Article published online: 2021-09-30

Reconstruction of the Medial Patellofemoral Ligament with Patellar Transosseous Sutures: Cross-Sectional Study with 34 patients

Reconstrucción del ligamento patelofemoral medial mediante suturas transóseas patelares: estudio transversal de 34 pacientes

Andrés Pakuts[1,2] Luis Fernando Martin[3] Christophe Riquoir[4] Alex Schadenberg[4]

[1] Clínica Red Salud Elqui, La Serena, Chile
[2] Centro Médico Ossis, La Serena, Chile
[3] Residente Traumatología y Ortopedia, Facultad de Medicina Clínica Alemana de Santiago-Universidad del Desarrollo, Santiago, Chile
[4] Interno, Facultad de Medicina, Pontificia Universidad Católica de Chile, Santiago, Chile

Address for correspondence Andrés Pakuts, Clínica Red Salud Elqui, La Serena, Chile (e-mail: andrespakuts@gmail.com).

Rev Chil Ortop Traumatol 2021;62(2):e104–e112.

Abstract

Introduction Recurrent patellar instability can lead to poor functional results and progressive articular damage in the long term, and is frequently addressed by medial patellofemoral ligament reconstruction (MPFLR), with multiple techniques that most commonly differ regarding the method of patellar fixation.

Objective To evaluate the results of MPFLR using a novel technique of patellar fixation using transosseous sutures. The main objective is to determine the redislocation rates and functional results. The secondary goals include an assessment of complications and other related variables, and a comparison between isolated MPFLR and MPFLR associated to tibial tubercle osteotomy.

Methods A cross-sectional study of 34 patients who underwent MPFLR from 2013 to 2019 with a minimum of 12 months of follow-up. The reconstruction was performed by the same first surgeon with double-bundle gracilis autograft in all cases. Fixation of the graft to the medial aspect of the patella was performed with two independent transosseous fixation points with high resistance sutures, and anatomic femoral fixation with an interference screw using anatomical and radiological landmarks. There were 27 patients with isolated MPFR, and 7 with associated tibial tubercle osteotomy.

Results The mean age was of 22.8 years (standard deviation [SD]: 9.1). Men comprised 50% of the sample. The mean follow-up from surgery to the application of the questionnaire was of 30.4 months (range: 12 to 72 months). The mean Kujala

Keywords
- medial patellofemoral ligament
- reconstruction
- patellar instability

received
May 17, 2020
accepted after revision
March 22, 2021

DOI https://doi.org/10.1055/s-0041-1735603.
ISSN 0716-4548.

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

score at follow-up was of 89.4 (SD: 12.8; median: 93.5; range: 51 to 100). There were no cases of redislocation. No other complications were identified during the follow-up. In total, 81% of patients returned to sports, with 47% returning to their previous level of participation. No significant differences were found when comparing isolated MPFLR with MPFLR associated osteotomy groups.

Conclusion The MPFLR procedure using transosseous sutures for patellar fixation showed that patellar stability was restored in the short to midterm. This technique is safe and has excellent functional outcomes, and it prevents potential complications of patellar tunnels or the morbidity associated to the use of implants.

Resumen

Introducción La inestabilidad rotuliana recurrente puede conducir a malos resultados funcionales y daño articular progresivo a largo plazo, y con frecuencia se aborda mediante la reconstrucción del ligamento patelofermoral medial (RLPFM), con múltiples técnicas que suelen diferir en el método de fijación de la rótula.

Objetivo Evaluar los resultados de RLPFM utilizando una técnica novedosa de fijación rotuliana mediante suturas transóseas. El objetivo principal es determinar las tasas de reluxación y los resultados funcionales. Los objetivos secundarios incluyen la evaluación de las complicaciones y de otras variables relacionadas, y la comparación entre RLPFM aislada y asociada a una osteotomía del tubérculo tibial.

Métodos Estudio transversal de 34 pacientes sometidos a RLPFM desde 2013 hasta 2019 con un seguimiento mínimo de 12 meses. La reconstrucción fue realizada por el mismo primer cirujano con autoinjerto de *gracilis* de doble banda en todos los casos. La fijación del injerto en la cara medial de la rótula se realizó utilizando dos puntos de fijación transóseos independientes con suturas de alta resistencia, y la fijación femoral anatómica, con un tornillo interferencial mediante referencias anatómicas y radiológicas. Hubo 27 pacientes con RLPFM aislada, y 7 con osteotomía de la tuberosidad tibial.

Resultados La edad media fue de 22,8 años (desviación estándar [DE]: 9,1). El 50% eran hombres. El seguimiento desde la cirugía hasta el cuestionario fue de 30,4 meses (rango: 12 a 72 meses). La puntuación media de Kujala en el seguimiento fue de 89,4 (DE: 12,8; mediana: 93,5; rango: 51 a 100). No hubo casos de reluxación. No se identificaron otras complicaciones durante el seguimiento. El 81% de los pacientes regresó a los deportes, y el 47% regresó a su nivel previo de participación. No se encontraron diferencias significativas al comparar RLPFM aislada con grupos de osteotomía asociada.

