



## Suture anchors for primary deltoid ligament repair associated with acute ankle fractures

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The aim of the study is to evaluate the clinical effect of primary suture anchors repair in the treatment of deltoid ligament rupture associated with ankle fractures. 34 patients with acute deltoid ligament rupture associated with ankle fractures were selected between 2011 and 2014. Medial clear space (MCS), American Orthopaedic Foot and Ankle Society (AOFAS) scores, visual analog scale (VAS) were noted. The mean follow-up was 28.4 (range, 22-35) months. The mean AOFAS score was 92.6 (range, 90-95) and the mean VAS score was  $1.06 \pm 0.65$  (range 0 to 2) points at the final follow-up. The mean MCS is  $(9.10 \pm 4.99)$  mm before and  $(3.71 \pm 0.33)$  mm after surgery in radiographs. At the postoperative final follow-up, the mean MCS of injured ankle is  $(3.74 \pm 0.32)$  mm in radiographs, and  $(3.65 \pm 0.17)$  mm of uninjured contralateral ankle. Using suture anchors for the primary repair of deltoid ligament rupture during the treatment of ankle fractures can achieve satisfactory outcomes.

**Keywords** : Ankle fracture, deltoid ligament, rupture, suture anchors, stress radiographs.

### INTRODUCTION

The deltoid ligament, which is the primary ligamentous stabilizer of the ankle joint (21), is injured more frequently than generally believed (7-9). Some earlier studies believed that repair of ruptured deltoid ligament was not necessary (4-

5,23). Rigid fixation of the syndesmosis and fracture allows the deltoid ligament to remain static while it undergoes a healing response (1,13,15,23). Neglect of the ligaments in the treatment of ankle injuries may be due to persistent pain or ankle instability (2,7,9,14,22,25). The published data regarding acute operative intervention for the deltoid ligament repair are sparse (14). Primary operative repair of acute deltoid ligament rupture remains controversial. The purpose of this study is to evaluate the clinical effect of primary suture anchors repair in the treatment of deltoid ligament rupture associated with ankle fractures.

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**Fig. 1.** — Preoperative radiographs of a 44-year-old woman with deltoid ligament rupture associated with ankle fractures. She had a history of tibiofibular fracture in ipsilateral limb with conservative treatment 31 years ago. (A,B) Postoperative radiographs of deltoid ligament repair and fracture fixation (C,D).

## PATIENTS AND METHODS

After receiving approval from the institutional review board, we evaluated the patients who had undergone primary suture anchors repair in the treatment of acute deltoid ligament rupture associated with ankle fractures between 2011 and 2014. In this study, operative repair of the deltoid ligament rupture was indicated if the MCS was  $>5$  mm in distance during the external rotation stress radiograph. Operative repair was also indicated if persistent medial ankle instability was evident on external rotation stress testing after fracture fixation. Medial exploration with suture anchor repair of the acute deltoid ligament rupture was indicated.  $MCS \leq 5$  mm during stress radiograph was considered a good result. We excluded patients with chronic deltoid ligament injury, isolated deltoid ligament injury, medial malleolus fracture, tibia pilon fracture, open fracture and pathological fracture from this study. 34 patients consented to be included in the study, and to receive primary suture anchors repair for acute deltoid ligament rupture before surgery.

We evaluated patients preoperatively with anteroposterior (Fig. 1-A), lateral radiographs (Fig. 1-B) and 3-dimensional CT. The mean follow-up was 28.4 (range, 22-35) months. All of the fractures were unilateral, with 14 fractures on the right and 20

on the left ankle. There were 13 women and 21 men with an average age of 37.3 years (range, 23-56) at the time of surgery. 23 patients had lateral associated with deltoid ligament rupture; 11 patients had lateral and posterior malleolus fractures associated with deltoid ligament rupture. We classified the fractures according to the AO classification system and Lauge-Hansen classification system. The 34 fractures included 9 patients were 44-B.2.1 subgroup, 16 patients were 44-B.3.1 subgroup, 7 were 44-C.1.1 subgroup, and 2 were 44-C.2.1 subgroup fractures. The 34 fractures included 11 supination-external rotation type IV fractures, 9 pronation-external rotation type III fractures, 12 pronation-external rotation IV fractures, and 2 pronation-abduction type IV fractures.

