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Ankle Fracture Fixation: Medial or Lateral First?

Ammar Karim, DO[1], Eric So, DPM, AACFAS[2], Benjamin C. Taylor, MD[3], Daniel Degenova, BS[4], William C. Nace, BS[4]

[1] *Orthopaedic Trauma Surgeon, Department of Orthopedic Surgery, Doctors Hospital, Columbus, OH*
[2] *Podiatric Surgeon, Department of Orthopedic Surgery, Doctors Hospital, Columbus, OH*
[3] *Fellowship Director, Orthopaedic Trauma and Reconstructive Surgery, Department of Orthopedic Surgery, Grant Medical Center, Columbus, OH*
[4] *Medical Student, Department of Orthopedic Surgery, Doctors Hospital, Columbus, OH*

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ABSTRACT

In unstable ankle fractures, the importance of reducing the lateral malleolus first to obtain an anatomic reduction of the talus is well established. Although this is a time-tested and common surgical approach, current surgical practice does not always follow the established dogma. Medial-first fixation may be a worthwhile alternative to lateral-first fixation in select instances. We performed a retrospective, cohort study in an urban level I trauma center to compare medial malleolus-first fixation of unstable ankle fractures with lateral malleolus-first fixation. Patient demographics, injury characteristics, and radiographic metrics including pre-, intra-, and final postoperative talocrural angles, medial clear space, and tibiofibular overlap were assessed. Complications were also reviewed. A total of 280 adult patients with operative bimalleolar ankle fractures from January 2010 to January 2015 met inclusion criteria. There were more open fractures (23.2% vs 9.4%, $p = .01$) and less isolated injuries in the medial-first group (59.2% vs 71.0%, $p = .02$). There were less isolated operative procedures (80.3% vs 89.1%, $p = .04$) and more intramedullary screw placement of the lateral malleolus (11.2% vs 4.3% $p = .02$) in the medial-first fixation group. There was also a strong trend in identifying more posterior tibial tendon injuries in the medial-first group compared with the lateral-first group (3.5% vs 0%, $p = .06$). There were no significant differences in fluoroscopy times or radiographic variables in the preoperative, intraoperative, or most recent postoperative images between either group. This approach demonstrates equivalent radiographic outcomes to lateral-first fixation and may be appropriate in select cases.

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Ankle fractures are one of the most commonly treated types of fractures in the United States, the incidence of which is approximately 187 fractures per 100,000 people each year (1). This rate has increased significantly in many industrialized countries, most likely because of growth in the number of people involved in athletics and in the size of the elderly population (2–4). As these injuries increase in frequency, so too does the surgical management of unstable ankle fractures.

For these unstable ankle fractures, the ideal treatment methods and postoperative rehabilitation regimens have been thoroughly investigated (5–7). Yablon et al. emphasized the importance of reducing the lateral malleolus first to obtain an anatomic reduction of the talus underneath the tibial plafond (8). The talus would essentially "follow" the anatomically reduced fibula and reduce the tibiotalar (ankle) joint with this maneuver alone (9–11). Although this is a time-tested and common surgical approach, current surgical practice does not always follow the established dogma. For example, obtaining an anatomic reduction of the fibula may be exceedingly difficult in the presence of comminution, osteopenic bone, soft-tissue incarceration, and in cases of bone loss. All of these factors may act to prohibit anatomic reduction of the fibula and thus reduction of the talus underneath the tibial plafond.

Considering this, the investigators believe that medial-first fixation is a worthwhile alternative to lateral-first fixation. Anatomically, the medial malleolus is connected to the talus via the deltoid ligament, and reduction may similarly act to reduce the talus underneath the tibial plafond. In addition, ankle fractures have been shown to have a not-insignificant incidence of soft-tissue injuries, such as ligamentous, cartilaginous, and posterior tibial tendon injuries (12–14). By approaching the medial side first, the surgeon may have an improved view of the tibiotalar joint itself and thus may be better able to diagnose and treat these injuries accordingly (10,15–17). The purpose of this study was to compare medial-first fixation to

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Address correspondence to: Benjamin C. Taylor, MD, Department of Orthopedic Surgery, Grant Medical Center, 285 E State St, Suite 500, Columbus, OH.

