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Functional Evaluation after Medial Patellofemoral Ligament Reconstruction in Athletes*

Avaliação funcional da reconstrução do ligamento patelofemoral medial em atletas

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Abstract

Objective The aim of the present study was to evaluate the clinical results, functional outcomes, and risk factors after anatomic reconstructions using knee flexor grafts in athletes.

Methods The authors followed-up 32 patients and 34 knees for 1 year in a prospective design case series evaluating pre- and postoperative functional scores (Kujala and Lysholm) and associated risk factors.

Results All of the 32 patients had a significant increase of the Lysholm and Kujala scores. Patients with < 5 preoperative dislocations had a better score on the Lysholm and Kujala scales. The mean preoperative Lysholm score was 62.8, and the mean postoperative score was 94.3. The mean preoperative Kujala score was 63.0, and the mean postoperative score was 94.0.

Conclusion Medial patellofemoral ligament reconstruction with hamstring graft in athletes with patellar instability improved clinical and functional scores. The bone drilling through the patella and the positioning of the femoral tunnel should be judiciously performed.

Keywords
- joint instability
- joint ligaments
- patellar dislocation
- patellofemoral joint
- athletes

Resumo

Objetivo Avaliar os resultados clínicos e funcionais da reconstrução anatômica do ligamento patelofemoral medial com tendões flexores em atletas.

Métodos Estudo tipo série de casos, prospectivo, que analisou a reconstrução do ligamento patelofemoral medial em 32 pacientes (34 joelhos). A avaliação funcional foi feita pelos escores Lysholm e Kujala nos períodos pré- e pós-operatórios, e os fatores de risco envolvidos foram avaliados.

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Palavras-chave
- instabilidade articular
- ligamentos articulares
- luxação patelar
- articulação patelofemoral
- atletas

Resultados Dos 32 pacientes analisados, todos obtiveram melhoria dos escores funcionais comparativamente ao período pré-operatório. Pacientes com menos de cinco episódios de luxação prévios obtiveram melhores resultados funcionais. O valor médio de Lysholm no pré-operatório foi de 62,8 e no pós-operatório de 94,3, quanto ao escore de Kujala a média pré-operatório foi de 63,0 e pós-operatória de 94,0.

Conclusão A reconstrução do ligamento patelofemoral medial com enxerto de tendão flexor do joelho em atletas propiciou melhoria dos escores clínicos e funcionais nos pacientes com instabilidade patelofemoral. A perfuração óssea da patela e o posicionamento do túnel femoral devem ocorrer de forma judiciosa.

Introduction

The medial patellofemoral ligament (MPFL) is the main static restrictor against patellar lateral translation between 0° and 30° of knee flexion.[1] It originates in the proximal third of the medial aspect of the patella and it is attached to the femur, as a saddle, between the medial epicondyle (ME) (10 mm proximally and 2 mm posteriorly) and the adductor tubercle (4 mm distally and 2 mm anteriorly), coursing below the vastus medialis muscle and the quadricipital tendon.[2] Biomechanically, it has resistance of 62 Newtons (N) and accounts for 60% of the medial soft tissue containment against patellar lateralization forces. It has an isometric behavior of between 0° and 70° when it begins to shorten.[1,3,4] The complete MPFL lesion can change the patellofemoral kinematics, deteriorating the joint function and mechanics, leading to recurrent lateral patellar instability (RLPI).[1,2,5]

The current incidence of symptomatic RLPI has increased, especially in athletes.[6] The characteristics of the population most affected by RLPI include female gender, increased body mass index (BMI), skeletal immaturity, age during the first episode (recurrence rates are higher in younger patients), mechanism of the lesion (traumatic lesions present worse prognosis), practiced sport modality, and level of competitiveness.[6–8] In symptomatic athletes with RLPI, surgical treatment depends on factors such as patellar height, tibial trochlear/tuberosity groove (TT-TG) distance, and trochlea dysplasia. Isolated MPFL reconstruction is the best therapeutic option for patients without anatomical alterations (normal patellar height, TT-TG distance < 2.0 cm, and absence of marked trochlea dysplasia) that present patellofemoral instability, allowing the return to sports and functional improvement in most cases.[9,10]

