

CURRENT PANORAMA OF ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION SURGERY IN BRAZIL

PANORAMA ATUAL DA RECONSTRUÇÃO DO LIGAMENTO CRUZADO ANTERIOR NO BRASIL

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ABSTRACT

Objective: This study aims to establish the current panorama of the anterior cruciate ligament reconstruction surgery in Brazil. **Methods:** A survey that consisted of a 24-item questionnaire including surgeon's demographics, preferred technique, graft selection, graft positioning, use of braces, drains, antibiotic prophylaxis and most common complications was conducted at the last three editions of a national knee surgery event. **Results:** Six hundred eight questionnaires were analyzed. Brazilian knee surgeons are mostly male, with mean age of 42 years (26-68) and are affiliated to at least one orthopedic society. Thirty-six percent (36%) perform more than 50 reconstructions per year. The preferred graft is the hamstring tendons graft (64%). The frequency of use of anatomical technique increased approximately from 55% from 2011 to 2013, to 85.5% in 2015 ($p < 0.001$). From 2011 to 2015, there was a progressive reduction from 56.8% to 18.1% in the frequency of use of trans tibial femoral tunnel drilling ($p < 0.001$). **Conclusion:** Our findings show that Brazilian knee surgeons' preferences are evolving according to the current world practice. **Level of Evidence V, Economic and Decision analysis study.**

Keywords: Anterior Cruciate Ligament. Knee. Surgery. Reconstruction. Survey.

RESUMO

Objetivo: O presente estudo tem como objetivo estabelecer o panorama atual da cirurgia de reconstrução do ligamento cruzado anterior no Brasil. **Métodos:** Nas últimas três edições de um evento nacional de cirurgia do joelho, realizou-se uma pesquisa que consistiu em um questionário de 24 itens incluindo dados demográficos do cirurgião, técnica preferida, seleção do enxerto, posicionamento do enxerto, uso de órteses, drenos, profilaxia antibiótica e complicações mais comuns. **Resultados:** Seiscentos e oito questionários foram analisados. O cirurgião brasileiro de joelho é majoritariamente do sexo masculino, tem idade média de 42 anos (26-68) e é afiliado a pelo menos uma sociedade ortopédica. Trinta e seis por cento (36%) realizam mais de 50 reconstruções por ano. O enxerto preferido é o enxerto de tendões isquiotibiais (64%). A frequência de uso da técnica anatômica aumentou de 55% nos anos de 2011 e 2013 para 85,5% em 2015 ($p < 0,001$). Após 2011, também foi observada redução progressiva de 56,8% para 18,1% até 2015 na frequência de uso da técnica de perfuração do túnel femoral trans tibial ($p < 0,001$). **Conclusão:** Nossos achados mostram que os cirurgiões brasileiros de joelho estão evoluindo de acordo com a prática mundial atual. **Nível de evidência V, Análise econômica e de decisão.**

Descritores: Ligamento cruzado anterior. Joelho. Cirurgia. Reconstrução. Inquéritos e Questionários.

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INTRODUCTION

Rupture of the anterior cruciate ligament (ACL) of the knee is an extremely common sports injury, with an estimated number of 300,000 new cases every year in the United States alone.^{1,2} Surgical procedure for ligament reconstruction is one of the most performed orthopedic surgeries³ and is currently the standard of care, specially for active individuals who aim to return to high-level sports activity.²

Since its first description, ACL reconstruction surgery has evolved considerably, specially in the last three decades. First proposals of ACL repair by suture appeared at the beginning of the 20th century.⁴ The 1960's and 70's witnessed the extra-articular procedures, such as the Lemaire⁵ or Andrews⁶ procedures, with poor long term results. The attention, therefore, turned to ACL reconstruction, and the patellar tendon would soon become the gold standard graft.

