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ORIGINAL ARTICLE

Is Fixation Necessary in Posterior Malleolus Fractures Accompanying Tibial Diaphyseal Fractures Treated with Intramedullary Nails?

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Abstract

Objective: The rate of posterior malleolar fracture accompanying the distal third tibial shaft fracture is extremely high. The surgical treatment of fractures with non-displaced posterior malleolar fracture remains a matter of debate. The aim of this study was to compare the clinical and radiological outcomes of distal third tibial shaft fracture fixation with or without non-displaced posterior malleolar fracture screw fixation.

Methods: Cases were evaluated in which intramedullar nailing was applied because of distal third tibial shaft fracture accompanied by posterior malleolar fracture between January 2016 and December 2021. Two groups were formed: those with and without posterior malleolar fixation in addition to intramedullary nailing. The clinical and radiological outcomes were compared between the groups.

Results: Posterior malleolar fracture was determined in 121 (41.7%) of distal third tibial shaft fracture. A total of 50 cases met the study inclusion criteria—31 from the group of patients who presented with posterior malleolar fixation and 19 from the group who did not present with posterior malleolar fixation. No significant difference was determined between the groups with respect to age, gender, side, dominant foot, and mechanism of injury ($P = .675$, $P = .106$, $P = .304$, $P > 0.999$, and $P = .706$, respectively). No significant difference was determined between the groups with respect to the operating time, bone healing, and the American Orthopedic Foot and Ankle Association score ($P = .147$, $P = .519$, and $P = .507$, respectively).

Conclusion: Posterior malleolar fracture was seen to accompany distal third tibial shaft fracture at the rate of 41.7%. Although >25% of the distal tibial joint surface was included in distal third tibial shaft fracture accompanied by posterior malleolar fracture, the application of posterior malleolar fixation did not prolong the operating time if the displacement was <2 mm. No difference was found between the 2 treatment techniques with respect to the American Orthopedic Foot and Ankle Association score and fracture healing.

Keywords: Tibial shaft fractures, intramedullary nail, posterior malleolar fractures, fracture fixation

Introduction

Tibial shaft fractures are one of the most commonly seen long bone fractures.[1] The rate of distal fractures is approximately 18% of all tibial fractures.[2] The majority of cases originate from high-energy trauma such as motor vehicle accidents, sports injuries, and fall from height.[1] It is worth mentioning that distal third tibial shaft fractures (DTTSFs) are accompanied especially by posterior malleolar fractures (PMFs).[3] Hou et al[4] reported that PMF accompany distal tibial fractures at the rate of 9.7% and recommended routine computed tomography (CT) imaging for analysis of these fractures. Behlmer et al[5] found that DTTSF was accompanied by distal tibial joint surface fracture at the rate of approximately 24%.

Intramedullary nailing is widely used in the treatment of tibial shaft fractures as it is a minimally invasive method.[6] However, the need for surgery in PMF remains a subject of controversy. When a decision is to be made with regard to surgery, Scheidt et al[7] recommended fixation, claiming that fragments comprising >25% of the posterior tibia cause talar translation. Subsequently, Raasch et al[8] reported that talar translation was not observed in PMF that included 40% of the distal tibial joint surface, and Harper et al[9] stated this rate to be 50%. Fitzpatrick et al[10] reported that the development of arthrosis was accelerated in PMF which included 50% of the joint cartilage. Although the importance of posterior malleolar stability in tibiotalar joint weight-bearing has not been fully clarified, the redistribution of weight on the ankle joint is affected, and this may create a predisposition for the development of post-traumatic arthritis in the patient.[11] The aim of this study was to determine whether fixation is necessary in PMF accompanying DTTSF or not.

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Material and Method

Approval for the study was granted by the Local Ethics Committee (registry number: 00174796252). Informed consent was obtained from all patients. A retrospective examination was made of 432 cases who underwent surgery in our clinic for a tibial fracture in the period January 2016–December 2021. A total of 290 (aged >18 years) cases, suffering from DTTSF were operated. The study initially included 121 cases of DTTSF accompanied by PMF.

