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Original article

Functional result relating to the positioning of the graft in anterior cruciate ligament reconstruction☆

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ABSTRACT

Objective: To ascertain the coronal angles for the femoral and tibial tunnels that provide the best postoperative result from anterior cruciate ligament (ACL) reconstruction surgery, through assessing the variables of the IKDC and Lysholm–Tegner questionnaires and the hop test.

Methods: Sixteen patients with a single unilateral ACL injury who underwent this surgery between 24 and 36 months earlier were evaluated. They were divided into four groups in which the tibial and femoral tunnel angles were greater than or less than 65° in the coronal plane.

Results: The results demonstrated that a more vertical angle for the tibial tunnel (72°) and a more horizontal angle for the femoral tunnel (60°), with valgus alignment of 12° correlated with the best values for the variables studied. This may indicate that the long-term results from this surgery are excellent.

Conclusion: A more horizontal femoral angle and a more vertical tibial angle produced better assessments in the tests that were applied and in the functional results evaluated.

Resultado funcional relacionado ao posicionamento do enxerto na reconstrução do ligamento cruzado anterior

Palavras-chave:
Joelho/cirurgia
Ligamento cruzado anterior
Resultado de tratamento
Traumatismos em atletas

RESUMO

Objetivo: Averiguar qual a angulação coronal dos túneis femoral e tibial que proporciona o melhor resultado no pós-operatório de cirurgia de reconstrução do LCA. As variáveis avaliadas foram os questionários IKDC e Lysholm-Tegner e o Hop-Test.

Métodos: Foram analisados 16 pacientes com pós-operatório entre 24 e 36 meses, com lesão isolada unilateral do LCA. Foram divididos em quatro grupos, nos quais os ângulos dos túneis tibial e femoral foram menores ou maiores do que 65° no plano coronal.

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Resultados: A angulação do túnel tibial mais verticalizada (72°) e do túnel femoral mais horizontalizada (60°) com o alinhamento em valgo de 12° relacionou-se com os melhores valores para as variáveis estudadas, o que pode indicar um resultado ótimo para a cirurgia em longo prazo.
Conclusão: A angulação femoral mais horizontalizada e a angulação tibial mais verticalizada têm melhores avaliações nos testes aplicados e nos resultados funcionais avaliados.

Introduction

Injuries or tears to the anterior cruciate ligament (ACL) in athletes or physically active individuals are seen very often in orthopedic practice. Epidemiological studies have showed that the incidence is approximately 80,000 injuries per year.[1]

The first reports on ACL injuries appeared in the literature in the nineteenth century.[2] Records of surgical reconstruction first appeared at the beginning of the twentieth century.[3] Over the last 30 years, many surgical techniques have been described for reconstructing this ligament, using several structures as a graft source. A long path was followed until the technique described by Campbell[4] in 1939, which used the patellar ligament, was returned to. Also in that year, Macey[5] described the first technique using the flexor tendons of the semitendinosus and gracilis (ST-G).

Although the great advances in surgical techniques have reduced the time taken for patients undergoing ACL reconstruction to return to their activities,[6] we did not find any studies in the literature correlating the angles of the tunnels with the postoperative results.

There is no consensus regarding the various techniques for ACL reconstruction that have been described, in relation to comparisons between the postoperative results. There is therefore a need for better examination of the possible variable that might correlate with a better final result.

Currently, tibial tunnels are constructed using prefabricated guides that are adjustable according to the angle that is desired.

The objective of this study was to ascertain the coronal angle of the femoral and tibial tunnels that would provide the best postoperative result from ACL reconstruction surgery, using the following assessment criteria: patient's complaints, satisfaction with the result, Lysholm–Tegner questionnaire (Annex 1), IKDC questionnaire (Annex 2), clinical examination and hopping on one foot.

Material

The knees of 16 patients were evaluated (Table 1). These patients were seen at the knee surgery outpatient clinic of the Sobradinho Regional Hospital, Federal District, Brazil, and had undergone ACL reconstruction performed by the same surgeon, who was a specialist in knee surgeon.

The demographic characteristics (gender, age body mass index (BMI) and dominant leg) are listed in Table 1.

