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Outcome Comparison Between Functional Ankle Instability Cases With and Without Anterior Ankle Impingement: A Retrospective Cohort Study

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ABSTRACT

Functional ankle instability (FAI) and anterior ankle impingement (AAI) are likely to occur simultaneously. Nevertheless, how AAI affects ankle instability remains largely unknown. This study aimed to assess patients with FAI + AAI and those having FAI without AAI after arthroscopic synovectomy combined with the modified Broström procedure. Patients with chronic ankle instability who underwent surgery at the Huashan Hospital of Fudan University (China) from January 2010 to December 2015 were reviewed. Propensity score matching was performed (FAI + AAI: n = 86; FAI without AAI: n = 43). Ankle function was assessed by the American Orthopedic Foot and Ankle Society (AOFAS) and the Meislin criteria at 3 months, 1 year, and final follow-up. In the FAI + AAI group, AOFAS scores increased from 52.6 ± 7.2 to 78.6 ± 8.2, 84.2 ± 6.4, and 83.6 ± 11.3 at 3 months, 1 year, and last follow-up, respectively ($p < .001$). In the FAI without AAI group, AOFAS scores increased from 64.3 ± 10.5 to 85.2 ± 8.6, 91.4 ± 7.9, and 90.2 ± 9.8 at 3 months, 1 year, and last follow-up, respectively ($p < .001$; all $p < .05$ for differences between the 2 groups at each time point). The 2 groups showed similar scores based on the Meislin criteria ($p = .38$). Hypertrophic distal fascicle of the anteroinferior tibiofibular ligament showed lower AOFAS scores (all $p < .05$). Patients with FAI with or without AAI had improved outcomes with arthroscopic synovectomy combined with the modified Broström procedure; however, patients with combined FAI and AAI showed a relatively poorer outcome in comparison with those suffering from FAI alone, probably because of hypertrophic distal fascicle of the anteroinferior tibiofibular ligament.

Chronic disability following ankle sprain is commonly caused by instability and impingement (1). Repeated ankle sprains with prolonged manifestations are known as chronic ankle instability (CAI) (2). Functional ankle instability (FAI) was recently defined as recurrent ankle instability affected by proprioceptive and neuromuscular impairments (3). Mechanical ankle instability (MAI) manifests clinically by morbid laxity, altered arthrokinematics, and talar test results showing a 5° difference (2). FAI, unlike MAI, reflects a more subjective situation with pain and instability with full ligamentous competence (4).

FAI and anterior ankle impingement (AAI) are more likely to be encountered together (5). AAI is accompanied by intra-articular synovitis, scarring, and fibrosis, and it is not easily detectable in CAI cases (6).

Although recent studies showed that patients with FAI achieve satisfactory outcomes after surgical reconstruction of lateral ligament insufficiency (5,7–9), about 13% to 35% of such individuals still show pain after the operation (10,11). Nery et al (11) reported significantly worse outcomes in patients with CAI and concomitant AAI who underwent soft tissue removal for anterior impingement; however, the study sample size was relatively small, preventing any firm conclusion regarding this matter. Nevertheless, the latter findings suggested that lesion prognosis and characteristics could differ in patients with AAI compared with those without AAI. Indeed, how AAI affects ankle instability is largely unknown, although such cases are rather common in the clinic. In patients with CAI, the incidence of AAI can be as high as 63%, whereas CAI without AAI only accounts for less than one half of the cases (12). The majority of existing reports have assessed ankle instability, considering AAI a simple secondary prognostic factor (5–9,11). In addition, samples sizes were relatively small, and some studies lacked adequate controls.

This study aimed to assess patients with concomitant FAI and AAI, comparatively to those with FAI without AAI, after arthroscopic

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Table 1
The Meislin criteria

Rating	Pain at Rest or With Activity	Physical Examination	Self-Assessment
Excellent	None	Normal	Normal
Good	None	No tenderness, minimal swelling	Greatly improved
Fair	Minimal pain with activities	Minimal/moderate tenderness, moderate swelling, instability	Somewhat improved
Poor	Pain at rest, moderate/severe; pain with activity	Severe swelling, limitation of range of motion	Unchanged or worse

synovectomy combined with the modified Broström procedure. The American Orthopaedic Foot and Ankle Society (AOFAS) scoring system and the Meislin criteria were used to compare these cases.

