Guidelines for Treatment of Lateral Patella Dislocations in Skeletally Mature Patients

Michael C. Liebensteiner MD, PhD, Florian Dirisamer, MD, Peter Balcarek, MD, and Philip Schoettle, MD, PhD

Abstract

The incidence of lateral patella dislocations is high, particularly in young females. Beside traumatic cases, many patients present with specific anatomical factors that predispose to lateral patella dislocations (torsional abnormalities of the femur or the tibia, trochlea dysplasia, patella alta, etc). It is of utmost importance to correct those pathologic factors during concomitant procedures as isolated reconstructions of the medial patellofemoral ligament would fail in the presence of severe anatomic risk factors. This article provides a comprehensive instruction on how to analyze the risk factors for lateral patella dislocation (anatomy, physical examination, imaging) and reports the authors' favorite surgical techniques. Moreover, treatment algorithms are provided for primary and recurrent cases of lateral patella dislocation.

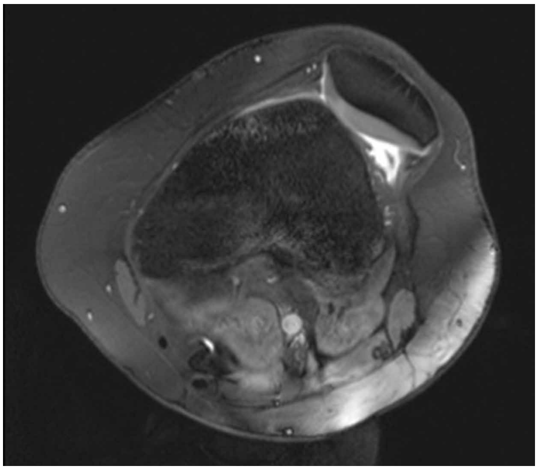

Figure 1. Trochlea dysplasia occurs when a flat or even slight convex trochlea contributes to patella instability.

Take-Home Points

- Lateral patella dislocation is sufficiently treated with modern versions of patellofemoral surgery.
- Comprehensive assessment for underlying osseous pathology is paramount (torsional abnormalities of the femur or tibia, trochlea dysplasia, patella alta, etc).
- In such cases, isolated medial patellofemoral ligament reconstructions will fail. Instead, the underlying osseous abnormalities must be addressed during concomitant procedures (derotational osteotomy, tibial tubercle transfer, trochleoplasty, etc).

The incidence of patellar instability is high, particularly in young females. In principle, cases of patellar instability can be classified as traumatic (dislocation is caused by external, often direct forces) or nontraumatic (anatomy predisposes to instability).[1-4] Because the vast majority of unstable patellae are unstable toward lateral and because instability is objective when the patella is fully dislocated, we use the term *lateral patella dislocation* (LPD) and refer to primary and recurrent LPD throughout this review.

Anatomy Predisposing to Patella Dislocation

Most patients present with specific anatomical factors that predispose to patellar instability (isolated or combined). These can be grossly categorized as osteochondral factors and soft-tissue factors.

Of the osteochondral factors, dysplasia of the femoral trochlea (trochlea groove [TG]) is most important. In healthy patients, the concave trochlea stabilizes the patella in knee flexion angles above 20°. In particular, the lateral facet of the trochlea plays a key role in withstanding the lateralizing quadriceps vector. The dysplastic trochlea, which has a flat or even a convex surface, destabilizes the patella (**Figure 1**). Moreover, patella alta is a pivotal factor in the development of LPD. A high-riding patella engages the femoral trochlea during higher degrees of knee flexion, making the patella very susceptible to dislocations when the knee is almost in extension.[5,6] In addition, high femoral anteversion (increased femoral internal torsion) has been reported as contributing to the development of LPD. Internal torsion of the distal femur brings the TG more medial and therefore provokes a lateral shift of the patella relative to the femur (**Figure 2**).[7-11] Valgus knee alignment is

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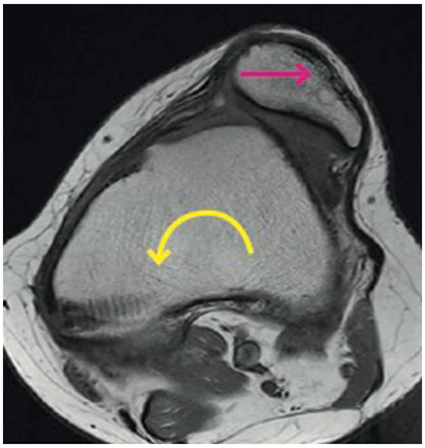

Figure 2. Internal torsion of the distal femur brings the trochlea groove more medial and therefore provokes lateral shift of the patella.

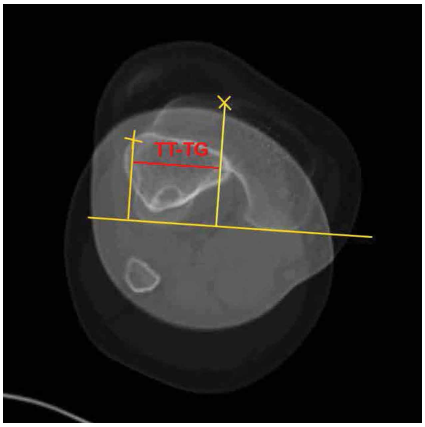

Figure 3. Tibial tuberosity-trochlea groove (TT-TG) distance projected on posterior condylar line and measured in millimeters. Normal, <15 mm; indication for surgery, >20 mm.

