Saudi J. Med. Pub. Health **Vol. 1,** No. 2, pp 1571-1583 (2024)

Saudi Journal of Medicine and Public Health

https://saudijmph.com/index.php/pub
https://doi.org/10.64483/202412444

Evidence-Based Rehabilitation and Functional Recovery After Patellar Dislocation: Physical Therapy Assessment, Neuromuscular Re-education, and Return-to-Activity Outcomes

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Abstract

Background: Patellar dislocation is a significant knee injury affecting young, active individuals, often associated with pain, functional limitation, and high recurrence risk. Understanding its etiology, biomechanics, and management strategies is essential for optimizing outcomes.

Aim: To review evidence-based rehabilitation and functional recovery strategies following patellar dislocation, emphasizing physical therapy assessment, neuromuscular re-education, and return-to-activity protocols.

Methods: A comprehensive literature review and clinical synthesis were conducted, analyzing epidemiology, pathophysiology, diagnostic evaluation, and treatment modalities. Imaging techniques (radiographs, CT, MRI) and structured physiotherapy interventions were examined alongside surgical indications and procedures.

Results: First-time dislocations without osteochondral injury respond well to conservative care, including early mobilization, quadriceps and hip strengthening, proprioceptive retraining, and bracing. Recurrence rates range from 15–60%, influenced by anatomical risk factors such as trochlear dysplasia, patella alta, and increased TT–TG distance. Surgical intervention—MPFL reconstruction, tibial tubercle osteotomy, or trochleoplasty—is reserved for recurrent instability or structural abnormalities. Prognosis depends on adherence to rehabilitation and correction of biomechanical contributors.

Conclusion: Individualized management integrating early reduction, structured physiotherapy, and selective surgery is critical to restoring stability and preventing long-term patellofemoral morbidity. Interprofessional collaboration enhances diagnostic accuracy and rehabilitation success.

Keywords: Patellar dislocation, rehabilitation, MPFL, trochlear dysplasia, physiotherapy, TT–TG distance, neuromuscular control.

Introduction

Patellar instability encompasses a continuum of pathological knee conditions in which the patella fails to maintain stable tracking within the trochlear groove during motion. This spectrum ranges from transient, self-reducing subluxation events to complete patellar dislocation, often reflecting an interplay between osseous morphology, soft-tissue restraint integrity, neuromuscular control, and dynamic lower-limb biomechanics. Clinically, patellar dislocation typically presents acutely with marked pain, apprehension, and a visible lateral displacement of the patella accompanied by functional limitation. Patients commonly demonstrate an inability to actively extend the knee due to pain, mechanical blockade, and reflex quadriceps inhibition, with the deformity often apparent at first examination [1]. The clinical significance of a first-time patellar dislocation lies not only in the acute disability it produces but also in its propensity for recurrence. Recurrence rates after an initial dislocation have been reported to range broadly from approximately 15% to 60%, highlighting substantial heterogeneity driven by patient age, anatomical risk factors, and the extent of associated soft-tissue or osteochondral injury [1]. This variability

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Receive Date: 17 December 2024, Revise Date: 30 December 2024, Accept Date: 31 December 2024

underscores the importance of early risk stratification and individualized management planning. Younger patients, individuals with generalized ligamentous laxity, and those with structural predispositions such as trochlear dysplasia, patella alta, or increased tibial tubercle–trochlear groove distance may be at higher risk for recurrent instability, which can lead to progressive cartilage damage, persistent pain, and functional decline over time [1].

From an epidemiologic standpoint, generalized patellar instability is estimated to account for up to 3% of knee-related clinical presentations, making it a relevant consideration in both primary care and sports medicine pathways. Because patellofemoral stability depends heavily on coordinated muscular function and movement control, physical therapy plays a central role in nonoperative management. Conservative treatment commonly includes early symptom control, protective bracing, restoration of range of motion, progressive quadriceps strengthening—particularly targeting the vastus medialis obliquus—hip and core stabilization, proprioceptive retraining, and correction of contributing biomechanical faults. This approach is frequently successful in first-time dislocators without significant structural injury and is often preferred to reduce surgical morbidity [1]. Nevertheless, conservative care is not universally appropriate. The presence of an associated fracture, particularly osteochondral injury, or persistent mechanical symptoms may necessitate surgical consultation. Recurrent dislocation episodes may also prompt operative consideration to restore stability and reduce the cumulative risk of chondral degeneration. Accordingly, patellar dislocation represents a condition in which early assessment, appropriate imaging when indicated, and coordinated rehabilitation planning are essential to optimize functional recovery and minimize long-term morbidity [1].

Etiology

Patellar dislocation most commonly results from a multifactorial interaction between acute mechanical forces and underlying structural or functional predispositions that reduce the patellofemoral joint's ability to resist lateral translation. In the acute setting, a first-time dislocation typically occurs following trauma, and the classic pattern is a non-contact twisting injury rather than a direct high-energy impact. A frequently described mechanism involves external rotation of the tibia with the foot planted, often combined with knee valgus and a sudden change in direction. This movement pattern increases the lateralizing forces across the patella by altering the line of pull of the quadriceps mechanism and increasing the lateral vector acting on the patella during early knee flexion. Alternatively, a direct blow to the medial aspect of the knee can physically drive the patella laterally, producing a dislocation through an externally applied force rather than through dynamic torsional loading. Beyond acute trauma, patient-specific tissue characteristics significantly influence susceptibility. Generalized ligamentous laxity is a recognized contributor because it reduces the passive restraint provided by capsuloligamentous structures. However, in many hypermobile individuals the clinical pattern is recurrent subluxation or intermittent instability episodes rather than a single dramatic dislocation, reflecting a chronic insufficiency of passive stabilizers rather than a one-time failure event. Ligamentous laxity is reported more commonly in females and may also be associated with inherited connective tissue disorders such as Marfan syndrome or Ehlers–Danlos syndrome, in which collagen composition and tissue elasticity compromise joint stability and increase the likelihood of patellar translation under otherwise tolerable loads [1][2].

