The Journal of Foot & Ankle Surgery 58 (2019) 1251–1256

Contents lists available at ScienceDirect

The Journal of Foot & Ankle Surgery

journal homepage: www.jfas.org

Case Reports and Series

Peroneal Tendon Lengthening as an Adjunct Procedure to Aid in the Reduction of the Lateral Malleolus in Diabetic Ankle Fractures: 2 Case Reports

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ARTICLE INFO

Level of Clinical Evidence: 4

Keywords:
fibular shortening
fibularis brevis
fibularis longus
fracture dislocation
tendon glycosylation

ABSTRACT

It is well-documented that individuals with longstanding diabetes mellitus are at risk for specific metabolic abnormalities; this includes but is not limited to increased glycation of collagenous soft-tissue structures. It is also apparent that such changes can manifest as thickening and increased stiffness of tendinous structures. What remains unknown are the biomechanical ramifications of these changes and how they should affect the surgical management of lower extremity injuries. Previous research suggests that the Achilles tendon demonstrates increased stiffness in the presence of diabetes. It is therefore reasonable to presume that increased collagen glycation and the resultant tendon stiffness can also lead to decreased extensibility and shortening of the peroneus longus and brevis tendons. The significance of this leads us to the conclusion that glycation of the peroneal tendons can create a deforming force in displaced lateral malleolar fractures because of the adjacent position of the peroneal tendons relative to the lateral malleolus. Complications stemming from this can lead to increased difficulty in reducing fibular fractures and subsequent shortening of the fibula. For the purpose of this article, we present 2 cases, 1 using open reduction with internal fixation and the other with external fixation. We will demonstrate that, in both reduction methods, lengthening of the peroneal tendons can be a useful adjunct procedure to aid in restoration of fibular length in diabetic ankle fractures.

Ankle fractures are continuously reported to be among the most common lower extremity injuries that can be treated by orthopedic physicians and podiatric surgeons. Fractures of the ankle are reported in as many as 10.2% of all bone injuries (1). Given the increasing prevalence of patients with diabetes (2–4), it is likewise expected that the number of diabetic patients with ankle fractures will rise. It is therefore important to consider that longstanding poor glycemic control has been associated with the accumulation of advanced glycation end products (AGEs), which are known to increase collagen and tendon stiffness (5). This has been proposed as a concomitant factor in the development of pathological lower extremity foot conditions in patients with diabetes (5–7).

Considering these details, it is important to develop improved clinical and surgical treatment plans that address the management of ankle traumas as they specifically pertain to the diabetic population. For the purposes of this article, we present peroneal tendon lengthening as an adjunct technique to aid in the restoration of fibular length following a displaced fibular fracture. To our knowledge, these case reports are the first to describe operative management that addresses the increased stiffness and contracture of pathological tendinous structures encountered in surgical management of displaced lateral malleolar fractures in diabetic ankle fractures.

Case Report

Case 1

A 64-year-old female presented to an outside emergency department for evaluation of severe right ankle pain and inability to bear weight immediately following a fall. The patient was given analgesic therapy and immobilized in a posterior mold. Seven days later, she was

Financial Disclosure: None reported.
Conflict of Interest: E.R.-C. is a speaker for Orthofix.
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https://doi.org/10.1053/j.jfas.2018.12.039

assessed at our outpatient podiatry clinic for surgical evaluation of a right ankle fracture.

The patient's medical history was significant for type 2 diabetes mellitus and coronary artery disease. On physical examination, the patient presented with diffuse ecchymosis and pitting edema of the right hindfoot extending proximally to the middle one third of the leg. There was associated right lower extremity pain localized to the medial malleolus and lateral ankle. Her skin was intact, pedal pulses were minimally palpable, and she was able to perform active range of motion of the pedal digits. Neurologic examination exhibited no evidence of lateralizing deficits or indication of compromise of the fascial compartments. Radiographic imaging obtained in our clinic revealed a right distal fibular fracture, a medial malleolar fracture with approximately 3 mm of displacement, and a questionable fracture of the posterior malleolus (Fig. 1). Following review of radiographic imaging obtained during the original emergency department evaluation, it was determined that little to no reduction was achieved since the initial encounter. Based on these findings, it was determined that the patient would benefit from open reduction and internal fixation of the right ankle fracture.

