

## [ Orthopaedic Surgery ]

# How to Deal With Chronic Patellar Instability: What Does the Literature Tell Us?

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**Context:** Patellar instability is a common clinical problem, affecting between 7 and 49 people per 100,000. However, not all patellar instabilities are equal, the etiology of the disorder is multifactorial, and a clear understanding of the cause of instability is crucial for appropriate surgical treatment. The goal of this article is to identify how to best treat patellar instability to provide good outcomes and hopefully prevent future osteoarthritis.

**Evidence Acquisition:** A PubMed search from 1983 through May 2015.

**Study Design:** Clinical review.

**Level of Evidence:** Level 4.

**Results:** Several subpopulations of patients with chronic patellar instability exist: (1) lateral patellar instability during the early arc of knee flexion (0°-30°), (2) lateral patellar instability persisting beyond 30° of knee flexion, (3) lateral patellar instability in greater knee flexion, and (4) medial patellar instability. In patients with lateral instability during the early arc of knee flexion, the medial patellofemoral deficiency is the essential lesion. Persistent instability beyond 30° of knee flexion suggests an unusually high patella, severe trochlear dysplasia, pathologic increment of the tibial tuberosity-trochlear groove distance, or a combination of these factors. In patients with lateral instability in greater knee flexion, increasing and unbalanced tension in the extensors pulls the patella out of the groove as the knee is flexed. Finally, medial patellar instability is an objective iatrogenic condition that appears after realignment surgery in the vast majority of cases.

**Conclusion:** The etiology of chronic patellar instability is multifactorial, and its treatment must therefore be personalized.

**Strength of Recommendation Taxonomy (SORT):** B.

**Keywords:** patellar instability; lateral patellar instability; medial patellar instability

Patellar instability is a common clinical problem affecting between 7 and 49 people per 100,000.<sup>29</sup> However, not all patellar instabilities are equal; the etiology of the disorder is multifactorial. Therefore, several subpopulations of patients with chronic patellar instability exist, and a clear understanding of the cause of instability is crucial for appropriate surgical treatment. The goal of this article is to identify how to best treat patellar instability to achieve good outcomes and prevent future osteoarthritis.

## LATERAL PATELLAR INSTABILITY DURING THE EARLY ARC OF KNEE FLEXION

Most lateral patellar instability occurs during the early arc (0°-30°) of knee flexion. Several anatomic and biomechanical studies have demonstrated that the medial patellofemoral ligament (MPFL) is the most important restraint to lateral patellar displacement between 0° and 30° of knee flexion.<sup>7,10,18</sup> Moreover, MPFL deficiency is the essential lesion in this subset of lateral patellar instability patients.<sup>26</sup>

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For patients with lateral patellar instability during the early arc (0°-30°) of knee flexion who have had at least 2 documented patellar dislocations, the current surgical approach is to stabilize the patella through an anatomic MPFL reconstruction using a mini-open technique and a graft stronger than the native MPFL.<sup>30</sup> This approach is intended to compensate for the underlying predisposing factors to patellar instability. Adequate graft position on the femur and appropriate tension on the graft are critical steps for ensuring a successful outcome after MPFL reconstruction.<sup>30</sup> The patellar attachment of the MPFL has received much less attention than the femoral attachment, but a double semitendinosus graft can reproduce the broad attachment site of the MPFL on the patella.<sup>30</sup> The MPFL is principally attached to the vastus intermedius tendon,<sup>24</sup> and some recommend a medial quadriceps tendon–femoral ligament (MQTFL) reconstruction.<sup>17</sup>

### Treatment of Chondral Lesions

Most patients with recurrent lateral patellar dislocation experience cartilage damage in the patellofemoral joint. The longer the patellar instability has lasted, the higher the likelihood and the grade of patellofemoral chondral injuries, specifically for trochlear lesions.<sup>14</sup> Patellar and trochlear lesions have been seen in 58% and 13% of patients with recurrent lateral patellar instability, respectively. The MPFL reconstruction not only prevents further patellar dislocation but may also stop the progression of knee osteoarthritis.<sup>27</sup> Using second-look arthroscopy, the effect of MPFL reconstruction on articular cartilage in the patellofemoral joint found that patellofemoral chondral status was only modified at the central ridge of the patella.<sup>21</sup> Therefore, treating chondral lesions is not necessary in the majority of cases, although in some cases, extracting loose bodies is warranted.

