Case Report

Minimally Invasive Reconstruction of the Ankle Lateral Ligament Complex in Chronic Ankle Instability: Clinical Outcomes, Return to Sport and Recurrence Rate at Minimum Follow up of 5 Years

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Abstract: Background: Chronic ankle instability is a common condition that develops after lateral ankle sprains. Many surgical techniques have been described in case of failure of conservative treatment. The purpose of this paper is to present the results in terms of clinical outcomes, return to sport and recurrence rate after reconstruction of the lateral ligament complex of the ankle with a minimally invasive approach at a minimum follow up of five years. Methods: This retrospective study involved forty-seven patients treated for chronic ankle instability from January 2013 to November 2017. The clinical outcomes were evaluated with the American Orthopedic Foot and Ankle Society ankle and hindfoot score (AOFAS score), the University of California–Los Angeles Rating Scale (UCLA Rating Scale), the Karlsson–Peterson ankle instability score and the Halasi scale at a mean follow up time of 80 months. Results: The mean age of the patients was 42 years (23–63). The mean VAS pain score decreased from 5.6 (2–9) pre-operatively to 0.7 (0–7) post-operatively. The mean UCLA Rating Scale score improved from 7.7 (4–8) before surgical treatment to 9.2 (6–10) afterwards. The AOFAS score increased from a pre-operative mean value of 66.5 (40–95) to a post-operative mean value of 94 (88–100) and the Halasi scale from a pre-injury mean value of 4.3 (2–8) to 4.5 post-operatively (2–8). The mean Karlsson–Peterson ankle instability score increased from 71 (40–90) pre-operatively to 87.9 (70–90) post-operatively. During this period of follow up, the procedure survival rate was 95.7%, with two cases of recurrence of ankle sprain post-operatively after twelve months in one case and forty months in the other case. Conclusions: The described technique of reconstruction of the anterior talofibular and calcaneofibular ligament with a minimally invasive approach with a semitendinosus autograft is a viable treatment option for chronic ankle instability and enables the majority of patients to regain their activity and sport level with a low recurrence rate at a mid-term follow up.

Keywords: ankle sprains; ankle instability; ankle ligaments; surgical treatment; ankle lateral ligament reconstruction; semitendinosus autograft; clinical outcomes; return to sport

1. Introduction

Lateral ankle sprains (LAS) are one of the most common musculoskeletal injuries consequent to physical activity and are related to a high rate of recurrence after the first episode [1]. The most commonly affected anatomical structures are the anterior talofibular ligament (ATFL), the calcaneofibular ligament (CFL) and, less frequently, the posterior talofibular ligament (PTFL), which stabilize the lateral side of the talocrural joint [2].

Up to 40% of affected individuals experience the development of a condition known as chronic ankle instability (CAI), when symptoms such as local pain, tenderness, swelling, feeling of instability and frequent falls last for more than 3 months [3].

The initial treatment of CAI is based on a conservative approach with an adequate physiotherapy program, while surgical indication should be proposed in the case of persistence of pain and instability after at least 3 months of treatment [4]. The instability that requires surgery can be functional and/or mechanical: the first type is reported by the patient as a feeling of instability and loss of strength due to neuromuscular and proprioceptive deficits, while the latter can be identified during physical examination as laxity and local tenderness [5]. As this condition can affect young patients, the surgical approach is also proposed for children and adolescents under 18 years old [6]. The surgical procedures range from repairs to non-anatomic tenodesis or anatomic reconstructions using autografts, allografts or fibular periosteal flaps [7–9]. Ankle arthroscopy can be performed in conjunction with these procedures in order to diagnose and treat eventual concomitant lesions such as osteochondral lesions, impingement, syndesmosis lesions or loose intra-articular bodies [10].

As far as anatomic reconstruction is concerned, open techniques have good clinical results but present complications regarding wound healing, post-operative fibrosis and stiffness [11]. As a consequence, minimally invasive techniques are nowadays an interesting solution for the treatment of CAI with a demonstrated reduction in such complications [12,13].

