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CASE SERIES

Open Ankle Fractures with Loss of the Medial Malleolus: A Case Series on a Rare Injury

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ABSTRACT

In patients with particularly high-energy injuries causing open ankle fractures, the medial malleolus can be extruded from the ankle and either lost at the scene of the injury or unable to be fixed at the time of operative intervention. Minimal reporting of this devastating injury exists in the literature. Our study aims to report the outcomes in patients with open ankle fractures and loss of the medial malleolus. We retrospectively reviewed eight patients with this injury pattern over a 14-year span (2000–2014). Two of these patients were treated with below-knee amputation for a mangled extremity. Five of the patients were treated with tibiotalocalcaneal (TTC) arthrodesis. Of the five patients treated with ankle and subtalar arthrodesis, two were treated with open reduction and internal fixation (ORIF) prior to their arthrodesis. The remaining three patients were treated with arthrodesis after their initial surgical treatment with irrigation and debridement (I&D) and external fixation. Four of the six patients required soft tissue coverage with a rotational or free flap. All patients undergoing TTC arthrodesis went on to fusion; at final follow-up (average 2.7 years; 1.1–8.2 years), they reported minimal pain in the operative extremity and were able to ambulate. We found TTC arthrodesis to be a viable option for patients with this devastating injury. These findings could aid orthopedic surgeons not only in preoperative patient education and prognosis but also in operative planning in patients with this rare injury.

Keywords: Bone loss, Medial malleolus, Open ankle fracture, Outcomes.

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INTRODUCTION

Ankle fractures are among the most common injuries treated by orthopedic surgeon. Epidemiological studies report an annual incidence of 100 to 122 ankle fractures per 100,000 persons.[1,2] Approximately 2 to 5% of these are open ankle fractures.[3,4] For optimal surgical outcomes in patients undergoing ORIF of distal tibia or bimalleolar ankle fractures, both lateral and medial malleoli must be anatomically reduced to impart stability to the ankle.[5]

However, in patients with particularly high-energy injuries causing an open ankle fracture, the medial malleolus can be extruded from the ankle and either lost at the scene of the injury or unable to be fixed at the time of operative fixation. One case report describes this injury pattern in a 17-year-old male.[6] At 3 years follow-up, the patient had returned to his usual activities and was without instability on radiographic stress views of the ankle. The author concluded that even with complete loss of the medial malleolus, the ankle can be stable as long as anatomic reduction of the lateral malleolus is obtained. However, another case report, describing a 6-year-old female with an open ankle fracture resulting in loss of the medial malleolus, showed advanced degenerative arthritic changes at 20 years follow-up.[7] While these two reports demonstrated a stable ankle on radiographic stress views, the medial malleolar osteoligamentous complex has been found to be a key stabilizer of the ankle, specifically to anterolateral rotation of the talus which is not easily identifiable on stress radiographs.[8,9] This rotatory instability would allow displacement of the talus which has been shown to reduce the tibiotalar contact area by 42%[10] and possibly accelerate the development of posttraumatic arthritis in the ankle.

While two case reports exist in the literature, to our knowledge, there have been no published data reporting the outcomes in a series of patients with this specific injury. Our study aims to investigate the outcomes in a series of patients with open ankle fractures and loss of the medial malleolus to aid orthopedic surgeons in preoperative patient education and operative planning for these patients.

MATERIALS AND METHODS

Institutional review board approval was obtained prior to beginning the study. All patients with a diagnosis of an open ankle fracture at the investigating institution between January 1, 2000 and October 1, 2014 were identified using International Classification of Disease, Ninth Revision codes (824.1, 824.3, 824.4, 824.5, 824.7, 824.9, and 823.9). This resulted in a cohort of 1,525 patients with a diagnosis of an open ankle fracture. The clinical records and radiographs were reviewed to identify patients

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with loss of the medial malleolus. There were eight patients who sustained an open fracture with loss of the medial malleolus. For these eight patients, a thorough chart review was performed to ascertain age, gender, mechanism of injury, date of injury, and any additional ankle procedures these patients had after their initial operative management for their open ankle fracture. Of the eight patients included in the study, two patients presented with a mangled, unsalvageable extremity that underwent lower extremity amputations. These patients were excluded from the study which left a cohort of six patients who sustained injuries resulting in loss of the medial malleolus without the need for amputation. The mean age was 45 years (20–73 years). Two (33%) of the patients were females, and 4 (67%) were males. A majority of patients had a high-energy mechanism of injury with 3 (50%) patients injured in a motor vehicle accident and 1 (17%) injured by a gunshot. Two (33%) patients sustained open ankle fractures with wounds over the medial malleolus that were neglected and were not seen by an orthopedic surgeon until 2 to 3 weeks after their injury. At their initial debridement, both patients' medial malleoli were found to be necrotic and were removed.

Descriptive characteristics including age, gender, and mechanism of injury for the six patients are summarized in Table 1. The average follow-up time for the included cases was 2.7 years (1.1–8.2 years) with a minimum of 12 months of follow-up. No statistical analysis was performed, as this was a case series.

