Original Article

Knee proprioception in individuals submitted to partial menistectomy and meniscal repair: observational study

Propriocepção do joelho em indivíduos submetidos à menistectomia parcial e à sutura meniscal: estudo observacional

Francklin Trindade da Silva[1]
Thiago Domingues Stocco[2]

[1]Faculdade de Ciências Médicas da Santa Casa de São Paulo (São Paulo). São Paulo, Brazil. trindadefrank@gmail.com
[2]Corresponding author. Universidade Santo Amaro (São Paulo), Universidade Estadual de Campinas (Campinas). São Paulo, Brazil. tdstocco@live.com

ABSTRACT | INTRODUCTION: Menisci play a fundamental role in the joint, in addition to generating joint stability and congruence, they influence knee proprioception. Lesions in this structure can often only be repaired surgically, due to the weak local blood supply, leading to unsatisfactory regeneration. The hypothesis of this study is that there may be less proprioceptive deficits in patients undergoing meniscal suture when compared to those undergoing partial menistectomy. **OBJECTIVE:** To evaluate the proprioceptive deficit of the knee in patients undergoing partial menistectomy and meniscal suture. **METHODS:** Cross-sectional observational study carried out at the UNISA orthopedics and rheumatology clinic in São Paulo. Participants were divided into two groups. In Group I, individuals who underwent partial menistectomy, while in Group II, who underwent meniscal suture, individuals were recruited up to 4 weeks after surgery. Approved by the ethics committee followed by CAAE 94144218.0.0000.0081. For data collection, three tests were performed: test of active and passive sense positioning and kinesthesia test. **RESULTS:** Four individuals participated in Group I and four individuals in Group II, of both genders, between 20 and 40 years old. The results indicate that the patients who underwent partial menistectomy and meniscal suture showed proprioceptive differences between the operated and the non-operated limbs, however the subjects who had the preserved structure presented smaller values of difference in comparison with the operated members of the two groups (Active Test: 30 ° = Group I 11.6 ° ± 5.0 vs Group II 6.9 ° ± 2.8, p = 0.010; 45 ° = Group I 9.4 ° ± 3.5 vs Group II 6.5 ° ± 2.8, p = 0.035; 60 ° = Group I 9.7 ° ± 4.3 vs Group II 6.5 ° ± 4.9, p = 0.103; Kinesthesia Test: Group I 132ms ± 51.5 vs Group II 96ms ± 28.8, p = 0.046). **CONCLUSION:** Higher proprioceptive deficits were found in subjects undergoing menistectomy compared to the sutured limb group, with a statistically significant difference.

KEYWORDS: Rehabilitation. Proprioception. Meniscus.

RESUMO | INTRODUÇÃO: Os meniscos desempenham um papel fundamental na articulação, além de gerar estabilidade e congruência articular, influenciam na propriocepção do joelho. Lesões nesta estrutura muitas vezes só podem ser reparadas cirurgicamente, pelo fraco suprimento sanguíneo local, acarretando uma regeneração insatisfatória. A hipótese desse estudo é que possa existir menores déficits proprioceptivos em pacientes submetidos à sutura meniscal quando comparados aos submetidos à menistectomia parcial, devido a conservação da estrutura que tem importância proprioceptiva. **OBJETIVO:** Avaliar o déficit proprioceptivo do joelho em pacientes submetidos à menistectomia parcial e à sutura meniscal. **METODOLOGIA:** Estudo observacional transversal realizado na clínica de ortopedia e reumatologia da UNISA, em São Paulo. Participantes foram divididos em dois grupos. No Grupo I, indivíduos submetidos à menistectomia parcial, enquanto no Grupo II, a submetidos à sutura meniscal, sendo recrutados indivíduos de até 4 semanas de pós-operatório. Aprovado pelo comitê de ética seguido pelo CAAE 94144218.0.0000.0081. Para coleta dos dados foram realizados três testes: teste de senso de posicionamento ativo e passivo e teste de cinestesia. **RESULTADOS:** Participaram deste estudo uma amostra por conveniência de oito indivíduos (Grupo I, n=4 e Grupo 2, n=4), de ambos os gêneros, com média de idade de 33,4 anos (±11 anos). Os sujeitos do grupo I apresentaram maior déficit de proprioceptivo em comparação com o grupo II, nos testes realizados. Teste ativo do grupo I: 15°= 11,9° ±6,1; 30°= 11,6° ±5,0; 45°= 9,4° ±3,5 e do grupo II, 15°= 7,6° ±3,9; 30°= 6,9° ±2,8. Teste de Cinestesia: Grupo I 132ms ±51,5 vs Grupo II 96ms ±28,8). **CONCLUSÃO:** Os meniscos demonstraram ser estruturas influentes para a propriocepção do joelho, apresentando maiores déficits em indivíduos que retiraram a estrutura.

