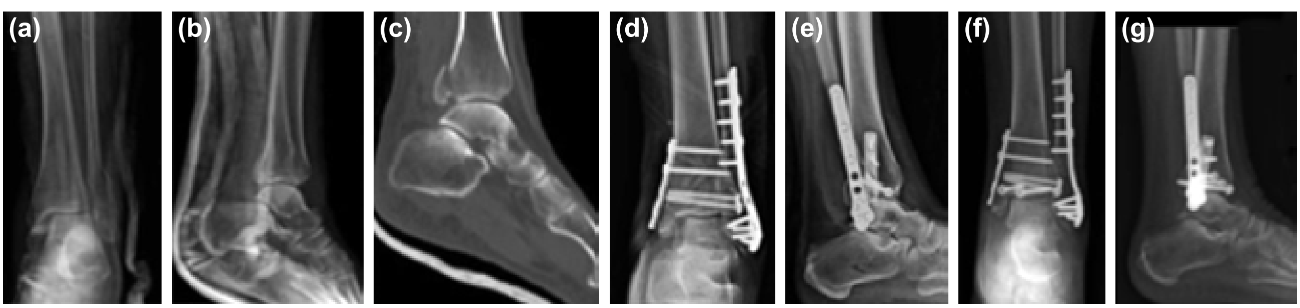

Figure 2. Posterior malleolar fracture treated with anteroposterior screw fixation **(a)** preoperative anteroposterior X-ray, **(b)** preoperative lateral X-ray, **(c)** preoperative sagittal section, **(d)** intraoperative anteroposterior X-ray, **(e)** intraoperative lateral X-ray, **(f)** postoperative 2-year X-ray, **(g)** postoperative 2-year lateral X-ray.

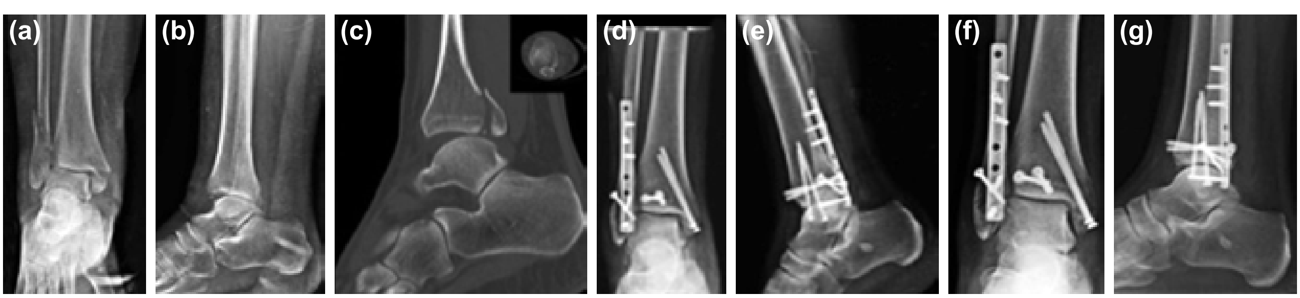

Figure 3. Posterior malleolar fracture treated with posteroanterior screw fixation **(a)** preoperative anteroposterior X-ray, **(b)** preoperative lateral X-ray, **(c)** preoperative sagittal section, **(d)** intraoperative anteroposterior X-ray, **(e)** intraoperative lateral X-ray, **(f)** postoperative 2-year X-ray, **(g)** postoperative 2-year lateral X-ray.

