Revision lateral ankle ligament reconstruction for patients with a failed modified Brostrom procedure

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Abstract

Purpose: The Brostrom-Gould procedure has been considered as a gold standard operative technique for chronic lateral ankle instability. Despite the popularity and excellent outcomes of the modified Brostrom procedure, some patients still experience recurrence of ankle instability. Few studies reported outcomes of revision reconstruction for patients with a failed modified Brostrom procedure. This study aimed to evaluate the outcomes of a percutaneous anatomic revision lateral ankle ligament reconstruction for patients with a failed modified Brostrom procedure.

Methods: From March 2017 to April 2020, 21 patients with persistent ankle instability after a modified Brostrom procedure underwent revision lateral ankle ligament reconstruction. The operation was performed through minimally invasive incisions. Functional assessment was performed using the Karlsson-Peterson ankle scoring system (KP) and the Visual Analogue Scale (VAS). The questionnaires of KP and VAS were completed before surgery and at the last follow-up. Patients’ subjective satisfaction level was graded as excellent, good, fair, and poor. Preoperative and postoperative anterior talar displacement and varus talus tilt angle in stress radiographs were recorded.

Results: The average age at the revision surgery time was 39.6 years. The mean follow-up was 39.2 months. The VAS score improved from 4.1 ± 1.5 preoperatively to 1.3 ± 1.3 at the final follow-up (p < .05). The KP score improved from 59.0 ± 20.2 preoperatively to 88.2 ± 9.6 at the last follow-up (p < .05). The mean varus talus tilt angle was 14.1 ± 3.9 mm preoperatively versus 4.9 ± 4.7 mm at the final follow-up (p < .05). The mean anterior talar displacement was 12.8 ± 2.2 mm versus 5.6 ± 3.7 mm at the last follow-up (p < .05).

Conclusions: The revision anatomic reconstruction of the lateral ligaments of the ankle is effective for patients with recurrent instability after a failed modified Broström procedure.

Keywords
Ankle instability, lateral ankle ligament reconstruction, revision surgery, modified Broström procedure

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Introduction

Ankle sprain is one of the most common musculoskeletal injuries, usually involving the lateral ligament complex. It should be routinely treated nonoperatively, with an 80–90% success rate. Despite the success rate of nonoperative treatment, the other patients eventually required surgical treatment to restore the instability of the ankle. Broström
procedure and modified Broström procedure, known as anatomical surgical procedures, were widely used for chronic lateral ankle instability. The Brostrom-Gould procedure has been considered as an effective and anatomical repair for chronic lateral ankle instability. However, recurrent instability can occur after a modified Brostrom procedure. It is a challenging problem to treat recurrent instability because of the poor quality of residual tissue, scar, adhesion, and high requirement of patients.

Few studies reported outcomes of revision reconstruction for patients with a failed modified Brostrom procedure. We used a semitendinuous allograft ligament and Tightrope system to reconstruct the lateral ankle ligament. The purposes of this study were to evaluate the outcomes of lateral ankle ligament reconstruction as a treatment for failed modified Brostrom procedure and to investigate the risk factors of the failure of initial lateral ankle ligament repair.

**Methods**

This was a retrospective study carried from March 2017 to April 2020. Approval for this study was obtained from our hospital’s institutional review board. All the operations were performed by one surgeon (the senior author). A total of 21 patients with persistent ankle instability after a modified Brostrom procedure underwent revision lateral ankle ligament reconstruction.

The criteria for inclusion in this study were (1) previous failed Modified Brostrom procedure, (2) persistent symptoms like pain, giving way. We identified the failure of initial modified Brostrom surgery as persist pain, giving way, and recurrent ankle sprain after first surgery for more than 6 months. The criteria for exclusion in this study were (1) ankle fracture, (2) with other ankle surgeries such as osteotomy, (3) with osteochondral lesions or synovitis on the preoperative MRI, (4) obvious ankle arthritis, (5) ankle instability with cavovarus deformity.

