DOI: https://doi.org/10.30795/2595-1459.2018.v1208

ORIGINAL ARTICLE

Scientific Journal of the Foot & Ankle

Evaluation of the results of the surgical treatment of chronic lateral ankle instability with knee flexor tendon autograft

Avaliação dos resultados do tratamento cirúrgico da instabilidade lateral crônica do tornozelo com autoenxerto dos tendões flexores do joelho

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ABSTRACT

Objective: To clinically and radiographically evaluate a group of patients undergoing lateral ankle ligament reconstruction surgery using knee flexor tendon autograft.

Methods: The study included and prospectively evaluated 10 patients undergoing lateral ankle ligament reconstruction using knee flexor autograft. Clinical evaluation was performed using the American Orthopedic Foot and Ankle Score (AOFAS), preoperatively and after 1 year of follow-up. Radiographic evaluation included anteroposterior projections associated with ankle varus stress and profile projections of the ankle anterior drawer, also preoperatively and 1 year postoperatively.

Results: A mean preoperative AOFAS of 69.3 (SD ± 11.49) was obtained. One year after surgery, there was an increase in the mean score of 98.2 (SD ± 3.01), showing a statistically significant improvement (p<0.001). The anterior tibiotalar angle values improved markedly, with statistical significance. Although the anterior tibiotalar subluxation values also showed a marked improvement, it was not possible to calculate statistical significance; the group of 10 patients had to be divided into two, as six patients met the criteria when compared to the contralateral side (group 1) and four patients had an absolute value of anterior subluxation of more than 10 mm (group 2).

Conclusion: After clinical and radiographic evaluation comparing preoperative and 1-year postoperative data, we conclude that in the analyzed group, the reconstruction technique used produced good or excellent results and should be considered for the treatment of chronic lateral ankle instability.

Level of Evidence III; Retrospective Comparative Study.

Keywords: Joint instability; Ankle; Reconstruction; Transplantation, autologous; Hamstring tendons.

RESUMO

Objetivo: Avaliar clínica e radiograficamente um grupo de pacientes submetidos à cirurgia de reconstrução ligamentar lateral do tornozelo usando autoenxerto de tendões flexores do joelho.

Métodos: Foram incluídos no estudo e avaliados prospectivamente dez pacientes submetidos à reconstrução ligamentar lateral do tornozelo utilizando autoenxerto dos flexores do joelho. A avaliação clínica foi realizada usando o escore AOFAS no pré-operatório e após 1 ano de seguimento. A avaliação radiográfica incluiu as incidências em AP associadas ao estresse em varo do tornozelo, ao perfil com gaveta anterior do tornozelo, também no pré-operatório e com 1 ano de pós-operatório.

Resultados: Foi encontrado um escore AOFAS pré-operatório médio de 69,3 (DP ± 11,49). Após um ano de pós-operatório, houve aumento do escore com uma média de 98,2 (DP ± 3,01), mostrando uma melhora estatisticamente significativa (p<0,001). Os valores do ângulo tíbiotalar anterior tiveram uma melhora importante com significância estatística e, embora os valores de subluxação anterior tibiotalar também tenham apresentado uma melhora importante, não houve a possibilidade de cálculo da significância estatística pois tivemos que dividir o grupo de 10

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Conflicts of interest: none. **Source of funding:** own.

Date Received: November 27, 2017. **Date Accepted:** February 26, 2018. **Online:** March 30, 2018.

pacientes em dois, já que 6 pacientes preencheram o critério comparado ao lado contralateral (grupo 1) e 4 pacientes tiveram mais de 10mm de subluxação anterior de valor absoluto (grupo 2).
Conclusão: Após avaliação clínica e radiográfica comparativa entre pré-operatório e com 1 ano de pós-operatório, concluímos que, no grupo analisado, a técnica de reconstrução utilizada produz bons e excelentes resultados e deve ser considerada para o tratamento de instabilidade lateral crônica do tornozelo.
Nível de Evidência III; Estudo Retrospectivo Comparativo.

Descritores: Instabilidade articular; Tornozelo; Reconstrução; Autoenxerto; Tendões dos Isquiotibiais.

How to cite this article: Stoffel CL, Lima E, Nascimento GM. Evaluation of the results of the surgical treatment of chronic lateral ankle instability with knee flexor tendon autograft. Sci J Foot Ankle. 2018;12(1):49-54.

