SOCIEDADE BRASILEIRA DE ORTOPEDIA E TRAUMATOLOGIA

RBO REVISTA BRASILEIRA DE ORTOPEDIA

www.rbo.org.br

Review Article

Lateral patellar retinacular release: changes over the last ten years☆

Leonardo Pini Rosalem Marciano da Fonseca[a,*], *Ednei Haruo Kawatake*[a], *Alberto de Castro Pochini*[b]

[a] *Hospital Novo Atibaia, Atibaia, SP, Brazil*

[b] *Universidade Federal de São Paulo, Escola Paulista de Medicina, Departamento de Ortopedia e Traumatologia, São Paulo, SP, Brazil*

ARTICLE INFO

Article history:
Received 18 May 2016
Accepted 30 June 2016
Available online 15 June 2017

Keywords:
Patellofemoral joint
Joint instability
Patellofemoral pain syndrome
Knee osteoarthritis
Knee arthroplasty

ABSTRACT

Lateral retinacular release is a useful resource in knee surgery that can be used for disorders of the extensor mechanism. For many years, it was indiscriminately used in the treatment of the various patellofemoral joint alterations, with conflicting functional results. This study aimed to analyze the changes that have occurred in the indications and clinical effectiveness of lateral retinacular release by reviewing the relevant literature of the past ten years, comparing it to the classic literature on the subject. It was found that less extensive releases decompress the lateral patellar facet, helping with pain control, while decreasing the risks of medial subluxation. Nowadays, there is clear evidence for its indication in the lateral patellar hypercompression syndrome associated with anterior knee pain, as long as there is no related instability; furthermore, it will normally play an adjuvant role in extensor mechanism alignment surgeries for cases of recurrent patellar instability. The initial results for symptomatic patellofemoral osteoarthritis are promising when lateral release is combined with cartilage debridement; in total knee replacement, it is more commonly used for the correction of valgus deformity in order to improve the components' congruency. Finally, distinguishing the different patellofemoral joint pathologies is seen as crucial in order to indicate this procedure. Further randomized control trials that compare surgical techniques with long-term results are still needed.

☆ Study conducted at the Hospital Novo Atibaia, Instituto de Cirurgia do Joelho Dr. Kenji Kawakami, Atibaia, SP, Brazil, and at the Universidade Federal de São Paulo, Escola Paulista de Medicina, Departamento de Ortopedia e Traumatologia, Centro de Traumato-Ortopedia do Esporte, São Paulo, SP, Brazil.

* *Corresponding author.*
E-mail: leo_pini_fonseca@yahoo.com (L.P. Fonseca).

http://dx.doi.org/10.1016/j.rboe.2017.06.003

Liberação retinacular lateral da patela: o que mudou nos últimos dez anos

Palavras-chave:
Articulação patelofemoral
Instabilidade articular
Síndrome da dor patelofemoral
Osteoartrite do joelho
Artroplastia do joelho

RESUMO

A liberação retinacular lateral da patela é um recurso útil nas cirurgias do joelho e pode ser feita nas desordens do mecanismo extensor. Durante muitos anos, foi usada de forma indiscriminada para o tratamento das diversas alterações da articulação patelofemoral, com resultados funcionais conflitantes. O objetivo deste artigo é analisar as mudanças ocorridas nas indicações e na eficácia clínica da liberação retinacular lateral da patela ao revisar a literatura pertinente dos últimos dez anos e contrapô-la com a literatura clássica sobre o tema. Encontrou-se que liberações menos extensas descomprimem a faceta lateral da patela, auxiliam no controle da dor, enquanto diminuem os riscos de subluxação medial. Atualmente, existem claras evidências para sua indicação na síndrome da hiperpressão lateral da patela associada a dor anterior do joelho, desde que não haja instabilidade concomitante; além disso, o procedimento geralmente atuará de forma adjuvante em cirurgias de realinhamento do mecanismo extensor nos casos de instabilidade patelar recorrente. Os resultados iniciais para os casos de osteoartrose patelofemoral sintomática são animadores quando se combina a liberação lateral com o desbridamento cartilaginoso; na artroplastia total do joelho, é mais comumente feita nas correções das deformidades em valgo para melhorar a congruência dos componentes. Finalmente, percebe-se como crucial a distinção das diferentes patologias da articulação patelofemoral para que se possa indicar esse procedimento. Ainda há necessidade de mais ensaios clínicos randomizados com vistas à comparação de técnicas cirúrgicas com resultados em longo prazo.