Functional assessment was performed using the Karlsson–Peterson ankle scoring system (KP) and the Visual Analogue Scale (VAS). The questionnaires of KP and VAS were completed before surgery and at the last follow-up. Patients’ subjective satisfaction level was graded as excellent, good, fair, and poor. Stress radiographs were taken under a TELOS stress device. Preoperative and postoperative anterior talocalcaneal angles were recorded.

**Surgical technique**

A total of 20 patients underwent a concomitant arthroscopic synovectomy or debridement. A small incision (5 mm) was made at the anterior aspect of the tip of the distal fibular. A guide pin was inserted from the anterior inferior of the lateral malleolus to the posterior of the fibular about 2–3 cm away from the tip of the distal fibular. There was a fossa on the anterior aspect of the lateral malleolus. It was the attachment point of ATFL and CFL. We used it as the landmark for the entry of bone tunnel. Another 5 mm incision was made at the penetrating site of the guide pin behind the fibular. Then a 4.5 mm in diameter drill ran along with the guide pin. Another two guide pins were placed at the desired position in the neck of the talus and calcaneus. Two small incisions were made before this procedure. The intraoperative fluoroscopy was used to confirm the locations of two pins. Two 7 mm tunnels were created at the neck of the talus and calcaneus using a 7 mm drill in diameter.

We used a semitendinuous allograft ligament and Tightrope system (ACL TightRope® RT, Arthrex, USA) to reconstruct the anterior talofibular ligament and calcaneofibular ligament at the same time. The allograft was trimmed to 13–15 cm in length according to the height of the patient and went through the fibular tunnel using the Tightrope system. The two free ends of the allograft were stitched by a nonabsorbable 2-0 suture. With the ankle and foot in the neutral position, two free ends of allograft passed through tunnels of the talar neck and calcaneus. Each end was fixed by 7 mm × 23 mm biodegradable interference screws (BioComposite Interference Screw, Arthrex, USA). The locations of bone tunnels and cortical button were examined under intraoperative fluoroscopy (Figures 1 and 2).

**Postoperative management**

All ankles were immobilized by U-shape plaster postoperatively immediately. Isometric contraction of the ankle was permitted 1 day after surgery. Two weeks postoperatively, a boot was recommended to support the ligament reconstruction. With the protection of the boot, patients were permitted partial weight-bearing. Full weight-bearing was allowed 6 weeks after the operation. Jogging and swimming were allowed 12 weeks postoperatively. Running and riding were permitted half a year after surgery.

**Statistical methods**

All analyses were performed with SPSS version 20 for Windows (IBM, NY, USA). The chi-square test was used for comparison of categorical data. The Shapiro-Wilk test was used to verify whether the data met the assumptions of a parametric test. The differences between the pre- and postoperative clinical and functional outcomes were analyzed using the Wilcoxon test because of the non-parametric
distribution of data. Numerical results were presented as the mean and standard deviation. Significance was set at $p < .05$.

Results

The study group comprised 11 males and 10 females. The average age at the revision surgery time was 39.6 years (range, 17–57). The mean follow-up was 39.2 months (range, 24–61). The average BMI was 25.5 (23.8 female and 27.4 male). The average time from the first ankle sprain or the first appearance of symptoms to the first modified Brostrom surgery was 5.5 years (range, 1–18). The average time from the first surgery to the revision operation was 29 months (range, 6–120). The VAS score improved from 4.1 ± 1.5 preoperatively to 1.3 ± 1.3 at the final follow-up ($p < .05$). The KP score improved from 59.0 ± 20.2 preoperatively to 88.2 ± 9.6 at the last follow-up ($p < .05$). The mean varus talar tilt angle was 14.1 ± 3.9 mm preoperatively versus 4.9 ± 4.7 mm at the final follow-up ($p < .05$). The mean anterior talar displacement was 12.8 ± 2.2 mm versus 5.6 ± 3.7 mm at the last follow-up ($p < .05$).

