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Original Research

Evaluation of Transsyndesmotic Fixation and Primary Deltoid Ligament Repair in Ankle Fractures With Suspected Combined Deltoid Ligament Injury

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ABSTRACT

The present prospective study examined the utility of the intraoperative tap test/technique for distal tibiofibular syndesmosis in the diagnosis of deltoid ligament rupture and compared the outcomes of transsyndesmotic fixation to deltoid ligament repair with suture anchor. This diagnostic technique was performed in 59 ankle fractures with suspected deltoid ligament injury. The width of the medial clear space of 59 cases was evaluated to assess the sensitivity and specificity. Those with deltoid ligament rupture were randomly assigned to 2 groups and treated with deltoid ligament repair with a suture anchor or with syndesmosis screw fixation. All the patients were assessed with the American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot scale, short-form 36-item questionnaire (SF-36), and visual analog scale (VAS). The tap test was positive in 53 cases. However, surgical exploration demonstrated that 51 cases (86.4%) had a combined deltoid ligament injury and fracture. The sensitivity and specificity of the tap test was 100.0% and 75.0%, respectively. Finally, 26 cases (96.3%) in the syndesmosis screw group and 22 (91.7%) in the deltoid repair group were followed up. No statistically significant differences were found in the AOFAS ankle-hindfoot scale score, SF-36 score, or VAS score between the 2 groups. The malreduction rate in the syndesmosis screw group was 34.6% and that in the deltoid repair group was 9.09%. The tap test is an intraoperative diagnostic method to use to evaluate for deltoid ligament injury. Deltoid ligament repair with a suture anchor had good functional and radiologic outcomes comparable to those with syndesmotic screw fixation but has a lower malreduction rate. We did not encounter the issue of internal fixation failure or implant removal.

Acute deltoid ligament injury seldom exists in isolation and is often accompanied by lateral malleolar fracture or bilateral malleolar fracture (1,2). In the Lauge-Hansen supination-external rotation (SER) types of fractures, deltoid ligament injury is very common. The Lauge-Hansen SER fracture type on radiograph plain film sometimes manifests only as an isolated lateral malleolar fracture, and the talus shift and widening of the medial clear space is not obvious, which can easily lead to a misdiagnosis (3). Accordingly, Michelson et al (4) proposed that stress tests should be performed for any isolated fibular fracture. Tornetta (5) reported that radiographic evidence of deltoid ligament rupture could still be observed in 26% of the cases after internal fixation. Schuberth et al (6) studied isolated distal fibular fracture using arthroscopy and found that about one third of these patients had a deltoid ligament injury. Magnetic resonance imaging has shown good accuracy in the detection of deltoid ligament tears (7). However, the quality of magnetic resonance imaging is strongly dependent, not only on the condition of the equipment, but also on the ability of the radiologists. Thus, the popularization of this method has been hindered, especially in primary care with poor equipment and technical issues. Given that 5% of ankle sprains include deltoid ligament injury (8), it would be of great clinical significance and economic benefit to find a simple and inexpensive diagnostic method that would be easy to popularize. Therefore, some manual stress tests were introduced to test the dynamic instability of the ankle. In addition to the commonly used external rotation stress test, the Cotton test, the intraoperative tap test/technique is an innovative method to estimate the stability of the syndesmosis that was first introduced in

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2010 (9). The principle of the tap test is that the force of tapping is converted into the force of syndesmosis diastasis. In our previous application of this technique, we found an interesting phenomenon when we assessed syndesmotic stability using this intraoperative tap test. If the deltoid ligament is intact, the widening of the medial clear space will be much smaller than if the ligament has ruptured. The lack of integrity of the deltoid ligament is a reason for obvious syndesmosis diastasis and widening of the medial clear space. Thus, we hypothesized that this intraoperative tap test/technique for distal tibiofibular syndesmosis could be used in diagnosing the integrity of the deltoid ligament. To the best of our knowledge, the present study is the first attempt to use the intraoperative tap test/technique as a diagnostic method for examining the integrity of the deltoid ligament. From June 2011 to December 2013, the patients with positive results for the tap test performed on ankle fractures were randomly assigned to 2 groups. A prospective study was performed to evaluate the diagnostic value of an intraoperative tap test/technique for acute deltoid ligament rupture and to compare the outcomes of acute ankle fractures with deltoid ligament injury treated with deltoid ligament repair with a suture anchor versus transsyndesmotic fixation.