Conclusión La RLPFM mediante sutura transósea para fijación en la rótula mostró que la estabilidad rotuliana fue restaurada en el corto y mediano plazo. Esta técnica es segura, tiene excelentes resultados funcionales, y evita posibles complicaciones de los túneles rotulianos o morbilidad asociada al uso de implantes.

Palabras clave
- ligamento patelofemoral medial
- reconstrucción
- inestabilidad rotuliana

Introduction

Different structures are responsible for patellar stabilization, including muscular, ligament and osseous factors. Among them, the medial patellofemoral complex has a significant role. The main medial stabilizer of this complex is the medial patellofemoral ligament (MPFL). Biomechanical studies show that it contributes between 50% and 80% to the medial contention of the patella, and it varies depending on the degree of knee flexion.[1–3]

A common finding in acute dislocations of the patella is MPFL tear; it is a major contributing factor for recurrent patellar instability that can lead to worse functional outcomes and possibly osteoarthritis in the long term.[1,4–7] Patellar dislocation is more frequent in young individuals, women, and patients who have suffered a previous dislocation. The risk of redislocation is of 17% after the first episode, and of 50% after the second, with high variability according to the presence of associated factors.[2,8–10]

Anatomical factors like trochlear dysplasia, high positioned patella, lateralization of the tibial tuberosity, and patellar tilt are considered major risk factors for recurrence.[11] The first episode of luxation is commonly treated conservatively, but, in recurrent dislocations, surgical treatment is recommended.[12] Medial patellofemoral

reconstruction (MPFLR) is probably the most widely used surgical technique.[13–15]

A great variety of techniques have been described for medial patellofemoral reconstruction, but none of them could actually be considered a gold standard.[8] Techniques differ regarding types of graft, fixation system, presence of tunnels, tensioning, and use of implants or devices. Different choices of grafts have been described, but no authors have reported significant advantages from the rest.[13] Hamstring autograft is probably the most commonly used for MPFL reconstruction.[12] Common patellar fixation techniques for MPFLR include anchors, bone tunnels, and interference screws.[16–19] Studies comparing fixation methods show a higher risk of patellar fracture in bone tunnel techniques.[17,20–25] Transosseous sutures have been described also for MPFLR with single-bundle reconstruction,[26] but no clinical studies were found for double-bundle reconstruction.

The aim of the present study is to evaluate double-bundle MPFL reconstructions in patients with recurrent lateral patellar dislocation operated with a novel patellar graft fixation technique using transosseous sutures. The primary objective is to determine the redislocation rate and functional outcomes, including return to sports, and the secondary outcomes include an assessment of risk factors, associated injuries, and complications.

Methods

We designed an observational cross-sectional study including patients who underwent MPFLR with patellar transosseous sutures between 2013 and 2019. The inclusion criteria were the following: patients with recurrent lateral patellar dislocation, primary reconstruction surgery, use of hamstring autograft, patellar fixation with transosseous sutures, minimum of 12 months for the evaluation, and surgery performed by the same first surgeon. The data obtained from clinical records and procedure protocols includes age, date of injury, date of surgery, relevant clinical evaluation at presentation and final follow-up, presence of risk factors, associated injuries, and meniscal and chondral status of the knee. Data regarding the postoperative Kujala Score and return to sports was obtained prospectively through a questionnaire.[27,28]

The standard preoperative evaluation included standard X-rays, computed tomography (CT) and magnetic resonance imaging. Anatomical risk factors were recorded using the Caton index in X-rays for patellar height, the Dejour classification for the degree of dysplasia,[29] the distance between the tibial tubercle and the trochlear groove (TT-TG) in the CT for tibial tubercle lateralization, and the hip-to-knee angle for femoral rotation.

All patients were operated on with a standarized surgical technique. The patient is placed in supine position on the operating table. Standard arthroscopy equipment and intraoperative radioscopic image intensifier are used in all cases. First, an examination under anesthesia to assess patellar laxity, with the lateral displacement test measured in quadrant in full extension, with 30° and 60° of knee flexion. Then, arthroscopic standard portals to asses MPFL status, patellar chondral injuries, patellofemoral dynamic tracking, and detection and treatment of associated injuries, such as meniscal or chondral lesions and loose bodies. Harvesting of an autograft from the gracilis tendon is performed in a minimally-invasive manner, by a 2-cm incision over the medial portion of the posterior flex fold of the knee in 90° of flexion and hip abduction, with the use of open tendon stripper first to retrieve the proximal portion in a retrograde manner, and then a closed tendon stripper for the distal part of the tendon in a anterograde manner. In patients in which a tibial tubercle osteotomy is planned as an associated procedure, the gracilis tendon is harvested in a retrograde fashion as commonly used, through the incision of the osteotomy approach.