Most patients’ first surgeries (18 patients) were minimally invasive, and suture anchors were used in 12 patients to strengthen the repair. None of the patients had osteochondral lesions of the talus. Only one patient had an ankle sprain history before the revision surgery. Seventeen patients were satisfied (excellent or good) with the surgery. The fair results occurred in three patients who complained of limited mobility of the ankle joints. The poor result occurred in one patient with soft tissue irritation from the button.

![Figure 1](image1). Schematic drawing of the lateral ankle ligament reconstruction method.

![Figure 2](image2). Intraoperative photos of percutaneous lateral ankle ligament reconstruction. (a) The fibular tunnel was located and created. (b) The allograft went through the fibular tunnel using the Tightrope system. (c) The minimally invasive 4 incisions. (d) Sutured incisions.
All patients returned to their normal sports activities. However, there were restrictions on the four patients with fair or poor results of strenuous exercises like running and climbing.

**Discussion**

The Brostrom procedure is an anatomical repair of the lateral ligaments. Despite nonoperative treatment working for most patients with ankle sprain, it is promising for patients who have rupture of lateral ligaments and chronic ankle instability. Bell et al. reported that the long-term results of the Broström procedure for chronic ankle instability are excellent with a 26-year follow-up. A study done by Li et al. in which they used suture anchors to perform a variant of the Gould-modified Broström procedure showed effective outcomes in high-demand athletes.

Although the modified Broström procedure yielded effective outcomes in chronic ankle instability, we still encountered recurrence of instability in clinical practice occasionally. So and his colleagues reviewed 11 studies including 669 Brostrom Gould procedures. Only 1.2% required revision surgeries. Failure of the primary Brostrom Gould procedure may lead to recurrent instability. Petera et al. reported a 6% failure rate of the Modified Broström procedure. Although none of the patients required revision surgery, all of them did not return to their index sports.

The causes of failure of lateral ankle ligament repair or reconstruction were various. Long-standing ligamentous insufficiency, poor quality of remnant ligament tissue, poor previous surgery technique, generalized joint hypermobility, and high body weight and varus deformity of foot were poor prognostic factors of the Broström procedure. Another trauma and poor patient compliance can also fail reconstruction. However, it was hard to evaluate the previous surgery technique and ligament condition. In this study, the average time from the first ankle sprain or the first appearance of symptoms to the first surgery was 5.5 years. The long history of ankle sprain and recurrent injury may lead to weakness and insufficiency of the lateral ankle ligament, which makes it hard to suture the ATFL ligament directly. The mean BMI of the male patients was obviously higher than that of the females (p = .02). Eight male patients’ BMI were more than 25, including five patients with more than 28. On the other hand, there were five female patients with a Beighton score equal or more than 4 points. However, in the male group, this number was only one patient (p = .038) (Generalized ligamentous laxity was defined as a Beighton score equal or more than 4 points). We considered that male patients with an initial failed modified Broström procedure were more likely to have the risk factor of high body weight, whereas female patients tended to have the risk factor of generalized ligamentous laxity. All in all, the causes of failure of the modified Broström procedure are numerous and various. It is crucial to identify the risk factors when repairing the lateral ankle ligament. Otherwise, this procedure would probably fail.

Lateral ankle ligament reconstruction using tendon allograft could get increased ankle stability and clinical and functional outcomes. In this study, the revision lateral ankle ligament reconstruction was an anatomic technique to restore the normal ankle anatomy and reserve normal joint mechanics. Using tendon allograft avoided sacrificing other anatomic structures.

This study has several advantages. The revision surgery was an anatomic reconstruction. We performed a single tunnel in the fibular, which was easy and decreased the possibility of fibular fracture. The single tunnel technique together with the fixation using the Tightrope system shortened the required length of tendon allograft. The minimally invasive incisions reduced the risk of potential wound problems. However, there were also several limitations of this study. First, inadequate repair of lateral ankle ligament may lead to failure. But it was hard to evaluate the primary surgery. So, the analysis of causes may not reflect the true reasons. Second, this is a retrospective study with small patient cases. More further comparative studies with larger sample size and a higher level of evidence are needed. Third, although this technique was a minimally invasive procedure, the Tightrope had its problems. The button was placed behind the lateral malleolus, and the irritation of peroneal tendons or other soft tissue would occur in certain patients.