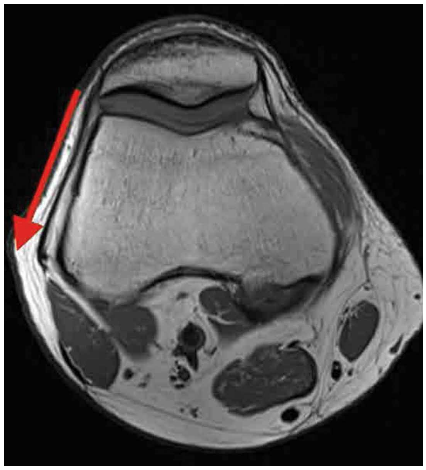

Figure 4. Lateral retinaculum provides restraint toward posterior rather than toward lateral.

also common in patients with LPD. First, tibiofemoral valgus brings the tibial tuberosity (TT) more toward lateral and therefore increases the pull on the patella toward lateral. Second, when the deformity is at the distal femur, there is often a hypoplastic lateral condyle, which can contribute to LPD in knee flexion angles above 45°. Deformities in the frontal plane (valgus) and the transverse plane (increased internal torsion of the femur, increased external torsion of the proximal tibia) commonly increase the TT-TG distance. TT-TG distance is a radiographic parameter, taken from magnetic resonance imaging (MRI) or computed tomography, that summarizes important aspects of patellofemoral alignment and gives an impression of the amount of lateralizing force of the extensor apparatus (discussed later) (**Figure 3**).

The anteromedial soft tissue of the knee (retinaculum) has 3 layers, the second of which contains the medial patellofemoral ligament (MPFL).[12,13] On the femoral side, the MPFL originates in direct proximity to the medial epicondyle and the adductor tubercle. The MPFL broadens toward the patella (V-shaped) and inserts at the superomedial border of the patella and the adjacent aspects of the quadriceps tendon.[14-17] It has been found to provide an important restraint against LPD.[18-20] In primary LPD, the MPFL has been found ruptured or severely damaged in more than 90% of cases, most often near the femoral insertion.[18,21-23] In patients with an elongated, insufficient MPFL, the patella may dislocate laterally without rupturing the MPFL. Another soft-tissue structure that contributes to patellar stabilization is the lateral retinaculum, which provides a restraint toward posterior rather than lateral (**Figure 4**). Cutting the lateral retinaculum would further decrease patellar stability in most cases.[18,24-26]

We strongly recommend that physicians assess for all these osteochondral and soft-tissue abnormalities in patients with LPD.

Diagnostics

Physical Examination

It is recommended that the physician starts the examination by assessing the walking and standing patient while focusing on torsional malalignment of the lower extremities (increased antetorsion of the femur, increased external torsion of the tibia), which is often indicated by squinting patellae.[8,27,28] In addition, valgus knee alignment, increased foot pronation, and weakness of hip external rotators and hip abductors (Trendelenburg sign) are regularly observed in patients with LPD.[29] Beyond walking and standing, additional functional tests (eg, single-leg squat, single-leg balancing, step-down test) were suggested as reliably provoking these pathologic kinematics.[30] It is also suggested that the patient be examined sitting with lower legs hanging. In many cases, patients who are asked to actively extend the leg with LPD present a so-called J sign, which means the patella moves laterally close to terminal knee

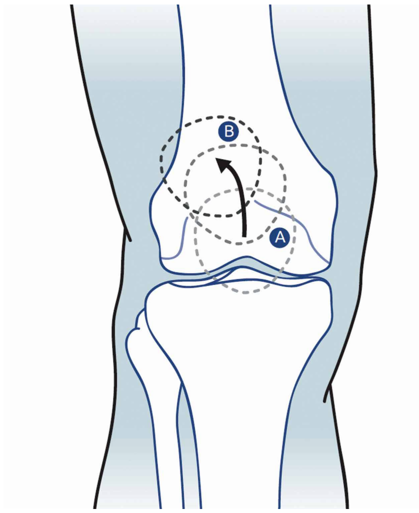

Figure 5. During seated, active knee extension, the patella moves along course resembling an inverted J (from A to B).

extension (**Figure 5**). Examination continues with the patient supine. The physician uses the patella glide test to determine how far the patella can be translated toward lateral and medial. Grade 1 indicates the patella can be translated one-fourth of its width, and grade 4 indicates it can be translated its full width[31] (**Figure 6**). The apprehension test is positive in the majority of patients with LPD and is performed in 30° knee flexion with relaxed quadriceps. The physician gently pushes the patella toward lateral. Avoidance or protective quadriceps contraction indicates a positive test.[32,33] It is recommended that the physician forgo the Zohlen test (low specificity) and instead use the extension test, in which the patient tries to extend the leg against physician resistance at 0°, 30°, 60°, and 90°. The extension test provokes pain in the case of significant degeneration at the respective joint areas under contact pressure. The patient should also be examined in the prone position in order to assess for torsional deformities. With knees in 90° flexion, maximum external rotation and maximum internal rotation of the hips are determined on both sides at the same time (**Figures 7A, 7B**). Patients with significant internal rotation (>60°) and poor external rotation are suspected as having increased femoral antetorsion.

Figure 6. In the patella glide test, the physician tests how far the patella can be translated toward lateral and medial. Grade 1: Patella can be translated for one-fourth its width. Grade 4: Patella can be translated its full width.

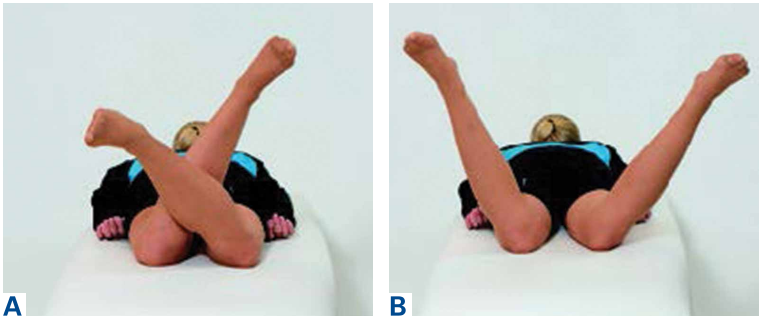

Figure 7. Hip (A) external and (B) internal rotation tested on both sides at same time. Significant internal rotation (>60°) and poor external rotation suggest increased femoral antetorsion.