INTRODUCTION

Ankle injuries are extremely common in professional and amateur sports [1,2]. Approximately 85% of all ankle injuries involve the lateral ligamentous complex [2]. Many cases progress to chronic instability, mainly due to the lack of adequate treatment in the acute phase[3]. Among patients with chronic ankle instability, approximately 20% seek surgical treatment after conservative treatment fails [3,4]. Chronic ankle instability and frequent sprains may lead to degenerative arthritis if left untreated[2,5]. Patients with chronic ankle instability often tend to have repeated sprains and a sense of giving way in everyday situations, such as walking on level ground. Typically, patients seek help after an acute sprain and report having a recurring problem or describe a feeling of looseness and insecurity in the ankle that "turns" unexpectedly. The chronic symptoms acquired after repetitive ankle sprains require careful evaluation, including routine radiographs under stress (talar tilt, anterior drawer) and, in some cases, a CT scan and MRI[6].

The lateral ankle ligament complex consists of three main ligaments: the anterior talofibular ligament (ATFL), the fibulocalcaneal ligament (FCL) and the posterior talofibular ligament (PTFL). The ATFL follows the lower oblique segment of the front border of the fibula to the lateral malleolar joint surface of the talus body[2,7], which is most often damaged in a lateral ankle sprain[2,8]. The FCL originates from the lower segment of the anterior border of the fibula, adjacent to the ATFL, and enters the lateral calcaneal tubercle[2,7]. The LFTP originates from the medial fibular surface adjacent to the digital fossa and enters the posterolateral aspect of the talus[2,7]. Therefore, the PTFL is the last to be injured in an inversion sprain [2].

Patients with ankle instability usually seek treatment after suffering a severe ankle sprain that becomes recurrent[9,10]. Diagnosis is based on clinical findings and is given when there is high laxity in anterior drawer maneuvers and inversion when compared with the contralateral ankle. Treatment can be surgical or conservative, with analgesia associated with physical therapy for proprioception and fibular strengthening, ankle braces and adjustments in sports modalities. The various surgical techniques include a direct ligament repair technique known as the Brostrom procedure, a non-anatomical reconstruction technique known as Chrisman-Snook and anatomical reconstruction with tendon graft, which is the focus of this study[10-12].

The objective of this study is to evaluate the clinical and radiographic results of patients undergoing chronic lateral ankle instability surgery using the anatomical reconstruction technique with knee flexor tendon autograft. Evaluation will be based on improvements in varus stress and anterior drawer radiographic markers and the American Orthopedic Foot and Ankle Score (AOFAS), and the results will be compared to those found in the literature[13,14].

METHODS

This study was approved by the Research Ethics Committee with registration in the Brazil Platform under the CAAE number: 15525914.7.0000.5342.

A prospective study was performed of patients undergoing lateral ankle ligament reconstruction surgery using knee flexor (gracile or semitendinosus) autograft, at our facility, between 2014 and 2016. The patients undergoing surgery in this period were evaluated using the AOFAS, both preoperatively and 1 year postoperatively. A radiographic evaluation was also performed, with anteroposterior projections associated with ankle varus stress to establish talar tilt, and profile projections with ankle anterior drawer, both preoperatively and 1 year postoperatively.

A total of 10 patients, between 25 and 47 years of age, with a mean age of 36.5 years, were selected for surgical reconstruction of the lateral ligamentous complex with knee flexor tendon autograft. Six (60%) patients were male,

and four (40%) female. Each had undergone unsuccessful conservative chronic lateral ankle instability treatment. We gave preference in the choice of this technique to high-demand patients performing occupational and/or sporting activities, such as agriculture or soccer, which required use of the ankle.

The talar tilt is measured in degrees and is evaluated using a radiograph in anteroposterior projection under varus stress applied to the ankle, performed manually, while one of the hands holds the ankle and the other causes bending of the talus varus (Figure 1). A line was plotted on the distal surface of the tibia and on the articular surface of the talus to obtain the angle between them[15,16]. An increased talar tilt indicates complete rupture of the FCL.

The anterior drawer maneuver evaluates the ATFL with the foot relaxed and is performed with a profile X-ray and while the ankle receives a displacement force anterior to the tibia (Figure 2). It is performed manually, with one hand holding the distal tibia and the other pulling the talus forward. When anterior translation or subluxation is greater than 5mm, the ATFL is considered broken[6,17].

The inclusion criteria were patients with chronic ankle instability, diagnosed by anamnesis and physical examination and confirmed by ankle MRI and radiographs and AP with varus stress and profile with anterior drawer, showing changes consistent with the diagnosis: anterior drawer greater than 10mm or more than 3mm compared with the contralateral side. Therefore, we had to divide the group of 10 patients into two, as six patients met the criteria compared with the contralateral side (group 1) and four patients had an absolute value of anterior subluxation of more than 10mm (group 2) and varus talar tilt greater than 10 degrees[13,14]. We also included patients undergoing chronic lateral ankle instability surgery involving lateral ligament reconstruction with knee flexor autograft between May 2014 and June 2016, who chose to participate.