Table 1 – Characteristics of the sample.

	n (%)
Gender	
Male	13 (83.25)
Female	3 (17.75)
Age (years)	
Up to 20	1 (6.25)
21–30	9 (56.25)
31–40	4 (25)
Over 40	2 (12.5)
Mean = 29.7	
BMI (kg/m²)	
18.5–24.9 (Normal)	10 (62.5)
25–29.9 (Overweight)	6 (37.5)
Mean = 24.96	
Dominant leg	
Right	11 (68.75)
Left	3 (18.75)
Ambidextrous	2 (12.5)

The inclusion criteria were as follows: a postoperative period of between 24 and 48 months; ACL injury alone, as confirmed by means of magnetic resonance imaging before the operation; physiotherapy applied after the operation; and having been released from rehabilitation (with or without returning to the same activity level as before the injury).

The exclusion criteria comprised presence of any associated injuries to the ligaments, menisci or joint cartilage, revision surgery, inflammatory signs, neuromuscular disorders, infection, arthrofibrosis, lower-limb fractures, or advanced osteoarthrosis in the femoropatellar or tibiofemoral joints with evident displacement of the joint axis.

Table 2 details the factors correlated with the type of sport practiced, the ground and the conditions under which the injury and the rehabilitation took place.

All the patients underwent the same standard surgical technique, consisting of grafting a single band from the semitendinosus and gracilis tendons (ST-G) and use of a proximal crosspin fixation implant and an absorbable interference screw, with a distal cortical post (Fig. 1).

Method

The patients were given explanations regarding the aims of the study and, after agreeing to participate, they signed a free and informed consent statement.

Table 2 – Factors relating to the injury.

	n (%)
Age (years) at the time of the injury	
Up to 20	4 (25)
21–30	9 (56.25)
31–40	2 (12.5)
Over 40	1 (6.25)
Mean = 26.2	
Environment at the time of the injury	
Sports practice (leisure)	13 (81.25)
Others	3 (18.75)
Sport practiced at the time of the injury	
Soccer	10 (62.5)
Others	6 (37.5)
Ground surfacing at the time of the injury	
Synthetic grass	6 (37.5)
Natural grass	4 (25)
Parquet floor	2 (12.5)
Mat	2 (12.5)
Others	2 (12.5)
Interval between injury and surgery (months)	
<6	8 (50)
6–12	2 (12.5)
13–24	4 (25)
>24	2 (12.5)
Mean = 13.85	
Side operated	
Right	7 (43.75)
Left	9 (56.25)
Relationship between dominant and operated sides	
Ipsilateral	6 (37.5)
Contralateral	8 (50)
Ambidextrous	2 (12.5)

The present study was submitted to the research ethics committee of the Foundation for Health Sciences Teaching and Research (FEPECS) and was approved by this body under report no. 0018/2010 and protocol no. 211/2010.

Non-sequential numbers were attributed to each knee that underwent surgery.

The clinical assessment was made firstly in a consultation office, where the patients' histories relating to the postoperative period were taken and the questions of the subjective International Knee Documentation Committee questionnaire (IKDC, 2000) and the Tegner–Lysholm Knee Scoring Scale were applied and scores were attributed. The latter scale has been validated for the Portuguese language.[7] Clinical examinations were performed in order to find out whether there was any presence of joint effusion, crepitation, pain or laxity (Lachman, pivot-shift and anterior drawer tests), and knee goniometry was performed. All these data were recorded on a specific form (Annex 3).

The patients performed a hop test, from which a lower-limb symmetry index was obtained. This comprised the ratio of measurements of the distance jumped by means of a one-leg hop on the side that underwent surgery in comparison with the non-operated side.

Lower-limb symmetry index = (distance with operated limb/distance with contralateral limb) × 100

Fig. 1 – Radiograph on knee that underwent the standard technique.

The patients then underwent radiography (X-ray) of the operated knee in anteroposterior (AP) view, in an upright standing position with weight-bearing in parallel and with parallel rays. The joint line tangential to the condyles and the axes of the tunnels that had been constructed for the grafts to be inserted were traced out on these radiographs, and in the coronal plane, and the angles in degrees were measured (Fig. 2).

Mean values were calculated from these angles and the patients were then grouped into categories, according to the angles of the femoral and tibial tunnels on the AP knee radiographs (Table 3).