Imaging

Radiographs are the basis for each patient's imaging analysis. For a patient with valgus or varus clinical appearance, a weight-bearing whole-leg radiograph is used to precisely assess the degree of deformity in the frontal plane. A true lateral radiograph (congruent posterior condyles) provides information about patellar height (patella alta/infera). Most indices that quantify patellar height use the tibia as reference (eg, tuberosity, anterior aspect of articulation surface). The Caton-Deschamps index measures the length of the articulating patella surface (A) and the distance from the most distal point of the patellar surface to the most anterior aspect of the articulating surface of the tibia (B); distance B divided by distance A yields the index, with values >1.2 indicating patella alta and values <0.6 indicating patella infera[34] (**Figure 8**). The lateral radiograph should also be checked for trochlear dysplasia, indicated by the crossing sign, the trochlear bump, or both (**Figure 9**). A weight-bearing anteroposterior (eg, Schuss) radiograph, which provides information on accompanying degeneration of the tibiofemoral joint, should be performed, particularly for elderly patients.

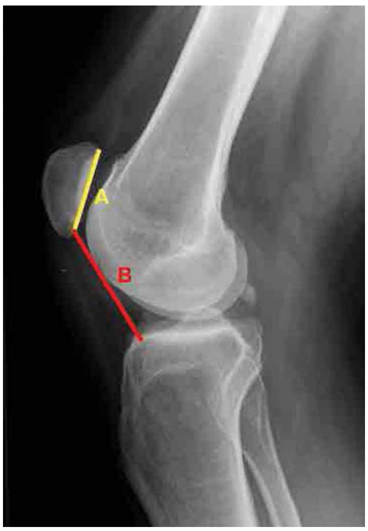

Figure 8. Caton-Deschamps Index: Distance B divided by distance A (patella alta, >1.2; patella infera, <0.6).

Figure 9. On true lateral radiograph, trochlear dysplasia is indicated by "crossing sign" (red arrow), and "trochlear bump" (yellow arrow, trochlear spur).

Figure 10. Dejour grading of trochlear dysplasia (grades A-D).

MRI is the gold standard for LPD diagnosis—it can be used to easily identify soft-tissue lesions and establish their patellar or femoral location (eg, MPFL rupture). MRI also provides information on potential pathologies of quadriceps tendon, patella tendon, and infrapatellar fat pad. Compared with radiographs, MRI is more sensitive in detecting osteochondral lesions in LPD. Furthermore, functional measurements (eg, patellar tilt, patellar shift) can be made on axial MRIs, as the posterior condyles provide a proper reference line. MRI also plays a key role in determining accompanying degenerative changes in patients with LPD and therefore helps distinguish between joint-preserving and prosthetic procedures. MRI also provides information on patellar height. In contrast to the radiographic patellar height assessment mentioned earlier, the patellotrochlear index of Biedert and Albrecht[35] allows patellar height to be related to the proximal end of the trochlea. From a biomechanical point of view, it seems more appropriate to determine patellar height respective of the trochlea, the articulating partner of the patella. Further typical imaging parameters in LPD—such as TT-TG distance, femoral and tibial torsion values, and Dejour trochlear dysplasia—are also reliably shown with MRI. With lateral radiographs, MRI classifies trochlear dysplasia as type A (flatter than normal, with sulcus angle >145°), type B (flat), type C (convex), or type D (convex with supratrochlear spur and cliff) (**Figures 10A-10D**).

Treatment

MPFL Reconstruction

Isolated MPFL reconstruction is commonly regarded as a standard, straightforward procedure. However, some authors have reported a considerable complication rate.[36] Most failures have been attributed to technical errors and inappropriate indications. The indication for isolated MPFL is regarded as inappropriate in patients with coexisting severe osseous pathologies, such as high-grade trochlear dysplasia and pathologic TT-TG distance.[37,38] We recommend against performing isolated MPFL reconstruction in patients with any of these conditions: TT-TG distance >20 mm; femoral anteversion >30°; type C or D trochlear dysplasia; severe patella alta; advanced patellofemoral cartilage degeneration; or tibiofemoral valgus >5°. With use of accurate indications and surgical technique, isolated MPFL reconstruction provides good outcomes in patients with LPD.[39,40] MPFL reconstruction has been performed with a wide variety of surgical techniques (eg, graft type, single-bundle vs double-bundle, fixation type).
Our preferred technique (double-bundle gracilis

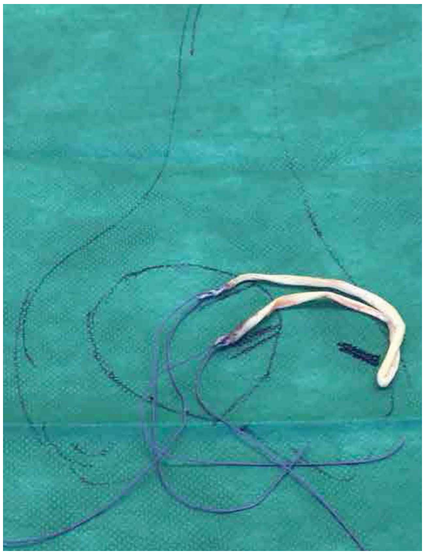

Figure 11. Gracilis double-bundle autograft is used for reconstruction of medial patellofemoral ligament. Course of reconstruction is illustrated schematically.

Figure 12. Mini-incision at superomedial aspect of the patella. One wire is placed at the superomedial corner of the patella, and the other wire is placed 1.5 to 2 cm further distally. After wire positions are checked with fluoroscopy, 2 patella tunnels are drilled. Drilling direction is slightly descending to avoid tunnel blow-out or risk of patella fracture.

