The Journal of Foot & Ankle Surgery 58 (2019) 57–61

Contents lists available at ScienceDirect

The Journal of Foot & Ankle Surgery

journal homepage: www.jfas.org

Ankle Stabilization With Arthroscopic Versus Open With Suture Tape Augmentation Techniques

J. George DeVries, DPM, FACFAS[1], Brandon M. Scharer, DPM, FACFAS[1], Taylor A. Romdenne, BS, CCRP[2]

[1] *Foot and Ankle Surgeon, BayCare Clinic Orthopedics and Sports Medicine, Green Bay, WI*
[2] *Research Coordinator, Aurora Research Institute, Aurora Health Care, Milwaukee, WI*

A R T I C L E I N F O

Level of Clinical Evidence: 3

Keywords:
anchor
ankle instability
arthroscopy
arthrotomy
Broström
suture tape

A B S T R A C T

Ankle instability is a common problem that often leads to surgery to stabilize the ankle if conservative methods are unsuccessful in returning the patient to full activity. Surgical ankle stabilization, including arthroscopic and open methods, has been performed with overall excellent results reported. Although initial ligament strength after repair is weaker than the native ligament, new methods of augmentation with suture tape have yielded initial strength comparable to native ligament. The present study compares arthroscopic ankle stabilization and open stabilization with suture tape augmentation. A retrospective comparative trial was undertaken with a follow-up satisfaction survey. A total of 55 patients were ultimately included, consisting of 43 arthroscopic patients and 12 open with suture tape augmentation patients. Ancillary procedures are reported. The mean follow-up duration was 24.2 months in the arthroscopic group and 21 months in the open group. There was a statistically significantly faster return to activity/sports in the arthroscopic group (127.2 days vs 170 days; $p = .008$). Although not statistically significant, there was a trend toward favoring the open group in terms of revision surgery and patient satisfaction. Our data indicate that both methods of stabilization are reasonable for ankle instability repair.

Lateral ankle ligament injuries are among the most common sports injury and are even more common in nonathletic individuals (1). Among sports injuries, basketball and soccer injuries are the most common, at 45% and 31%, respectively (2). The most common mechanism of injury for an ankle sprain is inversion. The inversion mechanism is responsible for potential tear or rupture of the lateral ligaments, consisting of the anterior talofibular ligament (ATFL), posterior talofibular ligament, and calcaneofibular ligament. Injury to these ligaments can result in significant disability with competitive sporting activities and activities of daily living.

Acute ankle sprains are usually treated nonoperatively with a period of rest, ice, compression, elevation, and functional rehabilitation. When individuals have recurrent ankle sprains and instability following nonoperative treatment, the result is chronic lateral ankle instability, which can lead to significant functional disability. This can include multiple recurrent sprains, chronic ankle pain, falls that can lead to other injury, and cartilage damage that can lead to arthritis and deformity.

Surgical stabilization of the lateral ligaments has been reported with good to excellent results for both open and arthroscopic methods (3–5). Cottom et al (4) reported on 40 patients (40 ankles) who underwent an arthroscopic "all-inside" Broström procedure with a *preoperative* American Orthopaedic Foot and Ankle Society (AOFAS) score of 41.2 and a postoperative AOFAS score of 95.4. In 2015, Yoo and Yang (5) reported on arthroscopic stabilization with and without internal brace ligament augmentation in 85 patients (85 ankles). The 2 studies showed excellent results in both groups, with no significant difference at 24 weeks after surgery in terms of the AOFAS score but a significant increase in the rate of return to sports participation in the internal brace group. These reports, and most published literature, cover repair of the ATFL and sometimes the calcaneofibular ligament. The posterior talofibular ligament is rarely repaired and indeed is rarely injured.

The purpose of this study was to evaluate and compare the clinical results of arthroscopic ankle stabilization and open ankle stabilization with suture tape augmentation. We hypothesized that findings would be similar in the 2 groups.

Patients and Methods

Institutional review board approval was obtained for the study (approval no. 17-009E). A chart and radiographic review were performed in consecutive patients who

Financial Disclosure: None reported.

Conflict of Interest: J.G.D. and B.M.S. serve as consultants for Bioventus; T.A.R. reports no conflicts of interest.