The postoperative results in terms of the following variables were evaluated for each group, in relation to the tunnel data:

- Patients' subjective satisfaction with the surgical result;
- Scoring from the Lysholm–Tegner and IKDC questionnaires;

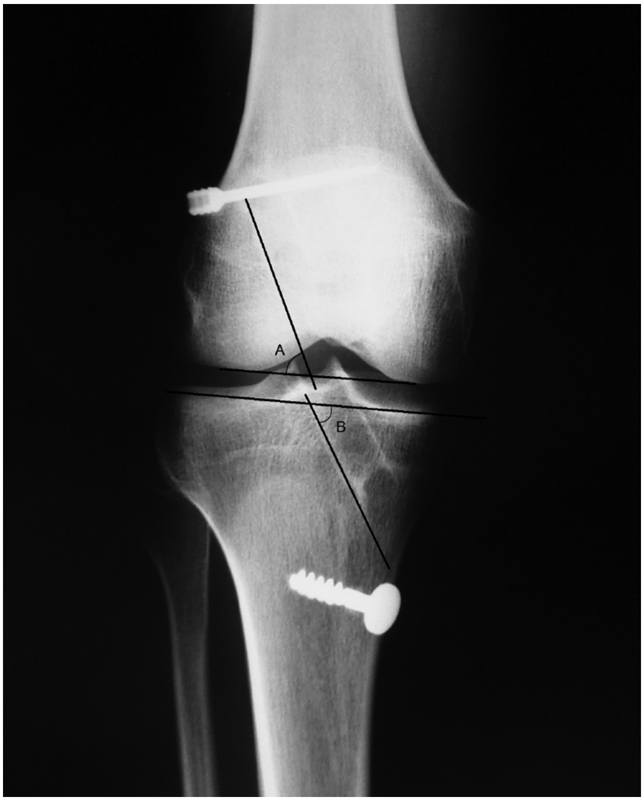


Fig. 2 – A = femoral coronal angle/B = tibial coronal angle.

- Limb symmetry index, with regard to the one-foot hop test.

Results

The mean angle of the tibial tunnels in the coronal plane (TTC) was 64.81° and that of the femoral tunnels (FTC) was 67.68°. The values measured at both sites were between 61 and 70° for most of the patients. The difference in alignment between the tibial and femoral tunnels (TTC–FTC) is shown in Table 4.

The factors relating to the postoperative period and the evaluations according to the tests applied are shown in Table 5.

Group I (femoral tunnels ≤ 65° and tibial tunnels in the coronal plane ≤ 65°)

There were five individuals in this group (four men and one woman). Their mean age was 29.6 years; the youngest was 22 years of age and the oldest was 46.

This group included the patients with tibial and femoral angles that were the most horizontal in the coronal plane.

Table 3 – Distribution of patients into groups according to anteroposterior radiography (coronal plane).

	TTC ≤ 65°	TTC > 65°
FTC ≤ 65°	GROUP I	GROUP II
FTC > 65°	GROUP III	GROUP IV

Table 4 – Tunnel angles.

	n (%)
Coronal angle of the tibial tunnel (TTC)	
≤60°	4 (25)
61–70°	9 (56.25)
>70°	3 (18.75)
Mean = 64.81°	
Coronal angle of the femoral tunnel (FTC)	
≤60°	2 (12.5)
61–70°	11 (68.75)
>70°	3 (18.75)
Mean = 67.68°	
TTC-FTC (°)	
<−10° (varus)	1 (6.25)
−10 to −1° (varus)	11 (68.75)
1 a 10° (valgus)	3 (18.75)
>10° (valgus)	1 (6.25)
Mean = −2.87° (varus)	

Both the femoral tunnels and the tibial tunnels had angles of between 55° and 64°, with a mean of 61.2° for the femoral tunnels and 61° for the tibial tunnels. The difference between the angles of the tibial and femoral axes ranged from varus of 9° to valgus of 9°.

All of these patients had suffered injuries while practicing sports, each on a different type of ground surfacing. One of them said that he had not returned to sports activity and declared that he was dissatisfied with the result from the surgery.

The mean IKDC score was 86.4 (range: 72–96) and the mean Lysholm score was 94.4 (range: 85–100).