The reconstruction of the MPFL may be functional or anatomical.[10] In functional reconstructions, the graft is not positioned in the original MPFL anatomical points, while in anatomical reconstructions the graft is fixed at the primary origin and attachment sites.[11] The proper graft placement at native attachment sites in anatomical reconstructions is one of the factors contributing to the success of this procedure.[11] There are no reports in the Brazilian literature analyzing the outcomes of this surgery in athletes. The present prospective study aimed to evaluate the clinical and functional outcomes of anatomical MPFL reconstruction with flexor tendons and to analyze the risk factors involved in the prognosis.

Materials and Methods

Sample Description

The present work was submitted to and approved by the Research Ethics Committee of our university and informed consent was obtained from the analyzed patients.

From January 2011 to December 2014, 32 patients underwent surgery for MPFL reconstruction with flexor knee tendon. Among them, 2 underwent a bilateral procedure, totaling 34 surgically treated knees. These patients were evaluated by 2 examiners with knee surgery experience and answered the Lysholm and Kujala questionnaires (validated in Portuguese) before the surgery and 24 months postoperatively (after the completion of the rehabilitation); the results were compared and submitted to statistical analysis.

The inclusion criteria were at least 1 episode of patellofemoral dislocation, conservative treatment with physiotherapy for at least 3 months without improvement of the symptoms, physical examination consistent with patellofemoral instability (positive apprehension test), complaint of pain, instability sensation with functional impairment, and compliance with the conditions defined in the informed consent term.

The exclusion criteria included lack of informed consent, patients already submitted to previous surgical treatment, movement restriction, patients with ligamentous hyperlaxity, presence of type C and D trochlear dysplasia according to the Dejour classification,[12] TT-TG distance > 20 mm, presence of high patella, and detection of chondral lesion at the patellar and/or trochlear articular surface with subchondral bone involvement.

Surgical Technique

All of the procedures were performed by the same team (Garms E. and Carvalho R. T.) with the technique recommended by Schock and Burks.[13] A free graft from one of the flexor tendons (gracilis tendon or semitendinosus tendon) was used with a femoral tunnel in the anatomical attachment region between the medial epicondyle (10 mm proximally and 2 mm posteriorly) and the tubercle adductor (4 mm distally and 2 mm anteriorly) through a single longitudinal approach in order to facilitate the identification of the bone parameters.[2] The patellar tunnel was made by drilling the bone between the upper third and the middle third of the medial facet of the patella, extending up to half of the patellar depth. Intraoperative fluoroscopy during the preparation of the patellar tunnel

was used as required to monitor guidewire insertion, drill angulation, and patellar button placement. The femoral fixation of the graft was performed with a metallic interference screw (7 × 20 mm), and the patellar fixation was done with a suspension button supported on the lateral cortex. The final fixation of the graft was done with the knee at 30° in flexion, after isometric testing and with minimal graft tension, only maintaining the patellar centralization on the trochlea. No lateral retinacular release was performed. All patients underwent the same postoperative rehabilitation.

Results

A total of 32 patients were evaluated, including 20 females (62.5%) and 12 males (37.5%). The patients were between 13 and 38 years old, with a mean age of 22.7 ± 6.9 years old. ►**Table 1** shows the descriptive analysis of the data observed in the sample of 32 patients and of 34 operated knees regarding the side and number of dislocations prior to the surgical procedure. The postoperative differences in the Lysholm and Kujala scores were calculated and were positive for all 34 comparisons, indicating improvement in every operated knee ($p < 0.001$) (►**Table 2**).

In the Lysholm score, differences ranged from 2 to 83, with a median value of 28.5 (interquartile range [IQR]: 17–40); in the Kujala score, differences ranged from 7 to 88, with a median value of 25 (IQR: 14–38).

