Clinical efficacy of arthroscopic reconstruction of the anterior talofibular ligament with preservation of the stump

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Research Article

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Abstract

Background

The purpose of this study was to investigate the clinical efficacy of anatomic reconstruction of the anterior talofibular ligament with preservation of the stump.

Methods

This retrospective study included 42 patients who underwent an endoscopic lateral ligament reconstruction between from June 2015 to June 2019. Fourteen consecutive patients (10 [71.4%] males and 4 [28.6%] female, mean age 27.79 ± 4.56 [range 26 to 36] years) with preserved anterior tibiofibular ligament stump were enrolled in this study. On the other side, there were 18 patients with unpreserved tibiofibular ligament stumps (unpreserved stump group), 12 males and 6 females, aged 20–36 years, mean (28.56 ± 5.67) years. The functional evaluation was carried out according to the Ankle-Hindfoot Score by the American Orthopaedic Foot and Ankle Society. The Tegner system was used to evaluate range of motion after the index procedure. Ankle proprioception was assessed using the visual analogue scale (VAS) to assess the degree of subjective pain symptoms. Operative time, fever time and wound healing time were also recorded.

Results

There were no statistically significant differences in postoperative outcomes such as postoperative fever time and wound healing time between the two groups ($P > 0.05$). The operative time was slightly longer in the stump-preserving group than in the non-stump-preserving group (94.14 ± 11.59 vs. 82.94 ± 15.61 $P < 0.05$). There were no statistically significant differences in preoperative AOFAS ankle-hindfoot scores, Tegner motor level scores, and VAS scores between patients in the retained-stump group and the non-reserved-stump group ($P > 0.05$). At 1 year after surgery, the AOFAS ankle-hindfoot scores and Tegner motor level scores improved and the VAS pain scores decreased in both the presurgical and non-presurgical groups. The AOFAS ankle-hindfoot scores and Tegner motion level scores 1 year after surgery were higher in the group with preserved stump than in the group without preserved stump ($P < 0.05$).

Conclusion

Arthroscopic reconstruction of the anterior talofibular ligament with and without preservation of the stump can achieve good clinical outcomes. Although arthroscopic anterior talofibular ligament reconstruction with preserved stump prolonged the operative time compared with surgery without preserved stump, it could better improve the subjective ankle function and motion status of patients and improve the prognosis.

Background

Lateral ankle ligament injuries are almost the most common sports related injuries due to the nature of the anatomy of the ankle[1].Although about 80% of patients can be treated well with conservative treatment, nearly 20% of patients will continue to have pain and experience repeated sprains due to chronic lateral instability of the ankle that gradually progresses to chronic ankle instability (CAI)[2]. Reconstruction of the anterior talofibular ligament and calcaneofibular ligament is considered critical in the treatment of lateral ankle injuries because the lateral collateral ligaments are difficult to suture during long-term disease progression or the soft tissues used for strengthening and repair are difficult to utilize. Currently, arthroscopic reconstruction of the anterior talofibular ligament and calcaneofibular ligament is an important modality for the treatment of chronic ankle instability, and has been used with good clinical results since[3].Many studies have found that the tibiofibular anterior ligament has a rich distribution of proprioceptors[4, 5],and it has been reported that reconstruction using autologous tendon grafts can achieve good results[6–8].Because the distal fibula is thin and there is a risk of fracture of the distal fibula during reconstruction, the establishment of the bone tract should also be a consideration for the surgeon. Anatomic reconstruction of the ligament has also been proposed in recent years [9], but the question of whether the stump of the anterior tibiofibular ligament should be preserved intraoperatively is still inconclusive. In this study, we retrospectively analyzed 32 patients undergoing arthroscopic anterior talofibular ligament and calcaneofibular ligament reconstruction in our sports medicine department from June 2015 to June 2019. And the purpose of this study was to compare the clinical efficacy of anatomic reconstruction of the anterior talofibular ligament whether with preservation of the stump or not.

Materials And Methods

Patients

In this study, 32 patients who underwent endoscopic anterior talofibular ligament combined with heel fibular ligament reconstruction from June 2015 to June 2019 were screened for eligibility. A simple randomization grouping method was applied to divide them into a preserved stump group and a non-preserved stump group(Table 1).

Table 1
Characterization of the sample

Variable	Stump non-preserved group	Stump preserved group
Age, year	28.56 ± 5.67	27.79 ± 4.56
Sex		
Male	12	10
Female	6	4
Causes of disease		
Sports injuries	11	8
Accident injuries	1	1
Other injuries	6	5

Inclusion criteria were as follows: (1) diagnosis of chronic ankle instability with ipsilateral ankle sprain $\geq$ 2 times; (2) conservative management for over 6 months, but without improved symptoms; (3) clinical examination revealed in every case a positive anterior drawer and talar tilt test.

