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All-inside arthroscopic allograft reconstruction of the anterior talo-fibular ligament using an accesory transfibular portal

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ABSTRACT

Background: Anatomic graft reconstruction of the anterior talo-fibular ligament is an alternative for patients who are bad candidates for standard procedures such as a Broström–Gould reconstruction (high-demand athletes, obesity, hyperlaxity or collagen disorders, capsular insufficiency or talar avulsions). The purpose of this study is to describe an all-inside arthroscopic technique for ATFL reconstruction, and the results in a series of patients with chronic ankle instability.
Methods: We reviewed patients with chronic ATFL ruptures treated with an all-inside arthroscopic allograft reconstruction of the ATFL, with a minimum 2-year follow-up. Twenty-two patients with lateral ankle instability were included. Mean follow-up was 34 ± 2.5 months.
Results: The mean AOFAS score improved from 62.3 ± 6.7 points preoperatively to 97.2 ± 3.2 points at final follow-up. Three patients suffered complications: one case each of ankle rigidity, superficial peroneal nerve injury and fibular fracture.
Conclusions: Chronic ATFL injuries are amenable to all-inside arthroscopic allograft reconstruction fixed with tenodesis screws. This procedure simplifies other reported techniques in that it facilitates identification and bone tunnel placement of the talar ATFL insertion.

1. Introduction

Ankle sprains are among the most common musculoskeletal injuries worldwide; most ankle ligament injuries occur as a consequence of inversion during plantar flexion, with the anterior talo-fibular ligament (ATFL) acting as a true collateral ligament. Indeed, up to 73% of ankle sprains involve the ATFL, according to some series [1–3]. Although most patients can be treated successfully with a rehabilitative exercise program and bracing, approximately 15–20% of patients remain symptomatic after conservative management [4].

Several surgical options are available for the patient with chronic lateral ankle instability after conservative treatment has failed. The Broström procedure with the Gould modification is currently considered the gold standard in the surgical management of chronic lateral ankle instability [5–7]. However, its use may be limited in patients with longstanding injuries, avulsions of the talar insertion of the ATFL, or midsubstance tears, as well as in patients with hyperlaxity or collagen disorders, poor tissue quality, obesity, or in high-demand athletes [8]. In these cases, anatomic reconstruction using free tendon grafts is an increasingly popular option, but few reports on long-term results are available [9–11].

Arthroscopy provides advantages over open surgery, with lower morbidity, better cosmesis, and shorter hospitalization times. Furthermore, concomitant intraarticular injuries can be evaluated and treated arthroscopically. Arthroscopic anatomic repair of the lateral ankle ligaments has been successfully reported by several authors [12–21]. Few studies have been published describing all-inside arthroscopic reconstruction using free tendon grafts [22], which would be indicated in cases unsuitable for other techniques such as the Broström–Gould procedure, such as in the previously described examples, with the added benefit of arthroscopic evaluation of the ankle joint. In this paper an all-inside

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arthroscopic anatomic reconstruction technique of the anterior tibio-fibular ligament (ATFL) using an allograft is described, and the results in an initial series of patients are presented.

2. Materials and methods

2.1. Patient selection

Patients treated between June 2011 and December 2013 and with a minimum 2-year follow-up were included in this retrospective case series. Patients were included if they presented a history of chronic ankle instability affecting the ATFL (recurrent sprains, giving way, instability), with an initial injury at least 12 months before surgery, and symptoms which interfered with their athletic or recreational activities.

ATFL injury was determined by physical examination (anterior drawer test) and by stress radiographs and magnetic resonance imaging (MRI), and later confirmed intraoperatively during ankle arthroscopy. Surgery was considered if they had a positive anterior drawer test >10 mm compared to the contralateral side, had at least two significant episodes of failure or instability of the joint in the previous six months, and if they were symptomatic in spite of a considerable amount of conservative treatment, including a course of at least 10–12 weeks of non-steroidal anti-inflammatory medication, taping, bracing, proprioception, stretching and strengthening exercises. Patients were excluded if they presented concomitant ankle pathologies such as hindfoot malalignment or ankle osteoarthritis. Though associated calcaneo-fibular ligament (CFL) injury is not uncommon in this setting, we also excluded patients if we observed a complete tear of the CFL during ankle arthroscopy, in order to limit the case series to patients in whom the ATFL injury was the main cause for their symptoms of lateral ankle instability.

Twenty-two consecutive patients with 22 ankles (16 male, 6 female), with an average age of 29.4 $\pm$ 5.7 years, and with a minimum 2-year follow-up (average 34 $\pm$ 2.5 months) were included. The left ankle was treated in 11 cases and the right ankle in the other 11 cases. Twelve patients were high-level athletes: European football (7 patients), basketball (3 cases) and ballet (2 cases). Median duration of surgery was 57 min (40–101 min), depending on the associated surgeries. Ankle arthroscopy revealed associated injuries in half of the patients: osteochondral lesions (OCL) in 6 cases (5 grade III, 1 grade IV according to the Berndt and Harty classification), 2 patients with partial ruptures of the calcaneo-fibular ligament, 2 cases of posterior ankle impingement syndrome (PAIS), and one patient with peroneal tendon synovitis. As a consequence, associated procedures were preformed in these 11 patients: bone stimulation technique (BST) using microfractures in 6 cases, resection of an “os trigonum” in posterior ankle impingement syndrome, and peroneal tendoscopy debridement in the cases of synovitis of the peroneal tendons. All clinical examinations and surgeries were performed by the same surgeon (first author).

2.2. Surgical technique

The patient is placed in a supine position, with the affected limb on a thigh holder allowing for free movement of the ankle. A thigh tourniquet is applied. No soft tissue distraction device is used, and no previous distension is performed. A 4 mm 30° scope (Stryker, Kalamazoo, MI) for ankle arthroscopy is used.

