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Case Report

Syndesmosis Injury with Concomitant Deltoid Disruption in a Trimalleolar Equivalent Ankle Fracture: A Case Report

Michael W. Downey[1]*, Justin J. Fleming[2], Benjamin Elgamil[3] and Cason Quinn[3]

[1]*Fellow, Foot/Ankle. Aria 3B Orthopaedics, Philadelphia PA USA*
[2]*Director, Foot/Ankle, Aria 3B Orthopaedics, Philadelphia PA USA*
[3]*Aria Health, Philadelphia PA USA*

***Corresponding author**
Michael W. Downey, Fellow, Foot/Ankle, Aria 3B Orthopaedics, 3110 Grant Ave, Philadelphia PA, 19114 USA, Tel: 2015-464-6600, email: michael.w.downey@gmail.com

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Abstract

Persistent pain on the medial side of the ankle for bimalleolar and trimalleolar equivalent fractures has been related to dynamic instability of the deltoid complex from non-anatomic healing if not addressed in the acute period. During high impact running/cutting sporting activities the deltoid complex may undergo increasing levels of force and inconsistent rotational stress. When injured there is variability in determining the exact nature of anatomical disruption or need of repair without direct visualization of the deltoid complex. Landmark studies have determined the disruption of the articular congruity and tibiotalar contact surface when talar shift occurs through disruption of the tibiotalar joint. Any external rotation type mechanism should heighten the physician's awareness to a syndesmotic injury. When excessive external rotation of the talus occurs disruption of the medial deltoid ligaments must intuitively take place. The mechanism and movement of the talus suggests tearing and disruption of the syndesmosis ligament as it abuts the fibula. Pain at the syndesmosis with proximal tibia and fibula squeeze or external rotation stress examinations should lead to suspicion for syndesmotic disruption that is not easily observed radiographically. Restoration of the deltoid ligament after syndesmosis repair in the appropriate clinical setting can improve ankle stability and reduce posttraumatic arthritis as well as minimize long-term postoperative pain. The present study describes a surgical technique with syndesmosis and deltoid ligament supplementation following an eversion type dislocation injury that resulted in a trimalleolar equivalent fracture.

ABBREVIATIONS

AOFAS: American Orthopaedic Foot & Ankle Society; SF-36: Short Form Health Survey; VAS: Visual Analog Score; AITFL: Anterior Inferior Tibiofibular Ligament; CAM: Controlled Ankle Motion; CT: Computed Tomography; MRI: Magnetic Resonance Imaging; PITFL: Posterior Inferior Tibiofibular Ligament; TTFL: Transverse Tibiofibular Ligament; IOL: Interossues Ligament

INTRODUCTION

There is scarce evidence involving treatment with concomitant syndesmosis and deltoid injuries. Controversy exists concerning the need to repair deltoid ligament ruptures after the fibula is fixed and syndesmosis is reduced in the setting of an acute ankle fracture. Several authors have concluded that deltoid ligament supplementation is not necessary with a concomitant stress-positive fibular fracture reduction to restore congruency of the ankle mortise. High-energy rotational ankle fracture dislocations during sporting activities are not without functional long-term complications [1,2]. Persistent pain on the medial side of the ankle for bimalleolar equivalent fractures has been related to dynamic instability of the deltoid complex if not addressed during the primary procedure due to non-anatomic healing [3]. Stufkens et al [4] examined 36 pts with pronation external rotation IV ankle fractures with a mean follow up of 13 years. They found that pain assessments using AOFAS score, SF-36 scale, and VAS were all greater in the deltoid ligament rupture group than those with an intact deltoid ligament. Jones et al demonstrated improved subjective and functional outcomes when approaching the deltoid complex for bimalleolar equivalent fracture types after fixation of the lateral malleolus and syndesmosis [2]. Primary repair of both the syndesmosis and deltoid complex should be considered when approaching these injury patterns in athletes to avoid long-term sequelae [2]. A bimalleolar equivalent or maisonneuve injury with associated disruption of the syndesmosis and concomitant deep deltoid injury adds complexity to the repair. During high impact running/cutting sporting activities the deltoid complex may undergo increasing levels of force and inconsistent rotational stress. When injured there is variability in determining the exact nature of anatomical disruption or need of repair without direct visualization of the deltoid complex. Hintermann et al [3] prospectively looked at 51 patients treated with suture anchors for medial ankle instability[3]. Even though they were not treating ankle fractures in the acute phase, 42% and 35% of their patients demonstrated inversion and eversion trauma respectively prior to their instability [3]. They had excellent results at 90% over an average of 4.4 year follow up and related the importance of diagnosis and treatment for this injury [3]. Though there are no demographic comparisons Hsu et al [5]demonstrated success of superficial deltoid injuries with suture anchors in 14 of 14 National Football League players with 86% returning to play the following season and all players able to return to running and cutting drills 6 months after their surgery with no complications of medial ankle symptoms [5]. Yu et al [6] performed a multicenter, retrospective cohort study illustrating the effect of primary deltoid ligament repair in the presence of ankle ORIF [6]. One-hundred and thirty one deltoid ligament ruptures were identified and repaired in the setting of 533 ankle fractures. With an average follow up 27 months, all 3 clinical outcome measures, AOFAS score, VAS score, and SF-36 score, had improved significantly post op ($p<0.05$). In 1988, Johnson and Hill [7] reported on 29 patients with fibular fractures undergoing ORIF with concomitant deltoid ligament ruptures that were not repaired. One-third of the patients had residual pain along medial ankle, two-thirds had medial ankle tenderness, and eight patients demonstrated ligamentous laxity. These authors suggested the need for additional deltoid ligament repair with ankle fracture fixation.