Address correspondence to: J. George DeVries, DPM, FACFAS, BayCare Clinic Orthopedics and Sports Medicine, 501 N. 10th Str, Manitowoc 54220, WI

E-mail address: jdevries@baycare.net (J.G. DeVries).

1067-2516/$ - see front matter
https://doi.org/10.1053/j.jfas.2018.08.011

underwent Broström ankle stabilization with either an arthroscopic technique or an open technique augmented with a suture tape brace from fibula to talus between July 17, 2014, and June 20, 2016. Patients were identified by a medical records search of patients who underwent a procedure under Current Procedure Terminology code 27695 or 27698. A review of patient charts categorized the patients in the appropriate groups. Inclusion criteria included clinical diagnosis of functional or structural ankle instability; failure of conservative measures; adjunctive procedures, including ankle arthroscopy, osteochondral defect (OCD) microfracture, peroneal tendon work (e.g., debridement, repair, retinacular repair), and syndesmotic stabilization; and complete chart and satisfaction information. These adjunctive procedures were included because they are routinely performed in conjunction with ankle stabilization and did not affect the postoperative protocol. Exclusion criteria included lack of sufficient chart information, revision surgery, and inability to contact the patient or obtain a patient satisfaction survey. Adjunctive procedures other than the foregoing also excluded patients from the study.

After identification of patients, a prospective patient satisfaction phone call was made by a clinical research coordinator (T.A.R.), an author not involved with the surgeons, patients, or practice. A script was read, and the patient was asked to classify his or her satisfaction as "very satisfied," "satisfied," "somewhat satisfied," or "not satisfied," as has been described previously (6,7). This was response then converted to a numerical score as 4, very satisfied; 3, satisfied; 2, mildly satisfied; or 1, not satisfied.

Surgical Technique

All operations were performed by 1 of 2 authors (J.G.D. and B.M.S.). In all cases, arthroscopy was used with standard anteromedial and anterolateral portals, and arthroscopic inspection and debridement, and, if necessary, microfracture of an OCD were performed. Noninvasive distraction was used in all cases.

The technique used for arthroscopic Broström ankle stabilization was consistent with previous reports (4,8). After arthroscopic treatment of intra-articular pathology, the anterior surface of the fibula was debrided down to bone, with exposure of the distal tip. Two 3.0-mm anchors were then placed approximately 1 cm proximal to the distal tip of the fibula and just below the ankle joint articular surface (Fig. 1). The attached sutures were then passed from the fibula out through the ATFL and inferior extensor retinaculum and through the skin in a space between the intermediate dorsal cutaneous nerve and the peroneal tendons. An accessory skin portal was then made at this level, through which the sutures were pulled from the exit point in the skin (Fig. 2). The ankle was then taken out of noninvasive distraction, and the sutures were tied down to secure the ligament repair and retinacular reinforcement. Initial stability was confirmed by clinical examination, the portals were primarily closed, and the patient was placed initially into a nonweightbearing plaster splint.

For an open Broström ankle stabilization with suture tape augmentation, the ankle was taken out of noninvasive distraction and the thigh holder and then placed supine on the table. A 4- to 5-cm incision parallel and superior to the peroneal tendons was made. Careful dissection was taken down to the ankle joint capsule, with care taken to preserve the inferior extensor retinaculum, and arthrotomy of the ankle joint capsule, including the remnant of the ATFL, was performed. The anterior surface of the fibula was debrided of soft tissue, and two 3.0-mm anchors were placed below the ankle joint. The ATFL and inferior extensor retinaculum were then repaired to the anterior surface of the fibula with the ankle held in neutral dorsiflexion and slight eversion. The fibular periosteum was then repaired over this repair. After completion of the Broström ankle stabilization, an anchor and suture tape system were placed over the capsule and repair, through the periosteum of the fibula and lateral talus (Fig. 3). The fibular anchor was placed first, then the anchor was placed anterior to the lateral articular surface of the talus, and with a hemostat placed under the suture tape, insertion of the talar anchor secured the suture tape augmentation. The ankle was held in neutral dorsiflexion during the insertion. Initial stability was confirmed by clinical examination, the incision was primarily closed, and the patient was placed initially into a non-weightbearing plaster splint.

