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Non-operative Management of Acute Knee Injuries

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Abstract

Purpose of Review Acute knee injuries are commonly encountered in both the clinical and sideline setting and may be treated operatively or non-operatively. This article describes an evidence-based approach to non-operative acute knee injury. This includes history, physical exam, imaging, and initial management. In addition, the non-operative management of three such injuries—ligament injury, meniscus injury, and patellar dislocation injury—will be discussed via a case-based practical approach.

Recent Findings Aside from grade III ACL tears, most acute knee ligament injuries, especially in the absence of other concurrent injuries, can be treated non-operatively. There is new evidence that acute traumatic meniscus tears in those younger than 40 can be successfully treated non-operatively and can do equally, as well as those that undergo surgery, at 1 year out from injury. Based on the current literature, a short period of knee bracing in extension with progression to weightbearing to tolerance is recommended after initial patellar dislocation.

Summary Many of the most common acute knee injuries, including MCL tears, meniscus tears, and patellar dislocations, can be managed non-operatively. A detailed systemic approach to initial evaluation, including pertinent history, physical exam, and appropriate imaging, is essential and complementary to the subsequent non-operative treatment algorithm.

Keywords Meniscus tear · Patellar instability · Rehabilitation · Ligamentous knee injury (ACL, MCL, PCL, LCL)

Introduction

Acute knee injuries are commonly seen on the sideline and in the clinical setting, limiting function, mobility, and quality of life. Acute knee injuries account for more than 625,000 emergency department (ED) visits with an incidence of 229 knee injuries per 100,000 ED visits and this continues to rise [1, 2]. Participation in sport and recreational activities is the most common cause of knee injury, with individuals under 25 years of age more likely to sustain injuries during athletics [1]. In fact, an estimated 2.5 million sports-related knee injuries occur annually among adolescents in the USA [1, 3]. Despite an abundance of research in injury prevention, acute knee injuries remain a common complaint seen by athletic trainers, physical therapists, and physicians [2].

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Although there are many acute knee injuries that require surgical intervention, many can be treated non-operatively. The aim of this article is to provide a straightforward approach to the evaluation of non-operative acute knee injuries, with a focus on recent evidence-based findings as they related to management and treatment. Some of the most common acute non-operative knee injuries will be explored via three clinical vignettes, allowing for a more fluid, real-to-life approach.

Anatomy

The knee is a complex hinge joint consisting of bone, cartilage, tendons, and ligamentous structures. As with any musculoskeletal injury, an understanding of the anatomy is vital to understating the pathophysiology and mechanism of injury. It is a weightbearing joint that is exposed to high-intensity rotational, explosive movement making it vulnerable to injury. A detailed overview of knee anatomy is beyond the scope of this article. Figure 1 outlines the major anatomical structures discussed in this article that comprise the majority of injuries.

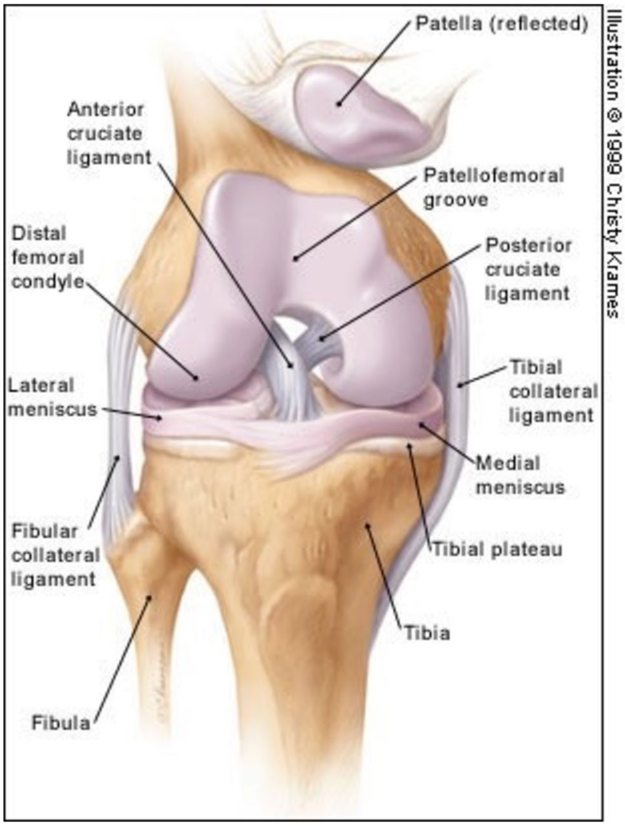

Fig. 1 Adapted from Bunt et al. [4]

History

A systematic approach to the injury history is vital for a thorough evaluation process. Key aspects include timing of injury, mechanism of injury, location of pain, presence and onset of swelling/effusion, and mechanical symptoms [4, 5]. Table 1 describes common findings in acute knee injury and what these findings may indicate diagnostically. Technology can aid in the evaluation of injuries via recorded video footage that may provide valuable information on mechanism of injury, situational pattern, and biomechanical analysis [6].

Physical Examination

A systematic examination of the knee is important to further investigate the information gleaned from the history and to provide objective data. The examination should include inspection, palpation, range of motion, strength evaluation, neurovascular assessment, and special (provocative) tests [4]. The examiner should be aware that pain and swelling may limit the examination in the acute setting, requiring serial exams once both have subsided [9]. Table 2 describes the knee examination including descriptions of the various exam maneuvers. It is recommended that the contralateral uninjured side be also examined for comparison.

Table 1 Common findings in acute knee injury and what these findings may indicate diagnostically [5, 7, 8•]

History	
Timing of injury	Depending on when the injury occurred, severity of effusion/swelling and pain can vary based on timing. Persisting pain/swelling after an injury can point to a more significant injury requiring more time off
Mechanism of injury	• Type of activity/sport • Direct or indirect trauma (contact/non-contact)—with direct trauma elevated fracture concern, indirect trauma concern of ligamentous injury • Cutting or pivoting injury—“position of no return” concerning for ACL injury.* • Sensation of dislocation or shifting—patellar subluxation/dislocation • Feeling or hearing a “pop”—ACL • Inability to bear weight • Extended or flexed knee—ACL (hyperextension) or PCL (trauma with knee in flexed position) • Valgus or varus position—MCL (valgus), LCL (varus)
Location of pain	• Anterior—patella, patellar/quadriceps tendon, bursa • Medial/lateral—medial collateral ligament (MCL), lateral collateral ligament (LCL), joint line tenderness (possibly indicating meniscus pathology) • Posterior—hamstring, posterior lateral corner, Baker’s cyst
Presence/onset of swelling/effusion	• Early onset—consider ACL/PCL tear, fracture, patellar/knee dislocation • Delayed onset—meniscus tear, loose body
Mechanical symptoms	• Locking, catching, clicking sensation—meniscus, loose body • Instability (giving out/way)—ligament injury, patellar instability

Legend: *ACL*, anterior cruciate ligament; *MCL*, medial cruciate ligament; *LCL*, lateral cruciate ligament; *PCL*, posterior cruciate ligament

*[4] created the concept of “position of no return” to describe the combined motions of hip adduction and internal rotation, external rotation of the tibia relative to the femur, internal rotation of the tibia on the foot, and forefoot pronation, often leading to an ACL injury

Table 2 Physical examination for acute knee injury [4, 9, 10, 14]