Patients and Methods

Cases of COI treated by arthroscopic synovectomy combined with the modified Broström procedure at the Department of Orthopedics of the Huashan Hospital of Fudan University in Shanghai, China, from January 2010 to December 2015 were reviewed.

The inclusion criteria were (i) diagnosis of CAI according to Altan et al (5); (ii) unilateral, repeated ankle sprains; (iii) pain sensation while carrying heavy objects; (iv) tenderness at the ankle's anterolateral aspect; (v) recurrent swelling; (vi) feeling of ankle collapse; and (vii) weakness. The exclusion criteria were (i) systemic disease affecting the musculoskeletal system, (ii) severe diffuse arthritic changes at the ankle joint (13), (iii) severe anatomic deformity of lower extremity, (iv) previous surgical operation of the ankle joint, (v) accompanying ankle fracture, or (vi) MAI.

From 432 potentially eligible patients, 310 who received the arthroscopic-assisted Broström treatment were included in the current study. Surgery was decided based on previous criteria (7). All patients complained of ankle instability and/or repeated symptomatic ankle sprains lasting >6 months following ankle sprain. All patients underwent a course of functional ankle rehabilitation supervised by a specialist physical therapist; this consisted of physical therapy, proprioceptive training, and bracing. Operative intervention was offered to patients when the ankle showed no response after 6 months of therapy.

The current study had approval from the ethics committee of the Huashan Hospital of Fudan University (China). The requirement for individual consent was waived because of the retrospective nature of this trial.

Grouping

The patients were assigned to the FAI + AAI group according to (i) a history of inversion injury of the ankle; (ii) persistent pain in the ankle's anterolateral aspect; (iii) pain increase during ankle dorsiflexion; (iv) magnetic resonance imaging showing anterior or anterolateral ankle synovial hyperplasia, semilunar injury, or ankle compression by anteroinferior tibiofibular ligament injury; (v) arthroscopic diagnosis (14); and (vi) exclusion of MAI (15). The criteria by Hintermann et al (15) were used to distinguish FAI from MAI. In all, 86 cases were assigned to the FAI + AAI group. The remaining patients were included in the FAI without AAI group.

Propensity Score Matching

The propensity score matching method was used to reduce selection bias; cases were matched for age, sex, body mass index, and a history of trauma. A statistician performed a 2:1 ratio matching in a blinded manner, and 43 cases were selected for the FAI without AAI group.

Surgical Technique

All surgeries were performed by X.W., a senior orthopedic surgeon and chief physician with 17 years of working experience specializing in ankle surgery. All surgeries were performed with an AXEL 300 TPY: OP932 (Aesculap AG, Tuttlingen, Germany) using the Twinfix 3.5-mm titanium suture anchor (Smith & Nephew, London, UK). All procedures were performed according to Nery et al (11).

Following arthroscopy, a 5-cm curvilinear incision was made 2 cm proximal to the fibular tip toward the fifth metatarsal base. The anterior talofibular ligament was removed from its attachment site and reattached to the fibula via insertion of a suture anchor between the anatomic footprints of the anterior talofibular ligament. Full inferior extensor retinaculum mobilization was finally sutured as described previously (16).

Postoperative Management

The patients were administered standard rehabilitation sessions. Non-weightbearing and short leg cast immobilization exercises were performed for 6 and 4 weeks postoperation, respectively. Two weeks after cast removal, the patients could gently move their ankles under protection by an orthosis. Six weeks postsurgery, partial weightbearing was introduced alongside other resistance exercises. All individuals progressively resumed their routine activities 3 months after surgery.

Clinical Outcome Assessment and Data Collection

Ankle function was assessed using an AOFAS-based questionnaire (17,18) and the Meislin criteria (19) at 3 months, 1 year, and last follow-up. All assessments were performed by the same investigator (L.C.). All follow-up visits were carried out at the outpatient clinic. Follow-up was censored in January 2017. AOFAS scores were excellent (90 to 100), good (80 to 89), fine (70 to 79), and poor (<70). The Meislin system measures pain during rest and function, clinical findings, and patient self-assessment (Table 1).

Statistical Analysis

Continuous data are mean ± standard deviation and assessed by Student's *t* test. A paired *t* test was performed to identify differences between preoperative and postoperative clinical outcomes. Analyses involving multiple time points were tested by repeated-measure analysis of variance with the Tukey post hoc test. Categorical variables presented as proportion and assessed by the chi-square or Fisher's exact test, as appropriate. Propensity score matching was based on methods described previously (20). SPSS 20.0 (SPSS Inc., Chicago, IL) was used by a blinded statistician for data analyses. Two-sided $p < .05$ reflected statistical significance.