Cases were excluded from the study if they were operated on using an implant other than intramedullary nail (n = 11), if they had a concomitant lower extremity fracture (n = 2), if they did not attend follow-up appointments (n = 4), or if they had a distal fibula

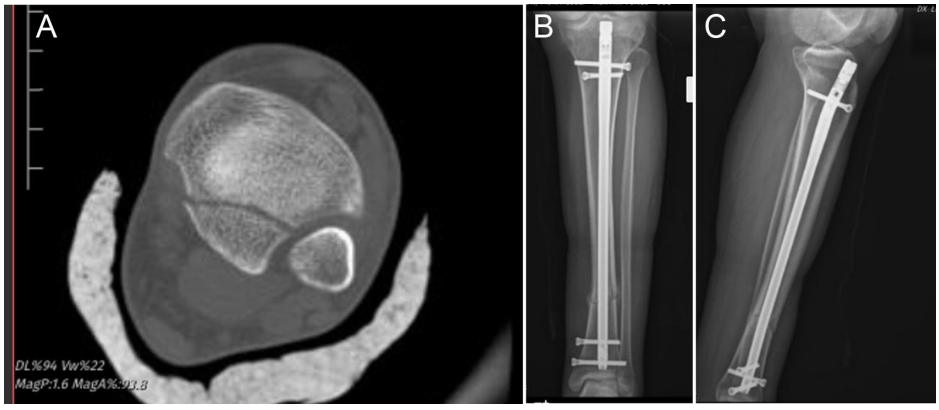

Figure 1. A-C. Case without posterior malleolar fixation. (A) Computed tomography image, (B) anterior posterior radiography, and (C) lateral radiography.

fracture (n = 7), or if they included <25% of the tibia plafond or displacement of >2 mm (n = 19). The PMF classification was made according to the Mason et al[12] criteria; type 2 and type 3 fractures were included in the study and type 1 fractures were excluded (n = 28).

In our clinic, CT is applied routinely to all cases determined with DTTSF. In the treatment of tibial shaft fractures, plate-screw fixation is used for those which include the distal region 5 cm from the tibial plafond on anterior–posterior (AP) or lateral radiographs, and for fractures at a higher level, intramedullar nails are used. If there is a concomitant distal fibula fracture, open reduction and internal fixation with a plate screw is performed at the same time. For PMF with >2 mm displacement and including >25% of the distal tibial plafond on imaging, fracture fixation is made with open or closed reduction.[13] The treatment of PMF with <2 mm displacement, but including >25% of the plafond, accompanying tibial shaft fracture is left to the decision of the surgeon.

All the cases were operated on by 2 surgeons according to the clinic approach. A standard single-dose antibiotic prophylaxis was administered to all patients preoperatively. All cases with posterior malleolar fixation were treated by applying 1 or 2 screws percutaneously from anterior to posterior before applying an intramedullary nail to the diaphyseal fracture with indirect reduction in the supine position. Patient was positioned supine on a radiolucent table with the effected limb semi-extended in 20-30° of flexion with a pre-countered foam wedge under the knee. Tourniquet was not used. A 2-3 cm midline incision was made over the quadriceps tendon, 2-3 cm proximal to the superior pole of patella. Quadriceps tendon was split to open the knee capsule. After sharp dissection of the capsule, the sleeve was introduced from patella–femoral sulcus with great care to prevent chondral damage. The entry point for the nail entrance was just medial to the lateral tibial eminence in the AP view and just edge of the anterior cortex and in line with the intramedullary canal in the lateral view. A maximum of 11.5 mm width nail was used with the suprapatellar approach (minimum 8.5 mm width). Reduction was performed with only manipulation. Distal locking was performed using magnetic locking device. Proximally and distally, nails were locked at least with 2 screws of appropriate length in 2 different planes. However, the number of the proximal or distal locking screws could change depending on the location and type of the fracture (Figures 1 and 2). No displacement of the posterior

Figure 2. A-C. Case with posterior malleolar fixation. (A) Computed tomography image, (B) anterior posterior radiography, (C) lateral radiography.

malleolar was observed during fracture fixation. All cases were closed reduced.

All the cases, with or without malleolar fracture fixation, were mobilized without weight-bearing on the fractured extremity on the day after the operation. A standard protocol of knee and ankle exercises was started immediately for patients whom PMF fixation was applied. In patients, who were not posterior malleol fixed, ankle brace was used for 3 weeks and then standard ankle exercises were started. All patients were asked to admit to the orthopedic polyclinics for follow-up examinations at 1, 3, 6, 12, and 24 weeks and at 12 months.

The cases in the study were separated into 2 groups: those who presented with PMF fixation (Yes-MF) and those who did not present with PMF fixation (No-MF). The groups were compared with respect to age, gender, fracture side, trauma mechanism, and concomitant distal fibula fracture. The operating times were compared between the groups. At the follow-up examinations, radiological reduction—loss of the fracture within the first 12 weeks—and absence of pain in the fracture line with joint movement and palpation were evaluated as fracture healing for both the tibial shaft and the malleolus.[14] Fracture healing taking longer than 12 weeks was defined as delayed union.[14] The status of bone union was compared between the groups. The American Orthopedic Foot and Ankle Association (AOFAS) Ankle-Hispanic Scale was used at the first-year follow-up examination to evaluate patient outcomes.[15]

Statistical Analysis

The conformity of quantitative variables to normal distribution was assessed with the Kolmogorov–Smirnov test. Independent groups of data were compared with the Mann–Whitney *U*-test or the independent samples *t*-test. Relationships between qualitative variables were examined with the Chi-square analysis. Continuous variables were stated as mean ± SD or median (25th-75th percentile) values, and categorical variables as number (n) and percentage (%). A value of $P < .05$ was accepted as statistically significant.

