Review Article

Management of Isolated Lateral Malleolus Fractures

Amiethab A. Aiyer, MD
Erik C. Zachwieja, MD
Charles M. Lawrie, MD
Jonathan R. M. Kaplan, MD

Abstract

Isolated lateral malleolus fractures represent one of the most common injuries encountered by orthopaedic surgeons. Nevertheless, appropriate diagnosis and management of these injuries are not clearly understood. Ankle stability is maintained by ligamentous and bony anatomy. The deep deltoid ligament is considered the primary stabilizer of the ankle. In the setting of an isolated lateral malleolus fracture, identifying injury to this ligament and associated ankle instability influences management. The most effective methods for assessing tibiotalar instability include stress and weight-bearing radiographs. Clinical examination findings are important but less reliable. Advanced imaging may not be accurate for guiding management. If the ankle is stable, nonsurgical management produces excellent outcomes. In the case that clinical/radiographic findings are indicative of ankle instability, surgical fixation options include lateral or posterolateral plating or intramedullary fixation. Locking plates and small or minifragment fixation are important adjuncts for the surgeon to consider based on individual patient needs.

From the Department of Orthopaedic Surgery, University of Miami Hospital, Miami, FL (Dr. Aiyer and Dr. Zachwieja), the Department of Orthopaedic Surgery, Washington University School of Medicine, Saint Louis, MO (Dr. Lawrie), and the Orthopaedic Specialty Institute, Orange, CA (Dr. Kaplan).

Dr. Aiyer or an immediate family member serves as a paid consultant to Medline and Paragon 28 and serves as a board member, owner, officer, or committee member of the American Orthopaedic Foot and Ankle Society. Dr. Lawrie or an immediate family member serves as a paid consultant to Medtronic. Dr. Kaplan or an immediate family member serves as a paid consultant to Medline and Paragon 28. Neither Dr. Zachwieja nor any immediate family member has received anything of value from or has stock or stock options held in a commercial company or institution related directly or indirectly to the subject of this article.

J Am Acad Orthop Surg 2019;27: 50-59

DOI: 10.5435/JAAOS-D-17-00417

Orthopaedic surgeons frequently evaluate and manage ankle fractures. Epidemiologic data report that isolated lateral malleolus fractures are the most common ankle fracture pattern (56% to 65% of all ankle fractures).[1,2] However, controversy remains in the orthopaedic literature about the appropriate evaluation and management of this ubiquitous injury. Current treatment paradigms are based on the stability of the ankle mortise. Isolated lateral malleolus fractures without lateral subluxation of the talus are stable, have a low chance of displacement, and do well with nonsurgical management.[3] Conversely, lateral malleolus fractures that have an incongruent ankle mortise are considered unstable and require surgical fixation.[4] Appropriate management has notable effects on outcomes. Sanders et al[5] noted in a randomized, controlled prospective study of 81 patients with nondisplaced, unstable isolated lateral malleolus fractures, that nonsurgical management resulted in an increased risk of fracture displacement and delayed union. Moreover, unstable fractures that are managed nonsurgically are associated with increased rates of posttraumatic ankle arthritis (PTAA).[3] Thus, determination of ankle stability is the crux of optimal management for isolated lateral malleolar injuries.

Anatomy

The ankle is a complex joint that comprises the talus, medial and lateral malleoli, and tibial plafond. In addition to the osseous architecture of the ankle mortise, three groups of ligamentous structures provide ankle static stability. The ligamentous support of the medial ankle comprises the deltoid ligament. The deltoid ligament contains both a superficial and deep layer. The deep layer originates from the intercollicular groove and posterior colliculus and inserts on the talus. The superficial layer originates from the anterior colliculus and inserts on the navicular, calcaneus (sustentaculum tali), talus, and spring ligament.[6]

The tibiofibular syndesmosis provides a soft-tissue connection between the distal tibia and fibula. It consists of the anterior inferior tibiofibular ligament, posterior inferior tibiofibular ligament, inferior transverse ligament, and interosseous ligament.[7] The lateral ligamentous structures of the ankle consist of the anterior talofibular ligament, calcaneofibular ligament, and posterior talofibular ligament.[6]

Biomechanics

The trapezoidal shape of the talus influences ankle motion. During dorsiflexion, the fibula rotates externally and translates laterally, accommodating the anteriorly wide talar dome. In plantarflexion, the narrower, posterior aspect of the talus is within the mortise, leading to internal rotation of the talus.[7] The ankle is considered stable when the talus moves in a normal physiologic pattern through full range of motion (ROM). In these conditions, most of the load is transmitted through the talar dome with the remainder through the medial and lateral talar facets.[8] Injury that leads to an unstable ankle and nonphysiologic movement of the talus within the tibial plafond markedly alters joint forces and contact pressures.