Results

Propensity Score Matching

The baseline features of both study groups are summarized in Table 2. No statistically significant differences were found between the 2 groups except for age ($p = .01$) and symptom duration ($p = .03$), prematching. After successful propensity score matching, age ($p = .85$) and symptom duration ($p = .74$) were comparable in both groups. The mean follow-up duration was 30.5 ± 20.9 months in the FAI + AAI group and 31.8 ± 23.0 months in the FAI without AAI group ($p = .517$). Fig. 1 presents the patient flowchart.

Arthroscopic Findings

In the FAI + AAI group, increased frequency of osteochondral talar lesions, osteophyte, and syndesmosis widening were found ($p = .011$, $p = .026$, and $p = .013$, respectively). Loose body and subchondral cyst occurrences were similar in both groups ($p = .571$ and $p = .732$, respectively).

In the FAI + AAI group, all cases showed synovial hypertrophy of the anterior talofibular ligament. An abnormal band-like structure was found along the anterior capsule in 14 individuals. Hypertrophic distal fascicle of the anteroinferior tibiofibular ligament was observed in 24 patients, including 12 with chondral lesions on the anterolateral aspect of the talar dome. A total of 37 patients showed meniscoid lesions. Of the 86 patients, 24 (27.9%) were positive in arthroscopic translation test; only 10 of 24 patients had abnormal scar tissues in the syndesmosis.

Table 2
Baseline characteristics of the patients before and after propensity score matching

	Before Propensity Score Matching			After Propensity Score Matching		
	FAI + AAI (n = 86)	FAI Without AAI (n = 104)	*p* Value	FAI + AAI (n = 86)	FAI Without AAI (n = 43)	*p* Value
Mean Age (y)	42.3 ± 12.7	36.18 ± 15.5	.01	42.3 ± 12.7	41.0 ± 13.8	.85
Gender, Male:Female, n	46:40	57:47	.72	46:40	23:20	.96
BMI, kg/m^2	25.4 ± 3.3	24.7 ± 2.9	.25	25.3 ± 3.3	25.0 ± 3.2	.48
Trauma, n (%)	60 (70.0)	82 (78.8)	.23	60 (70.0)	29 (67.4)	.93
Follow-Up (mo)	30.5 ± 20.9	31.8 ± 23.0	.52	30.5 ± 20.9	30.8 ± 22.7	.62
Symptom Duration (mo)	30.1 ± 37.6	24.0 ± 36.4	.03	30.1 ± 37.6	28.7 ± 32.6	.74

Abbreviations: AAI, anterior ankle instability; BMI, body mass index; FAI, functional ankle instability.

Clinical Outcomes

Among the matched patients, both groups showed marked improvement in AOFAS scores after surgery ($p < .001$). Overall mean AOFAS scores increased from 58.9 ± 10.1 (range 42 to 68) before surgery to 82.8 ± 8.3 (range 66 to 92), 88.1 ± 6.8 (range 72 to 98), and 86.2 ± 10.3 (range 68 to 96) at 3 months, 1 year, and last follow-up, respectively (all $p < .001$).

In the FAI + AAI group, AOFAS scores increased from 52.6 ± 7.2 to 78.6 ± 8.2, 84.2 ± 6.4, and 83.6 ± 11.3 at 3 months, 1 year, and last follow-up, respectively ($p < .001$). In the FAI without AAI group, AOFAS scores increased from 64.3 ± 10.5 to 85.2 ± 8.6, 91.4 ± 7.9, and 90.2 ± 9.8 at 3 months, 1 year, and last follow-up, respectively ($p < .001$). Values were significantly lower in the FAI + AAI group compared with the FAI without AAI group, both pre- and postoperatively (Fig. 2).