Inspection	Erythema, swelling, bruising, deformity (e.g., varus, valgus), asymmetry, atrophy	
Palpation	Soft tissue and bony landmarks, warmth, effusion	
Range of motion	Normal: extension 0 to − 10°, flexion 135°, assess patellar tracking (“J” sign) [10]	
Strength testing	Graded 0–5 for flexion and extension	
Neurovascular assessment	Sensation to light touch, deep tendon reflexes (graded 0–4 +) of Achilles and patellar tendon, palpation of popliteal, dorsalis pedis, and posterior tibialis pulses (graded 0–4 +)	
	Special (provocative) tests	
Test	Assess for	Description
Moving patellar apprehension test	Patellar stability/subluxation [11, 12]	Part 1: Knee at 90° applying lateral pressure to patella as knee brought into extension, positive test if patient reports apprehension@Part 2: Knee in extension applying medial pressure to the patella bringing it to 90° of flexion, less or absence of apprehension is reported by patient, confirming positive test
Lachman test	Most commonly used technique for ACL integrity [11, 13]	Patient supine, leg externally rotated, knee flexed 20–30°, stabilize femur with one hand applying pressure to the back of the knee with other hand, positive test results in anterior translation with no end point/soft end point
Posterior drawer test	PCL injury	Patient supine with knee flexed to 90°, assess for posterior “sag” sign, then with foot fixed on table, examiner holds thumbs at proximal tibia and pushes posteriorly assessing for posterior displacement of tibia
Gravity “sag” sign near extension test	PCL injury	Patient supine with distal femur on a 15 cm support and heel resting on table, knee at 20° flexion, inspect for a concave anterior contour
Varus stress test	LCL injury	Patient supine one hand buttresses the medial knee while the other hand applies medial pressure to the distal leg. Increased laxity and/or no LCL end point is a positive finding. Test should be done with knee in full extension and in 30° of flexion
Valgus stress test	MCL injury	Patient supine one hand buttresses the lateral knee while the other hand applies lateral pressure to the distal leg. Increased laxity and/or no MCL end point is a positive finding. Test should be done with knee in full extension and in 30°of flexion
Joint line tenderness test	Meniscal injury	Palpate along both lateral and medial joint line (good sensitivity, poor specificity) [14]
McMurray test	Meniscal injury	With one hand at knee joint and the other at the heel, knee is flexed to 90°, externally rotated and varus force applied to the joint while going into maximum flexion. Next, transition to internal rotation and *valgus* force while the knee is extended from the fully flexed position. This process is then reversed and typically repeated several times making sure to cover as much surface area of the knee. Positive test is when pain and/or popping is elicited. Sometimes popping is felt as well
Thessaly test	Meniscus injury	While examiner supports the patient by holding outstretched hands, patient stands flatfooted on the floor and then rotates knee and body internally and externally three times, keeping the knee in slight flexion (20°). Positive if pain is experienced along medial or lateral joint line [15]

Imaging

Various imaging modalities provide valuable adjuncts in the evaluation of acute knee injury and help complete the clinical picture.

Radiography

Standard radiographs are the initial test of choice for imaging acute knee injuries. Radiographs should be performed with the patient weightbearing when possible and include anterior-posterior (AP), lateral, sunrise or merchant views, and tunnel views [16]. The Ottawa Knee Rule (sensitivity of 97% and specificity 27%) and the Pittsburgh Knee Rule (sensitivity of 99% and specificity of 60%) are useful tools clinicians can use to decide on appropriateness of obtaining radiographs [17]. See Table 3 for description of the rules.

Ultrasonography

Ultrasonography (US) in the clinical setting is a viable diagnostic tool that continues to gain popularity in its use. US has many benefits: easy availability, portability, low cost, high spatial resolution, dynamic imaging, and ability to guide percutaneous procedures [18]. US is effective for evaluating injuries of the quadriceps and patellar tendons, MCL/LCL in as well as assessing neurovascular structures in real time, at the bedside, and on the sideline [18]. Recent studies demonstrate high sensitivity and specificity for diagnosis of ACL tears with ultrasound, but is user and protocol dependent [19].

Magnetic Resonance Imaging (MRI)

MRI is considered the gold standard for non-surgical evaluation of acute knee injury. An MRI should be ordered to confirm what is suspected based on history and physical exam. An MRI is very useful in the evaluation of osteochondral injuries, cruciate ligament tears, meniscus tears, and patellofemoral translation [20]. Typically, an MRI without contrast is adequate to assess an acute knee injury. When MRI is contraindicated, CT arthrography with intra-articular contrast can been used to evaluate patients with high degree of sensitivity [16].

Initial Treatment and Management

Regardless of the acute knee injury encountered, initial treatment and management include protection, rest, ice, compression, and elevation (RICE) [24]. The use of crutches to aid in non-weightbearing or protected weightbearing may be useful in addition to bracing, such as with a hinged knee brace, patellar stabilizer brace, or knee immobilizer. Non-steroidal anti-inflammatory (NSAIDs) medications for pain relief can also be of use initially [24].

A Case-Based Approach to Ligamentous Knee Injury

A 17-year-old female presents with an acute non-contact left knee injury that occurred during a soccer match the day prior. While pivoting at her knee with her left foot planted, she heard and felt "pop" in her knee, which was followed by severe pain and swelling. She left the match due to her pain and had difficulty weightbearing. Radiographs performed in the immediate care showed no acute fracture.

On presentation at the office, soft tissue swelling was noted on examination. Palpation revealed tenderness along the medial joint line, as well as guarding. The ligamentous examination showed:

- Pain and 1 + (3–5 mm) medial joint gapping during valgus stress testing at 30° and 0° of flexion (see Table 4 for suggested clinical grading of MCL injury).
- Varus stress testing demonstrates a lack of pain or lateral joint line opening.
- Posterior drawer test identified no laxity or posterior displacement of the tibia.
- There was no laxity or anterior displacement of the tibia noted during Lachman's or anterior drawer testing.

In this case, the clinical examination raises suspicion of an MCL injury; the absence of other abnormal findings in the other tests suggests the integrity of the lateral collateral ligament (LCL), anterior cruciate ligament (ACL), and posterior cruciate ligament (PCL) [25].

The clinical exam is vital in the evaluation of MCL injury. Despite the physical exam findings, clinical examination alone might not capture the complexity of these injuries. An MRI without contrast may provide more clarity as to the extent of injury. Although MRI injury grading of the MCL has been shown to correlate at around a 92% rate with the clinical exam grading, sometimes there is a discrepancy due to the clinical subjectivity of the clinical exam [26–28, 29•]. Due to the pain and large effusion that often accompanies these injuries, your physical examination may have reduced sensitivity.

Management decisions for these injuries are primarily influenced by the patient's age, ligament injured, severity of the injury, and the patient's activity level.

Initial treatment of these injuries begins with conservative measures irrespective of the ligament injured. Measures such as RICE are beneficial, as are NSAIDs medications for

Table 3 Clinical rules for obtaining radiographs after acute knee injury [17, 21–23]

Ottawa Knee Rule	• Age > 55 years • Tenderness at the head of the fibula • Isolated tenderness of the patella • Inability to flex knee to 90° Inability to bear weight (defined as an inability to take four steps, i.e., two steps on each leg, regardless of limping) immediately and at presentation to the emergency department One positive finding is an indication to obtain radiographs
Pittsburgh Knee Rule	Blunt trauma or a fall PLUS either of the following: 1. Age < 12 or > 50 years; 2. Inability to bear weight for 4 steps immediately after injury or in the ER

pain management. Protected weightbearing with crutches is often initially necessary [30].

There is consistent evidence that isolated grades I and II injuries and most uncomplicated grade III injuries of the MCL, LCL, and PCL can be managed non-operatively with a hinged knee brace and physical therapy. Rehabilitation of MCL and LCL injuries should focus on restoring range of motion, strength, and proprioception [31–37]. These injuries have a good prognosis, with most patients returning to sport without instability or functional limitations. Rehabilitation of PCL injuries should focus on quadriceps strengthening and neuromuscular training [38]. Research has shown that even in the absence of surgery, many patients can achieve a satisfactory outcome with good knee function [39].

