



Original article

Comparative evaluation of the results of three techniques in the reconstruction of the anterior cruciate ligament, with a minimum follow-up of two years[☆]



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ARTICLE INFO

Article history:

Received 23 December 2015

Accepted 12 April 2016

Available online 10 May 2017

Keywords:

Anterior cruciate ligament/injuries

Anterior cruciate ligament reconstruction

Knee

Orthopedic procedures

ABSTRACT

Objective: To compare the clinical results of the reconstruction of the anterior cruciate ligament by transtibial, transportal, and outside-in techniques.

Methods: This was a retrospective study on 90 patients (ACL reconstruction with autologous flexor tendons) operated between August 2009 and June 2012, by the medial transportal (30), transtibial (30), and “outside-in” (30) techniques. The following parameters were assessed: objective and subjective IKDC, Lysholm, KT1000, Lachman test, Pivot-Shift and anterior drawer test.

Results: On physical examination, the Lachman test and Pivot-Shift indicated a slight superiority of the outside-in technique, but without statistical significance ($p = 0.132$ and $p = 0.186$ respectively). The anterior drawer, KT1000, subjective IKDC, Lysholm, and objective IKDC tests showed similar results in the groups studied. A higher number of complications were observed in the medial transportal technique ($p = 0.033$).

Conclusion: There were no statistically significant differences in the clinical results of patients undergoing reconstruction of the anterior cruciate ligament by transtibial, medial transportal, and outside-in techniques.

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[☆] Study conducted at the Faculdade de Ciências Médicas da Santa Casa de Misericórdia de São Paulo, Departamento de Ortopedia e Traumatologia, Grupo de Cirurgia de Joelho, São Paulo, SP, Brazil.

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<http://dx.doi.org/10.1016/j.rboe.2017.05.003>

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Avaliação comparativa dos resultados de três técnicas na reconstrução do ligamento cruzado anterior com seguimento mínimo de dois anos

R E S U M O

Palavras-chave:

Ligamento cruzado anterior/lesões
Reconstrução do ligamento cruzado anterior
Joelho
Procedimentos ortopédicos

Objetivo: Comparar os resultados clínicos objetivos e subjetivos da reconstrução do ligamento cruzado anterior (LCA) pelas técnicas transtibial, transportal e “de fora para dentro”.
Métodos: Estudo retrospectivo de 90 pacientes operados entre agosto de 2009 e junho de 2012, para reconstrução do LCA pelas técnicas transportal medial (30), transtibial (30) e “de fora para dentro” (30). Os pacientes foram avaliados por meio do *International Knee Documentation Committee* (IKDC) objetivo e subjetivo, escore Lysholm e testes KT1000, de Lachman, Pivot-Shift e gaveta anterior.

Resultados: Em relação ao exame físico, nos testes de Lachman e Pivot-Shift encontrou-se uma discreta superioridade da técnica “de fora para dentro”, porém sem significância estatística ($p=0,132$ e $p=0,186$ respectivamente). Gaveta anterior, KT1000, IKDC subjetivo, Lysholm e IKDC objetivo apresentaram resultados semelhantes nos grupos avaliados. Um maior número de complicações foi relatado na técnica transportal ($p=0,033$).

Conclusão: Resultados clínicos objetivos e subjetivos sem significância estatística na comparação das três técnicas de reconstrução do LCA.

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Introduction

Reconstruction of the anterior cruciate ligament (ACL) is one of the most common orthopedic surgeries. The results of this procedure have been well documented in several studies as good-to-excellent in 85%–95% of patients.¹ Nevertheless, some issues regarding the placement of tunnels continue to be discussed and studied.²

The femoral tunnel can be made with a guide through the tibial tunnel, or a point closer to the origin of the ACL could be reached, which is therefore more similar to the original anatomy (“outside-in” or through the medial portal). In the last two decades, the most used method worldwide was the transtibial.³ Anatomical studies have shown that the positioning of the tunnel through this technique is not at the center of the ACL origin^{2,4}; other biomechanical^{2,5} and clinical^{6,7} studies show advantages regarding achieved stability with a more anatomical positioning of the femoral tunnel.