PALAVRAS-CHAVE: Reabilitação. Propriocepção. Menisco.

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Introduction

Menisci are described as semilunar fibrocartilaginous discs, located between the condyles of the tibia and the femur[1]. Each knee has two distinct menisci: the medial meniscus, in the form of a "C", less mobile, covering 51-71% of the medial tibial plateau; the lateral meniscus, in the shape of an "O", which covers 75-93% of the lateral tibial plateau[2].

Among the important functions of the meniscus are the transmission and distribution of load, shock absorption and increased joint congruence, in addition to helping to limit the end of flexion and extension movements, assist in joint nutrition and lubrication and contribute to proprioceptive function[3].

Proprioception can be defined as a set of afferent sensations, responsible for the sensation of movement and joint position, in addition to influencing reflex responses and voluntary motor control and contributing to the dynamic stability of the joint, helping in the protective role, especially at the extremes of amplitude of movement[4,5].

Afferent signals from the proprioception of the knee are sent from peripheral mechanical receptors found in joint structures as well as in the muscles surrounding the joint. These mechanoreceptors act by converting the mechanical stimulus of tension or compression into specific afferent electrical impulses, sending information to the central nervous system, being able to initiate protective muscular reflexes[6,7]. Zimny et al. (1988), identified the presence of three types of mechanoreceptors in the human medial meniscus: Pacini corpuscles, Ruffini terminations and Golgi tendon organ. It was observed that the mechanoreceptors penetrate part of the perimeniscal tissue going to the external and middle third of the meniscus body and to the horns, where a great concentration was demonstrated, mainly in the posterior horn.

The presence of mechanoreceptors in the meniscus indicates the importance of this structure in the proprioceptive function and the deficits that a meniscal injury or its total or partial surgical removal could cause for the dynamic stability of the joint, in addition to the deleterious effects such as the acceleration of the degeneration process of articular cartilage leading to early onset of osteoarthritis, the main joint disease, the second leading cause of hysical disability, generating a profound socioeconomic impact[9,10].

In this context, currently, techniques for tissue repair have been adopted, instead of menistectomy, (partial or total removal of the meniscus), its preservation by suture technique, keeping the maximum amount of tissue intact whenever possible. However, the meniscus suture procedure is in many cases ineffective or impossible, and the removal of meniscal tissue becomes inevitable[11]. Consequently, menistectomy presents itself as the most commonly used surgical intervention.

In Brazil, according to data from the Ministry of Health of 2019, in the last five years menistectomies represented approximately 80% of all surgical interventions for the treatment of meniscal injuries.

Previous studies have observed a significant decrease in proprioceptive function of the knee in patients with isolated meniscal injuries[13] and undergoing partial menistectomy[14]. However, no study has assessed whether there is a significant difference in knee proprioception in patients undergoing partial menistectomy and meniscal repair.

In this context, the hypothesis of this study is that, based on the literature, there may be a significant decrease in deficits caused in the proprioception of the knee of patients undergoing meniscal suture when compared to those undergoing partial menistectomy. This would indicate one more advantage that reinforces the idea of preserving the meniscus of the knee through its repair and, mainly, the importance of placing an even greater emphasis on the proprioceptive training phase in patients undergoing menistectomy, within a rehabilitation program.