The following procedures were performed with the patient in supine position, under general anesthesia, and with a thigh tourniquet inflated to 350 mmHg. Intraoperative fluoroscopic imaging was used.

Closed reduction of the displaced fracture was attempted and found to be unsuccessful. Attention was turned to the lateral aspect of the ankle, where the skin and superficial soft tissues were incised and reflected. On visualization of the fibular fracture, we were better able to appreciate the proximal shortening of the lateral malleolus. Repeated attempts to obtain the full length of the fibula were unsuccessful. It was determined that contracture of the peroneus longus and peroneus brevis tendons prevented adequate reduction of the fracture. At this point, a V-Y lengthening of the peroneus longus tendon was performed, which was followed by a transverse lengthening of the peroneus brevis tendon. Care was taken to avoid the underlying muscle fibers. This immediately resulted in ease of reduction of the lateral malleolus and restoration of fibular length. A distal Kirschner wire was drilled from the lateral malleolus to the tibia, securing the lengthened position. At this time, the medial malleolar plate was applied to the distal fibula, taking care to align the tangs of the plate over the fracture site. Three cancellous screws were inserted into the distal osteoporotic bone, and 1 gliding screw was inserted above the fracture site. An osseous distracting expanding device was used, and the final length of the fibula was obtained. The proximal screws were inserted, and the transmalleolar screw was inserted into the plate for tricortical fixation of the syndesmosis.

Next, attention was turned to the medial aspect of the right lower extremity. Concomitant soft tissue and bony procedures for the reduction of the medial malleolar fracture were performed. A medial malleolar plate was applied using appropriate AO fixation technique according to the manufacturer's protocol. Anatomic alignment and the adequate placement of the fixation were confirmed using the fluoroscope.

Postoperatively, the patient was kept non-weightbearing in a short leg cast. At 9 weeks after open reduction with internal fixation of the right ankle, radiographic imaging showed a stable and satisfactory appearance of a reduced medial malleolus and distal fibular fracture (Fig. 2). At this time, the patient was allowed to progress to full weightbearing and at-home stretches. The patient was lost to follow-up for 3 months, during which time she reported that she continued at-home therapy and graduated ambulation. She denied any significant events in this interval; on her return to clinic, she was referred to physical therapy. At 11 months postoperatively, she reported no pain and the ability to ambulate without an assistive device. The physical therapist reported a 90% improvement since the start of therapy, as well as restoration of 4/5 muscle strength to all muscle groups crossing the ankle joint. The patient is now >1 year past the time of her injury and has not returned to our clinic with complaints or complications.

Case 2

A 45-year-old female presented to an outside emergency department following an episode of syncope and subsequent right ankle injury. She was evaluated, and radiographs identified a right ankle fracture. The patient was given analgesics and was immobilized in a short leg splint and crutches. The patient presented to our outpatient podiatry clinic for surgical evaluation of right ankle fracture 8 days later.

