# Update on Patellar Instability

## *Atualização em instabilidade patelar*

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**Abstract**

Patellar instability is a multifactorial clinical condition that affects a significant number of patients and occurs due to morphological variations of the joint and patellofemoral alignment. The present literature review study aimed to identify and summarize current concepts on patellar instability, in relation to associated risk factors, diagnostic criteria, and the benefits and risks of conservative and surgical treatments. For this purpose, a search was conducted in the following electronic databases: MEDLINE (via Pubmed), LILACS and Cochrane Library. It is concluded that the accurate diagnosis depends on the detailed clinical evaluation, including the history and possible individual risk factors, as well as imaging exams. The initial treatment of patellar instability is still controversial, and requires the combination of conservative and surgical interventions, taking into consideration both soft tissues and bone structures, the latter being the most common reason for choosing surgical treatment, especially lateral patellar instability.

**Keywords**

- patella
- patellofemoral joint
- joint instability
- patellar dislocation

**Resumo**

A instabilidade patelar é uma condição clínica multifatorial, que acomete um número expressivo de pacientes, ocorrendo devido a variações anatômicas, morfológicas da articulação e do alinhamento patelofemoral. O presente estudo de revisão e atualização da literatura teve como objetivos identificar e sumarizar os conceitos atuais sobre instabilidade patelar em relação aos fatores de risco associados, os critérios diagnósticos e os benefícios e riscos dos tratamentos conservador e cirúrgico. Para tanto, foi realizado um levantamento nas bases de dados eletrônicas MEDLINE (via Pubmed), LILACS e Cochrane Library. Conclui-se que o diagnóstico preciso depende da avaliação clínica detalhada, incluindo o histórico e possíveis fatores de risco individuais, além de exames de imagem. O tratamento inicial da instabilidade patelar é ainda controverso, e requer a combinação de intervenções conservadoras e cirúrgicas, levando em consideração tanto os tecidos moles quanto as estruturas ósseas, sendo estas últimas a razão mais comum para a escolha do tratamento cirúrgico, principalmente instabilidade patelar lateral.

**Palavras-chave**

- patela
- articulação patelofemoral
- instabilidade articular
- luxação patelar

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## Introduction

Patellar instability is a common and disabling clinical condition that mainly affects young individuals. Anatomical factors such as trochlear dysplasia, patellar morphology, tibial tuberosity localization, and soft tissue rupture have been associated with primary dislocation and recurrent secondary instability.[1] Patellofemoral dislocation is a disabling lesion that represents $\sim$ 2 to 3% of all traumatic knee injuries and affects 5 to 43 cases per 100,000 young people and adolescents per year.[2–4] This condition can cause significant morbidity since it is associated with high recurrence rates, lesions and fractures of the patellofemoral cartilage, injury of adjacent soft tissues, which result in pain, decreased function and possible development of patellofemoral arthrosis.[2,5]

Patellofemoral joint instability is multifactorial, the presence of predisposing factors such as femoral anteversion, external tibial torsion, internal femoral torsion, geno valgus, patellar dysplasia, trochlear dysplasia, high patella, oblique medial vastus atrophy, flat foot, and generalized hyperlaxity may influence the occurrence of recurrent dislocations.[6,7]

Patellar dislocations are mainly lateral, and the main mechanism of injury during physical activity is the internal rotation of the femur with the foot planted, valgus component and a sudden lateral displacement of the patella, or a direct impact that displaces the patella from the joint. However, they can also occur after low-energy trauma in people with predisposing factors.[8,9] About 93% of traumatic patellar dislocations occur during flexion with valgus movement of the knee without direct contact, while medial dislocations are exclusively traumatic or iatrogenic.[9]

The clinical picture consists of complaints of feeling of falsehood, severe pain and secondary effusion. According to Sillanpaa et al.,[9] in 2008, conditions such as hemarthrosis, medial facet fracture and medial patellofemoral ligament (MPFL) injury occur in almost all patients after traumatic patellar dislocation, in addition, osteochondral fracture can be observed in 25% of the cases.