The joint is initially examined through a standard anteromedial portal, which will be used as the initial visualization portal. The anterolateral portal is used as a working portal. ATFL injury is confirmed through the presence of an avulsion of the fibular attachment at the corresponding ATFL footprint, a midsubstance tear, or, less frequently, a talar avulsion of the ATFL. Our method for graft reconstruction of the ATFL is loosely based on the open technique described by Coughlin and Schenck in 2001 [23]. The proximal insertion of the ATFL is identified, immediately distal to the distal antero-inferior tibiofibular ligament (AITFL). Using a tibial anterior cruciate ligament (ACL) guide (Arthrex, Naples, FL), a fibular tunnel is performed in a 50° angle to the long axis of the fibula in order to ensure sufficient tunnel length to accommodate the screw, from anterior-distal to posterior-proximal, using a cannulated 5.0 mm drill bit (Arthrex, Naples, FL) (Fig. 1).

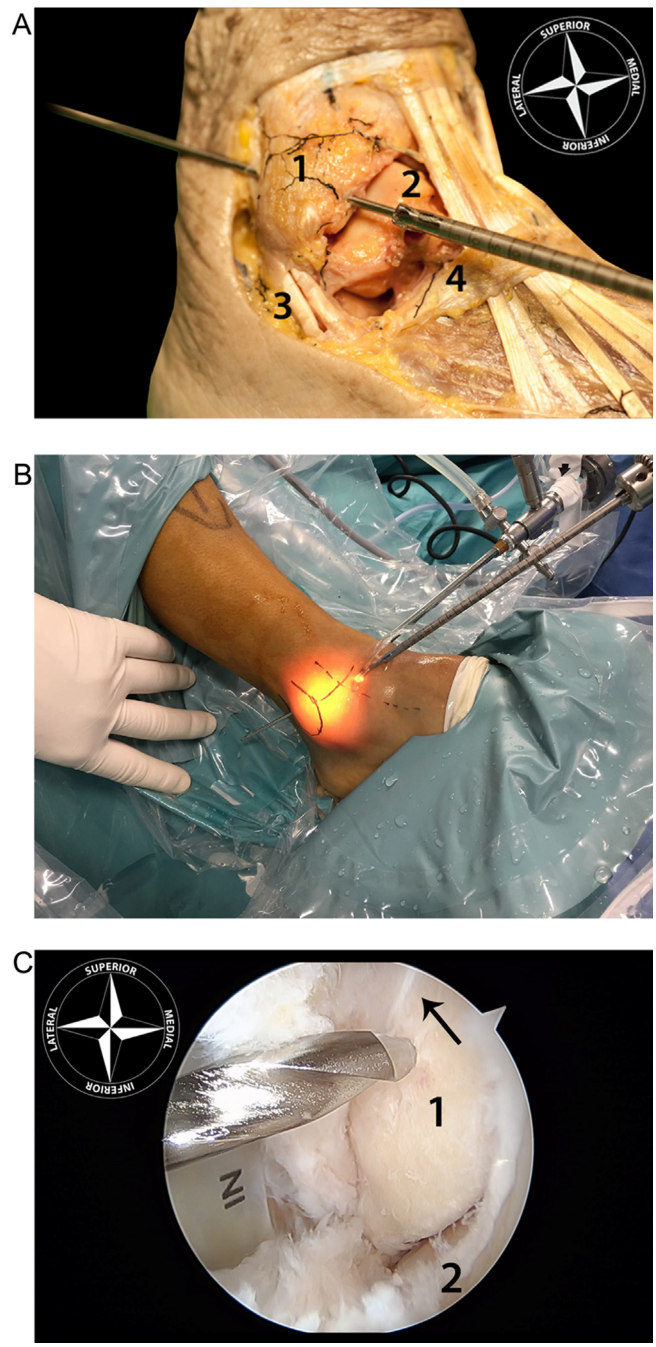

Fig. 1. Right ankle. Fibular tunnel using a cannulated 5.0 mm drill bit. 1a) Anatomic dissection in a cadaveric specimen. Image key: (1) fibula; (2) talus; (3) peroneal tendons; (4) extensor retinaculum. 1b) External view 1c arthroscopic view of the insertion of the guidewire, through the anteromedial portal. Image key: (1) fibula; (2) talus. Note the distal insertion of the antero-inferior tibiofibular ligament (arrow).

The scope is then inserted into the fibular tunnel from posterior to anterior through a vertical skin incision, with care not to entrap the peroneal tendons; the talar insertion of the ATFL can be easily identified from this angle, locating the remains of the talar ligament insertion. A guide pin is placed on the talar anatomic footprint of the ATFL aiming at the most posterior aspect of the medial malleolus [24], and a 25 mm long half tunnel is over reamed with a 5 mm drill bit (Fig. 2).