Anatomic variations further amplify risk by altering the osseous containment and tracking environment of the patella. Trochlear dysplasia reduces the depth and congruency of the trochlear groove, diminishing the bony restraint that normally becomes more effective as the knee flexes. Patella alta places the patella in a relatively superior position, delaying engagement with the trochlea during early flexion and prolonging the interval in which the patella is vulnerable to lateral displacement. These morphologic factors can convert routine movements into instability-provoking events, particularly when combined with dynamic valgus mechanics or inadequate neuromuscular control. In clinical practice, the presence of these structural predispositions is often associated with higher recurrence risk and may influence both rehabilitation strategies and surgical decision-making. Functional contributors are also important in the etiology of patellar instability. Muscular imbalance—most notably relative weakness or delayed activation of the vastus medialis obliquus—can impair medial stabilization during knee extension and early flexion. When medial dynamic control is insufficient, the lateral pull of the quadriceps and the influence of the lateral retinaculum can dominate, promoting maltracking and increasing the likelihood of lateral translation underload. Abnormal movement patterns at the hip and trunk can further increase lateral patellar stress by driving femoral internal rotation and dynamic knee valgus, though the immediate clinical emphasis often remains on restoring balanced quadriceps and hip stabilizer function. Distinct etiologic categories include habitual and congenital dislocations. Habitual dislocation is characterized by recurrent, often painless lateral displacement with each episode of knee flexion, typically driven by abnormal soft-tissue tensioning, including tightness of the vastus lateralis and iliotibial band, which persistently biases the patella laterally. Congenital dislocation is less common but clinically significant and is frequently reported in association with conditions such as Down syndrome. In these cases, structural abnormalities—such as a small patella combined with hypoplasia of the femoral condyle—contribute to persistent malalignment and failure of normal patellofemoral engagement, and surgical intervention is commonly required to achieve stable reduction and functional alignment [1][2][3].

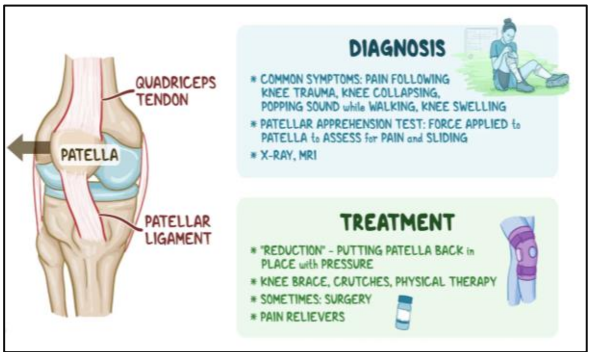

Fig. 1: Patellar Dislocation.

Epidemiology

Patellar dislocation represents a clinically important subset of knee trauma, accounting for an estimated 2% to 3% of knee injuries in many orthopedic and sports medicine case series. Although often considered less common than ligamentous injuries such as anterior cruciate ligament rupture, its impact is substantial because it frequently affects individuals during periods of high physical demand and may carry a meaningful risk of recurrence and long-term patellofemoral morbidity. The condition is most commonly encountered in young and physically active populations, reflecting both exposure to pivoting sports and the biomechanical stresses associated with rapid changes in direction, deceleration, and landing mechanics. Epidemiologic data indicate that the overall incidence of patellar dislocation is approximately 5.8 per 100,000 persons, though incidence varies considerably by age group and activity level. In adolescents, in whom participation in sports is high and underlying anatomic predispositions may become clinically apparent, reported incidence can rise markedly and has been described as reaching up to 29 per 100,000 [2]. This age-related gradient is clinically meaningful because adolescence is also the period in which the first dislocation commonly occurs, and early onset has been associated with a greater probability of recurrent instability across subsequent years. Accordingly, population-level incidence figures may underestimate the true burden in athletic subgroups, where repeated exposure to pivoting loads, combined with sport-specific movement patterns, can elevate risk [2][3].

While the overall risk profile highlights adolescent females and athletes as higher-risk categories, acute first-time dislocations may occur relatively equally in males and females, particularly when accounting for participation in high-risk activities and exposure to trauma. In many cohorts, the apparent female predominance is partially explained by differences in biomechanics and ligamentous laxity, but also by sport participation patterns and the higher prevalence of certain anatomic risk factors in females, including greater generalized joint laxity and dynamic valgus tendencies. Nonetheless, patellar dislocation remains a common injury in both sexes, and clinicians should maintain vigilance across all young active patients presenting with acute knee pain, swelling, and an inability to extend the knee after a pivoting event. In terms of age distribution, patellar dislocations occur most frequently in the second and third decades of life, with a notable concentration in the adolescent and young adult years. This distribution aligns with peak participation in high-intensity sports, occupational physical training, and recreational activities that involve cutting and twisting. The epidemiologic concentration in these age groups underscores the importance of timely recognition, appropriate imaging when indicated to assess for osteochondral injury, and structured rehabilitation to reduce the risk of recurrence and facilitate safe return to activity [2][3].

Pathophysiology

Patellar dislocation reflects a failure of the patellofemoral joint to maintain congruent tracking of the patella within the trochlear groove under dynamic loading. The overwhelming majority of dislocations occur laterally, which is not accidental but rather a predictable consequence of the limb's alignment and the vector forces generated by the extensor mechanism. The quadriceps muscle group exerts a resultant pull that is typically slightly lateral relative to the mechanical axis of the lower limb. During early knee flexion—when the patella has not yet fully engaged the bony containment of the trochlea—this lateralizing force can exceed the restraining capacity of medial soft tissues, allowing the patella to translate laterally over the trochlear ridge and dislocate. By contrast, medial patellar instability is uncommon in native anatomy and usually arises in atypical contexts such as congenital malalignment syndromes, severe quadriceps atrophy with altered force vectors, or iatrogenic destabilization after surgical procedures that excessively release lateral restraints or malposition the patella. Intra-articular patellar dislocation is also rare but may occur after high-energy trauma when the patella is avulsed or significantly disrupted from the quadriceps tendon and then rotates within the joint space, creating a mechanically locked and clinically dramatic presentation. Superior patellar dislocation represents another unusual pattern and is most often described in older patients, where forced hyperextension can cause the inferior pole of the patella to engage and "lock" against an anterior femoral osteophyte, producing acute mechanical obstruction distinct from lateral dislocation mechanics [2][3].