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

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The advent of arthroscopy revolutionized knee surgery, but also brought a new concept of isometric graft positioning, with transtibial femoral tunnel drilling.⁷ The arthroscopic isometric reconstruction became very popular in the last two decades of the 20th century, but often led to non-anatomic placement of femoral tunnels.⁸ The 21st century began with the introduction of the anatomical anterior cruciate reconstruction concept by Freddy Fu and coworkers.⁹ Since then, the pursuit of the ideal graft positioning has led to the so-called "anatomic" single-bundle reconstruction techniques, which can be accomplished by either by an anteromedial approach¹⁰ as well as an outside-in femoral drilling.¹¹

Today, there is still no consensus about the best ACL reconstruction technique. We present the current panorama of the anterior cruciate ligament reconstruction surgery in Brazil. We were also able to analyze the recent evolution of Brazil's knee surgeons preferences, since the present study includes data from the last 6 years.

MATERIALS AND METHODS

A survey was conducted at the last three editions of a national biannual knee surgery event that has the participation of most of the knee surgeons from all around the country. Local ethics committee waived the use of a consent term since there were no patients involved. Therefore, there was no consent form.

The survey was exactly the same in all three occasions and consisted of a 24-item questionnaire that was offered to all participants. (Appendix 1) It comprised questions about surgeon's demographics (gender, age, region of origin, year of graduation, titles and number of ACL surgeries per year), preferred technique, graft selection, graft positioning, femoral drilling technique, use of braces, drains, antibiotic prophylaxis and most common complications. The tunnel positioning was further analyzed by the use of figures. (Appendix 1) The questionnaires were filled independently by each surgeon, without any interference. No information was given and it should contain only the personal experience of each surgeon. The results were organized in an Excel (Microsoft Inc., California, USA) table. Data was presented in absolute frequency (n) and relative frequency (%). To analyze the frequencies and the association of categoric data it was used the Chi-square test or the Fisher's exact test when appropriate. Statistical analysis was conducted using the software PASW statistic 18.0 (SPSS Inc., Chicago, USA). Significance level (alpha) of 5% ($p < 0,05$) was adopted.

RESULTS

A total of 805 questionnaires were distributed in the three events, of which 608 were completed and returned (75% response). Surgeon's demographic are shown in Table 1. The vast majority of Brazilian knee surgeons that attended to the events were male (98,8%), with a mean age of 42 years old (26-68) and has specialist title and is affiliated to at least one orthopaedic society. Regarding the number of ACL procedures per year, 36% perform more than 50 reconstructions per year, 15% between 41 and 50 and 15% between 31 and 40 reconstructions. Of all surgeons, 97% perform arthroscopic surgery. The preferred graft is the hamstring tendons graft (64,4%). The patellar tendon is preferred by 10,4%, and 25,2% of the surgeons reported to use either hamstring or patellar tendon graft. The preferred femoral fixation device is interference screw followed by suspensory devices. Most of the surgeons use only interference screw for tibial fixation (79,3%). (Table 2) Forty six percent of the surgeons use antibiotic prophylaxis within the first 24 hours of the procedure, 26% only at anesthesia, 4,3% report antibiotic use within 48 hours, 19,8% use for more than 48 hours and 3,5 don't use antibiotic prophylaxis. The use of surgical drain fell from 40% to 25% from 2011 to 2015. ($p < 0,05$, Figure 1E)

Table 1. Demographics.

Characteristics	Values/ Occurrence	^a P-Value
Age [mean (range)] (anos)	42 (26-68)	-----
Gender [n (%)]		
Men	601 (98.8 %)	< 0.001
Women	7 (1.2 %)	
Member of at least 1 medical society [n (%)]		
Yes	581 (95.6 %)	< 0.001
No	27 (4.4 %)	
Number of ACL reconstructions per year [n (%)]		
01 to 10	52 (8.6 %)	< 0.001
11 to 20	84 (13.8 %)	
21 to 30	80 (13.2 %)	
31 to 40	68 (11.2 %)	
41 to 50	100 (16.4 %)	
> 50	224 (36.8 %)	

^ap-values for Chi-square tests. ACL: anterior cruciate ligament

Table 2 - Description of surgical preferences.