Thus, the objective of this study is to comparatively evaluate the proprioceptive deficit of the knee in patients undergoing partial menistectomy and meniscal suture and, therefore, to observe the influence of the meniscus on knee proprioception.

Methods

Study Type

This paper refers to a cross-sectional observational study, descriptive, analytical and comparative study, of a quantitative nature.

Research location

The survey was conducted at the Orthopedics and Rheumatology Outpatient Clinic of Universidade Santo Amaro, located in São Paulo, Brazil, in the year of Sep/ 2018- Sep/ 2019, period in which patients were recruited and evaluated following the evaluation protocol described below.

The research was started after approval by the university's Research and Ethics Committee, under the number 2.887.319 and CAAE 94144218.0.0000.0081.

Casuistry

Sample

This study included a convenience sample of eight individuals of both genders (3 women and 5 men), with a mean age of 33.4 years (± 11.5 years), previously submitted to surgical procedures to treat isolated lesions in the meniscus, being divided into two groups: Group I and Group II. In Group I, four individuals who underwent partial meniscectomy of the meniscus were included, while in Group II, four subjects where the technique of choice for treating the lesion was the meniscal repair.

Inclusion criteria

As an inclusion criterion, individuals who agreed with the Informed Consent Term were selected with the age group between 20 and 40 years old[15], having up to four weeks postoperatively, needing to have at least 90º of knee flexion and no longer showing signs of inflammation, such as pain and edema.

Exclusion criteria

The study excluded individuals who had cognitive deficits, who had other injuries or dysfunctions in the knee or other body segment that impaired the assessment or who previously performed some type of proprioceptive training after surgery.

Experimental Procedure

Knee proprioception assessment

To measure the proprioception of the knee were performed the method of evaluating the sense of positioning and kinesthesia[16-18].

a) Position sense assessment

The positioning assessment test to measure knee proprioception is divided into two methods: active test and passive test.

- Active test

The measurement of proprioception by the active method of assessing the sense of positioning is based on the individual's ability to actively move the knee joint to a pre-defined angle without the aid of the visual system. Therefore, the knee joint of the blindfolded individual is previously moved by the examiner to a target angle and returned passively to the initial position. Subsequently, the examiner requested that the individual actively move his lower limb in order to reproduce the angle previously demonstrated.

Before performing the definitive tests, the individual was instructed to do them without blindfolds, so that there would be no misunderstanding that would harm the results.

After the explanation, the patient was blindfolded and the examiner positioned his leg at predetermined angles of the knee joint (15°, 30°, 45° and 60°) for 10 seconds in a static position. Then, the individual was asked to perform the same movement actively, stopping at the same pre-established angle, as described in the previous test.

The tests were repeated three times at each angle and in a non-sequential manner, both on the limb submitted to surgery and the contralateral limb.

Thus, it evaluated the ability of the individual to define the angle of the knee joint position, measuring the difference between the actual angle of articulation angle with sensation perceived by the patient, as well as contralateral comparison.

- Passive test

Similar to the active test, in assessing the sense of positioning by the passive method, the knee joint of the blindfolded individual was also previously moved by the examiner to a predetermined target angle and returned passively to the initial position. However, the examiner then passively moved the joint at a speed of approximately 5°/ s and the individual was then asked to indicate when he had the feeling that the knee joint reached the target angle shown previously. The difference between the angle indicated by the individual and the target angle was recorded.