RESULTS

Of the six patients, 5 (83%) were treated with ankle and subtalar arthrodesis. Four of these patients were treated with a TTC nail, and one patient underwent compression arthrodesis with a Taylor spatial frame. Arthrodesis was performed on average 4.6 months (1.7–13 months) after the initial injury. Of the five patients treated with ankle and subtalar arthrodesis, two were treated with ORIF prior to their arthrodesis. The remaining three patients were treated with arthrodesis after their initial surgical treatment with I&D and external fixation. Four of the six patients required soft tissue coverage with a rotational or free flap. Table 2 provides the patients' surgical procedures and date of surgery (DOS) for each intervention. The indication for ankle and subtalar fusion in these patients is summarized in Table 3. All patients undergoing TTC arthrodesis went on to fusion. At most recent follow-up, these five patients were reporting minimal pain in the operative extremity and were able to ambulate.

In the one patient who did not have an ankle arthrodesis, at most recent follow-up, he reported debilitating ankle pain with ambulation and range of motion causing

Table 1: Patient demographics: Descriptive characteristics including age, gender, and mechanism of injury

Patient	*Age at time of injury (years)*	*Gender*	*Body mass index (kg/m^2)*	*Laterality*	*Mechanism of injury*
1	46	Female	22.7	Left	Motor vehicle accident
2	24	Female	21.2	Right	Motor vehicle accident
3	66	Male	37.1	Right	Fall from standing
4	73	Male	25.4	Right	Fall from standing
5	20	Male	25.1	Right	Gunshot wound
6	39	Male	29.9	Left	Pedestrian struck by motor vehicle

Table 2: Timeline of operative procedures for each patient

Patient	*Initial procedure (DOS)*	*Second procedure (DOS)*	*Third procedure (DOS)*	*Fourth procedure (DOS)*
1	External fixator (2/23/2014)	Subtalar and ankle arthrodesis with TTC nail (6/20/2014)	–	–
2	External fixator (7/8/2012)	ORIF right ankle fracture, free thigh flap to ankle (7/16/2012)	Ankle arthrodesis with lateral plate and compression screw (3/28/2015)	Revision ankle arthrodesis and subtalar arthrodesis with TTC nail (2/21/2014)
3	External fixation (1/13/2008)	Ankle and subtalar arthrodesis with Taylor spatial frame (3/4/2008)	Removal of Taylor spatial frame (2/6/2009)	–
4	External fixator (2/2/2012)	Repeat debridement (2/6/2012)	Sural flap (2/9/2012)	Removal of external fixator and ankle and subtalar arthrodesis with TTC nail (5/30/2012)
5	External fixator (8/2/2003)	Repeat debridement (8/5/2003)	Free latissimus flap to ankle (8/1/2003)	Removal of external fixator (11/24/2003)
6	ORIF (8/5/2013)	Free forearm flap (10/17/2013)	Ankle and subtalar arthrodesis with TTC nail (4/7/2014)	–

Table 3: Indication for ankle and subtalar arthrodesis

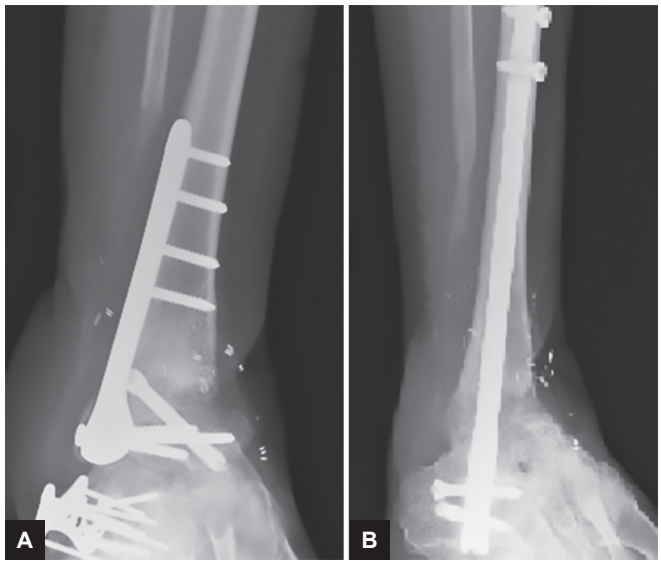
Patient	*Indication for TTC arthrodesis*
1	Comminuted pilon fracture in patient with poor bone quality secondary to diabetes mellitus
2	Nonunion of distal tibia fracture
3	Comminuted pilon fracture in patient with poor bone quality secondary to diabetes mellitus
4	Comminuted pilon fracture in patient with poor bone quality secondary to diabetes mellitus
6	Nonunion of distal tibia fracture

significant activity modification and decrease in his quality of life. An ankle fusion was recommended; however, the patient did not want any further operative intervention.

Illustrative Case Reports

Patient 2 is a 24-year-old female involved in a motor vehicle collision. Her orthopedic injuries included an open right ankle fracture with loss of the medial malleolus, right calcaneus fracture, and right clavicle fracture. She was initially treated with I&D with external fixation. At the time of her wound coverage with a free myocutaneous thigh flap, she underwent ORIF of the ankle (Fig. 1).