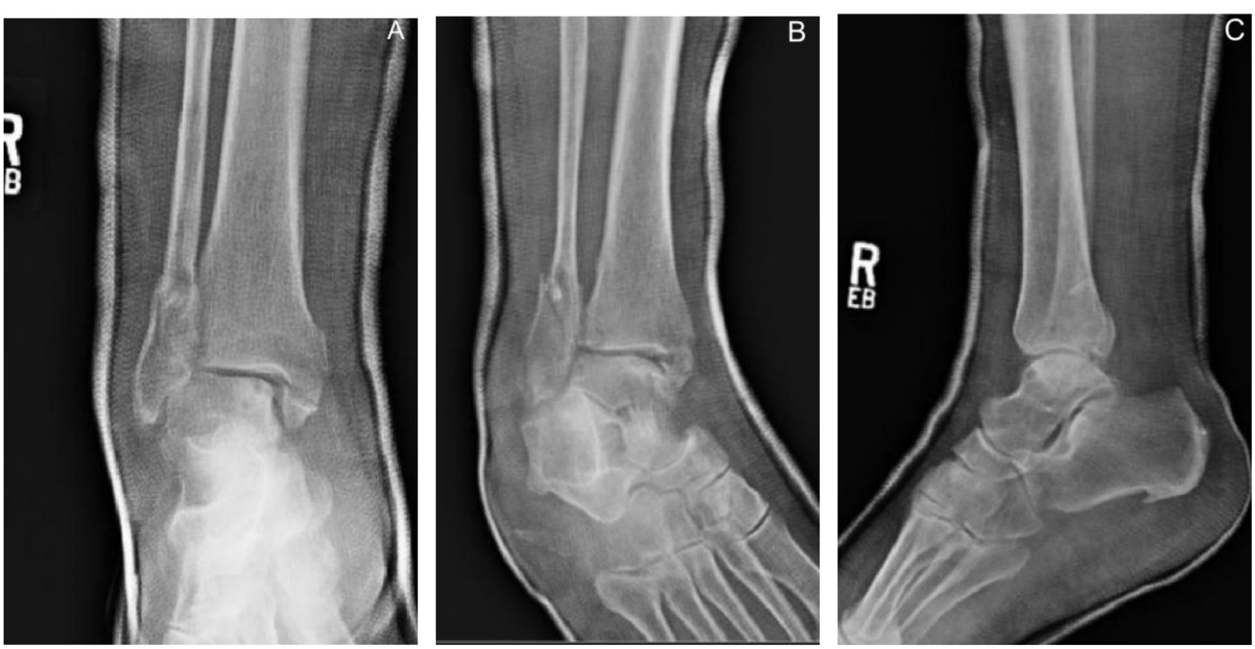

Fig. 1. Case 1 (*A*) anteroposterior, (*B*) mortise, and (*C*) lateral preoperative radiographs of right trimalleolar ankle fracture.