Like the active test, the tests were repeated three times at each angle of the knee joint (15°, 30°, 45° and 60°) in a non-sequential manner on both lower limbs.

b) Kinesthesia test

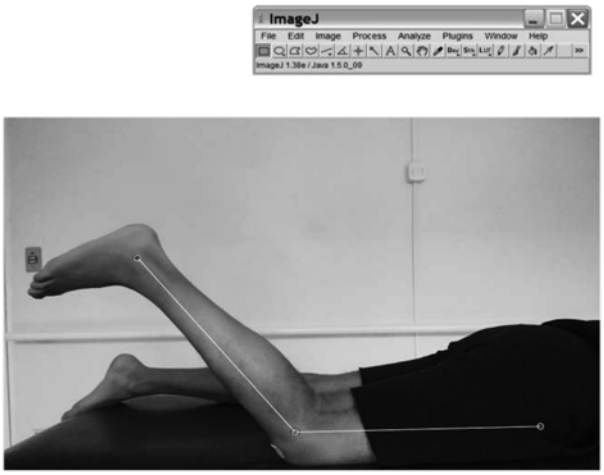
Unlike the assessment of proprioception by the position of the joint in space, kinesthesia is called detecting the perception of joint movement. The evaluation of kinesthesia was measured from the passive joint movement, where the evaluator held the distal portion of the patient's lower limb for an undetermined time, and then moved it. The patient was seated and blindfolded, and as soon as he noticed the knee joint movement he indicated. The time until the perception of the movement was recorded by a digital stopwatch.

Data acquisition procedure

Computerized photogrammetry was used o measure the angle of the knee joint, a technique for the analysis of photographic images to obtain the joint position[19]. For that, the images were captured by a digital camera (Sony Cyber-Shot DSC-W35, 7.2 megapixels). The individuals were positioned in the prone position on the stretcher and were marked with three self-adhesive markers located on the lateral malleolus, lateral condyle of the femur and greater trochanter of the femur, in order to stipulate points of reference for further analysis. The camera was positioned on a support with its height being normalized, aligning it with the individual's knee and at a distance of 1.5 meters.

Then, to measure the range of motion of the knee joint, the captured images were processed and analyzed on the computer using the ImageJ software (Figure 1) (NIH, http://rsb.info.nih.gov/ij).

Figure 1. Analysis of knee angulation through computerized photogrammetry



Source: The authos (2020).

Statistical Analysis

From the values obtained, descriptive statistics were used to present the results and compare the sample data. The results were expressed as mean and standard deviation and the appropriate statistical tests applied: The unpaired t Student test was performed to compare the data of the averages of the angulation achieved compared to the contralateral limb and between the operated members of the two groups. For the test, the level of significance was 95% ($p<0,05$). Minitab statistical software was used ® (version 19, Minitab Inc., StateCollege, EUA).

Results

The results obtained in the active and passive positioning sense test show that, individuals submitted to partial menistectomy (Group I) present differences between the target angle and the measured angle in most of the analyzed angles, demonstrating proprioceptive alteration in comparison with the non operated limb, with a statistically significant difference in most of the analyzed angles (Table 1).

Table 1. Test of sense of active and passive positioning of individuals undergoing partial menistectomy (Group I) – Difference value of the measured angle in relation to the target angle, between operated and non-operated limbs

Group I		Target angle			
		15°	30°	45°	60°
Active test	Op	11,9°(±6,1)	11,6°(±5,0)	9,4°(±3,5)	9,7°(±4,3)
	Nop	4,0°(±2,4)	2,8°(±2,5)	7,0°(±4,8)	3,2°(±2,5)
		p=<0,001	*p*=<0,001	*p*= 0,130	*p*=<0,001
Passive test	Op	6,5° (±4,6)	6,6° (±3,1)	8,0°(±3,2)	10,3°(±5,4)
	Nop	2,3 (±1,9)	1,8°(±1,2)	2,3°(±1,8)	3,5° (±2,2)
		p= 0,007	*p*=<0,001	*p*=<0,001	*p*=<0,001

Op= Operated; Nop= Non-operated; Autor

The values obtained in the passive positioning sense test, in individuals submitted to meniscal suture (Group II), show differences between the target angle and the measured angle, showing proprioceptive alteration in comparison with the non-operated limb. However, from a 60 ° angle, in the passive positioning sense test, there was no significant difference in knee proprioception compared to the non-operated limb (Table 2).