## LATERAL PATELLAR INSTABILITY PERSISTING BEYOND 30° OF KNEE FLEXION

Several anatomic factors contribute to patellar instability, such as trochlear dysplasia, patella alta, and increased tibial tubercle–trochlear groove (TT-TG) distance.<sup>8</sup> Beyond 30° of knee flexion, the stability of the patella depends mainly on the bony anatomy of the femoral trochlea. Persistent instability beyond 30° of knee flexion suggests an unusually high patella, severe trochlear dysplasia (grade C or D), pathologic increment of the TT-TG distance, or a combination of these factors.

An isolated MPFL or MQTFL reconstruction is insufficient for obtaining good clinical results in treating this type of instability.<sup>9,25,30,36</sup> The predisposing anatomic factors for instability should be corrected in association with MPFL reconstruction. The first step is to correct the malalignment (patellofemoral tracking) to neutralize the lateral displacing forces. Once the patellofemoral joint has been realigned, the second step is to stabilize the joint; that is, restore the passive restraining elements to achieve good patellofemoral balance. This restoration is accomplished by performing an MPFL or

MQTFL reconstruction. An MPFL/MQTFL reconstruction should never be used to pull the patella medially because this will cause an overload of the patellofemoral joint and provoke subsequent patellofemoral osteoarthritis.<sup>17</sup>

### Medialization of the Tibial Tubercle

A TT-TG threshold of 20 mm is recommended as an indicator for tibial tubercle osteotomy (TTO) for medialization.<sup>3</sup> However, to date, no strong evidence supports this recommendation.

TT-TG distance can change due to several factors. TT-TG distance may vary depending on knee flexion or when in a supine or weightbearing position. The TT-TG distance increases significantly at the end-stage extension of the knee.<sup>11</sup> This increase could be related to the rotational changes that occur with the “screw home” mechanism. The TT-TG distance decreases by more than 5 mm with weightbearing compared with being in a supine position during knee extension<sup>20</sup> and has been evaluated as an absolute value without taking individual joint size into consideration. The pathological influence of the TT-TG distance in patients with patella instability depends on individual joint size, with a TT-TG index of >0.23 being defined as pathological.<sup>19</sup> Therefore, the necessity of medial transfer of the tibial tubercle should be decided on a more individualized basis.

Moreover, there were no differences in TT-TG distance between the stable and unstable knee in patients with recurrent unilateral lateral patellar instability.<sup>6</sup> Therefore, the TT-TG distance alone may not be a crucial indicator for tibial tubercle osteotomy in patients with lateral patellar instability, concluding that TT-TG distance must be interpreted with caution.

Furthermore, a decreasing inter- and intraobserver correlation for TT-TG measurements in patients with severe compared with low-grade trochlear dysplasia has been demonstrated.<sup>12</sup>

Clinically, no difference in Kujala scores has been found based on TT-TG distance.<sup>36</sup> Similarly, isolated MPFL reconstructions performed in the setting of a TT-TG index >20 yielded similar Lysholm and Kujala scores to those with a TT-TG <20.<sup>23</sup> Moreover, there were no recurrent dislocations in either group.

It is not clear what pathological TT-TG value should be corrected. The TT-TG distance alone is not a sufficient indicator for medialization. Other factors such as a prominent J-sign, the circumstances surrounding the initial and posterior dislocation episodes (traumatic vs atraumatic), bilaterality, activity level, and patient expectations should be considered.

In patients with distal patellar articular damage, an anteromedialization of the tibial tubercle (Fulkerson osteotomy)<sup>16</sup> may be indicated, not only to correct the maltracking (alignment) but also to unload the distal pole of the patella and therefore help to reduce or eliminate anterior knee pain.