Introduction

Lateral retinacular release of the patella is a useful resource for knee surgeries and may be performed in disorders of the extensor apparatus, whether or not associated with other procedures. The theoretic basis of this technique is the imbalance of the extension mechanism caused by excessive tension of the lateral retinaculum, which contributes to patellofemoral disorders, such as anterior knee pain, acute or chronic instability, patellar chondropathy, and patellofemoral osteoarthrosis (OA).[1–3]

For many years, lateral retinacular release of the patella has been used indiscriminately for the treatment of various extensor mechanism abnormalities, presenting conflicting functional results.[4] Over the years, it has been noted that in order to effectively treat patellofemoral joint disorders, it is important to better understand the anatomical and biomechanical issues involved in this joint.[2]

This article aimed to analyze the changes in indications and clinical efficacy of lateral patellar retinacular release by reviewing the relevant literature of the last ten years, comparing it with the classic literature on the subject. To conclude, the authors suggest a possible role that lateral retinacular release plays today in the surgical treatment of major patellofemoral disorders.

Anatomy of the patellofemoral joint

The patellofemoral joint is intrinsically unstable and depends on bone morphology and musculotendinous structures to maintain its stability.[3] This stability is influenced by the geometry of the trochlear groove, both in depth and tilt, since the lateral surface of the trochlear groove is higher on the anterior surface of the femur and decreases in more distal and posterior positions, an important bone scaffold for the patellar excursion in extension and initial flexion. As the Q angle increases from flexion to extension, the tension in the quadriceps and patellar tendons decreases. This occurs because the tibia rotates externally, thus moving the tibial tubercle laterally, in a mechanism known as screw-home. This relationship contributes to greater patellar instability in extension and in small degrees of flexion, causing patellar dislocation. In turn, during flexion, the quadriceps and patellar tendons form a posterior force vector, providing greater patellar stability.[4,5]

The vastus medialis oblique (VMO) muscle actively acts as a stabilizer, while the medial patellofemoral ligament (MPFL) and the lateral retinaculum are passive stabilizers. Imbalances may occur due to VMO muscle weakening or increased tension in the lateral retinaculum.[3,4]

The iliotibial tract is inserted into Gerdy's tubercle, but also connects with the quadriceps tendon and the patellar

ligament; increased tension in the iliotibial tract may cause patellar lateralization. In turn, the MPFL is a primary restrictor of lateral patellar dislocation between 0° and 30° of flexion, acting as an important medial knee stabilizer.[4,5]

The imbalance of these forces generally represents an increased tension in the lateral retinaculum and a weakening in the VMO muscle. This can be improved with rehabilitation focused on muscle strengthening; however, the use of tight lateral retinaculum release has been a subject of debate.[3,6]

Biomechanical effects of lateral patellar retinacular release

The main biomechanical function of the patella is to increase the momentum of the extensor mechanism. The load on the joint increases with increasing flexion.[7] In their cadaveric studies, Ostermeier et al.[8] concluded that lateral release did not increase medial patellar instability throughout its range of motion; nonetheless, the contact pressure was more medial, between 60° and 120° of flexion, which reduces pressure on the lateral surface during flexion. Conversely, if an extended release is made, it can result in a significant increase in medial patellar instability, increasing the risk of medial dislocation of iatrogenic cause.[3]

Lateral retinacular release in patellofemoral instability

The stability of the patellofemoral joint depends on the alignment of the lower limb, on the patellar and trochlear osteocartilaginous architecture, on the integrity of the ligament structures, and on the function of the dynamic stabilizers.[4,9,10] Therefore, patellofemoral instability is a multifactorial problem, and proper treatment depends on an accurate understanding of the existing biomechanical relationships between the structures.[4] An accurate diagnosis that differentiates primary traumatic patellar dislocation from chronic instability and subluxation, and these from lateral patellar hyperpressure syndrome,[11] is paramount for the indication of lateral retinacular release.

Although the lateral retinaculum contributes to only 10% of the lateral stability of the patella,[12] when under excessive stress it often leads to abnormal contact of the lateral surface against the trochlea, increased lateral inclination of the patella (tilt), and pathological changes of the patellar tracking (maltracking). In turn, patellar hypermobility related to an increased ligament lassitude, with or without a high riding patella, or related to VMO muscle dystrophy may lead to patellofemoral instability, commonly observed in female adolescents.[2,10]

Over 100 different types of surgery have already been described for the treatment of patellofemoral instability, generally involving a combination of procedures such as lateral retinacular release with medial plication, proximal or distal re-alignment, and MPFL reconstruction.[13–22] To date, a gold-standard corrective surgery for the disorder has not yet been defined,[3,4] and the proportion of satisfactory results after isolated lateral retinacular release reported in the classical literature ranges from 30% to 100%.[14,23,24]