Restoration of the deltoid ligament after syndesmosis repair in the appropriate clinical setting can improve ankle stability and reduce posttraumatic arthritis as well as minimize any long-term post operative pain. The present study describes a surgical technique with syndesmosis and deltoid ligament supplementation following an eversion type dislocation injury that resulted in a trimalleolar equivalent Maisonneuve fracture.

CASE PRESENTATION

A 51 year-old male was referred to our clinic after sustaining a right ankle dislocation while playing soccer (Figure 1). He underwent closed reduction in the Emergency Department prior to presentation and placed into a short-leg splint without incident. Radiographs (Figure 2A) revealed a trimalleolar-equivalent ankle injury with a Maisonneuve component (Figure 2B) on the proximal fibula and a small posterior malleolar fracture (less than 1% of the articular surface). Surgery was scheduled in that same week to supplement the torn syndesmosis with the possibility of augmenting the attenuated deltoid ligaments.

The patient was placed in a supine position with an ipsilateral hip bump. Standard lateral dissection was utilized over the right fibula, being careful to protect neurovascular structures. Anatomic reduction of the distal fibula into the fibula incisura was made with a manual reduction force initially. Provisional stabilization with k-wires and a pelvic reduction clamp was then utilized with close attention to the transmalleolar axis (Figure 3). A 4-hole one-third tubular plate was adhered to the lateral fibula with a nonlocking 3.5mm bicortical screw in the most proximal hole. The second and fourth holes were utilized and prepared for two Knotless Tight-Rope™ Buttons (Arthrex, Inc., Naples, FL USA) paying close attention to the transmalleolar axis to avoid malreduction (Figure 4). The third hole was prepared in a lagged fashion with a nonlocking quadracortical 3.5mm screw, tightened appropriately to further stabilize the

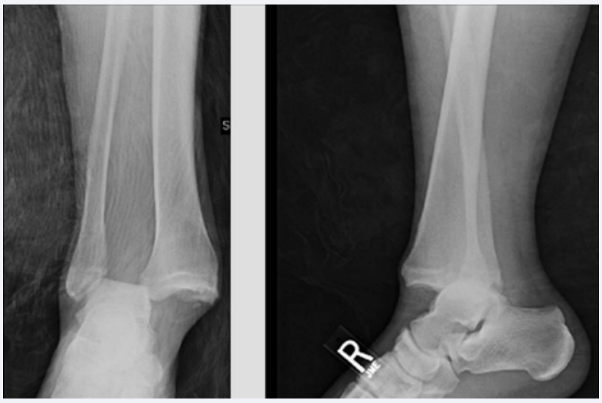

Figure 1 Pre-reduction radiographs demonstrating dislocation following patient presentation to the emergency room.