Next, we approach the patella with a longitudinal surgical incision over the proximal medial border. The incision is deepened to the bone with electrocautery, always extra-articularly, creating a bony bed that goes from the midpoint to the most proximal part of the medial border of the patella (►**Figure 1A**). Subsequently, with a 1.5-mm drill, 2 oblique perforations are performed between the deeper (posterior) rim of the bony bed and the anterior surface of the patella with a 45° inclination, serving as passage to the sutures (►**Figure 1B**). Once passed through bone, the sutures are returned under the periosteum to finally exit at the superficial (anterior) rim of the bony bed previously described. The procedure is repeated 2 cm to 3 cm apart. Hence, two anchoring points are now available to fixate the graft in the

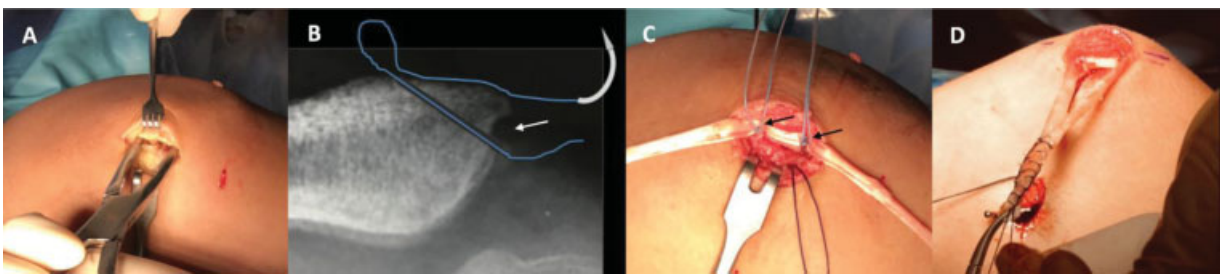

Fig. 1 (**A**) Preparation of the bony bed on the medial side of the patella. (**B**) Axial X-ray of the patella with schematic drawing of oblique perforation at 45° and the subperiosteal passage of high-resistance sutures serving as an anchoring point on the bony bed (white arrow), (**C**) Gracilis autograft placed on the bony bed fixated with high-resistance sutures (light blue sutures) to the medial aspect of the patella through both anchoring points (black arrows). (**D**) Graft fixated on the patella ready to check the isometry of the femoral fixation.

middle and proximal medial aspects of the patella with high resistance, non-absorbable sutures (►**Figure 1C**).

Once the graft is fixated to the patella, both loose ends are pointed to the femoral site of fixation and sutured together, taking care to keep the same tension in both reins. The femoral attachment site is addressed through a transverse skin incision and located by palpation in the flat spot between the medial epicondyle and adductor tubercle. This point is double-checked under intraoperative X-Ray at the anatomical point described by Schöttle et al.,[30] taking special care to obtain a true lateral view; additionally, we assess its functionality, testing the correct isometricity, detecting the tension of the graft in flexion and extension, with the correct point detected by the higher degree of tension in full extension. In that point, we place a 2,5-mm guide that is overdrilled with a 7-mm tunnel of 40 mm in length (►**Figure 1D**).[30] The graft is passed between layers 2 (vastus medialis) and 3 (capsule) of the medial patellofemoral ligament complex and fixated with a 7 mm x 28 mm interference screw to the femur, with the knee at approximately 30° of flexion, and keeping manual positioning of the patella to avoid overtensioning. In cases of open physis, femoral fixation was performed with sutures around the insertion of the distal adductor tendon.

An additional surgery was indicated for the management of associated risk factors in cases with significant abnormal patellar height or lateralization of the tibial tubercle. The degrees of dysplasia and femoral rotation did not change the protocol. A tibial osteotomy was performed with medialization of the tibial tubercle in patients with TT-TG longer than 20 mm and/or distalization of the tibial tubercle in cases with a Caton index of 1.4 or higher. When distalization osteotomies were indicated, associated medialization was added only if the TT-TG was longer than 24 mm, because of the intrinsic "medializing effect" of distalization. In cases if open physis, isolated MPFLR was performed regardless of osseous abnormalities in order to avoid growth disturbances.

A statistical analysis was performed with the Chi-squared and exact Fisher tests for the parametric variables. The Mood median or Mann-Whitney tests were used for the non-parametric variables. The normal distribution of different variables was tested with the Anderson-Darling or Kolmogorov-Smirnov tests. The median was used to determine differences in the case of variables that did not have normal distribution. The confidence interval (CI) of the proportions was calculated using the exact method for proportions. Statistical significance was set as *p*-values lower than 5%.

Results

The present study initially included 44 patients who met the criteria, but 10 patients could not be reached at the final evaluation; thus, a total of 34 patients were finally included.

In this group of 34 patients, the mean age was 22.8 years at the time of surgery (range: 10 to 42 years; standard deviation [SD]: 9.1; median: 20 years). Regarding gender, 50% (17 cases) were male and 17 cases were female patients.