There are some advantages to each technique. Among the advantages of the transtibial technique, it can be mentioned that no lateral incision is required in the distal thigh, an isometric position is obtained, and the femoral tunnel is in the same orientation as the tibial tunnel. The transportal technique achieves an anatomical femoral tunnel, independent tunnels, non-divergence in the placement of the femoral interference screw, and better rotational stability. The advantages of the outside-in technique include the anatomical positioning of the femoral tunnel, better rotational stability, no risk of posterior wall rupture, and less divergence of the tunnels when compared the transportal technique.⁸

This study aimed to compare the objective and subjective clinical results of the ACL reconstruction by the transtibial technique and by the transportal and outside-in anatomical techniques with the use of autologous flexor tendons as

a graft. It was hypothesized that the anatomical techniques would generate better results in the evaluated criteria.

Patients and methods

From August 2009 to June 2012, 170 patients (knees) underwent ACL reconstruction by the same surgeon. Of these, 119 met the inclusion criteria of the study: unilateral ACL injury; skeletally mature; no previous surgeries on the affected side (except for arthroscopic meniscectomy); absence of diffuse degenerative alterations (arthrosis); absence of associated ligament injuries (except medial collateral ligament grades I and II); and absence of morbid obesity. ACL re-rupture at any point in the study was an exclusion criterion, because the objective was to compare the stability of the knees with intact ACL. Re-ruptures were defined as new knee sprain associated with clinical instability. Of the 119 patients, 45 were underwent the transtibial technique (between 2009 and 2010), 35 transportal (between 2010 and 2011), and 39 outside-in (between 2011 and 2012). Five patients were excluded due to ACL re-rupture, two from the transtibial group, two from the transportal group, and one from the outside-in group.

Patients were retrospectively selected and randomly called up for clinical evaluation: all patients who had undergone each technique were listed; then, a sequence of patients to be contacted was elaborated, and by drawing lots patients were called until 30 members were allotted into each group: I – transtibial; II – transportal; and III – outside-in technique.

Patients were postoperatively evaluated with a KT1000™ arthrometer (MEDmetric – San Diego, California, United States) at 20 degrees of flexion and 133N, Lachman test, anterior drawer test, Pivot-Shift test, objective International Knee Documentation Committee (IKDC)⁹ score, subjective IKDC score, and Lysholm score.¹⁰ The preoperative clinical examination and the questionnaires were applied by the

Table 1 – Description of personal characteristics and diagnostic scales before surgery according to the reconstruction technique and result of statistical tests.

Variable	Technique used			Total (n=90)	p
	Transportal (n=30)	Transtibial (n=30)	Outside-in (n=30)		
<i>Age (years)</i>					0.119 ^a
Mean (SD)	31.4 (8)	37.1 (11.7)	36.2 (13.3)	34.9 (11.4)	
Median (min; max)	31 (15; 50)	34.5 (17; 59)	36.5 (16; 66)	33.5 (15; 66)	
<i>Gender, n (%)</i>					0.108 ^b
Male	29 (96.7)	30 (100)	27 (90)	86 (95.6)	
Female	1 (3.3)	0 (0)	3 (10)	4 (4.4)	
<i>Side, n (%)</i>					0.171
Right	21 (70)	16 (53.3)	14 (46.7)	51 (56.7)	
Left	9 (30)	14 (46.7)	16 (53.3)	39 (43.3)	
<i>Months from trauma</i>					0.262 ^c
Mean (SD)	24.6 (31.6)	21.4 (31.2)	15.4 (23.7)	20.5 (29)	
Median (min; max)	10.5 (1; 96)	7 (2; 120)	5.5 (1; 96)	6.5 (1; 120)	
<i>Type of injury, n (%)</i>					0.468
Acute	6 (20)	7 (23.3)	10 (33.3)	23 (25.6)	
Chronic	24 (80)	23 (76.7)	20 (66.7)	67 (74.4)	
<i>Associated injury, n (%)</i>					0.572
No	6 (20)	6 (20)	9 (30)	21 (23.3)	
Yes	24 (80)	24 (80)	21 (70)	69 (76.7)	
<i>Complications, n (%)</i>					0.033 ^b
No	27 (90)	30 (100)	30 (100)	87 (96.7)	
Yes	3 (10)	0 (0)	0 (0)	3 (3.3)	
<i>Lysholm pre</i>					0.358 ^c
Mean (SD)	62.7 (18.1)	66.2 (18.1)	59.5 (18.4)	62.8 (18.2)	
Median (min; max)	67.5(21; 100)	67.5(27; 100)	60.5 (19; 90)	64 (19; 100)	
<i>Subjective IKDC pre</i>					0.002 ^a
Mean (SD)	59.8 (17.3)	63.1 (19.7)	47.2 (16.2)	56.7 (18.9)	
Median (min; max)	60 (15; 90)	62.6(26; 100)	50 (17; 78)	58 (15; 100)	
Chi-squared test.					
^a ANOVA.					
^b Likelihood ratio test.					
^c Kruskal-Wallis test.					

