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ANKLE

A four-step approach improves long-term functional outcomes in patients suffering from chronic ankle instability: a retrospective study with a follow-up of 7–16 years

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Abstract

Purpose The aim of the present study was to assess the long-term outcomes of the treatment of chronic ankle instability (CAI) with a four-step protocol.

Methods Fifty-four patients with isolated anterior talo-fibular ligament (ATFL) lesion suffering from CAI who underwent surgical treatment between 2000 and 2009 were assessed. All the patients underwent a four-step protocol including synovectomy, debridement of ATFL lesion borders, capsular shrinkage, and 21-day immobilization and nonweightbearing. Median age at surgery was 31.6 years (18–48). Patients were examined preoperatively and at follow-up. Clinical assessment included the American Orthopaedic Foot and Ankle Society (AOFAS) ankle and hindfoot scoring system, Karlsson–Peterson score, Tegner activity level, and objective examination comprehending range of motion (ROM) and manual laxity tests.

Results AOFAS (preoperative, 64.8; postoperative, 92.4; $p < 0.001$) and Karlsson-Peterson score (preoperative, 62.5; postoperative, 88.8; $p < 0.001$) significantly improved after a median 11 years follow-up (7–16 years). Similarly median Tegner activity level significantly increased at follow-up compared to pre-operatory status (6.0 and 4.0 respectively, $p < 0.001$). Objective examination documented a statistically significant improvement in terms of ankle stability compared to preoperative manual laxity tests, with negative anterior drawer test observed in 48 (88.9%) patients ($p < 0.001$). Sagittal ROM was full in 50 patients (92%). Nine patients had subsequent ankle sprains (15.6%), two patients required further surgery, while seven were treated conservatively. No major complications were reported.

Conclusion Satisfying subjective and objective clinical outcomes in selected patients with isolated ATFL lesion suffering from CAI were reported with a treatment protocol including arthroscopic synovectomy, debridement of ATFL remnants, capsular shrinkage, and immobilization. These findings are of clinical relevance because they provide a suitable minimally invasive method for the treatment of mild to moderate ankle instability.

Level of evidence Level IV

Keywords Ankle · Chronic ankle instability · Ankle arthroscopy · Thermal capsular shrinkage · long-term outcomes

Introduction

Chronic ankle instability (CAI) is a condition of residual pain and persistent perception of giving way usually following multiple ankle sprains [10]. The degree of instability is usually in accordance to the involvement of the lateral ligamental complex, ranging from mild to serious symptoms, and therefore requiring a tailored approach according to its severity [32].

The Broström–Gould procedure is considered the gold-standard treatment [3, 9, 17, 19, 23] of mechanical joint laxity, while in the presence of concomitant ankle and subtalar joint instability, a reconstruction of the lateral ligamental complex with tenodesis is preferable [2, 14–16, 18, 25, 31, 33, 35]. However, in a significant percentage of patients, only the anterior talo-fibular ligament (ATFL) sustains an injury, and patients complain of mild symptoms such as

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impairment of ankle proprioception and anterolateral pain [26, 28].

Arthroscopic techniques encompassing thermal-assisted capsular shrinkage have been proposed for the treatment of mild chronic lateral ankle instability [6, 13, 20, 24, 29, 30]. However, controversy exists on the effectiveness of thermal shrinkage for the treatment of CAI, and scientific evidence supporting its long-term efficacy is insufficient to draw any firm conclusions, as the level of evidence of existing studies is rather small [36].

A protocol consisting of four-step operative procedures aiming to improve the functional outcomes and reduce the recurrence of laxity in the long term in patients with ATFL lesion has been implemented in our unit. The procedure includes synovectomy, debridement of ATFL lesion borders, capsular shrinkage, and 21-day immobilization and nonweightbearing.

