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A Novel Technique of Arthroscopic Ankle Lateral Ligament Repair Using a Knotless Suture Anchor

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Investigation performed at Kobe University Graduate School of Medicine, Kobe, Japan

Background: Although arthroscopic lateral ligament repair (ALLR) with suture anchors for chronic lateral ankle instability has become widely accepted, some complications have been reported as well. Establishment of a new technique is essential for better clinical outcomes after ALLR.

Purpose: To report a novel technique and good clinical results of ALLR using a knotless suture anchor.

Study Design: Case series; Level of evidence, 4.

Methods: We examined 30 patients (16 men and 14 women) who underwent ALLR. The mean age of the patients was 30.0 years, and the average period of postoperative monitoring was 21 months. The Japanese Society for Surgery of the Foot (JSSF) ankle-hindfoot scale was used for clinical evaluation postoperatively, and the Self-Administered Foot Evaluation Questionnaire (SAFE-Q) for patient-reported results. Surgical complications were also examined.

Results: The JSSF ankle-hindfoot scale showed a significant improvement from preoperatively to follow-up (from 72.1 to 96.1; $P < 0.001$), and the SAFE-Q was significantly improved in all subscales (pain and pain-related, physical function and daily living, social function, shoe-related, and general health and well-being; $P < 0.004$ for all). Complications included residual joint pain due to remaining osteophytes in 1 case, scar pain of the accessory anterolateral portal in 2 cases, and positive Tinel sign indicative of superficial peroneal nerve irritation at the anterolateral portal in 1 case.

Conclusion: The clinical results of the novel ALLR technique were overall satisfactory. Knot-related complications, one of the main reasons for postoperative complications, were reduced by using a knotless suture anchor.

Keywords: arthroscopic lateral ligament repair; chronic lateral ankle instability; complication; clinical outcome

Ankle sprains are the most common sports injury, accounting for about 20% of all musculoskeletal injuries.[21] In particular, lateral ankle ligament injuries occur in more than 80% of all ankle sprains.[23] Nonoperative therapy, including functional treatment, is recommended initially, and the response to the therapy is satisfactory in most cases. However, one-third of cases may develop chronic lateral ankle instability (CLAI) if not managed appropriately.[23] CLAI has the potential to develop into posttraumatic ankle osteoarthritis (OA) because the cascade of negative alterations to both the joint structure and the movement patterns of the affected person continues to stress the injured ligaments.[30] In addition, reduced performance in sport and recreational activities is more common in patients with CLAI than in those without.[12] Therefore, surgical treatment is indicated for those patients in whom nonoperative therapies fail.

The Broström procedure, modified by Gould, described as the direct anatomic repair of the anterior talofibular ligament (ATFL), has been widely accepted as the reference standard for lateral ankle stabilization.[3,8] Bell et al[2] reported excellent long-term results of the Broström procedure for CLAI with a 26-year follow-up. Recently, with the development of useful devices and the trend toward minimally invasive surgery, arthroscopic lateral ligament repair (ALLR) with suture anchors has become widely performed.[5] When comparing clinical results between arthroscopic and open repair, it was found that although there was no significant difference with regard to the Karlsson functional outcome score, total complication rate, or nerve and wound complications, the results of the American Orthopaedic Foot and Ankle Society (AOFAS) score showed a significant difference in favor of arthroscopic repair.[4]

In spite of the good clinical results after ALLR, some complications, including knot irritation, have been reported.[6,11] The knotless suture anchor was developed to simplify the arthroscopic procedure by allowing for soft

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tissue repair to the bone without the need to tie a knot.[24] At our institution, we currently use a knotless anchor, the Knotless SutureTak (Arthrex), for ALLR as knotless soft tissue fixation. Arthroscopic knotless suture anchors are well established in shoulder surgeries, such as the Bankart repair, with good clinical results; however, outcomes after ALLR with knotless suture anchors remain unknown.[18,25,26] Therefore, the purpose of this study was to report on our ALLR technique using a knotless suture anchor and the clinical results at the final follow-up. We hypothesized that the technique with the knotless suture anchor would resolve the knot-related complications.

METHODS

The study was approved by an institutional review board, and informed consent was obtained from all patients. We retrospectively examined 30 patients who underwent ALLR for CLAI by an experienced orthopaedic surgeon (N.K.) from December 2015 to March 2018; all patients were monitored for more than 1 year. Patients with severe attenuation of the soft tissue and with a history of previous failed surgery were excluded from this study. The study patients were 16 men and 14 women with a mean age of 30.0 years (range, 13-59 years), and the average period of postoperative monitoring was 21 months (range, 12-36 months).