In a series of 41 cases of recurrent patellar dislocation that underwent lateral retinacular release, Dandy and Griffiths[25] observed that the results considered good (51%) or excellent (39%) after a mean follow-up of four years presented a significant decrease in the following four years, at a secondary assessment.[26] These authors also demonstrated that patellar subluxation in extension, global ligament hyperlaxity, and the degree of osteochondral lesions of the patella at the time of the procedure were the worst prognostic factors.[25,26] In 1992, Aglietti et al.[23] demonstrated that the treatment of patellofemoral instability only by isolated lateral retinacular release led to a recurrence rate of 35%. Dainer et al.[27] concluded that this type of treatment was ineffective in cases of recurrent patellar dislocation.

These concepts remained consolidated in the opinion of experts over the years until 2004, when Fithian et al.[28] conducted a survey of 27 of the 45 members of the International Patellofemoral Study Group about their views on the indications of retinacular lateral release and observed that although most experts performed the procedure in less than 2% of their surgical cases, there was no consensus as to the best clinical or radiological evidence available for its indication. The authors concluded that the procedure should not be performed without objective evidence of a tensioned lateral retinaculum and that it should rarely be performed alone.

By analyzing the long-term results of 100 patients who underwent lateral retinacular release between 1986 and 1994, Panni et al.[29] noted a deterioration of the satisfactory results in the group with patellofemoral instability when compared with the group that had only anterior knee pain after a minimum follow-up of five years. Satisfaction rates fell from 72% to 50% over time in that group; the authors concluded that this reduction was probably due to the fact that other factors contributed to patellar instability, whose correction would not be possible with lateral retinacular release alone.

Similarly, in a literature review, Lattermann et al.[30] analyzed the results of 14 studies on the role of lateral retinacular release in the treatment of patellofemoral instability and observed a mean satisfaction rate of 80% in those studies with a follow-up time of less than four years; this rate decreased to 63.5% in studies where patients were assessed for a longer period. The authors concluded that the isolated procedure had little or no utility, and should be reserved for the rare cases in which the lateral patellar hyperpressure syndrome is clearly identified in the presence of a tensioned lateral retinaculum. They suggest that the procedure can be used as an adjunct in extensor mechanism realignment surgeries, and that it should be performed with great caution to avoid excessive release, which may cause iatrogenic medial subluxation of the patella. This feared complication[9,30,31] usually occurs when the retinacular release is extended beyond the vastus lateralis oblique (VLO) muscle fibers or exceedingly distal, until the Gerdy's tubercle.[3,22]

In order to try to understand the limits of the lateral retinacular release, recent studies on the subject appear to focus more on the surgical techniques used, analyzing them prospectively, associated or not with other procedures, and sometimes in the laboratory, in cadaveric biomechanical studies.[6,8,12,19,21,22,32,33]

In a series of 20 cases with history of recurrent patellar dislocation who underwent arthroscopic release of the VLO muscle tendon, Woods et al.[22] aimed to assess whether there was a significant loss of quadriceps torque force, with consequent functional impairment of the knee in these patients, which could explain the unsatisfactory postoperative results hitherto. The pre- and postoperative quadriceps strength was compared using an isokinetic dynamometer and the IKDC and *Short Form-36* functional scores in a minimum follow-up of two years. The authors found that 14 of the 20 patients (70%) had an increase in quadriceps strength, 17 (85%) reported a functional improvement of the operated knee, with consequent improvement of the physical state, and no cases of recurrence or medial instability were observed. They caution, however, that this technique should be used in suitably selected patients.

In contrast, two years later, Miller et al.[32] published a series of 25 patients who underwent arthroscopic medial plication without lateral retinacular release. One of the objectives was precisely to assess the need for the use of lateral release as part of routine surgery in patients with patellofemoral instability who have minimum patellar *tilt* and normal alignment. Their study used congruence angle, lateral patellofemoral angle, lateral patellar displacement, patellar physical examination maneuvers (seizure, compression, and patellar mobility), as well as the functional scales of Lysholm and Tegner, and subjective symptomatic criteria as comparative parameters between the pre- and postoperative periods, with a mean follow-up of 60 months. The authors observed an improvement in all assessed parameters, as well as satisfaction levels similar to those observed in studies with lateral retinacular release, which led to the conclusion that medial plication can lead to good results without the complication risks inherent to the release procedure.