Characteristics	Values/Occurrence	^a P-Value	
Surgical technique of preference [n (%)]			
Arthroscopic	590 (97.0 %)	< 0.001	
Open	18 (3.0 %)		
Graft preference [n (%)]			
Hamstring tendons	391 (64.4 %)	< 0.001	
Patellar tendon	63 (10.4 %)		
Either hamstring tendons or patellar tendon	153 (25.2 %)		
Femoral fixation device of preference [n (%)]			
Endobutton	139 (22.9 %)	-----	
Ezloc	4 (0.7 %)		
Interference screw	244 (40.1 %)		
Interference screw and/or Endobutton	23 (3.8 %)		
Interference screw and or press-fit	2 (0.3 %)		
Transverse screw	147 (24.2 %)		
Transverse screw and or Endobutton	21 (3.5 %)		
Transverse and/or Interference screw and/or Endobutton	2 (0.3 %)		
Transverse and/or Interference screw	17 (2.8 %)		
Thight rope	1 (0.2 %)		
Transverse screw	5 (0.8 %)		
Other	2 (0.3 %)		
Tibial Fixation [n (%)]			
Agraaf	2 (0.3 %)		-----
Interference screw	482 (79.3 %)		
Interference screw and origin	2 (0.3 %)		
Interference screw and/or Agraaf	64 (10.5 %)		
Interference screw and/or AO cancellous screw	36 (5.9 %)		
Interference screw and/or Washerlock	11 (1.8 %)		
AO cancellous screw	3 (0.5 %)		
AO cancellous screw and/or Washerlock	4 (0.7 %)		
Thight rope	1 (0.2 %)		
Other	2 (0.3 %)		
Use of surgical drain [n (%)]			
Yes	237 (39.1 %)	< 0.001	
No	369 (60.9 %)		
Use of Brace [n (%)]			
Yes	74 (12.2 %)	< 0.001	
No	532 (87.8 %)		
Use of Antibiotics			
No	21 (3.5 %)	< 0.001	
Yes at anesthetic induction	159 (26.2 %)		
Yes for 24 h	280 (46.2 %)		
Yes for 48 h	26 (4.3 %)		
Yes for more than 48 h	120 (19.8 %)		

^ap-values for Chi-square tests.

In 2011, 2013 and 2015 there were a higher frequency of hamstring graft use compared to patellar tendon graft or use of either graft ($p < 0,05$), without a change over the years. (Figure 1D) The frequency of use of anatomical technique increased approximately 55% in the years 2011 and 2013, to 85.5% in 2015. ($P < 0.001$, Figure 2) After 2011 it was also observed progressive reduction from 56.8% to 18.1% by 2015 in the frequency of use of transtibial femoral tunnel drilling technique. ($P < 0.001$, Figure 1B)

No differences were observed between the frequency of use of open or arthroscopic technique, use of double-bundle technique, brace, and graft choice between 2011, 2013 and 2015. ($P > 0.05$, Figure 1A, Figure 1C, Figure 1D, Figure 1F)

The preferred incision for harvesting hamstring tendons was the vertical longitudinal incision, followed by oblique and transverse incision. (Figure 3)

Association between ACL reconstruction frequency and other procedures with surgeon's age.