We compared preoperative clinical and radiographic findings with those at final follow-up. For clinical evaluation, the Japanese Society for Surgery of the Foot (JSSF) ankle-hindfoot scale, which has a maximum score of 100 points (40 points for pain, 50 points for function, and 10 points for alignment), was administered preoperatively and at final follow-up.[16] Patient-reported results were evaluated with the Self-Administered Foot Evaluation Questionnaire (SAFE-Q), which focuses only on the foot and has 34 questions divided into 5 subscales: (1) pain and pain-related; (2) physical functioning; (3) social functioning; (4) shoe-related; and (5) general health and well-being. There is also a sports activity subscale (9 optional questionnaire items).[17] Complications after ALLR were also examined. For radiological assessment, the anterior drawer distances (ADDs) and talar tilt angle (TTA) were evaluated preoperatively and at the final follow-up.

Operative Technique

The patient was placed in a supine position on an operating table under general anesthesia. A thigh holder was positioned to leave the foot elevated a few centimeters off the operating table. Next, a noninvasive ankle joint distractor was applied with manual tension, and the joint was slightly distracted. It was imperative to use a surgical marker to outline the distal fibula, the superficial peroneal nerve, the course of the peroneal tendons, and the ATFL and calcaneofibular ligament (CFL) before initiating the procedure (Figure 1).

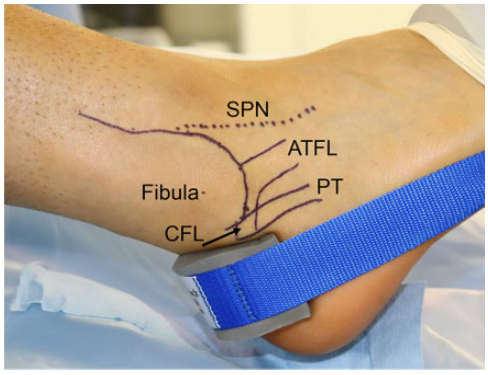

Figure 1. Outlining the distal fibula, the superficial peroneal nerve (SPN), the course of the peroneal tendon (PT), and the anterior talofibular ligament (ATFL) and calcaneofibular ligament (CFL) before initiating the procedure.

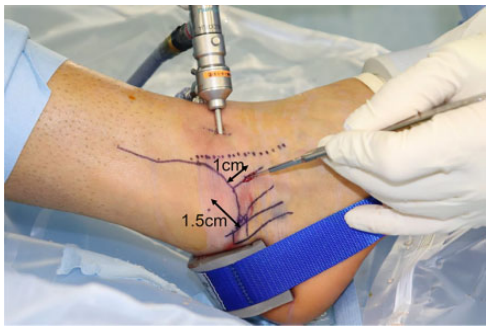

Figure 2. Marking of accessory anterolateral portal.

Ankle joint arthroscopy with standard anteromedial and anterolateral portals was performed, any hypertrophic synovium was debrided, and the scar tissue covering the anterior surface of the lateral malleolus was resected. Then, an accessory anterolateral portal was created 1.0 cm anterior to the fibula and 1.5 cm proximal to the tip of the lateral malleolus (Figure 2). The anterior cortex of the lateral malleolus was ablated with a steel bar through

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Ethical approval for this study was obtained from Kobe University Graduate School of Medicine (ref No. B190002).

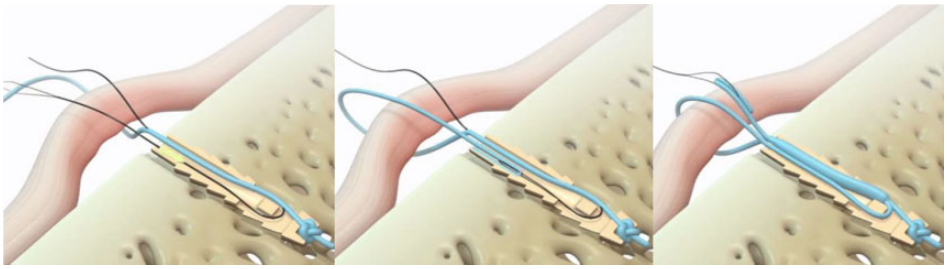

Figure 3. Knotless SutureTak. This anchor has an internal splice locking mechanism in the anchor body. Image provided courtesy of Arthrex, Naples, Florida (2020).