Table 1 Description of the different sports practiced by the participants (n = 34)

Variable	Results
Soccer	15
Gym	5
Basketball	5
Cycling	4
More than 1 sport	8
Other sports:	12
Volleyball, skating, pole dance, dancing, cheerleading, cross-fit, kick-boxing, jogging, squash, walking, and weightlifting	
No physical activity	2

Participation in sports was observed among 94% of the patients, and it is summarized in ►**Table 1**. The clinical evaluation of these patients showed generalized ligamentous hyperlaxity in 8 (24%), genu valgus in 14 (42%), and presence of significant clinical J sign in 2 (6%). According to the anatomical factors studied in our protocol, trochlear dysplasia was the most common finding, in 30 cases (88%). The degree of dysplasia according to the Dejour classification system is presented in ►**Table 2**. Patella alta according to Caton index > 1.2 was found in 8 patients (24%), with 2 (6%) of them with an index of 1.4. No patients had a Caton index > 1.4.

Abnormal lateralization of the tibial tubercle according to the TT-TG (> 15 mm) was found in 24 patients (71%). Of these patients, 11 had > 20 mm, and were considered for surgical correction by medialization osteotomy of the tibial tubercle. In total 4 patients in this group had open physis which contraindicated the procedure, so osteotomy was performed in the remaining 7 patients. Of these 7 patients, 2 had a concomitant Caton index of 1.4, so the osteotomy was performed with a distalizating and medializating effect in both of them. (►**Table 3**)

During the initial arthroscopy, a routine systematic examination of the entire joint in search for associated injuries and loose bodies showed a high prevalence of chondral injuries, significantly more frequent in the patella (31 cases, 91%) Only minor lesions were found in the meniscus, which

Table 2 Description of the range of dysplasia according to the Dejour classification (n = 34)

Variable	Results
Dysplasia:	30 (88%)
Dejour A	16
Dejour B	9
Dejour C	4
Dejour D	1
No dysplasia	4 (12%)

Table 3 Cases of patients with TT-TG > 20 mm (n = 11)

Gender	Age	TTTG	Caton index	Dysplasia*	Associated TTO
Female	14	24 mm	1.2	A	No (open physis)
Female	13	22 mm	1.1	A	No (open physis)
Male	14	25 mm	1.3	A	No (open physis)
Male	35	21 mm	1.1	A	No (open physis)
Female	20	23 mm	1.1	C	Medializing
Female	20	22 mm	1.1	C	Medializing
Female	27	23 mm	1.1	A	Medializing
Female	17	23 mm	1.2	B	Medializing
Male	39	23 mm	1.2	C	Medializing
Male	15	25 mm	1.4	B	Medial + distalizing
Male	15	24 mm	1.4	C	Medial + distalizing

Note: *According to the Dejour classification of patellofemoral dysplasia.
Abbreviations: TTO, tibial tubercle osteotomy; TT-TG, distance between the tibial tubercle and the trochlear groove.

required no treatment, and 12 patients (35%) had loose bodies that were removed (►**Table 4**).

The mean time elapsed between the first dislocation and surgery was of 72 months (range: 1 to 328 months; SD: 85.4; median: 39.7). The final evaluation with questionnaire or survey after surgery had a mean follow-up of 30.4 months (SD: 14.6) with a range between 12 and 72 months.

Regarding the functional results, the mean Kujala acore was of 89.4 points (SD: 12.8), with a median of 93.5 points, and a range between 51 and 100 points. There were no cases of postoperative dislocation during the survey and the clinical follow-up. No revision surgery was recorded. Only 2 (6%) patients complained of postoperative pain or mild instability during sports or daily activities. No other complications were identified during the follow-up.

Regarding the rate of return to sports, of the patients who participated in sports preoperatively (32/34 patients), 81% (26 patients) returned to sports after MPFL reconstruction, and 47% (15 cases) returned to their previous level of participation. The mean time until the return to sports was of 8.8 months (SD: 5.5), with a median 6.5, and a range between 2 and 24 months.

Table 4 Arthroscopic findings in 34 patients

Variable	Results
Meniscal injuries	7 (21%)
Chondral injuries:	
Medial tibiofemoral	0
Lateral tibiofemoral	5 (15%)
Patellofemoral:	32 (94%)
No injury	2 (6%)
Isolated trochlear	1 (3%)
Isolated patellar	25 (73%)
Both	6 (18%)
Loose Body	12 (35%)

We compared 2 different groups according to our treatment protocol regarding the indication for an associated tibial tubercle osteotomy: one treated with isolated MPFLR (27 patients) and the other with MPFLR associated to an osteotomy (7 patients). When comparing these two groups, we found no differences regarding the Kujala score, the dislocation rate, and the return to sports rate, as seen on ►**Table 5**.