Exclusion criteria were as follows: (1) combined osteoarthritis; (2) history of ankle fracture; (3) combined ankle deformity; (4) combined ankle osteochondral injury; (5) combined internal ankle ligament or inferior tibiofibular joint complex injury.

Planning and surgical technique

All patients were anesthetized by combined spinal dural block. Patients were placed in lateral position, and a tight tourniquet was applied. An arthroscope was performed through the anteromedial portal and anterolateral portal of the ankle joint. The ankle joint was inspected and associated lesions were treated.

In the unpreserved stump group, the stump of the anterior talofibular ligament was cleared. In the preserved stump group, the stump of the anterior talofibular ligament was preserved and not cleared.

A 3 cm longitudinal incision was made at 2 cm medial to the ipsilateral tibial tuberosity of the affected limb. The subcutaneous tissue was freed layer by layer to the point of attachment of the semitendinosus tendon and then removed with a tendon extractor. The tendon was trimmed to preserve the smooth tendonous portion, and one end was braided with sutures with a length of approximately 2 cm and a measured diameter of approximately 3–4 mm. The other end was fixed and left with sutures in place. An osseous tract was created in the tibial neck attachment area of the anterior talofibular ligament.

At the distal end of the fibula, in the area of attachment of the anterior talofibular ligament and the heel fibular ligament, two parallel osteopathic channels were drilled at an interval of 5 mm in the anterior-inferior and posterior-superior directions with the use of a Kirschner needle. The end of the Kirschner

needle with thread was passed through the two bone channels, and the skin was threaded out separately and prepared for use. The braided end of the tendon was introduced into the talar neck bone tunnel under direct arthroscopic view, and the graft was fixed with absorbable anchors. The suture left in the proximal side of the distal fibula is passed through the same incision as the free caudal end of the tendon, and the suture is used to introduce the tendon into the proximal bone tunnel of the distal fibula, and the tendon is tightened in the mildly valgus position of the ankle. A longitudinal incision is made on the posterior aspect of the lateral ankle, and the soft tissue is separated along the osteotomy tract to reveal the posterior aspect of the fibula, and the tendon is introduced posteriorly and anteriorly into the osteotomy tract on the remote side of the distal fibula by a suture left in the distal fibula, and the tendon is adjusted for tightness. The ankle joint is placed in a neutral position and the tendon is passed through the deep surface of the peroneal muscle to the skin incision of the heel bone. The tendon was retained 2 cm from the skin incision, and the caudal end of the tendon was braided to tighten the heel end of the ligament, and the graft was fixed by screwing an absorbable anchor into the heel bone channel. After fixation, the stability of the ankle joint was determined again by physical examination, and the ligament tension was reconstructed by microscopic exploration, and joint cavity irrigation and hemostasis were performed. The microscopic views of the combined heel-fibular ligament reconstruction with and without the retained stump of the anterior talofibular ligament are shown in

Postoperative management

A plastic support was used to immobilize the ankle joint for 2 weeks in neutral position and eversion. After surgery ,patients were advised to elevate the affected limb, apply ice to promote swelling of the lower leg, and perform early non-weight-bearing functional exercises and isometric exercises of the lower extremities. The skin sutures were removed 2 weeks after procedure and an ankle brace was applied. Partial weight-bearing functional exercises were started at 6 weeks after surgery, and full weight-bearing was performed at 2 months after surgery. Physical activities were encouraged after removing the brace 3 months later.

Postoperative follow-up and observational indexes

The American Orthopaedic Foot and Ankle Society (AOFAS) was evaluated to assess ankle function[10]. A 100-point AOFAS was used for assessment, with 0 for poor, and 100 for excellent at 1 year postoperative. The Tegner system was used to evaluate range of motion after the index procedure[11]. This evaluation method was scored from 0 to 10, and higher scores indicated better ankle motion. The evaluation period was preoperatively and 1 year postoperatively. Ankle proprioception was assessed using the visual analogue scale (VAS)[12] to assess the degree of subjective pain symptoms. The evaluation was graded on a scale of 0–10: mild pain 0–3; moderate pain, with an effect on the patient's night sleep 4–6; and significant pain 7–10. The evaluation period was preoperatively and 1 year postoperatively.

Statistical analysis

SPSS 26.0 statistical software (IBM Corporation, USA) was used to analyze the data. The measurement data were expressed as $\bar{x} \pm s$, and the measurement data were expressed as cases (%). The t-test was

used for statistical testing of the measurement data. Preoperative and postoperative data were compared using the paired data t-test. The χ^2 test was used to compare the measurement data. All tests were two-sided, and $P < 0.05$ was considered a statistically significant difference.