A thigh tourniquet was applied in a standard manner. Posterolateral approach was used to reduce lateral and posterior malleolus fractures, and lateral approach to isolated lateral fracture. We fixed the lateral and posterior malleolus fractures, thus ensuring its proper location. We decided to fix the tibiofibular syndesmosis with syndesmotic screws if there was a tibiofibular instability. If additional instability of the lateral ankle ligament was suspected, the lateral ankle ligaments should also be repaired. After fixation, stress radiograph was performed and if  $MCS > 5$  mm persisted, the deltoid ligament was repaired by FASTIN RC 5-

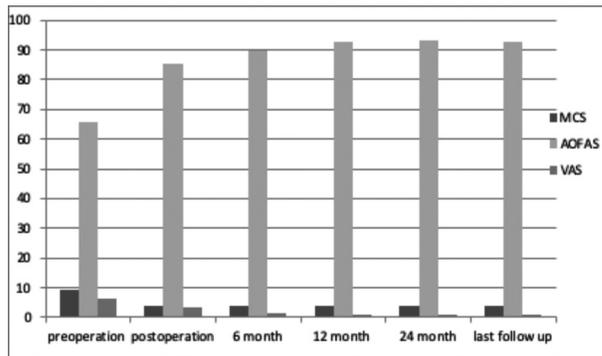


Fig. 2. — Bar chart showing the mean scores for the patients preoperatively and during the postoperative follow-up period.

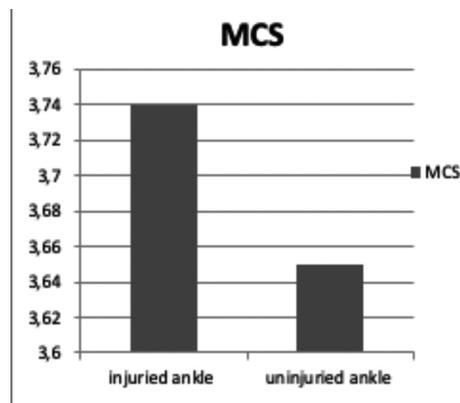


Fig. 3. — Bar chart showing the mean MCS of the injured and uninjured ankle at the final follow-up.

mm titanium screw anchor with 2 No.2 Orthocord sutures (DePuy Mitek Inc, Raynham, MA) or 3.5 mm Corkscrew® FT Suture Anchor with 2 needles and fiberwire sutures (Arthrex Inc, Naples, USA). We placed the anchor in the insertion of deltoid ligament at medial malleolus or termination of deltoid ligament at talus. (Fig. 1- C.D). Appropriate reduction was confirmed with fluoroscopy.

The foot was protected in a plaster cast for 3 to 4 weeks and then was allowed partial weight bearing as soon as pain allows. Rehabilitation starts afterward, with passive and active mobilization of the ankle joint. The syndesmotic screws were removed 8 weeks after surgery. All the patients were allowed full weight bearing at the 8-week after surgery. The patients were examined before and after surgery, and at the 6-, 12-, and 24-month and final follow-ups postoperatively. MCSs, AOFAS scores, VASs of injured ankles were noted. (Fig. 2)

MCSs of injured and uninjured ankles were noted from radiographs at the final follow-up. (Fig. 3) We evaluated the clinical effect with MCSs, AOFAS scores, and VASs.

For statistic calculations, SPSS statistics (SPSS Inc, Chicago, IL) version 17.0 was used. For evaluation of differences of MCS, two-paired-samples t test was applied. The level of significance was set at  $P < 0.05$ .

## RESULTS

According to Hintermann's classification of deltoid rupture (6) : a proximal injury (type I lesion) of the deltoid ligament was noted in 24 patients (70.6%), an intermediate injury (type II lesion) was noted in 3 patients (8.8%), and a distal injury (type III lesion) was noted in 7 patients (20.6%). All ankle fractures healed without MCS >5mm or talar subluxation after operative treatment. Implant loosening was not observed in any of the patients. No patient required revision surgery. 1 patient had arthritis at the place of tibiofibular syndesmosis on the radiograph, but no clinical symptom was found. 33 patients demonstrated maintenance of an anatomic ankle mortise reduction and showed no signs of arthritis. Syndesmotic screws were performed in 5 patients. Lateral ankle ligament was repaired in 1 patient. Complications of wound healing occurred in 1 patient, which completely healed after repeat debridement. We detected normal dorsiflexion in 28 patients and a 5- to 10-degree lack of dorsiflexion in 6 patients when compared with the uninjured contralateral limb. Paresthesia on the lateral aspect of the foot due to traction of the sural nerve occurred in 1 patients. Paresthesia resolved within 2 weeks without any additional treatment.

The mean AOFAS score was 89.7 (range, 85-94) at the postoperative 6-month follow-up, and 92.7 (range, 88-95), 93.3 (range, 90-95), and 92.6 (range, 90-95) at the 12-month, 24-month, and final follow-up, respectively. The mean VAS score was  $1.06 \pm 0.65$  (range 0 to 2) points at the final follow-up. The mean MCS is  $(9.10 \pm 4.99)$  mm before and  $(3.71 \pm 0.33)$  mm after surgery in radiographs. With the numbers available, statistical analysis showed statistical difference in terms of MCS of the ankle joints ( $P < 0.05$ ). At the postoperative final follow-up,

the mean MCS of injured ankle is  $(3.74 \pm 0.32)$  mm in radiographs, and  $(3.65 \pm 0.17)$  mm of uninjured contralateral ankle. Statistical significance was defined as  $P > 0.05$ .