An extensor carpi radialis tendon of the wrist or a gracilis tendon allograft is usually used, depending on availability; the ends are sutured with Krakow stitches to ensure a 4.0–5.0 mm

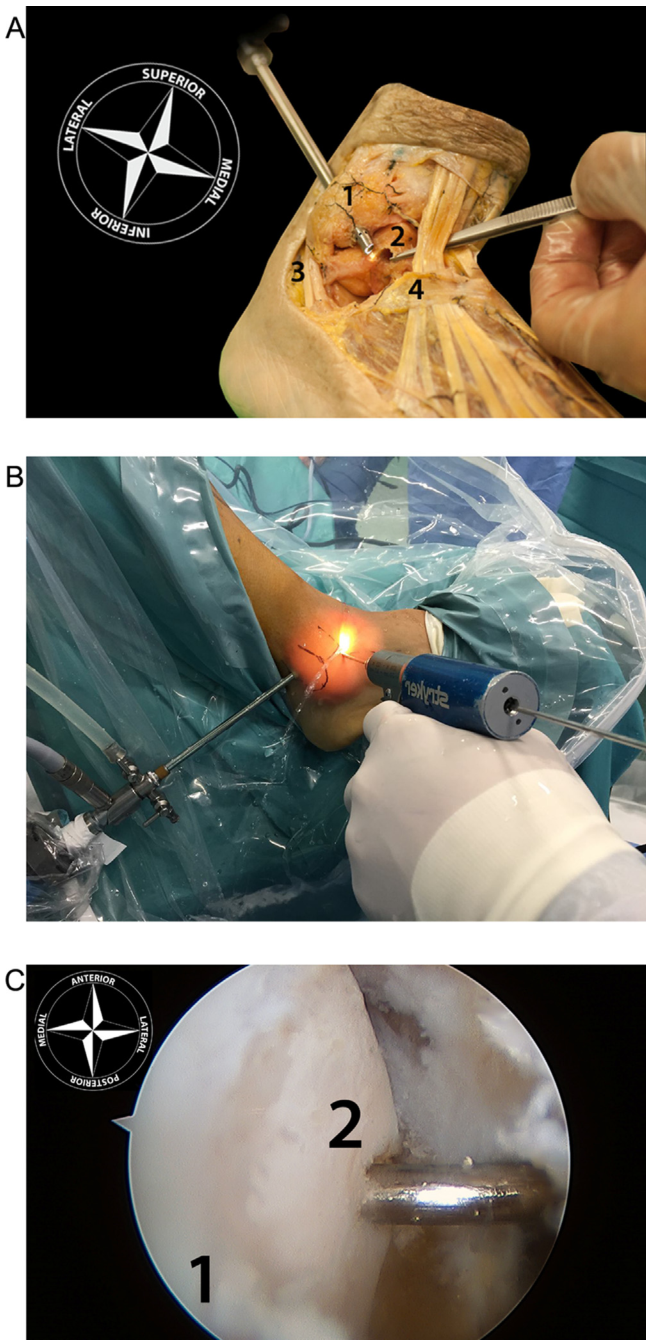

Fig. 2. Right ankle. Talar half-tunnel using a cannulated 5.0 mm drill bit, to a depth of 25 mm. 2a) Anatomic dissection in a cadaveric specimen. Image key: (1) fibula; (2) talus; (3) peroneal tendons; (4) extensor retinaculum. 2b) External view. 2c) Arthroscopic view through the transfibular portal. Note how the talar insertion of the ATFL is easy to see from this portal. Image key: (1) fibula (edge of tunnel); (2) talus.

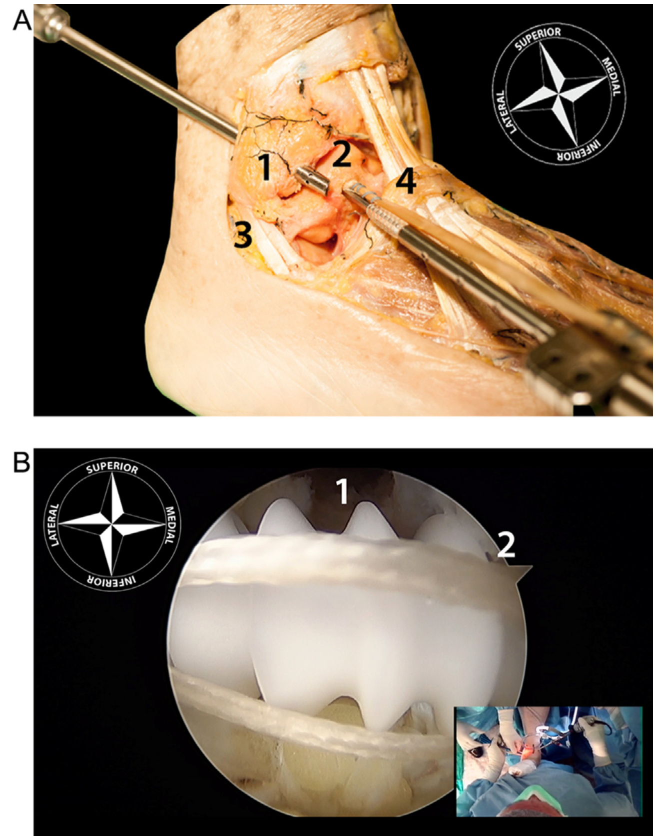

Fig. 3. Right ankle. Talar fixation using a 5.5 biotenodesis screw. 3a) Anatomic dissection in a cadaveric specimen. Image key: (1) fibula; (2) talus; (3) peroneal tendons; (4) extensor retinaculum. 3b) Arthroscopic view, visualized through the anteromedial portal. Image key: (1) fibula; (2) talus (to the right of the image). Inserted image: intraoperative view from the surgeon's point of view.

diameter (Fig. 3a). The graft is inserted into the talar tunnel and fixed with a 5.5 mm, 20 mm long Bio-Tenodesis® screw (Arthrex, Naples, FL), using the anteromedial portal for visualization (Fig. 3b). Once the graft is fixed to the talus, a Micro SutureLasso™ (Arthrex, Naples, FL) through the fibular tunnel is used to retrieve the graft intra-articularly or through the anterolateral portal, and pass it through the tunnel. The graft is then fixed to the fibula with another 5.5 mm, 20 mm long Bio-Tenodesis® screw, with the ankle slightly everted and in neutral dorsiflexion (Fig. 4). Fluoroscopy is generally not used for this procedure.

