Deltoid Ligament Repair in Acute Ankle Fractures: A 5-Year Follow Up

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Statement of Purpose

The direct repair of a deep deltoid rupture following a traumatic ankle fracture is not commonly performed. Previous studies do not fully account for the contributions of the medial deltoid to overall ankle stability as well as long-term patient satisfaction. Previously deep deltoid injuries were addressed by indirect means through syndesmotic ligament repair. However, this technique failed to confirm that the primary medial stabilizing structure was anatomically restored. The lack of direct deltoid repair potentially explains the less than optimal outcome associated with syndesmotic injuries. In our study results, an overwhelmingly positive response was provided with an average of a 5 year follow up. There was a 93% positive return to normal function. No patient required any secondary procedures related to the medial deltoid repair. In conclusion, the direct repair of the deltoid ligament demonstrated high patient satisfaction with a relatively uncomplicated return to normal activities.

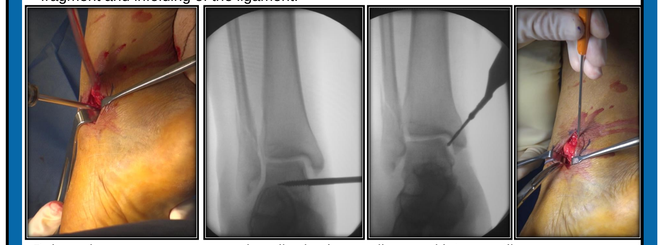
Literature Review

The consensus role of acute medial deltoid repair is largely contested in returning stability to the ankle following injury (1). The anatomy of the medial deltoid varies slightly among individuals but all are comprised of a superficial and a deep layer (2). The superficial layer subsists of the tibionavicular, tibiocalcaneal and posterior tibiotalar ligaments. This layer is described as fan shaped and more vertical in orientation. The deep layer involves the deep anterior tibiotalar and deep posterior tibiotalar. The deep layer is horizontally angled and only spans the ankle joint, unlike the superficial portion which traverses two joints (2). The deltoid ligament imparts medial stability to the ankle and resists talar abduction, pronation and external rotation throughout gait (2). The medial deltoid ligamentous complex is well established as the major stabilizer of the ankle with the syndesmosis as a secondary restraint (3). Ignoring the responsibility of the deltoid, causes the syndesmosis to be overextended and exceed the capacity of anatomic stability (3).

In the acute setting, a deep deltoid injury is associated with increased severity (4). The deep deltoid ligament is usually damaged with a concomitant fracture of the fibula or disruption of the syndesmosis (5). The deep deltoid ligament is seldom involved with isolated injuries and subtle concurrent pathology most be considered. The anterior portion of the deep deltoid ligament serves as the primary restraint for the external rotation of the talus and fails during syndesmotic injuries (6). The talus rotates within the mortise until it collides with the fibula which disrupts the anterior inferior talofibular ligament and either tears the medial deltoid or fractures the medial malleolus. The Lauge-Hansen classification underestimates soft tissue injuries in regards to the deltoid ligament in the setting of rotational injuries (7).

Materials and Methods

A retrospective review was conducted of all patients undergoing acute medial deltoid ligament repair by the senior author during the time period of 01/01/2005 through 12/31/2014. Twenty- four patients were identified. All pertinent medical records were thoroughly reviewed. Eligible patients suffered either a bimalleolar or trimalleolar equivalent ankle fracture with medial clear space widening on stress radiographs. At the time of the last clinical follow up, all records indicated satisfactory healing of all injuries and patients were released without restriction. A written modified AOFAS satisfaction survey that measured functional outcome and pain relief was sent to all available patients with a total of 3 replies. The remaining 21 patients were contacted by phone at least four times at which point a voicemail message was left to follow up with the primary author if interested in participating in the study. An additional 11 patients agreed and a phone survey was conducted. Of the 14 total patients, 10 Weber B and 4 Weber C fracture patterns were identified with 11 bimalleolar and 3 trimalleolar equivalent variants noted. Concurrent syndesmotic fixation by suture endobutton was required in 9 procedures. A total of 4 medial malleolar avulsion fractures were identified preoperative with one patient requiring excision due to instability of the fragment and infolding of the ligament.



Pain and success scores were described using medians and interquartile ranges, as these measurements are on an ordinal scale. The change in pain score from pre- to post-operative measurements was tested for significance using the paired Wilcoxon sign-rank test. Categorical variables were described using counts and percentages. All analyses were done using R software (version 3.0.2, Vienna, Austria). All surgical procedures were performed by the senior author and are described as the following; the patient was placed on the operating table in the supine position and underwent successful general anesthesia. A standard thigh tourniquet. A linear 3-cm incision was placed over the medial malleolus for inspection of the deltoid ligament. Attenuation of the deep deltoid ligament is noted with exposure of the entire medial talar dome and medial ankle gutter to verify no in folding of the ligament exists. A 2.7-mm drill bit and 4.5-mm tap were utilized to place a suture construct with bioabsorbable anchor in the medial body of the talus. Next, an oblique hole was drilled utilizing a 2.5-mm drill bit through the medial malleolus in the direction of the deep deltoid fibers and a micro-suture passer was used to capture the previously placed suture from the suture anchor. The repair was then secured but not finalized as the associated fibular fracture and any syndesmotic injury was addressed in standard fashion. To complete the medial repair the ankle was placed in sagittal neutral with mild varus angulation as the suture arm was secured to the medial cortex of the tibia by suture button. The ankle was then placed through range of motion and verified to be stable under stress fluoroscopy with restoration of the distal tibiofibular overlap.