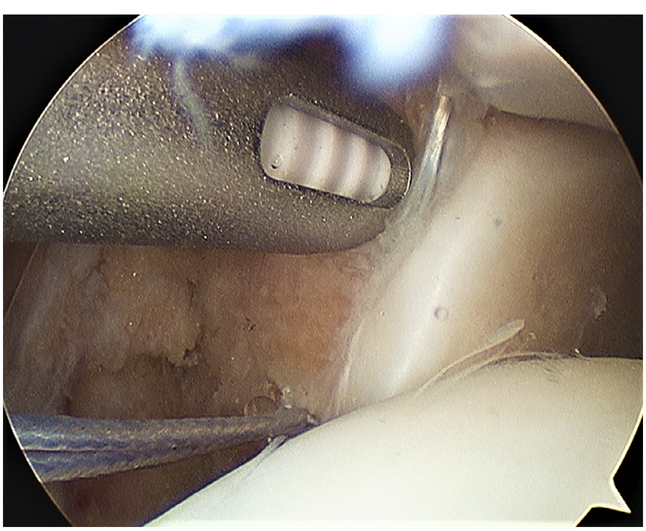

Fig. 1. Arthroscopic image of the anterior surface of the fibula cleared of soft tissue and placement of the anchors for arthroscopic Broström ankle stabilization. One anchor is placed approximately 1 cm proximal to the tip of the fibula, and another anchor is placed at or below the ankle joint line.

Fig. 2. Intraoperative clinical picture showing the sutures attached to the fibular anchors passed from the fibula and through the anterior talofibular ligament, inferior extensor retinaculum, and skin between the intermediate dorsal cutaneous nerve and the peroneal tendons. An accessory portal is then created, through which the sutures are pulled before tying down the repair.

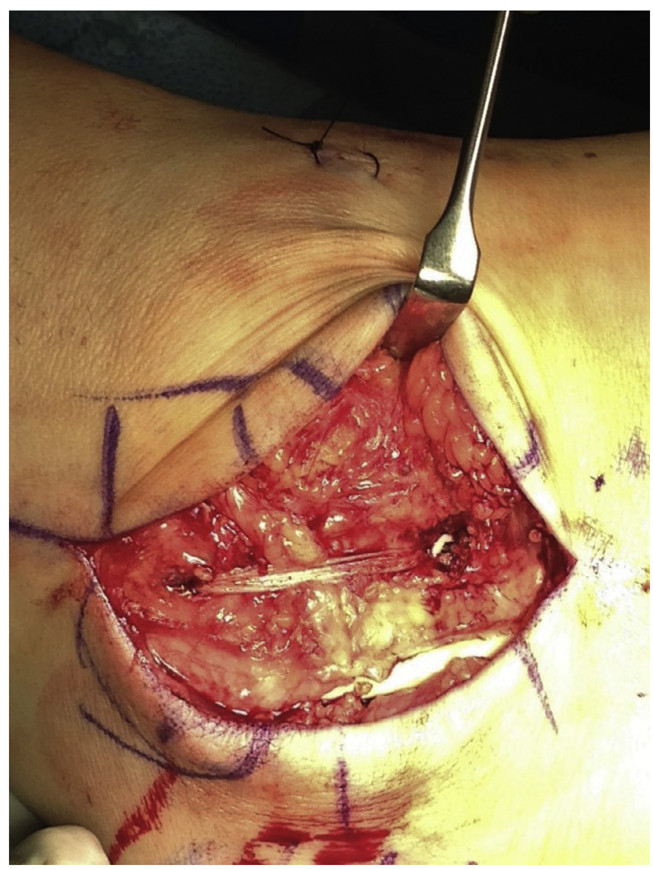

Fig. 3. Open Broström ankle stabilization augmented with suture tape. The typical Broström ankle stabilization has been performed, attached with anchors to the fibula. After this repair, a supracapsular reinforcement is performed with suture tape anchored from the fibula into the talus.

The postoperative protocol for both groups included 2 weeks of non-weightbearing in the splint. The patient was then allowed to perform weightbearing and range-of-motion exercises for 1 month in a controlled ankle motion walking boot. At approximately 6 weeks after surgery formal physical therapy was started, along with a transition into an ankle brace and regular shoes. Physical therapy was typically twice per week for 6 weeks or until goals were met. The ankle brace was used for all weightbearing for 1 month and thereafter only during sports and high-impact or high-risk activity.