No statistically significant difference was found between genders regarding the distribution of the Lysholm ($p = 0.073$) and Kujala scores ($p = 0.572$) (►**Table 3**).

The association between the number of pre-existing dislocations and the variations observed in the Lysholm and Kujala scores was evaluated and the results are shown in ►**Table 4**. In this analysis, the number of dislocations was

Table 1 Instrumented side and number of previous dislocations ($n = 34$)

Side—*n* (%)	
Right	14 (41.2%)
Left	20 (58.8%)
Previous dislocations—n (%)	
1	3 (8.8%)
2	5 (14.7%)
3	3 (8.8%)
4	4 (11.8%)
5	5 (14.7%)
7	1 (2.9%)
8	1 (2.9%)
9	1 (2.9%)
> 10	11 (32.4%)
Previous dislocations—n (%)	
≤ 5	20 (58.8%)
> 5	14 (41.2%)

Table 2 Lisholm and Kujala scores at pre- and postoperative evaluations ($n = 34$)

	Preoperative evaluation	**Postoperative evaluation**
Lysholm		
Mean (standard deviation)	62.8 (22.3)	94.3 (5.5)
Median	65.5	95.0
Minimum–Maximum	17–94	76–100
p-value (Wilcoxon test)	< 0.001	
Kujala		
Mean (standard deviation)	63.0 (21.3)	94.0 (5.3)
Median	63.5	95
Minimum–Maximum	10–90	73–100
p-value (Wilcoxon test)	0.115	

Table 3 Lisholm and Kujala scores variation according to the gender of the patients

	Female ($n = 21$)	**Male ($n = 13$)**
Lysholm		
Median (IQR)	36 (19–50)	23 (11–30)
Minimum–Maximum	6–73	2–83
p-value (Mann-Whitney test)	0.073	
Kujala		
Median (IQR)	25 (17–37)	20 (14–38)
Minimum–Maximum	7–86	8–88
p-value (Mann-Whitney test)	0.512	

Abbreviations: IQR, Interquartile range.

Table 4 Lisholm and Kujala scores variation according to the number of previous dislocations

	≤ 5 previous dislocations ($n = 20$)	**> 5 previous dislocations ($n = 14$)**
Lysholm		
Median (IQR)	20.5 (10–30)	36.5 (31–56)
Minimum–Maximum	2–83	11–71
p-value (Mann-Whitney test)	0.008	
Kujala		
Median (IQR)	22 (14–33)	31 (22–49)
Minimum–Maximum	7–88	12–79
p-value (Mann-Whitney test)	0.111	

Abbreviations: IQR, Interquartile range.

categorized in ≤ 5 and > 5. Values > 10 episodes cannot be analyzed due to the lack of knowledge of the exact number of dislocations. A significant difference was found between the groups with ≤ 5 previous dislocations and > 5 previous dislocations regarding the distribution of the Lysholm score variations ($p = 0.008$); the group with the highest number of lesions had a higher median of score variation than the group with the lowest number of lesions. No significant difference was found between groups with ≤ 5 previous dislocations and > 5 previous dislocations regarding the distribution of the Kujala score variations ($p = 0.111$).

No significant correlations were found between age and the Lysholm (rs $= 0.14$; $p = 0.441$) and Kujala scores (rs $= 0.01$; $p = 0.974$).

A total of 4 complications were reported among the 32 cases: 2 patellar fractures (surgically treated with reduction and internal osteosynthesis with cerclage), and 2 cases of arthrofibrosis (submitted to a new arthroscopy for arthrolysis and manipulation), which evolved satisfactorily but with greater time for functional recovery, around 7 months.