A central biomechanical concept in patellofemoral instability is the Q angle, which provides a clinically accessible approximation of the lateral vector acting on the patella. The Q angle is measured by drawing a line from the anterior superior iliac spine (ASIS) through the center of the patella and a second line from the patellar center to the tibial tubercle. This angle reflects the alignment of the quadriceps pull relative to the patellar tendon and, by extension, the tendency of the patella to be drawn laterally during quadriceps activation. Normal values are generally higher in females than in males, commonly reported around 18 degrees versus 14 degrees, reflecting differences in pelvic width and limb alignment. When the Q angle exceeds these typical ranges, the lateralizing component of quadriceps force is increased, placing greater stress on medial stabilizing structures and elevating the probability of maltracking, subluxation, and dislocation. Although the Q angle is not a perfect surrogate for three-dimensional lower-limb kinematics, it remains clinically useful for conceptualizing why certain anatomical alignments predispose to lateral instability. Patellar stability is governed by an interplay between static stabilizers and dynamic stabilizers, and the relative contribution of each changes with knee flexion angle. In early flexion—particularly within the first 20 degrees—the patella is only partially engaged in the trochlear groove, and soft-tissue restraints provide the dominant stabilizing effect. The medial patellofemoral ligament (MPFL) is the primary static restraint against lateral translation in this range. The MPFL functions as a checkrein that limits lateral excursion when the knee transitions from extension into early flexion, a phase in which the patella is most vulnerable. Consequently, MPFL disruption is almost universal in lateral patellar dislocation, and its injury is a key pathophysiologic event that not only accompanies the initial episode but also contributes to recurrence risk if healing is inadequate or if underlying anatomical drivers remain unaddressed. The acute tear of the MPFL is often associated with hemarthrosis and medial retinacular pain, and it may be accompanied by chondral or osteochondral injury as the patella impacts the lateral femoral condyle during displacement and relocation [1][2][3].

As knee flexion deepens, bony architecture becomes increasingly important. The trochlear groove provides osseous containment that guides and stabilizes the patella, and the congruency between patellar shape and trochlear morphology is a decisive determinant of stability. Trochlear dysplasia—characterized by a shallow or malformed groove—reduces this containment, allowing lateral translation to occur more easily even at higher flexion angles. Similarly, lateral femoral condyle hypoplasia diminishes the lateral "wall" that normally resists patellar escape. Patella alta, in which the patella sits higher than usual relative to the trochlea, delays engagement of the patella into the groove during flexion, prolonging the high-risk interval in which soft tissues must resist lateral forces without meaningful bony support. Excessive lateral patellar tilt further compromises tracking by positioning the patella so that it is already oriented toward lateral translation; this can reflect tight lateral retinacular structures, altered femoral rotation mechanics, or congenital alignment patterns. Collectively, these structural distortions alter the normal patellofemoral tracking pathway and shift load distribution, increasing the propensity for instability and the risk of articular cartilage injury over time. Dynamic stabilization depends heavily on neuromuscular control, particularly the function of the vastus medialis obliquus (VMO), the distal and obliquely oriented portion of the quadriceps that exerts a medially directed stabilizing pull on the patella. The VMO contributes to counterbalancing lateral quadriceps forces and helps maintain central patellar alignment during extension and early flexion. Weakness, delayed activation, or dysplasia of the VMO reduces this protective medial vector, allowing lateral drift during functional tasks such as squatting, stair descent, cutting, and landing. In addition, pain and effusion following a dislocation can produce reflex quadriceps inhibition, further weakening dynamic control at precisely the time the joint is most unstable. This combination—loss of the primary medial soft-tissue restraint through MPFL injury and diminished dynamic control through VMO inhibition—explains why the period after a first-time dislocation is particularly vulnerable to recurrent episodes unless rehabilitation restores strength, coordination, and movement control while addressing structural risk factors where feasible [1][2][3].

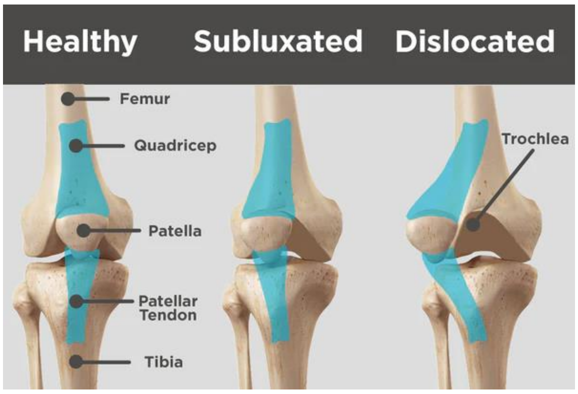

Fig. 2: Patellar dislocation and healthy one.

History and Physical

A careful history and structured physical examination are central to diagnosing patellar dislocation and differentiating acute traumatic instability from chronic or recurrent patellofemoral disorders. Patients with an acute lateral patellar dislocation commonly describe a sudden onset of severe knee pain accompanied by an obvious deformity following a characteristic mechanism: either a non-contact twisting event—often during pivoting, deceleration, or landing—or a direct blow to the anterior or medial aspect of the knee. Many patients report a sensation that the knee "gave way," frequently accompanied by an audible or palpable "pop," which may correspond to the patella translating out of the trochlear groove and/or to tearing of the medial stabilizing structures. Swelling is typically reported early, often developing rapidly due to hemarthrosis or acute inflammatory effusion, and patients may be unable to bear weight or actively extend the knee because of pain, mechanical dysfunction, and reflex quadriceps inhibition. In chronic or recurrent cases, the history may be less dramatic but remains distinctive. Pain is often localized to the anterior or anteromedial knee, reflecting patellofemoral cartilage irritation, maltracking, and recurrent soft-tissue strain. Patients may describe repeated episodes of the knee giving way, transient lateral "slipping," or feelings of instability during activities that load the patellofemoral joint, such as stair descent, squatting, kneeling, and athletic cutting maneuvers. Mechanical symptoms—including clicking, catching, or locking sensations—may suggest associated chondral injury, loose bodies, or synovial irritation. Symptoms are commonly exacerbated in flexion-based positions, which increase patellofemoral contact forces and may provoke maltracking in anatomically predisposed knees [2][3][4].