Results

The PMF determined in 121 (41.7%) DTTSF cases were evaluated. A total of 50 cases and 50 ankle met the study inclusion criteria, as 31 in the Yes-MF group and 19 in the No-MF group. No significant difference was determined between the groups with respect to age, gender, side, and dominant foot ($P = .675$, $P = .106$, $P = .304$, and $P = 1.000$, respectively). In the evaluation of the mechanism of injury, the fractures in the Yes-MF group were the result of fall from a height in 20 cases, in-vehicle (motor-vehicle) traffic accident in 7, and non-vehicle (pedestrian) traffic accident in 4. In the No-MF group, the injuries resulted from fall in 12 cases, in-vehicle traffic accident in 3, and non-vehicle traffic accident in 4 ($P = .706$) (Table 1). In cases with mid- and proximal region fibula fracture, no intervention was made to the fibula. In the preoperative radiological evaluation, none of the patients had signs of arthrosis.

The follow-up period was recorded as median 39 months (range, 17-47 months) in the Yes-MF group and median 30 months (range, 15-35 months) in the No-MF group ($P = .161$). Surgical time was median 48 minutes (range, 43-53 minutes) in the Yes-MF group and median 47 minutes (range, 45-54 minutes) in the No-MF group. Successful bone healing was seen in 29 cases and delayed bone healing in 2 cases in the Yes-MF group, and successful bone healing was observed in all the cases in the No-MF group ($P = .519$). In the 2 cases with delayed bone healing in distal tibial shaft, full bone union was determined in the 24th week. No case required reoperation. The AOFAS score was determined to be mean 84.87 ± 6.48 in the Yes-MF group and 83.63 ± 6.16 in the No-MF group ($P = .507$) (Table 2). In the first postoperative week follow-up examination, in the Yes-MF group, a superficial infection was detected at the wound site of 1 patient's knee. The infection recovered with oral antibiotic treatment.

No statistically significant difference was determined between the groups in terms of operating time, bone healing, and the AOFAS score ($P = .147$, $P = .519$, and $P = .507$, respectively).

Table 1. Comparison of Baseline Data Between Groups

Variable	With Malleous Fixation (n = 31)	Without Malleous Fixation (n = 19)	*P*
Age	37 (29-46)	42 (27-59)	.675
Side			.304
Right	19 (61.3)	8 (42.1)	
Left	12 (38.7)	11 (57.9)	
Dominant foot			.999
Yes	17 (54.8)	11 (57.9)	
No	14 (45.2)	8 (42.1)	
Gender			.106
Female	8 (25.8)	10 (52.6)	
Male	23 (74.2)	9 (47.4)	
Mechanism of injury			.706
Fall	20 (64.5)	12 (63.2)	
In-vehicle traffic accident	7 (22.6)	3 (15.8)	
Non-vehicle traffic accident	4 (12.9)	4 (21.1)	

Discussion

There is ongoing controversy on the subject of the incidence of PMF accompanying tibial shaft fractures and the diagnosis methodology.[2-5] Just as there are publications recommending routine CT imaging in the diagnosis of DTTSF,[16,17] there are also reports that careful examination of radiographs is sufficient for the diagnosis.[18] There is also controversy about the form of treatment for PMF accompanying tibial shaft fracture.[3,13,19-22] The importance of

Table 2. Comparison of Results Between Groups

Variable	With Malleous Fixation (n = 31)	Without Malleous Fixation (n = 19)	*P*
Follow-up (months)	39 (17-47)	30 (15-35)	.161
Surgical time (minutes)	53.63 ± 10.45	49.68 ± 8.39	.147
Bone healing			.519
Successful	29 (93.5)	19 (100)	
Delayed	2 (6.5)	0 (0)	
AOFAS	84.87 ± 6.48	83.63 ± 6.16	.507

AOFAS, American Orthopedic Foot and Ankle Association.

parameters such as the height and size of fracture fragments has been reported in the literature.[19,22] However, there are insufficient data stating the importance of fixation in non-displaced tibial shaft fractures accompanied by PMF treated with intramedullary nailing.

Schottel et al[23] reported a high rate of ankle injuries together with distal tibial fractures. They emphasized the difficulty of identification of these injuries and that the literature is lacking with respect to the evaluation of the results of untreated fractures. Boraiah et al[16] determined a high rate of PMF concomitant to distal tibial shaft fractures, especially spiral fractures. Routine CT imaging of the ankle joint has been recommended in distal tibial fractures to reduce morbidity associated with overlooked PMF. Lisitano et al[17] determined injuries related to the posterior of the ankle joint in 40.6% of DTTSFs.

