ABSTRACT

Purpose: To present a technical variation in tibial fixation of quadruple hamstring grafts during anatomic reconstruction of the anterior cruciate ligament (ACL). The secondary purpose was to decrease the costs associated with this procedure. Methods: Twenty patients who underwent ACL reconstruction were selected. A tibial tunnel was constructed using standard techniques, and a femoral tunnel was anatomically created using the outside-in technique. The hamstring autograft was passed (with its bend) into the tibial tunnel and affixed to the tibia using the suspensory technique and a simple staple. Femoral fixation was performed using a titanium interference screw. The patients underwent postoperative evaluations at 0, 3, 6 and 12 months using the subjective International Knee Documentation Committee (IKDC) form and Lysholm knee scores. Results: The IKDC and Lysholm score results improved over time (p<0.001) without major complications. The cost of the procedure could be reduced by using lower-cost hardware (staples). Conclusion: The proposed technique for anatomic ACL reconstruction using inverted hamstring grafts with their bend in the tibial tunnel, suspension-type fixation using a staple demonstrated good to excellent results after 1 year of follow up, with lower aggregate costs. Level of Evidence IV; Case series.

Keywords: Anterior cruciate ligament reconstruction. Tendons. Orthopedic fixation devices.

INTRODUCTION

Anterior cruciate ligament (ACL) injuries are frequent in active young people and can potentially cause instability and reduce knee function.1 Surgical treatment is recommended when patients complain of instability and to prevent associated injuries.2 This treatment is so widely accepted that approximately 100,000 ACL reconstructions are performed each year in the United States,3 and more than 90% of these surgeries yield good to excellent results.4 Courmapeau et al.5 showed that much of the costs of ACL reconstruction are related to disposable arthroscopy materials and implants; the high incidence of this procedure consequently raises concerns about its costs. In Brazil, the Unified Health System (Sistema Único de Saúde, SUS) pays R$ 486.00 for a titanium interference screw (source: personal contact with SUS suppliers, checked against payment receipts on November 29, 2017). Using the data on incidence in the United States as an example (since

RESUMO

Objetivo: Apresentar uma variação técnica na fixação do enxerto quadruplo de tendões flexores à tibia na reconstrução anatômica do ligamento cruzado anterior (LCA). O objetivo secundário é diminuir o custo associado ao procedimento. Métodos: Foram selecionados 20 pacientes que seriam submetidos à reconstrução do LCA. O túnel tibial foi realizado usando técnica padrão, e o túnel femoral foi realizado pela técnica anatômica para dentro. O enxerto (tendões flexores autólogos) foi passado com sua dobra dentro do túnel tibial e fixado com um agrafe simples pela técnica de suspensão. A fixação femoral foi realizada com parafuso de interferência de titânio. Os pacientes foram avaliados no pré-operatório e aos 3, 6 e 12 meses pós-operatórios usando o questionário International Knee Documentation Committee (IKDC) subjetivo e o questionário de Lysholm. Resultados: Os escores dos questionários IKDC e Lysholm tiveram sempre melhora com o tempo (p < 0.001) sem maiores complicações. O custo total da cirurgia foi reduzido usando material de custo menor (agrafe). Conclusão: A técnica proposta para reconstrução anatômica do LCA com enxerto de tendões flexores invertido com sua dobra no túnel tibial, com fixação tipo suspensão com um agrafe, mostrou bons a excelentes resultados após 1 ano de acompanhamento, com menor custo agregado. Nível de Evidência IV; Série de casos.

Descritores: Reconstrução do ligamento cruzado anterior. Tendões. Dispositivos de fixação ortopédica.

All authors declare no potential conflict of interest related to this article.

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Figure 1. Tibial guide for the ACL, placed through the anterolateral portal to create the outside-in anatomic femoral tunnel (A). Intra-articular view (B).
In terms of complications, two patients had limited extension (3° and 5°) compared with the normal side. However, this limitation did not compromise results during the evaluation period. All patients returned to their pre-injury activity levels without major complaints such as pain, instability, insecurity, or muscle deficit. No patient had graft rupture as of the time of the last evaluation.

**DISCUSSION**

During the first 4 weeks after ACL reconstruction, graft fixation is the weak link, and bone density plays an important role in this factor. Because its bone is spongy and denser than the tibia, fixation of the femur generally presents greater resistance. Additionally, femoral fixation may be transverse or suspension-type, both of...
which are more resistant than the techniques more commonly used in the tibia, which in turn mostly involve compression with interference screws.14-15 This weakness can be compensated by fixation using suspension in the tibia, thus increasing resistance of the fixation in the immediate postoperative period, which is essential for safe rehabilitation and to allow the graft to integrate. This study demonstrated that this is possible using simple fixation material. The technique described was possible because of the inverted folds in the graft, placing it within the tibial tunnel. This option was first described by Howell and Taylor,16 but even though these authors also used simple fixation materials, they described a more laborious type of graft fixation.

During anatomic reconstruction of the ACL, the femoral tunnel can be created by either the medial or medial accessory portals (transportal technique) or from the outside in.7,9,17-20 Cadaver studies have shown both techniques to be biomechanically similar.7,9,18,19 For the transportal technique, the tunnel must be created with the knee at approximately 110º flexion, and the femoral condyle should be protected to prevent a short tunnel and chondral injury.17 The outside-in technique has the advantage of better accuracy in positioning, with less risk of rupturing the posterior cortex of the femur (blow-out).7,8,17,20 The disadvantage of this technique is cosmetic, the need for an additional yet small incision.7,17 The outside-in technique was selected in this study, and none of the patients complained of the extra scar. Another important technical detail is that the graft is first fixed to the tibia. It is then pulled, and finally secured to the femur. The advantage is reduction of anterior draw without the need for other maneuvers, because the graft transmits the traction and pulls the tibia. (Figure 4) This fixation sequence is theoretically more logical and biomechanically superior. However, this superiority must be confirmed through future biomechanical studies.

Cost of the procedure is an important factor due to the high incidence of this type of surgery. The most common fixation method in the Brazilian public health system (SUS) utilizes titanium interference screws (one for the tibia and another for the femur). SUS pays R$ 486.00 for each of these screws, and R$ 25.00 for a simple, smooth staple; as a result, replacing one of these screws with a staple saves R$ 461.00 per surgery. This practice reduces the final cost of the procedure and contributes to the country's economy.

Limitations
First, even though one year is a short follow-up period, the main objective of this study was to prove that the technique is easy and effective, with good to excellent results. Although the sample size was small, the results showed significant improvement over time. Another weak point is the absence of a control group. Sample size was also not calculated. Objective results were not presented, but all patients who completed the follow-up returned to their pre-injury activities without pain, instability, or graft rupture, and none required additional surgery.

CONCLUSIONS
The proposed technique for anatomic ACL reconstruction, using an inverted autologous quadruple flexor tendon graft with the fold within the tibial tunnel fixed with the suspension technique and a staple, and an anatomic femoral tunnel created with the outside-to-inside technique, showed good to excellent results in this series of 20 cases, with lower material costs. Additionally, this technique can be reproduced with common materials available for ACL surgery.

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