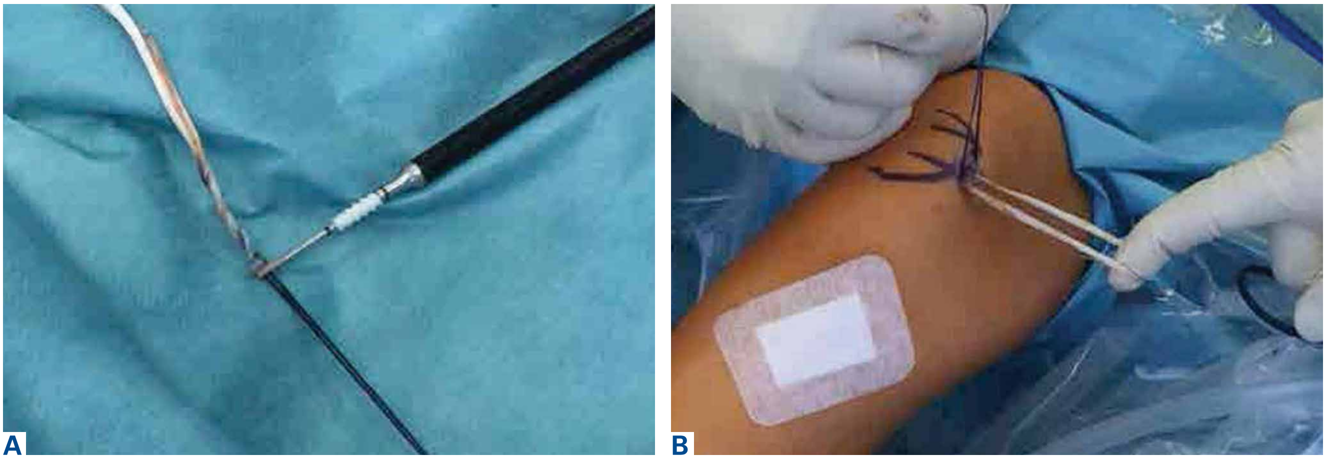

Figure 13. (A) Free ends of gracilis autograft are fixed in patella tunnels with knotless anchors (3.5 mm here) to obtain (B) a double-bundle reconstruction.

autograft with aperture fixation) is detailed in **Figures 11 to 16**.

Trochleoplasty

In cases of recurrent LPD or a flat or convex trochlea (Dejour type B, C, or D dysplasia), deepening trochleoplasty should be considered. Trochleoplasty is performed to reduce too prominent anterior bone stock and to increase conformity with the patella (concave groove), and to create a lateral trochlea facet as restraint against lateralizing quadriceps pull. Many authors have reported good clinical outcomes of trochleoplasty in patients with LPD caused by a dysplastic femoral trochlea.[41-48] In many cases, MPFL reconstruction is added to trochleoplasty. Several authors have recommended against performing trochleoplasty in cases of open physis,[49-52] which makes treatment of LPD in skeletally immature patients a special challenge, as trochlear dysplasia is often the key factor in failure of alternative procedures in the young.[51] Another contraindication to trochleoplasty is severe cartilage degeneration. Our preferred surgical technique is described in detail in **Figures 17 to 21**.

Osteotomy

The most popular type of osteotomy in the setting of LPD is the transfer of the TT (TTT). Many authors have reported good clinical outcomes with

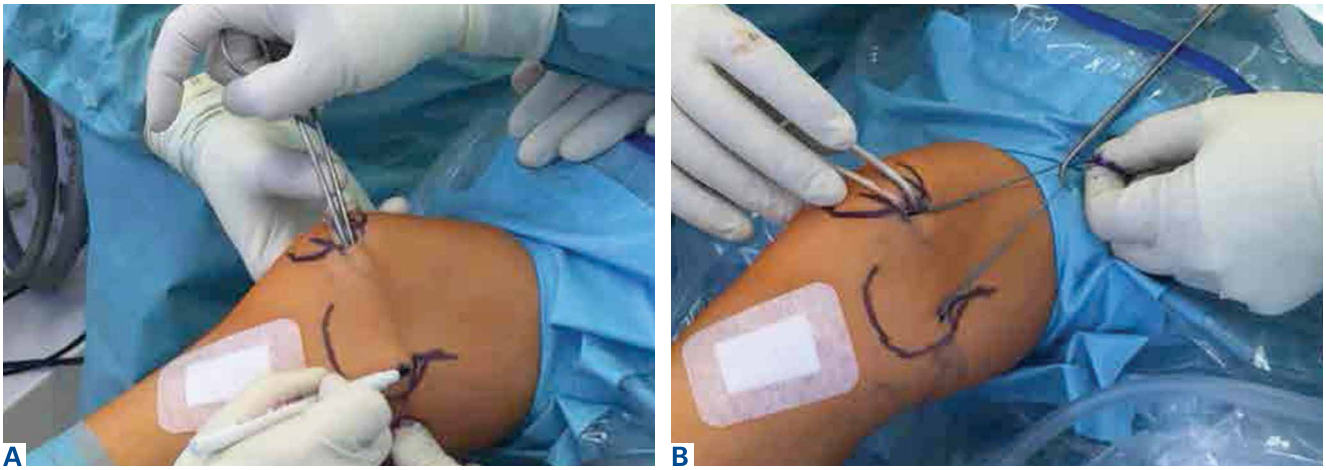

Figure 14. (A) Space between vastus medialis and joint capsule is developed with scissors down to the level of the medial femoral epicondyle. (B) A mini-incision is made there, and a shuttle thread inserted.