Physical examination in the acute setting often reveals a tense joint effusion or hemarthrosis, which supports the presence of intra-articular injury and is consistent with acute dislocation mechanisms. In chronic instability, effusion may be absent or minimal unless there has been a recent symptomatic episode. Observation should begin with overall limb alignment and gait as tolerated. Clinicians may note predisposing alignment features such as femoral anteversion, patella alta, tibial torsion, genu valgum or varum, genu recurvatum, pes planus, or generalized ligamentous laxity. These findings are clinically relevant because they reflect structural contributors that increase lateral patellar stress and may help stratify recurrence risk. Inspection may also reveal quadriceps atrophy, particularly of the medial quadriceps, which can compromise dynamic stabilization. Palpation should include assessment of the patella and surrounding soft tissues, with particular attention to tenderness at the medial patellar border and medial retinacular region, where injury to the medial patellofemoral ligament is common following lateral dislocation. Palpation across the superior, inferior, medial, and lateral poles of the patella can identify focal tenderness, contour irregularities, or pain suggestive of osteochondral injury. If pain permits, active and passive range of motion should be assessed, noting restriction, guarding, or crepitus that may indicate cartilage injury or intra-articular derangement. Because traumatic mechanisms can coexist with ligamentous injury, evaluation of collateral ligaments and cruciate ligaments is essential, particularly when the mechanism involved significant twisting or when the patient reports instability patterns not fully explained by patellar pathology alone. Specific patellar stability tests can further characterize the disorder. Some patients demonstrate a positive J sign, defined as excessive lateral deviation of the patella as the knee moves from flexion into extension, reflecting maltracking and diminished stabilizing control in terminal extension. Patellar mobility can be assessed through the patellar glide test: in a normal knee, the patella typically translates medially and laterally approximately 25% to 50% of its width. In recurrent dislocators or patients with marked laxity, translation may exceed this range, indicating insufficient passive restraint. The patellar apprehension test is a particularly informative maneuver. With the knee relaxed in approximately 20 to 30 degrees of flexion—where the patella is relatively vulnerable—the examiner applies a lateralizing force to the patella. A positive test is present when the patient exhibits apprehension, guarding, or involuntary quadriceps contraction to prevent lateral movement, reflecting learned fear and physiologic instability. Together, these historical and examination findings allow clinicians to identify acute dislocation, recognize chronic instability patterns, and determine whether further imaging and targeted rehabilitation or surgical consultation are warranted [2][3][4].

Evaluation

The diagnostic evaluation of patellar dislocation aims to confirm the injury pattern, identify associated osteochondral or ligamentous damage, and characterize anatomic risk factors that influence recurrence and guide treatment planning. Because patellar instability exists on a spectrum—from first-time traumatic dislocation to recurrent episodes associated with structural dysplasia—imaging is not simply confirmatory; it is integral to stratifying severity, detecting complications that require early intervention, and informing rehabilitation versus surgical pathways. A stepwise approach typically begins with plain radiographs, followed by advanced imaging such as computed tomography (CT) and magnetic resonance imaging (MRI) when clinically indicated. Each modality contributes distinct information: radiographs evaluate osseous injury and alignment, CT refines bony morphology and quantitative malalignment parameters, and MRI provides superior assessment of soft tissues, cartilage, and bone marrow injury patterns [4].

Plain Radiographs

Initial imaging should include anteroposterior (AP) and lateral radiographs of the affected knee, supplemented by an axial patellar view (often referred to as sunrise or Merchant view) [3]. These views serve several essential purposes. First, they screen for fractures—particularly osteochondral injuries that can accompany dislocation—and help identify loose bodies that may cause locking, catching, or persistent pain. Osteochondral fragments commonly originate from the medial aspect of the patella due to shear forces during lateral displacement and relocation, and they may also involve the lateral femoral condyle where the patella impacts during the dislocation event. Detecting such injuries early is critical because displaced fragments may require surgical fixation or removal to prevent ongoing mechanical symptoms and progressive chondral damage. Plain radiographs also provide insight into malalignment, degenerative changes, and predisposing anatomic factors. Patella alta can often be suspected radiographically and is clinically important because a high-riding patella delays engagement with the trochlear groove in early flexion, increasing vulnerability to lateral translation. One descriptive marker of patellar height relates to the Blumensaat line: when the knee is flexed to approximately 30 degrees, the inferior pole of the patella is expected to lie on a line drawn anteriorly from the intercondylar notch. Disruption of this expected relationship can support the suspicion of patella alta, though formal measurement is preferred for consistency [3][4].

Fig. 3: Lateral patellar dislocation.

The Insall–Salvati ratio remains the classic radiographic method for quantifying patellar height on the lateral view with the knee flexed to approximately

30 degrees. It is calculated as the ratio of patellar tendon length (LL, measured from the inferior patellar pole to the tibial tubercle) to patellar length (LP, the longest diagonal dimension of the patella). A normal ratio is approximately 1.0. Values greater than 1.2 suggest patella alta, while values less than 0.8 suggest patella baja. This measurement is clinically useful because it converts a qualitative impression into a reproducible parameter that can be tracked over time and incorporated into surgical decision-making when recurrent instability is present [3][4]. The lateral radiograph can also provide indirect evidence of trochlear dysplasia, a major contributor to recurrent patellar instability. The "crossing sign" is present when the line representing the trochlear groove crosses or lies in the same plane as the anterior border of the lateral femoral condyle, suggesting a flattened trochlea that provides reduced osseous containment. The "double contour sign" can be observed when the trochlea is convex or when the medial femoral condyle is underdeveloped, producing the appearance that the anterior border of the lateral condyle lies anterior to the anterior border of the medial condyle. These signs are valuable screening indicators, although they do not fully characterize trochlear morphology. The Merchant (sunrise) view is especially useful for evaluating patellar tilt and patellofemoral congruence. This axial projection is typically obtained at approximately 45 degrees of knee flexion and allows measurement of the sulcus angle and the congruence angle. These angles help quantify the depth of the trochlear groove and the degree to which the patella is centered within it. Abnormal values can support the diagnosis of maltracking and may correlate with instability severity, though interpretation should always be integrated with clinical findings and other imaging results [3][4].