Treatment of acute primary patellar dislocation aims to reduce the risk of recurrence or painful subluxation and prevent secondary osteoarthrosis.[5] Historically, the initial therapeutic choice is conservative for patients who have had an episode of acute dislocation, with the exception of cases of associated osteochondral lesions or fractures, where early surgical treatment is indicated.[10] According to studies of the natural history of the disease, 50 to 70% of patients are free of recurrent dislocations after conservative treatment.[11–14] On the other hand, some recent publications suggest high rates of recurrent instability for both operated and nonoperated patients.[2,15]

The long-term consequences of primary acute patellar dislocation include recurrent dislocations, patellar instability, cartilage injury, pain, limitation of activities of daily living, and secondary patellofemoral osteoarthrosis, with a six-fold increased risk of dislocation recurrence in patients with a history of contralateral patellar dislocation. In cases where $\geq$ 2 episodes of dislocation occur, the risk of recurrence is $\sim$ 50% if there was an injury to the MPFL.[9,16] However, recurrence rates and residual symptoms of instability after conservative treatment consequently lead to surgical indication. Despite the high incidence rates of patellofemoral instability, the management of patients with this condition is complex and remains variable in the literature.[2,8] Thus, the present study of review and updating of the literature aimed to identify and summarize the current concepts about patellar instability in relation to the associated risk factors, diagnostic criteria and the benefits and risks of conservative and surgical treatments. A survey was conducted in the electronic databases: MEDLINE (via Pubmed), LILACS and Cochrane Library, and included only studies with good methodological quality and high level of evidence such as systematic reviews, randomized clinical trials and prospective observational studies. The keywords (MeSH terms) used in the strategies were *Patella* or *Patellar Dislocation*, adapted for each database searched.

## Risk Factors

Studies report that $>$ 60% of patellar dislocations occur during physical activity. It is estimated that women have an approximate risk 33% higher than men,[3,17,18] although some studies do not find differences between genders for the occurrence of primary dislocation.[5,18,19] Age is another relevant risk factor, since most acute patellar dislocations occur in adolescents and young adults, especially between 10 and 17 years old.[3,17]

Anatomical and structural risk factors for patellar instability were identified, such as: high patella, abnormal patellar morphology, trochlear dysplasia, patellar hypermobility, variations in the anatomy of the MPFL, generalized ligament hyperlaxity, hypoplasia of the oblique medial vastus, increased Q-angle, increased femoral anteversion, valgus alignment, and external tibial rotation.[7,8,20]

Dejour et al.,[21] in 1994, considered four factors predisposing to dislocation: 1) trochlear dysplasia; 2) lateral inclination of the patella, interpreted as dysplasia of the vastus oblique medial; 3) high patella and 4) lateralization of the anterior tuberosity of the tibia (ATT) (increased Q angle). A prospective observational study analyzed the patellofemoral morphology in skeletally immature children with and without primary patellar dislocation and found significant differences in measurements related to trochlear dysplasia such as greater groove angle and lower trochlear depth ($<$ 3 mm), which result in increased central condylar height.[19] Another prospective study[18] analyzed the same risk factors in children and adults and showed similar findings, that is, trochlear dysplasia and excessive patellar height were the most common factors, with no differences in skeletal maturity. The combination of two or more associated risk factors is present in most patients who progress to primary patellar dislocation.[3] According to Santos Neto et al.,[22] in 2012, the morphology of the MPFL varies with the interepicondylar distance and the lateral condyle, and with the age of the patient.

The recurrence of patellar dislocation was investigated by prospective cohort studies that showed a total cumulative

incidence of ipsilateral recurrence between 36[23] and 54%[24] after 15 to 20 years, being significantly higher in patients < 18 years old at the first dislocation, presence of trochlea dysplasia, high patella and greater distance between the tibia tuberosity and the trochlear sulcus (TA-GT). Most events occurred within 5 years of the initial injury. Furthermore, approximately half of the patients who suffered lateral patellar dislocation present symptoms and radiographic alterations compatible with osteoarthrosis on average 25 years after the injury.[25] Thus, failures in the treatment of patellar dislocation can lead to recurrent patellar instability, persistent knee pain, and even patellofemoral osteoarthrosis.[26]

## Diagnostic Criteria

Although physical examination is the main diagnostic tool for patellar instability, imaging exams are used to assist in the clinical decision-making and differential diagnosis, and include conventional radiographs, magnetic resonance imaging (MRI), computed tomography (CT) and ultrasonography (US).[1,27] Radiological evaluation is often the first imaging examination to be requested, including incidences: a) anteroposterior, to evaluate the joint alignment and symmetry of bone structures; b) absolute profile at 30 degrees of flexion, which allows the measurement of patellar height from the relationship between the patella and tibia using indices such as: Insall-Salvatti,[28] Blackburne-Peel[29] and Caton-Deschamps,[30] in addition to the measurement of the plateau-patella angle [31]; (c) axial, to evaluate the angle of the trochlear groove and the shape and positioning (inclination) of the patella.

