Patellar instability

Abstract

Lateral patellar dislocation (PD) has multifactorial origin. Its treatment will depend on the physical demands of the patient, triggering event and injury mechanism of PD, number of dislocation episodes, patellofemoral joint morphology, and concomitant injuries. After primary PD, despite the risk of recurrence being 33-77%, first treatment option is mostly conservative, except if an osteochondral fragment needs to be refixed or removed. This practice has been questioned lately by the Patella Instability Severity Score that determines the risk for recurrent PD in function of age, bilaterality, and anatomical risk factors. Risk behavior in relation to sports activity seems to be an additional risk factor.
The treatment of recurrent PD is surgical with only low recurrent rate (2-4%). Medial patellofemoral ligament (MPFL) reconstruction is the most widely used technique. The ideal candidates are subjects with painless intervals between PD and without major trochlear dysplasia (TD) or patella alta. However, postoperative pain and loss of flexion might be observed if the graft is overtensioned or its fixation point malpositioned. Trochleoplasty is the only technique that aims at improving containment with the risk to increase peak forces due to incongruence. Due to the demanding technique its superiority over isolated MPFL reconstruction has been described only in grotesque TD and PD in higher knee flexion (>60°). Tibial tubercle osteotomy can be distalized in case of patella alta or medialized in case of lateralized tibial tubercle. Indication should be considered carefully, since patellar tracking will be influenced almost throughout the full range of motion and might therefore induce discomfort or pain.

**Résumé**

La luxation patellaire (LP) a une origine multifactorielle. Sa prise en charge dépend de la demande physique du patient, des facteurs déclenchant et du mécanisme lésionnel, du nombre d’épisodes de luxation, de la morphologie de l’articulation fémoropatellaire, et des lésions associées. Après un premier épisode de LP, malgré le risque de récidive de 33-77%, le traitement est principalement conservateur, sauf en cas de fragment ostéochondral nécessitant d’être refixé ou retiré. Cette prise en charge a été questionnée par le Patella Instability Severity Score, permettant à déterminer le risque de récidive de LP en fonction de l’âge, d’atteinte bilatérale et de facteurs de risques anatomiques. Les comportements à risque lié au sport semblent être un facteur de risque supplémentaire.

Le traitement des LP récidivantes est chirurgical avec un faible taux de récidive (2-4%). La reconstruction du ligament fémoropatellaire médial (MPFL) est la technique la plus utilisée. Le candidat idéal est un sujet avec des intervalles non-douloureux entre les LP, sans dysplasie trochléenne (DT) majeur, ni patella alta. Cependant, les douleurs postopératoires et la perte de flexion peuvent être observées en cas de tension trop élevée de la greffe ou de mauvais positionnement du point de fixation. La trochléoplastie est la seule technique qui a pour but d’améliorer le maintien de la rotule avec un risque d’augmentation des forces maximales à cause d’une incongruence. En raison d’une technique exigeante, sa supériorité par rapport à une reconstruction isolée du ligament MPFL a été décrite uniquement pour des DT importantes et des LP avec le genou en flexion élevée (>60°). L’ostéotomie de la tubérosité tibiale peut être distalisée en cas de patella alta ou médialisée en cas de tubérosité tibiale latéralisée. Les indications doivent être considérées soigneusement, puisque l’engagement patellaire sera influencé tout le long de la mobilité articulaire ce qui peut être l’origine à des douleurs quotidiennes même au repos.

**Introduction**

Lateral patellar dislocation (PD) mainly occurs in adolescents between 10 and 17 year of age, and slightly more frequent in women. Primary patella dislocation usually results from an indirect mechanism with knee valgus and external rotation of the tibia in 20-30 degrees of knee flexion [1]. Recurrent patellar instability can result from a trauma or non-trauma mechanism.

Patient history including injury mechanism, the information about high or low energy trauma or even habitual PD, and clinical examination is crucial, which typically shows knee effusion, pain on palpation over the medial patellofemoral ligament (MPFL) and lateral femoral condyle.
Patellar instability diagnosis should always be made with a well-documented dislocation episode, a validated manual reduction performed, or pathognomonic signs on MRI such as bony contusions of the medial patella facet and external femoral condyle. Clinical apprehension alone is not enough to make the diagnosis, which in rare cases might be subluxation or a sensation of multidirectional instability only. Treatment will depend on physical demands of the patient (sport and professional), number of dislocation episodes, triggering event and injury mechanism of PD, patellofemoral joint morphology, and concomitant injuries.