Figure 2 (A) – Post-reduction anterioposterior and lateral views showing the widened medial clear space and small posterior malleolar contribution (B) - Tibia/Fibula Views Demonstrating a Maisonneuve fibula fracture.

syndesmosis. To simulate anterior segment of the anterior inferior tibiofibular ligament (AITFL) and to further stabilize the syndesmosis, the suture strands of the inferior button were advanced to the anterolateral tibia and fastened using a 3 mm Bio-Pushlock™ anchor (Arthrex, Inc., Naples, FL USA) (Figure 5A, 5B). A stress view under fluoroscopic imaging revealed a significant talar tilt, which was attributed to an incompetent deep and superficial deltoid ligament (Figure 6). A 5 cm curvilinear incision was then utilized starting at the medial malleolus, ending inferior to the sustentaculum tali. Dissection was carried down to the deep deltoid ligaments protecting neurovascular structures where the dynamic instability and incompetence of the deltoid complex could be appreciated (Figure 7). A 4.75 mm Swivelock™ anchor (Arthrex, Inc., Naples, FL USA) was placed into the sustentaculum tali. The two strands of the 2 mm FiberTape™ (Arthrex, Inc., Naples, FL) were then fastened into the anterior and posterior colliculi respectively using 3.5 mm Swivelock anchors. The excess suture from each strand was fed into another Bio-Pushlock™ anchor then adhered 2 cm superiorly into the distal tibia. Final intraoperative fluoroscopy confirmed reduction of the syndesmosis, the talar tilt, and the medial clear space (Figure 8).

The subcutaneous and skin layers were then closed with absorbable suture and staples, respectively. The patient was placed into a non-weight bearing short-leg splint. Staples will be removed at two weeks in which he will be transitioned into a controlled ankle motion (CAM) boot for four weeks (6 week follow up). If radiographic and clinical healing are observed he will then start partial weight bearing (40lbs) in the CAM boot for two weeks with limited physical therapy and transitioned to full weight bearing in the CAM boot at 8 weeks. At his 10 week follow up visit if no complications arise and healing is appreciated (radiographically and clinically) he will then begin aggressive physical therapy and weight bear as tolerated in regular shoes.

DISCUSSION

Syndesmosis treatment and protocol is one of the most popular reported concepts in orthopaedic literature. Nevertheless, there is an increasing interest and focus directed to the deltoid complex for instability and insufficiency after long term follow up of injury [3,8-13]. There are limited reports that demonstrate the benefit of addressing the deltoid injury acutely and even fewer reports that address the syndesmotic rupture concomitantly with the deltoid complex.

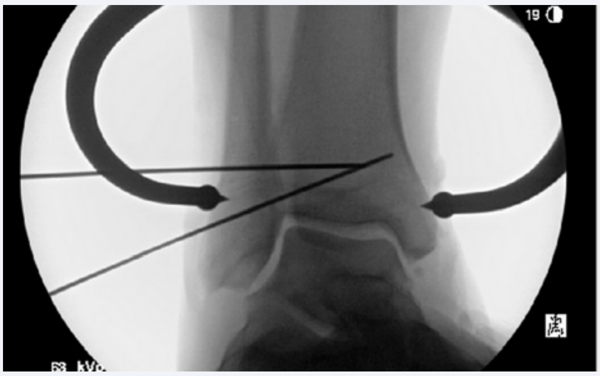

Figure 3 Shows provisional intraoperative stabilization with k-wires and a pelvic reduction clamp.

Figure 4 Demonstrates Suture button and screw combination with a reduced syndesmosis.

Anatomic analysis of the syndesmosis and deltoid ligaments demonstrates the importance of durable anatomical repair of these injuries. Due to variance between ankles of the same patient advanced imaging in the form of Computed Tomography [14] or Magnetic Resonance Imaging (MRI) as well contralateral films to compare allows precise diagnostic results if there are doubts [15]. Having contralateral imaging can assist the physician during intraoperative reduction techniques to restore exact anatomical variances. CT has been determined to be more sensitive than radiography for detecting diastasis of the syndesmosis [16]. MRI has also been determined to provide excellent sensitivity, specificity, positive predictive value, negative predictive value and accuracy when diagnosing syndesmosis injuries [17].

The syndesmosis is a fibrous joint between the concave distal lateral tibia known as the fibularis incisura and the convex distal medial fibula. The fibula is situated centrally and anteriorly in the incisura 97% of the time [18]. There is variable shape of the incisura, which can predispose patients to syndesmotic injury [19]. The anterior tubercle of the distal lateral tibia is typically larger than its posterior counterpart and prevents anterior translation of the fibula [20]. The distal tibiofibular joint is noted to be 32% externally rotated on average between the transmalleolar axis [20]. The ligaments are made up of the anterior inferior tibiofibiular ligament (AITFL) which resists excessive external rotation of the fibula, the posterior inferior tibiofibular ligament (PITFL) which resists posterior translation, the posterior transverse tibiofibular ligament (TTFL) which acts as a labrum for the posterior capsule to deepen the articular surface of the tibia, the interosseus membrane which merges with the interossues ligament (IOL) and prevents lateral translation. A normal external rotary force through the syndesmosis directs the fibula to externally rotate, medially translate and posterior displace 10 article in press. The syndesmotic stability is determined to be 33% through the TTL, 9% through the PITFL, 35% through the AITFL, and 22% through the interosseus