Discussion

The main goals of the present study were to assess the functional outcomes and redislocation rates. Regarding the evaluation of the functional results, the Kujala score is one of the most common scores used in patellofemoral disorders.[1,28] Schneider et al.,[31] in their systematic review, found a pooled estimate between 81.6 and 90 points using the Kujala score. In addition to this, they estimated the risk of objective recurrent instability after surgery between 0.3% and 2.1%.[31] In ►**Appendix 1**, we summarized the comparative findings in different clinical studies that involved more than 30 patients mostly from two major systematic reviews.[1,47] The redislocation rates among them vary between 0% and 4.5%, and the Kujala scores, between 75 and 94, which is comparable to the findings in the present series.

In the present series, the mean Kujala score was of 89.4 points, and no dislocation episodes (0%) were found in a mean follow-up of 30 months.

Achieving adequate patellar stabilization with satisfactory functional results is probably the main goal of our surgery, but return to sports is of crucial importance when considering our results and the expectations of the patients, especially those young and active. Nevertheless, few studies report their return to sports rate as shown by Schneider et al.[31] They report a pooled estimate of the rate of return to

Table 5 Comparison between isolated MPFLR and MPFLR + Associated TTO

Group	Redislocation rate	Median Kujala	Mean Kujala	Rate of return to sports
Isolated MPFLR	0%	93 (CI: 89.9–95)	88 (CI: 82.7–93.6)	78% (CI: 58%–91%)
MPFLR + associated TTO	0%	96 (CI: 88.6–100)	94 (CI: 89.1–99.4)	71% (CI: 29%–96%)
p-value	Not available	0.671	0.083	0.736

Abbreviations: CI, confidence interval; MPFLR, medial patellofemoral ligament reconstruction; TTO, tibial tubercle osteotomy.

sport of 84% (CI: 71% to 97%), which comparable to the 81% found in the present study. When considering patients that return to their previous level of participation, the results are significantly lower; Matassi et al.[32] and Lippacher et al.[19] report 39% and 53% respectively. Nevertheless, with a longer follow-up (6 years), Ambrožič qnd Novak[33] report a 70% return to the previous level. Many studies[34,35] addressing this issue show a slow recovery with prolonged programs of rehabilitation (> 8 months) after MPFLR. There are reports of even slower recovery if a tibial osteotomy is associated.[19] It has been demonstrated that subtle deficits in the global evaluation may remain for long time after the full discharge to return to sports.[36]

The MPFLR techniques have shown many differences among clinical studies. The type of patellar fixation is probably one the most significant, with a great variety that makes them difficult for comparison.

In general, we can divide patellar fixation in three types: anchors, bone tunnels, and suture techniques, as suggested in the systematic review by Kang et al.[37] They found no differences among them regarding Kujala scores, redislocation rates, and complications. On the other hand, many authors have found more complications related to the use of patellar bone tunnels, especially patellar fractures, and persistent pain.[17,20–25,38,39] Desai et al.,[1] in their systematic review, showed rates of patellar fractures between 0% and 17%, significantly higher in bone tunnel techniques, despite the fact that the clinical outcomes are similar to those of cortical fixation techniques. The risk of fracture increases as the tunnel size increases, especially for those > 4.5 mm, as seen with EndoButton techniques. Nonetheless, no fractures were reported with tunnels < 3 mm.[1,25] Our technique addresses this concern by using a small, oblique 1.5-mm perforation only for the passage of needles, and no fractures were found in the present study.

Transosseous suture fixation has shown adequate fixation strength in biomechanical testing in cadaveric models, and a maximum load to failure (540 ± 160 N) stronger than that of the native MPFL and of other fixation methods (anchor, interference screw, transpatellar bone tunnels or medial bone bridge).[16,18]

To our knowledge, no clinical studies have reported this technique nor clinical results of two-bundle MPFLR with patellar transosseous fixation.

A remarkable advantage of the technique described with transosseous sutures is its low cost, which avoids more expensive implants in the patella, such as anchors, screws, or suspension buttons.

Other complications of MPFLR published among systematic reviews are a postoperative positive apprehension sign between 3.6% and 8.2%, and a reoperation risk between 3.1% and 4.2%.[25,31] We found 2 cases (6%) with apprehension sign after surgery, and no revision surgery was needed.

Patellar instability involves a wide variety of anatomical abnormalities that make the patella prone to dislocation, such as trochlear dysplasia, patella alta, the TT-TG, and patellar tilt, which have been considered major risk factors for recurrence.[11,29] The current literature supports associated procedures in patients with demonstrated major risk factors and recurrent lateral dislocation, such as J sign with severe trochlear dysplasia, lateralization of the tibial tuberosity with TT-TG longer than 20 mm, patella alta with a Caton index higher than 1.2 to 1.4, and severe alignment abnormalities (severe genu valgus or femoral anteversion higher than 30°).[40–44] In this setting, tibial tubercle transfer plays a role when considering correction of abnormalities such as patella alta or an excessive TT-TG. Magnussen et al.,[44] in their systematic review regarding tibial tubercle distalization in patients with patella alta, report that this procedure is safe and effectively reduces recurrent patellar dislocation, with an overall risk of redislocation of almost 2%, with good to excellent functional outcomes.[44] When considering TT lateralization, in a systematic review, Boutefnouchet et al.[43] reported that the literature is sparse and heterogeneous, and a surgical threshold, such as the one for TT-TG alone, could not be determined.[43] In 1994, Dejour et al.[11] used a cutoff point at 20 mm; nevertheless, 20% of asymptomatic knees exceeded that value. This is similar to what is reported by Caplan et al.;[45] therefore, with the current evidence the TT-TG measurement should be used with caution and in combination with other findings to decide whether the surgical correction is necessary.[11,43,45]