After excluding the 24 cases with hypertrophic distal fascicle of the anteroinferior tibiofibular ligament, similar values for clinical parameters at the final follow-up were obtained in both groups (FAI + AAI 87.8 ± 7.9 versus FAI without AAI 90.2 ± 9.8; $p = .57$). AOFAS scores were lower in these 24 patients in comparison with the remaining subjects. In these 24 patients, AOFAS scores increased from 47.2 ± 6.1 before surgery to 70.2 ± 7.3 at 3 months, 73.5 ± 7.4 at 1 year, and 72.6 ± 9.3 at last follow-up; for the remaining patients, AOFAS scores increased from 54.7 ± 6.6 ($p = .056$ versus patients with hypertrophic distal fascicle) to 81.8 ± 8.2 ($p = .017$ versus patients with hypertrophic distal fascicle) at 3 months, 88.3 ± 7.6 ($p = .008$ versus patients with hypertrophic distal fascicle) at 1 year, and 87.8 ± 7.9 ($p = .014$ versus patients with hypertrophic distal fascicle) at last follow-up (Fig. 3).

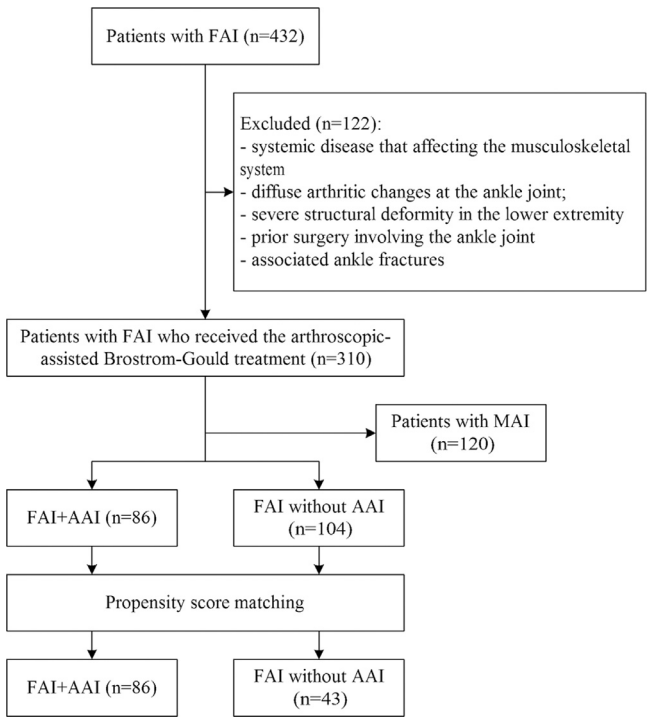

Fig. 1. Patient flowchart. AAI, anterior ankle impingement; FAI, functional ankle instability; MAI, mechanical ankle instability.

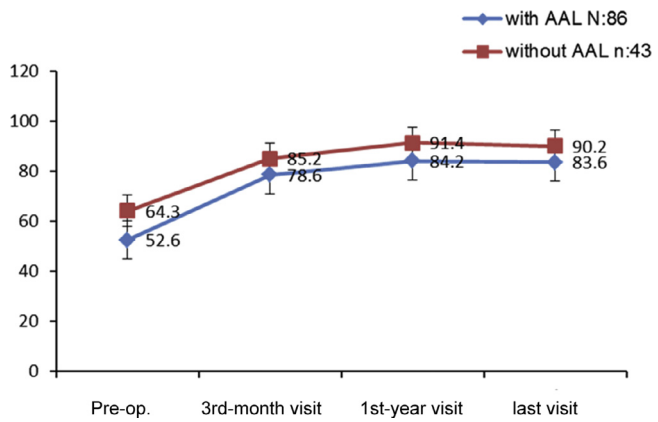

Fig. 2. Mean American Orthopaedic Foot and Ankle Society scores of cases with FAI and AAI (n = 86) and without AAI (n = 43) before and after surgery. AAI, anterior ankle impingement; FAI, functional ankle instability; preop, preoperatively.

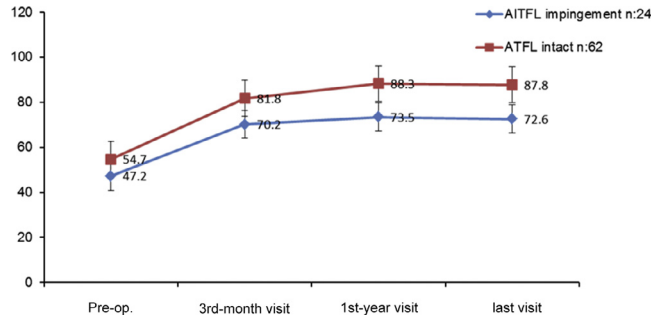

Fig. 3. Mean American Orthopaedic Foot and Ankle Society scores of cases with and without hypertrophic distal fascicle of the anteroinferior tibiofibular ligament pre- and postsurgery (all $p < .05$ between the 2 groups). AITFL, anteroinferior tibiofibular ligament; ATFL, anterior talofibular ligament.