A systematic review showed that radiographic measurement of patellar height using the Insall-Salvatti and Caton-Deschamps methods, and MRI by the Insall-Salvatti method, presented good validity, with significant difference between samples of healthy patients and of those with patellar instability ($p < 0.0001$). The measurement of the TA-GT distance evaluated by CT also demonstrated good intra- and interexaminer validity. The measurements of patellar inclination (patellar tilt) and the angles of the trochlear and lateral patellar groove also showed good discrimination validity between individuals with patellar instability and the control group ($p < 0.0001$). For the measurements of the congruence angle and height of the lateral and medial condyles, there was low validity beyond the substantial heterogeneity among the analyzed studies. Finally, there is insufficient evidence to determine the reliability and validity of patellar height using the Blackburne-Peel method, the angle of congruence by MRI, lateral patellar displacement by MRI, femoral anteversion by CT, the depth of the trolley, the crossing signal and Wiberg patellar classification. There was low reliability for the evaluation of trochlear dysplasia and groove angle by US.[1,32]

## Treatment

### Conservative treatment

The treatment of patellar instability and dislocation remains a challenge for surgeons due to the complexity of the procedures and the unsatisfactory results. Historically, conservative treatment (pharmacological, physiotherapy and immobilization) has been considered as the first option for primary patellar dislocations, except in the presence of osteochondral fracture [15] and MPFL avulsion.[33] However, there are still controversies in the literature regarding the indication for conservative or surgical treatment. Some studies have found high recurrence rates and residual symptoms of instability associated with conservative treatment (up to 44%),[13,14,26,34] and for this reason, surgical treatment has been recommended, but also has high recurrence rates (10 to 35%).[26]

A Cochrane[4] systematic review published in 2015 showed that although there is some evidence to support surgical treatment in primary patellar dislocation, the quality of evidence is very low due to the high risk of bias and inaccuracy in the effect estimates of the included studies. Therefore, new randomized clinical trials of better methodological quality have been recommended. ►**Table 1–**[4,8,26,35,36] shows the results of systematic reviews with meta-analysis comparing conservative with surgical treatment for primary patellar dislocation.

In general, the goals of conservative treatment after primary dislocation of the patella are to reduce swelling, strengthen the knee muscles and improve joint range of motion.[33] Physiotherapy for patients with patellar instability should focus on strengthening the closed kinetic chain of the quadriceps and gluteus muscles, and sensory-motor training. Closed kinetic chain exercises involving the gluteal musculature tend to force the external rotation of the femur and consequently decrease the Q angle during the gait cycle. Strengthening the quadriceps musculature with emphasis on the vastus oblique medial (VOM) helps in the proper positioning of the patella in the trochlear groove.[33,34,37,38] The period of immobilization after dislocation episode varies in the literature between 2 and 6 weeks.[8]

### Surgical treatment

The selection of the appropriate surgical procedure depends on the individual pathophysiology of patellar instability, which, for the most part, is anatomical in nature. For this reason, surgical techniques aim to restore normal anatomy, and there is an association between lateral patellar dislocations and medial soft tissue lesions.[15] Indications for surgical treatment are also related to pain and patient function. In many cases, patients have minimal symptoms at rest, but significantly limit their functional activities due to apprehension and instability. Therefore, the risk of recurrence is an important element to be considered in treatment.[6] The objective of surgical treatment of patellar instability is to stabilize it, restore normal kinematics and optimize the transmission of loads through the joint. Surgical techniques include bone procedures, such as osteotomy of the tibial tuberosity, with medialization and/or distalization, and trochleoplasty; soft tissue interventions, such as reconstruction of the medial patellofemoral ligament (MPFL).[39,40] Arthroscopic and minimally invasive techniques, such as medial plication and retinacular releases, are typically

**Table 1** Results of systematic reviews with meta-analysis on conservative versus surgical treatment for primary patellar dislocation