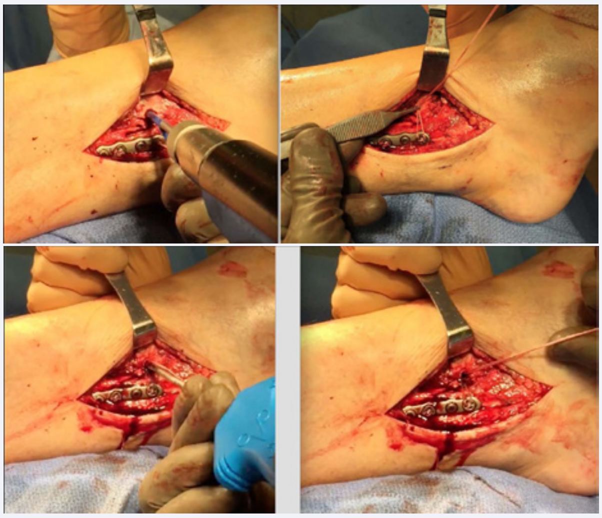

Figure 5 (A) – Demonstrates the predrill and the inferior strands of the suture button into the anterior lateral tubercle of the tibia. (B) - Shows the insertion of the 3 mm Bio-Pushlock™ anchor (Arthrex, Inc., Naples, FL USA) and the additional stabilization of the AITFL.

Figure 6 Reveals the stress view and a significant talar tilt attributed to an incompetent deep and superficial deltoid ligament.

ligament [21]. disruption of the articular congruity and tibiotalar contact surface when talar shift occurs through disruption of the tibiotalar joint [22,23]. Any external rotation type mechanism should heighten the physician's awareness to a syndesmotic injury. When excessive external rotation of the talus occurs disruption of the medial deltoid ligaments must intuitively take place. The mechanism and movement of the talus suggests tearing and disruption of the syndesmosis ligament as it abutes the fibula. Though subtle syndesmotic injuries (high ankle sprains) without fracture are beyond the scope of this case study, pain at the syndesmosis with proximal tibia and fibula squeeze or external rotation stress examinations should lead to suspicion for syndesmotic disruption that is not easily observed radiographically.

There is varied perception of what makes up the superficial and deep deltoid. The proximal deltoid attaches to both the anterior and posterior colliculus and the distal deltoid inserts on the navicular, talus, calcaneus, and helps make up the plantar spring ligament. Superficially the fibers of the deltoid are attached to the anterior colliculus and traverse to insert on the talus navicular and calcaneus as multiple studies have proven these ligaments contribute very little to the medial stability of the ankle [24,26]. The deep component is attached to the posterior colliculus and traverses to the talus. The deep deltoid is thought to provide stability between the talus and tibia by preventing valgus shifting, anterior/lateral translation and external rotation [27]. Deltoid pathology occurs when the ligament is under tension depending on the position of the ankle when external rotation of the talus occurs during injury. A variety of deltoid injury combinations can accompany an associated medial malleolar fractures; however that topic is yet again beyond the scope of this case study. The authors are evaluating a trimalleolar equivalent Maisonneuve fracture with an associated high fibula fracture and concomitant deltoid injury/syndesmosis disruption.

Many reports have demonstrated radiographic observance of the medial clear space for low-energy fractures predicting a deep deltoid injury with a gravity stress or applied manual force for injuries that may initially appear stable [28,29]. At our institution the decision to surgically stabilize the fibula is determined by a medial clear space of greater than 4mm during the stress denoting a deltoid complex injury. The decision to fix the syndesmosis is based on the introperative stress examination; as there is limited quality data in making the decision for operative versus non-operative treatment. Fractures of malleoli should increase the suspicion for syndesmosis involvement. Syndesmosis

Figure 7 Demonstrates medial ankle dissection with direct inspection of the torn deltoid ligaments.