Discussion

The most relevant finding of the present study was the clinical and functional improvement observed in the athletes submitted to the anatomical MPFL reconstruction with autologous graft of a flexor knee tendon (gracilis or semitendinosus tendon). This was evidenced by the increased postsurgery questionnaire scores (subjective evaluation), as well as the absence of new dislocation episodes after the surgical procedure (objective improvement). Our results are similar to those observed in other studies.[14–16]

The number of dislocation episodes was relevant to the functional evaluation, favoring individuals submitted early to MPFL reconstruction. The deleterious effect of RLPI in athletes and the delayed surgical treatment can impair the return to sports.[9,10] Our sample had a predominance of young women with RLPI, similar to other series.[6–8] The anatomical MPFL reconstruction with proper placement of the femoral tunnel may impact functional recovery.[17] The femoral tunnel 5 mm proximally or 3 mm shorter alters the length and the isometry of the graft, causing an overload in the medial articular cartilage of the patella $> 50\%$ when compared with a normal knee.[18] In the analyzed sample, the surgical technique used to drill the femoral tunnel was based on bone parameters (medial epicondyle and adductor tubercle) according to Nomura et al,[2] through a wider longitudinal approach between these two reference points, and aided by fluoroscopy in some cases. Isolated intraoperative fluoroscopy (IF) or lateral knee radiography can cause rotation errors and contribute to the inadequate placement of the femoral tunnel.[19] In this study, IF was used in 55% of the cases, with no loss of joint amplitude. In addition, there was no gross error in femoral or patellar tunnels when IF was not used. Our findings are consistent with a survey performed with knee surgeons at national level.[20] The authors emphasize the need to know this anatomy in order to improve surgical time, to facilitate the marking of the entry points of the bone tunnels, and to minimize radiation exposure both to the surgical staff and to the patient.

The patellar tunnel was drilled in the medial-lateral direction with depth ranging from a third to a half, and with the fixation of lateral button at the opposite end.[13] Some authors avoid this drilling due to the possibility of anterior cortical patellar violation or posterior cartilage transfixion; moreover, the introduction of a larger drill (> 4.5 mm in diameter) increases the risk of patellar fracture.[21] One option to reduce this complication is to use a thinner graft, such as gracilis graft.[16] Another option is the use of patellar anchor(s) to reduce the risk of fracture, but the type of material, their quantity and size were not well established yet.[22] The disadvantages include the high cost of some implants and their difficult removal, if required. We prefer to use this patellar fixation because of the greater biological contact at the graft-bone interface, with no impairment of the strength or mechanical rigidity of the implant-graft-implant construct,[23] which allows an earlier joint mobilization.

In nonanatomical surgical procedures, such as proximal realignments, grafts are not required. However, the clinical outcomes show a higher RLPI recurrence rate and a low satisfaction rate for surgical patients.[24] The autologous graft has a lower failure rate and higher functional questionnaires scores when compared to homologous grafts.[25] In addition, there are several options of autologous grafts for MPFL reconstruction, including the medial third of the patellar tendon, quadricipital tendon tape, and one of the knee flexor tendons (gracilis or semitendinosus).[11,18] The graft configuration with two separate bundles at the patella is more anatomical, reduces the risk of patellar fracture, presents a lower incidence of new dislocations, and increases functional scores compared with single bundles.[25,26] We have decided to perform the reconstruction with a single patellar tunnel and a free flexor tendon graft in order to avoid damage to the knee extensor apparatus and to reproduce the anatomical path of the graft deep to the vastus medialis fascia. Another disadvantage is the location of the origin of the patellar tendon in the anterior and inferior surfaces of the patella, which is a nonanatomic MPFL point, besides the lateral inclination of the collagen fibers in the tibial tuberosity, which would hamper the original vector of action forces for medial patellar containment in cases of surgical reconstruction with this graft repositioned to the medial side of the knee. Clinical outcomes obtained with free grafts in the analyzed sample were satisfactory and similar to the ones reported by other studies.[15,16,22]

The limitations of the present study include the lack of a control group to compare the results with another surgical technique or treatment modality; the short follow-up time; the lack of objective parameters to evaluate the muscular strength recovery (isokinetic test), and the lack of evaluation of the level of return to sports practice.

Conclusion

The anatomical MPFL reconstruction with flexor tendon provides clinical and functional improvement in athletes.

Patellar bone drilling and femoral tunnel positioning should be judicious.

Conflicts of Interest

The authors have no conflicts of interest to declare.

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