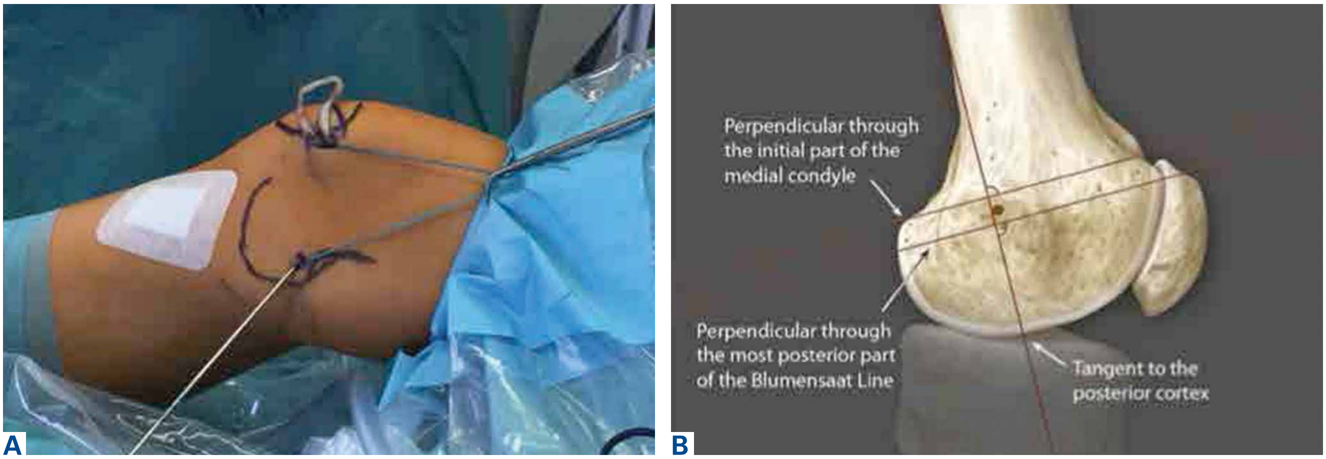

Figure 15. (A) Wire with eyelet is inserted at (B) Schoettle point under fluoroscopy, and then femoral tunnel is created with cannulated reamer (6 mm).

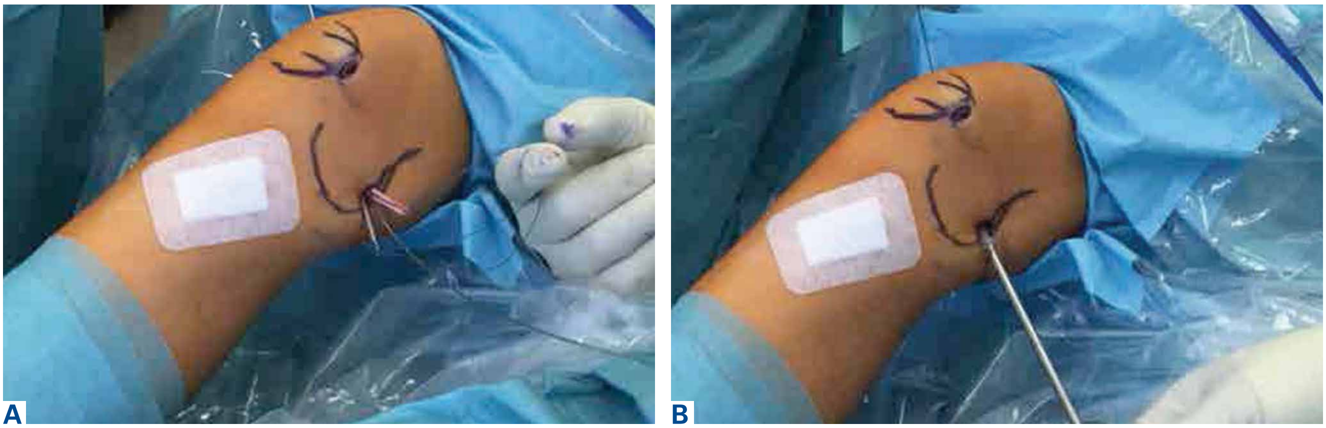

Figure 16. (A) Graft is shuttled to femoral insertion, pulled into the tunnel with eyelet wire, and (B) fixed with interference screw at 30° knee flexion.

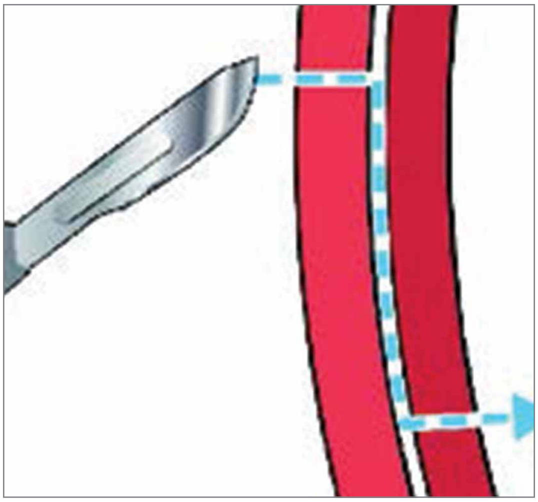

Figure 17. Lateral arthrotomy is performed as Z-plasty to facilitate subsequent potential lateral lengthening.

medializing TTT in patients with LPD and large TT-TG distances.[53-57] Similarly, good outcomes have been found with distalizing TTT in patients with LPD and patella alta.[58,59] We suggest routinely combining distal or medial TTT with MPFL reconstruction.[60] TTT can be tailored to the patient's pathology by combining medialization and distalization. Our preferred technique is to medialize the tuberosity so it ends with a TT-TG distance of at least 10 mm (avoid overcorrection).

Derotational osteotomies of the femur (externally rotating) provide good outcomes in patients with LPD and associated torsional deformities,[61-63] though the literature is incongruent with respect to whether rotational osteotomies of the femur should be performed at the proximal or distal aspect.[64-67] In the majority of our LPD cases, we combine femoral derotation with MPFL reconstruction.