In conclusion, the revision anatomic reconstruction of the lateral ligaments of the ankle is effective for patients with recurrent instability after a failed modified Broström procedure. It is a good option for patients meeting the criteria.

**Declaration of conflicting interests**

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**References**

1. Porter M, Shadbolt B, Ye X, et al. Ankle lateral ligament augmentation versus the modified Brostrom-Gould procedure: a 5-year randomized controlled trial. *Am J Sports Med* 2019; 47: 659–666.
2. Cox JS. Surgical and nonsurgical treatment of acute ankle sprains. *Clin Orthop Relat Res* 1985; 198: 118–126.
3. Bell SJ, Mologne TS, Sitler DF, et al. Twenty-six-year results after Brostrom procedure for chronic lateral ankle instability. *Am J Sports Med* 2006; 34: 975–978.
4. Anderson ME. Reconstruction of the lateral ligaments of the ankle using the plantaris tendon. *J Bone Jt Surg Am* 1985; 67: 930–934.
5. Schenck RC Jr. and Coughlin MJ. Lateral ankle instability and revision surgery alternatives in the athlete. *Foot Ankle Clin* 2009; 14: 205–214.
6. Colville MR. Surgical treatment of the unstable ankle. *J Am Acad Orthop Surg* 1998; 6: 368–377.
7. Cho BK, Kim YM, Choi SM, et al. Revision anatomical reconstruction of the lateral ligaments of the ankle augmented with suture tape for patients with a failed Brostrom procedure. *Bone Jt J* 2017; 99-B: 1183–1189.
8. Gould N, Seligson D and Gassman J. Early and late repair of lateral ligament of the ankle. *Foot Ankle* 1980; 1: 84–89.
9. Kuhn MA and Lippert FG. Revision lateral ankle reconstruction. *Foot Ankle Int* 2006; 27: 77–81.
10. Li X, Killie H, Guerrero P, et al. Anatomical reconstruction for chronic lateral ankle instability in the high-demand athlete: functional outcomes after the modified Brostrom repair using suture anchors. *Am J Sports Med* 2009; 37: 488–494.
11. So E, Preston N and Holmes T. Intermediate- to long-term longevity and incidence of revision of the modified Brostrom-Gould procedure for lateral ankle ligament repair: a systematic review. *J Foot Ankle Surg* 2017; 56: 1076–1080.
12. Sammarco GJ and Carrasquillo HA. Surgical revision after failed lateral ankle reconstruction. *Foot Ankle Int* 1995; 16: 748–753.
13. Petrera M, Dwyer T, Theodoropoulos JS, et al. Short- to medium-term outcomes after a modified Brostrom repair for lateral ankle instability with immediate postoperative weightbearing. *Am J Sports Med* 2014; 42: 1542–1548.
14. Finney FT and Irwin TA. Recognition of failure modes of lateral ankle ligament reconstruction: revision and salvage options. *Foot Ankle Clin* 2021; 26: 137–153.
15. O’Neil JT and Guyton GP. Revision of surgical lateral ankle ligament stabilization. *Foot Ankle Clin* 2018; 23: 605–624.
16. Remvig L, Jensen DV and Ward RC. Are diagnostic criteria for general joint hypermobility and benign joint hypermobility syndrome based on reproducible and valid tests? A review of the literature. *J Rheumatol* 2007; 34: 798–803.
17. Cao Y, Xu Y, Hong Y, et al. A new minimally invasive method for anatomic reconstruction of the lateral ankle ligaments with a Tightrope system. *Arch Orthop Trauma Surg* 2018; 138: 1549–1555.
18. Li Q, Ma K, Tao H, et al. Clinical and magnetic resonance imaging assessment of anatomical lateral ankle ligament reconstruction: comparison of tendon allograft and autograft. *Int Orthop* 2018; 42: 551–557.