Computed Tomography Scans (CT)

CT imaging adds value by providing high-resolution delineation of bony anatomy and enabling quantitative assessment of alignment parameters that influence instability. A primary CT-based measure in patellar dislocation evaluation is the tibial tubercle–trochlear groove (TT–TG) distance, which estimates the lateral offset between the tibial tubercle (the distal attachment of the patellar tendon) and the trochlear groove (the patellar track). The measurement is performed by first drawing a reference line tangent to the posterior borders of the femoral condyles. Two perpendicular lines are then drawn: one passing through the apex of the tibial tubercle (line A) and the other through the deepest point of the trochlear groove (line B). The distance between these two perpendicular lines is the TT–TG distance. Values are commonly considered normal when less than 20 mm, and measurements greater than 20 mm are generally regarded as abnormal and associated with increased lateralizing force on the patella. This parameter is important because it can influence surgical planning, particularly when realignment procedures are being considered. Beyond TT–TG measurement, CT can more precisely delineate osteochondral fractures, quantify patellar tilt, and characterize trochlear morphology. In patients with suspected loose bodies or articular surface injury, CT can help define fragment size, location, and displacement, supporting operative decision-making. It can also assist in preoperative mapping of bony anatomy when procedures such as tibial tubercle transfer are contemplated. While CT provides excellent bony detail, it is less informative for soft tissues, so it is often complementary to MRI rather than a replacement [3][4].

Magnetic Resonance Imaging (MRI)

MRI is highly valuable in patellar dislocation because it characterizes both soft-tissue injury and associated chondral damage, which are central determinants of prognosis and recurrence risk. In complete lateral dislocation, MRI often reveals a characteristic bone marrow contusion pattern involving the medial patella and the lateral femoral condyle, reflecting the impact mechanism during displacement and reduction. Recognition of this pattern can support the diagnosis even when the patella has spontaneously reduced before clinical evaluation. A key MRI contribution is assessment of the medial patellofemoral ligament (MPFL), the principal passive restraint to lateral translation in early flexion. MRI commonly demonstrates MPFL disruption after dislocation, frequently near its femoral attachment at the medial femoral epicondyle insertion [4]. Identifying the site and extent of MPFL injury can inform rehabilitation expectations and, in recurrent cases, surgical reconstruction planning. MRI is also more sensitive than plain radiography for detecting osteochondral lesions and articular cartilage damage, particularly on the medial patellar facet. Because chondral injury can drive persistent pain, swelling, and mechanical symptoms, its detection has direct implications for both prognosis and the urgency of orthopedic referral. Additionally, MRI aids in assessing trochlear anatomy and classifying trochlear dysplasia. Dejour's classification describes four grades: type A, in which the trochlea is flatter than normal with a sulcus angle greater than 145 degrees; type B, characterized by a flat trochlea; type C, in which the trochlea becomes convex; and type D, which is convex and associated with a supratrochlear spur. While classification itself does not dictate management in isolation, it provides a structured framework for describing morphology and correlating it with instability severity, recurrence risk, and potential surgical strategy. Overall, evaluation of patellar dislocation should be individualized, combining clinical assessment with imaging that progresses from radiographs to advanced modalities based on symptoms, suspected osteochondral injury, and the likelihood of recurrent instability. Plain films establish baseline osseous assessment and alignment, CT provides quantitative bony malalignment measures such as TT–TG distance, and MRI offers the most comprehensive evaluation of ligamentous disruption and cartilage injury. This integrated approach ensures that management decisions—whether conservative rehabilitation, bracing, or surgical consultation—are based on an accurate depiction of both injury sequelae and underlying predisposition [3][4].

Treatment / Management

Management of patellar dislocation is guided by the clinical context (first-time versus recurrent instability), the presence or absence of associated intra-articular injury (particularly osteochondral fractures and loose bodies), and the patient's anatomic risk profile (trochlear dysplasia, patella alta, excessive TT–TG distance, malalignment, and rotational abnormalities). The overarching goals are to restore patellar congruence, control pain and swelling, protect injured soft tissues—especially the medial stabilizers such as the MPFL—re-establish neuromuscular control and functional stability, and minimize recurrence and long-term patellofemoral cartilage deterioration. A pragmatic approach distinguishes acute reduction and early stabilization from subsequent rehabilitation, while reserving surgery for clearly defined indications in which structural injury or recurrent instability makes nonoperative care insufficient [5].

Acute Dislocations

The immediate priority in an acute patellar dislocation is prompt reduction. Reduction is typically performed in the emergency department, with analgesia and procedural sedation used as needed depending on pain severity, muscle guarding, and patient anxiety. The classic reduction maneuver aims to reverse the lateral displacement by reducing quadriceps tension and guiding the patella medially back into the trochlear groove. This is usually accomplished by flexing the hip to relax the quadriceps mechanism, applying gentle medial pressure to the lateral pole of the patella, and then slowly extending the knee. As extension proceeds, the patella often relocates smoothly with a perceptible reduction "clunk." In some settings, reduction can also be performed with the patient sitting upright and the legs hanging from the trolley, provided the operator can maintain controlled knee extension and medially directed patellar pressure. Following reduction, reassessment is essential to confirm restoration of alignment, neurovascular integrity, and to evaluate the degree of effusion, pain, and functional limitation. After successful reduction, the management strategy depends heavily on whether the dislocation is a first-time event and whether there is evidence of associated intra-articular pathology. For first-time dislocators without loose bodies, displaced osteochondral fragments, or significant intra-articular damage, conservative care remains the mainstay. Initial measures emphasize symptom control and protection of injured soft tissues. Analgesia, icing, and nonsteroidal anti-inflammatory drugs (NSAIDs) are commonly used to reduce pain and swelling, while activity modification minimizes provocative loading during early healing. Short-term bracing—often with a J brace or a patellar-stabilizing sleeve—may provide symptomatic stability and protect the medial soft tissues during the early post-injury phase, typically for approximately 2 to 4 weeks, allowing initial healing of the MPFL and medial retinaculum. Weight-bearing is generally permitted as tolerated, with crutches used when pain or apprehension limits safe gait. Early mobilization within comfort is often preferred over prolonged immobilization to reduce stiffness and facilitate restoration of quadriceps activation, provided patellar stability is maintained [5].