Table 5 – Factors relating to postoperative period.

	n (%)
Length of time since operation (months)	
24–36	10 (62.5)
36–48	6 (37.5)
Mean = 34.5	
IKDC	
95–100 (Excellent)	5 (31.25)
84–94 (Good)	9 (56.25)
65–83 (Fair)	2 (12.5)
Mean = 89.94	
Lysholm–Tegner	
<91	4 (25)
91–99	5 (31.25)
100	7 (43.75)
Mean = 95.5	
Hop test (limb symmetry index)	
<0.9	2 (12.5)
0.91–0.99	6 (37.5)
1.00	7 (43.75)
>1.00	1 (6.25)
Mean = 0.968	
Satisfaction with the result from the surgery	
Yes	14 (87.5)
No	2 (12.5)

During the physical examination, two patients presented positive Lachman tests.

In the hop test, the values ranged from 0.87 to 1 and the mean limb symmetry index was 0.95.

Group II (femoral tunnels ≤ 65° and tibial tunnels in the coronal plane > 65°)

The inclusion criteria for this group were fulfilled by only one individual: a 25-year-old male.

This patient presented a tibial angle that was more vertical and a femoral angle that was more horizontal, i.e. in principle similar to what is seen in the technique for constructing an arthroscopic transportal femoral tunnel.

The diaphysis-tunnel angle in the femur was 60° and in the tibia, 72°. The difference between the angles of the tibial and femoral axes was a valgus angle of 12°.

This patient presented maximum scores in the IKDC and Lysholm–Tegner questionnaires (100 and 97 points, respectively) and had negative Lachman, anterior drawer and pivot-shift tests in the physical examination. His limb symmetry index was 1 in the hop test. This patient did not present any spontaneous complaints when asked during the study period. He declared that he was satisfied with the result from the surgery and he returned to physical activity eight weeks after the operation.

Group III (femoral tunnels > 65° and tibial tunnels in the coronal plane ≤ 65°)

There were five individuals in this group (four men and one woman. The mean age of this group was 30.4 years: the youngest was 23 years of age and the oldest was 40.

This group included patients with tibial angles that were more horizontal and femoral angles that were more vertical in the coronal plane.

The angles formed by the axes of the diaphyses and tunnels were, for the femur, between 68° and 70° (mean: 69.2°) and, for the tibia, between 60° and 64° (mean: 61.8°). The difference between the angles of the femoral and tibial axes varied from −10° to −4°, i.e. always in varus.

All of the patients in this group had suffered injuries while practicing sports: three on synthetic grass and two on mats.

The scores from the IKDC questionnaire ranged from 85 to 97, with a mean value of 91.2, and the scores from the Lysholm questionnaire were from 88 to 100, with a mean of 93.4.

During the physical examination, one patient presented positive Lachman and pivot-shift tests. One individual stated that he had not returned to sports activity, but he considered himself satisfied with the results from the surgery.

In the hop test, the mean value of the limb symmetry index was 0.94, with a minimum of 0.85 and a maximum of 1.

All of these patients stated that they were satisfied with the postoperative results, although there were some spontaneous complaints such as pain while squatting, snaps and insecurity in performing jumps using the operated leg.

Group IV (femoral tunnels > 65° and tibial tunnels in the coronal plane > 65°)

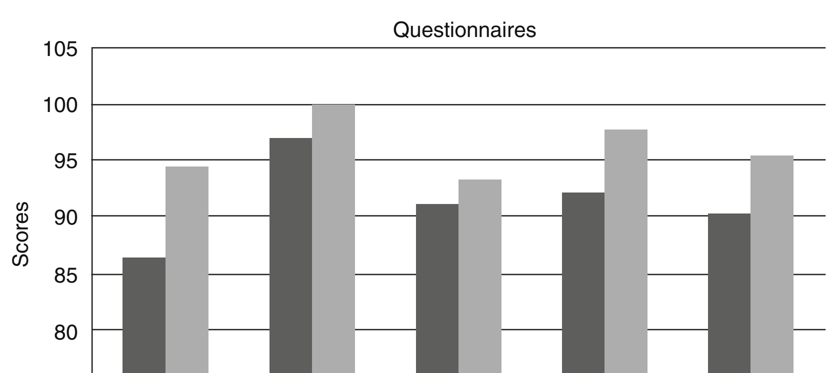
There were five individuals in this group (four men and one woman). Their mean age was 30 years: the youngest was 20 years of age and the oldest was 45.