Based on the Meislin criteria, the 3-month follow-up results were excellent, good, fair, and poor in 41 (31.7%), 49 (38.0%), 34 (26.3%), and 5 (3.8%) patients, respectively. The results at 1 year postoperatively were excellent in 72 (55.8%), good in 40 (31.0%), fair in 15 (11.6%), and poor in 2 (1.6%) patients. Final follow-up results were excellent, good, fair, and poor in 70 (54.3%), 39 (30.2%), 18 (14.0%), and 2 (1.6%) patients. Both groups showed similar values ($p = .38$).

Discussion

FAI can be manifested as multiple simultaneous ankle joint ailments. Along with lateral ligament complex insufficiency, several other secondary lesions, such as osteochondral lesions, intra-articular synovitis, loose bodies, and impingement lesions, have been described in such patients (21–24).These secondary pathologies could not account alone for some of the symptoms; they also affected the outcomes following surgery for lateral ligament insufficiency (24–26). Thus, understanding these associated pathologies is important to correlate the clinical findings, plan treatment, and accurately determine prognosis. Soft tissue impingement in the ankle's anterolateral gutter commonly occurs after 1 or repeated inversion injuries; however, it is often overlooked because of chronic pain (27–32). Its associations with ankle instability are largely unknown.

FAI and AAI are likely to be encountered together (5); however, how AAI affects ankle instability remains undefined. The current study aimed to compare FAI + AAI cases with those showing FAI without AAI after arthroscopic synovectomy combined with the modified Broström procedure. The results showed that patients with FAI with or without AAI had improved outcomes with arthroscopic synovectomy combined with the modified Broström procedure. Compared with FAI cases without AAI, those with both FAI and AAI had a relatively poorer outcome, probably because of hypertrophic distal fascicle of the anteroinferior tibiofibular ligament.

Multiple studies have reviewed AAI with related lesions in the unstable ankle (5–9,11). Most of them had relatively small sample sizes, however, with no direct comparison between FAI + AAI and FAI without AAI; therefore, how AAI impacts CAI remains unclear. As far as we know, this is the first report comparing FAI + AAI and FAI without AAI. In comparison with FAI cases without AAI, those with FAI and AAI had lower AOFAS scores both pre- and postoperatively.

In one of the largest case series published on the subject, Hintermann et al (15) found that intra-articular synovitis incidence was 32%. In the case series by Odak et al (6), a high incidence of intra-articular synovitis was observed (63%); in 43% of the patients, synovitis was localized in the anterior and/or anterolateral compartment of the tibiotalar joint. As a result, AAI is frequently neglected and mistaken for FAI. Patients with FAI may have vague complaints, but pain and a feeling of instability are often reported. There may be discomfort in the ankle or reduced dorsiflexion, but no ligamentous instability (32,33). This so-called functional instability is owing to soft tissue impingement, not true ligamentous instability (9).

The relationship between FAI and AAI remains unclear. Delahunt et al (4) attributed the ankle proprioception impairment to damaged joint capsule and ligaments (4). In contrast, Odak et al (6) suggested that ankle instability makes AAI develop, and that restoration of lateral ankle stability could prevent the further progression of intra-articular impingement and synovitis.

Description of surgical reconstruction for FAI cases with normal stress radiographic findings is relatively scarce (5,7–9). Takao et al (8) suggested that FAI is caused by impaired lateral ankle ligaments (8). Altan et al (5) performed arthroscopic synovectomy in 14 patients with FAI, improving long-term clinical outcomes compared with preoperative scores.

According to the present study, 84.5% of the patients achieved good to excellent scores >1 year postoperation, corroborating previous reports (5,7–9). Mean AOFAS scores increased postsurgery, indicating that the arthroscopic treatment is effective for FAI patients with or without AAI; synovitis excision and anterior talofibular ligament and scar tissue debridement promotes healing in the surrounding capsule (34).

