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Magnetic Resonance Imaging Findings in Acute Traumatic Patellar Dislocation

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Abstract
Acute traumatic patellar dislocation is a common injury with majority of them occurring in young adults less than 20 years old. Traumatic patellar dislocation is mostly associated with trauma sustained during physical or sports activity. Strong patellar displacement leads to injury involving medial stabilizing structures, notably the medial patella-femoral ligament (MPFL), most frequently at its femoral attachment. Displacement involving more than 50% of the patellar width is considered abnormal. X-ray and computed tomography (CT) are helpful in diagnosing bony risk factors for patellar dislocation and to detect small osteochondral bodies. Magnetic resonance (MR) imaging is the primary diagnostic modality of choice and helpful in detecting capsular, ligamentous, cartilaginous, and bone injuries and thus can help in deciding the course of management. Here in we review the typical MRI imaging findings in the knee after acute traumatic patellar dislocation.
Keywords: *Magnetic Resonance Imaging; Trauma; Patellar; Ligament; Dislocation.*

Introduction

Lateral patellar dislocation is a common entity seen in clinical practice. It usually occurs with trauma sustained during physical activity. Majority of the patients are young, active individuals under 20 years of age[1-3]. It is the second most common cause of traumatic hemarthrosis of the knee and accounts for 3% of all traumatic knee lesions[4-5].

Nearly half of the patients with a first dislocation will sustain recurrent dislocations after initial conservative management[6]. Chronic instability of the patella-femoral joint and recurrent dislocations might lead to cartilage damage and marked arthritis if not treated properly[7]. One of the common findings in acute traumatic patellar dislocation is hemarthrosis of the knee, due to rupture of the medial stabilizers of the patella.

MR imaging is currently the modality of choice in acute patellar dislocations. MR imaging is recognized as a standard procedure and has replaced diagnostic arthroscopy in evaluation of patellar dislocations[7]. MR imaging is a highly sensitive imaging modality for detecting capsular,

ligamentous, cartilaginous, and bone injuries associated with patellar dislocation[8-14] and is helpful in assessing anatomical factors contributing to chronic patellar instability. The aim of this article is to review the typical MR imaging findings after traumatic patellar dislocation and predisposing anatomic factors including trochlear dysplasia, patella alta and lateralization of the tibial tuberosity.

Anatomy and Biomechanics

Patello-femoral joint is a complex joint and its stability and normal function depends on passive stabilizers (bones and ligaments) and active stabilizers (extensor muscles)[7]. Joint geometry is crucial for stabilization during movement[7]. Any alteration in anatomy, such as extensor apparatus alignment defect, patella-femoral dysplasia or trauma may lead to patellar instability[15].

In normal individuals, both medial and lateral joint surfaces are symmetric and congruent with the trochlea of femur. The medial ligamentous stabilizers prevent lateral displacement of the patella during movement, most important being the medial patellar retinaculum and the medial patellofemoral ligament (MPFL)[7]. Vastus medialis obliquus (VMO) muscle also contributes significantly to the joint stability.

On MR imaging, the medial patellar retinaculum and MPFL appear as well-defined low-signal-intensity bands on T2 weighted images and often difficult to distinguish from each other[7]. The patellar third of the MPFL blends with the VMO muscle resulting in thicker attachment and so greater visualisation at MR imaging. The femoral third of the ligament is thin and may not be adequately depicted[8]. Patellofemoral stability results from complex interactions between passive and active stabilizers. Patellar trajectory in the femoral trochlea is not straight, but includes tilt, glide and rotation[15].

When the knee is in complete extension, the patella lies above and beyond the femoral sulcus. It enters the trochlea with 10–30° flexion of the knee. The trochlear entry is delayed in case of patella alta or short trochlea and in these cases, osteoarticular stabilization of the patella is lacking when the knee is in extension or slight flexion[16,17].

Predisposing Factors

Trochlear Dysplasia

One of the main factors contributing to chronic patellofemoral instability is trochlear dysplasia. In trochlear dysplasia, the trochlear joint surface is flattened proximally, and the concavity is less pronounced distally[7]. In more severe cases, the trochlear surface may even become convex with increasing hypoplasia of the medial joint surface. Because of its high frequency of occurrence bilaterally, trochlear dysplasia is believed to be a developmental anomaly[7]. Signs of trochlear dysplasia are found in more than 85% of patients with patellar dislocation[17].

A Classification system proposed by Dejour et al[18] distinguishes four types of trochlear dysplasia: (a) type A: normal shape of the trochlea preserved but a shallow trochlear groove; (b) type B: markedly flattened or even convex trochlea; (c) type C: asymmetric trochlear facets, with the lateral facet being too high and the medial facet being hypoplastic, which results in the flattened joint surface forming an oblique plane; and (d) type D: in addition to the features of type C, a vertical link between medial and lateral facets[7].