Fig. 1: Patient 2 is a 24-year-old female involved in a motor vehicle collision who underwent ORIF for her ankle injury



Figs 2A and B: Patient 2 with hardware failure and varus collapse of ankle fracture (A) that was treated with a TTC arthrodesis (B)

Figs 3A and B: Patient 5 is a 20-year-old male who was shot in the right ankle resulting in a pilon fracture with loss of the medial malleolus (A), which was treated definitively in an external fixator for 16 weeks. At most recent follow-up, the patient reported debilitating ankle pain with ambulation and Takakura stage IV osteoarthritis (B)

However, her ankle fracture went on to a nonunion with varus collapse. She then had an ankle arthrodesis which did not fuse; thus, she had a revision arthrodesis including the subtalar joint with a TTC nail (Fig. 2). At most recent follow-up, she achieved fusion of her ankle and subtalar joint, and was ambulating with minimal pain.

Patient 5 is a 20-year-old male who sustained a gunshot to the right ankle resulting in a pilon fracture with loss of the medial malleolus (Fig. 3). His pilon fracture was treated definitively in an external fixator for 16 weeks. He also required a sural flap. Figure 3 illustrates his injury and most recent follow-up imaging at 8 years after his injury which shows Takakura stage IV osteoarthritis.[11] At

most recent follow-up, the patient reported debilitating ankle pain with ambulation and range of motion. He was offered an ankle arthrodesis; however, he did not wish for further surgery.

DISCUSSION

This study represents the largest series of patients treated for an open ankle fracture with loss of the medial malleolus. While 83% of the patients were treated with TTC arthrodesis, the indications for this procedure were not to treat end-stage posttraumatic ankle arthritis. Instead, TTC arthrodesis was used as a salvage operation for distal tibia fracture nonunion and comminuted distal tibia fracture in patients with impaired bone quality secondary to diabetes mellitus. Initial nonunion after ORIF in two patients is likely due to the injury being an open fracture and high-energy injury as both of these factors have been shown to increase risk for nonunion. [12,13] Our study demonstrates that patients with this injury can be treated with TTC arthrodesis for failure of initial ORIF or as primary treatment in patients with poor bone quality from systemic disease, such as diabetes. All patients treated with TTC arthrodesis achieved fusion, reported minimal pain, and were able to ambulate at most recent follow-up. This is similar to reported TTC arthrodesis fusion rates which range from 76 to 100% and reported TTC arthrodesis patient satisfaction rates of 82 to 92% in the literature.[14-18]

In addition, our study adds to the knowledge regarding the natural history of patients with loss of the medial malleolus who are not treated with ankle arthrodesis. Patient 5 presented to clinic 8 years after his injury with clinical and radiographic end-stage posttraumatic ankle arthritis. Our results agree with the case report discussed earlier.[7] This is not surprising as ankle arthritis, unlike hip and knee osteoarthritis, is posttraumatic in 65 to 75% of cases.[19,20] While one study reported a latency period around 10 years for the development of ankle arthritis after injury,[21] a more recent study by Horisberger et al[22] demonstrated a 20.9-year latency period between ankle fracture and end-stage posttraumatic ankle arthritis, with malleolar and pilon fractures being the most common cause of posttraumatic arthritis. Compared with these studies, our patient developed posttraumatic arthritis at an accelerated rate. We believe that the reduction in the latency period is due to persistent instability from the loss of the medial malleolus. The importance of the medial malleolar osteoligamentous complex was described by Clarke et al[23] who created a dynamic weight-bearing cadaveric ankle model which demonstrated that there was minimal change in the contact area of the ankle joint even with 6 mm of lateral displacement of the lateral malleolus as long as the ankle was axially loaded and the deltoid ligament was intact. Once the deltoid ligament was divided, however, the contact area of the ankle joint was significantly decreased. Further dynamic testing of axially loaded cadaveric ankles confirmed the medial malleolar osteoligamentous complex to be a critical stabilizer of the ankle, specifically to anterolateral rotation of the talus.[8,9,24] Loss of this important complex in our patient likely led to chronic instability and a decreased latency period in the development of posttraumatic ankle arthritis.

This retrospective case series does have limitations. We were only able to identify six patients that met inclusion criteria for the study due to the rarity of this injury pattern. Moreover, we only were able to follow the natural history of an open ankle fracture with loss of the medial malleolus in one patient. Nonetheless, to our knowledge, this is the largest published series on the treatment and outcomes of patients with this injury.

Overall, we found TTC arthrodesis to be a viable option for patients with this devastating injury. Patients with loss of the medial malleolus treated by fracture fixation alone may develop posttraumatic ankle arthritis at a faster rate than patients with ankle fractures without loss of the medial malleolus. Both of these findings could aid the orthopedic surgeon not only in preoperative patient education and prognosis but also in operative planning in patients with this rare injury.

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