In an attempt to compare the success rates of surgical techniques, Ricchetti et al.[21] conducted a systematic review of the literature and contrasted the results of studies on isolated lateral retinacular release with those of studies that used this technique together with a medial realignment procedure (reefing, plication, VMO advance) for cases of recurrent patellar instability. After applying the inclusion and exclusion criteria, the authors reviewed 14 articles with level of evidence III and IV and observed a significant superiority of the combined procedure: the combined procedure had a mean success rate of 93.6%, associated with a lower likelihood of recurrence over time, versus the mean success rate of 77.3% for the isolated procedure, which had a significantly higher chance of recurrence (odds ratios). Therefore, the authors concluded that the use of isolated lateral retinacular release led to worse results over time when compared with joint procedures.

With comparable objectives, Lee et al.[33] retrospectively reviewed 31 cases of recurrent patellar dislocation treated by plication associated with percutaneous lateral retinacular release, with a median follow-up of 11.6 ± 2.4 years. As evaluation parameters, the authors used the Kujala and Tegner functional criteria, the subjective scale described by Drez et al.,[34] and semiotic and radiological measures similar to previous studies; they described the cases with dysplasia troclear by Dejour classification,[35] or those with patellofemoral osteoarthritis, imposing strict exclusion criteria. By being judicious in the selection of patients in which the aforementioned parameters were assessed, the authors observed significant improvements in the clinical and radiological results, a low complication rate, no cases with evolution to osteoarthritis (OA), and only 10% of recurrence. It is noteworthy that, of the three cases reoperated, two had trochlear dysplasia and one had systemic ligament hyperlaxity. Finally, the authors discussed the advantages of this type of surgical technique over the already renowned MPFL reconstruction as a surgical treatment option for recurrent patellar dislocations.

Lateral retinacular release in patellofemoral pain

Lateral retinacular release was widely used in the 1970s and 1980s as a treatment for anterior knee pain syndrome, with widely varying postoperative satisfaction rates among studies at the time.[13,36–39] Comparing the results of these studies is difficult due to the different methodologies used, patient selection, follow-up, evaluation criteria, and especially the different terminology used. Many studies did not distinguish between patients who had both patellofemoral pain and instability from those who had only pain or only instability.[14–16,39]

Nonetheless, it was demonstrated that in patients with lateral patellar hyperpressure syndrome, evidenced by an increase in the patellar tilt observed at knee CT or at the test of medial patellar slide in extension,[40] a significant improvement in pain was observed in the short term after lateral retinacular release.[9,11,38,40–42] However, the results were less than satisfactory in patients who had Outerbridge[43] grade III or IV patellar chondropathy at surgery and in those who presented patellofemoral instability in addition to pain.[3,13] In 1982,[18] Metcalf indicated that young women generally had worse prognosis and that the proportion of good and excellent results deteriorated after one year of follow-up. Krompinger and Fulkerson[42] reported worse lateral retinacular release results in patients with Q angles greater than 20 degrees, and Gecha and Torg[41] observed better results when patellar hypermobility or malalignment were not detected.

In their histological study, Mori et al.[44] suggested that the origin of patellofemoral pain lay in degenerative neuropathy found in the lateral retinaculum of symptomatic patients and therefore, its release would cause analgesia by denervating this tissue. Later, in 2004, Fithian et al.[28] demonstrated the

strong consensus among experts that the reduction of the lateral tension, which leads to a relief of the surface pressure together with the denervation, is the mechanism by which the lateral release relieves pain.

Panni et al.[29] published a retrospective clinical trial comparing long-term results of lateral retinacular release in a group of patients who presented only patellofemoral pain with those of another group who presented only instability, excluding those with a history of patellar dislocation and osteoarthritis. As evaluation parameters, the Lysholm II and Busch and DeHaven questionnaires were used, as well as the classical radiological measurements described by Merchant and Mercer.[39] Among the most important findings, the functional criteria did not deteriorate over time for patients who only had patellofemoral pain; the mean rate of satisfactory results remained at 70%, whereas those who had instability presented a significant worsening in their functional condition within five years after the procedure.

In a systematic review of the literature on the use of lateral retinacular release for anterior knee pain, Lattermann et al.[45] observed that the isolated procedure yielded 76% good results when studies were compiled; no significant difference was observed between open or arthroscopic procedures, and complication rates were minimal. The aggregate results indicated a need for revision surgery in 12% of the cases after a mean of 52 months of follow-up, but the authors emphasized that the surgical procedure is necessary in less than 15% of patients presenting with anterior knee pain. In their study, the authors called attention to the need for randomized clinical trials to better evaluate the benefits of this procedure in the treatment of anterior knee pain.