The angles formed between the axes of the diaphyses and tunnels among the patients in this group were the most vertical in the coronal plane. In the femur, the values ranged from 70° to 82° (mean: 74.2°), while in the tibia they ranged from 66° to 73° (mean: 70.2°). The difference between the angles of the femoral and tibial tunnels varied from −12° to + 3°, with a mean of −4° (varus).

All of the patients in this group had suffered injuries while practicing sports: three on natural grass, one on a parquet floor and one on synthetic grass.

The scores from the IKDC questionnaire ranged from 89 to 96, with a mean of 92.2, and the scores from the Lysholm questionnaire ranged from 95 to 100, with a mean of 97.8 (Fig. 3).

During the physical examination, two patients presented positive Lachman and pivot-shift signs. One individual said



	Group I	Group II	Group III	Group IV	Mean
IKDC	86.4	97	91.2	92.2	90.375
Lysholm	94.4	100	93.4	97.8	95.5

Fig. 3 – Scores from the IKDC and Lysholm–Tegner questionnaires.

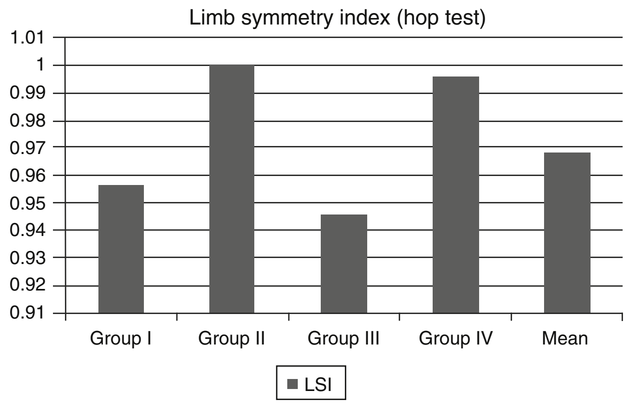


Fig. 4 – Limb symmetry index from the hop test.

that he had not returned to sports activity, but he considered himself satisfied with the result from the surgery.

In the hop test, the mean value of the limb symmetry index was 0.99 with a minimum of 0.92 and maximum of 1.07 (Fig. 4).

There were spontaneous complaints with regard to increased flexibility and paresthesia on the lateral face of the leg operated.

The means obtained from evaluating the study variables are presented in Table 6.

Discussion

The present study was conducted with the aim of correlating the angles of the bone tunnels with the postoperative results from ACL reconstruction. Some remarks need to be made regarding the criteria that led to choosing this topic and in relation to the methodology used.

Studies on patients with ACL reconstructions that compared two types of graft, i.e. ST-G and the patellar tendon (PT), using the same fixation technique, have shown that there is no significant difference in anteriorization of the tibia. The choice between grafts therefore continues to be at the surgeon's discretion.[8] This study did not aim to compare graft sources. Thus, only patients who underwent the technique with ST-G grafts were selected in the present study.

With regard to graft fixation, comparison between different fixation methods was not our objective. The personal preference of the surgeon involved in this study, who has had great experience in such procedures, is to use a proximal crosspin with an absorbable interference screw and a distal post with a metal screw and washer.

The inclusion and exclusion criteria had the objective of limiting the individuals studied to those who solely presented a unilateral ACL injury, thereby eliminating the bias relating to associated injuries. However, among the 300 patients who underwent this surgery over the three-year study period, only 26 fulfilled all the criteria and, of these, only 16 returned to the clinic for assessments for the present study.

The measurements of the tunnel angles were all made by the same researcher, by means of simple radiographs. This is an inexpensive and widely available technique, but it gives rise to the possibility of variation of the angle measured according to the incidence of the rays. New studies using magnetic resonance imaging might reduce or even eliminate this bias.

The patients were divided into groups according to the mean values for the angles of the tunnels constructed. Thus, only one patient could be included in Group II. It was precisely this individual who presented the best values for the postoperative results, among the variables studied. In the future, more patients could be included in new studies, in order to obtain a larger sample and ascertain whether these findings would be maintained, and also whether significance would be reached with a more substantial number of individuals studied.