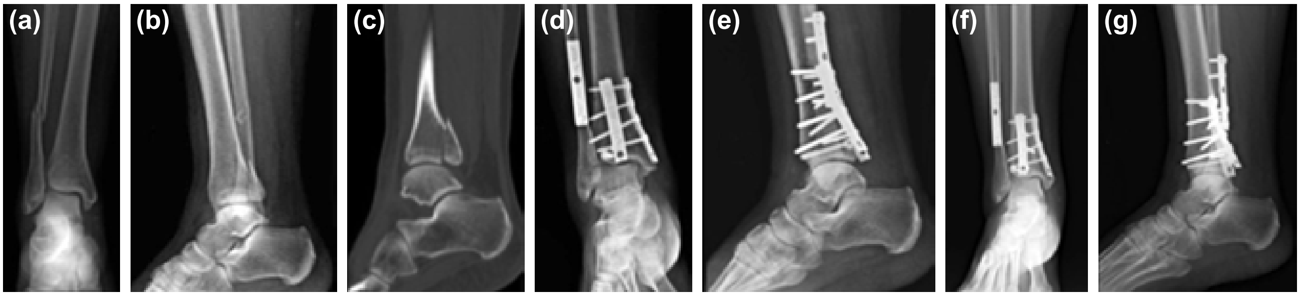

Figure 4. Posterior malleolar fracture treated with plate fixation **(a)** preoperative anteroposterior X-ray, **(b)** preoperative lateral X-ray, **(c)** preoperative sagittal section, **(d)** postoperative 6-month X-ray, **(e)** postoperative 6-month lateral X-ray, **(f)** postoperative 2-year X-ray, **(g)** postoperative 2-year lateral X-ray.

loss of reduction occurred on radiographic follow-up, and no hardware irritation or failure was seen. Clinical union of fracture was achieved in 3 months in all patients.

At final follow-up, arthritis score was 0 or 1 (mean: 0.63) for all patients. AOFAS score indicated results were excellent in 21 patients and good in 26 patients. Mean AAOS score was 92.4 (range: 32–100). Mean VAS score was 1.1 when resting and 1.3 when walking (range: 0–10).

Average dorsiflexion was 14.8°±2.7° (range: 11–23°) on affected side and 22.3°±2.5° (range: 17–27°) on unaffected site. Loss of dorsiflexion of ankle joint in affected side was mean 7°. There was significant difference in dorsiflexion of ankle joint between sides ($p<0.001$). Average plantar flexion was 38.6°±3.5° (range: 33–44°) in affected side and 47°±3.1° (range: 41–54°) in uninjured side. But there was no significant difference ($p=0.325$) in plantar flexion of ankle joint between sides (Table 2).

DISCUSSION

In recent years, there has been increased interest in fixing PMF fragments.[5,7,13] It is thought that it might reduce development of OA, which would ultimately result in better function. As of yet, however, there is no good scientific evidence of this.

Table 2. Comparison of range of motion between affected and unafffected side

	Dorsiflexion	Plantarflexion
	Mean±SD (Min.-Max.)	Mean±SD (Min.-Max.)
Affected side	14.8°±2.7°	38.6°±3.5°
	(11 to 23)	(33 to 44)
Unaffected side	22.3°±2.5°	47°±3.1°
	(17 to 27)	(41 to 54)
P value	<0.001	0.325

SD: Standard deviation; Min.: Minimum; Max.: Maximum.

Treatment of ankle fractures involving PM has been source of intense debate over the last several decades. Both non-operative and surgical treatments have been proposed by many authors. Factors such as fragment size, joint congruity, and talocrural and syndesmotic stability have to be taken into account for optimal treatment of PMF. While some authors have found no differences in clinical outcomes and ankle stability in PMF treatment based on posterior fixation, others have found that reduction and fixation performed on large fragments yields better results.[2,11,17,18] Furthermore, non-anatomical reduction of PMF leads to worse outcomes than non-operative treatment.[19]

In this study, all PMF were fixed and there was normal reduction. Good clinical results were obtained compared to unaffected ankle, AOFAS assessment was excellent/good for all patients, at rate of 21/26, and mean AAOS score was 92, which is comparable to other studies of outcomes after ankle fracture.[20,21] Mean VAS pain score was 1.1 when resting and 1.3 when walking (range: 0–10), which is also comparable to the literature.[20]

PM is an important structure of the distal tibiofibular joint, as it provides osseous restraint for the distal fibula as well as stability of the syndesmosis through the posterior inferior tibiofibular ligament (PITFL) and inferior transverse ligament. The other important effect of stabilizing PM is to restore attached PITFL to anatomic position with appropriate tension and integrity. This may be important even for smaller fractures when joint stress transfer is not significantly altered. Gardner et al. reported that increased syndesmotic stability was obtained in simulated cadaveric pronation external rotation stage 4 fractures after fixation of posterior fragment compared with conventional syndesmotic screw fixation.[5]

Another study suggested that CT scans might help to accurately determine size and anatomy of PM preoperatively.[22] In present study, all fractures were evaluated by CT scan preoperatively and size of fragment was measured on sagittal scan.

Restriction of dorsiflexion has been found to be significantly decreased compared with uninjured side.[23] In this study, we also found significant difference between injured and uninjured side when comparing dorsiflexion.