| Study/Year | Included and participating studies | Quality of studies included (GRADE) | Results |
|---|---|---|---|
| Yang et al.,[35] 2019 | 16 ECRs/observational studies<br>N = 918 participants<br>23 to 36 years old<br>Follow up: 1 to 5 years | Low | *Significant difference in favor of surgery:*<br>- Kujala: DMP 0.79 [0.30 to 1.28]<br>- Relapse: OR 0.44 [0.30 to 0.63] |
| | | | *There was no significant difference between the groups:*<br>- Pain (EAV): DMP 0.84 [0.36 to 9.03] |
| Lee et al.,[26] 2018 | 4 ECRs<br>N = 275 participants<br>23 to 36 years old<br>Follow up: 1 to 5 years | Moderate to low | *There was no significant difference between the groups:*<br>- Recidivism: RR 1.33 [0.89 to 2.00]<br>- Alley: DM 1.76 [- 2.02 a 5.54]<br>- Instability: RR 1.11 [0.89 to 1.40]<br>- Pain: DM - 0.39 [- 6.97 to 6.20]<br>- Tegner: DM 0.63 [- 0.32 to 1.58] |
| Longo et al.,[36] 2017 | 17 ECRs/observational studies<br>N = 2,086 (2,134 knees)<br>Average 20.3 years old<br>*Follow up*: average 5 years | NA | *Significant difference in favor of surgery:*<br>- Relapse: OR 0.54 [0.40 to 0.70]<br>(36.4% conservative x 25% surgical) |
| Saccomano et al.,[8] 2016 | 9 ECRs<br>N = 430 knees<br>13 to 36 years old<br>*Follow up*: 2 to 14 years | Moderate to low | *Significant difference in favor of surgery:*<br>- Recurrence: RR 0.62 [0.39 to 0.98]<br>- Pain: DMP - 0.32 [- 0.61 to - 0.03] |
| | | | *There was no significant difference between the groups:*<br>- Kujala: DMP 0.74 [0.08 to 1.40]<br>- Lysholm: DMP - 0.10 [- 0.45 to 0.26]<br>- Tegner: DMP – 0.61 [- 1.25 to 0.02] |
| Smith et al.,[4] 2015 | 6 ECRs<br>N = 344 participants<br>19 to 27 years old<br>Follow up: up to 2 years | Too low | *Significant difference in* favor of surgery (after 2 to 5 years)*:*<br>- Recurrence: RR 0.53 [0.33 to 0.87]<br>- Alley: DM 13.93 [5.33 a 22.53]<br>- Instability: RR 0.44 [0.27 to 0.72] |
| | | | *There was no significant difference between the groups:*<br>Recidivism:<br>after 6 to 9 years: RR 0.67 [-0.42 to 1.08]<br>after 14 years RR 0.93 [-0.67 to 1.30]<br>- Kujala:<br>after 6 to 9 years: RR -0.35 [-10.61 to 4.11]<br>after 14 years RR -1.00 [-8.60 to 6.60] |

Abbreviations: DM, mean difference; DMO, standardized mean difference; EAV, visual analogue pain scale; RCT, randomized clinical trial; GRADE, The Grading of Recommendations Assessment, Development and Evaluation; NA, not evaluated; OR, odds ratio; RR, Relative risk.

recommended for patients with minimal bone misalignment or trochlear dysplasia, or as adjuvants to provide additional soft tissue balance in patients undergoing bone repair procedures.[41] However, isolated arthroscopic lateral retinacular release may result in increased lateral mobility of the patella and medial instability, and is not recommended.[6]

### Reconstruction of the medial patellofemoral ligament

Among the surgical techniques for recurrent patellar dislocation, the restoration of the function of the MPFL is one of the most important factors. The MPFL is the main restrictor to lateral translation of the patella and contributes with 50 to 60% of the medial containment force against lateral patellar translation. However, comparing the techniques of reconstruction of the MPFL, the choice of graft, the positioning of this graft or its tension, is difficult, given the scarcity of clinical evidence of comparative studies. [26,42] Medial patellofemoral ligament reconstruction is indicated for patients with MPFL lesions or deficiency and who present recurrent instability without evidence of bone malalignment. Arthroscopic diagnosis can also be made prior to MPFL reconstruction to identify any osteochondral lesions or free bodies.[43] The reconstructive techniques of the MPFL involve autologous graft of the flexor tendons (gravitis or semitendinous), passed through a patellar bone tunnel in the femur or fixed to the patella with suture anchors. The quadriceps tendon can also be used as a graft for the MPFL.[43] The knee flexion angle during MPFL graft fixation ranges from 20° to 90°. Graft fixation at smaller and larger knee flexion angles during MPFL reconstruction showed satisfactory results reported by the patients and low recurrence rates.[44] Regarding the comparison between single-band or double band graft, there

seems to be no differences regarding the improvement of knee function, recurrence rate and occurrence of complications. The single band technique may present a higher risk of postoperative apprehension, and the double band may cause greater joint stiffness, but there is insufficient evidence in the literature to support or refute these findings.[45,46]

