



Original Article

The femoral tunnel view test during ACL reconstruction can ensure tunnel integrity[☆]



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ABSTRACT

Objective: Violation of the posterior femoral cortex commonly referred to as posterior wall blowout, can be a devastating intraoperative complication in anterior cruciate ligament reconstruction (ACLR) and can lead to loss of graft fixation or early graft failure. This study describes and analyzes whether the femoral tunnel view test can ensure the integrity of the femoral tunnel during ACLR.

Methods: Intraoperative femoral tunnel integrity using the 360° arthroscopic view test was performed in 584 ACLR patients between 2014 and 2016. Posterior wall blowouts were described by their location along the femoral tunnel (i.e., near the aperture or more proximal) and by the depth of the tunnel blowout (<3 mm, 3–5 mm, >5 mm), corresponding to the length of the posterior cortical wall of the violated femoral tunnel. The time spent for the test was measured during ACLR. Complications related to the femoral tunnel view test were also evaluated.

Results: The femoral tunnel view test was performed in all 584 patients. In 12 patients (1%), the femoral tunnel presented a posterior cortical blowout that did not extend beyond 3 mm. Only four patients (0.6%) presented posterior wall blowout that extended beyond 5 mm. The time for the test was 40 s (±20 s). No complications related to the test were reported.

Conclusion: The femoral tunnel view test is effective for ensuring the integrity of the femoral tunnel during ACL reconstruction, without increasing the surgical time and without an increase in the complications rate.

Clinical relevance: The femoral tunnel view test is a quick and straightforward test able to provide an adequate view of the patient's anatomy to ensure tunnel integrity during ACLR.

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O teste de visualização artroscópica do túnel femoral durante a reconstrução do LCA garante a integridade do túnel

R E S U M O

Palavras-chave:

Ligamento cruzado anterior
Túnel femoral
Artroscopia

Objetivos: A violação da cortical femoral posterior pode ser complicação intraoperatória devastadora na reconstrução do ligamento cruzado anterior (RLCA), pode levar à perda de fixação ou à falha precoce do enxerto. Este estudo descreve e analisa a capacidade do teste de visualização artroscópica do túnel femoral em evidenciar a integridade de suas paredes durante a RLCA.

Métodos: Foram prospectivamente avaliados 584 pacientes elegíveis à RLCA entre 2014 e 2016 quanto à integridade do túnel femoral com o uso do teste de visualização artroscópica. A localização ao longo do túnel femoral e a profundidade da violação no túnel (<3 mm, 3-5 mm, >5 mm) foram avaliadas. O tempo para o teste foi medido e a ocorrência de complicações relacionadas ao mesmo também foi analisada.

Resultados: Todos os 584 pacientes elegíveis foram submetidos ao teste de visualização do túnel femoral durante a cirurgia artroscópica para RLCA. Em 12 (1%) pacientes, o túnel femoral apresentou perda de integridade da cortical posterior, que não ultrapassou 3 mm. Apenas quatro (0,6%) pacientes apresentaram violação da cortical posterior, que se estendeu para além de 5 mm. O tempo médio dispendido no teste foi de 40 segundos (± 20). Nenhuma complicação realização foi relatada.

Conclusão: O teste de visualização do túnel femoral é eficaz para avaliar a integridade desse túnel durante a RLCA, sem aumentar o tempo cirúrgico e sem provocar aumento na taxa de complicações relativas ao procedimento.

Relevância clínica: O teste de visualização artroscópica do túnel femoral é uma técnica simples e rápida, capaz de obter visão adequada da anatomia do paciente, garante a integridade do túnel durante a RLCA.

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Introduction

Several parameters are important for the successful anterior cruciate ligament reconstruction (ACLR).¹⁻⁶ An adequate positioning of the femoral and tibial tunnels is one of the main determinants of the clinical outcome,⁷⁻¹¹ as the final position of both tunnels determines the kinematics of the ACL graft after surgery.^{1,3,4,12}

ACLR failure usually results from the use of an inadequate surgical technique, failure of the healing process, or post-operative trauma.^{11,13} The most frequent technical error observed in ACLR is the inadequate positioning of the femoral tunnel.^{13,14} An overly anterior position may result in rotational laxity or even graft clamping; in turn, an overly posterior position may cause posterior or lateral cortex fracture, which may lead to loss of graft restraint and fixation failure. Thus, if this complication is not readily recognized in the intraoperative period and optional fixation or salvage strategies are not employed, the risk of early graft failure is considerably increased.^{11,13,14} It is difficult to determine the true incidence of posterior wall blowout in ACLR since its description in the literature has not been well described.