## DISCUSSION

The stability of the loaded ankle is primarily due to the deltoid ligament, which exerts a restraining influence against valgus tilting, anterior translation and the external rotation of the talus. (3,16-17,22) Studies have shown that even small deviations from anatomic alignment result in greatly reduced joint contact areas (20). Such injuries may be a source of persistent pain or medial ankle instability. Repair of the deltoid ligament alone restored 57% of the original rotational stability in a Weber C fracture (26).

Hintermann et al. (7) observed by arthroscopy that at least 40% of 288 ankle fractures occurred with deltoid ligament damage. The incidence of medial ligaments injury may well be greater than initially believed (7-9), and with more sophisticated imaging technologies and ankle arthroscopy, deltoid ligament injuries will be identified more frequently either in isolation or in association with more complicated injury mechanisms. Diagnosis of injured deltoid ligament is particularly important to subsequent treatment. Swelling, ecchymosis, medial tenderness, initial injury radiographs and the fracture classification prompt the injury of the deltoid ligament. External rotational stress radiographs are helpful to gain indirect evidence of injury of the deltoid ligament in the management of acute ankle fractures (19,24-25). Magnetic resonance imaging (14), Ultrasonography (2) and Arthroscopy (7) can also provide more information for doctor. A combination of multiple modalities, including physical examination and radiographic analysis, is useful for the accurate diagnosis of deltoid ligament injury. We found that above-mentioned method was accurate and sensitive for identifying deltoid ligament injury.

In the 1980's and 1990's, the standard of practice in many communities is to perform open reduction internal fixation of the fibula, ensure that the mortise is anatomically restored and leave the deltoid

complex to heal without direct operative intervention (1,4-5,23). Some authors (4,15,28) concluded that primary repair of the deltoid was not necessary by reason of satisfactory outcome. However, residual pain, deformity, widening of MCS, ankle instability and arthritis still exist in small cohorts. Johnson and Hill (12) reported on lateral malleolar fractures with deltoid ligament rupture in 29 patients. The deltoid ligament was not repaired. 10 patients had residual pain along the medial ankle, and 18 patients had medial ligament tenderness. They recommended repairing the deltoid ligament complex. Murawski and Kennedy (18) reported the results of a minimum 2-year follow-up in 41 patients and observed that the deltoid may fold into the joint during dorsiflexion to potentiate impingement. A rupture of the deltoid ligament may result in persisting pain or ankle instability associated with acute ankle fracture when not appropriately treated (5,8-9,16,24).

In recent studies, orthopaedic surgeons pay more attention to the deltoid ligament injury, and believe deltoid ligament repair can reduce the risk of residual pain and ankle instability. Hsu et al. (10) reported 14 National Football League (NFL) players treated with ankle fracture fixation with primary deltoid complex repair. All NFL players were able to return to running and cutting maneuvers by 6 months after surgery. The majority of NFL players treated surgically for this injury pattern are able to return to play after surgery with no reported complications or persistent medial ankle pain or instability. Hintermann et al. (9) reported that primary operative repair produced satisfying results, and operative intervention should be considered in those acute injuries. Yu et al. (27) repaired 131 ruptured deltoid ligaments associated with ankle fractures. The results showed that deltoid ligament rupture could be repaired in patients with an unstable medial ankle after fracture fixation and prevent ankle stabilization-related complications. Our study reconfirmed prior studies (9-10,27) and got good MCSs, excellent AOFAS scores, good VASs, as well as satisfactory outcomes.

The present study had several limitations, including lack of a comparison group, multiple injury mechanisms, multiple type of fractures, small sample size, and relatively large number of surgeons. A randomized controlled trial is needed.

## CONCLUSION

Using suture anchor for the primary repair of deltoid ligament rupture during the treatment of ankle fractures can achieve satisfactory outcomes.