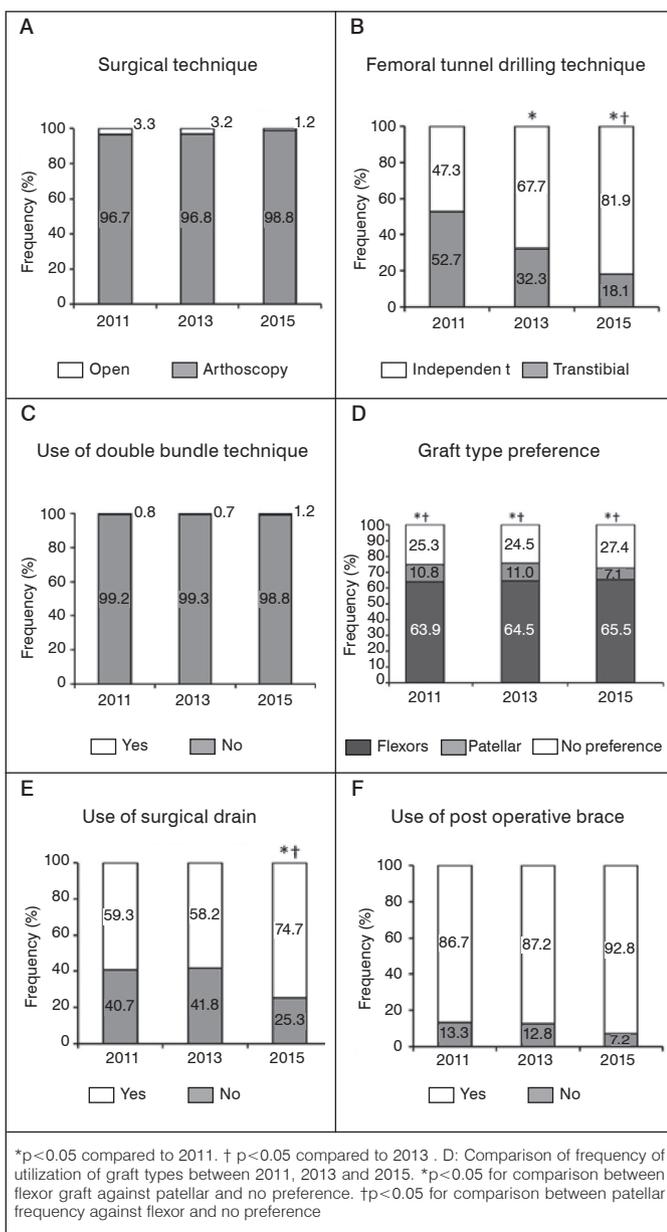


Figure 1. Comparison of frequency of utilization of medical procedures between 2011, 2013 and 2015.

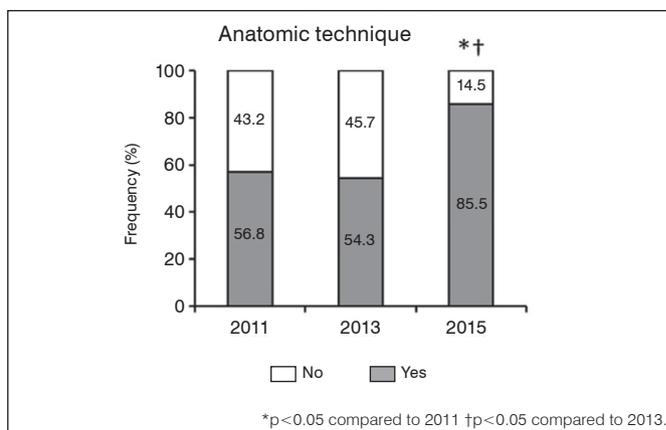


Figure 2. Frequency of utilization of the anatomic technique in 2011, 2013 and 2015.

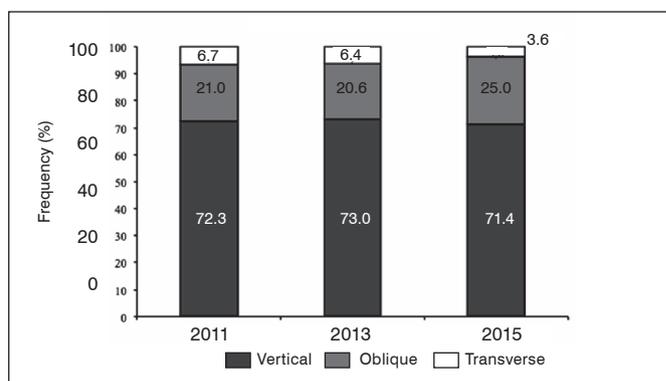


Figure 3. Type of hamstrings harvest incision.

A significant association between ACL reconstruction frequency per year and surgeon's age ($P < 0.001$) was identified. (Table 3) Professionals aged 35 to 60 had the highest number of ACL reconstructions/year, followed by professionals under the age of 35 years and above 60 years. Additionally, a significant correlation between the use of antibiotics ($P = 0.002$) was observed. (Table 3) The most common antibiotic prophylaxis regimen adopted was within 24 hours from anesthesia, followed by the use above 48h, between 24 and 48h and no antibiotic use. There was no significant association between the frequency of ACL reconstruction/year and the femoral tunnel drilling technique used ($P = 0.381$). (Table 3) Association Between the Report of using Anatomic Technique and Procedure Actually Used.