Recently, Pagenstert et al.[19] conducted a prospective double-blinded study of 28 patients, comparing the lateral retinacular release technique with their technique of lateral retinacular stretching. After a minimum follow-up of two years, the authors found better functional results in the Kujala score for the group submitted to stretching, who also presented less medial instability and less quadriceps atrophy, which are common complications reported in lateral retinacular release.[10,17,18,46,47]

Lateral retinacular release in patellofemoral OA

Isolated OA of the patellofemoral compartment is a prevalent disease, affecting approximately 11% of men and 24% of women over 55 years of age with complaints of patellofemoral pain. In rare cases, this condition is not associated with trochlear dysplasia or poor alignment of the lower limb.[48] Thus, it can be inferred that treatment with lateral retinaculum release will probably lead to unsatisfactory results.

In the classical study by Aglietti et al.,[23] less than 20% of the cases of pain or instability associated with patellofemoral OA presented favorable functional outcome after arthroscopic lateral retinaculum release. Using the same technique, Aderinto and Cobb[1] conducted a retrospective study to assess the results of 53 procedures in patients with patellofemoral OA, using the Oxford Knee score and the visual analogue pain scale (VAS). Although 80% of the patients reported an improvement in symptoms after a mean of 31 months of follow-up, 42% remained unsatisfied, which the authors interpreted as possibly due to high expectation of improvement by the patients. They concluded that this minimally invasive procedure is valuable for selected patients and promotes temporary pain relief, postponing the need for major interventions such as patellofemoral or total knee arthroplasty (TKA). In their study, the authors also demonstrated that the presence of femorotibial OA did not significantly influence the results obtained.

Recently, biomechanical experiences in cadavers pointed to a worsening of patellar stability after sequentially larger releases of the lateral retinaculum, but suggested that pressure on the lateral surface of the patella can be alleviated with this procedure.[5,8,12] Ostermeier et al.[8] demonstrated that the medialization after lateral release of the high patellofemoral pressure point that occurs in 30°–70° of flexion, in which most pain complaints are observed, could have a decompression effect on the lateral surface of the patella.

In 2008, Alemdaroglu et al.[49] conducted a prospective study in 35 patients above the fifth decade of life with grade II and IV patellar chondral lesions who underwent lateral retinacular release combined with cartilage debridement via radiofrequency. The authors observed improvements in the WOMAC index for OA and in the VAS, regardless of the degree of chondropathy, which were maintained for up to two years of follow-up.

Lateral retinacular release in TKA

Lateral retinacular release may become necessary if, after all implants are placed, the patella presents a tendency for lateral positioning or subluxation. The patellar component is usually placed more medially with respect to the center of the retropatellar surface, recreating the asymmetrical contours of the apex, centralizing the quadriceps tendon and patellar reaction force, and thereby improving alignment. However, once the femorotibial components have been cemented in place or snap-fitted onto the bone surfaces, failure to correct patellar position or failure in the femoral component rotation cannot be rectified by lateral release, which may necessitate formal revision.[50]

Lateral retinacular release is most commonly performed on knee arthroplasties with valgus deformity to improve joint congruity,[51–55] decreasing the incidence of anterior knee pain, especially if the patellar component is not performed.[52,56] With TKA, the forces and peak pressures significantly increase in the patellofemoral joint, and lateral release may reduce the ratio of these forces and pressure in this region,[8,54,57,58] with low rates of complications.[51,55,56]

Another indication for lateral release of the patella is when, after the access route has been created and the medial parapatellar arthrotomy has been performed, patellar eversion is not successful, or when it is not possible to achieve good surgical exposure with patellar eversion. Therefore, lateral retinacular release of the patella can be performed to achieve these goals and favor the surgical procedure.[55]

Complications of lateral patellar retinacular release

Hemarthrosis and medial patellar subluxation, usually of iatrogenic cause, are the main complications of lateral retinacular release.[4,9,22,31,37] More rarely, albeit not less seriously, complex regional pain syndrome, weakening of the knee extensor mechanism, and skin burn related to the arthroscopic procedure may be observed.[46] In addition to these complications, the procedure is considered to have failed in cases of insufficient release of the lateral retinaculum, hence maintaining the previous clinical picture.[2,9,10,22,41] In TKA, in turn, this procedure may present avascular necrosis of the patella as a complication; it is important to preserve the superolateral geniculate artery, located laterally to the superior pole of the patella, as it is the main source of patellar circulation, since the medial genicular vessels are sacrificed in the medial parapatellar approach to the knee.[50]