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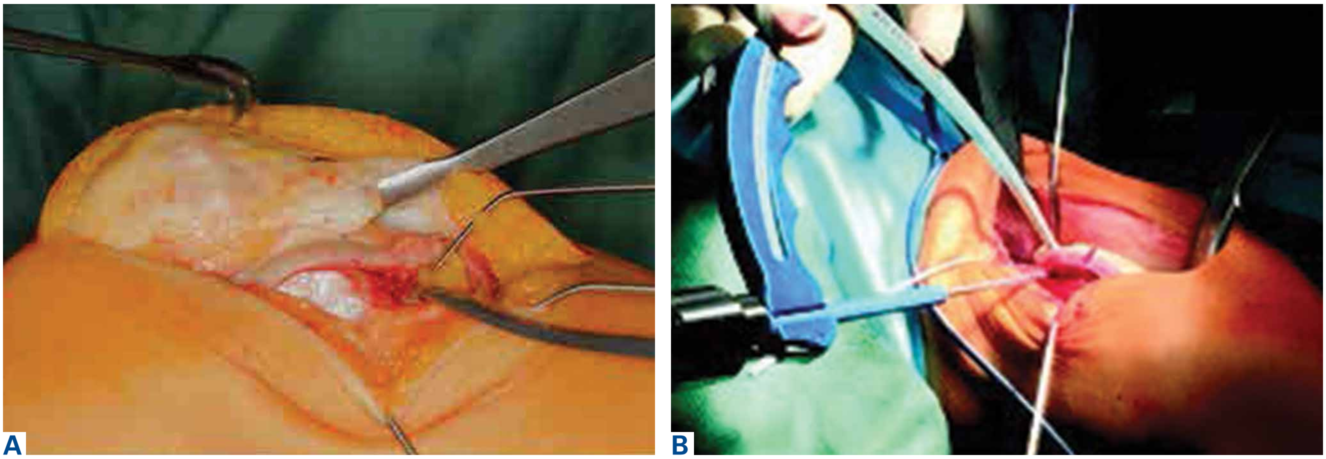

Figure 18. (A) Thin (4 to 5 mm) osteochondral flap is gradually elevated with curved chisels or (B) undermined with a special burr.

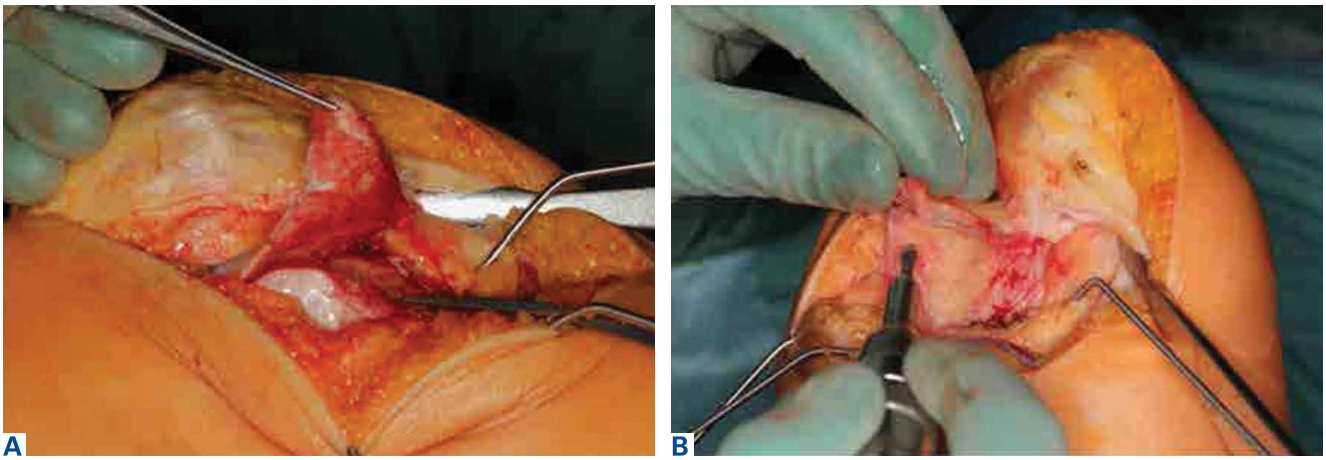

Figure 19. (A) After full elevation of trochlear flap, (B) bone stock underneath is remodeled (deepened) with a chisel, burr, or both.

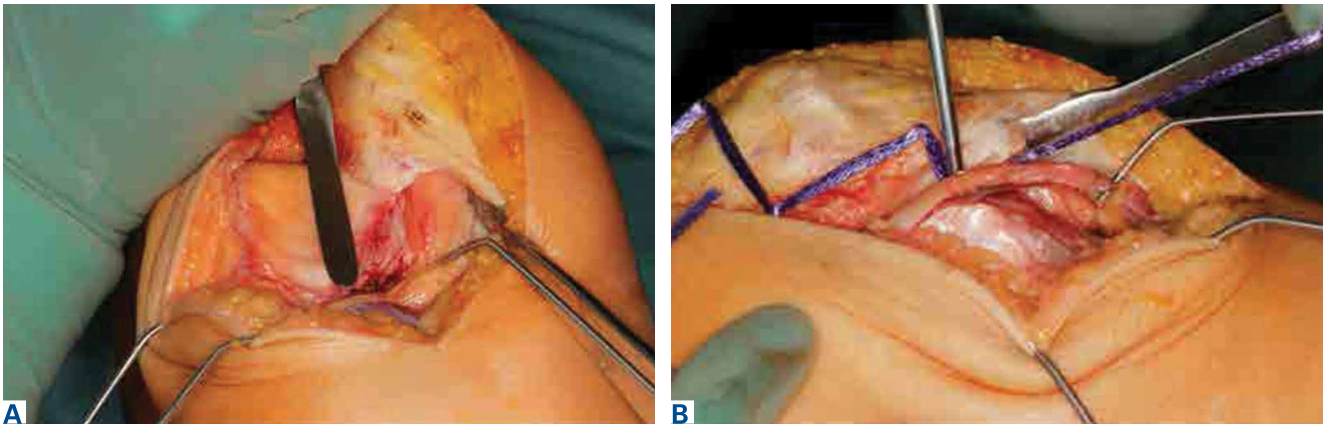

Figure 20. (A) Subsequently, trochlea flap is molded in and (B) secured with a Vicryl band that is fixed with several anchors.