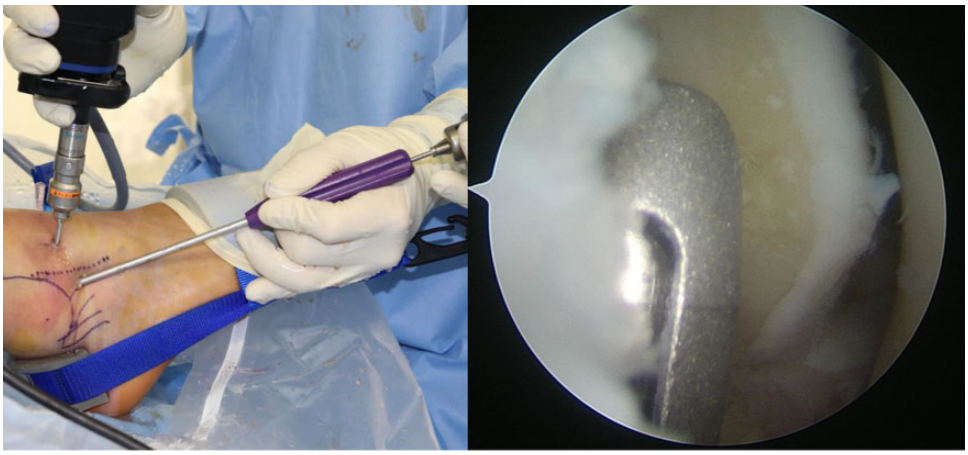

Figure 4. Placement of the suture anchor.

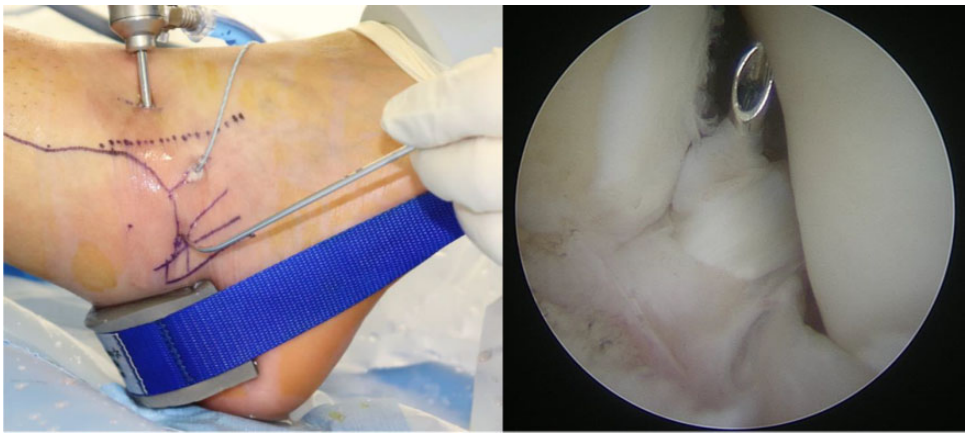

Figure 5. Penetrating the confluent fiber of the anterior talofibular ligament and the calcaneofibular ligament.

the accessory anterolateral portal to prepare for subsequent capsular and ligamentous adhesion.

We usually use the Knotless SutureTak anchor. This suture anchor has 1 suture string and 2 passing wires. It has a self-locking system, and we pass and shuttle the suture string with the passing wire into the locking mechanism. This anchor can control the tensioning without a knot (Figure 3).

The suture anchor was placed on the distal portion of the lateral malleolus along its anterior aspect and about 1.5 cm proximal to the fibula tip for the ATFL through the accessory anterolateral portal. This area was the normal ATFL footprint and was identified a few millimeters distal to the lower edge of the fibular attachment of the anterior inferior tibiofibular ligament (Figure 4).