A minimally invasive reconstruction of the lateral ligament complex using semitendinosus tendon autograft in chronic lateral ankle instability has been described, and demonstrated satisfying clinical outcomes and return to sport [14]. The purpose of the present study is to retrospectively assess clinical outcomes, return to sport and recurrence rate after minimally invasive reconstruction of the lateral ligament complex using semitendinosus tendon autograft at a mid-term follow up. Our hypothesis is that this study will confirm the promising outcomes and complication rate at a 5-year minimum follow up.

2. Materials and Methods

Inclusion criteria were the following: patients who underwent minimally invasive reconstruction of the anterior talofibular ligament (ATFL) and calcaneofibular ligament (CFL) with semitendinosus tendon autograft for a CAI resistant to conservative treatment for at least 6 months [14].

Exclusion criteria were the following: patients under 18 years old, revision cases, ankle/foot deformity and the presence of concomitant cartilage, bone or tendon lesions that required surgical correction.

All the surgical procedures were performed by the same senior surgeon.

All the patients were assed clinically and with MRI before surgery and had a grade 3 lesion of both the ATFL and CFL according to Malliaropoulos et al.'s classification [15].

MRI was used to detect possible concomitant lesions such as osteochondral lesions, impingement, syndesmosis lesions or loose intra-articular bodies requiring additional procedures.

As clinical outcome parameters, the American Orthopedic Foot and Ankle Society ankle and hindfoot score (AOFAS score), the University of California-Los Angeles Rating Scale (UCLA Rating Scale) and the Karlsson—Peterson ankle instability score were used and recorded both pre-operatively and post-operatively at the latest follow up [16,17]. Moreover, the Halasi activity scale was collected from the patients regarding the level of physical activity prior to the onset of the pathology and at the latest follow up in order to assess whether the patients were able to return to the same sport level after surgical treatment [18]. The pain level was assessed using a 10-point visual analog scale (VAS). The minimum follow up time was 5 years, with a mean time of 80 months.

3. Surgical Technique and Post-Operative Protocol

With the patient in supine position and with a tourniquet applied, a longitudinal 3 cm incision over the ipsilateral pes anserinus was made in order to harvest the semitendinosus tendon autograft, which was then tubularized with a whipstitch technique. All patients underwent an anterior ankle arthroscopy before the ligament reconstruction to confirm the absence of or assess any intra-articular lesions. The surgical approach for the minimally invasive reconstruction of the ATFL and CFL comprises four lateral incisions 5 mm long. The first incision was made at the level of the talar neck, inside which a guide wire was introduced in order to drill a 5.0 mm talar tunnel. The tubularized autograft was passed inside the tunnel with a Beath pin and a 6.0 × 25 mm interference screw was used to fix it. (Figure 1) The second incision was made 2 cm proximally to the tip of the fibula at its anterior border, at the fibular insertion of the ATFL, in order to introduce the guide wire for the fibular tunnel, which was drilled with a 4.5 mm width and with an oblique posteroinferior direction. The third incision was made where the guide wire exits the fibula. An eyelet wire was used to pass the semitendinosus graft previously fixed in the subcutaneous tissue from the first to the second incision, reproducing the ATFL course, then inside the fibular tunnel and eventually out through the third incision. (Figure 2) The fourth incision was made laterally on the foot at the level of the insertion of the CFL in the calcaneus, where a 6 mm tunnel was drilled. (Figure 3) To reconstruct the CFL, the autograft was passed from the third to the fourth incision in the subcutaneous tissue and then inside the calcaneal tunnel, where it was fixed with a 7.0 × 30 mm interference screw inserted, keeping the foot in slight eversion, maintaining neutral dorsiflexion and pushing the ankle into posterior drawer in order to give good tension to the neo-ATFL and neo-CFL.

Figure 1. The autograft has been passed through the talar tunnel and it is fixed with an interference screw.

Figure 2. The semitendinosus graft is passed from the second to the third incision using an eyelet.