**First dislocation**

In most review articles and textbook, it is recommended to treat primary PD conservatively, except if a osteochondral fragment typically originating from the inferomedial patellar facet can be refixed or needs to be removed (Figure 1). Therefore, MRI is absolutely mandatory after the first episode of lateral PD. Short-term immobilization (one to two weeks) with or without a brace and crutches are necessary to decrease pain and promote deswelling. Progressive knee range of motion is allowed and weightbearing as tolerated thereafter. The purpose of early rehabilitation is to avoid major strength loss and to prevent apprehension. Rehabilitation protocols consist first of all of muscle strengthening, especially the quadriceps and hip external rotator. Stretching exercises of the iliotibial tract, the lateral retinaculum and the hamstrings can improve range of motion. Several months may be necessary to restore quadriceps muscle strength, due to an avulsion of the vastus medialis muscle from the MPFL.

The risk of recurrence lies between 33-77% [2–4]. Recurrence rate varies according to risk factors described by Arendt: skeletal immaturity, increased sulcus angle or patella alta. Recurrence rate is 5.8% in patients without risk factors, 22.7% with one risk factor, and 78.5% with three risk factors [4], compared to recurrent instability of 1-3% after adequate surgical treatment. Functional impairment have been reported in 75% of patients, even more than three years after first PD [5], with on the other hand improved functional score 2-5 years after surgery [2].

The Patella Instability Severity Score (PISS) helps to determine the risk of redislocation ([Table 1]) [6], which is associated with a younger age, bilateral instability, and patellofemoral morphology. The odds ratio is 4.88 for patients who PISS is more than 4, when compared with patients who PISS is less than 3. Other risk factors have been described however not included in this score, such as sports activity, risk behavior, general laxity and gender. Therefore, surgery might be indicated in selected cases, especially in young patients with increased PISS above 3 or 4, participating in pivoting or contact sports, with or without patellar laxity requiring a return to sport. Contrary to recurrent patellar dislocations with the first onset in early adolescents, the pathoanatomical risk factors are only mild in adults that encounter their first episode of PD after a high impact or high velocity trauma. Osseous realignment procedures as tibial tubercle osteotomy (TTO) or trochleoplasty (as mentioned below) are therefore less frequently necessary combined with MPFL-reconstruction. Soft-tissue technique, as medial retinaculum plication has showed inferiority in comparison to MPFL reconstruction, and is not recommended [7].
Figure 1: (A) MRI showing patellar osteochondral lesion (double white arrow) and osteochondral fragment (simple white arrow) in the suprapatellar recessus. (B) Arthroscopy view showing osteochondral lesion of the inferomedial patella. (C) Osteochondral fragment.
Recurrent lateral patellar dislocation

Recurrent patellar dislocation can occur as a consequence of repetitive trauma or non-traumatic events. Generally, in non-traumatic instability, patients will typically present more predisposing anatomic factors than in traumatic instability. Another important aspect to consider is the presence of anterior knee pain between two PD episodes, that need specific attention, since they might be difficult or even impossible to treat by surgical means. Hence, patients with painless intervals between two PD do not need the same treatment as patients with painful intervals. Whereas first need patellar stabilization only without changing patellar tracking during daily life, the painful intervals need to be profoundly evaluated, whether patellar tracking throughout the entire range of motion needs to be addressed during surgery. A more complex surgical approach with torsional or frontal alignment correction might be indicated, depending on clinical examination and imaging studies.

The primary aim of treating recurrent PD is to prevent further dislocation. Type of surgery will depend on several parameters and often requires a combination of more than one procedure. Surgical techniques consist of MPFL reconstruction, trochleoplasty, TTO with distalizing and or medializing transfer, and distal

<table>
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<td>Age [years]</td>
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<tr>
<td>&gt;16</td>
<td>0</td>
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<tr>
<td>&lt;16</td>
<td>1</td>
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<tr>
<td>Bilateral instability</td>
<td></td>
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<td>No</td>
<td>0</td>
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<tr>
<td>Yes</td>
<td>1</td>
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<tr>
<td>Trochlear dysplasia</td>
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<td>&lt;16</td>
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<td>&gt;16</td>
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<td>1</td>
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<td><strong>Total maximal points</strong></td>
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Table 1: Patella Instability Severity Score (PISS), according to Balcarek et al. 2014
femoral osteotomy (DFO). Whereas the Lyon school with the “menu à la carte” promotes a morphologic approach, in which MPFL reconstruction is performed in combination with trochleoplasty in patients with trochlear dysplasia type B and D according to David Dejour, or in combination with distalizing TTO in patella alta (Caton-Deschamps-Index >1.2), or medializing in case of increased tibial tuberosity-trochlear groove (TT-TG) above 20mm [8], the AGA patellofemoral expert group has published a more functional guideline, that orients the need to correct pathologic morphological features according to the mechanical instability [9]. As patellar instability from 0° to 30° of knee flexion is generally caused by insufficient passive stabilizer, isolated MPFL reconstruction might be sufficient whereas patellar instability up to 60° of knee flexion implicate insufficient passive stabilizers and static stabilizers, requiring concomitant MPFL reconstruction and trochleoplasty or realignment of the extensor system. Finally, instability up to 90° is due to insufficient passive and static stabilizers and potential misalignment. This form is the most complex and might require a combination of MPFL reconstruction, trochleoplasty, and / or limb alignment correction.