Under physiologic loading, the deltoid ligament is considered the primary static stabilizer of the ankle, preventing external rotation and lateral displacement of the talus.[9] The syndesmosis and lateral ligamentous structures are secondary stabilizers. Disruption of the deltoid ligament in isolation, or in conjunction with the syndesmosis, leads to lateral translation of the fibula and external rotation of the talus, shifting the center of contact pressure on the talus, and decreasing the overall contact area. Hunt et al[10] demonstrated this elevated total contact stress of the tibiotalar joint. Ultimately, this condition may increase the risk for articular cartilage damage and PTAA.

Injuries that destabilize the ankle joint generally require open reduction and internal fixation to restore normal joint kinematics. However, an injury without instability can be managed conservatively with the assumption that the biomechanics of ankle joint motion is not altered. Clinical studies have repeatedly demonstrated excellent results for nonsurgical management of stable ankle fractures.[3] Unfortunately, determining ankle stability after an isolated lateral malleolus fracture remains a diagnostic dilemma.

Classification and Diagnosis

Fracture diagnosis begins with standard AP, lateral, and mortise radiographs of the ankle. Based on radiographic findings, classifications have been developed to describe the mechanism of injury, predict soft-tissue injury, and determine the need for surgical intervention. The two most commonly used classifications are the Lauge-Hansen[11] and Danis-Weber systems.[12,13]

The Lauge-Hansen[11] classification for ankle fractures was developed in 1954 and is based on the position of the foot at the time of injury and the deforming force. Supination external rotation (SER) injuries are the most common and may result in an isolated lateral malleolus fracture at the level of the syndesmosis. SER-2 injuries are lateral malleolus fractures without ligamentous instability. SER-4 injuries involve a lateral malleolus fracture, injury to the anterior inferior tibiofibular ligament, posterior inferior tibiofibular ligament, and medial-sided structures, resulting in an unstable ankle. Although this remains the most commonly used classification, it is important to recognize that the original experimental technique that created these injuries involved manual application of rotational forces to a fixed foot and does not accurately re-create in vivo injury mechanisms of combined axial loading/rotational deformation. Rodriguez et al[14] found that the Lauge-Hansen classification was only 65% accurate in predicting radiographic fracture patterns based on observed injury mechanisms.

The Danis-Weber classification is based on radiographs and evaluates the position of the distal fibula fracture in relation to the syndesmosis.[12,13] Type A fractures occur below the level of the syndesmosis and are generally stable fracture patterns. Type B fractures, which correspond to the SER pattern described in the Lauge-Hansen classification, originate at the level of the syndesmosis (Figure 1) and may or may not be stable. Type C fractures occur above the level of the syndesmosis and are often unstable injuries.[15]

An ideal *classification* would help determine treatment. Unfortunately, neither of these systems has been shown to accurately predict instability or the need for surgical treatment and have limited prognostic capabilities.[16-18] In 2007, Michelson et al[18] developed a classification based on the stability of the injury pattern. Instability was defined as injuries requiring a reduction, loss of reduction, lateral displacement of the talus leading to increased medial clear space (MCS), which represents

Figure 1

Lateral, AP, and mortise radiographs of a 28-year-old woman with an isolated lateral malleolus fracture without an associated medial-sided injury. This scenario is consistent with an SER-2 injury. Note that the fibula fracture exits at the level of the tibial plafond, which corresponds to a Weber B fracture. This condition was managed nonsurgically in a well-molded short leg cast with a brief period of immobilization. SER = supination-external rotation

the distance from the superior-medial aspect of the talus to the superior-lateral aspect of the medial malleolus at the level of the talar dome, and bimalleolar or trimalleolar injuries; stable injuries were those that did not meet the abovementioned criteria. After a literature review of all articles pertaining to ankle fractures, treatment, and outcomes, the authors concluded that unstable ankle fractures have improved outcomes with surgical intervention, whereas nonsurgical treatment produces better results in stable ankle fractures. Pakarinen[19] also evaluated a stability-based classification. In this classification scheme, unstable injury patterns included high fibular fractures with positive stress tests, lateral malleolar fractures with talar shift or tilt on the mortise or lateral radiographs, and bimalleolar or trimalleolar injuries. Fractures not meeting these criteria were considered stable. Unstable fractures were managed with *surgical treatment*, and stable fractures were managed nonsurgically. The author found that by using this classification scheme to determine treatment, patients were successfully treated at a minimum follow-up of 2 years.

For the remainder of this article, the focus will be on evaluation and management of isolated Weber B ankle fractures.