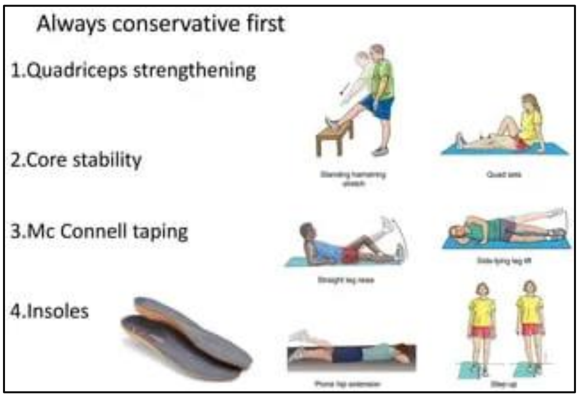

Fig. 3: Physiotherapy of patella instability.

Rehabilitation is the central component of nonoperative management. Physiotherapy is initiated with progressive goals: restoring pain-free range of motion, limiting effusion, reactivating quadriceps function, and addressing neuromuscular and biomechanical contributors to lateral instability. Particular emphasis is placed on strengthening the quadriceps—especially the vastus medialis obliquus—because it contributes a medially directed stabilizing vector that supports patellar tracking. Hip and core strengthening are also prioritized to reduce dynamic valgus and femoral internal rotation patterns that amplify lateral patellar stress. Proprioceptive retraining and balance work address sensorimotor deficits that often follow traumatic instability, improving functional control during gait, squatting, and sport-specific cutting movements. Return to sport or high-demand activity is typically staged and criterion-based, depending on pain, swelling, strength symmetry, movement quality, and patient confidence. Despite conservative treatment being standard for uncomplicated first-time dislocation, the role of early surgery remains debated. A Cochrane review has indicated that while some evidence may favor surgical intervention in certain outcomes, the overall evidence quality has been insufficient to justify a broad change in practice for routine first-time dislocations [5]. This reinforces a risk-based approach: most patients without structural injury can be managed nonoperatively, while those with clear intra-articular damage or persistent instability warrant early orthopedic assessment. Some clinicians advocate arthroscopy when osteochondral fracture is suspected or confirmed, with open repair of the fragment when feasible, as fragment preservation may reduce future cartilage morbidity [6].

Surgical Management

Surgical intervention is considered when the probability of recurrence is high, when structural injury demands mechanical correction, or when conservative management fails to achieve functional stability. Common indications include a first-time dislocation with an osteochondral fracture or loose body, imaging—particularly MRI—demonstrating substantial MPFL disruption in a context where instability risk is high, persistent subluxation noted on axial (Merchant) radiographs with a normal contralateral knee suggesting pathologic maltracking, failure to improve with appropriate rehabilitation in the presence of predisposing anatomy, and recurrent dislocations[6]. Evidence suggests that early stabilization can reduce subsequent dislocation rates, but this benefit may not translate into clear long-term subjective superiority for all patients, making individualized selection crucial [7]. Operative strategies generally fall into proximal realignment, distal realignment, and trochlear procedures, often combined to address both soft tissue insufficiency and bony malalignment. The choice depends on the dominant drivers of instability—soft tissue disruption alone versus structural predisposition such as elevated TT–TG distance, patella alta, severe trochlear dysplasia, or rotational deformity [6][7].

Arthroscopy, with or without open debridement, is often used to evaluate the joint for osteochondral injury and remove loose bodies that may cause mechanical symptoms. When osteochondral fragments are displaced but contain sufficient subchondral bone, fixation is favored to preserve articular congruity; when fragments are not repairable, removal and chondroplasty may be performed to reduce mechanical irritation. This approach is particularly important because osteochondral injury can be the major driver of persistent pain and swelling after an otherwise “successful” reduction. Proximal realignment typically focuses on restoring the medial soft tissue restraints, most importantly the MPFL. MPFL repair involves reattaching the torn ligament, often using anchors at the femoral attachment site near the medial epicondyle, through a medial incision that allows access adjacent to the vastus medialis region. However, in patients with recurrent instability, tissue quality and repeated trauma often make reconstruction more reliable than repair. MPFL reconstruction commonly uses gracilis or semitendinosus autograft or an allograft, recreating the ligament’s function as a primary checkrein against lateral translation in early flexion. Importantly, isolated MPFL repair or reconstruction is generally not recommended when major bony abnormalities are present—such as TT–TG distance greater than 20 mm, convex trochlear dysplasia, severe patella alta, advanced cartilage degeneration, or severe femoral anteversion—because failure to correct dominant structural malalignment can leave excessive lateralizing forces unaddressed and increase the risk of persistent symptoms or recurrence [1].

Distal realignment procedures aim to modify the mechanical alignment of the extensor mechanism. Lateral release involves cutting the lateral retinaculum to reduce excessive lateral tethering and improve patellar centering, but it is rarely performed in isolation because it is insufficient as a standalone stabilizer and may worsen medial instability if overdone. Instead, it is typically used as an adjunct when there is clear lateral retinacular tightness contributing to tilt or maltracking, combined with other stabilizing procedures. Tibial tubercle osteotomy is a principal distal realignment technique when lateralization of the tibial tubercle contributes to a high TT–TG distance and poor tracking. The Fulkerson osteotomy (anteromedialization) involves cutting and mobilizing a segment of the anterior tibia containing the tibial tubercle, allowing the surgeon to shift the patellar tendon insertion medially and anteriorly. This adjustment reduces the Q angle and decreases the lateral vector acting on the patella, thereby lowering recurrence risk and improving tracking mechanics. In patients with patella alta, distalization of the tibial tubercle can lower patellar height, promoting earlier trochlear engagement. Such bony procedures must be selected carefully, particularly in younger patients, because they are generally not appropriate in those with open growth plates. When rotational deformity is a major contributor—such as excessive femoral anteversion causing dynamic internal rotation and lateral patellar stress—a femoral derotational osteotomy may be considered. This approach targets the proximal driver of maltracking and is usually reserved for carefully selected cases with consistent clinical and imaging evidence of torsional malalignment. As with other osteotomies, skeletal maturity and growth plate status strongly influence appropriateness [1][5][6][7].