2.3. Postoperative management

The ankle is immobilized in a posterior ankle splint for two weeks following the surgery, followed by a walker-type ankle foot orthosis (DonJoy, Surrey, United Kingdom), which is then weaned off over 4–6 weeks. A physiotherapy program including hydrotherapy, as well as mobility and proprioception exercises, is commenced 3 weeks postoperatively. Cycling and swimming are allowed after 4–6 weeks, once the orthosis is removed, and return to sport at 12 weeks.

2.4. Statistical analysis

This study retrospectively collected data. Continuous variables are presented as mean and standard deviation for parametric variables, and median and range for nonparametric variables; categorical variables are presented as number of cases. Student's t-test for paired samples was used to compare preoperative and

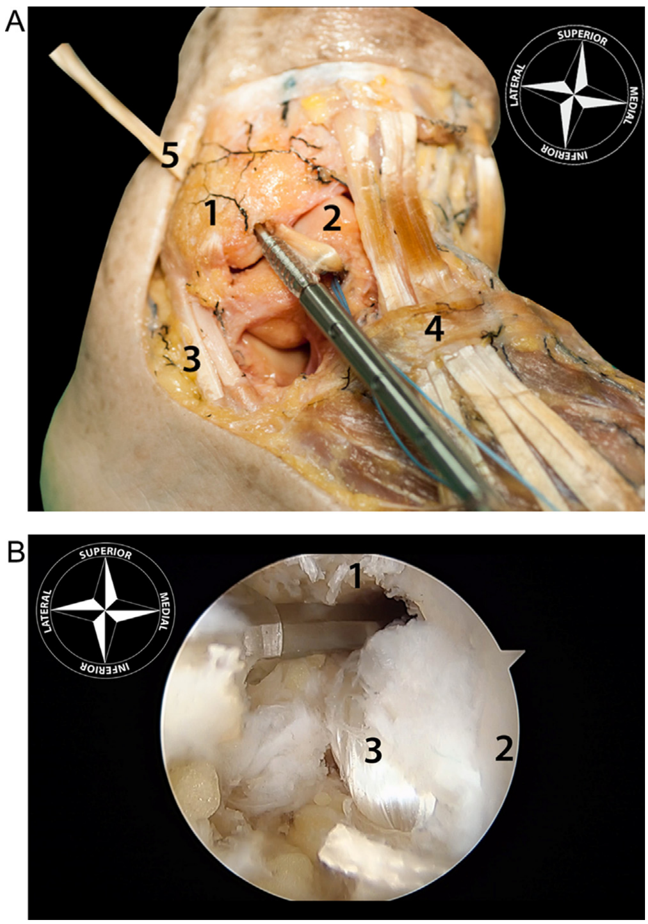

Fig. 4. Right ankle. Fibular fixation using a 5.5 biotenodesis screw. 4a) Anatomic dissection in a cadaveric specimen. Image key: (1) fibula; (2) talus; (3) peroneal tendons; (4) extensor retinaculum (5) graft. 4b) Arthroscopic view through the anteromedial portal. Image key: (1) fibula; (2) talus; (3) graft.

Table 1
General demographic information and results of the patient series.

Total number of patients	22 (100%)
• Male	16 (72.7%)
• Female	6 (27.3%)
Age (average ± SD)	29.4 ± 5.7 years
Side affected	
• Left	11 (50%)
High-demand physical activity	12 (54.5%)
• European football	7 (31.8%)
• Basketball	3 (13.6%)
• Ballet	2 (9.1%)
Follow-up (mean ± SD)	34.0 ± 2.5 months
Duration of surgery (median, range)	57 (40–104) min
Arthroscopic findings	11 (50%)
Osteochondral lesions (grade III, IV)	6 (27.2%)
Posterior ankle impingement syndrome	2 (9.1%)
Partial rupture of CFL	2 (9.1%)
Synovitis of peroneal tendons	1 (4.5%)
Associated procedures	11 (50%)
• Bone stimulation techniques	6 (27.2%)
• "Os trigonum" resection	2 (9.1%)
• Peroneal tendoscopy & debridement	3 (13.6%)
Complications	3 (13.6%)
• Fibular fracture	1 (4.5%)
• Superficial peroneal nerve injury	1 (4.5%)
• Rigidity	1 (4.5%)
Athletic activity (mean ± SD)	21.5 ± 3.0 weeks
AOFAS scores (mean ± SD)	
• Preoperative	62.3 ± 6.7 points
• Postoperative	97.2 ± 3.1 points

postoperative AOFAS scores. Significance was set at $p < 0.05$. Data was analyzed using SPSS version 20.0.

3. Results

The general description of the patient series is summarized in Table 1. The average preoperative American Orthopaedic Foot and Ankle Society (AOFAS) ankle score improved from 62.3 ± 6.7 points preoperatively to 97.2 ± 3.2 points after a minimum 2-year follow-up ($p < 0.001$). Average time to athletic recovery, as described subjectively by the patients, was 21.5 ± 3.0 weeks. Three patients suffered complications: one case each of ankle rigidity – in a patient with associated posterior ankle impingement syndrome–, a transient superficial peroneal nerve (SPN) injury – recovering after 5 weeks–, and fibular fracture (Table 1). The fibular fracture was a posterior cortical avulsion that occurred while drilling the distal fibular bone tunnel, and was treated by fixing the graft proximally with a biodegradable interference screw and a staple in the fibular cortex in order to stabilize the fracture. No intra-operative fractures occurred passing the scope through the fibular tunnel, and no postoperative fractures of the fibula or talus during follow-up were observed.