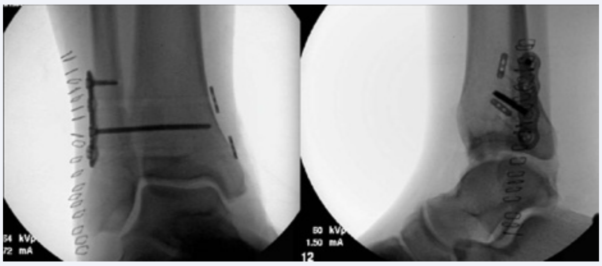

Figure 8 Shows final intraoperative fluoroscopy views confirming reduction of the syndesmosis, the talar tilt, and the medial clear space.

instability has been shown to occur as high as 60% for pronation external rotation injuries with high fibula fractures and up to 45% in supination external rotation injuries with low fibula fractures [16,30]. The level of fibula fracture is not indicative of a syndesmosis rupture. Standard of care when approaching bimalleolar or trimalleolar equivalent fractures is to fix the lateral malleolus and address the syndesmosis if disrupted after the introperative stress. The hook test has been determined to assess syndesmosis disruption with widening greater than 2mm of the fibula [31]. However, syndesmosis injuries are rotational in nature and utilizing the hook test makes it difficult to assess all planes of discrepancy. Additionally, the amount of force needed to provide coronal widening is debatable. The authors determine syndesmotic instability by utilizing an intra-operative external rotation stress test (Cotton test). Instability is determined by inspecting the lateral mortise of the tibiotalar joint and the medial clear space during the stress examination. If the talus shifts under external stress rotation and the medial clear space changes this indicates a positive stress examination and the syndesmosis is then reduced and fixed with screw fixation, suture button, or both. A stress on the syndesmosis is only performed after all fractures have been fixed. Care must be taken not to use excess force when externally rotating the ankle after fixation of the fibula as this could cause disruption in the fixation recently applied and could falsely demonstrate widening coming from the deltoid ligament injury [19]. If clamping the syndesmosis is considered, the clamp trajectory should be closely evaluated to avoid overcompression and external rotation 100 of article in press. Gardner et al demonstrated a malreduction rate up to 52% when evaluating a postoperative CT [32]. The transmalleolar axis must be appreciated to avoid syndesmosis malruduction [32]. Compression with a clamp is not associated with restriction of ankle motion and there have been studies demonstrating loss of compression once the clamp is removed with a noncompressed screw [33,34]. If using screw fixation for our syndesmosis approach the authors utilize a lagged syndesmosis technique with overdrilling the fibula and underdrilling the tibia prior to placement of a 3.5mm nonlocking fully threaded cortical screw [32]. Kwaadu et al [32] demonstrates that with a lagged syndesmosis technique there is maintained reduction with no late widening, as well no decrease in functional stability [32]. Neutral position of the ankle has been recommended by Van den Bekrom et al [35] however Tonetta et al [34] found no difference in range of motion following the position of the ankle when tightening further challenging the positional nature of the syndesmotic screw. They relate that the position of the ankle during screw insertion does not limit ankle motion [34]. Lagging the syndesmosis stabilizes the reduction anatomically and decreases the chance of the screw backing out [32]. During the fibula approach for lateral malleolar fractures it is important to address osteochondral lesions that may result from traumatic injury. When the syndesmosis is reduced the mortise of the ankle is typically restored and may decrease the medial clear space of the medial gutter. If the talus position is restored in the mortise the interposition of the deltoid ligaments is allowed to scar down. There have been reports demonstrating successful outcomes for trimalleolar and bimalleolar equivlent fractures when not addressing the deltoid complex as Zeegers et al [36] found in 169 lateral malleolar fractures repaired, that 16.6% had a deltoid ligament rupture that was not treated and 0% of the patients experienced deltoid insufficiency postoperatively [36]. These authors relate that 54% of the 169 fractures repaired were related to sports injuries; however, there was no specific correlation between deltoid injuries and sports [36]. Additionally a large majority of the fractures assessed were low-energy falls and five of the post operative radiographs demonstrated medial clear space widening compared to the intraoperative films and the authors conclude to explore the medial aspect of the joint if widening is demonstrated [36]. Stromose et al [37] looked at deltoid injuries not addressed with both Weber C and B fracture fixation and found that the function was improved without chronic insufficiency postoperatively and that there were no differences between those patients and the randomized patients that had sutures placed to correct the deltoid rupture [37]. These studies do not address the type of mechanism and energy associated with the fracture types and which prove inadequate when addressing deltoid injuries.