Patients and Methods

The intraoperative tap test was performed in 59 cases of ankle fractures suspected to be combined with deltoid ligament injury from June 2011 to December 2013. The data from 59 patients were collected by 2 of us (K.W., J.L.). The study inclusion criteria were as follows: (1) medial clear space widening >4 mm and talus outward shifting; (2) SER IV fracture type, pronation-abduction type, or pronation-external rotation type, according to the Lauge-Hansen classification; and (3) isolated fibular fractures with the medial malleolus tenderness, swelling, and ecchymosis. The exclusion criteria included (1) multiple fractures of the ipsilateral limb; (2) open fractures; (3) previous ankle injuries and deformities; (4) age <16 years or >70 years; and (5) pregnancy. Three-dimensional computed tomography (CT) was performed routinely to determine the fracture type and the size of the posterior malleolar fracture. All patients provided written informed consent, and the ethics committee approved the present study.

Intraoperative Tap Test/Technique and Grouping

All the surgical operations were performed by a set of 3 senior surgeons (K.W., J.L., J.H.). The patients underwent surgery under either epidural or general anesthesia. The patients were placed in the supine position, and a posterolateral incision was used to access the fibula. First, open reduction and internal fixation (ORIF) was performed at the lateral malleolus. For the posterior malleolar fracture, as long as the size of the fragment was large enough to allow for screw insertion, internal fixation was undertaken. When the fracture fragments were larger, an antiglide plate (one-third tubular plate) was used for internal fixation. When the fracture fragments were smaller, such as with a Volkmann tuberosity avulsion fracture, a cannulated screw was used. A 2.7-mm drill was placed on the fibula slightly posterior to the midline at the syndesmotic level (2 to 5 cm from tibial plafond); however, the lateral tibial cortex was kept intact. We inserted the 3.5-mm tap (Trauson, Changzhou, China) into the bone hole, and, after feeling the tap breaking though the second cortex, we stopped (Fig. 1A). C-arm fluoroscopy allowed us to obtain a mortise view of the ankle joint to estimate the degree of talar shift and the width of the medial clear space. We then continued tapping. When resistance was felt once again, we progressed for another 3 turns and compared the talar shift and widening of the medial clear space to the previous fluoroscopic image (Fig. 1B). The tap test/technique was performed by the same 3 surgeons (K.W., J.L., J.H.) independently. The other 2 surgeons left the operating room and 1 surgeon performed the tap test with fluoroscopic guidance. That surgeon then left, and the second surgeon performed the same test. Every surgeon made a judgment independently. If ≥2 of the surgeons agreed the medial clear space was obviously wider than before, that was defined as a positive result. After completion of the tap test, the medial clear space of all the patients was evaluated to demonstrate whether the deltoid ligament was injured. The cases that proved to be fractures combined with deltoid ligament injury during surgery were randomly assigned to 2 groups by coin toss. The syndesmosis screw group was treated with transsyndesmotic fixation using a 3.5-mm fully threaded cortical screw, and the deltoid ligament repair group underwent repair with a suture anchor.