There is no consensus in the literature regarding fragment size of PMF that should be fixed. Minimum size of fragments fixed in the present study was 10%. Lindsjö et al. found significantly higher incidence of post-traumatic OA among patients with posterior fragments involving the tibial plafond (34%) than in fractures with small posterior fragments (17%) or no posterior involvement (4%).[11] Jaskulka et al. reported that even small PM fragments (tibial rim fractures) may increase risk of arthritis.[2] In our study, correlation between fragment size and arthritis was not evaluated. But score of arthritis was 0 or 1 on follow-up.

Limitations of this study include that there was no non-operative control group, and due to relatively small cohort, there was no comparison made between fragment size and results or between plate fixation and screw fixation. Retrospective nature of this study contributes to a certain amount of bias. Strengths of the study include that CT scan was used to measure size of fragments and results of minimum 2-year follow-up were evaluated.

Conclusion

In conclusion, unstable ankle fractures with PM involvement require surgical fixation. Fixation of even small PM fragments can facilitate rehabilitation by creating a more stable construction. This might stabilize the syndesmosis, and make early range of motion easier. Procedure offers benefit even in elderly patients where bone quality may make adequate fixation difficult.

Conflict of interest: None declared.

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ORİJİNAL ÇALIŞMA - *ÖZET*

Trimalleoler ayak bileği kırıklarında posterior malleol fiksasyonunun önemi: Retrospektif çalışma

Dr. Sinan Karaca,[1] Dr. Meriç Enercan,[2] Dr. Güzelali Özdemir,[1] Dr. Sinan Kahraman,[3] Dr. Mutlu Çobanoğlu,[4] Dr. Metin Küçükkaya[3]

[1]Fatih Sultan Mehmet Eğitim ve Araştırma Hastanesi, Ortopedi ve Travmatoloji Kliniği, İstanbul
[2]İstanbul Florence Nightingale Hastanesi, Ortopedi ve Travmatoloji Kliniği, İstanbul
[3]Adnan Menderes Üniversitesi Tıp Fakültesi, Ortopedi ve Travmatoloji Anabilim Dalı, İstanbul
[4]İstanbul Bilim Universitesi Tıp Fakültesi, Ortopedi ve Travmatoloji Bölümü, İstanbul

AMAÇ: Bu çalışmanın amacı cerrahi olarak tedavi edilen trimalleoler kırıklarda posterior malleol (PM) fiksasyonunun etkinliği ve önemini değerlendirmektir.

GEREÇ VE YÖNTEM: 2004 ile 2011 yılları arasında PM içeren ayak bileği eklemi kırıklı toplam 57 olgu açık redüksiyon ve internal fiksasyonla tedavi edildi. Posterior malleol fiksasyonu 46 olguda kanüllü vida ile, 11 olguda plak ise plak ile gerçekleştirildi. Tüm olgular Amerikan Ortopedik Ayak ve Ayak Bileği birliği Skoru (AOFAS), Amerikan Ortopedik Cerrahlar Akademisi Ayak ve Ayak Bileği Anketi (AOOS), Görsel Analog Skala (VAS) ve sağlam tarafla karşılaştırılan ayak bileği eklemi hareketliliği ile değerlendirildi.

BULGULAR: Yaşları 23 ile 85 arasında (ortalama 55.9) olan, 36'sı kadın ve 21'i erkek olan olguların ortalama takip süresi 44.6 (24–108) aydı. Cerrahiye kadar geçen süre 1.1 (1–3) gündü. AOFAS'a göre 21 olgu mükemmel ve 26 olgu iyi olarak değerlendirildi. AOOS skoru ortalama 92.4 (32–100) idi. Ortalama VAS istirahatta 1.1 ve yürümede 1.3 idi. Sağlam tarafla karşılaştırıldığında, ayak bileği eklemi plantar fleksiyonunda anlamlı farklılık görülmedi ($p=0.325$) ancak ayak bileği eklemi dorsifleksiyonunda anlamlı farklılık görüldü ($p<0.001$).

TARTIŞMA: Posterior malleolün anatomik redüksiyon ve rijit internal fiksasyonu, yeterli fiksasyon için zayıf kemik kalitesi problem olan yaşlı hastalarda bile tatminkar klinik ve fonksiyonel sonuçlar sağlar. Küçük PM fragmanlarının bile fiksasyonu rehabilitasyona daha stabil bir yapı oluşturabilir.

Anahtar sözcükler: Ayak bileği kırığı; posterior malleol; sindezmoz yaralanması.

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