For a detailed recovery timeline for collateral ligament and PCL injuries based on current evidence, please refer to Table 5.

Non-operative management is appropriate for isolated grade I injuries of the ACL and most grade II injuries. Non-operative management of grade III ACL injuries may be an option for patients with a low activity level or in patients who are willing to modify their lifestyle and avoid high-demand sports. In addition to a functional hinged knee brace, a rehabilitation program focusing on quadriceps and hamstring strengthening, neuromuscular control, and agility training is indicated in these patients [40–42]. There remains a long-term risk for secondary meniscal and chondral injuries due to the inherent instability of an ACL-deficient knee [43]. Figure 2 outlines a typical recovery timeline for these injuries with non-operative and operative management [44–46].

Non-operative Treatment of an Acute Meniscus Tear in a Young Adult

Case Presentation

A 32-year-old female, healthy, and active soccer player presents with a chief complaint of knee pain following an injury during a game. She suddenly felt a sharp pain in the lateral aspect of her knee while attempting to pivot and change direction quickly. She was unable to keep playing and noted immediate swelling and limited range of motion. The patient has no prior history of knee injuries. On examination, the patient appears uncomfortable and is limping. The affected knee is visibly swollen, and there is tenderness over the lateral joint line to palpation. Range of motion is limited, with full extension but limited flexion, with a joint effusion. No gross instability is noted during ligamentous testing. Thessaly and McMurray's tests are positive for pain along the lateral joint line. The clinical picture, mechanism of injury, physical examination findings, and positive special tests raise the clinical suspicion of an acute lateral meniscus injury.

The incidence of traumatic meniscus tears in stable knees varies across different populations. In the general population, it is estimated that approximately 6% of acutely injured knees suffer a meniscus tear, with the medial meniscus accounting for about 75% of these cases [50, 51]. The annual occurrence

Table 4 Physical examination findings for grading MCL severity

Grade 1 (strain of ligament)	Valgus stress of the knee at 0° and 30° of flexion produces pain only, no gapping
Grade 2 (partial tear of ligament)	Valgus stress of the knee at 30° causes pain and gapping, but pain only at 0°
Grade 3 (complete tear of ligament)	Valgus stress of the knee at 0° and 30° of flexion produces gapping and pain Gapping grading: 1 +: 3–5 mm 2 +: 6–10 mm 3 +: > 10 mm

of acute meniscus injuries per 1000 individuals ranges from 0.5 to 0.7 [51]. Males are more commonly affected, with a mean annual incidence rate of 0.9 per 1000, while females have an incidence rate of 0.4 per 1000 per year [52].

Among athletes who sustain acute knee trauma and develop hemarthrosis, it is reported that approximately 15% of cases result in isolated meniscus tears [53]. It is worth mentioning that these numbers are estimations and may vary in different study populations.

In our case, the most common presentation of an acute meniscal tear was observed. Patients may also experience locking or catching sensations indicating a displaced or flipped meniscus. During a knee exam, patients with associated ligamentous injuries may show signs of instability. Meniscal tears are classified based on type, location, trauma, and size [54]. Traumatic and degenerative meniscal tears have different pathophysiology and management algorithms. Acute meniscal tears are mostly commonly longitudinal, followed by radial and root tears. Longitudinal tears may progress to bucket-handle tears, leading to an unstable meniscus. Horizontal meniscus tears are primarily thought to be related to a degenerative process.

Ultrasound can be accurate and extremely helpful in diagnosing lateral meniscus lesions and should be considered a

Table 5 Return to sport for acute ligamentous knee injuries [31–33, 44–49]

	Non-operative (conservative) management	Operative management (rare, usually reserved for high grade or complex injuries)
MCL and LCL	Grade I: 2–4 weeks Grade II: 4–6 weeks Grade III: 6–8 weeks	3–6 months
PCL	Grade I: 4–6 weeks Grade II: 6–8 weeks Grade III: 8–12 weeks	6–9 months
ACL	Dependent on functional recovery, often several months to a year	9–12 months (this timeline can vary widely depending on various factors, including the specifics of the surgical technique used and the individual's response to rehabilitation)

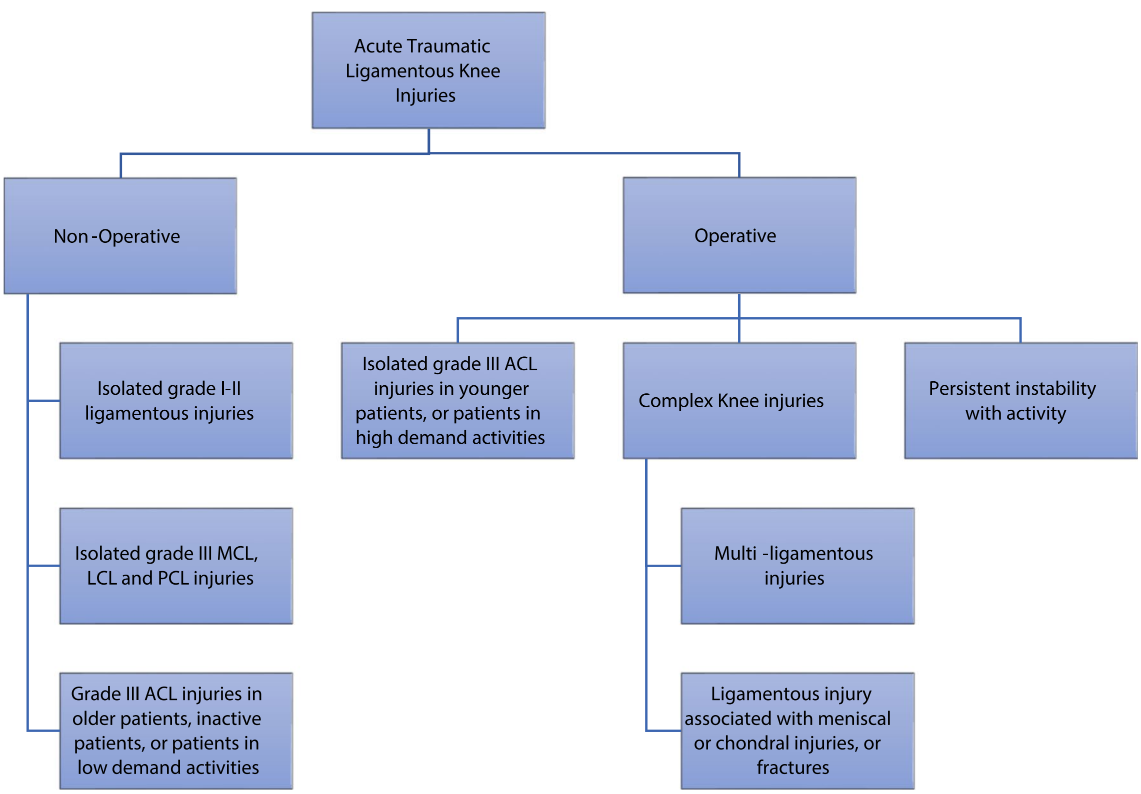

Fig. 2 Criteria for non-operative vs operative management of acute ligamentous knee injuries

clinical tool for diagnosing knee pathology. MRI continues to be a useful preoperative tool with high accuracy for discriminating meniscus tears and other pathologies [55–57].

Options for meniscal tear management broadly fall into two categories: non-operative and operative management. Meniscectomy, partial or total; meniscus repair; and meniscus transplantation, either meniscus scaffold or allograft transplantation, are examples of surgical treatment. With limited evidence directly comparing each option, optimal management strategies can be complex. Decision-making requires a thorough assessment of patient factors, tear characteristics, and patient's treatment preference [58].