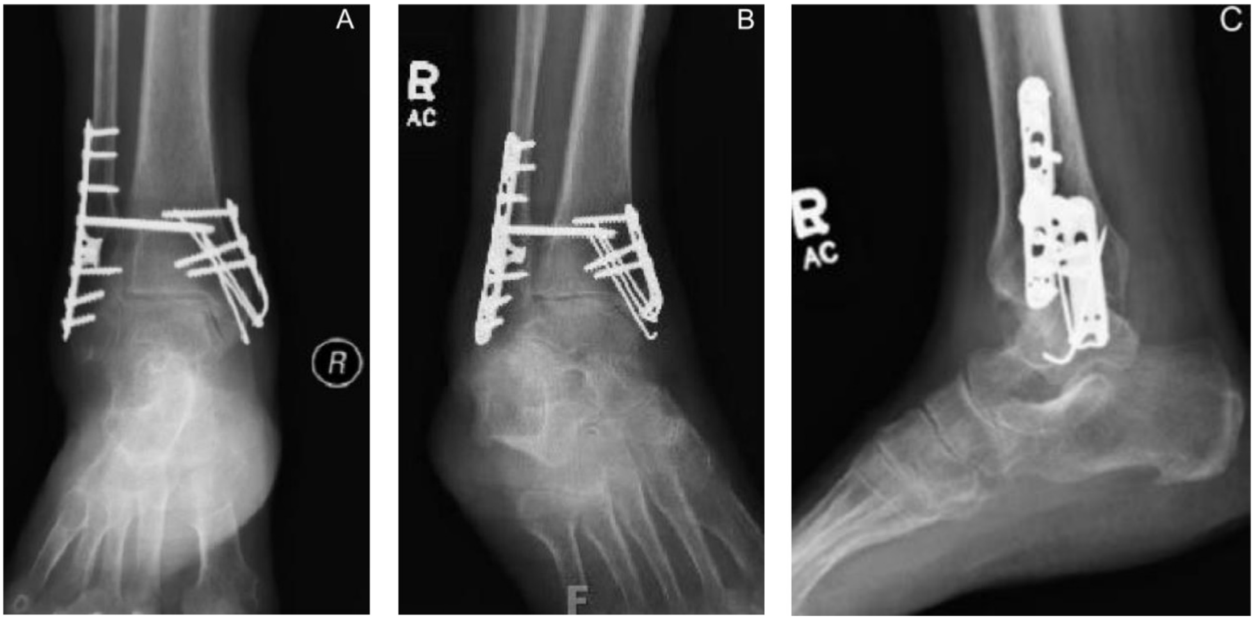

Fig. 2. Case 1 (*A*) anteroposterior, (*B*) mortise, and (*C*) lateral ankle radiographs 9 months after open reduction internal fixation of right trimalleolar ankle fracture.

The patient's medical history was significant for type 2 diabetes mellitus, hypertension, and hypercholesterolemia. On physical examination, the patient presented with edema, ecchymosis, and tenderness to the right ankle. The skin was intact with no evidence of skin tenting or neurovascular compromise. Pedal pulses and protective sensation were noted to be intact. Radiographs of the right ankle depicted a severely displaced oblique fracture through the distal fibular metadiaphysis. Further noted, was the presence of a mildly displaced transverse fracture through the base of the medial malleolus, and significant medial widening of the ankle mortise (Fig. 3). Closed reduction was attempted, and a short leg cast was applied to the right lower extremity. Given the complex nature and instability of the fracture pattern, as well as the presence of osteopenic bone, it was determined that the patient would benefit from surgical fixation of the right bimalleolar ankle fracture with application of a circular external fixator.

The following procedures were performed with the patient in supine position, under general anesthesia, and with the thigh tourniquet inflated to 300 mmHg. Intraoperative fluoroscopic imaging was used. Using manual manipulation, closed reduction of the medial and lateral malleolar fracture fragments was attempted. Anatomic reduction of the medial fragment was achieved; however, there was an inability to achieve adequate length of the lateral malleolus. Next, a longitudinal incision was made along the distal aspect of the fibula and a Cobb periosteal elevator was used to manipulate the fibular fragment to adequate anatomic alignment, after which, the medial malleolar fracture was reduced.

At this time, the circular external fixator device was approximated over the patient's leg and was fixated in place with the use of both smooth Kirschner and olive wires. Adequate anatomic positioning was confirmed using the fluoroscope, and immediate postoperative radiographs were obtained (Fig. 4).

Fig. 3. Case 2 (*A*) anteroposterior, (*B*) mortise, and (*C*) lateral preoperative radiographs of right bimalleolar ankle fracture.