Results

All patients had no postoperative incision infection, the incision healed in one stage, and there were no complications such as nerve and blood vessel injury or fracture, and no significant ankle stiffness or pain during activity. The operative time was slightly longer in the group with preserved stump than in the group without preserved stump ($P < 0.05$). No statistically significant differences were seen in the general conditions of the patients, including postoperative fever time and wound healing time, and other general postoperative conditions (Table 2). The preoperative and postoperative classical images are shown in Figs. 3 and 4.

Table 2
Comparison of operative time, incision healing time and preoperative general information between patients in the stump-preserving and non-stump-preserving groups

	stump-preserving groups (n = 14)	non-stump-preserving groups (n = 18)	t/ χ^2	P
Sex, Male	10	12	0.083	0.773
Age, year	27.79 $\pm$ 4.56	28.56 $\pm$ 5.67	0.414	0.682
operative time, minute	94.14 $\pm$ 11.59	82.94 $\pm$ 15.61	2.243	0.032
Postoperative fever time, day	2.42 $\pm$ 0.94	2.44 $\pm$ 1.25	0.04	0.969
incision healing time, day	10.21 $\pm$ 1.42	10.16 $\pm$ 1.29	0.099	0.922
All patients completed more than 1 year of follow-up after surgery, and there were no statistically significant differences in the preoperative AOFAS ankle-hindfoot scores, Tegner motor level scores, and VAS scores between the preserved-stump group and the non-preserved-stump group ($P > 0.05$, Table 3). At 1 year postoperatively, the AOFAS ankle-hindfoot scores and Tegner motor level scores improved and the VAS scores decreased in the presurgical group with and without the preserved stump group, with statistically significant differences between the two groups before and after surgery ($P < 0.05$). The AOFAS ankle-hindfoot scores and Tegner motor level scores were higher in the group with preserved stump than in the group without preserved stump at 1 year postoperatively ($P < 0.05$, Table 4).				

Table 3
Comparison of preoperative functional scores between patients in the stump-preserving and non-stump-preserving groups

	stump-preserving = 14)	non-stump-preserving = 18)	t	P
AOFAS	57.00 ± 9.18	59.50 ± 7.39	0.854	0.400
Tegner	2.57 ± 1.02	2.50 ± 1.10	0.188	0.852
VAS	5.92 ± 1.68	6.11 ± 1.60	0.312	0.757

Table 4
Comparison of functional scores before and after surgery between patients in the stump-preserving and non-stump-preserving groups

	stump-preserving = 14)	non-stump-preserving = 18)	t	P
Pre- AOFAS	57.00 ± 9.18	59.50 ± 7.39	0.854	0.400
Post- AOFAS	91.78 ± 3.62	85.39 ± 3.35	5.177	0.001
t	16.31	11.24	-	-
P	< 0.001	< 0.001	-	-
Pre- Tegner	2.57 ± 1.02	2.50 ± 1.10	0.188	0.852
Post- Tegner	7.07 ± 1.00	6.11 ± 1.37	2.208	0.035
t	10.88	9.06	-	-
P	< 0.001	< 0.001	-	-
Pre- VAS	5.92 ± 1.68	6.11 ± 1.60	0.312	0.757
Post- VAS	1.57 ± 0.94	1.78 ± 1.06	0.574	0.570
t	12.01	8.85	-	-
P	< 0.001	< 0.001	-	-

Discussion

Inversion sprains are more common in ankle injuries due to the structural characteristics of the talus itself[10]. The anterior talofibular ligament and the heel-fibular ligament are also more susceptible to injury since they are under greater tension in the inversion position[11].

The anterior talofibular ligament and the calcaneofibular ligament are important components of the lateral collateral ligament of the ankle joint that play an important role in maintaining the lateral stability of the ankle joint, which can lead to chronic ankle instability if not treated properly after injury[12]. Surgical treatment is one of the main options for this disease.

With the advancement of minimally invasive concepts and techniques, arthroscopic surgery has been rapidly developed. Compared with traditional surgery, arthroscopic surgery has the advantages of less damage, clear vision, and delicate operation, and can treat other intra-articular lesions at the same time[13]. Since Hawkins[14] first reported arthroscopic anterior talofibular ligament reconstruction in 1987, more and more studies have suggested that both arthroscopic-assisted reconstruction of the anterior talofibular ligament in combination with the heel-fibular ligament and autografts can achieve good clinical results [15–20].