The incidence of hemarthrosis varies greatly between studies and depends on the technique chosen; a relative increase is reported in arthroscopic procedures in which there was failure in the identification and hemostasis of the superolateral genicular artery.[13,22] The classic study by Hughston and Deese[31] indicated that lateral retinacular release had been previously performed in 89% of the 65 knees operated for symptomatic medial subluxation of the patella. The authors recommended that the knee should be flexed and extended several times intraoperatively to confirm the improvement of patellar congruence in the trochlear groove after lateral release. A practical way to avoid this dreaded complication is to ensure that the release does not extend beyond the fibers of the VLO.[4]

Fortunately, with the passage of time and the identification of the limits of lateral retinacular release, lower rates of complications have been observed when the procedure is judiciously indicated.[22,46] Elkousy[46] elaborated an instructive dichotomy of the complications related to diagnostic and indication errors from those related to intraoperative technical errors, suggesting ways to prevent, detect, and fix the problem.

Final considerations

The main conclusions of this review of the literature regarding the role of the lateral retinacular release of the patella in the main disorders of the patellofemoral joint include:

(1) Less extensive retinacular releases, which respect the upper and lower limits, decompress the lateral surface of the patella and aid in pain control, while reducing the risks of medial dislocation of iatrogenic cause.
(2) There is clear evidence for its indication in lateral patellar hyperpressure syndrome, demonstrated by an increase of the lateral patellar tilt associated with anterior knee pain, since there is a concomitant instability.
(3) It will usually act adjunctively in extensor mechanism realignment procedures in cases of recurrent patellar instability.
(4) In TKA, it is most commonly performed in the correction of valgus deformities to improve the congruence of the components, as well as to decrease the peak pressure in the patellofemoral joint.
(5) When this procedure is combined with cartilaginous debridement, the initial results (<2 years) for patellofemoral OA are encouraging.
(6) It is necessary to accurately differentiate the distinct pathologies of the patellofemoral joint so that this procedure can be indicated.
(7) Further randomized clinical trials comparing long-term results of surgical techniques are still necessary.

Conflicts of interest

The authors declare no conflicts of interest.

REFERENCES

1. Aderinto J, Cobb AG. Lateral release for patellofemoral arthritis. Arthroscopy. 2002;18(4):399–403.
2. Panni AS, Cerciello S, Vasso M. Patellofemoral instability: surgical treatment of soft tissues. Joints. 2013;1(1):34–9.
3. Clifton R, Ng CY, Nutton RW. What is the role of lateral retinacular release? J Bone Jt Surg Br. 2010;92(1):1–6.
4. Colvin AC, West RV. Patellar instability. J Bone Jt Surg Am. 2008;90(12):2751–62.
5. Merican AM, Amis AA. Anatomy of the lateral retinaculum of the knee. J Bone Jt Surg Br. 2008;90(4):527–34.
6. Niimoto T, Deie M, Adachi N, Usman MA, Ochi M. Quantitative stress radiography of the patella and evaluation of patellar laxity before and after lateral release for recurrent dislocation patella. Knee Surg Sports Traumatol Arthrosc. 2014;22(10):2408–13.
7. Clarke HD, Scott WN, Insall JN, Pedersen HB, Math KR, Vigorita VJ, et al. Anatomy. In: Scott WN, Insall JN, editors. Insall & Scott surgery of the knee. 5th ed. New York: Churchill Livingstone; 2012. p. 2–45.
8. Ostermeier S, Holst M, Hurschler C, Windhagen H, Stukenborg-Colsman C. Dynamic measurement of patellofemoral kinematics and contact pressure after lateral retinacular release: an in vitro study. Knee Surg Sports Traumatol Arthrosc. 2007;15(5):547–54.
9. Fulkerson JP, Shea KP. Disorders of patellofemoral alignment. J Bone Jt Surg Am. 1990;72(9):1424–9.
10. Senavongse W, Amis AA. The effects of articular, retinacular, or muscular deficiencies on patellofemoral joint stability. J Bone Jt Surg Br. 2005;87(4):577–82.
11. Ficat P. The syndrome of lateral hyperpressure of the patella. Acta Orthop Belg. 1978;44(1):65–76.
12. Christoforakis J, Bull AM, Strachan R, Shymkiw R, Senavongse W, Amis AA. Effects of lateral retinacular release on the lateral stability of the patella. Knee Surg Sports Traumatol Arthrosc. 2006;14(3):273–7.
13. Aglietti P, Pisaneschi A, Buzzi R, Gaudenzi A, Allegra M. Arthroscopic lateral release for patellar pain or instability. Arthroscopy. 1989;5(3):176–83.
14. Bigos SJ, McBride GG. The isolated lateral retinacular release in the treatment of patellofemoral disorders. Clin Orthop Relat Res. 1984;(186):75–80.
15. Henry JH, Goletz TH, Williamson B. Lateral retinacular release in patellofemoral subluxation: indications, results, and