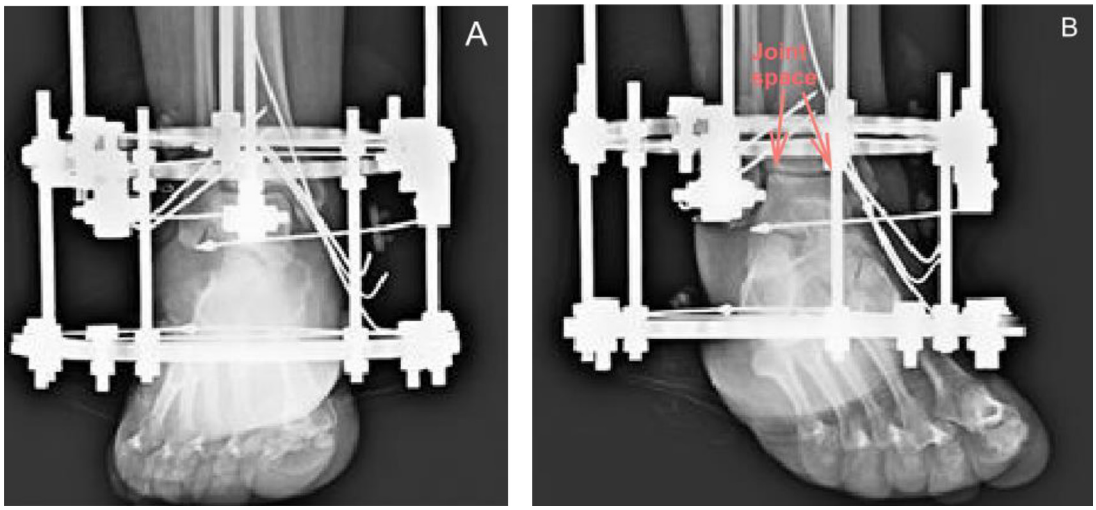

Fig. 4. Case 2 (*A*) anteroposterior and (*B*) mortise radiographs immediately following application of the circular external fixator for management of bimalleolar ankle fracture. (*Arrows*) uniform ankle joint space alignment.

Postoperatively, the patient was instructed to ambulate at 15% partial weightbearing to the right lower extremity for 1 week. The patient was further instructed to ambulate with an assistive walker device at all times.

The patient returned for follow-up radiographs 1 week postoperatively. The radiographs demonstrated proximal lateral displacement of the fibular fracture fragment with evidence of valgus deformation of the ankle joint. Additionally, there was an increase in the medial clear space as well as incongruity of the ankle joint articular surfaces (Fig. 5). The impression is that despite pinning of the fracture with a frame to neutralize forces, the ankle began to displace to the original deformity secondary to the over pull of the peroneal tendons. The patient was prescribed a bone stimulating device and was scheduled for readjustment of the circular external fixator and additional procedures as indicated.

Surgical Revision of Case 2

The following procedures were performed with the patient in supine position, under general anesthesia, and with the thigh tourniquet inflated to 300 mmHg. Intraoperative fluoroscopic imaging was used.

The distal Kirschner wires were sequentially loosened to allow for repositioning of the foot. The function of this step was to facilitate lengthening of the fibula to follow.

The appropriate skin and soft-tissue dissection for identification of the peroneal tendons was completed. The peroneus longus tendon was identified, and a V-Y lengthening of the tendon was performed (Fig. 6). After this, the peroneus brevis tendon was lengthened transversely. Care was taken to avoid the underlying muscle fibers. At this point, manual manipulation and traction were applied to the distal extremity. There was notable ease of reduction of the lateral malleolus. Intraoperative fluoroscopy was used to confirm the increased fibular length, reduction of the medial clear space of the ankle joint, and adequate anatomic alignment of the talus under the tibia. Postoperative radiographs were obtained the following week (Fig. 7).

Postoperatively, the patient was instructed to remain non-weightbearing to the right lower extremity with continued use of the bone stimulator. At 10 weeks following the surgical revision, the patient was instructed to weight bear as tolerated. At 20 weeks following the surgical revision, she underwent removal of the external fixator and a long controlled ankle movement walker boot was applied to the right lower