Most studies on MPFL reconstruction, alone or combined with other techniques, show positive results, with improvement of pain and physical function and low incidence of recurrent dislocations. A systematic review[47] analyzed the effects of this surgery on skeletally immature patients (mean 13.2 years old and 4.8 years postoperatively, autologous flexor graft). There was a significant improvement in the Kujala questionnaire from 59.1 to 84.6 points before and after surgery. The complication rate was 25%, 3.8% redislocation and 11.4% subluxation. The systematic review by Lee et al.,[26] in 2018, compared the techniques of medial realignment and reconstruction of the MPFL and observed a significant difference in favor of reconstruction in physical function evaluated by the Kujala questionnaires (mean difference [DM] - 8.91 [- 14.05 to - 3.77]) and Lysholm (DM - 13.51 [- 21.35 to - 5.68]).

A combined surgical approach appears to be indicated for patients with increased tuber-trochlear tibiasule (TAS-GT) or severe trochlear dysplasia. The indication for the reconstruction of the MPFL combined with a bone procedure such as osteotomy is influenced by individual anatomical changes.[38]

### Osteotomy of the anterior tuberosity of the tibia

Osteotomy of the tibial tuberosity is another treatment option for patients with patellofemoral instability. It refers to the alteration of the position of the tibial tuberosity, realignment of the knee extensor mechanism and correction of misalignment and instability. This procedure is indicated in patients with recurrent instability, increased TA-GT distance, high patella, or high-grade osteochondral lesions in the patellofemoral joint.[33,40,43] One of the most common techniques is the anteromedialization osteotomy described by Fulkerson et al.,[48] which involves the transfer of the tibial tuberosity anteromedially, and is indicated for patients with increased TA-GT distance, high patella, or osteochondral lesions. The medialization of the ATT, also known as the Elmslie-Trillat procedure, is an option to treat patellar malalignment in patients without high patella. [43] The results after the transfer of the ATT have shown good results. A systematic review analyzed 38 studies with a total of 1,182 surgeries, and reported a recurrence rate of dislocation of 7%.[49]

### Trochleoplastia

Patellar instability with severe trochlear dysplasia is the main indication for trochleoplasty, a surgical technique capable of correcting and remodeling the bone architecture of the femoral trochlea. [50] Specific indications for trochleoplasty include patients with extreme patellar malalignment (identified by the "J" sign on clinical examination and TA-GT distance $>$ 10 mm), abnormal trochlear morphology in the presence of normal or almost normal articular cartilage.[15,51]

Different techniques for surgical correction of trochlear dysplasia were described:1) elevation of the lateral facet; 2) deepening of the groove with or without subchondral trochlear removal, followed by fixation of the corrected trochlear cartilage; and 3) resection of a subchondral cartilaginous flap, remodeling of the trochlea andre-fixation of the cartilage.[50,52]

Trochleoplasty is contraindicated for patients with open epiphyseal plaque or diagnosed with diffuse patellofemoral arthrosis. Complications associated with trochleoplasty include arthritis as a result of damage to the cartilage of the trochlea, and arthrofibrosis.[53] Given the technical requirements and potential complications, the clinical outcomes after trochleoplasty present satisfaction rates between 67 and 95%.[15,52]

According to Banke et al.,[52] trochleoplasty combined with MPFL reconstruction has shown good results for the treatment of chronic patellar instability. This concept of associated treatment is a safe option, not only as rescue therapy, but also as a primary procedure in relation to the treatment of patients with important anatomical changes, such as severe trochlear dysplasia. Isolated reconstruction of the MPFL, for these cases, according to the authors, can lead to 46% of recurrent dislocation.

### Angular deformities

According to Zhang et al.,[54] femoral deformities, such as valgus or rotary, can lead to patellar dislocation and sometimes must be corrected. Distal varization osteotomy and external femoral derotation osteotomy can often prevent further dislocations of the patella, without the need for other corrective associations. According to the authors, the internal rotation of the femur should be excessive for osteotomy, citing 4 cases with 30°, 45° and 60° of internal rotation of the femur, in which they performed external derotation osteotomy and dislocations no longer occurred.

## Conclusion

The available scientific evidence regarding the treatment of patellar instability is still controversial and of low to moderate methodological quality. However, updating regarding treatment and diagnosis strategies and knowledge of the risk factors of this injury are important to assist the decision-making of the surgeon. It is essential to understand the importance of the surgical technique regarding the individual anatomical alterations involved. Future studies with greater methodological rigor are still needed to address topics that remain uncertain.

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

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