Detecting Tibiotalar Instability

In the setting of an isolated Weber B lateral malleolus fracture, identifying whether tibiotalar instability is present is critical in deciding between surgical and nonsurgical management. Unstable fracture patterns with lateral translation of the talus or talar tilting on standard non–weight-bearing radiographs are suggestive of deltoid disruption and benefit from open reduction and internal fixation (ORIF) (Figure 2). However, patients with a reduced ankle mortise on radiographs require further investigation. A multitude of methods have been proposed to assess deltoid injury and tibiotalar instability, including stress radiographs, MRI, and physical examination alone.

One of the most common methods to assess tibiotalar instability is using the mortise view radiograph to measure the MCS (Figure 3). Murphy et al[20] reviewed 49 ankle radiographs without pathology and found the mean MCS in males to be 3.8 ± 0.7 mm and in females 2.9 ± 0.5 mm. Increased MCS is suggestive of deltoid ligament disruption and ankle instability. The authors found that tall patients and men were at risk for a false-positive diagnosis of deltoid rupture. Currently, consensus on the amount of MCS indicative of instability is lacking. Using initial non–weight-bearing injury radiographs, Schuberth et al[21] showed that for an MCS of 3 mm, 4 mm, ≥5 mm, and ≥6 mm, the false-positive rate for deltoid rupture was 88.5%, 53.6%, 26.9%, and 7.7%, respectively, compared with direct arthroscopic visualization of the ligament. This finding led the authors to conclude that deltoid ligament integrity cannot be predicted by the MCS on initial injury radiographs.

Findings of physical examination of medial-sided tenderness, swelling, and ecchymosis are also unreliable at determining instability. DeAngelis

Figure 2

A 19-year-old woman with isolated lateral malleolus Weber B fracture. **A**, Obvious medial clear space widening and lateral subluxation of the talus are present on initial injury radiographs, indicating an unstable ankle mortise. **B**, The patient underwent successful open reduction and internal fixation (ORIF).

Figure 3

Mortise radiograph showing measurement for medial clear space.

et al[22] evaluated 55 patients with Weber B lateral malleolus fractures and a normal MCS on initial radiographs. They found that medial-sided tenderness as a marker of deltoid ligament injury had a sensitivity of 57% and a specificity of 59%.

Nortunen et al[23] assessed morphological factors on standard non–weight-bearing injury radiographs that may indicate stability. The authors evaluated 286 consecutive patients with an isolated lateral malleolus fracture without evidence of incongruity or medial widening on standard injury radiographs. Analysis revealed three independent radiographic variables that were predictors of stability: maximum width of the fracture line on the lateral radiograph of <2 mm, only two fracture fragments, and female sex. However, it is important to note that the specificity of detecting a stable lateral malleolus fracture in patients with posterior diastasis of <2 mm and only two fracture fragments was 39% and 13%, respectively, indicating a very high false-negative rate using these criteria.

Figure 4

Manual external rotation stress radiographs are performed with the ankle in neutral dorsiflexion, the tibia internally rotated 10°, and a manual external rotation force applied.

Manual External Rotation Stress Radiographs

Currently, dynamic imaging with the use of stress radiographs remains the standard practice to detect tibiotalar instability. Options include manual external rotation stress radiographs, gravity stress radiographs, or weight-bearing radiographs. Manual external rotation stress radiographs are performed by manually internally rotating the tibia approximately 10° while applying an external rotation to the foot with the ankle in neutral dorsiflexion (Figure 4). Studies have suggested that an MCS greater than 4 or 5 mm indicates deltoid ligament disruption. Park et al[24] obtained fluoroscopic mortise views of six cadaveric ankles after destabilizing the ankles according to the SER mechanism. The authors found a sensitivity, specificity, positive predictive value, and negative predictive value of 100% for absolute MCS >5 mm with applied dorsiflexion and external rotation. However, clinical data suggest otherwise. Schottel et al[25] noted that an MCS cutoff of greater than 5 mm produced a sensitivity and specificity of only 66% and 77%, respectively, for deltoid ligament tear confirmed by MRI. Using an MCS cutoff of 4 mm, the sensitivity was 73% and the specificity was 46%.

An inherent problem with manual stress examination is the reproducibility of the test. As noted by Park et al,[24] the position of the ankle when external rotation stress is applied affects the predictive value of the deep deltoid ligament status. The authors found the highest specificity and positive predictive value for deep deltoid injury when the ankle was held in a dorsiflexed position and an external rotation force applied. Another important consideration is that the amount of applied force necessary has not been determined.