Deltoid Ligament Repair With Suture Anchor and Transsyndesmotic Screw Fixation

We used a 5-cm curved incision from the tip of medial malleolus. Blunt dissection of the fascia was conducted to protect the great saphenous vein and the saphenous nerve. The anterior colliculi of the medial malleolus were exposed and the injuries of the superficial and deep layers of the deltoid ligament observed. If the superficial ligament such as the tibionavicular ligament and the tibiocalcaneal ligament were not completely ruptured, we cut along the longitudinal direction of the ligament fiber bundle to prepare subsequent repair. A superficial layer rupture and a deep layer rupture were both considered as positive. After fixation of the fibula, the medial clear space will narrow, and exposure of the deep ligaments will become difficult. We placed the foot in plantarflexion with the talus in valgus, and the assistant performed traction of the forefoot to further expose the medial malleolus clearance of the talus. Depending on the different areas of the deltoid ligament rupture, the method for repair also differs. For the middle part of the ligament, interrupted sutures were used directly. For avulsion of the ligament from its insertion on the medial malleolus, a 5.0-mm suture anchor (Fastin; Johnson & Johnson, Raynham, MA) was placed into the distal end of the medial malleolus, and the residual deep ligament was sutured to the tip of the medial malleolus. For avulsion of the ligament from its insertion on the talus, 1 suture anchor was entered at the termination of the talus (Fig. 2D), 2 holes were predrilled at the tip of the medial malleolus parallel to each other. Two bundles of suture were knotted at the proximal end of the medial malleolus, and attention was given to apply appropriate tension with the foot in neutral dorsiflexion. The syndesmosis was held in place using a large pointed reduction clamp that compressed the tibia and fibula at the level of syndesmosis, with the ankle placed in neutral position. After suturing, the tap test was conducted again to determine the stability of the medial structure (Fig. 2C). After pressing against the lateral cortex of the tibia, we turned the tap 3 more times, and the distance of the medial clear space had decreased to <1 mm. A typical case is shown in Fig. 2. After repairing the deep layer, we also directly repaired the superficial layer using an interrupted suture technique. For the syndesmosis screw group, we reduced the syndesmotic joint using the previously reported method. Next, at 2 to 5 cm above the tibial plafond, we used a 3.5-mm tricortical screw to fix the syndesmosis through the previously drilled hole.

Postoperative Treatment

On postoperative day 2, the patients of both groups were encouraged to perform active and passive movement of the ankle joint under analgesia. Every patient routinely underwent 3-dimensional CT postoperatively. We checked the anterior fibular–incisura distance between in the uninjured and injured ankle 1 to 2 cm proximally to the ankle joint on the CT scan. An anterior fibular–incisura distance that was wider or narrower than its uninjured side was considered to indicate malreduction. Standard anteroposterior and lateral radiographs were obtained during the follow-up period.

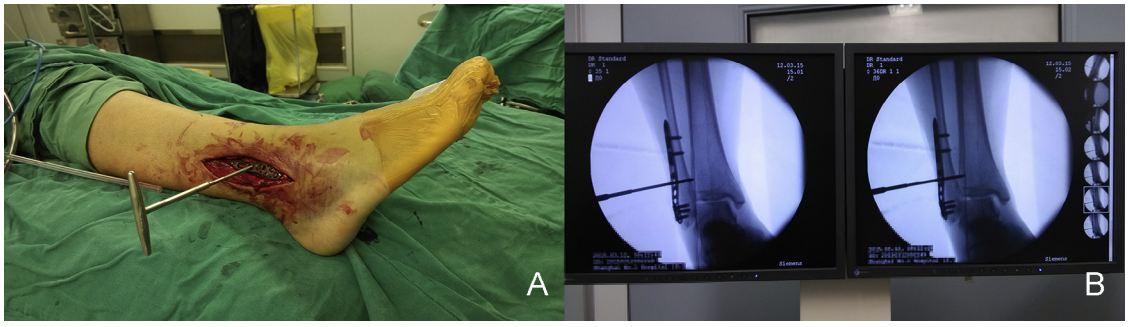

Fig. 1. Tap test/technique. *(A)* The tap test during surgery. *(B)* C-arm fluoroscopic images of the tap test. *(Left)* The medial clear space is normal. *(Right)* The medial clear space is obviously widened, suggesting positive tap test results.