The exclusion criteria were patients who refused to participate in the study and patients for whom the AOFAS was not recorded preoperatively or 1 year postoperatively. Patients for whom AP X-rays of the ankle in varus stress and a profile of the ankle anterior drawer were not performed (either preoperatively or 1 year postoperatively), patients who did not continue to follow-up, patients with osteoarthritis and patients with associated injuries and hollow foot were also excluded.

Surgical treatment

The surgical technique was performed with the patient supine. A pneumatic tourniquet was used on the thigh root of the limb to be operated upon. An approach equal

Figure 1. Varus stress.
Source: Author's personal archive.

Figure 2. Anterior drawer/anterior subluxation.
Source: Author's personal archive.

to that used in anterior cruciate ligament reconstruction was made, 2cm inferior and medial to the anterior tibial tuberosity, to remove the knee flexor tendon, gracilis or semitendinosus graft. After the graft was removed, it was prepared for grafting, with cleaning of the muscle debris and suturing of the ends with appropriate absorbable multifilament yarn.

A minimally invasive lateral approach was then made (Figure 3) of approximately 3-4cm, slightly curved, in the ankle on the distal end of the fibula, with dissection and location of the insertion site of the ATFL in the talus and of the insertion site of the FCL in the calcaneus. The four osseous tunnels were then constructed, one in the talus at the exact ATFL insertion site, two in the fibula in inverted "V" format and one in the calcaneus at the FCL insertion (Figure 4). We used a 4.8-mm or 4.5-mm drill for the four tunnels and 6.0mm only at the introduction site of the interference screws in the talus and calcaneus. The flexor graft was then passed through the bone tunnels, the ankle positioned at 90° and neutral in the anterior view, tightening the graft ends carefully so as not to evert the ankle, which would cause inversion restriction. The ends were then fastened using two cannulated interference screws, measuring 7 x 20mm in the talus and 7 x 25mm in the calcaneus. Plane suturing was performed with absorbable multifilament yarn and skin suturing with mononylon 3-0.

Figure 3. Approach.
Source: Author's Personal Archive.

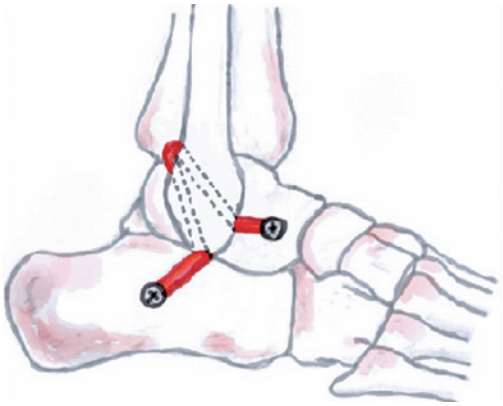

Figure 4. Path of the tendon and bone tunnels.
Source: Drawing by Rodrigo Cattani.

Postoperatively, an orthopedic boot was used for 6 weeks, allowing weight bearing as tolerated after the second week. We allowed passive and active mobility exercises after the second week. After removal of the orthopedic boot in the sixth week, we started physical therapy to gain range of motion and stretching with light to moderate muscle strengthening. After 12 weeks, we started intense muscle strengthening in the gym, with permission to walk and progression to straight line running according to each patient's response and demand. We allowed a return to football, volleyball and other sports 6 months postoperatively.

Statistical analysis

The data were entered into an Excel spreadsheet and analyzed using the *Statistical Package for the Social Sciences* (SPSS) statistical package, version 22.0.

In the descriptive approach, the variables were described as frequencies, means, medians, standard deviations and interquartile ranges. Quantitative variables were tested for normality using the Kolmogorov-Smirnov test. At the analytical stage, the continuous variable means were compared using Student's t test for independent samples or the Mann-Whitney test. Pearson's Chi-square test or Fisher's Exact test was used to evaluate the association between categorical variables.

RESULTS

Analysis of the preoperative AOFAS values revealed a broad range of results that varied between 55 and 90, with a mean of 69.3 (SD ± 11.49). The AOFAS evaluated one year after surgery had a range of 92 and 100, with a mean of 98.2 (SD ± 3.01), showing statistical significance ($p<0.001$) (Table 1).

The preoperative tibiotalar angle values ranged from 10° to 18.2°, with a mean of 13.515° (SD ± 2.52). The postoperative values ranged from 0° to 7.5°, with a mean of 2.52° (SD ± 2.63), which showed statistical significance ($p<0.001$) (Table 1).

For the preoperative anterior subluxation values, we used the following two diagnostic criteria: absolute subluxation value greater than 10mm, or value of 3mm more than the contralateral side, as described in the methods.