Demographic data recorded by chart review included age, sex, height, weight, body mass index (BMI), past medical history (including arthritis, rheumatoid arthritis, obesity [defined as BMI ≥30], coronary artery disease, hypertension, hypothyroidism, and diabetes), and social history (including tobacco dependence, alcohol abuse, or illegal drug use) at the time of the procedure. Procedure information included side of surgery, type of surgery, and all adjunctive procedures. Recovery included time to weightbearing in a boot and then in a brace, time to wearing normal shoes, and time to return to activity/sports. Complications and treatment were recorded as well. The satisfaction score obtained by phone interview was recorded and converted to a numerical score, and the date of the survey served as the total follow-up time.

Statistical analysis was performed to compare the arthroscopic group and open with suture tape augmentation ankle stabilization group by 1 of the authors (J.G.D.). The datasets were tested for normality using the Kolmogorov–Smirnov test, which found a normal distribution for age and BMI and a non-normal distribution for time to weightbearing in a boot, time to weightbearing in a brace, time to return to sports/activity, follow-up time, and satisfaction in both groups. Categorical data (e.g., sex, side, adjunctive procedures, medical history, social history) was compared between the 2 groups using Fisher's exact test. The non-normally distributed continuous variables of time to weightbearing in a boot, time to weightbearing in a brace, time to return to sports/activity, follow-up time, and satisfaction were recorded as mean ± standard deviation and range and were compared between the 2 groups using the 2-tailed Mann–Whitney *U* test. For normally distributed variables, age and BMI were recorded as mean ± standard deviation and range and were compared in the 2 groups using the 2-tailed unpaired Student's *t* test. Statistical significance was set at $p \leq .05$. Statistical analysis was performed using Excel (Microsoft, Redmond, WA).

Results

The final study group consisted of 55 patients. A total of 115 patients were identified to have undergone Broström ankle stabilization during the study period. Of these, 39 patients could not be contacted for the satisfaction survey, and 7 patients who were contacted did not complete the survey. Of the remaining patients, 12 were excluded because of adjunctive procedures (metatarsal or calcaneal osteotomy, fracture repair, or total ankle replacement), and 2 in the open group were excluded because suture tape augmentation was not used. This left a total of 55 patients in the study group, including 43 in the arthroscopic group and 12 in the open with augmentation group.

The arthroscopic group had a mean patient age of 44.7 ± 13.2 (range 16 to 69) years, with 16 males (37.2%) and a mean BMI of 34.2 ± 6.5 (range 18.9 to 48.0). In comparison, the open group with augmentation had a mean age of 39.5 ± 16.0 (range 17 to 64) years, with 6 males (50%) and a mean BMI of 33.1 ± 6.4 (range 23.4 to 47.7). The arthroscopic group had 32 (74.4%) patients with a BMI ≥30, 4 (9.3%) patients with diabetes, and 7 (16.3%) current smokers. This compares to the open group with augmentation that had 8 (66.7%) patients with BMI ≥ 30, no diabetic patients, and 1 (8.3%) current smokers. None of these between-group differences was statistically significant (Table 1).

Table 1
Patient demographic data and medical history

Variable	Arthroscopic (n = 43)	Open (n = 12)	*p* Value
Age, y, mean ± SD	44.7 ± 13.2	39.5 ± 16.0	.32
Male sex, n (%)	16 (37.2)	6 (50)	.51
BMI, mean ± SD	34.2 ± 6.5	33.1 ± 6.4	.62
Obesity (BMI ≥30), n (%)	32 (74.4)	8 (66.7)	.72
Diabetes, n (%)	4 (9.3%)	0 (0%)	.57
Tobacco dependence, n (%)	7 (16.3%)	1 (8.3%)	.67

Abbreviations: BMI, body mass index; SD, standard deviation.
All categorical variables were compared using the 2-tailed Fisher's exact test; all continuous variables were compared using the 2-tailed unpaired *t* test.

The procedures were completed on the right ankle in 23 (53.5%) patients in the arthroscopic group and in 5 (41.7%) patients in the open group. All patients underwent concomitant ankle arthroscopy. Ancillary procedures in the arthroscopic group included 14 (32.6%) OCD microfracture procedures, 16 (37.2%) procedures involving peroneal work, and 3 (7.0%) syndesmotic stabilizations. In the open group, there were 3 (25.0%) OCD microfractures, 6 (50.0%) peroneal procedures, and 1 (8.3%) syndesmotic stabilization (Table 2).