MR imaging has been shown to allow highly accurate and reproducible measurements of the femoral sulcus[7] and trochlear dysplasia is evaluated by determining lateral trochlear inclination, trochlear facet asymmetry, or trochlear depth[19,20]. Lateral trochlear inclination is best assessed using axial fat-saturated T2-weighted sequences[13]. First line is drawn along the subchondral aspect of the lateral facet and the second line along the posterior aspect of the femoral condyles. Inclination angle between the two lines is measured and an angle of less than 11° indicates trochlear dysplasia with high sensitivity and specificity[19]. Trochlear facet asymmetry and trochlear depth are best assessed using axial fat-saturated T2-weighted sequences

[20] and are measured 3 cm above the tibio-femoral joint cleft[7]. For trochlear asymmetry, the ratio of the length of the medial trochlear facet to the length of the lateral trochlear facet is calculated and expressed as a percentage[7]. Trochlear facet ratio less than 40% indicates dysplasia with high sensitivity and specificity[20]. For Trochlear depth, a reference line is drawn parallel to the posterior aspect of the femoral condyles (D) and three lines is drawn perpendicular to the reference line indicating the maximum anteroposterior diameters of the lateral (A) and medial trochlear facets (C) and the deepest point of the sulcus (B)[7]. Trochlear depth is calculated as (A + C/2) – B and a depth of 3 mm or less indicates dysplasia.

Patella Alta

Patella Alta, also known as isolated high patella or high riding patella may be seen in cases of recurrent dislocations. It is defined as a patella that is too high above the trochlear fossa and occurs when the patellar tendon is too long[21] and is one of the main factors in patellofemoral misalignment. Additionally genu varum deformity of the knee contributes to patella alta configuration by shortening the distance between the quadriceps myotendinous junction and the tibial tuberosity[7]. High riding patella is seen in 25 % cases of acute patellar dislocations.

Sagittal MR images are used to asses Patellar height ratio. The ratio is obtained by dividing the length of the patellar tendon (A) by the longest supero-inferior diameter of the patella (B) (Insall-Salvati index) and a ratio of more than 1.3 indicates a high-riding patella. The length of the patellar tendon is reliably measured on MR images, with a higher sensitivity to predict instability as compared with the classic indices used in conventional radiography[22].

Tibial Tubercle to Trochlear Groove distance

Normally the tibial tuberosity lies vertically under the femoral sulcus, thus directing the force vector inferiorly during knee bending. However with excessive lateralization of the tibial tuberosity, the patella is pulled laterally during flexion[7] and so excessive lateral displacement of tibial tuberosity is a risk factor for patellar instability. It is assessed on axial fast T2-weighted MR images. The distance from the deepest point of the trochlea to the middle of the tibial tubercle is measured with the posterior plane of the condyles serving as the reference line[7]. A distance of less than 15 mm is considered normal while distance between 15 and 20 mm is borderline. Distance more than 20 mm indicates marked lateralization of the tuberosity[7]

MR Imaging findings in Acute Patellar Dislocation

Medial Patellar Stabilizer Injury

Injury to medial ligamentous stabilizers (MPFL and medial patellar retinaculum) are seen in MR imaging in majority of patients with lateral patellar dislocation and MR imaging has more than 80% sensitivity as compared to open exploration[12]. MPFL and medial patellar retinaculum are difficult to appreciate separately on MR images, especially at patellar insertion and so considered a single entity while evaluating for presence of injury on MRI images. The ligamentous complex may be divided into three regions for evaluation: (A) Patellar insertion (B) mid substance, and (C) femoral origin and approx. 50% and 90% of the injuries involve the patellar insertion[8,9].

Full-thickness tear of a medial ligamentous stabilizer appears as complete disruption and discontinuity of the ligament with presence of adjacent soft-tissue edema. Wavy or retracted fibres surrounded by effusion are conspicuous for complete disruption[7]. Partial tear shows irregular appearance or partial discontinuity of the ligament (Figure 1) and the presence of tendinous or peritendinous edema[7]. Disruption of the ligaments at the patellar insertion is partial in two-thirds of the cases and complete in one-third[7].