The present study is aimed at analyzing the ability of the femoral tunnel arthroscopic visualization test to evidence the integrity of the femoral tunnel walls during ACLR. The hypothesis is that direct vision of the tunnel in its entirety is ensured

with the use of the arthroscopic visualization test, which could secondarily minimize the complications related to a tunnel fracture during ACLR.

Methods

Between January 1, 2015 and May 31, 2016, 640 patients with ACL injury underwent ACLR and their data were prospectively collected. All patients with ACL injury, with injury time of less than 12 months were included, without any gender, age, or trauma mechanism distinction. Patients with multiligament lesions, associated degenerative conditions in the knee, incomplete physeal closure, arthroscopic procedures prior to surgery at knee level, or those who underwent other concomitant major procedures (e.g., high tibial osteotomy) were excluded. The study was approved by the Ethics Committee of the institution (CAAE No. 61368116.3.0000.5127).

The 584 (91.3%) patients included in the final study group underwent ACLR using the inside-out technique described below (quadruple hamstring technique)^{15,16}; the procedures were performed by the Knee Group of this institution.

ACLR – inside-out technique

The technique used is a previously published modification, which is briefly described herein.^{8,14,15,17} The grafts are

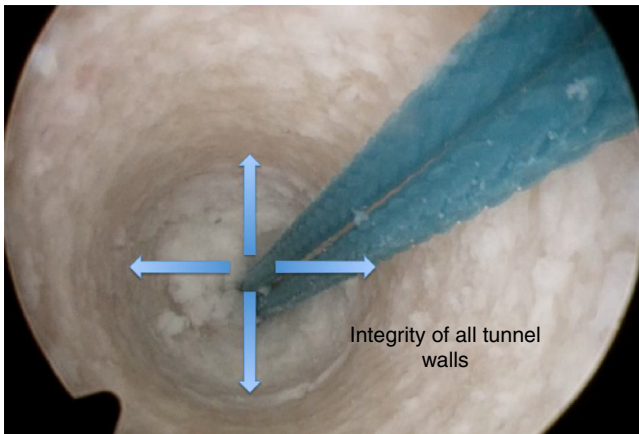


Fig. 1 – Photograph of arthroscopic visualization of the femoral tunnel during reconstruction of the anterior cruciate ligament, demonstrating the integrity of all walls.

removed with an open stripper, preserving the tibial insertion, which ensures better fixation and vascularization. The knee should be flexed at 120° for better visualization when the femoral tunnel is punctured. The inside-out femoral tunnel is placed 7 mm from the posterior border of the lateral femoral condyle. The remainders of the ACL are used as an anatomical reference, and the femoral guide is used through the anteromedial portal. After the femoral tunnel is created, an arthroscopic camera is positioned in the medial portal, allowing direct visualization of the femoral tunnel walls. After general visualization of the entrance, the arthroscopic chamber is advanced inside the tunnel to assess its integrity. Lens rotation allows a 360° view of the tunnel, which is important for evaluating cortical integrity (Fig. 1).¹⁵ In case of a small fracture of the posterior wall, tunnel length must be increased. The tibial tunnel is drilled in a standard manner, with a guide near the medial tibial spine and anteriorly to the tibial insertion of the posterior bundle of the ACL. The tibial guide is then positioned so that the guidewire divides or remains within the center of the ACL tibial stump. The graft is moved from the tibia to the femur. Through the portal, a 25 mm interference screw of the same diameter as the tunnel is introduced into the femoral tunnel. For tibial fixation, a 20 mm interference screw of the same diameter as the tunnel is also used. The graft is secured with the knee in 20° of flexion.

Patients were assessed intraoperatively as to the integrity of the femoral tunnel with 360° arthroscopic visualization. Several variations of posterior wall blowout may occur, depending on their location along the femoral tunnel or the depth of the tunnel violation (<3 mm, 3–5 mm, or >5 mm; Fig. 2). The test duration during ACLR was measured, with the mean time outlined by statistical analysis. The presence of complications related to the test was also analyzed.

Statistical analysis

All the calculations were made using SPSS software (version 20.0, SPSS Inc., Chicago, IL), with a 95% confidence interval and a 5% level of significance; statistical relationships were considered significant when $p \leq 0.05$. Descriptive data

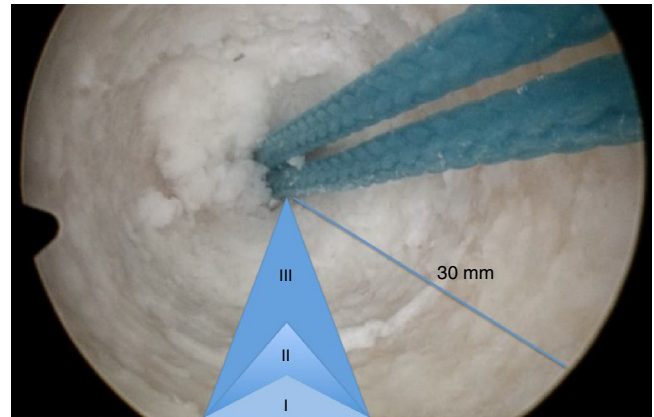


Fig. 2 – Photograph of the visualization of the femoral tunnel during anterior cruciate ligament reconstruction, demonstrating the depth with the possible areas of involvement: (I) up to 3 mm, (II) 3–5 mm, (III) >5 mm.