Postoperative follow-up for both groups evaluated return to activity, complications, and satisfaction. The mean duration of follow-up at the satisfaction survey was 737.1 ± 233.5 days (24.2 ± 7.7 months; range 342 to 1041 days) in the arthroscopic group and 637.8 ± 217.0 days (21.0 ± 7.1 months; range 358 to 960 days) in the open group, with no statistically significant difference between the groups ($p = .17$). The arthroscopic group had a mean time to weightbearing in a boot (41 patients) of 21.5 ± 7.6 (range 7 to 34) days, time to weightbearing in a brace (37 patients) of 41.8 ± 7.6 (range 25 to 63) days, and time to return to sports/activity (35 patients) of 127.2 ± 96.3 (range 53 to 569) days). The open group with augmentation had a mean time to weightbearing in a boot (12 patients) of 20.3 ± 9.4 (range 11 to 41) days, time to weightbearing in a brace (12 patients) of 45.2 ± 7.8 (range 41 to 62) days, and time to return to sports/activity (9 patients) of 170.7 ± 66.4 (range 56 to 174) days. There was a statistically significant difference between the groups only in the time to return to sports/activity ($p = .008$). The arthroscopic group had a total of 6 complications (14%), 5 of which necessitated a return to the operating room (11.6%; 3 for revision, 1 for open Broström, and 1 for wound debridement), and 1 superficial infection treated with oral trimethoprim-sulfamethoxazole. The open group had 2 (16.7%) complications, neither of which required surgery and were treated with oral corticosteroids in a case of peroneal tendinitis and oral cephalexin in a case of mild superficial infection. After converting the answers to the satisfaction phone survey into numerical values of 1 to 4, the mean satisfaction score was 3.04 ± 1.02 for the arthroscopic group and 3.58 ± 0.51 for the open group, with no statistically significant difference between the groups ($p = .17$) (Table 3).

Discussion

Historically, the open modified Broström operation has been the gold standard procedure, with good to excellent results (9,10). In recent years, the arthroscopic approach has become more widely used and researched.

Lee et al (11) reviewed 28 ankles that underwent joint arthroscopy with concomitant open Broström–Gould stabilization and reported a frequency of 7% to 100% for associated intra-articular pathological features. Of the 28 ankles reviewed, 100% were found to have some degree of synovitis. Other pathological features were talar dome OCDs in 2 (7%), talar dome fibrillation in 7 (30%), loose bodies in 3 (11%), Bassett's lesion in 2 (7%), anterolateral impingement in 4 (14%), and distal anterior tibial spurring in 4 (14%). Hintermann et al (12) reported similar findings in 148 patients with intra-articular pathological features associated with lateral ankle instability and found cartilage damage in 66%

Table 2
Surgical information

Variable	Arthroscopic (n = 43)	Open (n = 12)	*p* Value
Right side, n (%)	23 (53.5)	5 (41.7)	1
Ankle arthroscopy, n (%)	43 (100)	12 (100)	1
Osteochondral defect microfracture, n (%)	14 (32.6)	3 (25)	.74
Peroneal work, n (%)	16 (37.2)	6 (50)	.51
Syndesmotic stabilization, n (%)	3 (7)	1 (8.3)	1

All variables were compared using the 2-tailed Fisher's exact test.

Table 3
Follow-up and outcomes

Variable	Arthroscopic (n = 43)	Open (n = 12)	*p* Value
Follow-up, d, mean ± SD	737.1 ± 233.5	637.8 ± 217.0	.17
Time to weightbearing in boot, d, mean ± SD	21.5 ± 7.6	20.3 ± 9.4	.31
Time to weightbearing in brace, d, mean ± SD	41.8 ± 7.6	45.2 ± 7.8	.76
Return to sports/activity, d, mean ± SD	127.2 ± 96.3	170.7 ± 66.4	.008
Complications, n (%)	6 (14)	2 (16.7)	1
Revision surgery, n (%)	5 (11.6)	0 (0)	.57
Satisfaction, mean ± SD	3.04 ± 1.02	3.58 ± 0.51	.17

Abbreviation: SD, standard deviation.
All categorical variables were compared using the 2-tailed Fisher's exact test; all continuous variables were compared using the 2-tailed unpaired Mann-Whitney *U* test.

of their patients. These 2 studies concluded that arthroscopic inspection is necessary owing to the high incidence of concomitant intra-articular pathology.