Mulliez et al.,[46] in a study with 129 patients, found no differences when comparing the functional results between isolated MPFLR (91 patients, 70%) and MPFLR associated to tibial osteotomy (38 patients in the group, 30%) in patients with TT-TG longer than 20 mm and Caton index higher than 1.2.[46] According to our protocol, 11 (32%) of our patients had indication for osteotomy, but, because of open physis in 4 of them, we finally performed an associated osteotomy in 7 (20%) cases, and did not find differences in functional results, dislocations or complications. We must be aware that these two groups are not entirely comparable because of the higher grade of abnormal anatomical factors in the osteotomy group; still, the results showed no significant differences.

The limitations of the present study are the following: the small sample size (34 patients), which can affect the comparison of groups, and a longer follow-up is required to assess the long-term efficacy of this technique, even though

the vast majority of studies found in the literature share both of these problems. Another limitation is heterogenous groups of patients with different grades of osseous abnormalities and associated procedures, which could limit the generalization of the technique. Finally, the rate of non-reachable patients was of 23%, which is comparable to what is found in the literature.[1,31,47]

Conclusion

Reconstruction of the medial patellofemoral ligament using patellar fixation with transosseous sutures showed excellent functional outcomes, with an acceptable rate of return to sport in the midterm, with no cases of redislocation with a follow-up of 1 to 6 years. The surgical technique described is safe and could avoid possible complications related to the use of patellar tunnels, as well as the morbidity and additional costs related to the use of implants.

Conflict of Interests
The authors have no conflict of interests to declare.