comparison to open patellofemoral reconstruction. Am J Sports Med. 1986;14(2):121–9.
16. McGinty JB, McCarthy JC. Endoscopic lateral retinacular release: a preliminary report. Clin Orthop Relat Res. 1981;(158):120–5.
17. Merican AM, Kondo E, Amis AA. The effect on patellofemoral joint stability of selective cutting of lateral retinacular and capsular structures. J Biomech. 2009;42(3):291–6.
18. Metcalf RW. An arthroscopic method for lateral release of subluxating or dislocating patella. Clin Orthop Relat Res. 1982;(167):9–18.
19. Pagenstert G, Wolf N, Bachmann M, Gravius S, Barg A, Hintermann B, et al. Open lateral patellar retinacular lengthening versus open retinacular release in lateral patellar hypercompression syndrome: a prospective double-blinded comparative study of complications and outcome. Arthroscopy. 2012;28(6):788–97.
20. Pastides PS, Dodd M, Gupte CM. Patellofemoral instability: anatomy, classification, aetiology, and review of treatment options. Ann Orthop Rheumatol. 2014;2(4):1035.
21. Ricchetti ET, Mehta S, Sennett BJ, Huffman GR. Comparison of lateral release versus lateral release with medial soft-tissue realignment for the treatment of recurrent patellar instability: a systematic review. Arthroscopy. 2007;23(5):463–8.
22. Woods GW, Elkousy HA, O'Connor DP. Arthroscopic release of the vastus laterals tendon for recurrent patellar dislocation. Am J Sports Med. 2006;34(5):824–31.
23. Aglietti P, Pisaneschi A, De Biase P. Recurrent dislocation of patella: three kinds of surgical treatment. Ital J Orthop Traumatol. 1992;18(1):25–36.
24. Chen SC, Ramanathan EB. The treatment of patellar instability by lateral release. J Bone Jt Surg Br. 1984;66(3):344–8.
25. Dandy DJ, Griffiths D. Lateral release for recurrent dislocation of the patella. J Bone Jt Surg Br. 1989;71(1):121–5.
26. Dandy DJ, Desai SS. The results of arthroscopic lateral release of the extensor mechanism for recurrent dislocation of the patella after 8 years. Arthroscopy. 1994;10(5):540–5.
27. Dainer RD, Barrack RL, Buckley SL, Alexander AH. Arthroscopic treatment of acute patellar dislocations. Arthroscopy. 1988;4(4):267–71.
28. Fithian DC, Paxton EW, Post WR, Panni AS. Lateral retinacular release: a survey of the International Patellofemoral Study Group. Arthroscopy. 2004;20(5):463–8.
29. Panni AS, Tartarone M, Patricola A, Paxton EW, Fithian DC. Long-term results of lateral retinacular release. Arthroscopy. 2005;21(5):526–31.
30. Lattermann C, Toth J, Bach BR Jr. The role of lateral retinacular release in the treatment of patellar instability. Sports Med Arthrosc. 2007;15(2):57–60.
31. Hughston JC, Deese M. Medial subluxation of the patella as a complication of lateral retinacular release. Am J Sports Med. 1988;16(4):383–8.
32. Miller JR, Adamson GJ, Pink MM, Fraipont MJ, Durand P Jr. Arthroscopically assisted medial reefing without routine lateral release for patellar instability. Am J Sports Med. 2007;35(4):622–9.
33. Lee JJ, Lee SJ, Won YG, Choi CH. Lateral release and medial plication for recurrent patella dislocation. Knee Surg Sports Traumatol Arthrosc. 2012;20(12):2438–44.
34. Drez D Jr, Edwards TB, Williams CS. Results of medial patellofemoral ligament reconstruction in the treatment of patellar dislocation. Arthroscopy. 2001;17(3):298–306.
35. Dejour H, Walch G, Nove-Josserand L, Guier C. Factors of patellar instability: an anatomic radiographic study. Knee Surg Sports Traumatol Arthrosc. 1994;2(1):19–26.
36. Christensen F, Søballe K, Snerum L. Treatment of chondromalacia patellae by lateral retinacular release of the patella. Clin Orthop Relat Res. 1988;(234):145–7.
37. Johnson RP. Lateral facet syndrome of the patella: lateral restraint analysis and use of lateral resection. Clin Orthop Relat Res. 1989;(238):148–58.