Several studies have reported clinical results of arthroscopic stabilization. Nery et al (13) reported the long-term results of arthroscopic ankle stabilization in 38 patients with a mean follow-up of 9.8 years. The mean AOFAS score was 90, with only 1 patient requiring reoperation. Corte-Real et al (14) also showed similar results in 31 patients with a mean follow-up of 24.5 months and a mean AOFAS score of 94.4. Based on these and other studies, arthroscopic stabilization appears to be an effective repair with good to excellent results.

Lee et al (15) reported that there was no significant difference in torque to failure between the open and arthroscopic modified Broström operation through a biomechanical study of 11 human cadaveric specimens. However, Waldrop et al (16)reported that an ATFL with the standard Broström repair to be at least 50% weaker than the native ATFL at time 0. In comparison, Viens et al (17) reported that Broström repair with suture tape augmentation had comparable strength and stiffness to intact ATFL in a cadaveric model. These results have spurred the increased use of suture tape to more closely mimic the strength of the native ATFL.

Some previous studies have reported that earlier mobilization did not increase complications such as joint laxity and actually helped improve patient outcomes (18–20). Karlsson et al (18,19) noted that athletes who underwent earlier mobilization after an anatomic lateral ankle ligament procedure were able to return to sporting activities earlier and had a quicker return of plantarflexion compared with patients who were fully immobilized postoperatively. This would suggest that the stronger the repair, the earlier that functional rehabilitation can occur. Yoo and Yang (5) compared arthroscopic modified Broström procedures with and without suture tape augmentation and found a quicker return to activity and sports in the patients in the internal brace group.

Two recent comparisons of open and arthroscopic repairs have been reported in the literature. Rigby and Cottom (21) compared a similar arthroscopic repair as reported here with a traditional open repair. Their 62 patients included 32 patients in the traditional open repair group and 30 in the arthroscopic repair group. There was no statistically significant between-group difference in functional or satisfaction outcome scores, but earlier weightbearing was seen in the arthroscopic repair group. This differs from our present study, in which we used an internal augmentation to the open repair, which may explain our finding of no difference in time to weightbearing. A systematic review including 505 open repairs and 216 arthroscopic repairs indicated that although the complication rate may be higher with arthroscopic repairs, but this did not affect efficacy or patient satisfaction (22).

Our results show that the patients who underwent open stabilization with augmentation had less surgical revisions compared with the arthroscopic group. Although the between-group difference in overall complication rate was not statistically significant, 5 patients in the arthroscopic group needed revision (4 performed and 1 planned at the time of this study), for a rate of 11.6%. In contrast, there were no revisions in the open group with augmentation ($p = .57$). Similarly, the difference in patient satisfaction was not statistically significant but trended toward favoring the open repair group, with a numerical value of 3.04 for arthroscopic repair and 3.58 for open with suture tape augmentation ($p = .17$). Even though the differences between the 2 groups were insignificant, based on studies mentioned previously, stabilization with suture tape augmentation is a much stronger construct, as likely will be demonstrated in our patient cohort with future follow-up results. This may come at a cost of decreased return to activity, however. We found a statistically significantly mean faster return to full activity/sports in the arthroscopic group (127 days vs 170 days; $p = .008$). This may demonstrate the preservation of tissues with the arthroscopic approach.

This study has several limitations. The number of cases was relatively small, and this was a retrospective review. With the small patient cohort, we were able to identify trends but found no statistically significant differences in several outcome measures, thus making it difficult to draw conclusions. Moreover, an objective comparative functional examination was not performed postoperatively, but instead patients' subjective reports of function were recorded. In addition, the patient volume differed significantly between the 2 groups, and random selection was not performed. Additional randomized comparative prospective studies are needed.

In conclusion, both the arthroscopic and open with suture tape augmentation stabilization techniques are effective approaches for surgical treatment of chronic lateral ankle instability. Our results demonstrate that arthroscopy remains an effective and reliable procedure even with the increased popularity of suture tape augmentation. Although the suture tape strength is clearly superior, the question is whether it is needed in the long term to prevent reoperation.