References

1 Desai VS, Tagliero AJ, Parkes CW, et al. Systematic Review of Medial Patellofemoral Ligament Reconstruction Techniques: Comparison of Patellar Bone Socket and Cortical Surface Fixation Techniques. Arthroscopy 2019;35(05):1618–1628
2 Krebs C, Tranovich M, Andrews K, Ebraheim N. The medial patellofemoral ligament: Review of the literature. J Orthop 2018;15(02):596–599
3 Gonçaives MB, Júnior LH, Soares LF, Gonçaives TJ, Dos Santos RL, Pereira ML. Medial patellofemoral ligament reconstruction to treat recurrent patellar dislocation. Rev Bras Ortop 2015;46 (02):160–164
4 Atkin DM, Fithian DC, Marangi KS, Stone ML, Dobson BE, Mendelsohn C. Characteristics of patients with primary acute lateral patellar dislocation and their recovery within the first 6 months of injury. Am J Sports Med 2000;28(04):472–479
5 Mäenpää H, Lehto MU. Patellofemoral osteoarthritis after patellar dislocation. Clin Orthop Relat Res 1997;(339):156–162
6 Sillanpää P, Mattila VM, Iivonen T, Visuri T, Pihlajamäki H. Incidence and risk factors of acute traumatic primary patellar dislocation. Med Sci Sports Exerc 2008;40(04):606–611
7 Sillanpää PJ, Mattila VM, Visuri T, Mäenpää H, Pihlajamäki H. Patellofemoral osteoarthritis in patients with operative treatment for patellar dislocation: a magnetic resonance-based analysis. Knee Surg Sports Traumatol Arthrosc 2011;19(02):230–235
8 Blønd L. Patellar Instability - An Update. Acta Orthop Belg 2017;83 (03):367–386
9 Fithian DC, Paxton EW, Stone ML, et al. Epidemiology and natural history of acute patellar dislocation. Am J Sports Med 2004;32 (05):1114–1121
10 Subramanian P, Patel R. Patellofemoral instability: an overview. Orthop Trauma 2019;33:119–126
11 Dejour H, Walch G, Nove-Josserand L, Guier C. Factors of patellar instability: an anatomic radiographic study. Knee Surg Sports Traumatol Arthrosc 1994;2(01):19–26
12 Stefancin JJ, Parker RD. First-time traumatic patellar dislocation: a systematic review. Clin Orthop Relat Res 2007;455(455):93–101
13 Amin NH, Lynch TS, Patel RM, Patel N, Saluan P. Medial Patellofemoral Ligament Reconstruction. JBJS Rev 2015;3(07):3–4
14 Howells NR, Barnett AJ, Ahearn N, Ansari A, Eldridge JD. Medial patellofemoral ligament reconstruction: a prospective outcome assessment of a large single centre series. J Bone Joint Surg Br 2012;94(09):1202–1208
15 Mistry JB, Bonner KF, Gwam CU, Thomas M, Etcheson JI, Delanois RE. Management of Injuries to the Medial Patellofemoral Ligament: A Review. J Knee Surg 2018;31(05):439–447
16 Russ SD, Tompkins M, Nuckley D, Macalena J. Biomechanical comparison of patellar fixation techniques in medial patellofemoral ligament reconstruction. Am J Sports Med 2015;43(01): 195–199
17 Migliorini F, Driessen A, Quack V, Schenker H, Tingart M, Eschweiler J. Patellar fixation graft via suture anchors versus tunnel techniques during isolated MPFL reconstruction for recurrent patellofemoral instability: a systematic review of the literature. Arch Orthop Trauma Surg 2020;140(09):1201–1210
18 Lenschow S, Schliemann B, Gestring J, Herbort M, Schulze M, Kösters C. Medial patellofemoral ligament reconstruction: fixation strength of 5 different techniques for graft fixation at the patella. Arthroscopy 2013;29(04):766–773
19 Lippacher S, Dreyhaupt J, Williams SR, Reichel H, Nelitz M. Reconstruction of the medial patellofemoral ligament: clinical outcomes and return to sports. Am J Sports Med 2014;42(07): 1661–1668
20 Lippacher S, Reichel H, Nelitz M. [Patellar fracture after patellar stabilization]. Orthopade 2010;39(05):516–518
21 Parikh SN, Nathan ST, Wall EJ, Eismann EA. Complications of medial patellofemoral ligament reconstruction in young patients. Am J Sports Med 2013;41(05):1030–1038
22 Parikh SN, Wall EJ. Patellar fracture after medial patellofemoral ligament surgery: a report of five cases. J Bone Joint Surg Am 2011;93(17):e97 (1–8)
23 Sanchis-Alfonso V, Montesinos-Berry E, Ramirez-Fuentes C, Leal-Blanquet J, Gelber PE, Monllau JC. Failed medial patellofemoral ligament reconstruction: Causes and surgical strategies. World J Orthop 2017;8(02):115–129
24 Schiphouwer L, Rood A, Tigchelaar S, Koëter S. Complications of medial patellofemoral ligament reconstruction using two transverse patellar tunnels. Knee Surg Sports Traumatol Arthrosc 2017;25(01):245–250
25 Shah JN, Howard JS, Flanigan DC, Brophy RH, Carey JL, Lattermann C. A systematic review of complications and failures associated with medial patellofemoral ligament reconstruction for recurrent patellar dislocation. Am J Sports Med 2012;40(08):1916–1923
26 Brown GD, Ahmad CS. The docking technique for medial patellofemoral ligament reconstruction. Oper Tech Orthop 2007;17(04): 216–222
27 Gil-Gámez J, Pecos-Martín D, Kujala UM, et al. Validation and cultural adaptation of "Kujala Score" in Spanish. Knee Surg Sports Traumatol Arthrosc 2016;24(09):2845–2853
28 Kujala UM, Jaakkola LH, Koskinen SK, Taimela S, Hurme M, Nelimarkka O. Scoring of patellofemoral disorders. Arthroscopy 1993;9(02):159–163
29 Dejour D, Le Coultre B. Osteotomies in patello-femoral instabilities. Sports Med Arthrosc Rev 2007;15(01):39–46
30 Schöttle PB, Schmeling A, Rosenstiel N, Weiler A. Radiographic landmarks for femoral tunnel placement in medial patellofemoral ligament reconstruction. Am J Sports Med 2007;35(05):801–804
31 Schneider DK, Grawe B, Magnussen RA, et al. Outcomes After Isolated Medial Patellofemoral Ligament Reconstruction for the Treatment of Recurrent Lateral Patellar Dislocations: A Systematic Review and Meta-analysis. Am J Sports Med 2016;44(11): 2993–3005
32 Matassi F, Innocenti M, Andrea C, Zanna L, Malone J, Civinini R. Timing for Safe Return to Sport after Medial Patellofemoral Ligament Reconstruction: The Role of a Functional Test Battery. J Knee Surg. 2019 Sep 4
33 Ambrožič B, Novak S. The influence of medial patellofemoral ligament reconstruction on clinical results and sports activity level. Phys Sportsmed 2016;44(02):133–140