E-mail address: drbentaylor@gmail.com (B.C. Taylor).

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Table 1
Patient demographics and injury characteristics (n = 280)

Variable	Medial First Fixation (n = 142)	Lateral First Fixation (n = 138)	*p* Value
Age (years)	48.7 ± 17.4 (18–86)	47.8 ± 17.2 (19–84)	.68
Sex (Male)	39 (27.5%)	50 (36.2%)	.13
Diabetes mellitus	18 (12.7%)	18 (13.0%)	.63
Tobacco use	38 (26.8%)	42 (30.4%)	.69
Vascular disease	9 (6.4%)	5 (2.9%)	.15
Fracture laterality (right)	84 (59.2%)	72 (52.1%)	.70
Open fracture	33 (23.2%)	13 (9.4%)	*.01*
Isolated injury	84 (59.2%)	98 (71.0%)	*.02*
Tibiotalar dislocation	106 (74.7%)	98 (71.0%)	.53
Syndesmotic injury	51 (35.9%)	50 (36.2%)	.87

Categorical variables are given as absolute numbers with percentages in parentheses. Noncategorical variables are given as means ± standard deviations, with ranges in parentheses.

lateral-first fixation of bimalleolar and trimalleolar ankle fractures. We hypothesized that medial-first fixation will result in equivalent radiographic parameters and anatomic reduction compared to lateral-first fixation.

Patients and Methods

After institutional review board approval was obtained, prospectively collected trauma registry data were used to identify all patients with bimalleolar ankle fractures (identified by International Classification of Diseases, Ninth Revision, code) who were treated operatively between January 1, 2010, and January 31, 2015, by 1 of 6 board-certified, fellowship-trained trauma orthopedic surgeons at our institution, an urban Level 1 trauma center. A database (Microsoft Excel, Redmond, WA) was created that included all patients >18 years of age operatively treated for a bimalleolar ankle fracture within this period. Patients with previous ankle surgeries or ankle fractures, malleoli treated in different surgeries or with external fixation, age at the time of injury <17 years, and follow-up <1 year were excluded from the analysis. All ankle fractures included in the study were classified as AO/OTA 44 injuries. Electronic and written medical records were examined to collect demographic data, information regarding the patient's injury, perioperative data, and follow-up period data points (Table 1). Radiographic measurements, ankle fracture characteristics, and evaluation of patient data were performed by 2 medical students (D.D., W.N.), 1 senior resident (E.S.), 1 orthopedic trauma fellow (A.K.), and 1 fellowship-trained orthopedic trauma surgeon (B.T.) (Fig. 1).

Statistical Analysis

Statistical analysis was performed with means, ranges, and confidence intervals calculated for continuous variables and compared using Student's *t* tests. Frequencies were calculated for continuous variables and compared using Fisher's exact test for increased accuracy in small proportion analysis. A significance level of $p \leq .05$ was set as significant, with a trend defined as a *p* value being between .05 and .1.

Results

Ultimately, this analysis included 280 adult patients with unstable ankle fractures after applying inclusion and exclusion criteria. There were 138 patients (49%) in the lateral-first fixation group and 142 patients (51%) in the medial-first fixation group. There were more open fractures (Fig. 2) in the medial-first group versus the lateral-first group (23.2% vs 9.4%, *p* = .01); and less isolated injuries in the medial-first group versus the lateral-first group (59.2% vs 71.0%, *p* = .02). There were no significant differences with respect to other patient demographics or fracture characteristics (Tables 1 and 2).