MPFL reconstruction is the most popular technique [10] performed either isolated or in combination with other osseous techniques. The purpose is to reconstruct MPFL anatomy, which inserts on the superior third of the medial patellar border and the medial border of the distal quadriceps tendon and attaches distally and anteriorly to the adductor tubercle, just above the medial femoral epicondyle. This technique can be performed by an autologous tendon graft (gracilis, semi-tendinosus, quadriceps or even a strip of the adductor tendon), an allograft or artificial tape [11,12]. It is a safe and effective method to stabilize the patella when in the absence of major TD, absence of patella alta, and no other pathological factors. Moreover, it is rarely indicated in patients with a history of more than 5-8 episodes of PD. Important to note, that preoperative painful condition in daily activity can rarely be treated by MPFL reconstruction only, as it only prevents from further PD, but does not influence patellar tracking above 45° flexion. Increased tension or malpositioning of the femoral tunnel might cause however postoperative pain especially in higher flexion. Pain (30%) and loss of flexion (10%) are frequently seen after surgery and can be due to tunnel malposition, graft overtensioning, or graft placement intra-articularly, that create a stable but painful patella. Graft harvesting can be another origin of postoperative pain. Early knee range of motion is necessary to avoid loss of flexion, intra-articular and retinacular scarring, but also to prevent persisting apprehension. Graft fixation is rarely a limiting factor for early range of motion.

MPFL reconstruction has a high rate of success (77-94%) [1] with low rate of redislocation (1-4%) [13–15]. However, a recent systematic review shows complications in up to 26% of patients [16]. Postoperatively, 30% of patients may encounter postoperative complains after MPFL reconstruction. Pain, discomfort, loss of strength or flexion are among the most common complications.

Trochleoplasty is performed in high-grade trochlear dysplasia with the purpose to reconstruct either a flat or even concave trochlear articular surface (Figure 2). Indication for trochleoplasty is controversial. The AGA patellofemoral expert suggest that trochleoplasty should be considered if patellar instability exceeds 30° of flexion [9]. The Lyon school advocates sulcus trochleoplasty in knees with a supratrochlear spur only (trochlear dysplasia type B or D) [17,18]. In both, a sulcus deepening or flattening trochleoplasty is promoted by performing an osteochondral flap, according to Bereiter’s or Dejour’s technique. Variants of trochleoplasties have been published, such as the recession wedge trochleoplasty, which is performed in case of an increased trochlear bump [8,19], that does not address the flat or even convex trochlear surface; the proximalisation of the lateral trochlear facet according to Biedert [20], or the lateral facet elevation
described by Albee et al. [21], later increasing lateral patellar contact pressures and leading to early osteoarthritic changes. Trochleoplasty is a technically highly demanding procedure, with currently only little evidence in literature of superiority except for decreased postoperative recurrent instability in high-grade trochlear dysplasia, but no evidence of improved functional outcome or delayed osteoarthritic progression.

Sulcus deepening trochleoplasty shows good functional results with satisfaction in 77-100% of the patients and low recurrence rate (0-2%), in mid-term follow-up studies [22–25]. There seems to be improved outcome if trochleoplasty is combined with MPFL reconstruction than performed as a single technique [26]. Loss of range of motion and arthrofibrosis have been reported in up to 17% of the patients, requiring revision surgery (including manipulation under anesthesia or arthroscopic debridement). [27].