Little is known about how AAI affects the clinical outcomes of FAI. Okuda et al (24) found that persistent ankle pain following repair of the lateral ligamentous complex likely results from intra-articular conditions. Nery et al (11) reported significantly worse outcomes in cases of chronic lateral ankle instability with concomitant AAI who had undergone soft tissue removal for anterior impingement, although a limited number of patients were involved (11). According to the present study, significantly decreased AOFAS scores were observed in cases with AAI compared with those without AAI both pre- and postoperatively, in agreement with previous studies (11,24). Interestingly, after excluding the 24 patients with hypertrophic distal fascicle of the anteroinferior tibiofibular ligament, both study groups presented comparable clinical outcomes, whereas AOFAS scores were significantly lower in these 24 patients compared with the remaining ones. This could be caused by chondral lesions on the anterolateral aspect of the talar dome or abnormal movement of the syndesmosis, which needs to be confirmed. Impingement by the anteroinferior tibiofibular ligament was first reported by Bassett et al (35), whose findings corroborate the results that impingement by the anteroinferior tibiofibular ligament is less common but has poor prognosis.

The present study is not without limitations. It was a retrospective study with the inherent biases and limitations; however, this was in part compensated with all procedures carried out by the same surgeon (X.W.) and postsurgery rehabilitation following the same protocol. Additionally, we used the propensity score matching strategy, which allows more objective and comparative evaluations. Nevertheless, sample size was relatively small and from a single center. Finally, follow-up was short. Additional studies are necessary to address these issues.

In conclusion, patients with FAI with or without AAI had improved outcomes when arthroscopic synovectomy was combined with the modified Broström procedure. In comparison with cases of FAI without AAI, those having FAI and AAI showed a relatively poorer outcome, probably because of hypertrophic distal fascicle of the anteroinferior tibiofibular ligament.

References

1. Watson AD. Ankle instability and impingement. Foot Ankle Clin 2007;12:177–195.
2. Brown C, Padua D, Marshall SW, Guskiewicz K. Individuals with mechanical ankle instability exhibit different motion patterns than those with functional ankle instability and ankle sprain copers. Clin Biomech 2008;23:822–831.
3. Delahunt E, Monaghan K, Caulfield B. Ankle function during hopping in subjects with functional instability of the ankle joint. Scand J Med Sci Sports 2007;17:641–648.
4. Delahunt E, Monaghan K, Caulfield B. Altered neuromuscular control and ankle joint kinematics during walking in subjects with functional instability of the ankle joint. Am J Sport Med 2006;34:1970–1976.
5. Altan E, Ozbaydar MU, Tonbul M, Senaran H, Temelli Y, Akalan E. Arthroscopic synovectomy in the treatment of functional ankle instability: outcomes and gait analysis. Eur J Orthopaed Surgery Traumatol 2015;25:189–197.
6. Odak S, Ahluwalia R, Shivarathre DG, Mahmood A, Blucher N, Hennessy M, Platt S. Arthroscopic evaluation of impingement and osteochondral lesions in chronic lateral ankle instability. Foot Ankle Int 2015;36:1045–1049.
7. Jeong BO, Kim TY, Song WJ. Effect of preoperative stress radiographic findings on radiographic and clinical outcomes of the modified Broström procedure for chronic ankle instability. J Foot Ankle Surg 2016;55:125–128.
8. Takao M, Innami K, Matsushita T, Uchio Y, Ochi M. Arthroscopic and magnetic resonance image appearance and reconstruction of the anterior talofibular ligament in cases of apparent functional ankle instability. Am J Sport Med 2008;36:1542–1547.
9. Kim SH, Ha KI. Arthroscopic treatment for impingement of the anterolateral soft tissues of the ankle. J Bone Joint Surg Br 2000;82:1019–1021.
10. Ajis A, Younger AS, Maffulli N. Anatomic repair for chronic lateral ankle instability. Foot Ankle Clin 2006;11:539–545.
11. 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 Sport Med 2011;39:2381–2388.