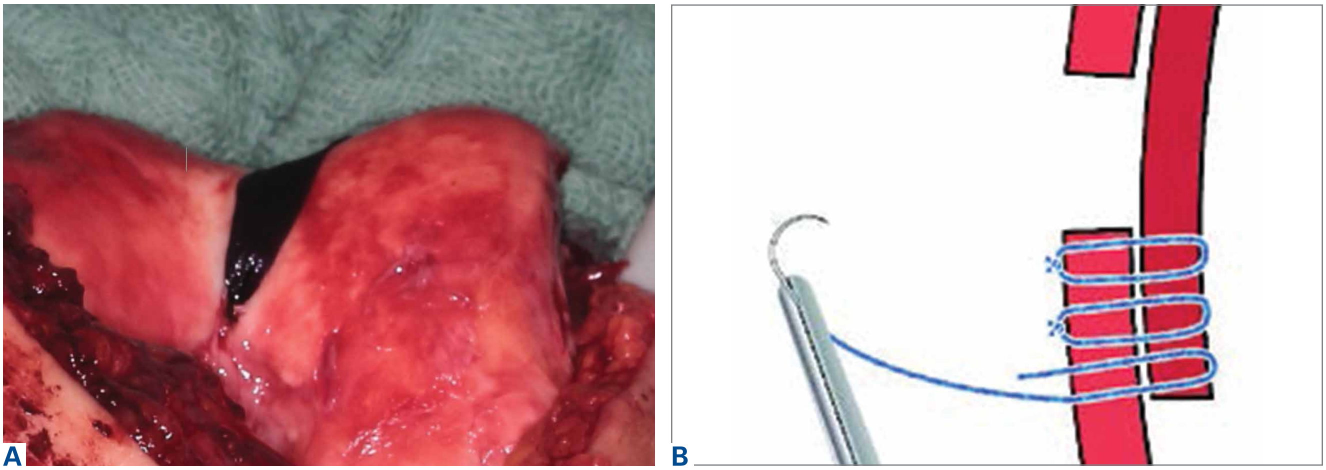

Figure 21. (A) After successful deepening trochleoplasty, (B) lateral retinacular lengthening can be performed during closure of lateral capsule. In the majority of cases, additional reconstruction of medial patellofemoral ligament is performed.

Table 1. **Patellar Instability Severity Score**

Age, y	
>16	0
≤16	1
Bilateral instability	
No	0
Yes	1
Trochlear dysplasia	
None	0
Mild (type A)	1
Severe (types B-D)	2
Patellar height, Insall-Salvati ratio	
≤1.2	0
>1.2	1
Tibial tuberosity-trochlea groove distance, mm	
<16	0
≥16	1
Patellar tilt,°	
≤20	0
>20	1
Total points	7

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Table 2. **Predicted Risk of Patellar Redislocation Given Number of Risk Factors[a]**

Risk Factors, n	Mean Predicted Risk of Recurrence, %
0	13.8
1	30.0
2	53.6
3	74.8
4	88.4

[a]Risk factors: trochlear dysplasia, history of contralateral dislocation, skeletal immaturity, and Caton-Deschamps index >1.45.

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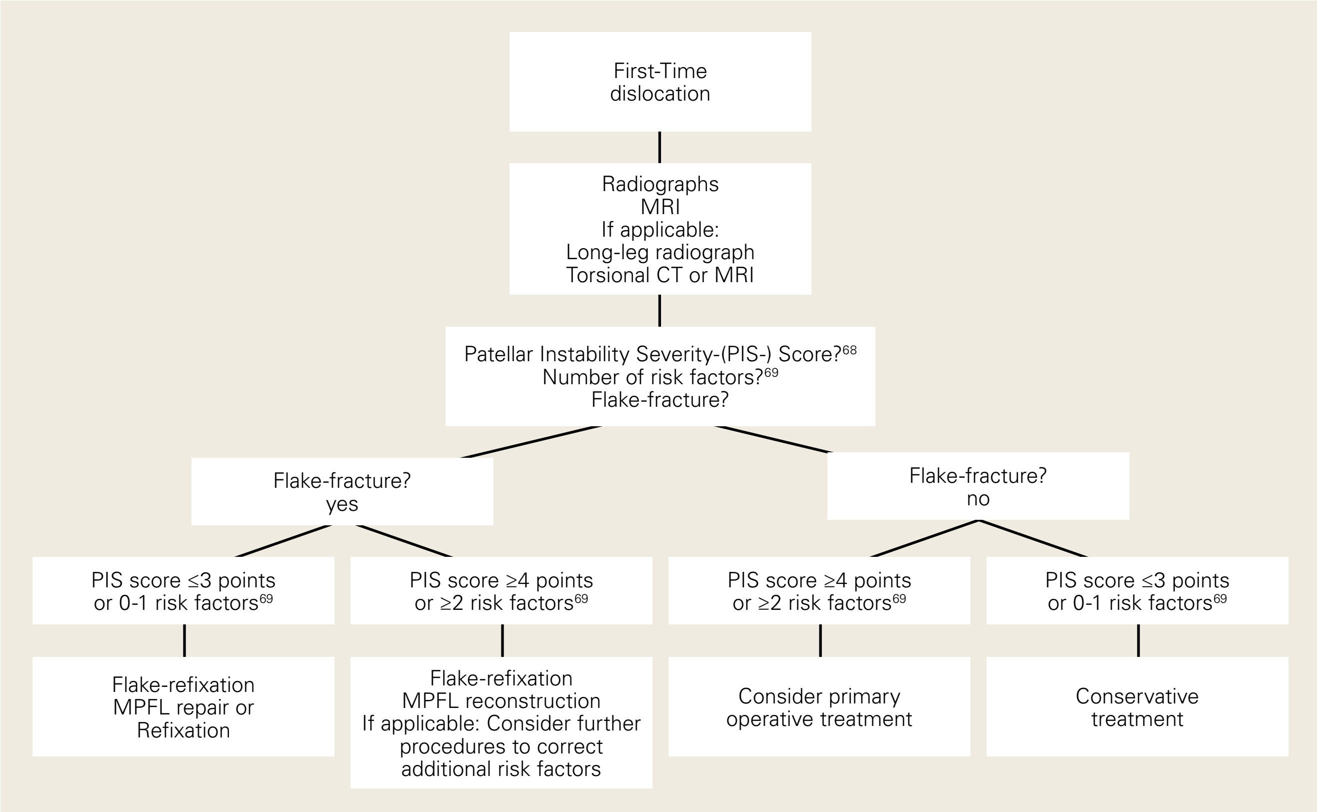