Biomechanical studies on cadavers have shown that constructing the femoral tunnel at an angle of 60° in the coronal plane minimizes the impact of the graft against the posterior cruciate ligament (PCL) and reduces the tension on the graft under flexion. These studies have also shown that the loss of flexion and anterior laxity are greater when the tibial tunnel is drilled at an angle ≥75° in the coronal plane, and that if the femoral tunnel is constructed more vertically via an transtibial route (between 70° and 80°), there will be an impact against the PCL. These tunnels increase the tension on the graft under flexion, which explains the limitation on flexion that is observed clinically. This impact against the PCL stretches the graft, which may explain the greater anterior laxity.[9]

It has been suggested from in vitro studies that, in order to reduce the tension under flexion, the tibial tunnel should be positioned at 60° in the coronal plane, because the angle of the femoral tunnel and the tension on the graft would be controlled by this angle and this would improve the flexion and diminish the anterior laxity.[10]

Thus, the enthusiasm for conducting new studies with the aim of finding the ideal angle for the tibial and femoral tunnels is justified.

Table 6 – Mean values for the variables analyzed, per group.

Group	FTC (°)	TTC (°)	ΔCoronal (°)	IKDC	Lysholm	LSI
I	61.2	61	−0.2	86.4	94.4	0.956
II	60	72	12	97	100	1.00
III	69.2	61.8	−7.4	89.8	93.4	0.946
IV	74.2	70.2	−4	92.2	97.8	0.996

FTC, angle of the femoral tunnel in the coronal plane; TTC, angle of the tibial tunnel in the coronal plane; ΔCoronal, result from the subtraction TTC − FTC; LSI, limb symmetry index (hop test).

In the present study, it was observed that the groups analyzed presented differences in the outcome variables according to the tunnel angles. Group I, in which the tunnels were most horizontal (mean value for the tibial tunnel = 61° and for the femoral tunnel, 61.2°), had the lowest score for the IKDC questionnaire (mean: 86.4) and the second lowest score for the Lysholm questionnaire (mean = 94.4) and for the limb symmetry (mean: 0.956). Group II, in which the tibial tunnel was more vertical (72°) while the femoral tunnel remained more horizontal (60°), showed the best results and the values were the maximum possible for the IKDC, Lysholm and limb symmetry index variables. Group III, in which the femoral tunnel was more vertical (mean: 69.2°) while the tibial tunnel was more horizontal (61.8°), had the second worst IKDC (mean: 91.2) and the worst values for the Lysholm variables (93.4) and for the limb symmetry index (0.946). Group IV, in which the tibial tunnel (70.2°) and femoral tunnel (64.2°) were the most vertical, showed the second best results for the three variables: Lysholm (97.8), IKDC (92.2) and limb symmetry index (0.996).

Conclusion

From the data obtained in the present study, it can be concluded that the results from groups II and IV were superior to those from groups I and III. The two groups with the best indices were the ones with the tibial tunnel more vertical. The highest scores from the IKDC, Lysholm and limb symmetry index were obtained from a patient in whom the angles constructed were 60° for the femoral tunnel and 72° for the tibial tunnel, which gave rise to a varus alignment for the tunnels. The worst results for the variables studied were found in the group in which the tibial tunnel was most horizontal and the alignment of the tunnels was most displaced toward valgus. Nonetheless, further studies are needed in order to confirm these findings.

Conflicts of interest

The authors declare no conflicts of interest.

Annex 1. Lysholm questionnaire.

Limping (5 points)	**Pain(25points)**
Never = 5	None = 25
Slight or periodic = 3	Occasional or slight during heavy exercise = 20

Annex 1 (*Continued*)

Severe or constant = 0	Limping during heavy exercise = 15
	Considerable during or after walking for more than 2 km = 10
Support (5 points)	Considerable during or after walking for less than 2 km = 5
Never = 5	Constant = 0
Stick or crutch = 2	
Impossible = 0	**Swelling (10 points)**
	None = 10
Locking (15 points)	With heavy exercise = 6
No locking or feeling of locking = 10	With ordinary exercise = 2
There is a feeling, but without locking = 10	Constant = 0
Occasional locking = 6	
Frequent = 2	**Going up stairs (10 point)**
Joint locked during examination = 0	No problem = 10
	Slightly impaired = 6
Instability (25 points)	One step at a time = 2
Never unstable = 25	Impossible = 0
Rarely, during athletic activities and other heavy exercises = 20	
	Squatting (5 points)
Frequently during athletic activities and other heavy exercises (or incapable of participation) = 15	No problem = 5
	Slightly impaired = 4
Occasionally during daily activities = 10	Not beyond 90 degrees = 2
Frequently during daily activities = 5	Impossible = 0
At each step = 0	
	Total score: ____________
Score key: Excellent: 95–100; Good: 84–94; Fair: 65–83; Poor: < 64	

Annex 2. IKDC subjective questionnaire.