Non-operative management is helpful as the initial treatment of acute knee trauma. The "PRICE" (protection, RICE) protocol is applied in this situation. Non-operative management often involves anti-inflammatory and analgesic medications, bracing, gentle range of motion exercises, and quadriceps strengthening [59]. Numerous studies continue to show a great benefit of physical therapy. Yet, arthroscopic knee procedures remain the most common orthopedic surgeries, with approximately 1 million performed annually in the USA [60, 61].

Many types of meniscal tears may not require surgical treatment. Those include small (≤ 10 mm) [62] stable tears, peripheral tears in a well-vascularized zone, and asymptomatic tears found incidentally on MRIs and during arthroscopy. Current evidence suggests non-operative treatment for stable acute lateral meniscus tears and those incidentally found during ACL reconstruction surgeries. Meniscus tears left in situ during ACL reconstruction have a low reoperation rate (from 0 to 30%) [63]. When compared to medial meniscus tears, lateral meniscus tears (especially those measuring less than 10 mm) have lower reoperation rates when left in situ [64, 65].

If mechanical symptoms are absent, the patient may begin treatment with an individualized physical therapy program and delay surgical treatment for persistent symptoms. Recent studies in traumatic meniscal tears in young patients with stable non-osteoarthritic knees showed no significant difference in clinically relevant improvements [61, 66••, 67••]. In one study, 74% of patients with meniscal tears did not undergo surgery within 1 year [61]. This same study involved young active adults, with the majority having tears that could be linked to a traumatic incident (74%). These recent findings can aid in the discussion with younger patients and help with shared decision-making, so as to not necessarily favor surgery even in cases of traumatic meniscus tear. Therefore, physical therapy may be offered as a viable alternative to surgery for patients with stable meniscal tears, even in younger patients, which had not been shown in prior studies [61, 66••, 67••]. Figure 3 depicts the decision-making process for the optimal management of meniscal injuries.

With increasing knowledge of the importance of the meniscus and interest in meniscal preservation, approximately 35% of meniscal tears are currently considered repairable [68]. These include longitudinal, radial, root, and ramp tears. With high suspicion for a repairable lesion, referral should not be delayed as a repair completed as early as possible appears to produce a better clinical outcome, including a decreased failure rate [69, 70].

Nonobstructive tears in the well-vascularized zone have the potential to heal. With observed meniscal repair failure rate within 7–48% [71], researchers started to evaluate the potential use of orthobiologics as a standalone treatment or an augmentation during arthroscopy and meniscal repairs. A small number of studies on orthobiologics have been performed up to date. Findings indicated that PRP augmentation in meniscus repair significantly improves the rate of meniscus healing. PRP was found to improve the chances of meniscus healing by over six times [72]. The use of orthobiologics in managing acute meniscal tears has shown promise, although research for their use is limited and further studies are needed.

There is still controversy and uncertainty about the ideal management of meniscal tears, including which ones should be repaired and methods of assessment post-repair. More recent randomized control studies provide evidence-based support for non-operative management of meniscus tears, even in the younger population [61, 66••, 67••]. There is still a need for both more basic science and clinical research to identify the best practice when treating different meniscal pathologies [73–75].

Case-Based Management of Acute Patellar Dislocation

A 15-year-old male basketball player complains of acute right knee pain and swelling after his knee "popped out of place" after twisting his right knee with his leg planted during a basketball game yesterday. He fell to the ground with immediate pain and after he straightened his knee, it "went back into place." He was able to bear weight after the injury but could not continue to play due to pain and inability to fully extend his knee.

He presents to your office with a large joint effusion and tenderness to palpation of the medial patellar facet. His ROM is from 10 to 110, pain with patellar grind, and a positive patellar apprehension test. He has a negative McMurray's, is negative for pain and laxity with valgus and varus stress, and has negative Lachman's and posterior drawer tests.

Radiographs of the right knee (AP, lateral, oblique, merchant) demonstrate a small joint effusion with normal alignment of patellofemoral joint. No acute fracture or osteochondral defects.

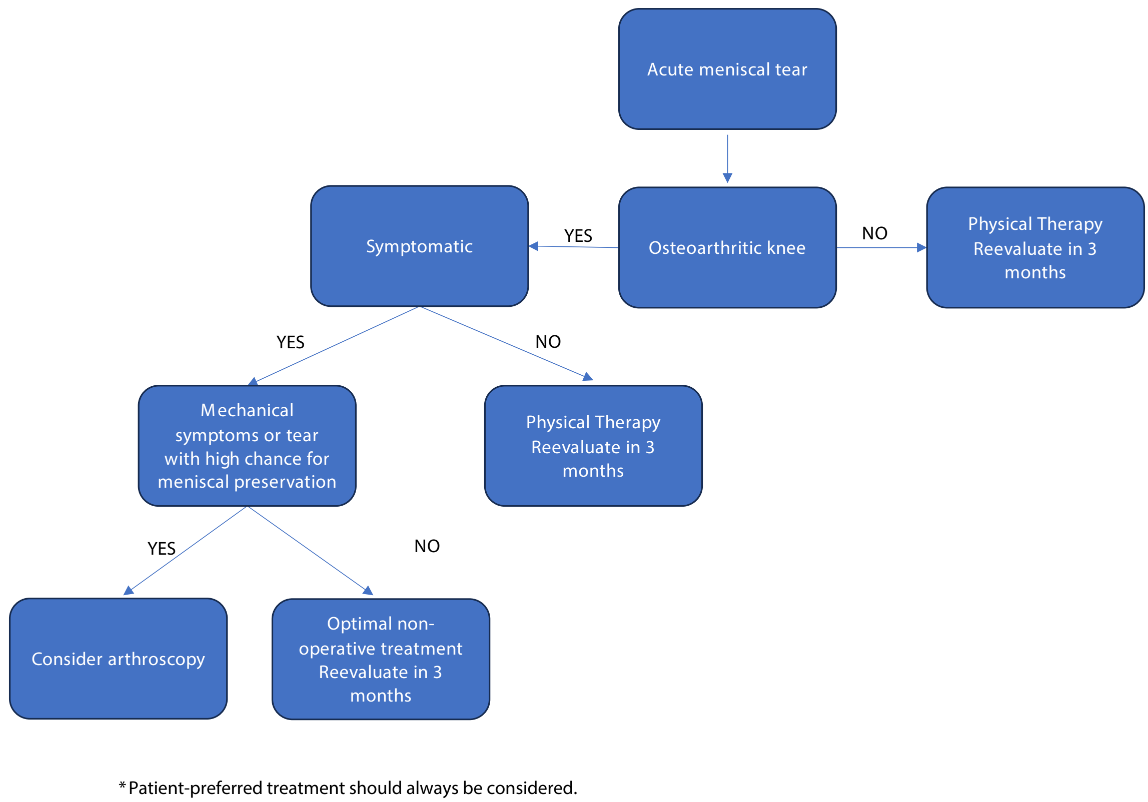

Fig. 3 Management of acute meniscal tear

Based on the history and physical examination findings, our suspicion is that he suffered an acute patellar dislocation.

Patellar dislocations account for about 2–3% of all knee injuries [76].

The average incidence of patellar dislocation is 5.8 per 100,000 with the highest incidence in the 10–17-year age group [77, 78]. Most episodes of patellar dislocation occur from a non-contact injury after flexion-rotation to the knee which results in lateral dislocation of the patella across the lateral femoral condyle [79].

A thorough history and physical examination should be performed during initial evaluation to confirm a patellar dislocation and to rule out other injuries such as an ACL or MCL tear that can involve a similar mechanism of injury.

Initial radiographic evaluation of the patient should include an AP extension weightbearing view, bilateral merchant or sunrise view, 45° flexion weightbearing view, and 30° flexion lateral view to look at patellar location and an osteochondral fragment. A merchant or sunrise view is key as it can show an osteochondral fracture of the medial facet of the patella without lateral subluxation of the patella [80].