We compared the report of the use of anatomic technique and the tunnel positioning demonstrated in the questionnaires' figures. Only 84.5% of the professionals who reported use of anatomical technique demonstrated proper tunnel positioning technique. It was observed that 98.6% and 85% of all professionals demonstrated proper positioning of the tibial tunnel and femoral tunnel, respectively ($P < 0.001$). In addition, 24% of the surgeon's that are using the transtibial technique claim that they are using anatomic reconstruction technique, and 27.8% of them believe that they are achieving the anatomic femoral positioning. (Table 4)

Complications After ACL Reconstruction.

The most common reported complications after ACL reconstruction using the transtibial and anatomical techniques were anterior pain (34.8% and 32.4%, respectively), persistent muscle atrophy (28.8% and 40.5%, respectively) and difficulty in achieving full flexion

Table 3. Multiple association.

	Number of ACL reconstructions per year												P - Value
	1 a 10		11 a 20		21 a 30		31 a 40		41 a 50		> 50		
	n	%	n	%	n	%	n	%	n	%	n	%	
Femoral drilling technique													
Transtibial	26	50.0%	32	38.1%	31	39.2%	21	30.9%	41	41.4%	82	36.6%	P = 0.381
Anatomic	26	50.0%	52	61.9%	48	60.8%	47	69.1%	58	58.6%	142	63.4%	
Surgeon's age													
< 35 yo.	36	69.2%	35	41.7%	14	17.5%	30	44.1%	26	26.0%	37	16.5%	P < 0.001
35 > 60 yo.	15	28.8%	44	52.4%	65	81.3%	35	51.5%	64	64.0%	177	79.0%	
> 60 yo.	1	1.9%	5	6.0%	1	1.3%	3	4.4%	10	10.0%	10	4.5%	
Use of Antibiotics													
No	4	7.7%	0	0.0%	0	0.0%	1	1.5%	2	2.0%	14	6.3%	P = 0.002
Yes at induction	4	7.7%	23	27.4%	18	22.8%	25	36.8%	30	30.3%	59	26.3%	
Yes for 24 h	32	61.5%	40	47.6%	37	46.8%	36	52.9%	39	39.4%	96	42.9%	
Yes for 48 h	4	7.7%	2	2.4%	4	5.1%	2	2.9%	3	3.0%	11	4.9%	
Yes for more than 48 h	8	15.4%	19	22.6%	20	25.3%	4	5.9%	25	25.3%	44	19.6%	

Table 4. Association between the report and actual use of anatomic technique.

	"I use anatomic technique"				P - Value
	Yes		No		
	n	%	n	%	
Tibial tunnel positioning					
1 or 2 (anatomic position)	356	98.6%	168	68.6%	P < 0.001
3 (non-anatomic position)	5	1.4%	77	31.4%	
Femoral tunnel positioning					
2 ou 3(anatomic position)	307	85.0%	102	41.6%	P < 0.001
1,4 ou 5 (non-anatomic position)	54	15.0%	143	58.4%	
Femoral drilling technique					
Transtibial	56	15.5%	177	72.2%	P < 0.001
Anatomic	305	84.5%	68	27.8%	

(11.6% and 4.0% respectively) followed by difficulty in full extension, extension gain, flexion gain, hemarthrosis, stiffness and persistent instability, which alone did not exceed 10% of cases. (Table 5) Additionally, a single case (0.3%) of thromboembolism was reported after ACL reconstruction of anatomical access. Only 7.3% and 5.1% of professionals using the transtibial and anatomical approach, respectively, reported having not observed any complications after ACL reconstruction. (Table 5)

DISCUSSION

The present study defined the current panorama of the anterior cruciate ligament reconstruction surgery in Brazil. To the best of our knowledge, this is the first study that analyzed the evolution of the Brazilian knee surgeon's preferences.

Our results shows that most of Brazilian knee surgeons are performing an adequate number of ACL procedures each year, in accordance to the opinion that a surgeon should perform at least 30 procedures per year to be considered a "high volume" surgeon and ensure lesser complication incidence and better cost-effectiveness.^{12,13} A recent similar study from Croatia found that almost 75% of respondents performed four or less ACL reconstructions per month, meaning less than fifty ACL reconstructions per year.¹⁴ The preferred choice of graft (hamstring tendons) is in accordance to the graft's choice observed around the world.¹⁵ The semi-tendinosus tendon with or without the gracilis tendon, started to gain popularity in the 80's and has become the more commonly used graft for years now. Nevertheless, patellar tendon graft is still considered

Table 5. Complications.