FORMULÁRIO DE AVALIAÇÃO SUBJETIVA DO JOELHO IKDC 2000
2000 IKDC SUBJECTIVE KNEE EVALUATION FORM

Nome completo ____

Data do questionário: _____/______/_____ Data da lesão: _____/______/____

Sintomas*:

* Gradue sintomas no nível mais alto de atividade em que você acha que poderia funcionar sem sintomas significativos, mesmo se você não está realmente exercendo atividades neste nível.

1. Qual é o maior nível de atividade que você pode executar sem dor significativa no joelho?
   4☐ - Atividades muito extenuantes como salto ou giro como no basquete ou futebol
   3☐ - Atividades extenuantes como o trabalho físico pesado esqui ou tênis
   2☐ - Atividades moderadas como o trabalho físico moderado, correr ou fazer jogging
   1☐ - Atividades leves como caminhar, trabalho doméstico ou jardinagem
   0☐ - Incapaz para executar qualquer uma das atividades acima, devido a dor no joelho

2. Durante as últimas 4 semanas, ou desde sua lesão, quantas vezes você sentiu dor?

	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Nunca	10	9	8	7	6	5	4	3	2	1	0	Todo o tempo

Quando você sente dor, qual a intensidade?

	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
Nenhuma dor	10	9	8	7	6	5	4	3	2	1	0	A pior dor imaginável

3. Durante as últimas 4 semanas, ou desde sua lesão, seu joelho esteve endurecido ou inchado?
   4☐ - De maneira alguma
   3☐ - Ligeiramente
   2☐ - Moderadamente
   1☐ - Muito
   0☐ - Extremamente

4. Qual é o maior nível de atividade que você pode executar sem edema significativo no joelho?
   4☐ - Atividades muito extenuantes como salto ou giro como no basquete ou futebol
   3☐ - Atividades extenuantes como o trabalho físico pesado esqui ou tênis
   2☐ - Atividades moderadas como o trabalho físico moderado, correr ou fazer jogging
   1☐ - Atividades leves como caminhar, trabalho doméstico ou jardinagem
   0☐ - Incapaz para executar qualquer uma das atividades acima, devido a edema no joelho

5. Durante as últimas 4 semanas, ou desde a sua lesão, o joelho travou ou agarrou?
   0☐ - Sim   1☐ - Não

6. Qual é o maior nível de atividade que você pode executar sem falseio significativo no seu joelho?
   4☐ - Atividades muito extenuantes como salto ou giro como no basquete ou futebol
   3☐ - Atividades extenuantes como o trabalho físico pesado esqui ou tênis
   2☐ - Atividades moderadas como o trabalho físico moderado, correr ou fazer jogging
   1☐ - Atividades leves como caminhar, trabalho doméstico ou jardinagem
   0☐ - Incapaz para executar qualquer uma das atividades acima, devido a falseio no joelho

Atividades esportivas:

7. Qual é o maior nível de atividade que você pode participar regularmente?
   4☐ - Atividades muito extenuantes como salto ou giro como no basquete ou futebol
   3☐ - Atividades extenuantes como o trabalho físico pesado esqui ou tênis
   2☐ - Atividades moderadas como o trabalho físico moderado, correr ou fazer jogging

1☐ - Atividades leves como caminhar, trabalho doméstico ou jardinagem
0☐ - Incapaz para executar qualquer uma das atividades acima, devido ao joelho