(mean, median, scale, proportions) were reported for the entire cohort. The statistical analysis focused on the descriptive analysis.

Results

A total of 620 patients underwent ACLR during the study period. Of these, 584 remained eligible after the exclusion criteria were applied. Regarding the patients' gender, 475 (81.4%) were male. The mean age was 28 years (± 13); 356 patients (61%) presented injury to the right limb, and the most injury-related activity was soccer practice, observed in 368 cases (63.3%), followed by falls in 79 patients (13.6%).

The femoral tunnel visualization test was performed on all 584 eligible patients. In 12 (2%) patients, the femoral tunnel presented a posterior cortical violation of no more than 3 mm from the entrance, which does not compromise femoral fixation. Only four patients (0.7%) presented posterior wall blowout that extended beyond 5 mm; in those cases, the open fixation was modified to over-the-top fixation in three cases. The other case was modified with the technique of two incisions to deviate the tunnels from the joint (two-incision technique). The mean time for the test was 40 s (± 20). No complications related to the trial were reported.

Discussion

The most important finding of the present study was that the arthroscopic visualization test of the femoral tunnel is simple, fast, free of complications, and ensures a full visualization of the femoral tunnel in ACLR with the inside-out technique. The most common error with the ACLR surgical technique is the inadequate positioning of the tunnels, which can be identified in 70–80% of the reconstructions.^{6,18,19} For anatomical ACLR, the femoral and tibial tunnels should be made in the center of their respective fixations; therefore, it is crucial in viewing the fixation at an appropriate angle and in its entirety.^{3,4,9,12} If these steps are not followed, the diagnosis of posterior wall

blowout may not be immediately made. Although the femoral tunnel is the most important in ACLR and the test has been evaluated for such visualization, it can be extrapolated to other tunnels in ligament reconstructions at knee level.

When the posterior femoral cortex is ruptured and the complication is immediately identified, it may be possible to maintain the original plan for fixation if the cortical defect is minimal (<3 mm).^{11,14,20} A posterior wall blowout that does not extend beyond 3–5 mm from the tunnel entrance can be recovered by discrete anterior redirection of the guide or by increasing tunnel length, followed by the same planned fixation. Before drilling continues, however, a probe should be used to evaluate and confirm the degree of rupture. If the posterior wall blowout is detrimental to fixation (defined by an extension greater than 5 mm or if it affects a large circumference of the tunnel), several rescue options are available and should be used. Two examples are the suspensory fixations, which use the lateral femoral cortex, and over-the-top fixation. Both methods are useful, as they do not require an intact posterior cortex.^{13,14}

Arthroscopic ACLR was previously associated with a steep learning curve. Topliss and Webb²¹ reviewed data from primary ACLR procedures for 12 consecutive months and demonstrated that 65% of femoral tunnels and 59% of tibial tunnels were positioned outside acceptable parameters. Behrend et al.²⁰ assessed tunnel placement in 54 patients and observed that the femoral tunnels were correctly positioned in 78%, and 22% were positioned too anteriorly. Sudhahar et al.²² suggested as a possible explanation the increased precision in tunnel positioning with increased surgical experience. Only in 55% of cases, the orthopedic surgeon was able to predict the femoral position in a sagittal plane. Obviously, with more experience, the surgeon is able to better visualize, understand arthroscopic anatomy, and adapt to the three-dimensional aspect of the knee. Proper tunnel positioning is fundamental for anatomic ACLR; however, adequate positioning does not ensure wall integrity.^{1,3,22}

The main limitation of this study is that all procedures were performed by experienced surgeons and, therefore, correct positioning of the drill guides was obtained in most cases, thus minimizing the complications related to tunnel wall integrity. However, even in such cases, direct visualization of the tunnels is useful to ensure the integrity of the tunnels. The potential disadvantage of the technique is the need to modify the portal for direct visualization, although this does not significantly increase the duration or the technical difficulty of the procedure.

Conclusion

The femoral tunnel arthroscopic visualization test ensured the visualization of femoral tunnel integrity during ACLR, without increasing the surgical time and the rate of complications.

Conflicts of interest

The authors declare no conflicts of interest.

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