4. Discussion

This study describes a technique for all-inside arthroscopic reconstruction of the ATFL using free tendon allografts, and shows promising results in a series of consecutive patients, of which over half were high-demand athletes. The Broström–Gould reconstruction is the mainstay of surgical management of chronic ATFL instability; however, some patients are bad candidates for this type of procedure, and reconstruction using tendon autograft or allograft is usually preferred [8,11,22].

Arthroscopy has advantages over open surgery in that it is less aggressive, allowing for lower postoperative morbidity and better cosmesis. The high prevalence of intra-articular lesions makes it advisable to perform an arthroscopy at the time of surgery, in order to address intra-articular lesions and lateral instability concomitantly. Chondral injuries of the tibiotalar joint have been observed in up to 77% of patients with recurrent lateral instability [25,26]. Arthroscopic stabilization of the lateral ankle ligaments can be easily converted to open techniques if necessary. Drakos et al. found no significant differences between open and arthroscopic repair of lateral ankle instability in a biomechanical study performed in twenty cadaveric specimens [27], and Giza et al. reported similar results in seven matched cadaveric ankle pairs [28].

Arthroscopic repair of the lateral ankle ligaments was first described by Hawkins in 1987 using staples [29]. Other authors described arthroscopic treatment of lateral ankle instability using suture anchor fixation, thermal shrinkage and bone tunnels [15]. Most authors, however, only describe the surgical technique, without reporting on clinical outcomes or complication rates. Level IV evidence is available on arthroscopic variations of Broström–Gould repair and suture anchors, with series including 14–85 patients and complication rates varying between 0–36% (Table 2) [30–32]. A systematic review of arthroscopic suture anchor repair of the ATFL found improvement in all cases, although with a relatively high complication rate [33]. Recently, Matsui et al.

Table 2
Published case series of arthroscopic repair of the ATFL for lateral ankle instability.

	Study type	Number of cases	Technique	Mean age (years)	Mean follow-up (months)	Preoperative AOFAS score (mean)	Postoperative AOFAS score (mean)	Complication rate
Corte-Real and Moreira [32]	Retrospective case series	28	Ligament repair, suture anchor	33.3	27.5	NA	85.3 (65–100)	29%
Kim et al. [31]	Retrospective case series	28	Ligament repair, suture anchor	38.6	15.9	60.8 ± 16.7	92.5 ± 6.1	36%
Acevedo and Mangone [30]	Case series	24	Broström, suture anchor	39	10.9	NA	NA	16.7%
Nery et al. [19]	Case series	38	Broström, suture anchor	28.8	9.8 years	NA	90 (44–100)	5.3
Cottom and Rigby [14]	Prospective case series	40	Broström, suture anchor	45.6	12.13	41.2 (62–64)	95.4 (84–100)	7.5%
Vega et al. [20]	Retrospective case series	16	Ligament repair, suture anchor	29.3	29.3	67 (59– 77)	97 (95–100)	12.5%
Acevedo and Mangone [11]	Retrospective case series	73	Broström, suture anchor	35	28	28.3	90.2[a]	6.8%
Labib and Slone [16]	Retrospective case series	14	Broström, suture anchor	NA	3 (2–14)	NA	93 (80–100)	None described
Matsui et al. [18]	Retrospective case-control	19	Broström, suture anchor	28	12	NA	NA	11%
Yoo and Yang [21]	Case-control	85 (22 with internal brace)	Broström, suture anchor	23	7.4	65.8 ± 21.8	98.0 ± 16.8	0%
Cottom et al. [13]	Prospective case series	45	Broström, suture anchor	45 (16–75)	14 (12–20)	49 ± 3	95 ± 4	7%
Current series	Retrospective case series	22	Allograft, biotenodesis screws	29.4 ± 5.7	34.0 ± 2.5	62.3 ± 6.7	97.2 ± 3.2	13.6%

NA: not available.
[a] Karlsson score.

compared open and arthroscopic repair of the ATFL, with an earlier recovery among patients treated arthroscopically [18].

Several authors have described arthroscopic techniques to reconstruct the lateral ankle ligaments [22,34–39]. Priano et al. published the first available case series in 1994, of 10 patients treated with arthroscopic reconstruction of the ATFL [38]. The authors did not state the rate of complications, but admitted their technique required a long learning curve. Lui described a technique of anatomical reconstruction of both the ATFL and CFL in 2007 [36]. More recently, Guillo published an arthroscopic ATFL and CFL reconstruction technique [22,34,35] that used lateral ankle endoscopy through a sinus tarsi portal to better locate the calcaneal insertion of the CFL. Takao et al. has also recently described a similar all-inside-out technique [40].

The described technique allows all-inside reconstruction of the ATFL, and we believe that using an accessory portal behind the fibula to guide the scope through the fibular tunnel significantly simplifies the procedure (Table 3). The talar insertion of the ATFL is quite challenging to identify using standard arthroscopic portals. This way, the anterolateral portal remains free to be used as a working portal, allowing for identification of the talar remnants of the ATFL and preparation of the talar aspect of the reconstruction under direct visualization.

The patients described in this series showed significant improvement of AOFAS scores, and all high-demand athletes could return to their previous level of activity after an average of 21 weeks. The complication rate (13.6%) is in line with those published in clinical series of arthroscopic repair, where rates up to 36% have been described (Table 2). One patient suffered postoperative rigidity, but he was also treated for PAIS, with “os trigonum” resection. A fibular fracture occurred in another case, an avulsion of the posterior cortex during drilling of the bone tunnel. This complication, though uncommon, is possible with any lateral ligament reconstruction technique, open or arthroscopic, using fibular bone tunnels for fixation. We suffered no complications when passing the scope through the fibular tunnel to visualize the talar portion of the procedure, nor in the postoperative follow-up period. A third patient suffered injury to the SPN that recovered after approximately 5 weeks. Injury to the SPN, irritation at the portal sites, or prominent implants have been described as some of the associated complications [41]. Caution when creating portals and when introducing instruments is paramount, and a thorough

Table 3
Key points and pearls of the arthroscopic ATFL reconstruction technique presented in this paper.