The values ranged between 10.5mm and 12mm in the patients who met the absolute value criterion and between 3mm and 5mm longer than the contralateral side in the patients who met the comparative contralateral criterion. Therefore, we had to divide the 10 patients into two groups, as six patients met the criteria compared with the contralateral side (group 1) and four patients had an absolute value of anterior subluxation of more than 10mm (group 2). For the group with anterior subluxation greater than 10mm (group 2), the preoperative value ranged between 10.5mm and 12mm, with a mean of 11mm. The postoperative values ranged between 2.7mm and 4.5mm, with a mean of 3.67mm. For the group where the contralateral side comparison was made (group 1), the preoperative value ranged between 3mm and 5mm longer than the contralateral side, with a mean of 3.66mm. The postoperative value varied between 1mm less (-1) and 1.8mm more than the opposite side, with a mean of 0.3mm. Both groups showed a marked improvement in the parameters, which returned to values considered normal. However, due to this division, we needed to calculate statistical significance separately for the two groups, which resulted in inconclusive results due to the small sample sizes (Table 1).

DISCUSSION

It is well documented in the literature that non-anatomical ankle ligament reconstruction techniques, such as the Chrisman-Snook, in which peroneal tendons are used for reconstruction, have produced poor results. Therefore, they are no longer recommended and maintain only historical value, in terms of being cited[6].

Direct ligament repair and re-tensioning techniques, such as that described by Brostrom[18], and later modified by Gould[19], have produced good results overall, but poor results and recurrence of instability have been cited[20,21], especially in cases of high-demand patients and athletes[22].

Table 1. Results of the AOFAS and changes in radiographic measurements

	Pre-op mean	Post-op mean	Stat. signif.
AOFAS	69.3 (SD ± 11.49)	98.2 (SD ± 3.01)	(p<0.001)
Tibiotalar angle	13.515° (SD ± 2.52)	2.52° (SD ± 2.63)	(p<0.001)
Anterior subluxation 1	3.66mm	0.3mm	Inconclusive
Anterior subluxation 2	11mm	3.67mm	Inconclusive

To overcome these possible shortcomings of direct ligament repair, especially in high-demand patients and relapse cases, anatomical reconstruction with knee flexor tendon autograft has demonstrated excellent results in early studies. Boyer & Younger[23] and Coughlin et al.[24] have obtained excellent results in terms of return of stability, mobility and ankle function.

In a 2011 publication, Ellis et al.[2] evaluated this same reconstruction technique in 11 patients undergoing surgery between 2004 and 2008, but not using bank graft and flexor autograft. They obtained good and excellent results in 10 of 11 operated patients.

Similar techniques in the literature use other allografts, as described by Pagenstert et al.[25], who used a free thin plantaris tendon graft, fixed without screws, and demonstrated excellent results, with a marked improvement in the AOFAS.

The goal of lateral ligament reconstruction with knee flexor tendon graft is to provide a return to stability without affecting ankle mobility, thereby ensuring a complete and satisfactory return to the physical and occupational activities undertaken before the injury. Our study was able to meet these objectives, achieving excellent results as demonstrated by the collected data, both in functional terms according to the AOFAS and according to imaging data collected in radiographic examinations pre- and postoperatively.

This study included a case series with a limited number of patients and no control group. The results must be confirmed in future studies with better designs. We did not find any studies in the national or international literature with such a design. There are few studies published in the literature on this technique, and most of them are not new. No Brazilian work was found showing the results of this surgical technique, making this study a pioneering one in Brazil.

CONCLUSIONS

We achieved marked improvements in both AOFAS and the radiographic measurements used to evaluate talar tilt and anterior subluxation. We demonstrated statistically significant improvements in the evaluated criteria, both clinically and radiographically. Therefore, we conclude that, in the analyzed sample, the reconstruction technique produces good and excellent results and should be considered for the treatment of chronic lateral ankle instability.

The results show the re-establishment of ankle functionality in practice and a return to the desired activities of patients undergoing the procedure, both occupational and

those involving sports and recreation. Taking into account that we have used this technique on younger patients, who are in high demand from both occupational and sports points of view, these good results provide further evidence of the quality of the surgical technique.

We were able to achieve statistically significant results consistent with evidence published in world literature using the lateral ankle ligament complex anatomical reconstruction technique, demonstrating it to be a consolidated technique with good reproducibility.

Authors' Contribution: Each author made significant individual contributions to this manuscript: CLS (https://orcid.org/0000-0003-0403-1819)* conception and planning of the activities that led to the study, wrote the article, participation in the review process, performed the surgeries, interpreted the study results, approval of the final version; EL (https://orcid.org/0000-0003-0960-3222)* conception and planning of the activities that led to the study, wrote the article performance of the surgeries; GMN (https://orcid.org/0000-0003-0817-2854)* wrote the article, performed the surgeries. *ORCID (Open Researcher and Contributor ID).

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