The aim of the present study was to retrospectively evaluate the long-term outcomes of patients with isolated ATFL treated according to the local protocol. Our hypothesis was that a four-step operative procedure—including synovectomy, debridement of ATFL lesion borders, capsular shrinkage, and 21-day immobilization and nonweightbearing—would provide improvement in functional outcomes and a low rate of recurrence of laxity in the long term.

Materials and methods

The study was conducted in accordance with the ethical standards of the institution and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all patients. Ninety patients suffering from mild ankle instability and anterolateral pain unresponsive to at least 6 months of conservative treatment underwent surgery between 2000 and 2009. Inclusion criteria were isolated ATFL incompetency documented by magnetic resonance imaging (MRI) and manual laxity tests, absence of multiple ligament insufficiency or cartilage defects requiring treatment. Patients were included whenever positivity to anterior drawer test in plantarflexion compared to contralateral side was detected, or in the presence of anterior talar slight movement (corresponding to grade 1) in neutral position. Patients positive to anterior drawer test greater or equal than a grade 2 or to talar tilt test were excluded.

All of them underwent an operative procedure including synovectomy, debridement of ATFL lesion borders, capsular shrinkage, and 21-day immobilization and nonweightbearing. Surgical operations and rehabilitation protocol were carried out according to those described by the authors in a previous paper [29]. All the operations were performed by the same experienced senior surgeon.

Outcome measures

Patients were examined preoperatively and at follow-up. Clinical assessment included the American Orthopaedic Foot and Ankle Society (AOFAS) ankle and hindfoot scoring system as primary outcome, Karlsson–Peterson score, Tegner activity level and objective examination comprehending range of motion (ROM), anterior drawer and talar tilt test. Anterior drawer test was regarded as positive either when anterior talar translation (corresponding to grade 1) in neutral position was observed or when increased laxity in plantarflexion compared to contralateral side was detected. Talar tilt was regarded as positive if the talar tilt angle on the injured was more than 6° compared to the contralateral side, or had a value greater than 10°. Complications such as infection, deep thrombosis, neurovascular injuries and recurrence of ankle sprains were recorded. Patients were asked if they would have undergone surgery again. An expert observer performed clinical assessment.

Statistical analysis

IBM SPSS Statistics for Windows®, Version 21.0 (IBM Corp., Armonk, USA) was used to analyse data. The non-normal distribution of the measured variables was verified using the Shapiro–Wilk test. Wilcoxon signed-rank test for related samples was used to compare the pre-operative and follow-up status. Statistical significance was established at $p < 0.05$. A power analysis was performed to verify that the study sample achieved a power of 80%. A sample size of 17 patients was calculated to detect a minimal clinically important difference of at least 10 points in AOFAS score between pre- and post-operative status.

Results

Fifty-four patients (60% of the original group) were successfully contacted and were available for clinical examination after an average follow-up of 11.5 years (7–16). Mean age at surgery was 31.6 years (18–48). Thirty-two were male and 22 female. Patient demographics are reported in Table 1. Forty-two patients (77%) were amateurs, eight (14%) practiced sport at competitive level, while four (7%) were sedentary. Most ($n = 38$, 70%) practiced noncontact sports; sixteen patients (30%) practiced contact sports.

Mean AOFAS, Karlsson–Peterson and Tegner scores significantly increased at follow-up compared to pre-operatory status, showing a statistically significant difference ($p < 0.05$). A detailed overview of the results of clinical assessment is shown in Table 2. All patients complained

Table 1 Patient demographics and anthropometric data

No. of patients	54
Gender	
Male	32
Female	22
BMI (SD)	24.7 (2.1)
Age at surgery in years, mean (SD)	31.6 (8.1)

BMI body mass index, *SD* standard deviation

giving-way symptoms before surgery and were positive to anterior drawer test in plantarflexion. None of the patients was positive to talar tilt test. Objective examination at follow-up documented a statistically significant improvement in terms of ankle stability compared to pre-operative manual laxity tests, with negative anterior drawer test observed in 48 (88.9%) patients ($p < 0.05$). Sagittal ROM was full in 50 patients: three subjects experienced five degrees dorsiflexion limitation compared to the contralateral side. In one patient, 10 degrees dorsiflexion limitation was observed. Nine patients underwent subsequent ankle sprains (15.6%), in two patients requiring further surgery, while seven were treated conservatively. In two patients, damage to the superficial branch of the peroneal nerve occurred which patients referred to as altered sensation in the anterolateral aspect of the foot. All patients stated that they would have undergone surgery again. None reported swelling, neither at rest nor during or after activities. No infection, deep thrombosis, or any other major complications were reported.