### Distalization of the Patella

Patellar height can be measured on conventional lateral radiographs by several indices or ratios: the Caton-Deschamps index,<sup>3</sup> the Blackburne-Peel ratio,<sup>28</sup> or Insall-Salvati ratio.<sup>28</sup>

Controversies exist on how to measure patellar height. Patellar height may be normal when measured by 1 index and abnormal when measured by another. Moreover, the excessive lateral patellar tilt seen in many patients with lateral patellar instability may result in inaccurate measurement of patellar height because the patellar length appears shortened in radiographs. Moreover, ratios using radiographs do not depict the real articular congruence between the patella and the distal femur.<sup>5</sup> Patellar height can be measured on sagittal magnetic resonance imaging, using the true articular cartilage patellochondral relationship.<sup>5</sup> Patella height is measured comparing the distal patella/superior trochlear overlap to the length of the patella articular surface.<sup>5</sup> An index value of less than 12.5% is considered patella alta.<sup>5</sup>

Controversies also exist on what to do with a patella alta.<sup>3</sup> A Caton-Deschamps index of  $\geq 1.2$  has been suggested as an indication for tibial tubercle distalization<sup>3</sup>; however, no strong evidence supports this recommendation to date.

Currently, data do not support the safety of tibial tubercle distalization at long-term follow-up. Tibial tubercle distalization always implies a certain degree of medialization (decrease of the TT-TG distance).<sup>35</sup> Moreover, tibial tubercle distalization is risky in patients with chondral lesions of the distal pole of the patella because it provokes an overload of this area in initial flexion (J. P. Fulkerson, unpublished data). In addition, MPFL reconstruction causes the patella to descend.<sup>13,22</sup> Finally, the biomechanical consequences of patella distalization associated with MPFL reconstruction are not known.

A pathologic ratio or index is insufficient for indicating a tibial tubercle distalization. Other factors must be considered, such as a prominent J-sign, the circumstances surrounding the initial and posterior dislocation episodes (traumatic vs atraumatic), bilaterality, activity level, and patient expectations. Caution is needed in interpreting the indication for patellar distalization.

### Trochleoplasty

Of all the major risk factors for the development of chronic lateral patellar instability, trochlear dysplasia appears to be the most important.<sup>8</sup> Interestingly, in an analysis of failed surgery for patellar instability, severe trochlear dysplasia (Dejour type B-D) was significantly more frequent in a surgical failure group (89%) than in the control group (21%).<sup>25</sup> However, they did not observe statistical differences in patellar height ratio (Insall-Salvati index) or TT-TG distance between the 2 groups.<sup>25</sup> Trochlear dysplasia appears to be a major risk factor for failure of operative stabilization of recurrent patellofemoral instability.<sup>25</sup> A more tailored operative procedure, including reconstruction of the MPFL and trochleoplasty, may be indicated.<sup>25</sup> High degrees of trochlear dysplasia correlate with poor clinical outcome because the MPFL graft can be overloaded due to more instability being present in dysplastic situations.<sup>36</sup> Trochleoplasty should be considered in cases with high degrees of trochlear dysplasia (level of evidence 4).

Sulcus-deepening trochleoplasty is an acceptable revision option for the surgical treatment of patients with persistent

patellar dislocation and high-grade trochlear dysplasia.<sup>9</sup> Trochleoplasty is a useful and reliable surgical technique to improve patellofemoral instability in patients with a dysplastic trochlea.<sup>15</sup> However, while improved stability is predictable, pain is less predictable and may even increase after surgery. The overall results depend on the type of the dysplasia, with a significantly better clinical outcome for type B and D.<sup>15</sup>

In the context of a trochleoplasty, concern exists about the long-term consequences to healthy cartilage. However, the vast majority of patients who are candidates for trochleoplasty have severe chondropathy. Moreover, many patients with trochlear dysplasia will develop patellofemoral osteoarthritis in the long term.<sup>3</sup> Caution is needed in assessing indications for trochleoplasty. Trochleoplasty should be considered a salvage procedure in very select cases with severe trochlear dysplasia<sup>9</sup>; only in very exceptional cases is it the primary surgery.