38. Larson RL, Cabaud HE, Slocum DB, James SL, Keenan T, Hutchinson T. The patelar compression syndrome: surgical treatment by lateral retinacular release. Clin Orthop Relat Res. 1978;(34):158–67.
39. Merchant AC, Mercer RL. Lateral release of the patella: a preliminary report. Clin Orthop Relat Res. 1974;(103):40–5.
40. Abdalla RJ, Cohen M, Gorios C, Roveda J. Release lateral de patela: revisão de conceitos. Rev Bras Ortop. 1994;29(8):536–40.
41. Gecha SR, Torg JS. Clinical prognosticators for the efficacy of retinacular release surgery to treat patellofemoral pain. Clin Orthop Relat Res. 1990;(253):203–8.
42. Krompinger WJ, Fulkerson JP. Lateral retinacular release for intractable lateral retinacular pain. Clin Orthop Relat Res. 1983;(179):191–3.
43. Outerbridge RE. The etiology of chondromalacia patellae. J Bone Jt Surg Br. 1961;43:752–7.
44. Mori Y, Fujimoto A, Okumo H, Kuroki Y. Lateral retinaculum release in adolescent patellofemoral disorders: its relationship to peripheral nerve injury in the lateral retinaculum. Bull Hosp Jt Dis Orthop Inst. 1991;51(2):218–29.
45. Lattermann C, Drake GN, Spellman BS, Bach BR Jr. Lateral retinacular release for anterior knee pain: a systematic review of literature. J Knee Surg. 2006;19(4):278–84.
46. Elkousy H. Complications in brief: arthroscopic lateral release. Clin Orthop Relat Res. 2012;470(10):2949–53.
47. Small NC. Complications in arthroscopic surgery performed by experienced arthroscopists. Arthroscopy. 1988;4(3):215–21.
48. Lonner JH. Patellofemoral arthroplasty. In: Scott WN, Insall JN, editors. Insall & Scott surgery of the knee. 5th ed. New York: Churchill Livingstone; 2012. p. 1010–20.
49. Alemdaroglu KB, Cimen O, Aydogan NH, Atilhan D, Iltar S. Early results of arthroscopic lateral retinacular release in patellofemoral osteoarthritis. Knee. 2008;15(6):451–5.
50. Schindler OS. Patellar resurfacing in total knee arthroplasty. In: Scott WN, Insall JN, editors. Insall & Scott surgery of the knee. 5th ed. New York: Churchill Livingstone; 2012. p. 1161–90.
51. Kusuma SK, Puri N, Lotke PA. Lateral retinacular release during primary total knee arthroplasty: effect on outcomes and complications. J Arthroplasty. 2009;24(3):383–90.
52. Peretz JI, Driftmier KR, Cerynik DL, Kumar NS, Johanson NA. Does lateral release change patellofemoral forces and pressures? Clin Orthop Relat Res. 2012;470(3):903–9.
53. Ogata K, Ishinishi T, Hara M. Evaluation of patelar retinacular tension during total knee arthroplasty. Special emphasis on lateral retinacular release. J Arthroplasty. 1997;12(6):651–6.
54. Hsu HC, Luo ZP, Rand JA, An KN. Influence of lateral release on patelar tracking and patellofemoral contact characteristics after total knee arthroplasty. J Arthroplasty. 1997;12(1):74–83.
55. Hocking RA, MacDonald SJ. Managing patella problems in primary total knee arthroplasty. In: Lotke PA, Lonner JH, editors. Master techniques in orthopaedic surgery: knee arthroplasty. 3rd ed. Philadelphia: Lippincott Williams & Wilkins; 2009. p. 171–5.
56. Zha GC, Sun JY, Dong SJ. Less anterior knee pain with a routine lateral release in total knee arthroplasty without patelar resurfacing: a prospective, randomized study. Knee Surg Sports Traumatol Arthrosc. 2014;22(3):517–25.

57. King JJ 3rd, Chakravarty R, Cerynik DL, Black A, Johanson NA. Decreased ratios of lateral to medial patellofemoral forces and pressures after lateral retinacular release and gender knees in total knee arthroplasty. Knee Surg Sports Traumatol Arthrosc. 2013;21(12):2770–8.

58. Matsuda S, Ishinishi T, White SE, Whiteside LA. Patellofemoral joint after total knee arthroplasty. Effect on contact area and contact stress. J Arthroplasty. 1997;12(7):790–7.