Discussion

The most important finding of the present study is that the four-step approach proposed appears a suitable treatment option in patients with isolated ATFL lesion suffering from CAI. It provides improvement in clinical and functional results with a low percentage of complications after an average follow-up of 11.5 years.

It has been reported that in a significant percentage of patients reaching 80%, only the ATFL sustains an injury, and the patient refers persistent anterolateral pain and subjective instability secondary to impairment of ankle proprioception, the so-called micro-instability [26]. Micro-instability represents a frequent but minor pattern of CAI affecting the ATFL's superior fascicle accounting for the persistence of symptoms following multiple ankle sprains, which clinical examinations and stress radiograph may not be sensitive enough to detect [26]. ATFL superior fascicle, an intra-articular structure, tenses during ankle plantar flexion and relaxes during dorsiflexion [8], and for this reason, its tension should be assessed by performing anterior drawer test in plantarflexion. In our case series, only patients suffering from a subjective feeling of giving way with isolated ATFL lesion documented by MRI and positivity to anterior drawer test in plantarflexion were included.

Previous studies demonstrated improvements in clinical and functional outcomes following arthroscopic thermal capsular shrinkage in patients affected by moderate chronic ankle joint laxity [6, 13, 20, 24, 29, 30]. According to a recent systematic review, thermal stabilization procedures possess the same advantages of the Broström technique and are technically simple with a short recovery time [21]. However, despite short-term promising clinical results, controversy exists on the effectiveness of thermal shrinkage for the treatment of CAI, and scientific evidence supporting its long-term efficacy in restoring ankle laxity is insufficient to draw firm conclusions [36].

Vuurberg et al. [34] reported a high recurrence rate of ankle sprains (68%) after a period of 12–14 years from capsular shrinkage in a retrospective study on patients affected by CAI, despite improved subjective results and satisfying functional outcomes. Authors conclude in view of the high percentage of patients sustaining subsequent inversion sprain, that arthroscopic capsular shrinkage is not recommended as joint stabilization procedure in patients with CAI [34].

The discrepancy between studies may be related to the differences among inclusion criteria of the patients treated, as some authors discourage from adopting this approach in case of mechanical CAI [21] and to the variability in post-operative protocols [36]. In fact, the definition of "CAI" itself is not clear, as it encompasses different degrees of anatomical incompetence and symptoms, ranging from minor discomfort to severe tibiotalar and subtalar laxity. Such

Table 2 Overview of the results of clinical assessment

	Pre-operative	Post-operative	*p* value
AOFAS scale, mean (SD)	64.8 (SD 9.1)	92.4 (SD 7.2)	< 0.001
Karlsson-Peterson score, mean (SD)	62.5 (SD 5.6)	88.8 (SD 9.4)	< 0.001
Tegner activity level, median (range)	4 (3–6)	6 (3–10)	< 0.001
Positive anterior drawer test, no. (%)	54/54 (100%)	6/54 (11.1%)	< 0.001
Positive talar tilt test, no. (%)	0/54 (0%)	0/54 (0%)	n.s.

AOFAS American Orthopaedic Foot and Ankle Society, *SD* standard deviation

an heterogeneity of pathologic conditions included under the same definition poses inherent challenges to clinical decision-making and can lead to uncertainty in which form of treatment should be performed. For these reasons, we believe that clinical outcomes could be enhanced by assessing the severity of ankle instability according to the involvement of the anatomic structures which are affected in this pathologic condition.