If an osteochondral fracture is present, an MRI should be obtained to further examine the extent of injury. Also, if a hemarthrosis is present, the likelihood of an osteochondral fracture increases, and an MRI should be considered for further evaluation. MRI is a reliable modality that demonstrates osteochondral injuries in a first-time patellar dislocation [81, 82].

MRI is also important to examine the chondral surfaces of the patellofemoral joint and determine the extent of damage to the medial patellofemoral ligament (MPFL) which is the primary restraint to lateral subluxation of the patella in early flexion [83].

MRI studies demonstrate that articular cartilage damage can occur in as many as 76% of patients after a single patellar dislocation [84, 85].

Treatment for first-time patellar dislocation is still mixed and controversial. Both non-operative and operative treatment can be chosen after a first-time patellar dislocation, but there is not a lot of published literature to fully support one method over the other.

Individuals treated non-operatively after a first-time patellar dislocation have from a 20 to 60% risk of dislocating again with a symptoms rate of recurrent instability greater than 50% [86, 87]. This has led to an increase in initial surgical repair and reconstruction of the medial patellar stabilizers [88–91].

However, non-operative management is still the first-line treatment for first-time patellar dislocations and instability [92, 93]. Most first-time patellar dislocations are treated non-operatively except for those associated with displaced patellar or lateral femoral condylar osteochondral fractures (> 5 mm) and/or complete VMO avulsion of the patellar insertion site [87, 94]. If not treated appropriately, an episode of patellar dislocation can lead to recurrent episodes of dislocation, knee instability, and degeneration of the patellofemoral joint [95, 96].

A recently published systematic review compared conservative and surgical treatments for acute patellar dislocation in children and adolescents revealed no significant differences in clinical outcomes between conservative and surgical treatment [97•].

Conservative management should provide functional recovery and minimize the rate of recurrent patellar dislocation [98, 99]. Restoring the function of the MPFL is key in the treatment of patellar dislocation as the MPFL serves as the primary restraint against lateral patellar translation [95, 100].

Traditionally, non-operative treatment consists of initial immobilization/bracing, acute pain management, and rehabilitation. However, the literature is sparse in what specific protocol should be followed [101].

There is conflicting evidence of duration of bracing and whether it is beneficial in treatment for an acute patellar dislocation.

A recently published survey of orthopedic surgeons recommended the use of a knee brace during the first 4 weeks with weightbearing to tolerance, with ROM from full extension to 30° of flexion during the first 15 days, and up to 60° of flexion for an additional 15 days [102].

A study by Mäenpää and Lehto studied the effects of patellar bandage or brace, posterior splint, or plaster cast for treatment of patellar dislocation. There was a threefold higher risk of re-dislocation in the group treated with immediate mobilization and restriction in motion was more frequent in the cast group [103].

However, a recently published randomized control trial by Honkonen et al. compared the efficacy of a patella stabilizing, motion restricting knee brace versus a neoprene non-hinged knee brace for the treatment of first-time traumatic patellar dislocation. The results of the study showed that knee immobilization was associated with quadriceps muscle atrophy, more restricted knee ROM, and worse functional outcomes in the first 6 months of the study. There was no statistical difference in re-dislocation rate between the two groups. Immobilization in extension may help the medial structures including the MPFL to heal but can cause stiffness of the knee and weakness of the quadriceps muscle [104•].

Based on the current literature, a short period of knee bracing in extension with progression to weightbearing to tolerance is recommended after initial patellar dislocation [105].

The objective of a rehabilitation program is to be able to safely and effectively return back to sports with full functional recovery. Rehabilitation protocols after primary patellar dislocation consist of strengthening the quadriceps (particularly the vastus medialis muscle) and hamstring, closed kinetic chain exercises, and increasing proprioception and balance [106–109].

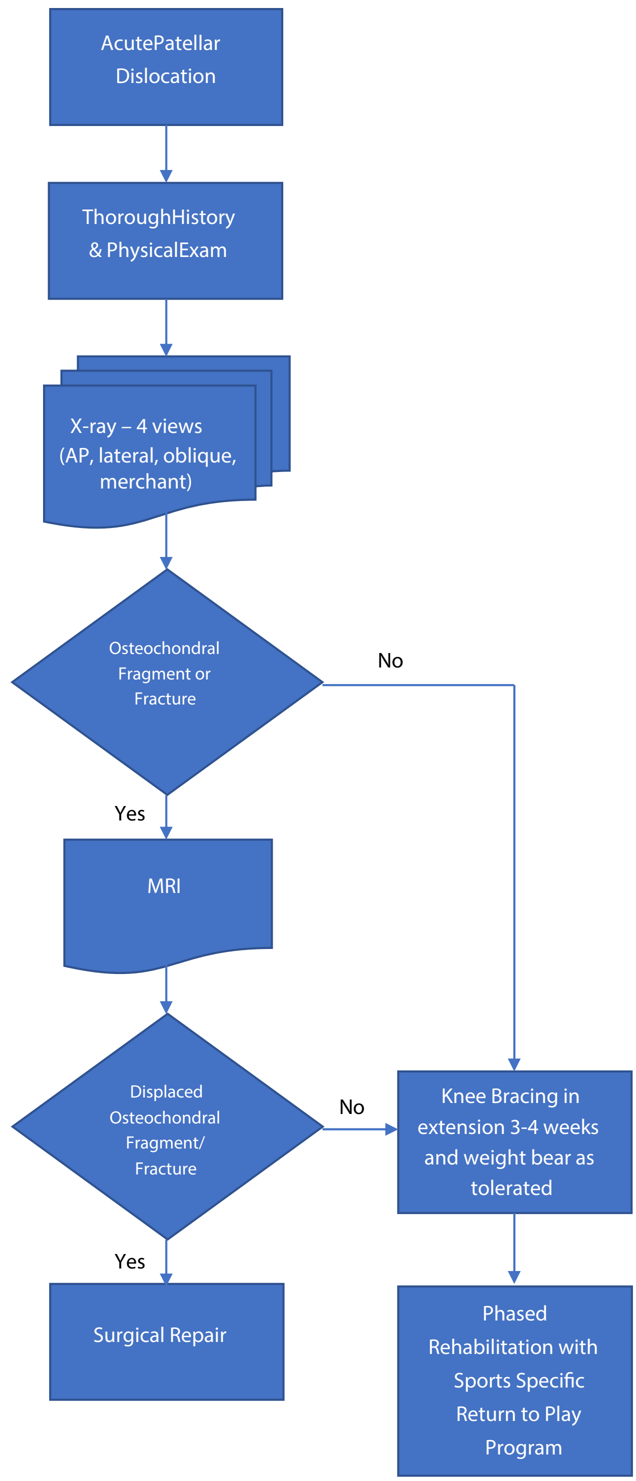

Fig. 4 Management of acute patellar dislocation

Strengthening the quadriceps and VMO is primarily emphasized in treatment, but it is also important to target the hip abductors and knee and hip extensors in rehabilitation [110, 111••].

The program should be performed in phases which include resolution of acute inflammation, restoration of knee range of motion, recovery of neuromuscular strength and motor patterns, and finally sports-specific exercises with return back to sport [112]. There is no published data that tells us how long it takes to return to sports after conservative management. However, with a functional progression back to sport, the risk of recurrent patellar dislocation can be reduced with the goal to be able to return back safely.

The management of acute patellar dislocation continues to evolve. However, conservative management is the standard of care for treatment of a primary patellar dislocation without osteochondral fracture. Figure 4 is a flowchart for management of acute patellar dislocation.