References

1. Waterman BR, Owens BD, Davey S, Zacchilli MA, Jr Belmont PJ. The epidemiology of ankle sprains in the United States. J Bone Joint Surg Am 2010;20:2279–2284.
2. Garrick J. The frequency of injury, mechanism of injury, and epidemiology of ankle sprains. Am J Sports Med 1977;5:241–242.
3. Hamilton WG, Thompson FM, Snow SW. The modified Brostrom procedure for lateral ankle instability. Foot Ankle 1993;14:1–7.
4. Cottom JM, Rigby RB. The “all inside” arthroscopic Brostrom procedure: a prospective study of 40 consecutive patients. J Foot Ankle Surg 2013;25: 568–574.
5. Yoo JS, Yang EA. Clinical results of an arthroscopic modified Brostrom operation with and without internal brace. J Orthopaed Traumatol 2016;17: 353–360.
6. Heerspink FOL, Verburg H, Reininga IHF, van Raaji TM. Chevron versus Mitchell osteotomy in hallux valgus surgery: a comparative study. J Foot Ankle Surg 2015;54:361–364.
7. Scharer BM, DeVries JG. Comparison of chevron and distal oblique osteotomy for bunion correction. J Foot Ankle Surg 2016;55:738–742.
8. Acevedo J, Mangone P. Arthroscopic lateral ankle ligament reconstruction. Tech Foot Ankle Surg 2011;10:111–116.
9. Cox JS. Surgical and nonsurgical treatment of acute ankle sprains. Clin Orthop Relat Res 1985;198:118–126.
10. Gould N, Seligson D, Gassman J. Early and late repair of lateral ligament of the ankle. Foot Ankle 1980;1:84–89.
11. 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;4:284–289.
12. Hintermann B, Boss A, Schafer D. Arthroscopic findings in patients with chronic ankle instability. Am J Sports Med 2002;30:402–409.

13. Nery C, Raduan F, Del Buono A, Asaumi ID, Cohen M, Maffulli N. Arthroscopic-assisted Brostrom-Gould for chronic ankle instability: a long term follow-up. Am J Sports Med 2011;39:2381–2388.
14. Corte-Real NM, Moreria RM. Arthroscopic repair of chronic lateral ankle instability. Foot Ankle Int 2009;30:213–217.
15. Lee KT, Lee JI, Sung KS, Kim JY, Kim ES, Lee SH, Wang JH. Biomechanical evaluation against calcaneofibular ligament repair in the Brostrom procedure: a cadaveric study. Knee Surg Sports Traumatol Arthosc 2008;16:781–786.
16. Waldrop NE 3rd, Wijdicks CA, Jansson KS, LaPrade RF, Clanton TO. Anatomic suture anchor versus the Brostrom technique for anterior talofibular ligament repair: a biomechanical comparison. Am J Sports Med 2012;40:2590−2596.
17. Viens NA, Wijdicks CA, Campbell KJ, Laprade RF, Clanton TO. Anterior talofibular ligament ruptures, part 1: biomechanical comparison of augmented Brostrom repair techniques with the intact anterior talofibular ligament. Am J Sports Med 2014;42:405–411.
18. Karlsson J, Lundin O, Lind K, Styf J. Early mobilization versus immobilization after ankle ligament stabilization. Scand J Med Sci Sports 1999;9:299–303.
19. Karlsson J, Rundholm O, Bergsten T. Faxén E, Styf J. Early range of motion training after ligament reconstruction of the ankle joint. Surg Sports Traumatol Arthrosc 1995;3:173–177.
20. Kirk K, Campbell J, Guyton G, Parks B, Schon L. ATFL elongation after Brostrom procedure: a biomechanical investigation. Foot Ankle Int 2008;29:1126–1130.
21. Rigby RB, Cottom JM. A comparison of the “all-inside” arthroscopic Brostrom procedure with the traditional open modified Brostrom-Gould technique: a review of 62 patients. Foot Ankle Surg 2018 Feb 5. https://doi.org/10.1016/j.fas.2017.07.642. [Epub ahead of print].
22. Guelfi M, Zamperetti M, Pantalone A, Usuelli FG, Salini V, Oliva XM. Open and arthroscopic lateral ligament repair for treatment of chronic ankle instability: a systematic review. Foot Ankle Surg 2018;24:11–18.