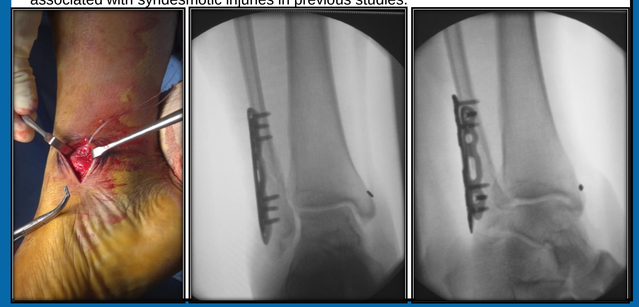
Results

Fourteen patients (7 female, 7 male) agreed to participate in the study. The mean average age was 42 years old (IQR 17 to 68). The mean average patient follow up was 70.6 months. Of these patients, the median subjective preoperative pain scale was 9 (IQR 5 to 10) out of 10, which improved postoperatively to 1 (IQR 0 to 5) out of 10. The median decrease in pain score was 8 (IQR 3 to 10). The median improvement of pain score was 90.7 (IQR 65 to 100) out of 100, and the median score rating the overall success of the procedure was 91.1 (IQR 60 to 100) out of 100. The median satisfaction score for return to normal activity was 93 (IQR 70 to 100) out of 100 and higher demand activities 88 (IQR 60 to 100) out of 100. The overall return to function capacity measured 85.5 (IQR 33 to 100). One patient had lateral hardware removed without disruption of the medial repair. Two patients complained of medial swelling with activities.

No reports of infections or wound complications were found within our study population. No patient required revision or medial hardware removal.

Analysis and Discussion

Classically, the deep deltoid ligament has been addressed by indirect repair secondary syndesmotic fixation (7). This false stability can be attributed to the compression of the talus within the mortise opposed to anatomic restoration (8). Boden et al utilized a cadaveric model to indict syndesmotic instability occurs only after a more proximal disruption of the interosseous membrane (3). Syndesmotic reduction is not without complication and malreduction is possible (8). Metallic screw fixation of the syndesmosis typically requires screw removal in active patients (9, 10). Syndesmotic injures are a negative predictor for long-term prognosis following ankle fractures but the study never addressed the possibility of coexistent medial deltoid pathology (8). The deltoid ligament was not directly restored unless a medial malleolar fracture was present. The bimalleolar equivalent fracture was not accounted for in the examination of functional outcome studies (8). Of the 51 patients involved in the study, only 18 received medial malleolar screw fixation (8). In a recent comparison study, 8 patients responded to a follow up questionnaire with no difference in outcome between syndesmotic fixation and deltoid repair at an average of 50 months follow up (11). A multicenter study demonstrated similar positive outcomes in patient satisfaction (12). The possibility of a simultaneous deltoid injury may contribute to the negative outcome associated with syndesmotic injuries in previous studies.



Analysis and Discussion

Our review assessed patient satisfaction for acute deltoid repair with an average follow up of over 5 years. The goal of this research was serve as a pilot study to confirm patient responded positively to the deltoid repair technique. The results demonstrated that patients were exceedingly satisfied and rated their ability to return to normal activity at 93%. As a relatively new procedure, there is an important need to substantiate the longevity of the repair technique. While the possibility of future complications exist, this study shows minimal negative effects within our population at an average of 5 years follow up.

The limitations of this study are typical of those associated with retrospective reviews. The data collected was reliant on patient participation which may be outcome dependent. While the study population was small, the results were overwhelmingly positive. No further procedures were required due to insufficient repair or hardware irritation. Ideally follow up imaging would have removed some subjectivity of the results. Although unavoidable, the deltoid was not an isolated repair and the other procedures may affect the patient's outcome perception.

In conclusion, the repair of acute deltoid injuries utilizing suture anchors demonstrated tremendously positive patient satisfaction with no further procedures performed at a 5 year follow up. The severity of soft tissue pathology is misjudged in ankle fractures (6). Contributions from missed or untreated deltoid injuries likely contribute or even add to dissatisfaction associated with syndesmotic injuries (3). The direct visualization of the deltoid repair allowed for closer anatomic correction then relying on syndesmotic fixation alone to address injury. This technique did not require hardware removal in active patients as typically needed with syndesmotic screw fixation. This study validated the deltoid ligament repair as an effective initial procedure when required in unstable ankle fractures.

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