same surgeon, who also performed all the surgeries. The postoperative evaluation was conducted by physicians who were not present at the time of surgery, interns of the knee surgery group. The KT1000™ assessment was not applied preoperatively due to operational issues.

A total of 90 patients were reassessed, 86 males and four females. There were a total of 51 right and 39 left knees. The mean age was 34.9 years. All of the 90 patients practiced some physical activity before the injury. The subjective IKDC and the preoperative mean Lysholm scores were 56.70 (14.9–100) and 62.80 (15–100), respectively. Only 25.6% of the patients presented acute injuries (less than three months); 74.4% had chronic injuries (more than three months of trauma). The patients were separated into three groups, in relation to the surgical technique: transtibial group, trans-medial portal group, and outside-in group. Table 1 shows that preoperative personal and clinical characteristics did not differ between groups ($p > 0.05$); only the subjective IKDC showed a statistically significant mean difference between the techniques ($p = 0.002$). Patients in the outside-in group had a lower mean subjective IKDC than the patients in the other groups. Therefore, the groups were preoperatively homogenous in general.

Regarding the surgical technique, arthroscopy, treatment of possible meniscal and chondral lesions, and ACL reconstruction were performed, with fixation of a semitendinous and gracile flexor tendon graft (harvested by the surgeon himself, always using the same technique).

In the transtibial technique, the tibial tunnel was made with the knee in extension and using an extension guide (65 Howell Guide®; Biomet Sports Medicine Inc., Warsaw, Ind.). Subsequently, a conventional transtibial guide (aimer) was placed in the posterior margin of the intercondyle. Before passing the guide wire (Kirschner 2.4), the aimer was rotated distally to reach a more horizontal position. At that moment, the femoral tunnel was drilled; the graft was then passed and fixated with an Endobutton® (Smith & Nephew, Andover, MA, United States) in the femur and with a metallic interference screw in the tibia.

In the transportal technique, the tibial tunnel was made in the same way as in the transtibial technique, using an extension guide (65 Howell Guide®; Biomet Sports Medicine Inc., Warsaw, Ind.). An accessory medial portal was used to visualize the positioning of the tunnel. With the knee at 90 degrees of flexion, the center of the native ACL (anatomical

Table 2 – Description of the postoperative diagnostic scales according to reconstruction technique and result of the statistical tests.