Key points:
- Identification of the fibular insertion of the AFTL using the distal (or accessory) antero-inferior tibiofibular ligament as a reference.
- Drilling of the fibular tunnel using a tibial ACL reconstruction guide and a 5.0 mm cannulated drill bit.
- Insertion of the scope through the fibular tunnel to identify the talar insertion of the ATFL.
- Insertion of the graft through the anterolateral portal and talar fixation using a 5.5 mm Bio-Tenodesis® screw.
- Under direct visualization through the anteromedial portal, the graft is retrieved through the fibular tunnel using a nitinol suture lasso recovered through the anterolateral portal.
- Fibular fixation using a 5.5 mm, 20 mm Bio-Tenodesis® screw through the anterolateral portal.

Pearls:
- Correct identification of talar and fibular insertion of the ATFL.
- Preparation of the graft, ensuring a 4.0–5.0 mm diameter. An extensor carpi radialis tendon or gracillis tendon allograft is recommended.
- It is important that the entire talar and fibular tunnels are occupied by graft, and the interference screw does not protrude from the talus or fibula.
- Postoperative treatment with a posterior ankle splint for 2 weeks, followed by an ankle-foot orthosis for 8–12 weeks.

knowledge of ankle anatomy is mandatory. In an anatomical study, arthroscopic ATFL sutures were found to entrap the extensor tendons, peroneus tertius or the superficial peroneal nerve in 6 of 10 cadaveric specimens [41]; care should also be taken when placing accessory portals anterior to the tip of the lateral malleolus, so as not to injure the SPN [42]. The location of the SPN varies, however, depending on foot and ankle positions, moving laterally from combined plantarflexion and inversion to dorsiflexion [43]. Other structures found to be at risk are the sural nerve, and medial calcaneal branch of the tibial nerve the at the exit point of the guide wire when performing the fibular and talar bone tunnels, respectively [44].

We admit this study has several limitations. First, it is a case series, without a control group to compare this procedure to other methods. The study group is heterogeneous, with a significant percentage of combined injuries and associated arthroscopic procedures, but these findings are common in chronic ankle instability [12]. These could however act as confounding factors when evaluating the results of ATFL reconstruction. In order to isolate the effect of the ATFL reconstruction on symptoms of instability, we excluded patients with a complete tear of the CFL. Associated injuries of the CFL should however be addressed, if they are found to contribute to the symptoms of lateral ankle instability. Failure to recognize and treat an associated CFL injury could compromise surgical results. The lack of a control group and randomized allocation allows for bias; however, the definition of clear inclusion criteria and of consecutive patients, without loss of patients to follow-up, attempt to minimize the effects of a possible selection bias. Second, the retrospective nature of data analysis implies that some variables of interest were not collected, such as stress radiographs of the ankle to measure talar tilt. Third, this study did not include any objective measurements of ankle instability or clinical scores specific to this type of injury, as the AOFAS score was not designed specifically for ankle instability. It is likely the AOFAS score lacks sensitivity to detect subtle differences in high-demand athletes. In addition, the AOFAS research committee published a policy statement in 2011 recommending against the use of this instrument due to concerns regarding its validity [45]. However, the AOFAS score remains one of the most popular methods for reporting results following hindfoot surgery, and the results described do not differ significantly from the scores reported in other series following repair of the ATFL. Other scores would be more suitable in future studies. The anterior drawer test is an entirely subjective measure with low interobserver reliability. Finally, as this is a procedure that entails the creation of bone tunnels, long-term post-operative X-ray evaluation would be desirable in order to exclude tunnel widening or arthritic changes. This study is limited to describing the surgical technique and the clinical results in a retrospective case series. Comparison to other procedures such as the Broström–Gould technique are beyond the scope of this study, and further prospective studies comparing this method to other procedures would be desirable, and are planned in order to address these issues. We currently perform both techniques in our practice, depending on patient circumstances. We also use this technique in cases of a previous failed Broström–Gould procedure.

5. Conclusions

In this paper, we have described a technique for ATFL reconstruction using an allograft fixed with tenodesis screws. We believe this technique is much easier to learn and perform than other previously described techniques, particularly regarding the preparation of the talar bone tunnel for the graft under direct visualization by passing the scope through the fibular tunnel. Arthroscopic ATFL reconstruction using a graft is an option in patients who may be bad candidates for standard reconstruction methods. The results in this case series show improvement in ankle function, with a relatively low complication rate in line with previously published case series of arthroscopic ATFL repair, and we believe this technique can be considered in cases which are poor candidates for other more standard procedures.

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Conflict of interest

The authors have no conflict of interest to declare.