Trochleoplasty is reserved for recurrent dislocators with significant trochlear dysplasia, particularly when the trochlea is flat or convex and fails to provide adequate bony containment. The procedure deepens and reshapes the trochlear groove, creating a more stable path for patellar tracking, and it is often combined with MPFL reconstruction to address both osseous and soft tissue stabilizers. Trochleoplasty is relatively uncommon and generally avoided in patients with open growth plates or advanced degenerative joint disease, given concerns about growth disturbance and the limited benefit in severely arthritic joints. In severe dysplasia with repeated dislocation despite other interventions, however, it can be an important option in specialized centers. In summary, treatment of patellar dislocation should be individualized and staged: urgent reduction and symptom control in the acute phase, structured rehabilitation as the cornerstone for uncomplicated first-time dislocations, and selective surgery when osteochondral injury, recurrent instability, or significant structural predisposition makes conservative care insufficient. Effective management integrates patient goals, recurrence risk, imaging findings, and biomechanical correction to support durable stability and safe return to activity [5][6][7].

Differential Diagnosis

Acute patellar dislocation can present dramatic pain, swelling, functional limitation, and a sensation of instability, but several other knee pathologies may produce overlapping clinical features. Differentiating these conditions is essential because management priorities and rehabilitation pathways can differ substantially. Anterior cruciate ligament (ACL) injury is one of the most important alternative diagnoses, particularly in patients reporting a non-contact twisting mechanism, an audible “pop,” immediate swelling, and a feeling of the knee “giving way.” Both ACL rupture and patellar dislocation may generate hemarthrosis and acute apprehension with weight-bearing. However, ACL injury more commonly produces subjective instability during pivoting, a positive Lachman or pivot-shift test (when tolerated), and diffuse joint-line discomfort rather than focal medial patellar tenderness. Patellar dislocation, in contrast, often has localized tenderness over the medial patellar border and medial retinaculum due to MPFL injury and may demonstrate patellar apprehension or excessive lateral glide. Medial collateral ligament (MCL) injury can also mimic aspects of patellar dislocation, especially when valgus stress or contact mechanisms are involved. Patients may present with medial knee pain and swelling; however, instability is typically provoked by valgus stress testing rather than patellar mobilization, and patellar alignment is usually preserved. Meniscal injury is another frequent consideration, as patients can report twisting injury, pain, swelling, and mechanical symptoms such as clicking, catching, or locking. Meniscal tears tend to produce joint-line tenderness and provocative test findings (eg, McMurray-type maneuvers) and may have delayed swelling, whereas dislocation events often cause immediate swelling from hemarthrosis and focal patellofemoral tenderness [7][8].

In subacute or chronic presentations, patellofemoral syndrome is a common differential, characterized by anterior knee pain exacerbated by stairs, squatting, prolonged sitting, and kneeling. Unlike frank dislocation, patellofemoral syndrome usually lacks a discrete traumatic onset and does not produce the dramatic instability episode described by dislocators, though maltracking may coexist. Medial synovial plica syndrome can also generate anterior or anteromedial pain with clicking, snapping, or a catching sensation, and may be worsened by repetitive flexion-extension. Chondromalacia patellae overlaps with patellofemoral syndrome and refers more specifically to cartilage softening or degeneration, producing activity-related anterior knee pain and occasional crepitus rather than acute deformity. Importantly, these diagnoses can coexist with patellar instability, particularly after recurrent episodes, so clinicians should treat the differential as a structured framework rather than a mutually exclusive list, integrating history, physical examination, and imaging to reach the most accurate and clinically actionable diagnosis [7][8].

Prognosis

Prognosis after patellar dislocation is heterogeneous and depends on patient age, activity demands, anatomic predisposition, the presence of osteochondral injury, and adherence to rehabilitation. In uncomplicated first-time dislocators managed nonoperatively, structured physiotherapy commonly extends for two to three months, focusing on restoring quadriceps strength—particularly the vastus medialis obliquus—improving hip and core control, and re-establishing proprioception and movement quality. This rehabilitation is not optional in a functional sense: if the medial retinacular structures do not heal adequately and the VMO does not regain effective dynamic stabilization, lateral maltracking can persist and recurrent instability becomes more likely. Even with appropriate management, studies suggest a 20% to 40% risk of re-dislocation after the initial episode, with substantially higher rates after a second dislocation, reflecting the cumulative injury to medial stabilizers and the reinforcing role of structural risk factors [8].

Symptom persistence after the first dislocation is common. Atkin and colleagues reported that at six months, 58% of patients continued to experience limitations in strenuous activity despite regaining range of motion, indicating that recovery is often more functional and confidence-limited than purely mechanical [9]. Early after injury, patients frequently reduce sport participation, and tasks that increase patellofemoral load—especially kneeling and squatting—remain challenging. Notably, failure to return to sport has been observed in a substantial subset, reported as 55% in some cohorts, suggesting that psychological factors (fear of recurrence), residual pain, and incomplete neuromuscular recovery contribute meaningfully to outcome. Maenpaa and colleagues similarly found that more than half of patients experience complications after a first-time dislocation, including re-dislocation, recurrent subluxation, or persistent patellofemoral pain, emphasizing that "successful reduction" does not guarantee durable symptom resolution [10]. Patients with prominent anatomic abnormalities that precipitated the initial dislocation may also be at risk of contralateral patellar instability, sometimes requiring assessment or intervention for the opposite knee. Nevertheless, stability tends to improve with advancing age, likely reflecting reduced exposure to high-risk pivoting activities, changes in neuromuscular control, and differences in tissue behavior over time. Overall, prognosis is best when injury-associated intra-articular damage is absent, rehabilitation is rigorous and sustained, and modifiable biomechanical contributors are corrected early [8][9][10].