Variable	Technique used			Total (n = 90)	p
	Transportal (n = 30)	Transtibial (n = 30)	Outside-in (n = 30)		
Objective IKDC, n (%)					
C	3 (10)	0 (0)	0 (0)	3 (3.3)	0.531 ^a
B	6 (20)	9 (30)	6 (20)	21 (23.3)	
A	21 (70)	21 (70)	24 (80)	66 (73.3)	
Subjective IKDC					
Mean (SD)	98.5 (3.4)	98.7 (3.3)	97.2 (3.6)	98.2 (3.5)	0.200 ^b
Median (min; max)	100 (88; 100)	100 (85; 100)	98.9 (86; 100)	100 (85; 100)	
Absolute KT1000™, n (%)					
0-2	27 (90)	28 (93.3)	26 (86.7)	81 (90)	0.698 ^a
3-5	2 (6.7)	2 (6.7)	4 (13.3)	8 (8.9)	
6-10	1 (3.3)	0 (0)	0 (0)	1 (1.1)	
Lysholm score					
Mean (SD)	97.4 (5.1)	98.4 (3.4)	98.2 (3.7)	98 (4.1)	0.627 ^b
Median (min; max)	100 (78; 100)	100 (86; 100)	100 (87; 100)	100 (78; 100)	
Pivot-Shift, n (%)					
Negative	23 (76.7)	24 (80)	28 (93.3)	75 (83.3)	0.186
Positive	7 (23.3)	6 (20)	2 (6.7)	15 (16.7)	
GA, n (%)					
Negative	24 (80)	27 (90)	27 (90)	78 (86.7)	0.439 ^c
Positive	6 (20)	3 (10)	3 (10)	12 (13.3)	
Lachman, n (%)					
Negative	21 (70)	22 (73.3)	27 (90)	70 (77.8)	0.132 ^a
Positive	8 (26.7)	8 (26.7)	3 (10)	19 (21.1)	
++	1 (3.3)	0 (0)	0 (0)	1 (1.1)	
Return to sports practice, n (%)					
No	6 (20)	10 (33.3)	9 (30)	25 (27.8)	0.550 ^a
8 months	11 (36.7)	10 (33.3)	9 (30)	30 (33.3)	
<8 months	13 (43.3)	10 (33.3)	12 (40)	35 (38.9)	
Chi-squared test.					
^a Kruskal-Wallis test.					
^b ANOVA.					
^c Likelihood ratio test.					

positioning) was marked through the conventional antero-medial portal. The guidewire (Kirschner 2.4) was inserted and positioned at the previously marked point; the knee was flexed between 120 and 130 degrees, and finally the guidewire was advanced until it passed the lateral cortex of the femur. Subsequently, the femoral tunnel was made with the respective drill. The femoral fixation was made using an Endobutton® (Smith & Nephew, Andover, MA, United States), and the tibial fixation was made with a metallic interference screw.

In the outside-in technique, the tibial tunnel was made with the knee flexed at 90° and the tibial guide at 55°. Then, the femoral tunnel was made, with an anatomical femoral guide, which was introduced through the antero-medial arthroscopic portal and positioned anatomically. An incision of approximately 1 cm was made over the lateral epicondyle; the fascia lata was perforated to reach the bone, allowing the outside-in guidewire insertion, followed by the corresponding drill bit. The fixation was made with a metallic interference screw, from the outside in, into the femur and the tibia.

All groups underwent the same rehabilitation protocol, using crutches for two weeks without postoperative immobilization. Patients were authorized to perform open kinetic chain quadriceps exercises after the eighth week, run after 16 weeks, and return to sports after six months, after a proprioceptive assessment and strength tests applied by the physiotherapist.

For statistical assessment, quantitative characteristics were described by summary measures (mean, standard deviation, median, minimum, and maximum)¹¹ and compared among the techniques using analysis of variance (ANOVA) followed by Bonferroni multiple comparisons when necessary, or using Kruskal-Wallis tests *apud* Netter.¹² Qualitative characteristics were described as absolute and relative frequencies¹¹; the association was tested with the chi-squared test or likelihood ratio test when the sample was insufficient for the application of chi-squared test.¹¹ Some of the scales assessed had semiquantitative values and were described as absolute and relative frequencies and compared among the techniques using the Kruskal-Wallis test. A 5% significance level was adopted. For the sample calculation, objective IKDC

was used as the primary outcome criterion. In order to detect a minimum difference of 20% in the incidence of C or D (postoperative objective IKDC) among the groups, with an alpha error of 5% and a power of 80%, 30 patients in each group were needed.

This study was approved by the research ethics committee of the institution.

Results

The assessment two years after surgery was performed with physical examination, KT1000TM arthrometer, objective and subjective IKDC score, Lysholm score, and time to return to sport. Table 2 shows the objective and subjective postoperative results.