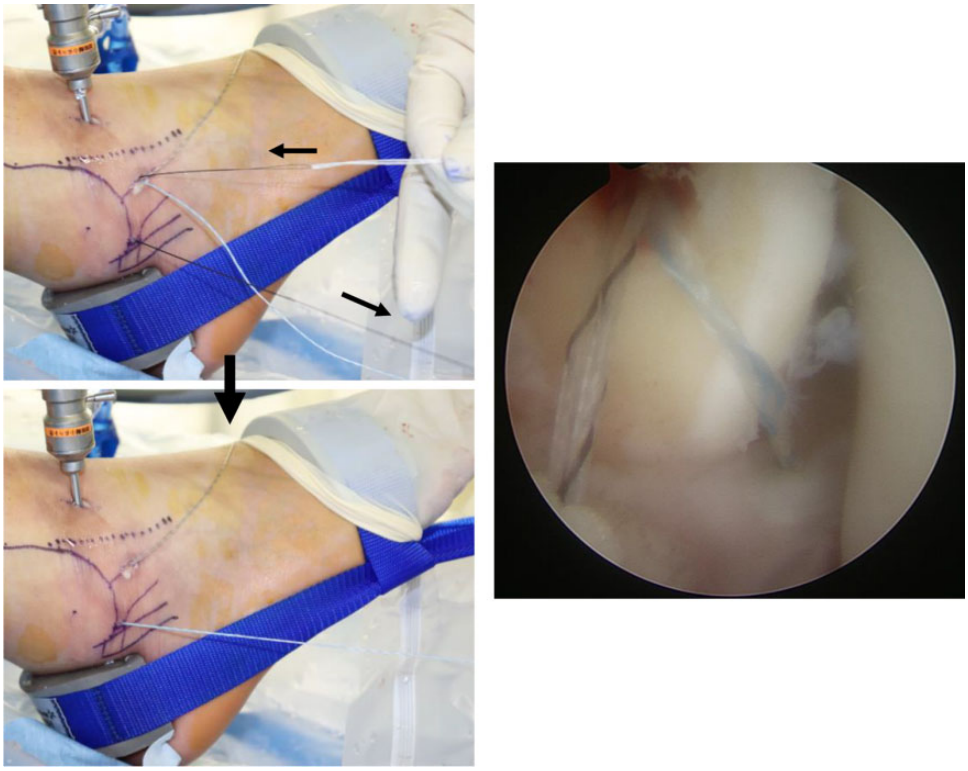

Figure 6. Leading of the suture string onto the skin.

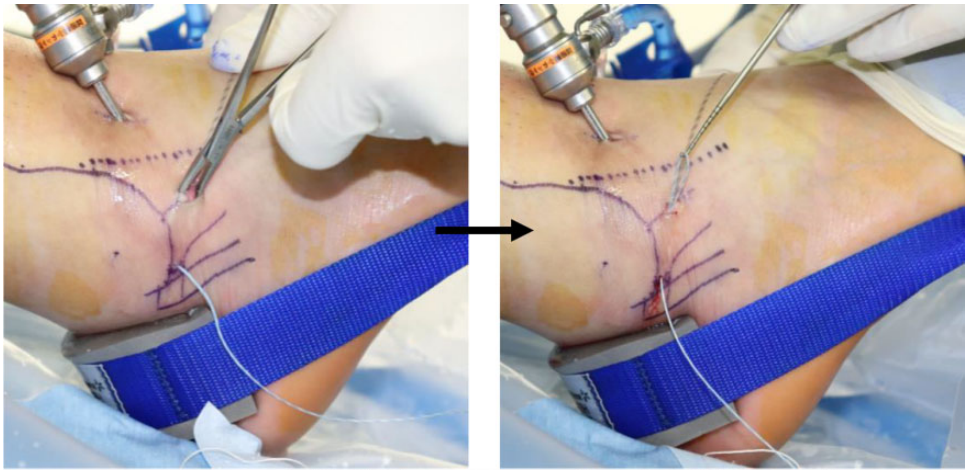

Figure 7. Peeling off the subcutaneous tissue and retrieving the suture string to the accessory.

A microsuture lasso was then used to capture the lateral capsule/ligamentous structures. The location was just anterior to the fibula tip, and we intended to penetrate the confluent fiber of the ATFL and CFL (Figure 5). Caution was taken to avoid the sural nerve and peroneal tendons. The Nitinol loop wire was then advanced and used to capture a suture string of the suture anchor, which was pulled to exit the skin (Figure 6).

Next, we peeled off the subcutaneous tissue between the accessory anterolateral portal and penetrated point and led the suture string to the accessory anterolateral portal using the probe (Figure 7). The foot was then released from distraction while the assistant surgeon held in an everted and slightly neutral to the dorsiflexed position. A suture string was passed into the small circle of a passing wire, and we then drew the other passing wire in order to attach the lateral capsule/ligamentous structures to the lateral malleolus (Figure 8). Finally, we used a knot pusher to prevent the suture anchor from falling out (Figure 9).