Figure 3. The autograft has been passed through the fibular tunnel and is coming out from the third incision. The calcaneal guide wire has been placed in the fourth incision.

The post-operative protocol was based on a 4-week period of a walker boot, with gentle mobilization allowed after 5–7 days. The patients were allowed partial weight-

bearing for the first two weeks, then progressing to full weight-bearing and full ROM exercises. After 5 months, full physical activity was allowed.

4. Statistical Analysis

Continuous variables were described using the arithmetic mean. Categorical variables were described using frequency distributions and percentages. Survival analysis was carried out using the Kaplan–Meier approach for the recurrence of ankle sprain, which was considered an end point. The t-test was performed for continuous variables to compare means, while Fisher's exact test was performed for categorical variables.

Data were collected with Microsoft Excel® and all data were analyzed using SAS 9.4 (SAS Institute, Cary, NC, USA), and statistical significance was maintained at a *p* value of less than 0.05.

All procedures performed were in accordance with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

5. Results

As recorded in the database of our department, from January 2013 to November 2017 fifty-four patients underwent minimally invasive reconstruction of the ATFL and CFL using semitendinosus tendon autograft and met the inclusion criteria. Three patients were then excluded due to the presence of concomitant cartilage, bone or tendon lesions, and two more patients were excluded for ankle/foot deformity. A total of forty-nine patients completed the baseline survey, but two of them were lost at follow up (Figure 4).

A total of 47 patients were therefore enrolled in the present study, with 28 females and 19 males (40.4%M/59.6%F). The mean age of the patients was 40, ranging from 17 to 63.

The mean follow up time was 80 months, ranging from 67.5 to 94.4 (Table 1).

Table 1. Description of patient characteristics.

Characteristics	Average	Range
Age (years)	42.1	23–63
Weight (kg)	74.6	53–92
Height (m)	1.7	1.64–1.85
BMI	25.6	19–33.46
	N	%
Male/Female	19/28	40.4/59.6
Right/Left	35/12	74.5/25.5

The average pre-operative VAS pain score was 5.6 (2–9), and the reduction at last follow up was to a mean value of 0.7 points (ranging from 0 to 7) ($p < 0.05$).

Similarly, the mean AOFAS ankle and hindfoot score pre-operative result was 66.53 (ranging from 40 to 95), which increased significantly to 94 points (ranging from 88 to 100) at final follow up ($p < 0.05$).

The UCLA score determined pre-operatively (after the onset of the pathology) showed an average value of 7 (ranging from 4 to 8). At final follow up, the increase in the UCLA score was up to 9.2 points (ranging from 6 to 10) ($p < 0.05$).

With regard to the Karlsson—Peterson instability scale, the mean result found pre-operatively was 71 (ranging from 40 to 90), which improved up to a mean value of 87.9 (ranging from 70 to 90) post-operatively at last follow up ($p < 0.05$).

In terms of the level of physical activity, the Halasi scale was determined prior to the onset of the pathology with a mean value of 4.3 points (ranging from 2 to 8), and was 4.5 points (ranging from 2 to 8) at final follow up (*p*: 0.5). More specifically, in 34 cases, the patients were able to return to the same level of physical activity before the ankle injury,