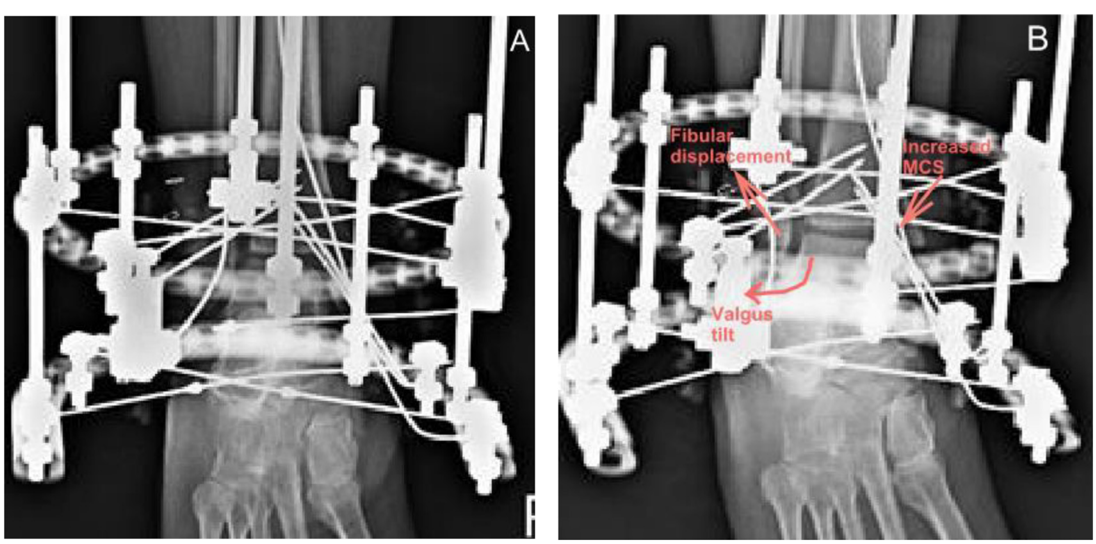

Fig. 5. Case 2 (*A*) anteroposterior and (*B*) mortise radiographs 1 week after application of circular external fixator. (*Arrows*) displacement of the fibular fracture, valgus tilt of the talus, and increased medial clear space (MCS) of the ankle joint.

Fig. 6. Intraoperative skin and soft-tissue dissection for (*A*) exposure of the peroneal muscles, (*B*) isolation of the peroneus longus tendon, and (*C*) V-Y lengthening of the peroneus longus tendon.

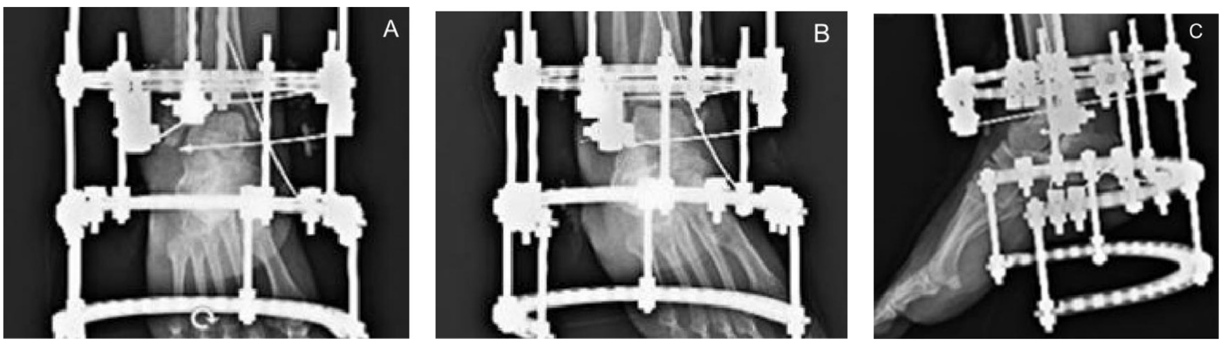

Fig. 7. (*A*) Anteroposterior, (*B*) mortise, and (*C*) lateral radiographs 1 week after operative adjustment of circular external fixator with peroneus longus and brevis tendon lengthening.

Fig. 8. Case 2 (*A*) anteroposterior and (*B*) lateral radiographs 5 months after operative adjustment of circular external fixator with peroneus longus and brevis tendon lengthening. Radiographs show a stable fibro-osseous union with adequate ankle joint alignment.

extremity. At this point, she was instructed to continue progressive weightbearing and physical therapy. Radiographs were obtained at 5 months following the revision surgery (Fig. 8). The patient recovered well, with no complications. She is now 1-year postoperative removal of the external fixator and has not returned to our clinic with complaints or complications.