Complications	Femoral Drilling Technique			
	Transtibial		Anatomic	
	n	%	n	%
Persistent muscle atrophy	67	28.8%	151	40.5%
Difficulty to achieve total extension	24	10.3%	28	7.5%
Difficulty to achieve total flexion	27	11.6%	15	4.0%
Anterior pain	81	34.8%	121	32.4%
Hemarthrosis	0	0.0%	8	2.1%
Persistent instability	10	4.3%	10	2.7%
Stiffness	2	0.9%	4	1.1%
Thromboembolism	0	0.0%	1	0.3%
None	17	7.3%	19	5.1%

the gold standard by several surgeons.¹⁶ Although the double bundle technique can't be considered a new approach to the ACL reconstruction, it's use among Brazilian surgeons was reflected to be predominantly nonexistent for all the time points. We believe that aspects such as technique learning curve and costs are the main reason why we see this scenario in Brazil. This finding was somewhat expected as the popularity of the double bundle technique has never been large among Brazilian surgeons.

The most important finding of the present study is the trend to the gradual abandonment of the isometric positioning technique that use transtibial approach for femoral drilling. We observed a progressive reduction in the frequency of use of transtibial femoral tunnel drilling technique and a higher frequency of the single-bundle anatomic technique with independent drilling, either through the anteromedial portal or outside-in technique, which also is in accordance to the world trend. Despite the fact that the discussion is far from over, there is a crescent number of studies showing that anatomic reconstruction could restore ACL function more closely to the native ligament, with better biomechanical and clinical results, specially regarding knee rotation.⁷ Another interesting finding was the misconception of the so-called "anatomic technique". Only 84.5% of the professionals who reported use of anatomical technique demonstrated proper tunnel positioning technique using the questionnaire's figures. Moreover, 24% of the surgeons reporting the use of transtibial femoral drilling technique also reported to be using anatomic reconstruction technique. It is known that transtibial femoral tunnel drilling results in non-anatomic placement of the femoral tunnels.^{8,17} Literature also shows a confusion

regarding the proper report of the chosen ACL reconstruction technique among articles. Van Eck et al., examined 74 studies that claimed to use "anatomic technique" for ACL reconstruction and found a gross under-reporting of specific operative technique data.¹⁸

When harvesting the hamstrings tendons we found a preference for longitudinal incision. It is known that iatrogenic injury to the infrapatellar branch of the saphenous nerve is a common complication during ACL reconstruction with hamstrings tendon.¹⁹ A recent systematic revision concluded that the available studies suggest less neurological damage if an oblique incision is used.²⁰ Our finding on the use of post-operative brace after ACL reconstruction suggest a low indication of brace which have diminished over time and had never been greater than 14% of all the respondents of our survey. Our results may be justified by evidence²¹ that suggest that the use of post-operative brace have poor effect on pain control during the post-operative phase. However, different surgeons indicate the use of brace for different reasons such as protection and range of motion control. Perhaps a more interesting question would be to those who indicate bracing, what are the main reasons for prescribing this intervention.

Our study has some limitations. First of all, it is based on a survey. The answers may not reflect the real practice of each surgeon. Secondly, we did not investigate results, rehabilitation protocols, return to sports criteria or some other information that could be interesting. Thirdly, the vast majority of responders were male, which do not reflect totally the gender distribution of knee surgeons through our country. Still, it is in fact a predominantly male speciality in Brazil. However, our strength rely on the high number of responders and specially on the fact that data from 3 different events were analyzed, which made possible to observe shifts in preference trends through the past 6 years.

CONCLUSION

The current panorama of the anterior cruciate ligament surgery in Brazil shows that Brazilian knee surgeons preferences are in accordance to the current world practice, with recent substitution of isometric graft positioning through transtibial femoral tunnel drilling technique for anatomic positioning through independent femoral tunnel drilling technique.