in 10 cases, the patients had an improved level of sport activity and in 3 cases, the level decreased after surgical treatment (Table 2).
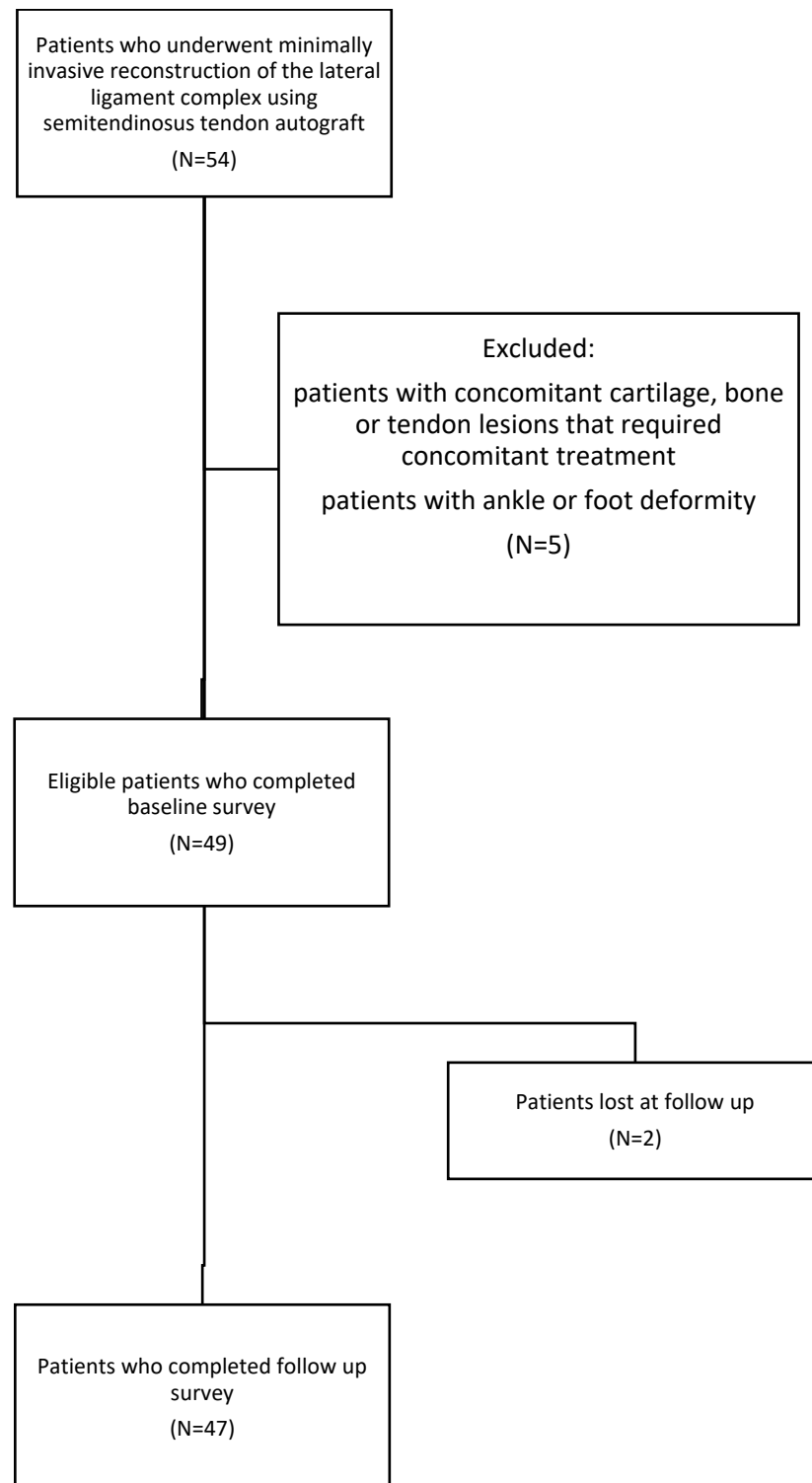

Figure 4. Patient enrollment flowchart.

Table 2. Score results pre- and post-operatively.

	Average	Range	p
VAS PRE	5.6	2–9	$p < 0.05$
VAS POST	0.7	0–7	
UCLA PRE	7.7	4–8	$p < 0.05$
UCLA POST	9.2	6–10	
AOFAS PRE	66.5	40–95	$p < 0.05$
AOFAS POST	94	88–100	
HALASI PRE	4.3	2–8	$p = 0.5$
HALASI POST	4.5	2–8	
KARLSSON–PETERSON PRE	71	40–90	$p < 0.05$
KARLSSON–PETERSON POST	87.9	70–90	