References

[1] Colville MR. Surgical treatment of the unstable ankle. J Am Acad Orthop Surg 1998;6:368–77.
[2] Golanó P, Vega J, Pérez-Carro L, Götzens V. Ankle anatomy for the arthroscopist. Part II: role of the ankle ligaments in soft tissue impingement. Foot Ankle Clin 2006;11:275–96, doi:http://dx.doi.org/10.1016/j.fcl.2006.03.003 v–vi.
[3] Woods C, Hawkins R, Hulse M, Hodson A. The Football Association Medical Research Programme: an audit of injuries in professional football: an analysis of ankle sprains. Br J Sports Med 2003;37:233–8, doi:http://dx.doi.org/10.1136/bjsm.37.3.233.
[4] Krips R, de Vries J, van Dijk CN. Ankle instability. Foot Ankle Clin 2006;11:311–29, doi:http://dx.doi.org/10.1016/j.fcl.2006.02.003 vi.
[5] Gould N, Seligson D, Gassman J. Early and late repair of lateral ligament of the ankle. Foot Ankle 1980;1:84–9.
[6] Ferkel RD, Chams RN. Chronic lateral instability: arthroscopic findings and long-term results. Foot Ankle Int 2007;28:24–31, doi:http://dx.doi.org/10.3113/FAI.2007.0005.
[7] Buerer Y, Winkler M, Burn A, Chopra S, Crevoisier X. Evaluation of a modified Broström–Gould procedure for treatment of chronic lateral ankle instability: a retrospective study with critical analysis of outcome scoring. Foot Ankle Surg 2013;19:36–41, doi:http://dx.doi.org/10.1016/j.fas.2012.10.005.
[8] Guillo S, Bauer T, Lee JW, Takao M, Kong SW, Stone JW, et al. Consensus in chronic ankle instability: aetiology, assessment, surgical indications and place for arthroscopy. Orthop Traumatol Surg Res 2013;99:S411–9, doi:http://dx.doi.org/10.1016/j.otsr.2013.10.009.
[9] Coughlin MJ, Schenck RC, Grebing BR, Treme G. Comprehensive reconstruction of the lateral ankle for chronic instability using a free gracilis graft. Foot Ankle Int 2004;25:231–41.
[10] Takao M, Oae K, Uchio Y, Ochi M, Yamamoto H. Anatomical reconstruction of the lateral ligaments of the ankle with a gracilis autograft: a new technique using an interference fit anchoring system. Am J Sports Med 2005;33:814–23, doi:http://dx.doi.org/10.1177/0363546504272688.
[11] Acevedo JI, Mangone P. Arthroscopic brostrom technique. Foot Ankle Int 2015;36:465–73, doi:http://dx.doi.org/10.1177/1071100715576107.
[12] Choi WJ, Lee JW, Han SH, Kim BS, Lee SK. Chronic lateral ankle instability: the effect of intra-articular lesions on clinical outcome. Am J Sports Med 2008;36:2167–72, doi:http://dx.doi.org/10.1177/0363546508319050.
[13] Cottom JM, Baker JS, Richardson PE. The "all-inside" arthroscopic Broström procedure with additional suture anchor augmentation: a prospective study of 45 consecutive patients. J Foot Ankle Surg 2016;55:1223–8, doi:http://dx.doi.org/10.1053/j.jfas.2016.07.023.
[14] Cottom JM, Rigby RB. The "all inside" arthroscopic Broström procedure: a prospective study of 40 consecutive patients. J Foot Ankle Surg 2013;52:568–74, doi:http://dx.doi.org/10.1053/j.jfas.2013.02.022.
[15] Espinosa N, Smerek J, Kadakia AR, Myerson MS. Operative management of ankle instability: reconstruction with open and percutaneous methods. Foot Ankle Clin 2006;11:547–65, doi:http://dx.doi.org/10.1016/j.fcl.2006.07.003.
[16] Labib SA, Slone HS. Ankle arthroscopy for lateral ankle instability. Tech Foot Ankle Surg 2015;14.
[17] Matsui K, Takao M, Miyamoto W, Innami K, Matsushita T. Arthroscopic Broström repair with Gould augmentation via an accessory anterolateral port for lateral instability of the ankle. Arch Orthop Trauma Surg 2014;134:1461–7, doi:http://dx.doi.org/10.1007/s00402-014-2049-x.
[18] Matsui K, Takao M, Miyamoto W, Matsushita T. Early recovery after arthroscopic repair compared to open repair of the anterior talofibular ligament for lateral instability of the ankle. Arch Orthop Trauma Surg 2016;136:93–100, doi:http://dx.doi.org/10.1007/s00402-015-2342-3.
[19] Nery C, Raduan F, Del Buono A, Asaumi ID, Cohen M, Maffulli N. Arthroscopic-assisted Broström–Gould for chronic ankle instability: a long-term follow-up. Am J Sports Med 2011;39:2381–8, doi:http://dx.doi.org/10.1177/0363546511416069.

[20] Vega J, Golanó P, Pellegrino A, Rabat E, Peña F. All-inside arthroscopic lateral collateral ligament repair for ankle instability with a knotless suture anchor technique. Foot Ankle Int 2013;34:1701–9, doi:http://dx.doi.org/10.1177/1071100713502322.

[21] Yoo J-S, Yang E-A. Clinical results of an arthroscopic modified Brostrom operation with and without an internal brace. J Orthop Traumatol 2016; 17:353–60, doi:http://dx.doi.org/10.1007/s10195-016-0406-y.

[22] Guillo S, Archbold P, Perera A, Bauer T, Sonnery-Cottet B. Arthroscopic anatomic reconstruction of the lateral ligaments of the ankle with gracilis autograft. Arthrosc Tech 2014;3:e593–8, doi:http://dx.doi.org/10.1016/j.eats.2014.06.018.

[23] Coughlin MJ, Schenck RC. Lateral ankle reconstruction. Foot Ankle Int 2001;22:256–8, doi:http://dx.doi.org/10.1177/107110070102200315.

[24] Michels F, Guillo S, Vanrietvelde F, Brugman E, Ankle Instability Group, Stockmans F. How to drill the talar tunnel in ATFL reconstruction? Knee Surg Sports Traumatol Arthrosc 2016;24:991–7, doi:http://dx.doi.org/10.1007/s00167-016-4018-0.