Gravity Stress Radiographs

Alternatively, numerous studies have suggested the use of gravity stress radiographs to assess the competency of the deep deltoid ligament.[26-28] Gravity stress radiographs are performed by placing the patient in the lateral decubitus position with the injured side down. The most distal half of the leg is then placed over the end of the table, allowing the foot to fall into external rotation because of gravity. A standard mortise radiograph of the ankle is then taken (Figure 5). The gravity stress view was first introduced by Michelson et al.[26] Using eight cadaver specimens, superficial and deep deltoid transection combined with fibular osteotomy produced a lateral talar shift of 2 mm or greater in all specimens when the gravity stress view was performed. Proposed benefits of this technique include no radiation exposure to the physician and the constant force of gravity as opposed to an unreproducible force applied by the practitioner. In addition, the position of the ankle does not affect the effectiveness of the examination.[29] Clinically, Schock et al[27] and LeBa et al[28] demonstrated in their prospective studies of patients with isolated SER fibula fractures that gravity stress radiographs are as effective as manual stress radiographs, while being less painful.

Weight-bearing Radiographs

Recent literature has questioned whether a positive stress radiograph indicates complete rupture of the deep deltoid ligament and consequent instability in patients with no MCS widening on initial radiographs. Koval et al[30] showed that 19 of 21 patients with MCS >5 mm on manual external rotation stress imaging and no lateral talar subluxation on static injury radiographs had a partial tear of the deep deltoid ligament on MRI; these patients were successfully treated nonsurgically. This has led to the investigation of using weight-bearing radiographs to evaluate ankle stability and dictate management. Hoshino et al[31] evaluated 38 patients with an isolated lateral malleolar fracture, a normal ankle mortise on non–weight-bearing static radiographs and a positive external rotation stress test. These patients were then placed into a short leg walking cast. They returned to the clinic seven days after injury and were evaluated with weight-bearing radiographs. If the MCS was less than or equal to 4 mm the patients continued nonsurgical treatment. If the MCS was greater than 4 mm, the deltoid ligament was considered ruptured, and the patient was offered surgical treatment. The authors noted that 8% of the patients had MCS widening at follow-up and were offered surgical treatment. At 1-year follow-up, the average American Orthopaedic Foot and Ankle Society (AOFAS) score was 91 ± 8.1, which is considered to be a good to excellent result. However, it should be noted that the AOFAS is a nonvalidated scoring system. These findings are consistent with results from Holmes et al;[32] patients with a Weber B ankle fracture and an intact mortise on initial non–weight-bearing radiographs were seen at 1-week follow-up and gravity stress views were obtained. Using an MCS cutoff of 7 mm, surgical treatment was recommended for those patients with values greater than this. Fifty-one patients without MCS widening on gravity stress views were followed for 1 year with serial weight-bearing radiographs to evaluate for MCS widening. At final follow-up, the mean AOFAS Hindfoot score was 93.2. All patients except one had decreased MCS at 1 year, and clinical fracture union was 100%.

Overall, identifying stability of the ankle can be assessed with manual external rotation stress radiographs, gravity stress radiographs, or weight-bearing radiographs. Weight-bearing radiographs take into account the inherent stability of the ankle in neutral position and have been shown to be an acceptable method for determining management.[30,31] However, they may be influenced by the amount of weight being placed by the patient. Gravity stress radiographs are not influenced by ankle position, rely on the constant force of gravity, and are less painful for patients. Manual external rotation stress radiographs are commonly used and have reproducible results if performed by well-trained personnel. Although the superiority of one imaging technique over the other has not been determined, treating clinicians must select the modality that is optimal for a given patient. Regardless of the modality used, evaluation of the MCS is important to gauge the presence of medial-sided injury. Although the absolute value of the MCS can be helpful for optimizing management, its utility may be limited by magnification or the radiographic technique. Comparing the MCS with the contralateral side or using the ratio of the superior clear space to the MCS may correct for this effect.

Figure 5

Gravity stress radiographs are performed with the patient in the lateral decubitus position with the most distal half of the affected leg over the table. A bump is placed under the calf allowing the foot to fall into external rotation.

Magnetic Resonance Imaging

The utility of MRI is also limited. Regardless of MCS, Nortunen et al[33] found that the deep deltoid ligament was injured in all patients with an SER fracture pattern. Similarly, they noted that although the severity of deltoid ligament injury correlated with increased MCS, remarkable variability was seen in measurements between similar MRI findings. On the basis of these findings, the authors do not recommend using MRI to aid in clinical decision making.