12. Lavery KP, McHale KJ, Rossy WH, Theodore G. Ankle impingement. J Orthopaed Surg Res 2016;11:97.
13. Moustafa El-Sayed AM. Arthroscopic treatment of anterolateral impingement of the ankle. J Foot Ankle Surg 2010;49:219–223.
14. Moustafa El-Sayed AM. Arthroscopic treatment of anterolateral impingement of the ankle. J Foot Ankle Surg 2010;49:219–223.
15. Hintermann B, Boss A, Schafer D. Arthroscopic findings in patients with chronic ankle instability. Am J Sport Med 2002;30:402–409.
16. Cho BK, Kim YM, Kim DS, Choi ES, Shon HC, Park KJ. Outcomes of the modified Broström procedure using suture anchors for chronic lateral ankle instability—a prospective, randomized comparison between single and double suture anchors. J Foot Ankle Surg 2013;52:9–15.
17. Ibrahim T, Beiri A, Azzabi M, Best AJ, Taylor GJ, Menon DK. Reliability and validity of the subjective component of the American Orthopaedic Foot and Ankle Society clinical rating scales. J Foot Ankle Surg 2007;46:65–74.
18. Kitaoka HB, Alexander IJ, Adelaar RS, Nunley JA, Myerson MS, Sanders M. Clinical rating systems for the ankle-hindfoot, midfoot, hallux, and lesser toes. Foot Ankle Int 1994;15:349–353.
19. Hassan AH. Treatment of anterolateral impingements of the ankle joint by arthroscopy. Knee Surg Sports Traumatol Arthrosc 2007;15:1150–1154.
20. D'Agostino Jr. RB. Propensity score methods for bias reduction in the comparison of a treatment to a non-randomized control group. Stat Med 1998;17:2265–2281.
21. Ferkel RD, Chams RN. Chronic lateral instability: arthroscopic findings and long-term results. Foot Ankle Int 2007;28:24–31.
22. Hua Y, Chen S, Li Y, Chen J, Li H. Combination of modified Broström procedure with ankle arthroscopy for chronic ankle instability accompanied by intra-articular symptoms. Arthroscopy 2010;26:524–528.
23. Kerkhoffs GM, Handoll HH, de Bie R, Rowe BH, Struijs PA. Surgical versus conservative treatment for acute injuries of the lateral ligament complex of the ankle in adults. Cochrane Database System Rev 2007;(2):CD000380.
24. Okuda R, Kinoshita M, Morikawa J, Yasuda T, Abe M. Arthroscopic findings in chronic lateral ankle instability: do focal chondral lesions influence the results of ligament reconstruction? Am J Sport Med 2005;33:35–42.
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.
26. Mardani-Kivi M, Mirbolook A, Khajeh-Jahromi S, Hassanzadeh R, Hashemi-Motlagh K, Saheb-Ekhtiari K. Arthroscopic treatment of patients with anterolateral impingementof the ankle with and without chondral lesions. J Foot Ankle Surg 2013;52:188–191.
27. Shane AM, Reeves CL, Vazales R, Farley Z. Soft tissue impingement of the ankle: pathophysiology, evaluation, and arthroscopic treatment. Clin Podiatr Med Surg 2006;33:503–520.
28. Buda R, Baldassarri M, Parma A, Cavallo M, Pagliazzi G, Castagnini F, Giannini S. Arthroscopic treatment and prognostic classification of anterior soft tissue impingement of the ankle. Foot Ankle Int 2016;37:33–39.
29. Zwiers R, Wiegerinck JI, Murawski CD, Fraser EJ, Kennedy JG, van Dijk CN. Arthroscopic treatment for anterior ankleimpingement: a systematic review of the current literature. Arthroscopy 2015;31:1585–1596.
30. Walsh SJ, Twaddle BC, Rosenfeldt MP, Boyle MJ. Arthroscopic treatment of anterior ankleimpingement: a prospective study of 46 patients with 5-year follow-up. Am J Sports Med 2014;42:2722–2726.
31. Mitev K, Mladenovski S, Kaftandziev I. Posttraumatic soft tissue impingement of the ankle: arthroscopic findings and surgical outcomes. Pril (Makedon Akad Nauk Umet Odd Med Nauki) 2014;35:237–242.
32. Thein R, Eichenblat M. Arthroscopic treatment of sports-related synovitis of the ankle. Am J Sport Med 1992;20:496–498.
33. Wolin I, Glassman F, Sideman S, Levinthal DH. Internal derangement of the talofibular component of the ankle. Sur Gynecol Obst 1950;91:193–200.
34. Groters S, Groen BE, van Cingel R, Duysens J. Double-leg stance and dynamic balance in individuals with functional ankle instability. Gait Posture 2013;38:968–973.
35. Bassett FH III, Gates HS III, Billys JB, Morris HB, Nikolaou PK. Talar impingement by the anteroinferior tibiofibular ligament. A cause of chronic pain in the ankle after inversion sprain. J Bone Joint Surg Am 1990;72:55–59.