In regard to operative variables, there were less isolated operative procedures in the medial-first group versus the lateral-first group (80.3% vs 89.1%, *p* = .04). There was less plating of the lateral malleolus (88.0% vs 95.7% *p* = .02), and more intramedullary screw placement of the lateral malleolus (11.2% vs 4.3%; *p* = .02) in the medial-first fixation group compared with the lateral-first fixation group. There was also a strong trend in identifying more posterior tibial tendon injuries in the medial-first group compared with the lateral-first group (3.5% vs 0%, *p* = .06) (Table 3). There were no significant differences in fluoroscopy times or radiographic variables in the preoperative, intraoperative, or most recent postoperative images between either group.

With regard to complications between the 2 groups, we found no statistically significant differences in any of the variables studied, with the sole exception being that there was a smaller incidence of deep vein thromboses in the medial-first group (2.9% vs 9.4%, *p* = .02). There was no difference in the superficial or deep infection rate between the medial-first and lateral-first fixation groups (superficial 4% vs 3%, *p* = .73; deep 3% vs 3%, *p* = .97). Superficial infections were defined as involving only the skin and subcutaneous tissue of the incision. Local wound care and oral antibiotics were administered. Deep infections were defined as involving deep soft tissue or bone. Deep infections required parenteral antibiotics, surgical debridement, and wound care.

Discussion

Fixation of bimalleolar ankle fractures by first addressing the lateral malleolus is a time-tested and accepted approach. It serves to anatomically reduce the fibula and ankle mortise, thus allowing the talus to center underneath the tibial plafond, as demonstrated by Yablon et al. (8). Although this strategy is widely accepted amongst orthopedic surgeons, alternative fixation strategies exist; the purpose of the current study was to evaluate medial-first fixation compared with traditional lateral-first fixation.

Although restoration of the lateral aspect of the ankle is important to ankle stability, the medial structures also should be given equal consideration. According to Davidovitch and Egol, the medial malleolus and the deltoid ligament (referred to as the "medial malleolus osteoligamentous complex") is key to keeping the talus reduced underneath the tibial plafond, restoring ankle stability, and highlighting the importance of an accurate and anatomic reduction of the medial malleolus (18). Clark et al. axially loaded a cadaveric bimalleolar ankle fracture model and assessed tibiotalar stability. They found that a 6-mm lateral displacement of the lateral malleolus had no change on the contact area of the ankle as long as it was axially loaded; however, once the deltoid ligament was sectioned, all ankles showed a significant decrease in tibiotalar contact area (19). Similarly, Solari et al. looked at a cadaveric model of Weber C bimalleolar ankle fractures. They found that fixation of the fibular fracture restored 32% of the rotational stability, whereas isolated fixation of the medial malleolus reconstituted 57%. Fibular fixation combined with a syndesmotic screw restored 51% of original stability, and the addition of medial malleolar fixation improved stability to 101% (20). There are also studies that highlight fixation of the medial malleolus alone in bimalleolar ankle fractures, such as the work of Svend-Hansen et al. and Joy et al.; however, those studies were associated with poor results when compared with bimalleolar fixation (21,22). Although the authors of this study recognize the importance of the medial malleolus and its fixation in unstable ankle fractures, we do not agree with medial-alone fixation for the vast majority of patients, but believe the notion that fixation of both sides are both roughly equally important, and that fixation of the medial side first has its merits.

In this study, we found a significantly higher incidence of open injuries in those ankles treated with medial-first fixation. Open fractures of the ankle are an important issue to be considered, and these injuries should be treated according to established surgical principles (23,24). Anatomic reduction and stable fixation is achieved after thorough debridement and lavage of the open wounds has taken place. In open ankle fractures, these wounds are most commonly transverse, and located on the medial side, just proximal to the medial malleolus fracture (Fig. 2). Because of the proximity of the medial-sided wound to the osseous injury, and considering the fact that the surgeon must debride that would before undergoing any sort of fixation, medial-first fixation may be indicated in this instance once the wound is thoroughly debrided.