Patellar Defects

Majority of patients show subluxation or tilt of the patella on MR imaging[8]. Subluxation is defined as partial lateral dislocation of the patella from the femoral groove and is evaluated subjectively[7]. Patellar tilt is diagnosed by determining the lateral patellofemoral angle. Marrow edema at medial

aspect of the patella and the femoral condyle is a typical finding after patellar dislocation and is due to contusions. Chondral or osteochondral lesions of the medial patella are seen in more than 2/3rd cases[7] and detected at MR imaging with a very high sensitivity (Figure 1). Approximately 50% of the cases have the finding of a concave impaction deformity of the inferomedial patella and is considered a highly specific sign of prior patellar dislocation[8,10]. Prompt surgery is required if the defects are larger than 1 cm^2[7]. Standard pulse sequences are reliable for diagnosing grade III or IV central cartilages defect while the diagnostic accuracy for grade I or II defects is lower.

Lateral Condylar Defects

In majority of patients (more than 80%), marrow edema of the lateral femoral condyle resulting from patellar impaction is seen[8-14]. In rare cases, condylar fracture may occur. About 40% of the patients present with osteochondral lesions of the anterolateral or midlateral aspect of the condyle [13]. Completely separated bone fragments i.e intraarticular bodies in the joint space may be seen and are an indication for surgery.

Effusion

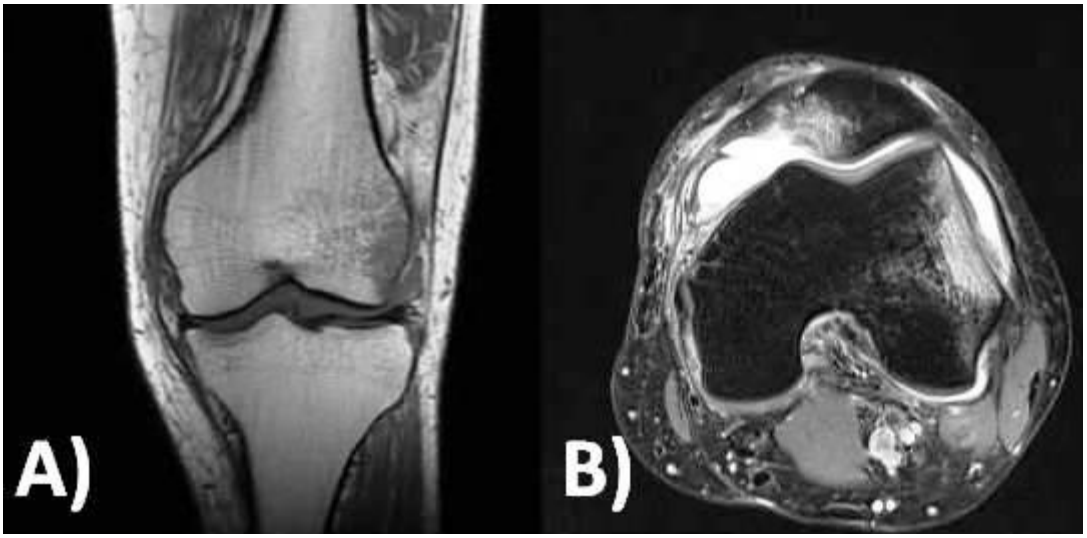
It is a characteristic finding after dislocation and is majority of the patients and the amount of effusion decreases with time[7]. Joint effusion is defined as a fluid depth of more than 4 mm in the suprapatellar recess on midline sagittal images and more than 10 mm in the lateral recess on lateral sagittal images[23]. Fluid-fluid levels in the effusion represent hemorrhage as a result of sedimentation of blood components.

Ancillary Findings

Include edema, hemorrhage or tears of VMO muscle adjacent to the MPFL, intraarticular bodies, meniscal, collateral, or a cruciate ligament injuries.

Management

Appropriate management is essential to limit recurrence of dislocation, painful subluxation and osteoarthritis. Management may be non-operatve or operative. Non operative management is recommended by some authors[5] except in cases of chondral lesion, osteochondral defects or major lesions of the medial stabilizing structures on clinical and radiological assessment. Surgical techniques include MPFL reconstruction, vastus medialis plasty, medial capsular plication, patellat tenodesis, tibial tubercle medialzation and trocheloplasty.



Coronal (A) T1 weighted image reveals marrow edema involving the lateral femoral condyle. On Axial T2FS images (B), partial tear of the medial ligamentous stabilizer complex is seen with marrow edema in medial patellar aspect and lateral femoral condyle. Defect is also seen at medial pole of patella with mild joint effusion. Associated Trochlear Dysplasia also seen.

Conclusions

Acute traumatic patellar dislocation is a common injury in young active population. MR imaging is the modality of choice in suspected patellar dislocation and is essential in the evaluation of typical injury patterns. Further MR imaging can also be diagnostic in evaluating anatomic variants contributing to patellofemoral instability. Many surgical techniques are available for correction of predisposing factors contributing to patellofemoral instability and to stabilize the joint. Correct imaging findings help orthopedic surgeons in selecting the optimal treatment for better patient management.

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