[25] Sugimoto K, Takakura Y, Okahashi K, Samoto N, Kawate K, Iwai M. Chondral injuries of the ankle with recurrent lateral instability: an arthroscopic study. J Bone Joint Surg Am 2009;91:99–106, doi:http://dx.doi.org/10.2106/JBJS.G.00087.

[26] Lee J, Hamilton G, Ford L. Associated intra-articular ankle pathologies in patients with chronic lateral ankle instability: arthroscopic findings at the time of lateral ankle reconstruction. Foot Ankle Spec 2011;4:284–9, doi:http://dx.doi.org/10.1177/1938640011416355.

[27] Drakos MC, Behrens SB, Paller D, Murphy C, DiGiovanni CW. Biomechanical comparison of an open vs arthroscopic approach for lateral ankle instability. Foot Ankle Int 2014;35:809–15, doi:http://dx.doi.org/10.1177/1071100714535765.

[28] Giza E, Shin EC, Wong SE, Acevedo JI, Mangone PG, Olson K, et al. Arthroscopic suture anchor repair of the lateral ligament ankle complex: a cadaveric study. Am J Sports Med 2013;41:2567–72, doi:http://dx.doi.org/10.1177/0363546513500639.

[29] Hawkins RB. Arthroscopic stapling repair for chronic lateral instability. Clin Podiatr Med Surg 1987;4:875–83.

[30] Acevedo JI, Mangone PG. Arthroscopic Lateral Ankle Ligament Reconstruction. Tech Foot Ankle Surg 2011;10:111–6, doi:http://dx.doi.org/10.1097/BTF.0b013e318229bdb8.

[31] Kim ES, Lee KT, Park JS, Lee YK. Arthroscopic anterior talofibular ligament repair for chronic ankle instability with a suture anchor technique. Orthopedics 201134:, doi:http://dx.doi.org/10.3928/01477447-20110228-03.

[32] Corte-Real NM, Moreira RM. Arthroscopic repair of chronic lateral ankle instability. Foot Ankle Int 2009;30:213–7, doi:http://dx.doi.org/10.3113/FAI.2009.0213.

[33] Wang J, Hua Y, Chen S, Li H, Zhang J, Li Y. Arthroscopic repair of lateral ankle ligament complex by suture anchor. Arthroscopy 2014;30:766–73, doi:http://dx.doi.org/10.1016/j.arthro.2014.02.023.

[34] Guillo S, Cordier G, Sonnery-Cottet B, Bauer T. Anatomical reconstruction of the anterior talofibular and calcaneofibular ligaments with an all-arthroscopic surgical technique. Orthop Traumatol Surg Res 2014;100:S413–7, doi:http://dx.doi.org/10.1016/j.otsr.2014.09.009.

[35] Guillo S, Takao M, Calder J, Karlson J, Michels F, Bauer T, et al. Arthroscopic anatomical reconstruction of the lateral ankle ligaments. Knee Surg Sports Traumatol Arthrosc 2016;24:998–1002, doi:http://dx.doi.org/10.1007/s00167-015-3789-z.

[36] Lui TH. Arthroscopic-assisted lateral ligamentous reconstruction in combined ankle and subtalar instability. Arthroscopy 2007;23:554.e1–5, doi:http://dx.doi.org/10.1016/j.arthro.2006.07.038.

[37] Piraino JA, Busch EL, Sansosti LE, Pettineo SJ, Creech C. Use of an all-suture anchor for re-creation of the anterior talofibular ligament: a case report. J Foot Ankle Surg 2015;54:126–9, doi:http://dx.doi.org/10.1053/j.jfas.2014.08.020.

[38] Priano F, Gatto P. Arthroscopic reconstruction of inveterate anterior talofibular ligament tears. Notes on the technique employed and the short-term results. J Sports Traumatol Relat Res 1994;16:97–104.

[39] Prissel MA, Roukis TS. All-inside, anatomical lateral ankle stabilization for revision and complex primary lateral ankle stabilization: a technique guide. Foot Ankle Spec 2014;7:484–91, doi:http://dx.doi.org/10.1177/1938640014548418.

[40] Takao M, Glazebrook M, Stone J, Guillo S. Ankle arthroscopic reconstruction of lateral ligaments (ankle anti-ROLL). Arthrosc Tech 2015;4:e595–600, doi:http://dx.doi.org/10.1016/j.eats.2015.06.008.

[41] Drakos M, Behrens SB, Mulcahey MK, Paller D, Hoffman E, DiGiovanni CW. Proximity of arthroscopic ankle stabilization procedures to surrounding structures: an anatomic study. Arthroscopy 2013;29:1089–94, doi:http://dx.doi.org/10.1016/j.arthro.2013.02.011.

[42] Jorge JT, Gomes TM, Oliva XM. An anatomical study about the arthroscopic repair of the lateral ligament of the ankle. Foot Ankle Surg 2017;0, doi:http://dx.doi.org/10.1016/j.fas.2017.01.005.

[43] de Leeuw PAJ, Golanó P, Sierevelt IN, van Dijk CN. The course of the superficial peroneal nerve in relation to the ankle position: anatomical study with ankle arthroscopic implications. Knee Surg Sports Traumatol Arthrosc 2010;18:612–7, doi:http://dx.doi.org/10.1007/s00167-010-1099-z.

[44] Klammer G, Schlewitz G, Stauffer C, Vich M, Espinosa N. Percutaneous lateral ankle stabilization: an anatomical investigation. Foot Ankle Int 2011;32:66–70, doi:http://dx.doi.org/10.3113/FAI.2011.0066.

[45] Pinsker E, Daniels TR. AOFAS position statement regarding the future of the AOFAS clinical rating systems. Foot Ankle Int 2011;32:841–2.