TTO can be performed by distalizing the tibial tubercle to correct patella alta (Figure 3) [28]. The cut-off values of the different measurement methods, are controversially discussed in literature. The authors suggest to combine the Caton-Deschamps-Index (CD-I, >1.4), the patellar tendon length (>55mm) and the patellotrochlear index (<0.15) to get full appreciation of the patellar height and to correct it to a CD-I of 1.1 to 1.2, and patellar tendon length of 50mm. Distalizing of more than 10mm is absolutely rare, and rarely consists of more than 15% of the entire patellar tendon length. Distalizing a high-riding patella improves patellar tracking (especially functional lateralization and decreases j-sign) and decreases patellofemoral contact pressure. The tibial tubercle is usually fixed with two or three bicortical lag screws. The tibial tubercle can be medialized to correct increased TT-TG distance. This measurement is highly debated in literature, since it might be over-estimated in full extension of the knee using osseous landmarks such as
on CT scans, and underestimated in dysplastic hence flat trochlea or quadriceps contraction [29]. This osteotomy. Whether distalized and/or medialized should be indicated cautiously, and performed only if excessive lateral tracking is present combined with patella alta or patellar instability in higher flexion and associated pain, since it influences patellar tracking from 20-30° of flexion to full flexion.

TTO in the treatment of patella instability shows satisfactory functional outcome with few complications [28,30]. However, they often require another operation to for hardware removal (21%) [31]. A rare but serious complication is tibial shaft fracture, most often observed in male and physically active patients. A recent randomized control trial has shown higher satisfaction and improved alignment in patients with TTO reconstruction associated with MPFL reconstruction, in comparison of patients with TTO alone [32]. Therefore, surgical procedures as Elmslie-Trillat and Fulkerson osteotomy are rarely indicated. DFO should be considered in specific cases only [33,34], with excessive valgus of more than 8° or femoral antetorsion of more than 25-30°, depending on the measurement method applied. It is usually combined with MPFL reconstruction. The aim of this surgery is to place the femur under the correctly oriented patella in the soft-tissue sleeve, and not to force patellar reduction onto the trochlear groove. Lateral release consists of sectioning the lateral retinaculum, which can however destabilize the patella even more to the medial and the lateral. It should only be performed, if the patella cannot be reduced into the trochlear groove or excessive tilt above 20° [35,36]. The authors prefer lateral retinaculum lengthening.
whenever possible [37]. Its indication for anterior knee pain is obsolete, as well as its routinely combined with MPFL reconstruction. Much more frequently, the clinician nowadays might face the situation where a lateral release has been performed, and there is persisting patellar instability or patellofemoral pain [38]. Reconstruction of the lateral retinaculum from the ventral border of the iliotibial tract to the lateral border of the patella might be challenging by sutures only [38–40] and might need complete reconstruction using auto-or allograft.

**Return to sports**

Patellar instability is a major concern in young athletic population. Patients treated non-operatively could return to sport in 69% of cases after 6 months [41]. However, 58% of these patients reported limitations in strenuous activities [41]. A study showed a return to their most physical activities in 86% of patients after 3 years, however only 26% were able to return without limitations [5].

Return to sport is slightly improved after surgery compared to conservative treatment [2]. Patellar stabilization surgery enables the patient to resume and maintain their sports activity postoperatively [42], which seems to be comparable to an age and gender matched control group [42]. Most studies after MPFL reconstruction showed high return to sport from 88% to 100% [43]. However, only 53-69% could return to their pre-injury level of sport [43–45]. Similar results have been published after trochleoplasty or TTO [30,46]. There is a trend of increased physical activity, if trochleoplasty is performed in patients with trochlear dysplasia type B or D rather than combined MPFL with TTO and if patella alta is surgically corrected [38], however available data is limited. In long-term follow-up (5-10 years), there is no obvious advantage in functional scores when surgical stabilization is performed.

Chondral lesions are a further issue after PD. 50% of the patients treated conservatively show cartilage injuries of grade III-IV Outerbridge classification at 8 years of follow-up [47]. Cartilage might comparably be an issue at long-term after conservative or surgical treatment and might be more determined by natural history of patients with trochlear dysplasia rather than the treatment option.

**Practical implications**

- Patella instability is frequent in young athletes and its recurrence rate is a major concern. Risk factors can be evaluated by the Patella Instability Severity Score: young age, bilateral instability, trochlear dysplasia, increased patellar height, increased TT-TG, and increased patellar tilt.
- Surgical indication is based on physical demands of the patient, number of dislocation episodes, triggering event and injury mechanism of PD, patellofemoral joint morphology, and concomitant injuries.
- Type of surgery will depend on patients' complaints whether there is PD only or a painful underlying condition with associated maltracking. Latter often requires a combination of different techniques (medial patellofemoral ligament reconstruction, trochleoplasty, tibial tuberosity osteotomy, distal femoral osteotomy).
- Return to sport is high after conservative or surgical treatment, however some patients will keep limitations due to postoperative discomfort.
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