Table 2. Test of sense of active and passive positioning of individuals submitted to meniscus repair (Group II) – Difference value of the measured angle in relation to the target angle, between operated and non-operated limbs

Group II		Target angle			
		15°	30°	45°	60°
Active test	Op	7,6° (± 3,9)	6,9° (± 2,8)	6,5° (± 2,8)	6,5° (± 4,9)
	Nop	3,4° (± 2,0)	2,0° (± 1,5)	2,8° (± 2,4)	3,2° (± 2,1)
		p= 0,003	*p*= <0,001	*p*= 0,002	*p*= 0,043
Passive test	Op	8,2° (± 4,7)	6,5° (± 3,6)	7,5° (± 4,7)	7,0° (± 4,8)
	Nop	2,5° (± 1,9)	2,7° (± 2,6)	2,5° (± 1,3)	5,5° (± 2,6)
		p= 0,001	*p*= 0,007	*p*= 0,002	*p*= 0,188

Op= Operated; Nop= Non-operated; Autor

The results presented in the kinesthesia test show that, in individuals undergoing meniscus repair (Group II), there is reduced movement perception, compared to individuals undergoing menistectomy (Group I), with statistically significant results (Table 3).

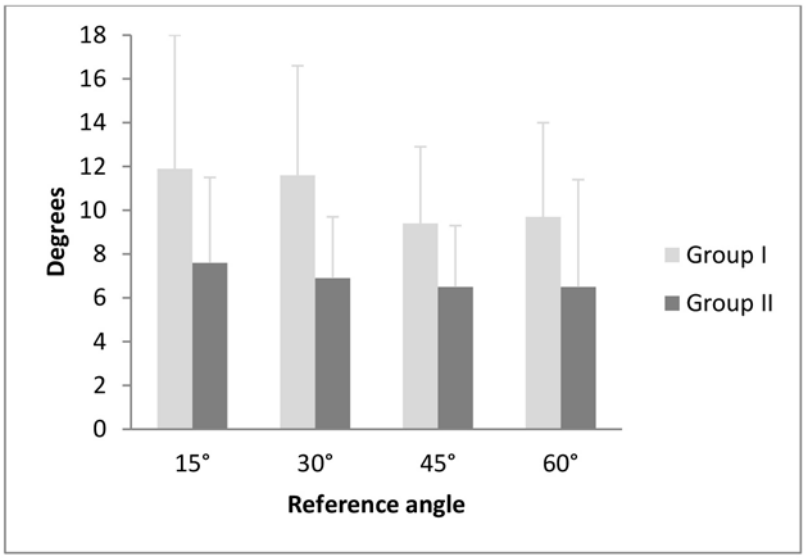
Table 3. Kinesthesia test - comparison between the average response time to the movement of the operated and non-operated limbs of individuals undergoing partial menistectomy (Group I) and meniscus repair (Group II)

	Mean time (ms)		
	Operated limb	**Non-operated limb**	***P value***
Group I	132 (± 51,5)	87 (± 32,7)	0,186
Group II	96 (± 28,8)	60 (± 10,0)	<0,001