Discussion

Achieving adequate anatomic reduction of a malaligned fibular fracture can be challenging. Patients with diabetes have a higher risk of complications after sustaining an ankle fracture, including fracture displacement and hardware failure (8). It can be inferred that these complications may in part be attributed to failure to appropriately address the abnormal musculoskeletal system present in patients with diabetes. These 2 case reports emphasize the importance of using ankle fracture reduction techniques that specifically address the impaired musculoskeletal system in diabetics. When treating malaligned fibular fractures in patients with diabetes, it is important to address not only the resultant bony abnormalities and malalignment, but also the structural changes seen in the adjacent tendinous structures.

Diabetes mellitus has been linked with an increased risk in numerous musculoskeletal impairments and complications of the musculoskeletal system (7). More specifically, the formation of AGEs and AGE receptors in collagen-rich structures may be a primary mechanism in musculoskeletal complications observed in people with diabetes (9−13). These AGE products are known to form in all people, but occur at a faster rate and accumulate more in people with diabetes (9,10,12). The accumulation of such products can lead to tendon, ligaments, and skin that become increasingly thicker, stiffer, and weaker, and thus more prone to injury (9,14,15). We believe that the traumatic musculoskeletal effects following an ankle fracture, coupled with the structural changes in the tendons of patients with diabetes, may have a cumulatively negative impact on the reducibility of such displaced fibular fractures.

Unrelated to the challenges of fracture reduction secondary to the tendinous compromise seen in diabetics is the practical challenge of achieving good anatomic alignment and reduction of any displaced fibular fracture. One of the most important, and often most difficult goals of fibular fracture reduction, is reestablishment of adequate fibular length. Adequate reduction of the fibula must be achieved because restoration of the length and rotation of the distal fibular segment achieves a congruent ankle mortise (16), which provides a buttress against lateral talar subluxation (17). This residual lateral talar subluxation is associated with a 90% chance of degenerative changes and poor outcomes (16). As little as a 1-mm lateral shift of the talus can decrease the contact area of the ankle by an average of 42% (18). Further, a fibular displacement of as little as 1 mm will change the mobility of the talus and fibula and the distribution of load in the talofibular and talotibial articulations (19).

Assessment of adequate fibular length can be approached by specific radiographic parameters as seen on an ankle mortise image (20). One should be able to appreciate an obvious equidistant and parallel joint space (20). Further, evidence of adequate fibular length can be demonstrated by the presence of “Shenton’s line of the ankle” which is depicted as a small spike of dense subchondral tibial bone that can be followed along the syndesmotic space to the fibula at the exact level of the subchondral medial articular spurring of the fibula (20). Finally, the ability to complete an imaginary circle that aligns perfectly with the contours of the tip of the lateral malleolus superiorly and the lateral part of the articular surface of the talus medially further demonstrates satisfactory fibular length (20).

Despite the extensive research that can be found to support the importance of restoring fibular length in ankle fractures, there is a shortage of articles that can be found that discuss less conventional approaches to addressing fibular shortening. To our knowledge, this article is the first to discuss a novel approach to restore fibular length by addressing the atypical tendinous structures in patients with diabetes. For the purposes of this article, we present 2 cases, 1 using open reduction with internal fixation and the other with external fixation. These cases have demonstrated that, with both reduction methods, lengthening of the peroneus longus and brevis tendons can be a useful adjunct procedure to aid in the reduction of difficult-to-reduce lateral malleolar fractures in patients with diabetes. By lengthening the peroneus longus and brevis tendons, we address the increased stiffness and contracture of the tendons and therefore eliminating the deforming force on the adjacent lateral malleolus in a superior, lateral, and posteriorly displaced direction. This allows for increased ease in the process of fracture reduction and restoration of length of the displaced fibula in diabetic ankle fractures.

In conclusion, we have presented case reports to assist with surgical management of difficult-to-reduce fibular fractures, as seen in diabetic ankle fractures. We recognize that a larger patient population, coupled with a more distinctive cohort, should be used to generalize this approach to all diabetic ankle fractures. Lengthening of the peroneus longus and peroneus brevis can be a useful consideration, however, when faced with the arduous task of restoring adequate fibular length in the presence of atypical and problematic soft-tissue structures.

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