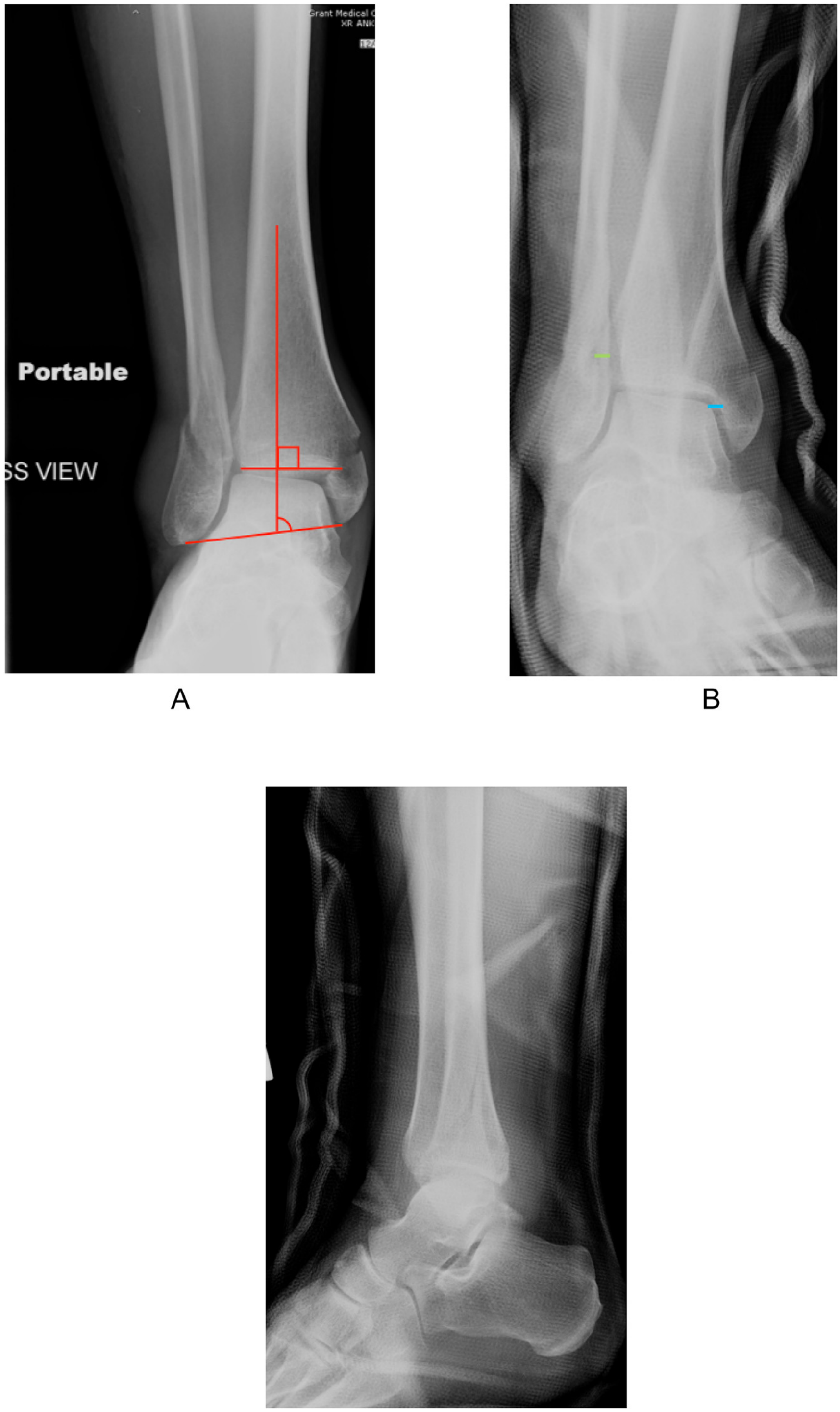

Fig. 1. (*A*) Prereduction radiograph of a bimalleolar ankle fracture demonstrating measurement of the talocrural angle (normal value 83° ± 4°). (*B*) Postreduction mortise radiograph demonstrating the tibiofibular overlap (green line; normal value >6 mm) and the medial clear space (blue line; normal value <4 mm). (*C*) Postreduction lateral radiograph.