Management

If the medial malleolus is fractured or the talus is laterally translated on injury radiographs, surgical treatment is advocated. Weber B fractures that show no widened MCS or talar subluxation on stress imaging are considered stable and can be managed nonsurgically. Management of lateral malleolus fractures without joint subluxation on injury radiographs, but signs of instability on stress examination, is less clear. Classically, these patients were thought to benefit from surgical treatment. However, recent literature has sought to investigate this idea. Egol et al[17] noted that based on AOFAS scores, 100% (20/20) of patients with a positive stress radiograph (MCS $\geq$ 4 mm) and negative clinical signs of deltoid disruption (medial tenderness, ecchymosis, and swelling) managed nonsurgically had good or excellent clinical results. Two patients had persistent widening of the MCS at 7.4-month follow-up. Sanders et al[5] prospectively studied 81 patients with Weber B fractures and positive stress examinations randomized to surgical or nonsurgical treatment. No functional differences were found between the surgical and nonsurgical groups at 1-year follow-up. However, 20% of the nonsurgical group did show radiographic malalignment within 1 year after injury, and a higher rate of delayed union was found in this cohort. Although short-term follow-up demonstrates acceptable outcomes with nonsurgical management of stress-positive lateral malleolus fractures, the long-term consequences of radiographic malalignment and widened MCS are notable. Yde and Kristensen[34] demonstrated at a follow-up of 3 to 10 years that SER-4 ankle fractures with a nonanatomic reduction managed surgically had a good functional result in 83% of patients, compared with 55% in nonsurgically managed fractures. Similarly, Tunturi et al[35] demonstrated a strong association between fracture displacement and development of PTAA. Thus, we recommend surgical fixation of all stress-positive lateral malleolus fractures to avoid long-term sequela.

Nonsurgical Treatment

If the ankle is found to be stable, lateral malleolus injuries can be managed nonsurgically with either immediate weight bearing or a brief period of immobilization. Understanding the patients' symptoms, including pain with weight bearing, time elapsed since injury, bone quality, and risk factors for healing need to be considered. The senior authors primarily use pain levels to guide treatment. If the pain is severe (Visual Analog Scale six or higher), patients are placed into a well-padded/molded cast and kept non–weight bearing for 2 to 3 weeks and then transitioned into a walking boot. Patients with decreased pain (Visual Analog Scale five or less) are placed into a walking boot or ankle brace immediately, with emphasis on ROM exercises. Patients return 6 weeks after injury to obtain repeat weight-bearing radiographs to assess the status of fracture healing. Alternatively, patients may be brought back at more frequent intervals to gauge pain and obtain additional radiographs. It is important to consider that this protocol represents the practice of the senior authors. Provided that the patient has decreased pain and radiographs demonstrate healing/persistent ankle stability, formal physical therapy can begin to work on strengthening, gait training, ROM, and stretching.

Surgical Treatment

Surgical management of unstable isolated lateral malleolar ankle fractures is addressed through open reduction and internal fixation. Multiple fixation methods have been described, including lateral versus posterolateral plating, nonlocked versus locked plating, and intramedullary fixation. In the lateral plating technique, a one-third tubular plate or an anatomic distal fibular plate is used. Anatomic distal fibular plates are precontoured to match the anatomy of the lateral malleolus and allow for the placement of multiple screws in a nonlinear configuration. A nonlocking one-third tubular plate is most commonly used, either in the neutralization or bridging mode. The former is applied in conjunction with a lag screw, for interfragmentary compression between proximal and distal fragments of the fracture. Plate application in a bridging fashion is indicated when notable comminution is present or in fracture patterns not amenable to lag screw fixation. Length, rotation, and sagittal alignment can be accomplished through plate-assisted reduction maneuvers, such as a push screw technique or pulling the plate with a bone hook. Fixation calls for at least two to three bicortical screws proximal to the fracture and two to three screws distal to the fractures, which are often unicortical because of proximity to the distal syndesmotic and ankle joints. When using one-third tubular plates, we prefer to use 4.0-mm cancellous screws distally in metaphyseal bone because of improved pullout strength and maximum insertion torque.[36] The primary advantage of lateral plating with one-third tubular plates is the decreased cost compared with locking plates. Disadvantages include surgical implant prominence and potential for intra-articular screw penetration. However, newer low-profile anatomically contoured plates can help avoid soft-tissue irritation that screw placement into the distal fibula may cause.

Posterolateral plating of the fibula takes advantage of an antiglide mode of fixation. Although this is biomechanically the most stable construct, there has been concern for peroneal tendon irritation. Weber and Krause[37] retrospectively reviewed 70 patients who were treated with an antiglide plate for Weber B lateral malleolus fractures. The authors found that peroneal tendon irritation was associated with a prominent or oblique screw head in the most distal screw hole, specifically if it was a posteroanterior lag screw. Thus, in an effort to avoid peroneal irritation, we recommend avoiding placing the plate within 1 cm from the tip of the lateral malleolus. In addition, if a posteroanterior lag screw is required, we suggest placing a 2.0- or 2.4-mm screw under the plate or using a 2.7-mm lag screw through the plate. Bariteau et al[38] evaluated the biomechanical characteristics of minifragment and small fragment fixation constructs for the distal fibula in an effort to identify fixation options with a lower risk for soft-tissue irritation. The authors used osteoporotic synthetic fibular bone models to compare the biomechanical strength between these two groups. They found no statistically significant difference in the mean load to failure or mean stiffness between fixation constructs using either 2.4-mm screws or 3.5-mm screws. This led the authors to conclude that lower-profile *surgical implants* may be a suitable fixation tool, pending more clinical investigation.