ms= miliseconds; Autor

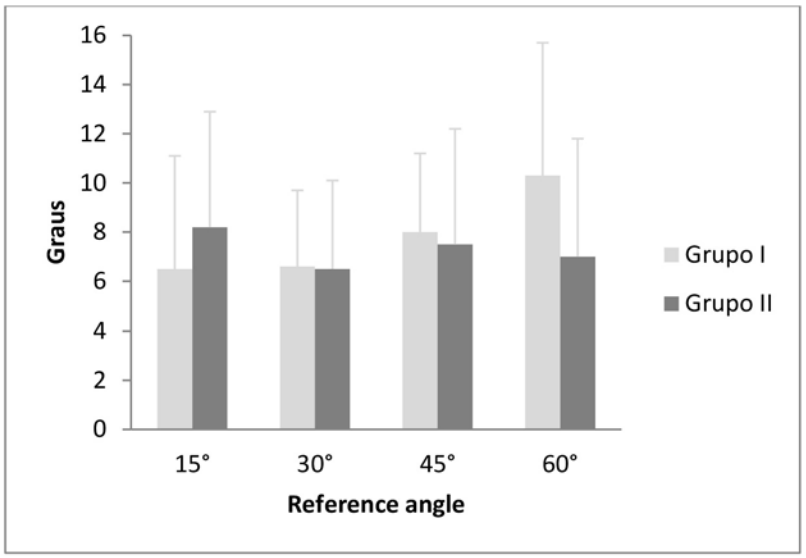
The results obtained in the active positioning sense test show that post-suture individuals (Group II) had lower proprioceptive deficits in relation to those submitted to menistectomy (Group I), in comparison with the operated limbs, in three of the four angles evaluated (Graphic 1).

Graphic 1. Test of active positioning sense of individuals after partial menistectomy (Group I) and meniscal repair (Group II) - Mean difference between the reference angle and the measured angle of the operated limbs; 15°= Group I vs Group II (p= 0.024); 30°= Group I vs Group II (p= 0.010); 45°= Group I vs Group II (p= 0.035); 60°= Group I vs Group II (p= 0.103)



Although there is no statistically significant difference, the results obtained in the passive positioning sense test show that, individuals submitted to menistectomy showed greater difference in the operated limb in three of the four angles analyzed, in comparison with the sutured individuals (Graphic 2).

Graphic 2. Passive positioning test of individuals after partial menistectomy (Group I) and meniscal repair (Group II) - Mean difference between the reference angle and the measured angle of the operated limbs; 15°= Group I vs Group II (p= 0.380); 30°= Group I vs Group II (p= 0.943); 45°= Group I vs Group II (p= 0.764); 60°= Group I vs Group II (p= 0.128)



The obtained results in the active positioning sense test show that individuals who underwent partial menistectomy (Group I) had a longer response time to movement compared to those submitted to meniscal repair (Group II), with a statistically significant difference (Table 4).

Table 4. Kinesthesia test - comparison of the difference in response time to movement between operated limbs of individuals undergoing partial menistectomy (Group I) and meniscal repair (Group II)

	Mean time (ms)		
	Group I	**Group II**	***p* value**
Operated limb	132 (± 51,5)	96 (± 28,8)	0,046

ms= miliseconds; Autor

Discussion

The present study aimed to analyze quantitatively and comparatively the proprioception of the knee in individuals undergoing partial menistectomy and meniscal repair, through three tests.

The results show that there is a reduction in proprioception in individuals after partial menistectomy and meniscus suture, being higher in individuals undergoing partial menistectomy, in two of the three tests performed.

Differences in knee proprioception after partial menistectomy and meniscal repair were found, in comparison with the non-operated limb, showing statistically significant results in 94% of the angles analyzed in the tests of sense of active and passive positioning.

It was observed that the results found in individuals undergoing partial menistectomy diverge from a previous study[20] that assessed knee proprioception through the passive positioning sense test, in patients with six months postoperative period after partial menistectomy. The authors noted that there were no differences in proprioception and comparison with the control group. However, the participants had a longer time until the analysis, causing greater tissue healing, however an important data to be analyzed is that the work does not show whether the participants underwent any type of rehabilitation.

Proprioceptive differences were evidenced in the three tests analyzed, in participants who underwent meniscus suture, in comparison with the non-operated limb. However, the analysis of the 60° angle in the passive positioning test showed that there was no statistically significant difference between the non-operated limb, that is, there was no deficit in proprioception. This may be related to greater pressure on the meniscus at this angle, which improves the afferent response of the mechanoreceptors present in the structure, corroborating the study by Karahan[21], in which greater proprioceptive deficits were found at angles greater than or equal to 60°, showing an importance of the integrity of the structure for better afferent response during functional activities[22].