To avoid complications such as arthrosis after additional operations, instability, and trauma, preoperative CT imaging of the ankle has been recommended in these fractures. Van der Werken and Zeegers[24] determined isolated PMF in 17 of 148 tibial fracture cases, and all of these were DTTSF. Of the 17 PMF, only 9 were detected preoperatively, 4 were determined during the operation, and the other 4 were identified as a result of retrospective examination. Kukkonen et al[18] examined 72 cases of operated tibial shaft fracture and reported PMF accompanying tibial shaft fracture in 18 (25%) cases. All the cases determined with PMF were reported to be concomitant to DTTSF. Of these 18 cases, only 10 could be diagnosed preoperatively. However, when examined retrospectively, it was reported that all the fractures could be seen on direct radiographs. Therefore, it was concluded that the preoperative ankle radiographs of cases with tibial shaft fracture should be examined more carefully and with a high level of suspicion.

In the current study, PMF was determined accompanying distal tibial fractures at the rate of approximately 41%. The rates of PMF accompanying tibial shaft fractures and the fact that significant morbidity can develop when these fractures are overlooked have been emphasized in the above-mentioned studies. However, there is no consensus on the subject of whether PMF accompanying DTTSF can be diagnosed from routine CT imaging or from careful examination of ankle radiographs. As CT imaging is performed routinely in our clinic in the diagnosis of all DTTSF, all the PMFs could be determined. Thus, this study demonstrates the benefit of routine ankle CT in DTTSF cases, which are associated with posterior malleolar injuries at a high rate.

Hendrickx et al[3] determined displaced PMF in some cases during the treatment of tibial shaft fracture with intramedullar nailing. Guo et al[19] compared the results of cases treated conservatively or with screw fixation applied from anterior to posterior in PMF accompanying tibial shaft fracture, including more or less than 25% of the tibia distal joint surface. No significant difference was observed with respect to the AOFAS and visual analog scale (VAS) scores between PMFs of small and moderate size that were fixed or not fixed with screws. However, treatment in that study was planned only according to the malleolus size.

Kempegowda et al[20] stated that PMF fixation should be performed first to prevent intraoperative PMF displacement. With this technique, even better reduction and outcomes were obtained compared to cases where the tibia was fixed first. In a study by Georgiadis et al.[13] 4 cases of tibial shaft fracture were treated with intramedullar nailing, and it was reported that PMF displacement occurred intraoperatively in patients where ankle problems had been overlooked preoperatively, and thus the importance of preoperative ankle evaluation was emphasized. In another study by Konrath et al.[21] successful results were reported to be obtained with screw fixation of distal intra-articular fracture in tibia diaphyseal fractures accompanied by PMF. In the current study, the treatment was planned according to preoperative PMF displacement in addition to the amount of the joint involved. In non-displaced fractures including >25% of the distal tibial joint, no significant difference was determined in the AOFAS and VAS scores between the cases with and without screw fixation of the PMF before nail application to the tibial shaft.

Zhang et al[22] aimed to calculate the risk of displacement with intramedullary nailing according to the height of the fracture fragment in PMF accompanying tibial shaft fracture and revealed the importance of the PMF height in the treatment decision. It was stated that when the PMF fragment is >31.2 mm in height, the possibility of secondary displacement is as high as 93%. In the current study, the malleolar height was not examined, and only the amount of displacement in the fracture and the size of the fractured posterior malleolar fragment were evaluated. In PMF cases with greater malleolar height, which are non-displaced and are >25% in size, evaluation of the AOFAS and VAS scores after intramedullary nailing of the accompanying tibial shaft fracture can be made as 2 studies combined. Thus, the effect of height can be seen in non-displaced fractures.

There were some limitations in this study, primarily that it is a retrospective study. Another limitation can be said to be that there was a relatively small patient group of cases with accompanying distal fibula fracture after the exclusion of cases with distal fracture not suitable for nailing.

In conclusion, the results of this study showed PMF accompanying distal third tibial shaft fractures at the rate of 41.7%. Although >25% of the tibial plafond was involved in PMF cases accompanying DTTSF, when the displacement was <2 mm, posterior malleolar fixation did not prolong the operation time, but the AOFAS score and fracture healing results were similar for both treatment options. Therefore, posterior malleolar may not be detected in such cases.

Ethics Committee Approval: Ethics committee approval was received for this study from the Ethics Committee of Health Sciences University Umraniye Training and Research Hospital (date: April 13, 2018; approval number: 2018-08.12).

Informed Consent: Informed consent was obtained from all patients.

Peer-review: Externally peer-reviewed.

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