Conclusion

The initial overall evaluation and management of acute knee injury continues to include a thorough history of present illness and physical examination, paired with appropriate imaging. Ultrasound has become a powerful tool to be used both at bed side and on the field of play. Non-operative treatment and management is still first-line treatment for MCL injuries and patellar dislocations. There is new evidence that many carefully selected patients with traumatic meniscus tears can also be successfully treated non-operatively. Continued larger cohort, longitudinal studies will continue to provide valuable information for management of acute knee injuries.

Declarations

Conflict of Interest Shaheen Jadidi declares that he has no conflict of interest.
Aaron Lee declares that he has no conflict of interest.
Eliza Pierko declares that he has no conflict of interest.
Haemi Choi declares that he has no conflict of interest.
Nathaniel S. Jones declares that he has no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

References

Papers of particular interest, published recently, have been highlighted as:
- • Of importance
- •• Of major importance

1. Gage BE, et al. Epidemiology of 6.6 million knee injuries presenting to United States emergency departments from 1999 through 2008. Acad Emerg Med. 2012;19(4):378–85.
2. Gray AM, Buford WL. Incidence of patients with knee strain and sprain occurring at sports or recreation venues and presenting to United States emergency departments. J Athl Train. 2015;50(11):1190–8.
3. Caine D, Maffulli N, Caine C. Epidemiology of injury in child and adolescent sports: injury rates, risk factors, and prevention. Clin Sports Med. 2008;27(1):19–50, vii.
4. Bunt CW, Jonas CE, Chang JG. Knee pain in adults and adolescents: the initial evaluation. Am Fam Physician. 2018;98(9):576–85.
5. Davenport M, Oczypok MP. Knee and leg injuries. Emerg Med Clin North Am. 2020;38(1):143–65.
6. Della Villa F, et al. Systematic video analysis of ACL injuries in professional male football (soccer): injury mechanisms, situational patterns and biomechanics study on 134 consecutive cases. Br J Sports Med. 2020;54(23):1423–32.
7. Johnson MW. Acute knee effusions: a systematic approach to diagnosis. Am Fam Physician. 2000;61(8):2391–400.
8.• McHugh CG, Matzkin EG, Katz JN. Mechanical symptoms and meniscal tear: a reappraisal. Osteoarthr Cartil. 2022;30(2):178–183. **Literature review finding that mechanical symptoms treated with arthroscopy do lead to better outcomes.**
9. Grover M. Evaluating acutely injured patients for internal derangement of the knee. Am Fam Physician. 2012;85(3):247–52.
10. Rousseau-Saine A, Nault ML, Hiemstra LA. What is the J-sign and why is it important? Curr Opin Pediatr. 2023;35(1):97–101.
11. Smith BW, Green GA. Acute knee injuries: part I. History and physical examination. Am Fam Physician. 1995;51(3):615–21.
12. Ahmad CS, et al. The moving patellar apprehension test for lateral patellar instability. Am J Sports Med. 2009;37(4):791–6.
13. Jackson JL, O'Malley PG, Kroenke K. Evaluation of acute knee pain in primary care. Ann Intern Med. 2003;139(7):575–88.
14. Magee DJ, Manske RC. Knee. In: Orthopedic physical assessment. Philadelphia: Elsevier Inc; 2021. p. 887–955.
15. Karachalios T, et al. Diagnostic accuracy of a new clinical test (the Thessaly test) for early detection of meniscal tears. J Bone Joint Surg Am. 2005;87(5):955–62.
16. Kijowski R, et al. Imaging following acute knee trauma. Osteoarthr Cartil. 2014;22(10):1429–43.
17. Seaberg DC, et al. Multicenter comparison of two clinical decision rules for the use of radiography in acute, high-risk knee injuries. Ann Emerg Med. 1998;32(1):8–13.
18. Alves TI, et al. US of the knee: scanning techniques, pitfalls, and pathologic conditions. Radiographics. 2016;36(6):1759–75.
19. Raja AE, et al. Prone Lachman with ultrasound: a literature review and description of the technique. Curr Sports Med Rep. 2022;21(9):336–42.
20. Fritz B, Fritz J. MR imaging of acute knee injuries: systematic evaluation and reporting. Radiol Clin North Am. 2023;61(2):261–80.
21. Bauer SJ, et al. A clinical decision rule in the evaluation of acute knee injuries. J Emerg Med. 1995;13(5):611–5.
22. Cheung TC, et al. Diagnostic accuracy and reproducibility of the Ottawa Knee Rule vs the Pittsburgh Decision Rule. Am J Emerg Med. 2013;31(4):641–5.
23. Seaberg DC, Jackson R. Clinical decision rule for knee radiographs. Am J Emerg Med. 1994;12(5):541–3.
24. Browne GJ, Barnett P. Common sports-related musculoskeletal injuries presenting to the emergency department. J Paediatr Child Health. 2016;52(2):231–6.
25. Bronstein RD, Schaffer JC. Physical examination of knee ligament injuries. JAAOS J Am Acad Orthop Surg. 2017;25(4):280–7.