In this study, all patients were reconstructed arthroscopically using autografts to dissect the anterior talofibular ligament and the heel-fibular ligament. The preoperative and postoperative AOFAS ankle function evaluations showed significant improvement in ankle function compared to the preoperative period. The preoperative and postoperative VAS scores indicated that the postoperative ankle pain was significantly reduced compared to the preoperative condition. The preoperative and postoperative Tegner motor function evaluation indicated that the patient's postoperative motor status improved significantly compared with the preoperative condition. It was suggested that arthroscopic reconstruction of the anterior talofibular ligament combined with the heel-fibular ligament using autograft with arthroscopic assistance could achieve good clinical results. This is generally consistent with the results of previous studies [15–20].

In the present study, the functional evaluation of the AOFAS ankle joint and the evaluation of Tegner's motion level were higher in the postoperative preserved stump group than in the unpreserved stump group. Lateral ankle instability is not only related to ligaments and other relevant structures that maintain the stability of the ankle joint, but also to muscle strength and proprioception[21]. The restoration and exercise of proprioception is of great importance in the treatment of ankle instability[22]. Previous studies of ligament reconstruction in other areas have discovered that there is a large number of small proprioceptors in ligaments[23, 24]. With the increasing number of studies on ankle instability in recent years, a large quantity of proprioceptors has also been found in the tibiofibular anterior ligament. The preservation of the anterior tibiofibular ligament preserves the presence of some proprioceptors and therefore the recovery of proprioception in the patient's ankle joint is improved, which could lead to the result of this study.

In this study, the procedure with preservation of the anterior tibiofibular is longer compared to surgeries without it. Compared to the preserved stump group, the other group has to perform an extra step of intra-articular stump cleaning. However, the ankle joint itself has a small joint cavity[25], and preserving the stump increases the difficulty of the surgical operation during ligament reconstruction, resulting in an increased operative time. There was no difference in incision healing time and fever time, considering that the same approach and the same bone tract were used for all surgeries except whether the ligament stump was preserved or not, and no additional incision or additional injury was added. Previous studies found differences in fever time between using autografts and allografts. The difference in histocompatibility between autologous and allograft is considered to be the result of it. Autografts were used in this study without exception, therefore the fever time remains the same.

This study has the following drawbacks: 1. This study is a retrospective study, and further prospective studies are needed for further comprehensive evaluation. 2. This study is a single-center study with a limited sample size, and further studies with a larger sample size are needed for further confirmation. 3. The overall follow-up results of this study are satisfactory, but there is a lack of comparative studies with other procedures.

Conclusions

In summary, arthroscopic reconstruction of the anterior talofibular ligament combined with the heel-fibular ligament can achieve good clinical efficacy. Although arthroscopic reconstruction of the anterior talofibular ligament combined with the heel-fibular ligament with preservation of the stump prolongs the operative time compared with surgery without preservation of the stump, it can improve the subjective ankle function and movement of the patient.

Abbreviations

VAS

visual analogue scale;

AOFAS

American Orthopaedic Foot and Ankle Society

CAI

chronic ankle instability

Declarations

Ethics approval and consent to participate

All patients in this study received authorized consent from the patients themselves and their families, agreed to the surgical protocol and signed a preoperative informed consent form for the surgery. All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Consent for publication

Not applicable.

Availability of data and materials

Please contact author for data requests.

Competing interests

The authors declare that they have no competing interests.

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No funding was received for this study.

Authors' contributions

ZH collected the clinical data, performed the statistical analysis, and drafted the manuscript. CHL and GZW helped in collecting the clinical data and participated in the design of the study. KL participated in the statistical analysis. All authors read and approved the final manuscript.

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Figures

Figure 1

Arthroscopic view of the anterior talofibular ligament reconstruction with preservation of the stump.

Figure 2

Arthroscopic view of the unpreserved stump of the anterior talofibular ligament reconstruction.

Figure 3

Female, 20 years old, diagnosed with left ankle anterior talofibular ligament injury, underwent arthroscopic reconstruction of the anterior talofibular ligament with preservation of the stump. A: No bone abnormality was seen on the anterolateral radiograph of the ankle joint before surgery B: Positive lateral radiograph of the ankle joint on the second day after surgery showed the position of the fibula and the heel bone tract.

Figure 4

Male, 27 years old, diagnosed with left ankle anterior talofibular ligament injury, underwent arthroscopic reconstruction of the anterior talofibular ligament without preserving the stump A: preoperative ankle MRI showed thickened anterior talofibular ligament with hypoechogenicity and localized patchy strong echogenicity, and the calcaneofibular ligament was poorly visualized B: postoperative day 2 ankle frontal and lateral radiographs showed the position of the fibula and heel bone tract.