In highly comminuted fractures, patients with osteoporotic bone, or short metaphyseal segments, locking plates are often advocated. Locking plates create a fixed-angle construct and rely on the strength of the screw head threading into the plates, thereby enabling stability with unicortical fixation. This phenomenon is in contrast to nonlocking constructs, which rely on friction created between the screw/plate and bone. Both one-third tubular plates and anatomic distal fibular plates are available in locking designs. Although locking plates have been found to provide superior fixation strength in osteoporotic fractures throughout the body, Davis et al[39] evaluated the biomechanical properties of locking and nonlocking plates in Weber B fibula fractures in a cadaver model. Evaluation of torsion, load to failure, and axial stiffness demonstrated no differences between the two groups. In a retrospective clinical analysis of precontoured locking distal fibular plates versus conventional one-third tubular plates, Lyle et al[40] found no difference in the complication rate or revision surgery rate at 2-year follow-up. Low-profile (2 mm thickness or less) anatomically contoured plates with locking options are now available and may aid in reducing the risk of wound-healing complications or soft-tissue irritation previously noted in the literature.[41] However, distal fibular locking plates had a mean cost greater than six times that of a one-third tubular plate. Although these lower-profile plating options are more expensive initially, the initial surgical implant cost may offset costs of revision surgery secondary to surgical implant-related issues.

In patients with poor soft-tissue envelopes or high risk for wound-healing complications, intramedullary fixation is another stabilization technique. Fibular intramedullary nailing demonstrates greater resistance to torque to failure than traditional fibular plating with a lag screw[42] and is a low-profile surgical implant. Ramasamy and Sherry[43] report good and excellent results in 11 elderly patients treated with fibular nailing for a Weber B ankle fracture. The authors note that this technique requires only a 15-mm skin incision and minimal soft-tissue stripping, which is ideal for this specific patient population. A prospective, randomized controlled trial of 100 patients elder than 65 years with ankle fractures randomized to undergo standard ORIF with traditional one-third tubular plating or fibular nailing demonstrated markedly fewer wound infections in the fibular nail group, with similar functional outcomes and union rates. Moreover, although the fibular implant was more expensive than a traditional plate, the overall cost of the management of the intramedullary nail was less expensive because of the high rate of revision surgery in the plating group.[44]

Conclusion

For patients in whom an isolated lateral malleolar injury is suspected, evaluation begins with a history and physical examination. Initial injury radiographs are reviewed, and if obvious tibiotalar instability or medial-sided injury is present, surgical treatment is recommended. In patients with an isolated lateral malleolus fracture without instability on injury radiographs, weight-bearing radiographs are attempted. The radiographs are evaluated for alignment of the ankle, the MCS, the presence or absence of lateral talar subluxation, and the length/rotational alignment of the fibula. If osseous injury is isolated to the lateral malleolus and patients are unable to place 50% or more weight on the ankle for the weight-bearing radiographs, either gravity or manual stress radiographs are performed to assess for tibiotalar instability. If widening medially, lateral talar subluxation, or talar tilting is present, surgical treatment is offered. Surgical options include lateral plating, posterolateral antiglide plating, or intramedullary fixation. Small and minifragment fixation may be used to achieve biomechanical stability while decreasing the risk of surgical implant irritation. In certain clinical scenarios, locking constructs may be an important consideration. For patients who are contemplating or would prefer to avoid surgical treatment, the patient is placed into a well-molded short leg cast. The patient is asked to follow up in 1 week for repeat weight-bearing radiographs to assess for MCS widening or fracture displacement. At that point, a secondary conversation regarding options for management is held with the patient.

References

Evidence-based Medicine: Levels of evidence are described in the table of contents. In this article, References 4, 5, and 44 are level I studies. References 1, 17, 22, 23, 26, 28, and 29 are level II studies. References 16, 32, 40, and 41 are level III studies. References 2, 3, 14, 18-21, 24, 31, 33-35, 37, and 43 are level IV studies. References 6-11, 15, 25, 27, 30, 36, 38, 39, and 42 are level V studies.

References printed in **bold type** are those published within the past 5 years.