The rehabilitation process in the two surgical procedures evaluated is different, especially with regard to weight unloading, where in a procedure such as partial menistectomy it is usually performed in the first week as tolerated by the individual and, in patients undergoing meniscal repair have a longer time until the total weight bearing, with an average of around 4-6 weeks, as the process of regeneration of the sutured structure must be respected[23]. It is also known that, a prolonged immobilization time leads to neuromuscular damage and proprioceptive response, due to a relation to the response to traction or joint coaptation stimulus found in the mechanoreceptors, this response mechanism to the stimulus can harm the subjects submitted to surgical approach that are without weight unloading. Therefore, when analyzing subjects submitted to meniscal suture in this study, during the kinesthesia test, the results show that, in relation to the non-operated limb, these deleterious effects are present in the subjects submitted to meniscal repair. On average, these individuals presented partial weight unloading with the use of crutches and knee immobilizers in the first two weeks, corroborating the results presented. This can also be explained because there is no difference of the operated limbs in the subjects after partial menistectomy and meniscus suture, in relation to the passive positioning sense test, where there is a greater proprioceptive demand of the structure[24].

However, an analysis of the results presented by the men who underwent partial meningectomy in comparison with demonstrated sutures, the same post post partial menistectomy showing early weight discharge, reproduced with the first proprioceptive results with statistically significant differences in the proprioception between the operated limbs, that is , there is a proprioceptive influence of the meniscus and its removal can affect the joint in relation to the response time[25-28].

Since the menisci of the knee are important structures for the proprioceptive function, the removal after the partial menistectomy approach would directly influence the proprioception and the kinematics of the joint, corroborating the results presented in the present study[29].

With the help of the data presented, we can understand the importance of proprioceptive training in patients undergoing these types of surgery and of initiating functional neuromuscular rehabilitation at an early stage, such as in the implementation of balance, strength and muscular resistance exercises, active or manual joint mobilization. Some of the exercises that can be applied include working with training in unipodal support and even using unstable bases, where the body would need the proprioceptive system to perform such a task[26,27].

One of the difficulties found in the present study was to find patients that meet the inclusion criteria, especially when dealing with injuries and / or surgical procedures such as isolated meniscus sutures that often, due to their injury mechanism (knee flexion and strength rotational), can lead to partial or total rupture of other structures, commonly associated with the anterior cruciate ligament 30. Therefore, the reduced sample in this study represents a potential bias in the results.

The present work becomes the first study to comparatively evaluate knee proprioception in individuals undergoing partial menistectomy and meniscal suture, with potential results that can be explored in future studies, with a larger number of participants and even a comparison in individuals with longer surgery time, specific surgical type correlating the amount of tissue removed in relation to loss of proprioception and, after discharge from rehabilitation.

Conclusion

The knee menisci proved to be very influential structures for knee proprioception in the results presented.

Differences in the proprioception of the knee after partial menistectomy were found, in comparison with the non-operated limb in two of the three tests performed, unlike the individuals submitted to meniscal repair, which were in the three tests performed.

When comparing the results of proprioception in relation to the operated limb of the two groups, the individuals who underwent partial menistectomy were shown to have greater proprioceptive deficits in relation to the suture group. However, as the results showed proprioception differences in the two groups, emphasis should be placed on neuromuscular stimuli as early as possible to mitigate long-term deleterious effects, both in patients undergoing menistectomy and those undergoing meniscal repair.

Author contributions

Silva FT participated in the collection of research data, statistical analysis of research data, interpretation of results and writing. Stocco TD participated in the conception, design, statistical analysis of research data, interpretation of results and writing of the scientific article

Competing interests

No financial, legal or political competing interests with third parties (government, commercial, private foundation, etc.) were disclosed for any aspect of the submitted work (including but not limited to grants, data monitoring board, study design, manuscript preparation, statistical analysis, etc.).

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