34 Krych AJ, O'Malley MP, Johnson NR, et al. Functional testing and return to sport following stabilization surgery for recurrent lateral patellar instability in competitive athletes. Knee Surg Sports Traumatol Arthrosc 2018;26(03):711–718
35 Saper MG, Fantozzi P, Bompadre V, Racicot M, Schmale GA. Return-to-Sport Testing After Medial Patellofemoral Ligament Reconstruction in Adolescent Athletes. Orthop J Sports Med 2019;7(03):232–235
36 Shams K, DiCesare CA, Grawe BM, et al. Biomechanical and Functional Outcomes After Medial Patellofemoral Ligament Reconstruction: A Pilot Study. Orthop J Sports Med 2019;7(02): 232–237
37 Kang H, Zheng R, Dai Y, Lu J, Wang F. Single- and double-bundle medial patellofemoral ligament reconstruction procedures result in similar recurrent dislocation rates and improvements in knee function: a systematic review. Knee Surg Sports Traumatol Arthrosc 2019;27(03):827–836
38 Christiansen SE, Jacobsen BW, Lund B, Lind M. Reconstruction of the medial patellofemoral ligament with gracilis tendon autograft in transverse patellar drill holes. Arthroscopy 2008;24(01):82–87
39 Dhinsa BS, Bhamra JS, James C, Dunnet W, Zahn H. Patella fracture after medial patellofemoral ligament reconstruction using suture anchors. Knee 2013;20(06):605–608
40 Carstensen SE, Menzer HM, Diduch DR. Patellar Instability: When is Trochleoplasty Necessary? Sports Med Arthrosc Rev 2017;25 (02):92–99
41 Balcarek P, Rehn S, Howells NR, et al. Results of medial patellofemoral ligament reconstruction compared with trochleoplasty plus individual extensor apparatus balancing in patellar instability caused by severe trochlear dysplasia: a systematic review and meta-analysis. Knee Surg Sports Traumatol Arthrosc 2017;25 (12):3869–3877
42 Kita K, Tanaka Y, Toritsuka Y, et al. Factors Affecting the Outcomes of Double-Bundle Medial Patellofemoral Ligament Reconstruction for Recurrent Patellar Dislocations Evaluated by Multivariate Analysis. Am J Sports Med 2015;43(12):2988–2996
43 Boutefnouchet T, Downham C, Bassett J, Thompson P, Sprowson A. The Efficacy of Medial Patellofemoral Ligament Reconstruction Combined with Tibial Tuberosity Transfer in the Treatment of Patellofemoral Instability. Knee Surg Relat Res 2016;28(02): 99–109
44 Magnussen RA, De Simone V, Lustig S, Neyret P, Flanigan DC. Treatment of patella alta in patients with episodic patellar dislocation: a systematic review. Knee Surg Sports Traumatol Arthrosc 2014;22(10):2545–2550
45 Caplan N, Lees D, Newby M, et al. Is tibial tuberosity-trochlear groove distance an appropriate measure for the identification of knees with patellar instability? Knee Surg Sports Traumatol Arthrosc 2014;22(10):2377–2381
46 Mulliez A, Lambrecht D, Verbruggen D, Van Der Straeten C, Verdonk P, Victor J. Clinical outcome in MPFL reconstruction with and without tuberositas transposition. Knee Surg Sports Traumatol Arthrosc 2017;25(09):2708–2714
47 Yeung M, Leblanc MC, Ayeni OR, et al. Indications for Medial Patellofemoral Ligament Reconstruction: A Systematic Review. J Knee Surg 2016;29(07):543–554

Appendix 1 Studies with more than 30 patients

Study	N° of patients	Mean follow-up (months)	Graft type	Kujala score (standard deviation)*	Redislocation
Howells et al., 2012[y]	193	16	ST	81.7	0
Astur et al., 2015[d]	58	60	GC	79.6 (14.5)	0
Goyal et al., 2013[d]	32	38	QD	91.3	0
Kang et al., 2014[d]	45	34	ST	90.9 (6.6)	0
Kita et al., 2015[d]	42	38	ST	93.6	4.5%
Krishna Kumar et al., 2014[d]	30	25	GC	87	0
Lee et al., 2017[d]	44	48	GC/synthetic	83 (16)	0
Mulliez et al., 2015[d]	124	12	GC/ST	74.7 (20.5)	0.8%
Niu et al., 2017[d]	64	25	ST	91.8 (3.7)	0
Niu et al., 2017[d]	32	48	ST	92 (4.8)	0
Panni et al., 2011[d]	51	33	ST	86.8 (14.4)	0
Valkering et al., 2017[d]	31	37	GC	80.9 (2)	0
Von Engelhar et al., 2018[d]	30	24	GC	92 (10)	0
Wagner et al., 2013[d]	50	12-24	GC	87 (13)	2%
Han et al., 2011[y]	52	68	ST	82.6	0
Lippacher et al., 2014[y]	68	25	GC	87.5	2%
Ma et al., 2013[y]	32	40	ST	87	0
Matsushita et al., 2014[y]	34	108	ST	92	0
Panni et al., 2011[y]	48	33	ST	86.8 (7.2)	0
Smith et al., 2014[y]	30	12	ST/GC	84.1 (20.6)	1%
Wang et al., 2013[y]	58	48	ST	92.9 (4.32)	0
Zhou et al., 2014[y]	32	18	ST	91 (7)	0
Present study	34	30	GC	89.4 (12.8)	0

Abbreviations: ST, semitendinous; GC, gracilis; QD, Quadriceps Notes: *If available; [y]systematic review by Yeung et al.[47]; [d]systematic review by Desai et al. [1]