During this period of follow up, the procedure survival rate was 95.7%. We found two cases of recurrence of ankle sprain after surgical treatment (4.3%). (Figure 5) Both the patients were able to return to the pre-operative sport level as reported in terms of UCLA score and Halasi scale, but during activity, they experienced a new episode of ankle sprain. The time of recurrence was twelve months in one case and forty months in the other case. Both patients reported that they had never re-experienced ankle instability before the new episode and that the new ankle sprain happened because of a traumatic event during physical activity.
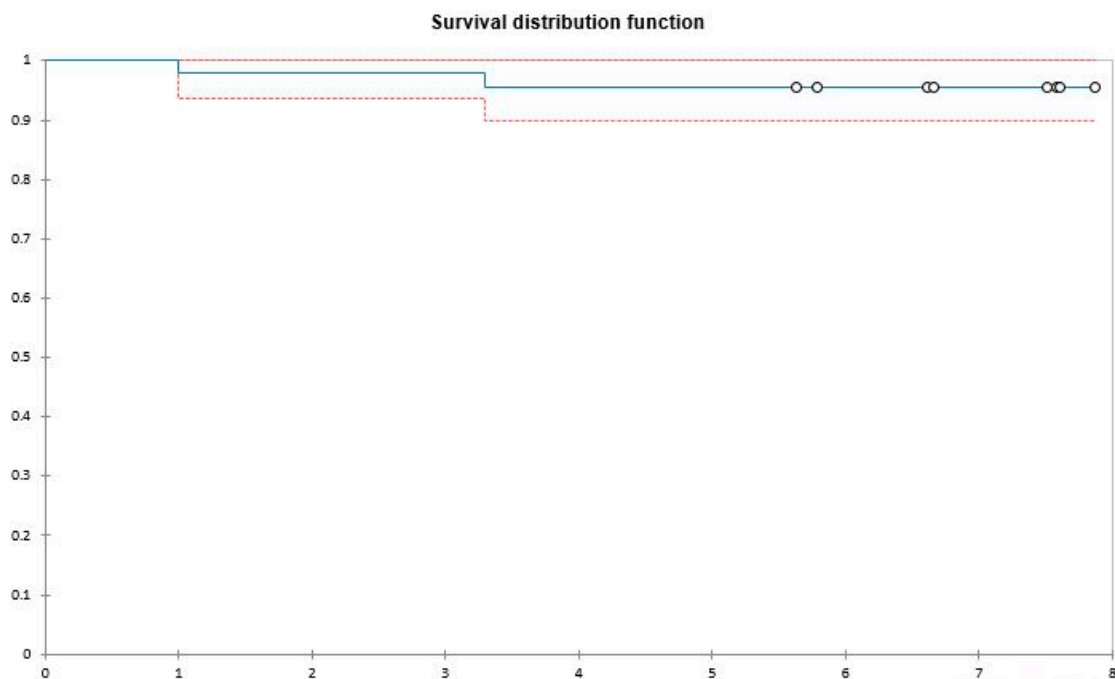
Figure 5. Kaplan–Meier survival distribution.

6. Discussion

Chronic lateral ankle instability is a common condition in both recreationally active people and athletes [1,3]. It is associated with disabling symptoms for the patients with decreased strength, diminished range of motion and functional impairment, which determine serious consequences in terms of time lost from work and sport [19].

CAI is initially treated conservatively with bracing and functional rehabilitation [20,21]. Patients who experience residual instability after 3–6 months of conservative treatment

are eligible for surgery in order to restore ankle stability and prevent the occurrence of early arthrosis of the ankle joint. Many surgical procedures have been described ranging from simple repairs to complex reconstructions [22]. The techniques are divided into anatomic repairs, non-anatomic tenodesis and anatomic reconstructions using autograft or allograft. The gold standard is anatomic repair with the Bröstrom technique and its modifications; the main limit of this surgical procedure is in the case of severely attenuated or absent ligaments [23]. Non-anatomic tenodesis is nowadays less used as hindfoot biomechanics are not correctly restored [24]. A systematic review of the literature with a mean follow up of 15.3 years published by Noailles et al. evaluated eight hundred and one ankles and concluded that anatomical repair compared to non-anatomical tenodesis resulted in a diminished loss of range of motion and less development of secondary osteoarthritis [25]. Therefore, non-anatomic tenodesis procedures have been replaced by anatomic reconstructions with allograft, autograft or fibular periosteal flap.