26. Andrews K, et al. Review: medial collateral ligament injuries. J Orthop. 2017;14(4):550–4.
27. Lundblad M, et al. Medial collateral ligament injuries of the knee in male professional football players: a prospective three-season study of 130 cases from the UEFA Elite Club Injury Study. Knee Surg Sports Traumatol Arthrosc. 2019;27(11):3692–8.
28. Phisitkul P, et al. MCL injuries of the knee: current concepts review. Iowa Orthop J. 2006;26:77–90.
29.• Vosoughi F, et al. Medial collateral ligament injury of the knee: a review on current concept and management. Arch Bone Jt Surg. 2021;9(3):255–262. **Literature review on current management of MCL injuries including anatomy, physical examination, and MCL imaging.**
30. Petersen W, et al. Management after acute injury of the anterior cruciate ligament (ACL), part 2: management of the ACL-injured patient. Knee Surg Sports Traumatol Arthrosc. 2023;31(5):1675–89.
31. Mahmood A, Umer HM, Paramasivan A, Sheharyar K, Tahoun R, Thonse R. Does delayed ligament reconstruction surgery lead to poor outcomes in patients with multiligament knee injuries? Cureus. 2023;15(1):e34219. https://doi.org/10.7759/cureus.34219.
32. Lin KM, Atzmon R, Pierre KJ, Vel MS, Brinson K Jr, Sherman SL. Common soft tissue injuries about the knee in American football. HSS J. 2023;19(3):330–8. https://doi.org/10.1177/15563316231165298.
33. Chapman G, Vij N, LaPrade R, Amin N. Medial-sided ligamentous injuries of the athlete's knee: evaluation and management. Cureus. 2023;15(3):e36360. https://doi.org/10.7759/cureus.36360.
34. Gibilisco M, Maduri P, Chang RG. Ligament injuries, in a case-based approach to knee pain: a pocket guide to pathology, diagnosis and management. Springer; 2023. p. 21-57.
35. Wang T. Diagnosis and non-operative treatment of medial collateral ligament. in Second International Conference on Biological Engineering and Medical Science (ICBioMed 2022). SPIE; 2023.
36. Yi Z, et al. The association between bone bruises and concomitant ligaments injuries in anterior cruciate ligament injuries: a systematic review and meta-analysis. Indian J Orthop. 2023;57(1):20–32.
37. Gilmer BB, Wahl CJ. Editorial commentary: the timing and treatment of combined anterior cruciate ligament–medial collateral ligament injuries: conservative management, early repair, augmentation, and delayed reconstruction of the medial collateral ligament. Elsevier; 2023. p. 1108–1110.
38. Martinez E, Koay I. Physical therapy as nonsurgical and presurgical management of common knee pathologies. J Urgent Care Med. 2022;16(9):13–6.
39. Wang D, et al. Nonoperative treatment of PCL injuries: goals of rehabilitation and the natural history of conservative care. Curr Rev Musculoskelet Med. 2018;11(2):290–7.
40. Hunt ER, Parise CN, Butterfield TA. The effectiveness of nonoperative treatment for anterior cruciate ligament rupture on patient-reported outcomes and muscular strength: a critically appraised topic. J Sport Rehabil. 2020;29(7):1032–7.
41. Giummarra M, Vocale L, King M. Efficacy of non-surgical management and functional outcomes of partial ACL tears. A systematic review of randomised trials. BMC Musculoskelet Disord. 2022;23(1):332.
42. Filbay SR, Dowsett M, Chaker Jomaa M, Rooney J, Sabharwal R, Lucas P, Van Den Heever A, Kazaglis J, Merlino J, Moran M, Allwright M, Kuah DEK, Durie R, Roger G, Cross M, Cross T. Healing of acute anterior cruciate ligament rupture on MRI and outcomes following non-surgical management with the cross bracing protocol. Br J Sports Med. 2023;57(23):1490–7. https://doi.org/10.1136/bjsports-2023-106931.
43. Mehl J, et al. The ACL-deficient knee and the prevalence of meniscus and cartilage lesions: a systematic review and meta-analysis (CRD42017076897). Arch Orthop Trauma Surg. 2019;139(6):819–41.
44. Legnani C, et al. Relationships between jumping performance and psychological readiness to return to sport 6 months following anterior cruciate ligament reconstruction: a cross-sectional study. J Clin Med. 2023;12(2):626.
45. Hong IS, Pierpoint LA, Hellwinkel JE, Berk AN, Salandra JM, Meade JD, Piasecki DP, Fleischli JE, Ahmad CS, Trofa DP, Saltzman BM. Clinical outcomes after ACL reconstruction in soccer (football, futbol) players: a systematic review and meta-analysis. Sports Health. 2023;15(6):788–804. https://doi.org/10.1177/19417381231160167.
46. Cronström A, Tengman E, Häger CK. Return to sports: a risky business? A systematic review with meta-analysis of risk factors for graft rupture following ACL reconstruction. Sports Med. 2023;53(1):91–110.
47. Ford K, et al. Return to sport after knee injuries in collegiate wrestling. Iowa Orthop J. 2023;43(1):131.
48. Parker KM, Treme GP, Richter DL. Double-bundle PCL reconstruction in the multiple-ligament injured knee. Video J Sports Med. 2023;3(4):26350254231176828.
49. D'Ambrosi R, Hallé A, Hardy A. Good clinical and radiological results following remnant-preserving posterior cruciate ligament reconstruction: a systematic review. Knee Surg Sports Traumatol Arthrosc. 2023;31(6):2418–32.
50. Maffulli N, et al. Acute haemarthrosis of the knee in athletes. A prospective study of 106 cases. J Bone Joint Surg Br. 1993;75(6): 945–9.
51. Nielsen AB, Yde J. Epidemiology of acute knee injuries: a prospective hospital investigation. J Trauma. 1991;31(12):1644–8.
52. Hede A, et al. Epidemiology of meniscal lesions in the knee. 1,215 open operations in Copenhagen 1982–84. Acta Orthop Scand. 1990;61(5):435–7.
53. DeHaven KE. Diagnosis of acute knee injuries with hemarthrosis. Am J Sports Med. 1980;8(1):9–14.
54. Anderson AF, et al. Interobserver reliability of the International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine (ISAKOS) classification of meniscal tears. Am J Sports Med. 2011;39(5):926–32.
55. Miller GK. A prospective study comparing the accuracy of the clinical diagnosis of meniscus tear with magnetic resonance imaging and its effect on clinical outcome. Arthroscopy. 1996;12(4):406–13.
56. Rose NE, Gold SM. A comparison of accuracy between clinical examination and magnetic resonance imaging in the diagnosis of meniscal and anterior cruciate ligament tears. Arthroscopy. 1996;12(4):398–405.
57. Timotijevic S, Vukasinovic Z, Bascarevic Z. Correlation of clinical examination, ultrasound sonography, and magnetic resonance imaging findings with arthroscopic findings in relation to acute and chronic lateral meniscus injuries. J Orthop Sci. 2014;19(1):71–6.
58. Karia M, et al. Current concepts in the techniques, indications and outcomes of meniscal repairs. Eur J Orthop Surg Traumatol. 2019;29(3):509–20.
59. Beaufils P, et al. The knee meniscus: management of traumatic tears and degenerative lesions. EFORT Open Rev. 2017;2(5):195–203.
60. Deviandri R, Daulay MC, Iskandar D, Kautsar AP, Lubis AMT, Postma MJ. Health-economic evaluation of meniscus tear treatments: a systematic review. Knee Surg Sports