Soft-tissue entrapment has been reported as a cause of irreducible ankle fractures. Medial-first fixation allows the surgeon to inspect the fracture site for any source of soft-tissue entrapment or injury by retaining the ability to “book open” the joint through the fracture site. The posterior tibial tendon, deltoid ligament, and joint capsule have all been implicated to interpose within the medial malleolar fracture and therefore prevent anatomic reduction (25–29). As such, a medial-first approach may allow for identification of these intraoperative findings more readily. Previous reports have also described the incidence of posterior tibial tendon ruptures with unstable ankle fractures (30,31). Medial bone fragments off the distal tibia may be a possible radiographic indicator suggestive of posterior tibial tendon injury (30,31). Difficulty with anatomic reduction and a pronation-external rotation mechanism of injury should also raise the surgeon’s suspicion for

Fig. 2. Clinical example of a typical transverse-oriented wound on the medial side of an open ankle fracture.

posterior tibial tendon rupture (31,32). It is important to recognize sources of interposition on the lateral side such as interposition of the capsule, anterior syndesmosis, or bony avulsions. Although not statistically significant, there was a strong trend in this study of identifying posterior tibial tendon ruptures with the medial-first approach. Accordingly, the medial-first approach may facilitate prompt identification and repair (Fig. 3).

We also found that there were statistically less plate and screw constructs, with an increased incidence of intramedullary screw placement of the lateral malleolus in the medial-first fixation group. In select situations, reducing the medial side first will result in locating tibiotalar congruency and improved ability to reduce the lateral malleolus fracture. With the lateral malleolus fracture appropriately reduced, it may be possible to forgo a formal open approach to the lateral malleolus and instead fix the fracture with a more percutaneous technique, such as the intramedullary screw (33).

The incidence of intra-articular pathology associated with ankle fractures is reported to be between 63% and 73% of patients (34,35). A recent study by Adams et al. found that acute intra-articular ankle fracture results in an overall catabolic environment. Consideration must be undertaken of early evacuation of the joint space with lavage to reduce the intra-articular inflammatory burden (36). Although lavage and inspection of the ankle joint is possible through the lateral-first approach, articular extension is inherent with medial malleolar fractures; therefore, the medial-first approach provides the advantage of accessing the ankle joint more readily via talar eversion for treatment of intra-articular loose bodies, osteochondral lesions, and joint lavage compared with lateral-first fixation.

In this study, we compared the radiographic reduction in patients with bimalleolar ankle fractures who had medial-first fixation to lateral-first fixation. The main finding of the current study was that there were no significant differences in the pre-, intra, or final postoperative radiographic metrics between the medial-first fixation and lateral-first fixation group. These findings suggest that medial-first fixation yields anatomic reduction that is noninferior to lateral-first fixation. The authors believe that this study can provide information regarding surgical treatment of bimalleolar ankle fractures, and broadens the available surgical approach that an orthopedic surgeon may apply to these injuries.

Table 2
Operative variables

Variable	Medial First Fixation (n = 142)	Lateral First Fixation (n = 138)	*p* Value
Time from Injury (days)	2.6 ± 4.0	3.3 ± 4.9	.15
Isolated procedure	114 (80.3%)	123 (89.1%)	.04
Fluoroscopy time (seconds)	63.4 ± 45.8 (10.8–164.8)	72.4 ± 33.5 (29.9–125.0)	.51
Medial malleolar fixation			
Screws	115 (80.1%)	102 (73.9%)	.07
Minifragment plate	23 (16.2%)	27 (19.6%)	.52
Tension band	4 (2.9%)	13 (9.4%)	.02
Lateral malleolar fixation			.02
Plate construct	125 (88.0%)	132 (95.7%)	
Intramedullary screw	17 (11.2%)	6 (4.3%)	
Posterior tibial tendon rupture	5 (3.5%)	0 (0%)	.06

Categorical variables are given as absolute numbers with percentages in parentheses. Noncategorical variables are given as means ± standard deviations, with ranges in parentheses.