Regarding the objective evaluation, very similar results were obtained when comparing the three groups, for objective IKDC, KT1000TM, and anterior drawer test. In the Lachman score and Pivot-Shift test, better results were observed in the outside-in group, but without statistical significance ($p = 0.132$ and $p = 0.186$; chi-squared test and Kruskal-Wallis test, respectively). Regarding the subjective evaluation, the Lysholm and subjective IKDC scores showed similar results ($p = 0.627$ and $p = 0.200$, respectively; ANOVA).

Regarding return to sports practice, 27% of the patients did not resume, 33.3% returned after eight months, and 38.9% before eight months. When comparing return to sports among the three groups, similar results were observed ($p = 0.550$, Kruskal-Wallis test).

During patient enrollment, five re-ruptures were observed, two in the transtibial group, two in the medial transportal group, and one in outside-in the group. When comparing the occurrence of rupture between the groups, these five cases were included, which led to a total of 32 patients in the transtibial group, 32 in the medial transportal group, and 31 in the outside-in group. No statistically significant difference was observed (chi-squared test, $p = 0.8$).

Discussion

Recent studies have shown a trend toward better results when using the anatomical technique, in which the femoral tunnel is placed in the center of the original ACL.^{7,13} Several biomechanical studies in cadavers^{2,5,13,14} and clinical studies in humans^{6,7} comparing the transtibial technique with anatomical techniques (medial transportal or outside-in) demonstrated superior results (objective and subjective) in anatomical techniques, especially regarding rotational stability. Nonetheless, there is no evidence of a long-term superiority, nor that one technique presents fewer complications, such as new rupture or evolution of arthrosis. In some studies demonstrating the superiority of one technique over another the physical examination of the knee was performed without the action of the muscles (such as cadaver knees or anesthetized patient)^{2,5,15,16} and used subjective questionnaires.^{7,17}

In spite all these considerations, in 2015 Robin et al.⁸ published a systematic review of the advantages and disadvantages of the transtibial, medial transportal, and outside-in

techniques. Despite the differences between them,^{8,18} these authors concluded that there is no gold standard for making the femoral tunnel, which leads to questions about the standardization of the femoral tunnel in the various studies already mentioned.

When analyzing the physical examination, no statistical difference was observed in the anterior drawer and Lachman tests, as expected, since stability in the coronal plane is maintained in all techniques. In the Pivot-Shift test, which analyzes the rotational stability, the anatomical technique is expected to show an advantage.¹⁹⁻²³ In the present study, there were fewer cases of Pivot-Shift positivity in the outside-in technique, without statistical significance. However, these data should be carefully analyzed, because with a larger sample, perhaps some statistical difference would be observed, or it could simply confirm that there really are no differences between the techniques. Therefore, more studies and especially larger samples are needed for more precise conclusions.

This study aimed to compare patients with different femoral tunnel positioning and with intact graft. Nonetheless, it is important to comment on re-rupture, since Rahr-Wagner et al.²⁴ recently published a retrospective study demonstrating more re-ruptures in knees that underwent the medial transportal technique when compared with transtibial technique. It is worth remembering that the study by Rahr-Wagner et al.²⁴ was based on data from the Danish registry, therefore including patients operated by several surgeons in several hospitals, which generates probable biases. In addition, other prospective studies comparing these two techniques did not observe more re-ruptures in the anatomical technique.^{25,26} When enrolling patients for the present study, two re-ruptures were observed in the transtibial group, two in the medial transportal group, and one in the outside-in group, with no statistical significance.

This study has limitations, such as the small sample size, since similar results are expected in the outcome criteria used to evaluate reconstructions of the anterior cruciate ligament, which requires samples with a large number of patients; the impossibility of blinding the examiners in the evaluations, since the scars of each technique are different; the fact that the KT1000TM was not applied preoperatively prevented postoperative comparison; and the fact that the intra- and interobserver agreements were not assessed, which impoverishes the evaluation of the physical examination.

Conclusion

No statistically significant differences were found in objective and subjective clinical results when comparing patients submitted to ACL reconstruction by transtibial, transportal, and outside-in techniques.

Conflicts of interest

The authors declare no conflicts of interest.

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