Traumatol Arthrosc. 2023;31(9):3582–93. https://doi.org/10.1007/s00167-022-07278-8.
61. Skou ST, et al. Early surgery or exercise and education for meniscal tears in young adults. NEJM Evidence. 2022;1(2):EVIDoa2100038.
62. Pierre A, et al. Outcome of 95 stable meniscal tears left in place after reconstruction of the anterior cruciate ligament. Rev Chir Orthop Reparatrice Appar Mot. 2001;87(7):661–8.
63. Shelbourne KD. Editorial commentary: meniscus tears seen at the time of anterior cruciate ligament reconstruction are overtreated. Arthroscopy. 2021;37(12):3507–9.
64. Duchman KR, et al. The fate of meniscus tears left in situ at the time of anterior cruciate ligament reconstruction: a 6-year follow-up study from the MOON cohort. Am J Sports Med. 2015;43(11):2688–95.
65. Shelbourne KD, Gray T. Meniscus tears that can be left in situ, with or without trephination or synovial abrasion to stimulate healing. Sports Med Arthrosc Rev. 2012;20(2):62–7.
66.•• van de Graaf VA, et al, Effect of early surgery vs physical therapy on knee function among patients with nonobstructive meniscal tears: the ESCAPE randomized clinical trial. Jama 2018;320(13):1328–1337**. Multicenter, randomized trial looking at physical therapy versus arthroscopic meniscectomy in patients 45–70 year of age and found equivalent patient-reported knee function over a 24-month period.**
67.•• van der Graaff SJA, et al. Arthroscopic partial meniscectomy versus physical therapy for traumatic meniscal tears in a young study population: a randomised controlled trial. Br J Sports Med. 2022;56(15):870–6. **Multicenter, randomized control trial in patients 18–45 years with traumatic meniscus tears comparting arthroscopic partial meniscectomy versus physical therapy. They found that early arthroscopic partial meniscectomy was not superior to physical therapy with optinal delayed arthroscopic partial meniscectomy at 24-month follow-up.**
68. Espejo-Reina A, et al. One-third of meniscal tears are repairable: an epidemiological study evaluating meniscal tear patterns in stable and unstable knees. Arthroscopy. 2019;35(3):857–63.
69. Stone RG, Frewin PR, Gonzales S. Long-term assessment of arthroscopic meniscus repair: a two- to six-year follow-up study. Arthroscopy. 1990;6(2):73–8.
70. Wouters DB. Repair of a meniscus tear within 3 weeks after trauma significantly reduces the likelihood of a recurrent tear compared with later repairs. Knee Surg Sports Traumatol Arthrosc. 2023;31(6):2246–50.
71. Nepple JJ, Dunn WR, Wright RW. Meniscal repair outcomes at greater than five years: a systematic literature review and meta-analysis. J Bone Joint Surg Am. 2012;94(24):2222–7. https://doi.org/10.2106/JBJS.K.01584.
72. Kaminski R, et al. A prospective, randomized, double-blind, parallel-group, placebo-controlled study evaluating meniscal healing, clinical outcomes, and safety in patients undergoing meniscal repair of unstable, complete vertical meniscal tears (bucket handle) augmented with platelet-rich plasma. Biomed Res Int. 2018;2018:9315815.
73. Ahmed I, et al. The meniscal tear outcome (METRO) review: a systematic review summarising the clinical course and outcomes of patients with a meniscal tear. Knee. 2022;38:117–31.
74. Becker R, et al. From meniscal resection to meniscal repair: a journey of the last decade. Knee Surg Sports Traumatol Arthrosc. 2020;28(11):3401–4.
75. Kopf S, et al. Management of traumatic meniscus tears: the 2019 ESSKA meniscus consensus. Knee Surg Sports Traumatol Arthrosc. 2020;28(4):1177–94.
76. Jain NP, Khan N, Fithian DC. A treatment algorithm for primary patellar dislocations. Sports Health. 2011;3(2):170–4.
77. Fithian DC, et al. Epidemiology and natural history of acute patellar dislocation. Am J Sports Med. 2004;32(5):1114–21.
78. Nietosvaara Y, Aalto K, Kallio PE. Acute patellar dislocation in children: incidence and associated osteochondral fractures. J Pediatr Orthop. 1994;14(4):513–5.
79. Kramer DE, Pace JL. Acute traumatic and sports-related osteochondral injury of the pediatric knee. Orthop Clin North Am. 2012;43(2):227–36, vi.
80. Beaconsfield T, et al. Radiological measurements in patellofemoral disorders. A review. Clin Orthop Relat Res. 1994;308:18–28.
81. Elias DA, White LM, Fithian DC. Acute lateral patellar dislocation at MR imaging: injury patterns of medial patellar soft-tissue restraints and osteochondral injuries of the inferomedial patella. Radiology. 2002;225(3):736–43.
82. von Engelhardt LV, et al. How reliable is MRI in diagnosing cartilaginous lesions in patients with first and recurrent lateral patellar dislocations? BMC Musculoskelet Disord. 2010;11:149.
83. Desio SM, Burks RT, Bachus KN. Soft tissue restraints to lateral patellar translation in the human knee. Am J Sports Med. 1998;26(1):59–65.
84. Kirsch MD, et al. Transient lateral patellar dislocation: diagnosis with MR imaging. AJR Am J Roentgenol. 1993;161(1):109–13.
85. Vollnberg B, et al. Prevalence of cartilage lesions and early osteoarthritis in patients with patellar dislocation. Eur Radiol. 2012;22(11):2347–56.
86. Cofield RH, Bryan RS. Acute dislocation of the patella: results of conservative treatment. J Trauma. 1977;17(7):526–31.
87. Stefancin JJ, Parker RD. First-time traumatic patellar dislocation: a systematic review. Clin Orthop Relat Res. 2007;455:93–101.
88. Ahmad CS, et al. Immediate surgical repair of the medial patellar stabilizers for acute patellar dislocation. A review of eight cases. Am J Sports Med. 2000;28(6):804–10.
89. Buchner M, et al. Acute traumatic primary patellar dislocation: long-term results comparing conservative and surgical treatment. Clin J Sport Med. 2005;15(2):62–6.
90. Nikku R, et al. Operative treatment of primary patellar dislocation does not improve medium-term outcome: a 7-year follow-up report and risk analysis of 127 randomized patients. Acta Orthop. 2005;76(5):699–704.
91. Nomura E, Horiuchi Y, Kihara M. A mid-term follow-up of medial patellofemoral ligament reconstruction using an artificial ligament for recurrent patellar dislocation. Knee. 2000;7(4):211–5.
92. Clark D, et al. Adolescent patellar instability: current concepts review. Bone Joint J. 2017;99-b(2):159–170.
93. Weber AE, et al. An algorithmic approach to the management of recurrent lateral patellar dislocation. J Bone Joint Surg Am. 2016;98(5):417–27.
94. Khormaee S, et al. Evaluation and management of patellar instability in pediatric and adolescent athletes. Sports Health. 2015;7(2):115–23.
95. Matic GT, et al. Return to activity after medial patellofemoral ligament repair or reconstruction. Arthroscopy. 2014;30(8):1018–25.
96. Sanders TL, et al. High rate of recurrent patellar dislocation in skeletally immature patients: a long-term population-based study. Knee Surg Sports Traumatol Arthrosc. 2018;26(4):1037–43.
97.• Lee DY, et al. A systematic review and meta-analysis comparing conservative and surgical treatments for acute patellar dislocation in children and adolescents. Knee Surg Relat Res. 2023;35(1):18. **No differences in clinical outcomes between conservative treatment and surgical treatment in children and adolescents with acute patellar dislocations.**

98. Armstrong BM, et al. A feasibility study for a pragmatic randomised controlled trial comparing cast immobilisation versus no immobilisation for patients following first-time patellar dislocation. Knee. 2012;19(5):696–702.
99. Rood A, et al. Tape versus cast for non-operative treatment of primary patellar dislocation: a randomized controlled trial. Arch Orthop Trauma Surg. 2012;132(8):1199–203.
100. Ji G, et al. Surgical versus nonsurgical treatments of acute primary patellar dislocation with special emphasis on the MPFL injury patterns. J Knee Surg. 2017;30(4):378–84.
101. Duthon VB. Acute traumatic patellar dislocation. Orthop Traumatol Surg Res. 2015;101(1 Suppl):S59-67.
102. D'Ambrosi R, et al. Management of the first episode of traumatic patellar dislocation: an international survey. Knee Surg Sports Traumatol Arthrosc. 2023;31(6):2257–65.
103. Mäenpää H, Lehto MU. Patellar dislocation. The long-term results of nonoperative management in 100 patients. Am J Sports Med. 1997;25(2):213–7.
104.• Honkonen EE, et al. A randomized controlled trial comparing a patella-stabilizing, motion-restricting knee brace versus a neoprene nonhinged knee brace after a first-time traumatic patellar dislocation. Am J Sports Med. 2022;50(7):1867–1875. **Patella-stabilizing, motion-restricting knee brace versus a neoprene nonhinged knee brace did not result statistically significant reduction in redislocations. Knee immobilization resulted in worse functional outcomes in the first 6 months after injury.**
105. Flores GW, et al. Conservative management following patellar dislocation: a level I systematic review. J Orthop Surg Res. 2023;18(1):393.
106. Bitar AC, et al. Traumatic patellar dislocation: nonoperative treatment compared with MPFL reconstruction using patellar tendon. Am J Sports Med. 2012;40(1):114–22.
107. Camanho GL, et al. Conservative versus surgical treatment for repair of the medial patellofemoral ligament in acute dislocations of the patella. Arthroscopy. 2009;25(6):620–5.
108. Smith TO, et al. Rehabilitation following first-time patellar dislocation: a randomised controlled trial of purported vastus medialis obliquus muscle versus general quadriceps strengthening exercises. Knee. 2015;22(4):313–20.
109. Straume-Næsheim TM, et al. Medial patellofemoral ligament reconstruction is superior to active rehabilitation in protecting against further patella dislocations. Knee Surg Sports Traumatol Arthrosc. 2022;30(10):3428–37.
110. Fisher B, et al. Medial patellofemoral ligament reconstruction for recurrent patellar dislocation: a systematic review including rehabilitation and return-to-sports efficacy. Arthroscopy. 2010;26(10):1384–94.
111.•• Rund JM, Hinckel BB, Sherman SL. Acute patellofemoral dislocation: controversial decision-making. Curr Rev Musculoskelet Med. 2021;14(1):82–87. **The standard of care for patients without osteochondral loose bodies or fracture is non-operative treatment. Based on MRI findings, first-time dislocators who are at high risk, soft tissue stabilization may be considered, but most patients will be treated non-operatively.**
112. Respizzi S, Cavallin R. First patellar dislocation: from conservative treatment to return to sport. Joints. 2014;2(3):141–5.

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