AUTHORS' CONTRIBUTIONS: Each author has significantly contributed to this article. GCC (ORCID: 0000-0001-7811-7354): writing, statistical analysis and intellectual concept of the manuscript and development of the research project. LFBN (orcid 0000-0003-1588-3494): data collection and writing. LRPA (orcid 0000-0003-4729-4539): data collection and analysis. PEPT (orcid 0000-0003-3246-5059): revision and intellectual concept. GHAA (orcid 0000-0001-6962-2519): data analysis, writing and revision. WMAJ (orcid 0000-0003-0736-191X): critical analysis of intellectual concept and final approval of the manuscript version to be published. *ORCID (Open Researcher and Contributor ID).

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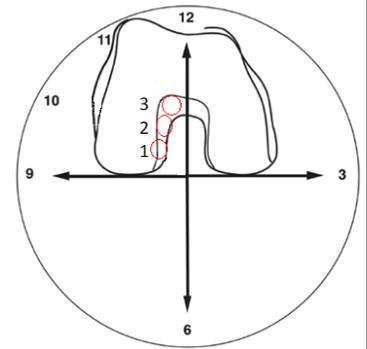
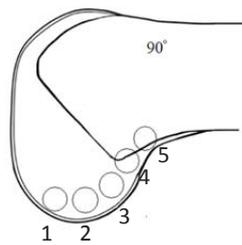
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Appendix 1. Questionnaire.

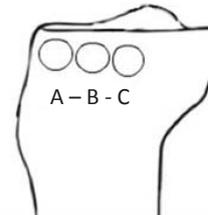
1. Gender
 Male
 Female
2. Age: _____
3. In which region of Brazil do you work?
 North
 Northeast
 Central West
 Southeast
 South
4. Do you have any title from Orthopedic Societies?
 Yes () No ()
5. Which one(s)? If necessary, you can choose more than one alternative.
 Brazilian Society of Orthopedics and Traumatology (SBOT)
 Brazilian Society of Knee Surgery (SBCJ)
 Brazilian Society of Sports Medicine (SBME)
 Others: Which one(s)?

6. Do you do ACL reconstruction surgery?
 Yes () No ()
7. How many ACL reconstructions do you do per year, approximately?
 1 to 10
 11 to 20
 21 to 30
 31 to 40
 41 to 50
 more than 50
8. Year of graduation: _____
9. Year of completion of residence: _____
10. Have you completed your knee residence?
 Yes () No ()
11. Year of completion of knee R4: _____
12. Which technique do you use for ACL reconstruction?
 Arthroscopy
 Open - Arthrotomy
13. What is your preferred graft for ACL reconstruction? If you wish, you can tick more than one option:
 Patellar
 Flexor
 Quadriceps
 Allograft
14. What is your femoral fixation of choice for the graft chosen above?
 Transverse pin
 Interference screw
 Endobutton plaque
 Ezloc
 Other: _____
15. What is your tibial fixation of choice for the graft chosen above?
 If you wish, you can tick more than one option.
 Interference screw
 Post (bolt + washer)
 Washerlock screw (lock washer)
 Agraf
 Other: _____
16. To remove the flexor tendons, which access route do you use?
 Longitudinal
 Cross-sectional
 Oblique
 Other: _____

17. What is your femoral tunnel making technique?
 Through the tibial tunnel (Transtibial)
 Through the accessory medial portal (Medial transportal)
 Guidewire "Outside-in"
 Other: _____
18. How do you do ACL reconstruction?
 Single band
 Double band
19. What is your preferred location for your femoral tunnel in the figures below? Tick one location. If you do double band, tick two locations:



20. What is your preferred location for your tibial tunnel in the figure below? Tick one location.



21. Do you use the anatomical ACL reconstruction technique?
 Yes () No ()
22. Do you use a suction drain in the postoperative period?
 Yes () No ()
23. Do you use postoperative bracing?
 Yes () No ()
24. Do you use any prophylactic antibiotic therapy?
 No
 Only in anesthesia induction
 For 48 h
 For more than 48 h
25. Which complications do you commonly observe in the follow-up of your patients after ACL reconstruction?
 Anterior pain
 Persistent muscular atrophy
 Infection
 Persistent instability
 Full extension gain difficulty
 Full flexion gain difficulty
 Thromboembolism
 Stiffness