The surgical technique we perform in our department is minimally invasive reconstruction of the lateral ligament complex using semitendinosus tendon autograft. In the present study, we enrolled forty-seven patients with a mean follow up of 6.7 years. The aim was to assess the post-operative clinical outcome, return to sport and rate of sprain recurrence. Pain relief and functional outcome were evaluated using the VAS scale, the AOFAS score and the Karlsson–Peterson ankle instability score. The promising results we collected are in accordance with other similar studies. Wang et al. performed minimally invasive reconstruction of lateral ligaments of the ankle using semitendinosus autograft on twenty-five patients and reported an increase in AOFAS score from a mean pre-operative value of 71.1 to a mean post-operative value of 95.1 [12]. Similarly, in another study on thirty-six patients who underwent anatomical reconstruction of the lateral ligaments of the ankle with semitendinosus allograft, the improvement in terms of AOFAS score was from 42.3 pre-operatively to 90.4 post-operatively [26]. Also, the Karlsson–Peterson ankle instability score in a systematic search of the literature published by Vuuberg et al. showed a post-operative increase to a mean value of 90.1 after anatomic reconstruction of the lateral ligament complex [24].

In order to evaluate the ability to return to everyday activities and participation in physical activity and sports after surgery, the UCLA score was collected both pre-operatively and after the surgical procedure. Only in one other study on chronic ankle instability did the authors decide to use the UCLA score, to report the outcomes of repair with a modified Broström technique in children and adolescents under 18 years old with a mean UCLA score of 9.3 [6]. Even through the population enrolled in this study is not comparable to ours, we can conclude that the mean result of 9.2 after minimally invasive reconstruction of lateral ligaments of the ankle with autograft in adults is as effective as the gold standard technique in children in terms of return to participation in physical activity.

Moreover, another key point of this study was to assess whether the patients were able to regain the same activity level as before the onset of chronic ankle instability. For this purpose, we used the Halasi scale at the final follow up and compared these scores to the pre-pathology values. The results found showed that 72.3% of our patients could return to the same sport level as before, and 21.3% of them increased the level of activity performed after surgery. In just three cases, the patients returned to a lower level of physical activity (6.4%). We can conclude that the minimally invasive procedure we perform to treat chronic ankle instability confirms the good functional outcomes at a longer period of follow up [14].

Recurrence of ankle sprain after minimally invasive reconstruction of the lateral ligament complex using semitendinosus tendon autograft was found in two out of forty-seven patients enrolled in this study (4.3%). As compared to reconstruction with semitendinosus allograft, Youn et al. followed a series of fifteen patients, and in one case, revision surgery was performed on a girl who experienced ankle trauma six months after the primary procedure [27]. The clinical results of anatomic lateral ligament reconstruction with autologous tendons have already been compared to the gold standard modified Broström–Gould procedure, showing that the latter has a higher rate of sprain recurrence

post-operatively [28]. Also, another study by Petrera et al. on fifty-five patients who underwent modified Broström repair showed a failure rate of 6%, with three patients who experienced a traumatic retear [29].

The limitations of this study are its retrospective nature, the lack of a control group and the absence of a power analysis. Therefore, large-scale studies with a control group may be needed in order to achieve further acknowledgment of the outcomes of this procedure and to compare it to other techniques in terms of effectiveness.

7. Conclusions

Minimally invasive reconstruction of the ATFL and CFL using semitendinosus tendon autograft in chronic lateral ankle instability is a safe procedure that enables the majority of patients to regain their activity and sport level with a low recurrence rate even at a mid-term follow up.

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