8. Como o seu joelho afeta sua habilidade para:

		Sem dificuldade	Dificuldade mínima	Dificuldade moderada	Dificuldade extrema	Impossível realizar
A	Subir escadas	4☐	3☐	2☐	1☐	0☐
B	Descer escadas	4☐	3☐	2☐	1☐	0☐
C	Ajoelhar-se	4☐	3☐	2☐	1☐	0☐
D	Agachar-se	4☐	3☐	2☐	1☐	0☐
E	Sentar com joelhos fletidos	4☐	3☐	2☐	1☐	0☐
F	Levantar-se de cadeira	4☐	3☐	2☐	1☐	0☐
G	Correr em linha reta	4☐	3☐	2☐	1☐	0☐
H	Saltar com a perna afetada	4☐	3☐	2☐	1☐	0☐
I	Parar e arrancar rapidamente	4☐	3☐	2☐	1☐	0☐

Função:

9. Como você classificaria a função de seu joelho em uma escala de 0-10, considerando 10 como sendo o normal, função excelente e 0 como a incapacidade de realizar quaisquer de suas atividades diárias habituais, que podem incluir esportes?

FUNÇÃO ANTES DE SUA LESÃO NO JOELHO

	0	1	2	3	4	5	6	7	8	9	10	
Impossível realizar atividades diárias	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Sem limitação às atividades diárias

FUNÇÃO ATUAL DO SEU JOELHO

	0	1	2	3	4	5	6	7	8	9	10	
Impossível realizar atividades diárias	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	Sem limitação às atividades diárias

Annex 3. Research protocol followed by the interviewees and interviewers.

PROTOCOLO DE PESQUISA
"RELAÇÃO ENTRE O POSICIONAMENTO DOS TÚNEIS ÓSSEOS E O PÓS-OPERATÓRIO TARDIO DA RECONSTRUÇÃO DO LIGAMENTO CRUZADO ANTERIOR".

Data do Questionário:______________
Ficha Número_____
Nome do Paciente:____
Gênero: ☐Masculino ☐Feminino
Idade (Anos): ______
Profissão:________________
Altura (m) __________
Peso (Kg) __________
IMC (Kg/m^2) __________

HISTÓRICO
Perna Dominante: ☐Direita ☐Esquerda ☐Ambidestro
Lado Operado: ☐Direito ☐Esquerdo
Data da Lesão:_____________
Ambiente da Lesão_________________________________
Mecanismo de Lesão____
Atividade Esportiva Prévia a Cirurgia ☐Sim ☐Não
Frequência no Esporte Prévio a Cirurgia (x/semana):___
Nome do Esporte Prévio a Cirurgia:______________
Posição no Esporte Prévio a Cirurgia:______________
Data Cirurgia:____________
Técnica Cirurgia:____
Implante_______________________________
Fixação Tibial__________________________
Fixação Femoral_________________________
Retorno ao Esporte Após Cirurgia ☐Sim ☐Não
Tempo até o retorno___________________
Mesmo Esporte ☐Sim ☐Não
Nível de Atividade Após Cirurgia ☐Igual ☐Melhor ☐Pior
Novo Esporte no pós-op.:____________________________
Frequência no pós-op. (X/semana):_________

ANAMNESE
Pontos Lysholm Tegner __________
Pontos IKDC _________
Satisfeito com resultado ☐Sim ☐Não
Dor EVA_____
Queixa (espontânea)____

EXAME FÍSICO
ADM Flexão Lado Operado _________
ADM Flexão Lado Não Operado_______
ΔFlexão______
ADM Extensão Lado Operado_________
ADM Extensão Lado Não Operado_______
ΔExtensão______
Derrame articular ☐Sim ☐Não
Crepitação ☐Sim ☐Não
Dor ☐Sim ☐Não
Lachman ☐Positivo ☐Negativo
Pivot-shift ☐Positivo ☐Negativo
Gavetaant ☐Positivo ☐Negativo
HOP-TEST-ISM______

ARTROMETRIA KT-1000
TTAMM Lado Operado______
TTAMM Lado Não Operado_________
ΔTTAMM______
TAQM Lado Operado______
TAQM Lado Não Operado_________
ΔTAQM______

DINAMOMETRIA ISOCINÉTICA
Pico Torque 60°/s Lado Operado_____
Pico Torque 60°/s Lado Não Operado_____
ΔPico Torque60°/s______
Pico Torque 180°/s Lado Operado_____

Pico Torque 180°/s Lado Não Operado ____
ΔPico Torque 180°/s_______

ANGULAÇÃO DOS TÚNEIS
Tibial Plano Coronal____________
Tibial Plano Sagital__________
Femoral Plano Coronal____________
Femoral Plano Sagital__________

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