### Additional Surgery on the Lateral Retinaculum

After MPFL reconstruction, additional surgery on the lateral retinaculum is necessary in rare cases to achieve good patellofemoral balance.<sup>2</sup> This is an intraoperative decision. The intraoperative patella tilt test<sup>2</sup> is helpful in making this decision. It requires placing a transverse Kirschner wire (K wire) through the proximal patella, from medial to lateral. With the knee in full extension and at 20° of flexion, the K wire should be parallel to the surgery table. If the K wire is tilted (positive test), a lateral patellar retinaculum lengthening should be considered or a lateral retinaculum release may be necessary. Finally, we must note that lateral retinaculum reconstruction would be helpful in the patient with postexcessive lateral retinaculum release, since both medial and lateral retinaculum assist in restraining lateral translation of the patella.

### Femoral Osteotomy

Lateral patellar instability results from a deficient MPFL, which may have become incompetent because of trochlear dysplasia, patella alta, genu valgum, abnormal limb torsion, or a combination of these factors.<sup>35</sup> When the trochlea is dysplastic, the MPFL may not be sturdy enough to withstand the normal lateral pull of the quadriceps. If abnormal limb torsion is also present, then the lateral displacement force acting on the patella is increased, and the ligament is more likely to fail and allow lateral patellar instability.<sup>35</sup> If the limb is realigned, the lateral displacement force acting on the patella is decreased, eliminating lateral patellar instability.<sup>35</sup> If limb torsion exceeds normal by 20°, realignment could be beneficial<sup>34,35</sup>; however, if the torsional deformity is  $>30^\circ$  or if a significant genu valgum ( $>5^\circ$ ) is present, osteotomy may be beneficial.<sup>35</sup>

## LATERAL PATELLAR INSTABILITY IN GREATER KNEE FLEXION

Lateral patellar instability in greater knee flexion is a very different situation from instability in extension. In this patient subgroup, patellar luxation occurs when the knee is flexed

more than 40°, but the patella is well centered in the trochlear groove in or near extension. In these patients, increasing and unbalanced tension in the extensors pulls the patella out of the groove as the knee is flexed.<sup>1</sup> Moreover, a flat lateral condyle is seen around the sulcus terminals.<sup>4</sup> These factors collectively lead to MPFL insufficiency.

Currently, the standard surgical approach in patients with lateral patellar instability in greater knee flexion involves lateral retinaculum lengthening, lengthening of the rectus lateralis tendon, and quadriceps tendon lengthening.<sup>1</sup> If needed, the lateral condyle may be raised.<sup>4</sup> The final step is an MPFL reconstruction.

## MEDIAL PATELLAR INSTABILITY

Medial patellar instability is an objective condition that may appear after realignment surgery that included an excessive lateral retinaculum release.<sup>32</sup> It frequently causes incapacitating and disabling chronic anterior knee pain along with serious psychological problems.<sup>32</sup> In general, medial patellar instability occurs in the first 30° of knee flexion and is often overlooked because patients complain of the patella moving laterally with early knee flexion.

Extensive release of the lateral retinaculum is a major cause of medial patellar instability.<sup>31,32</sup> It can result from excessive severance of the lateral retinaculum with transection of the vastus lateralis tendon; release of the lateral retinaculum in the context of trochlear dysplasia, patella alta, or hyperelasticity; or release of a lateral retinaculum that was already lax, demonstrating poor patient selection.<sup>31</sup> This iatrogenic condition should no longer exist, and it could be virtually eliminated by avoiding overrelease of the lateral retinaculum.<sup>31</sup>

All too often, the pain and disability from medial patellar instability is much worse than the preoperative symptoms for which the surgery was performed. The diagnosis can be established by physical examination (a positive Fulkerson relocation test) and simple therapeutic tests (significant relief of pain with a “reverse” McConnell taping), and it can be confirmed by imaging (stress radiography and stress axial computed tomography scans).<sup>31</sup> Reconstruction of the deep transverse layer of the lateral retinaculum using a central strip of the iliotibial band can successfully treat these severely disabled patients.<sup>32</sup>

## CONCLUSION

The etiology of chronic patellar instability is multifactorial, and its treatment must therefore be personalized. This is the only way to avoid failures and subsequent operations.

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