Taking this in consideration, patients with isolated ATFL lesion suffering from minor symptoms of instability may benefit from a minimally invasive arthroscopic approach, while patients with severe ligamentous laxity could benefit from a lateral fibulotalocalcaneal ligament (LFTCL) complex repair or tenodesis procedure.

Several factors have to be considered which may justify the long-term favourable results reported in our study. First of all, patient selection is crucial benefit from this treatment strategy. An accurate pre-operative evaluation including manual laxity tests and imaging is fundamental to determine the extent of the anatomic involvement, as this surgical approach does not apply to cases in which concomitant LFTCL complex impairment is present. In addition, this underlines the importance of the endoscopic approach in clinical practice, which allows the assessment of ATFL and adjacent capsular status and the treatment of associated intra-articular pathology. In our case series, only patients with isolated ATFL lesion were included. ATFL's superior fascicle is an intra-articular structure continuous to the joint capsule, an anatomical situation which allows its accessibility during ankle arthroscopy [5, 22, 28].

Eventually, the rehabilitation protocol applied consisted of bracing with non-weightbearing for 3 weeks. According to current literature, no consensus exists on the postoperative protocol to apply following thermal shrinkage, as weightbearing following surgical treatment varies between studies, ranging between 3 and 5 days [6, 34], and 2–3 weeks [13, 20, 24, 29, 30]. The importance of prolonged immobilization and non-weightbearing to prevent lengthening of the treated tissue after thermal shrinkage allow effective reduction in capsular volume and ultimately restore micro-instability should be stressed [29]. A period of 7–10 days may not be sufficient to allow the shortening of collagenous fibres within the connective tissue [1, 4, 7]. The postoperative protocol requiring 20 days of immobilization and non-weightbearing may be the reason of the lower rate of ankle sprain recurrence reported in the present study in the long-term compared to the study by Vuurberg et al. [34], in which postoperative compression bandage and non-weightbearing were kept for 3–5 days, thus allowing early mobilization and walking.

These results fit into current knowledge, and are compatible with recent findings on ankle microinstability [5, 27], but also shed light on the importance of rigorous patient selection and appropriate treatment strategy according to the degree of anatomical incompetence. It is important to recognize that the ATFL superior fascicle represents the intraarticular part of the ligament and can be, therefore, treated arthroscopically [5]; in addition, the examination of the ankle joint in dorsiflexion without distraction allows the visualization of this structure and is, therefore, preferable when approaching the patient with this technique [27]. Ankle micro-instability represents a mild pattern of chronic ankle instability due to an injury affecting the ATFL's superior fascicle, as opposed to classical chronic ankle instability involving the LFTCL complex [26, 28]. The proposed four-step protocol, which relies on the selection of patients affected by isolated ATFL lesion, may, therefore, be a valid therapeutic option for addressing micro-instability. These findings are of clinical relevance because they provide a safe and effective minimally invasive method for the treatment of mild to moderate ankle instability.

The present study is a retrospective cohort, single-surgeon series, non-comparative in design and includes a relatively small sample size with a high drop-out rate. These findings are, therefore, limited in generalizability. A larger series of prospectively recruited patients as well as the inclusion of a control group would certainly increase the validity of the results. Further randomized clinical trials are needed to substantiate these findings.

Conclusion

A four-step treatment protocol including arthroscopic synovectomy, debridement of ATFL remnants, capsular shrinkage, and immobilization provided satisfying long-term subjective and objective clinical outcomes in selected patients with isolated ATFL lesion suffering from CAI.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no competing interests.

Ethical approval This study was performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

Informed consent All persons gave their informed consent prior to their inclusion in the study.