Figure 22. Algorithm for primary lateral patella dislocation.

Abbreviations: CT, computed tomography; MPFL, medial patellofemoral ligament; MRI, magnetic resonance imaging; PIS, Patellar Instability Severity. See Table 1 for PIS scores and Table 2 for risk factors.

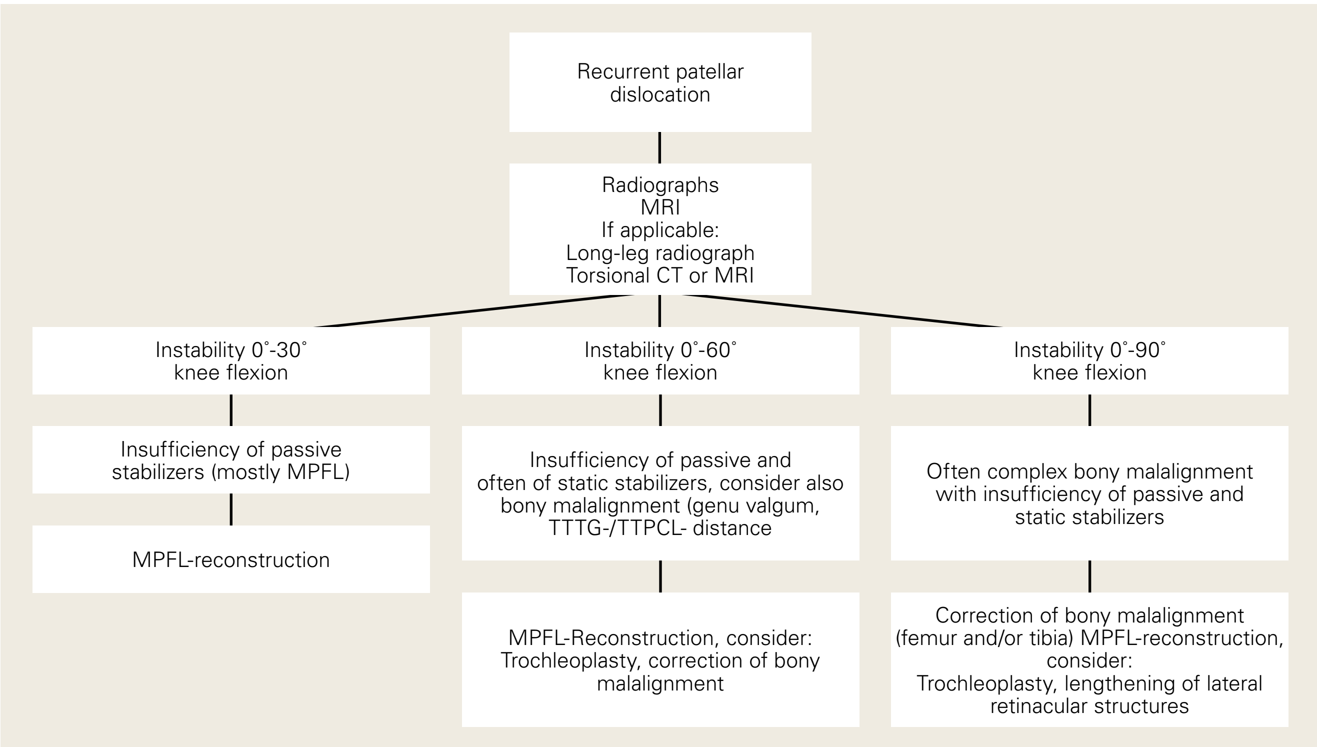

Figure 23. Algorithm for recurrent lateral patella dislocation.

Abbreviations: CT, computed tomography; MPFL, medial patellofemoral ligament; MRI, magnetic resonance imaging; TT-PCL, tibial tuberosity-posterior condylar line; TT-TG, tibial tuberosity-trochlea groove.

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Treatment Algorithms

We suggest using different algorithms for primary LPD (**Figure 22, Tables 1-2**) and recurrent LPD (**Figure 23**).

Conclusion

In skeletally mature patients, LPD is sufficiently treated with modern versions of patellofemoral surgery. Comprehensive assessment for underlying pathology is paramount as preparation for developing an appropriate surgical plan for the patient.

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