The current study has important limitations. First, this is a retrospective review of 2 patient cohorts and carries biases inherent to this type of study design. Second, there was a strong trend in the medial-first fixation group to detect posterior tibial tendon injuries; however, this weak association is likely from a lack of significant power. Additionally, this was not a blinded study, and the selection of the approach was left to surgeon preference. Despite similar demographic profiles and operative details, we are unable to draw any conclusions regarding length of hospital stay, revision surgery, and other complication rates. Finally, radiographic findings do not take into account clinical outcomes. Because we did not collect clinical outcome data, we are not able to comment on functional outcomes; nonetheless, radiographic alignment and anatomic reduction often correlate strongly with clinical and functional deficits. Future analyses would include patient-reported outcomes as well as quantification of joint access and osteochondral debris removal with either approach.

Table 3
Radiographic and follow-up variables

Variable	Medial First Fixation (n = 142)	Lateral First Fixation (n = 138)	*p* Value
Preoperative measurements			
Talocrural angle	82.5 ± 8.1	82.2 ± 9.8	.74
Tibiofibular overlap	9.5 ± 3.9	9.8 ± 3.2	.48
Medial clear space	4.2 ± 1.7	4.2 ± 1.4	.70
Intraoperative measurements			
Talocrural angle	80.4 ± 3.3	80.7 ± 3.3	.55
Tibiofibular overlap	9.9 ± 2.9	10.1 ± 2.8	.70
Medial clear space	3.1 ± 1.0	3.1 ± 0.9	.88
Follow-up measurements			
Talocrural angle	79.3 ± 10.9	80.3 ± 7.1	.31
Tibiofibular overlap	8.6 ± 2.9	9.0 ± 3.0	.28
Medial clear space	3.2 ± 0.9	3.1 ± 0.9	.34
Complications			
Superficial infection	4 (3%)	3 (2%)	.73
Deep infection	3 (3%)	4 (3%)	.97
Deep venous thrombosis	4 (2.9%)	13 (9.4%)	.02
Nonunion	5 (3.5%)	3 (2.2%)	.72
Implant removal	22 (15.5%)	22 (15.9%)	.56

Categorical variables are given as absolute numbers with percentages in parentheses. Non-categorical variables are given as means ± standard deviations, with ranges in parentheses.

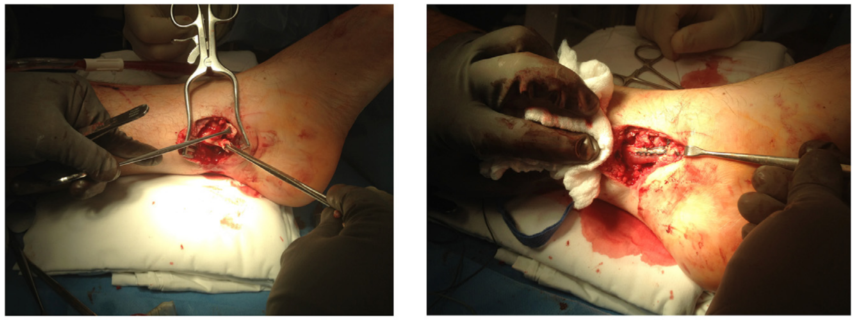

Fig. 3. Clinical examples of (*A*) a posterior tibial tendon rupture identified during fixation of an open bimalleolar ankle fracture and (*B*) its subsequent repair.

In conclusion, the authors would suggest that medial-first ankle fracture fixation is a valid surgical approach to the treatment of unstable ankle fractures. Our data demonstrate that there are equivalent radiographic outcomes compared with lateral-first fixation, with the advantage of identifying potential posterior tibial tendon injuries and in the treatment of open ankle fractures, especially those that already have a medial-sided wound. To the best of the authors' knowledge, this is the largest study to address this concept. In the future, we hope to encourage further prospective studies with clinical results to validate these findings.

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