## REFERENCES

1. **Bluman EM.** Deltoid ligament injuries in ankle fractures: should I leave it or fix it? *Foot Ankle Int.* 2012 ; 33 : 236-238.
2. **Chen PY, Wang TG, Wang CL.** Ultrasonographic examination of the deltoid ligament in bimalleolar equivalent fractures. *Foot Ankle Int.* 2008 ; 29 : 883-886.
3. **Close JR.** Some applications of the functional anatomy of the ankle joint. *J Bone Joint Surg Am.* 1956 ; 38-A : 761-781.
4. **de Souza LJ, Gustilo RB, Meyer TJ.** Results of operative treatment of displaced external rotation-abduction fractures of the ankle. *J Bone Joint Surg Am.* 1985 ; 67 : 1066-1074.
5. **Harper MC.** The deltoid ligament. An evaluation of need for surgical repair. *Clin Orthop Relat Res.* 1988 : 156-168.
6. **Hintermann B.** Medial ankle instability. *Foot Ankle Clin.* 2003 ; 8 : 723-738.
7. **Hintermann B, Regazzoni P, Lampert C, et al.** Arthroscopic findings in acute fractures of the ankle. *J Bone Joint Surg Br.* 2000 ; 82 : 345-351.
8. **Hintermann B, Valderrabano V, Boss A, et al.** Medial ankle instability: an exploratory, prospective study of 52 cases. *Am J Sports Med.* 2004 ; 32 : 183-190.
9. **Hintermann B, Knupp M, Pagenstert GI.** Deltoid ligament injuries: diagnosis and management. *Foot Ankle Clin.* 2006 ; 11 : 625-637.
10. **Hsu AR, Lareau CR, Anderson RB.** Repair of acute superficial deltoid complex avulsion during ankle fracture fixation in national football league players. *Foot Ankle Int.* 2015 ; 36 : 1272-1278.
11. **Jeong MS, Choi YS, Kim YJ, et al.** Deltoid ligament in acute ankle injury : MR imaging analysis. *Skeletal Radiol.* 2014 ; 43 : 655-633.
12. **Johnson DP, Hill J.** Fracture-dislocation of the ankle with rupture of the deltoid ligament. *Injury.* 1988 ; 19 : 59-61.
13. **Jones CR, Nunley JA 2nd.** Deltoid ligament repair versus syndesmotric fixation in bimalleolar equivalent ankle fractures. *J Orthop Trauma.* 2015 ; 29 : 245-249.
14. **Luckino FA 3rd, Hardy MA.** Use of a flexible implant and bioabsorbable anchor for deltoid rupture repair in bimalleolar equivalent weber B ankle fractures. *J Foot Ankle Surg.* 2015 ; 54 : 513-516.
15. **Maynou C, Lesage P, Mestdagh H, et al.** Is surgical treatment of deltoid ligament rupture necessary in ankle fractures? *Rev Chir Orthop Reparatrice Appar Mot.* 1997 ; 83 : 652-657.
16. **Michelsen JD, Ahn UM, Helgemo SL.** Motion of the ankle in a simulated supination-external rotation fracture model. *J Bone Joint Surg Am.* 1996 ; 78 : 1024-1031.
17. **Michelson JD, Hamel AJ, Buczek FL, et al.** The effect of ankle injury on subtalar motion. *Foot Ankle Int.* 2004 ; 25 : 639-646.
18. **Murawski CD, Kennedy JK.** Anteromedial impingement in the ankle joint : outcomes following arthroscopy. *Am J Sports Med.* 2010 ; 38 : 2017-2024.
19. **Park SS, Kubiak EN, Egol KA, et al.** 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.
20. **Ramsey PL, Hamilton W.** Changes in tibiotalar area of contact caused by lateral talar shift. *J Bone Joint Surg Am.* 1976 ; 58 : 356-357.
21. **Rein S, Hagert E, Schneiders W, et al.** Histological analysis of the structural composition of ankle ligaments. *Foot Ankle Int.* 2015 ; 36 : 211-214.
22. **Savage-Elliott I, Murawski CD, Smyth NA, et al.** The deltoid ligament : an in-depth review of anatomy, function, and treatment strategies. *Knee Surg Sport Traumatol Arthrosc.* 2013 ; 21 : 1316-1327.
23. **Stromsoe K, Hoqevold HE, Skjeldal S, et al.** The repair of a ruptured deltoid ligament is not necessary in ankle fractures. *J Bone Joint Surg Br.* 1995 ; 77 : 920-921.
24. **Tornetta P 3rd.** Competence of the deltoid ligament in bimalleolar ankle fractures after medial malleolar fixation. *J Bone Joint Surg Am.* 2000 ; 82 : 843-848.
25. **van den Bekerom MP, Mutsaerts EL, van Dijk CN.** Evaluation of the integrity of the deltoid ligament in supination external rotation ankle fractures : a systematic review of the literature. *Arch Orthop Trauma Surg.* 2009 ; 129 : 227-235.
26. **van den Bekerom MP, Lamme B, Hogervorst M, et al.** Which ankle fractures require syndesmotric stabilization. *J Foot Ankle Surg.* 2007 ; 46 : 456-463.
27. **Yu GR, Zhang MZ, Aiyer A, et al.** Repair of the acute deltoid ligament complex rupture associated with ankle fractures : a multicenter clinical study. *J Foot Ankle Surg.* 2015 ; 54 : 198-202.
28. **Zeegers AV, van der Werken C.** Rupture of the deltoid ligament in ankle fractures : should it be repaired? *Injury.* 1989 ; 20 : 39-41.