References

1. Arnoczky SP, Aksan A (2002) Thermal modification of connective tissues: basic science considerations and clinical implications. J Am Acad Orthop Surg 8:305–313
2. Baray AL, Philippot R, Neri T, Farizon F, Edouard P (2016) The Hemi-Castaing ligamentoplasty for chronic lateral ankle instability does not modify proprioceptive, muscular and posturographic parameters. Knee Surg Sports Traumatol Arthrosc 24:1108–1115
3. Broström L (1966) Sprained ankles: VI. Surgical treatment of "chronic" ligament ruptures. Acta Chir Scand 132:551–565
4. Cline S, Wolin P (2001) The use of thermal energy in ankle instability. Clin Sports Med 21:713–725
5. Dalmau-Pastor M, Malagelada F, Calder J, Manzanares MC, Vega J (2020) The lateral ankle ligaments are interconnected: the medial connecting fibres between the anterior talofibular, calcaneofibular and posterior talofibular ligaments. Knee Surg Sports Traumatol Arthrosc 28:34–39
6. de Vries JS, Krips R, Blankevoort L, Fievez AW, van Dijk CN (2008) Arthroscopic capsular shrinkage for chronic ankle instability with thermal radiofrequency: prospective multicenter trial. Orthopedics 31:655
7. Flory PJ, Garrett RR (2002) Phase transition in collagen and gelatine systems. Am J Chem Soc 80:4836–4845
8. Golanó P, Vega J, de Leeuw PA, Malagelada F, Manzanares MC, Götzens V et al (2010) Anatomy of the ankle ligaments: a pictorial essay. Knee Surg Sports Traumatol Arthrosc 18:557–569
9. Gould N, Seligson D, Gassman J (1980) Early and late repair of lateral ligament of the ankle. Foot Ankle 1:84–89
10. Guelfi M, Zamperetti M, Pantalone A, Usuelli FG, Salini V, Oliva XM (2018) Open and arthroscopic lateral ligament repair for treatment of chronic ankle instability: a systematic review. Foot Ankle Surg 24:11–18
11. Hertel J (2002) Functional anatomy, pathomechanics, and pathophysiology of lateral ankle instability. J Athl Train 37:364–375
12. Hiller CE, Kilbreath SL, Refshauge KM (2011) Chronic ankle instability: evolution of the model. J Athl Train 46:133–141
13. Hyer CF, Vancourt R (2004) Arthroscopic repair of lateral ankle instability by using the thermal-assisted capsular shift procedure: a review of 4 cases. J Foot Ankle Surg 43:104–109
14. Jung HG, Kim TH, Park JY, Bae EJ (2012) Anatomic reconstruction of the anterior talofibular and calcaneofibular ligaments using a semitendinosus tendon allograft and interference screws. Knee Surg Sports Traumatol Arthrosc 208:1432–1437
15. Kennedy JG, Smyth NA, Fansa AA, Murawski CD (2012) Anatomic lateral ligament reconstruction in the ankle. A hybrid technique in the athletic population. Am J Sports Med 40:2309–2317
16. Kim HN, Jeon JY, Dong Q, Noh KC, Chung KJ, Kim HK, Hwang JH, Park YW (2015) Lateral ankle ligament reconstruction using the anterior half of the peroneus longus tendon. Knee Surg Sports Traumatol Arthrosc 23:1877–1885
17. Lee JH, Lee SH, Jung HW, Jang WY (2020) Modified Broström procedure in patients with chronic ankle instability is superior to conservative treatment in terms of muscle endurance and postural stability. Knee Surg Sports Traumatol Arthrosc 28:93–99
18. Mabit C, Tourné Y, Besse JL, Bonnel F, Toullec E, Giraud F, Proust J, Khiami F, Chaussard C, Genty C et al (2010) Chronic lateral ankle instability surgical repairs: the long term prospective. Orthop Traumatol Surg Res 96:417–423
19. Maffulli N, Del Buono A, Maffulli GD, Oliva F, Testa V, Capasso G, Denaro V (2013) Isolated anterior talofibular ligament Brostrom repair for chronic lateral ankle instability. 9-year follow-up. Am J Sports Med 41:858–864