It is the surgeon's preference as to how many cortices to cross when applying syndesmostic fixation. Moore et al [38] established that there was no statistical significance in loss of reduction, osteolysis/breakage of screw, or subsequent hardware removal when comparing the utilization of 3 or 4 cortices of bone when using 3.5 mm fully threaded cortical screws [38]. There are no current recommendations that prove superior; however multiple screws are more stable than one screw biomechanically and quadra cortical fixation tends to be more rigid than tricortical fixation. Multiple screws have been recommended for Maisonneuve injuries, larger/obese patients, in severely osteoporotic bone, or diabetic ankle fractures to increase fixation stability [39]. There are varied recommendations on screw removal and timing for screw removal if it is desired. Dynamic stability has been utilized and suggested with the suture button technique (Arthrex Inc., Naples, FL, USA). It has been biomechanically shown to be inferior to screw fixation [40,41]. These do not typically need to be removed and have the advantage of allowing anatomic micromotion of the syndesmosis. Coetzee et al [42] demonstrated a prospective randomized trial comparing screw fixation to suture button and showed higher ankle scores with the suture button[42]. There have been reports of wound problems from knot prominence [43] however this risk is decreased with the advance of the knotless tight rope (Arthrex Inc., Naples, FL, USA). Two suture buttons are recommended to reduce the amount of sagittal plane motion and a combination of screw/suture button can also be recommended for larger patients or severe widening of the syndesmosis to add to the construct [19]. To add to the stability of the tight rope construct the authors recommend securing the the suture strands of the inferior button into the anterolateral tibia while fastening using a 3 mm Bio-Pushlock™ anchor (Arthrex Inc., Naples, FL, USA) (Figure 5A, 5B).

Arthroscopic intervention has been suggested as a reliable diagnostically to determine medial ankle instability. Hsu et al [5] relates arthroscopy a valuable tool when paired with an external rotation or valgus stress test to represent the dynamic instability of the medial ankle structures [5]. These authors advocate evaluation of superficial deltoid injuries with arthroscopic and stress evaluation initially with examination under anesthesia and fluoroscopic stress views. Hinterman et al [3] relates that arthroscopy was diagnostically valuable for patients that complain of medial instability chronically. In an additional study evaluating acute fractures Hintermann et al [44]made reference that 84.4% of deep deltoid injuries can be visualized with arthroscopy while superficial deltoid injuries were not visible [44]. Schuberth et al [45] evaluated deep deltoid configuration arthroscopically comparing this with the radiographic medial clear space for supination external rotation fractures and noted that careful evaluation of the deltoid must occur, as the medial clear space does not always predict the injury [45]. Despite this evaluation the authors did relate a 91.6% correlation with the radiographic classification of ankle fractures and deltoid injuries [45].

In our study the authors did not utilize arthroscopic evaluation of the deltoid complex. After stabilizing the lateral column and syndesmosis a valgus stress test was then utilized and demonstrated gross widening and valgus tilt of the talus with appreciation of a deep deltoid injury being obvious (Figure 7). We then opened the medial aspect and evaluated the deltoid directly and further confirmed the rupture of the deltoid with invagination and retraction of the ends in the medial gutter. While arthroscopic evaluation does appear to benefit the diagnosis with subtle injuries, gross widening and valgus tilt after fixation of the fibula and syndemosis may warrant direct evaluation and repair without arthoscopic findings.

The limitations to our study are inherent to any case report. With limited follow up of the patient and further limited prospective randomized data confirming success of acute deltoid intervention, it becomes difficult to ascertain strength of the approach. Nevertheless, we present a case report that required close attention to the deltoid complex after the syndesmosis was reduced for a dislocated trimalleolarequivelent Maisonneuve fracture.

Prompt diagnosis, reduction of the syndesmosis together with additional stability to the AITFL with the 3 mm Bio-Pushlock™ anchor (Arthrex Inc., Naples, FL, USA) (Figure 5A, 5B), continued valgus tilt of the talus after reduction and fixation of the fibula/syndesmosis with a positive valgus stress views to assess the dynamic instability (Figure 6), direct visualization of the deltoid complex (Figure 7), and open repair with fibertape and swivellock anchors all may lead to better functional outcome for high-energy sporting ankle injuries. This may reduce long-term instability and pain, chondral wear of the tibiotalarjoint, and subsequent posttraumatic arthritis.

Further retrospective evaluations, randomized prospective studies, demographic comparisons, low-energy versus high-energy assessments for acute deltoid repair on behalf of both subtle injuries and obvious deformities for functional and clinical outcomes is warranted.

CONFLICT OF INTEREST

Justin J. Fleming, DPM, FACFAS is a paid consultant for Arthrex Inc., Naples, FL, USA and Stryker Inc., Kalamazoo, MI, USA.

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