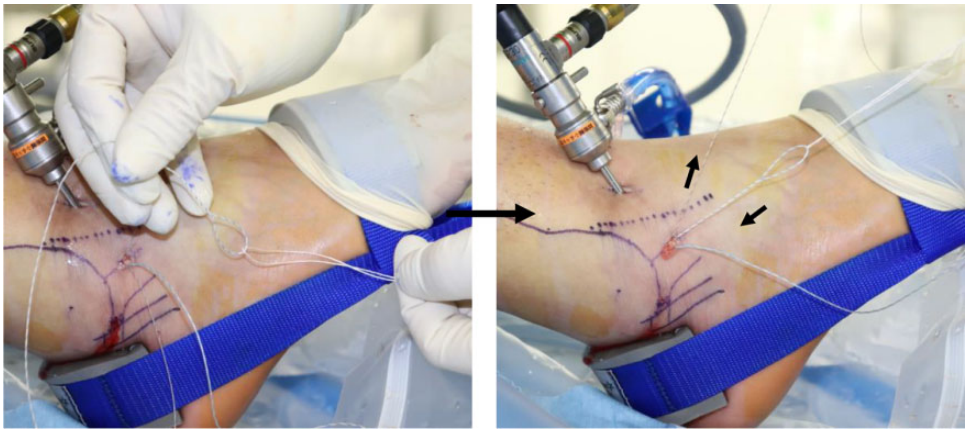

Figure 8. Passing the end of the suture string to the loop of the passing wire and then shuttling the suture pulling the nonloop end of the passing wire.

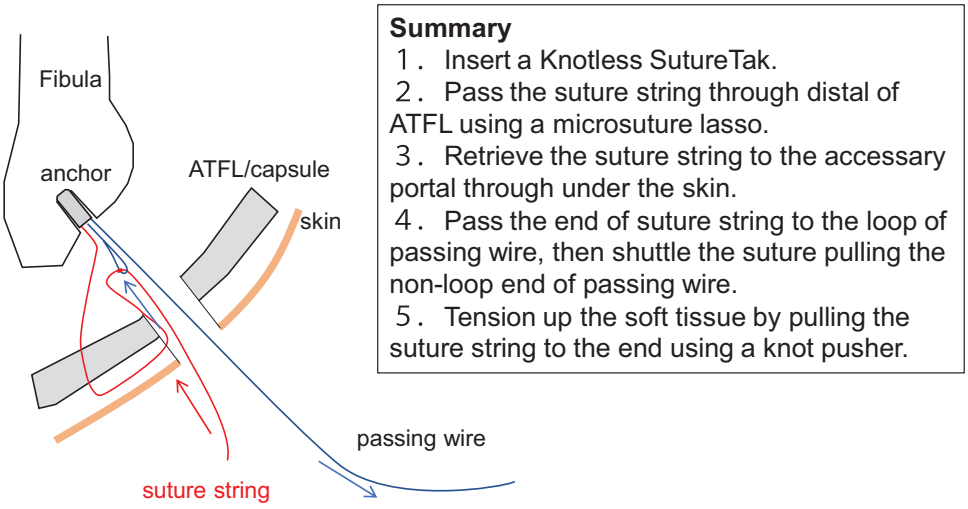

Figure 9. Schema and summary of this procedure. ATFL, anterior talofibular ligament.

After the operation, load cast immobilization was performed for 3 weeks, followed by the use of an ankle brace. Formal functional treatment to strengthen the peroneal muscle was initiated after removal of the cast. The ankle brace was worn for 12 weeks and thereafter used for any sports or higher impact activities until 6 months after surgery. A return to noncontact sports was expected at 6 to 8 weeks after the operation. Patients could return to sports without limitations approximately 3 months after the operation.

Statistical Analysis

All measurements were expressed as means with ranges. An unpaired, 2-tailed Student t test was used to compare differences between 2 values. Data analyses were performed using Excel (Microsoft Japan Inc). Differences of $P < .05$ were considered statistically significant.

RESULTS

When comparing the outcomes from preoperatively to follow-up, we found that the JSSF ankle-hindfoot scale showed a significant improvement, from 72.1 to 96.1 ($P < 0.001$), and the SAFE-Q was significantly improved on all subscales (pain and pain-related, from 61.9 to 87.5; physical function and daily living, from 72.4 to 93.9; social function, from 70.7 to 97.3; shoe-related, from 73.1 to 89.2; general health and well-being, from 63.7 to 91.8) ($P < 0.004$ for all). The overall complication rate was 13.3%. The complications encountered included residual joint pain due to remaining osteophytes in 1 case, scar pain of the accessory anterolateral portal in 2 cases, and positive Tinel sign indicative of superficial peroneal nerve irritation at the anterolateral portal in 1 case. However, no recurrence was observed. According to the radiographic assessment, ADD improved from 8.7 mm to 7.9 mm. TTA also improved, from 8.1° to 6.2° ($P = 0.018$).