20. Maiotti M, Massoni C, Tarantino U (2005) The use of arthroscopic thermal shrinkage to treat chronic lateral ankle instability in young athletes. Arthroscopy 21:751–757
21. Matsui K, Burgesson B, Takao M, Stone J, Guillo S, Glazebrook M; ESSKA AFAS Ankle Instability Group (2016) Minimally invasive surgical treatment for chronic ankle instability: a systematic review. Knee Surg Sports Traumatol Arthrosc 24:1040–1048
22. Matsui K, Takao M, Tochigi Y, Ozeki S, Glazebrook M (2017) Anatomy of anterior talofibular ligament and calcaneofibular ligament for minimally invasive surgery: a systematic review. Knee Surg Sports Traumatol Arthrosc 25:1892–1902
23. Nery C, Raduan F, Del Buono A, Asaumi ID, Cohen M, Maffulli N (2011) Arthroscopic-assisted Broström–Gould for chronic ankle instability: a long-term follow-up. Am J Sports Med 39:2381–2388
24. Oloff LM, Bocko AP, Fanton G (2000) Arthroscopic monopolar radiofrequency thermal stabilization for chronic lateral ankle instability: a preliminary report on 10 cases. J Foot Ankle Surg 39:144–153
25. Ramdass RS, Grierson KR (2019) A comparison of split peroneus brevis tendon and semitendinosus allograft tendon for lateral ankle ligament reconstruction. J Foot Ankle Surg 58:1197–1202
26. Vega J, Peña F, Golanó P (2016) Minor or occult ankle instability as a cause of anterolateral pain after ankle sprain. Knee Surg Sports Traumatol Arthrosc 24:1116–1123
27. Vega J, Malagelada F, Karlsson J, Kerkhoffs GM, Guelfi M, Dalmau-Pastor M (2020) A step-by-step arthroscopic examination of the anterior ankle compartment. Knee Surg Sports Traumatol Arthrosc 28:24–33
28. Vega J, Malagelada F, Manzanares Céspedes MC, Dalmau-Pastor M (2020) The lateral fibulotalocalcaneal ligament complex: an ankle stabilizing isometric structure. Knee Surg Sports Traumatol Arthrosc 28:8–17
29. Ventura A, Terzaghi C, Legnani C, Borgo E (2012) Arthroscopic four-step treatment for chronic ankle instability. Foot Ankle Int 33:29–36
30. Ventura A, Terzaghi C, Legnani C, Borgo E (2013) Treatment of post-traumatic osteochondral lesions of the talus: a four-step approach. Knee Surg Sports Traumatol Arthrosc 21:1245–1250
31. Ventura A, Terzaghi C, Legnani C, Borgo E (2014) Lateral ligament reconstruction with allograft in patients with severe chronic ankle instability. Arch Orthop Trauma Surg 134:263–268
32. Ventura A, Legnani C (2016) Chronic ankle instability. In: Volpi P (ed) Arthroscopy and sport Injuries. applications in high-level athletes, Springer, Cham, Switzerland, pp 399–404
33. Ventura A, Legnani C, Corradini C, Borgo E (2020) Lateral ligament reconstruction and augmented direct anatomical repair restore ligament laxity in patients suffering from chronic ankle instability up to 15 years from surgery. Knee Surg Sports Traumatol Arthrosc 28:202–207
34. Vuurberg G, de Vries JS, Krips R, Blankevoort L, Fievez AWFM, van Dijk CN (2017) Arthroscopic capsular shrinkage for treatment of chronic lateral ankle instability. Foot Ankle Int 38:1078–1084
35. Wang W, Xu GH (2017) Allograft tendon reconstruction of the anterior talofibular ligament and calcaneofibular ligament in the treatment of chronic ankle instability. BMC Musculoskelet Disord 18(1):150
36. Yasui Y, Murawski CD, Wollstein A, Takao M, Kennedy JG (2016) Operative treatment of lateral ankle instability. JBJS Rev. https://doi.org/10.2106/JBJS.RVW.15.00074