1. Lindsjo U: Operative treatment of ankle fractures. *Acta Orthop Scand Suppl* 1981; 189:1-131.
2. Jehlicka D, Bartonicek J, Svatos F, Dobias J: Fracture-dislocations of the ankle joint in adults. Part I: Epidemiologic evaluation of patients during a 1-year period [Czech]. *Acta Chir Orthop Traumatol Cech* 2002; 69:243-247.
3. Gougoulias N, Khanna A, Sakellariou A, Maffulli N: Supination-external rotation ankle fractures: Stability a key issue. *Clin Orthop Relat Res* 2010;468:243-251.
4. Makwana NK, Bhowal B, Harper WM, Hui AW: Conservative versus operative treatment for displaced ankle fractures in patients over 55 years of age: A prospective, randomised study. *J Bone Joint Surg Br* 2001;83:525-529.
5. Sanders DW, Tieszer C, Corbett B; Canadian Orthopedic Trauma Society: Operative versus nonoperative treatment of unstable lateral malleolar fractures: A randomized multicenter trial. *J Orthop Trauma* 2012;26:129-134.
6. Close JR: Some applications of the functional anatomy of the ankle joint. *J Bone Joint Surg Am* 1956;38-A:761-781.
7. Norkus SA, Floyd RT: The anatomy and mechanisms of syndesmotic ankle sprains. *J Athl Train* 2001;36:68-73.
8. Calhoun JH, Li F, Ledbetter BR, Viegas SF: A comprehensive study of pressure distribution in the ankle joint with inversion and eversion. *Foot Ankle Int* 1994;15: 125-133.
9. Harper MC: An anatomic study of the short oblique fracture of the distal fibula and ankle stability. *Foot Ankle* 1983;4:23-29.
10. **Hunt KJ, Goeb Y, Behn AW, Criswell B, Chou L: Ankle joint contact loads and displacement with progressive syndesmotic injury. *Foot Ankle Int* 2015;36:1095-1103.**
11. Lauge-Hansen N: Fractures of the ankle. III: Genetic roentgenologic diagnosis of fractures of the ankle. *Am J Roentgenol Radium Ther Nucl Med* 1954;71:456-471.
12. Danis R: Les fractures malleolaires, in Danis R, eds: *Theorie et pratique de l'osteosynthese [French]*. Paris, Mission et Cie, 1949, pp 133-165.
13. Weber B: *Die verletzungen des oberen sprunggelenkes [German]*. Bern, Hans Huber, 1972.
14. Rodriguez EK, Kwon JY, Herder LM, Appleton PT: Correlation of AO and Lauge-Hansen classifications for ankle fractures to the mechanism of injury. *Foot Ankle Int* 2013;34:1516-1520.
15. **Tartaglione JP, Rosenbaum AJ, Abousayed M, DiPreta JA: Classifications in brief: Lauge-Hansen classification of ankle fractures. *Clin Orthop Relat Res* 2015;473: 3323-3328.**
16. Gardner MJ, Demetrakopoulos D, Briggs SM, Helfet DL, Lorich DG: The ability of the Lauge-Hansen classification to predict ligament injury and mechanism in ankle fractures: An MRI study. *J Orthop Trauma* 2006;20:267-272.
17. Egol KA, Amirtharajah M, Tejwani NC, Capla EL, Koval KJ: Ankle stress test for predicting the need for surgical fixation of isolated fibular fractures. *J Bone Joint Surg Am* 2004;86-A:2393-2398.
18. Michelson JD, Magid D, McHale K: Clinical utility of a stability-based ankle fracture classification. *J Orthop Trauma* 2007;21:307-315.
19. Pakarinen H: Stability-based classification for ankle fracture management and the syndesmosis injury in ankle fractures due to a supination external rotation mechanism of injury. *Acta Orthop Suppl* 2012;83:1-26.
20. **Murphy JM, Kadakia AR, Schilling PL, Irwin TA: Relationship among radiographic ankle medial clear space, sex, and height. *Orthopedics* 2014;37: e449-e454.**
21. Schuberth JM, Collman DR, Rush SM, Ford LA: Deltoid ligament integrity in lateral malleolar fractures: A comparative analysis of arthroscopic and radiographic assessments. *J Foot Ankle Surg* 2004;43: 20-29.
22. DeAngelis NA, Eskander MS, French BG: Does medial tenderness predict deep deltoid ligament incompetence in supination-external rotation type ankle fractures? *J Orthop Trauma* 2007;21: 244-247.
23. **Nortunen S, Leskela HV, Haapasalo H, Flinkkila T, Ohtonen P, Pakarinen H: Dynamic stress testing is unnecessary for unimalleolar supination-external rotation ankle fractures with minimal fracture displacement on lateral radiographs. *J Bone Joint Surg Am* 2017;99:482-487.**
24. Park SS, Kubiak EN, Egol KA, Kummer F, Koval KJ: Stress radiographs after ankle fracture: The effect of ankle position and deltoid ligament status on medial clear space measurements. *J Orthop Trauma* 2006;20:11-18.
25. **Schottel PC, Fabricant PD, Berkes MB, et al: Manual stress ankle radiography has poor ability to predict deep deltoid ligament integrity in a supination external rotation fracture cohort. *J Foot Ankle Surg* 2015;54: 531-535.**
26. Michelson JD, Varner KE, Checcone M: Diagnosing deltoid injury in ankle fractures: The gravity stress view. *Clin Orthop Relat Res* 2001:178-182.
27. Schock HJ, Pinzur M, Manion L, Stover M: The use of gravity or manual-stress radiographs in the assessment of supination-external rotation fractures of the ankle. *J Bone Joint Surg Br* 2007;89: 1055-1059.
28. **LeBa TB, Gugala Z, Morris RP, Panchbhavi VK: Gravity versus manual**