DISCUSSION

The most important finding of the present study was that the novel ALLR technique with knotless suture anchors demonstrated good clinical results without any of the knot-related complications described by others.[6,11]

Ankle sprains are a common injury, and more than 20% of patients may develop CLAI; up to 78% of CLAI cases may develop posttraumatic ankle OA correlated with varus malalignment.[19,27,30] Therefore, CLAI is generally considered an indication for surgery to manage ankle instability and to protect against secondary OA. A multicenter retrospective review of 310 lateral ankle ligament reconstructions, which included 4 operative techniques (direct capsular ligament repair, augmented repair, ligamentoplasty using part of the peroneus brevis tendon, and ligamentoplasty using the whole peroneus brevis tendon), showed that 92% of the cases demonstrated satisfactory outcomes at a mean 13-year follow-up.[13] Gold standard treatments such as the Broström-Gould procedure, including a modified version, have shown excellent clinical results.[2,31]

Recently, some modified arthroscopic techniques have become popular. In a human cadaveric study, Giza et al[7] reported that there was no statistical difference in strength or stiffness of a traditional open repair when compared with an arthroscopic anatomic repair of the lateral ligaments of the ankle. Nery et al[15] reported on the arthroscopically assisted Broström-Gould procedure for chronic ankle instability and showed that the postoperative AOFAS scores were graded as excellent and good in almost all patients (94.7%). Vega et al[28] reported that an all-inside arthroscopic lateral collateral ligament repair for ankle instability with a knotless suture anchor technique showed an improved postoperative AOFAS score without major complications at the final follow-up. In the present study, the JSSF scores we evaluated were also significantly improved postoperatively. In other recent reports, Takao et al[22] described a novel arthroscopic technique using lasso-loop stitch with an 18-gauge hollow needle through 2 portals. In addition, Acevedo et al[1] reported an arthroscopic technique by defining the "safe zone" between the superficial peroneal nerve and the peroneal brevis tendon; in the current study, we performed all procedures in this safe zone. Rigby and Cottom[20] reported that there were no statistically significant differences identified using any of their functional or patient satisfaction outcome scores between open and arthroscopic techniques. These results emphasize that arthroscopic techniques are comparable with conventional procedures.

Patients with chronic foot and ankle disease tend to feel anxiety and depression, which may lead to low SAFE-Q scores.[14] In the current study, the postoperative SAFE-Q scores were significantly improved from preoperatively on all subscales, indicating satisfactory results even from a patient-oriented point of view. In terms of radiographic assessment, patients who had a TAA of $>10^{\circ}$ and/or an ADD >8 mm were considered candidates for surgery for CLAI,[10] and we observed an improvement in both TAA and ADD after surgery.

High complication rates have been reported with arthroscopic repair of lateral ankle instability. Wang et al[29] reported that 31 of 178 patients experienced complications such as nerve damage, delayed wound healing, or superficial infection. Yeo et al[32] reported operation-related complications, including knot pain, in 20% of cases. Corte-Real and Moreira[6] reported complications in 29% of cases, including delayed wound healing, tenderness on the scar, numbness of the superficial peroneal nerve, deep venous thrombosis, and the appearance of an asymptomatic prominent suture anchor from the fibula on radiographs. In contrast, Guelfi et al[9] reported a relatively low complication rate (15.27%). In our study as well, some complications were observed, but the complication rate itself was low (13.3%). Furthermore, no recurrence was observed.

We hypothesize that one of the reasons for the low complication rate was that we reduced knot-related complications by using a knotless suture anchor. Thal[24] reported the advantages of using a knotless suture anchor in that biomechanical testing demonstrated increased suture strength when compared with standard suture anchors. The current study supported the concept that knotless sutures can provide a secure and low-profile repair without knot-tying, as good clinical outcomes without severe complications were seen.

Limitations

This study has some limitations, including its small sample size, short-term outcomes, and retrospective study design. In addition, we did not compare our technique specifically with a knotted suture anchor in our hands and evaluate knot-related complications.

CONCLUSION

The clinical results of our method for ALLR were overall satisfactory. Knot-related complications, one of the main reasons for postoperative complications, were reduced by using a knotless suture anchor. Future prospective studies with larger cohort samples and longer follow-up that will address the limitations of the current study may uncover more evidence for ALLR for CLAI.

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