Complications

Complications of acute patellar dislocation can be immediate, delayed, and treatment-related. Acute complications include associated osteochondral fracture and loose bodies, which may present with persistent swelling, mechanical catching, locking, or failure of symptoms to improve as expected. These injuries matter because they can accelerate articular cartilage degeneration and contribute to chronic patellofemoral pain if not recognized and appropriately managed. Recurrence is a major complication in its own right, as repeated instability episodes increase the likelihood of chondral injury, persistent apprehension, and functional limitation. Over the longer term, degenerative patellofemoral arthritis can develop, particularly in individuals with recurrent dislocation or untreated structural malalignment that sustains abnormal joint loading. Surgical care introduces additional complication profiles. General operative risks include infection, neurovascular injury, and thromboembolic events such as deep vein thrombosis or pulmonary embolism. Complications specific to MPFL procedures include saphenous nerve neuritis, which may present as medial knee paresthesia or neuropathic pain, and graft or repair failure leading to recurrent instability or rupture. After tibial tubercle osteotomy, patients commonly report pain over hardware or screw sites, and some experience difficulty kneeling comfortably due to local tenderness and altered tibial tubercle contour. There is also a recognized risk of proximal tibial fracture, reflecting the structural stress created by the osteotomy and fixation [11]. Even after anatomically tailored stabilization, a residual risk of recurrent lateral patellar instability persists, particularly when multiple predisposing factors coexist or when neuromuscular control remains suboptimal. These potential complications reinforce the need for careful patient selection, comprehensive preoperative imaging when surgery is considered, and disciplined postoperative rehabilitation. Monitoring for worsening pain, recurrent effusion, mechanical symptoms, neurovascular changes, and signs of infection remains essential in both operative and nonoperative pathways [10][11].

Postoperative and Rehabilitation Care

Postoperative rehabilitation is procedure-dependent and must align with both tissue healing timelines and biomechanical goals. Recovery after an isolated lateral release is generally more rapid, with earlier return of motion and functional activity compared to bony realignment procedures. In contrast, osteotomies require more prolonged protection, gradual weight-bearing progression, and careful strengthening to ensure bony union and avoid fixation stress. Across surgical types, there is typically an initial period of immobilization or bracing to protect repairs or reconstructions, followed by staged increases in range of motion, quadriceps activation, and functional loading. Rehabilitation commonly extends from six months to a year in patients undergoing substantial stabilization or bony realignment, particularly those aiming to return to pivoting sports or physically demanding work. Physiotherapy remains vital after immobilization because quadriceps inhibition, gait compensations, and proprioceptive deficits can persist and may undermine surgical success if not corrected. Core and hip strengthening, neuromuscular re-education, landing and cutting mechanics retraining, and progressive sport-specific conditioning are typically integrated as the patient advances. Return-to-sport decisions should be criterion-based, emphasizing strength symmetry, movement quality, absence of effusion, and confidence under dynamic tasks rather than time alone [11].

Patient Education

Effective deterrence of recurrence relies on aligning patient behavior with the biology of healing and the realities of neuromuscular rehabilitation. Patients should be strongly discouraged from returning prematurely to contact or pivoting sports before completing sufficient physiotherapy to restore quadriceps strength, hip and core control, and dynamic knee stability. Early return while medial soft tissues are still healing and neuromuscular control remains impaired increases recurrence risk and can exacerbate cartilage injury. During early rehabilitation, slip-on braces or stabilizing sleeves may be helpful to improve confidence and reduce lateral translation tendencies, particularly in higher-risk activities, though braces should be framed as adjuncts rather than substitutes for strengthening and movement retraining. Education should emphasize adherence to a structured physiotherapy plan after an initial dislocation, as consistent participation can reduce the likelihood of further instability and may avert the need for operative intervention. Patients should also be taught practical warning signs that warrant reevaluation, such as recurrent giving-way episodes, persistent swelling, locking or catching, or escalating anterior knee pain. Clear education about staged rehabilitation goals and expected timelines can improve compliance and reduce frustration, which is particularly important for adolescents and athletes who may feel pressure to return quickly [11].

Other Issues

Establishing the etiology of the dislocation is fundamental, especially in recurrent dislocators, because the dominant driver—soft-tissue insufficiency versus bony malalignment—can significantly alter the management plan and the likelihood of success with conservative care. Many acute dislocations can be managed conservatively with bracing and physiotherapy emphasizing quadriceps, VMO, and core strengthening, provided there is no evidence of loose bodies or significant intra-articular damage. Clinicians should maintain a high index of suspicion in patients presenting with a large hemarthrosis and normal radiographs, as a sizeable osteochondral fragment can be occult on plain films and may require early fixation if displaced. When surgery is indicated, procedures are typically individualized to the patient's anatomical profile, and most bony realignment options are not appropriate in patients with open physes. Finally, even after optimal surgical stabilization, a small but meaningful recurrence risk remains, making long-term neuromuscular conditioning and movement quality central to durable outcomes [3][7][9].

Enhancing Healthcare Team Outcomes

Optimal care for patellar dislocation depends on coordinated interprofessional collaboration, particularly in the early phase when diagnostic clarity and timely imaging determine whether serious intra-articular injuries are missed. Close liaison between emergency medicine clinicians, orthopedic teams, radiology services, and physiotherapists supports safe reduction, appropriate post-reduction assessment, and efficient escalation to CT or MRI when needed to rule out osteochondral fractures, loose bodies, or significant MPFL injury. Once a patient is directed into a nonoperative pathway, physiotherapists become central to outcome optimization, as high-quality rehabilitation may be the decisive factor in preventing recurrence and restoring function. Communication among team members—sharing imaging findings, documenting stability assessments, and aligning rehabilitation restrictions with injury severity—reduces fragmentation of care and improves patient confidence. Interprofessional teamwork therefore enhances both safety and functional recovery, ensuring that management is not merely reactive to the acute episode but proactive in preventing long-term patellofemoral disability [10][11].

Conclusion:

Patellar dislocation represents a complex interplay of traumatic forces, anatomical predispositions, and neuromuscular deficits. Successful management requires a staged, patient-specific approach. For uncomplicated first-time dislocations, conservative care remains the cornerstone, emphasizing early mobilization, quadriceps activation—particularly the vastus medialis obliquus—and hip/core strengthening to restore dynamic stability. Proprioceptive retraining and movement quality correction are essential to reduce recurrence risk. Surgical intervention should be reserved for cases with osteochondral injury, recurrent instability, or significant structural malalignment. Procedures such as MPFL reconstruction, tibial tubercle osteotomy, and trochleoplasty address both soft tissue insufficiency and bony abnormalities but require careful patient selection and postoperative rehabilitation to ensure durable outcomes. Long-term prognosis hinges on rigorous physiotherapy, patient education, and adherence to staged return-to-sport criteria. Interprofessional collaboration among emergency clinicians, orthopedic surgeons, radiologists, and physiotherapists is vital to optimize care and prevent chronic patellofemoral dysfunction. Ultimately, early recognition, comprehensive imaging, and biomechanically informed rehabilitation strategies are key to restoring function and minimizing morbidity.

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