external rotation stress view in evaluating ankle stability: A prospective study. ***Foot Ankle Spec*** **2015;8:175-179.**

29. **Ashraf A, Murphree J, Wait E, et al: Gravity stress radiographs and the effect of ankle position on deltoid ligament integrity and medial clear space measurements.** ***J Orthop Trauma*** **2017;31:270-274.**

30. Koval KJ, Egol KA, Cheung Y, Goodwin DW, Spratt KF: Does a positive ankle stress test indicate the need for operative treatment after lateral malleolus fracture? A preliminary report. *J Orthop Trauma* 2007;21:449-455.

31. Hoshino CM, Nomoto EK, Norheim EP, Harris TG: Correlation of weightbearing radiographs and stability of stress positive ankle fractures. *Foot Ankle Int* 2012;33:92-98.

32. **Holmes JR, Acker WB II, Murphy JM, McKinney A, Kadakia AR, Irwin TA: A novel algorithm for isolated Weber B ankle fractures: A retrospective review of 51 nonsurgically treated patients.** ***J Am Acad Orthop Surg*** **2016;24:645-652.**

33. **Nortunen S, Lepojarvi S, Savola O, et al: Stability assessment of the ankle mortise in supination-external rotation-type ankle fractures: Lack of additional diagnostic value of MRI.** ***J Bone Joint Surg Am*** **2014; 96:1855-1862.**

34. Yde J, Kristensen KD. Ankle fractures: Supination-eversion fractures of stage IV. Primary and late results of operative and non-operative treatment. *Acta Orthop Scand* 1980;51:981-990.

35. Tunturi T, Kemppainen K, Patiala H, Suokas M, Tamminen O, Rokkanen P: Importance of anatomical reduction for subjective recovery after ankle fracture. *Acta Orthop Scand* 1983;54:641-647.

36. **Wang T, Boone C, Behn AW, Ledesma JB, Bishop JA: Cancellous screws are biomechanically superior to cortical screws in metaphyseal bone.** ***Orthopedics*** **2016; 39:e828-e832.**

37. Weber M, Krause F: Peroneal tendon lesions caused by antiglide plates used for fixation of lateral malleolar fractures: The effect of plate and screw position. *Foot Ankle Int* 2005;26:281-285.

38. Bariteau JT, Blankenhorn BD, Lareau CR, Paller DJ, DiGiovanni CW: Biomechanical evaluation of mini-fragment surgical implant for supination external rotation fractures of the distal fibula. *Foot Ankle Spec* 2013;6:88-93.

39. Davis AT, Israel H, Cannada LK, Bledsoe JG: A biomechanical comparison of one-third tubular plates versus periarticular plates for fixation of osteoporotic distal fibula fractures. *J Orthop Trauma* 2013;27: e201-e207.

40. **Lyle SA, Malik C, Oddy MJ: Comparison of locking versus nonlocking plates for distal fibula fractures.** ***J Foot Ankle Surg*** **2018;57:664-667.**

41. Schepers T, Van Lieshout EM, De Vries MR, Van der Elst M: Increased rates of wound complications with locking plates in distal fibular fractures. *Injury* 2011;42: 1125-1129.

42. **Smith G, Mackenzie SP, Wallace RJ, Carter T, White TO: Biomechanical comparison of intramedullary fibular nail versus plate and screw fixation.** ***Foot Ankle Int*** **2017;38: 1394-1399.**

43. Ramasamy PR, Sherry P: The role of a fibular nail in the management of Weber type B ankle fractures in elderly patients with osteoporotic bone–a preliminary report. *Injury* 2001;32:477-485.

44. **White TO, Bugler KE, Appleton P, Will E, McQueen MM, Court-Brown CM: A prospective randomised controlled trial of the fibular nail versus standard open reduction and internal fixation for fixation of ankle fractures in elderly patients.** ***Bone Joint J*** **2016;98-B: 1248-1252.**