An MRI based Pictorial Review of Trochlear Dysplasia with Emphasis on Patellofemoral Instability.

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Learning objectives

To review the typical MR evaluation parameters for diagnosis of trochlear dysplasia and patella alta, two of the common variants contributing to patellofemoral instability and patellar dislocation.

In this poster we present a pictorial review of the findings of trochlear dysplasia, patella alta and patellar dislocation on MRI of the knee using clinical cases from our centre.

Background

Patellar dislocation is characterized by the complete loss of contact between the patellafemoral joint surfaces. In almost all cases, the patella dislocates laterally.

Most patients with patellar dislocation are young and active individuals. There is a long list of possible differential diagnoses, including femoral trochlear dysplasia. Femoral trochlear dysplasia is a geometric abnormality of the shape and depth of the trochlear groove, mainly at its cranial part. Since trochlear dysplasia is a relatively common abnormality in young active population and associated with significant disability if left untreated, early diagnosis and treatment are warranted.

The most common predisposing factors for patellar instability include trochlear dysplasia, patella alta, and lateralization of the tibial tuberosity. Important secondary factors contributing to patellofemoral instability are femorotibial malrotation, genu recurvatum (back-knee), and ligamentous laxity (Ehlers-Danlos and Marfan syndromes).

Imaging findings OR Procedure details

Trochlear dysplasia

Trochlear dysplasia has been identified as one of the main factors contributing to chronic patellofemoral instability. In individuals with trochlear dysplasia, the trochlear joint surface is flattened proximally, and the concavity is less pronounced distally. This combination results in considerable loss of lateral patellar tracking and in lateral dislocation of the patella at the initiation of flexion. In the more severe expressions of trochlear dysplasia, 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.
The classic criteria for diagnosing trochlear dysplasia were defined for conventional radiographs:

"Crossing sign": It is a line represented by the deepest part of the trochlear groove crossing the anterior aspect of the condyles, assessed from lateral radiographs.

"Double contour sign": It is a double line at the anterior aspect of the condyles and is present if the medial condyle is hypoplastic. A decreased trochlear depth and a large sulcus angle can be assessed from standard axial radiographs.

Dejour et al proposed a classification distinguishing four morphologic types of trocley dysplasia:

Type A: Normal shape of the trochlea preserved but a shallow trochlear groove

Type B: Markedly flattened or even convex trochlea

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

Type D: In addition to the features of type C, a vertical link between medial and lateral facets (cliff pattern on parasagittal images).

The four types of trochlear dysplasia have direct implications for the best surgical approach to correct patellar instability.

Axial and sagittal MR images allow accurate identification of the type of trochlear anomaly.

**Patella Alta**

Patella alta or high-riding patella is a patella that is too high above the trochlear fossa and occurs when the patellar tendon is too long. With patella alta, the degree of flexion needs to be higher for the patella to engage in the trochlea, compared with a normal knee. This problem leads to reduced patellar contact area and decreased bone stability in shallow degrees of flexion. Also, a genu varum deformity of the knee contributes to a patella alta configuration and may predispose to lateral patellar subluxation.
About 25% of the patients with acute patellar dislocation have a high-riding patella depicted on MR images. Though patella alta is an asymptomatic normal anatomic variant in most individuals, its diagnosis is important because it increases the risk of patellar dislocation in conjunction with other factors.

Numerous parameters for measuring the vertical distance of the patella from the trochlear joint surface have been proposed for conventional radiographs. These parameters are based on osseous landmarks and usually determine the patellar length in relation to its distance from the tuberosity or the femorotibial joint cleft. Some of these parameters have also been determined with MR images, and these techniques can be transferred to MR imaging. However, unlike conventional radiographs, MR images depict the true three-dimensional anatomic structure of the patellofemoral joint and its ligamentous structures. The length of the patellar tendon can be reliably measured on MR images, which results in a higher sensitivity for predicting instability compared with the classic indices used at conventional radiography.

For MR imaging, the measurement of the patellar height ratio is recommended. The patellar height ratio is calculated as the length of the patellar tendon measured posteriorly from the apex of the patella to its attachment to the tibial tuberosity on a sagittal MR image, divided by the longest supero-inferior diameter of the patella (Insall-Salvati index). The normal patellar height ratio reported is 1.1 (standard deviation, 0.1). Patella alta is defined as a patellar height ratio of more than 1.3, which is the normal ratio plus two standard deviations (sensitivity of 78%, specificity of 68%).

The patellotrochlear index has recently been proposed as a more accurate reflection of the functional height of the patella. This index is a measure of the patellofemoral contact area determined from sagittal MR images. A mean patellotrochlear index of 32% has been reported for a normal population (standard deviation, 12%), whereas patients with patellofemoral instability have a mean value of 15%. Studies remain to be done to validate thresholds and give clinically applicable recommendations.

Images for this section:
Fig. 1: Fig. 1 is the axial fat-saturated T2-weighted MR image showing shallow femoral trochlea (Dejour type A), with abnormal medial to lateral articular surface ratio (1:3), 3 cm proximal to the joint line.
**Fig. 2:** Fig. 2 is the sagittal fat-saturated T2-weighted MR image showing normally positioned patella as the patellar height ratio measured is less than 1.3.
**Fig. 3**: Fig. 3 is the sagittal fat-saturated T2-weighted MR image showing Patella Alta as the patellar height ratio measured is 1.48 i.e. more than 1.3.
Fig. 4: Fig 4,5 and 6 are the fat saturated T2 weighted MR images showing bone marrow oedema in the medial portion of the patella and in the lateral femoral condyle consistent with recent lateral dislocation of the patella and impaction injury. Also note the moderate knee joint effusion and background shallow femoral trochlea.
**Fig. 5:** Fig 4, 5 and 6 are the fat saturated T2 weighted MR images showing bone marrow oedema in the medial portion of the patella and in the lateral femoral condyle consistent with recent lateral dislocation of the patella and impaction injury. Also note the moderate knee joint effusion and background shallow femoral trochlea.
**Fig. 6:** Fig 4, 5 and 6 are the fat saturated T2 weighted MR images showing bone marrow oedema in the medial portion of the patella and in the lateral femoral condyle consistent with recent lateral dislocation of the patella and impaction injury. Also note the moderate knee joint effusion and background shallow femoral trochlea.
Fig. 7: Fig. 7, 8 and 9 are the fat saturated T2 weighted MR images. Fig. 7 and 8 showing impaction fracture of the inferomedial portion of the patella and multiple marrow fat droplets in the suprapatellar pouch. There is lateral tilt of patella. Fig. 9 showing kissing oedema in the lateral femoral condyle. All these features are suggestive of recent lateral dislocation of the patella.
**Fig. 8:** Fig. 7, 8 and 9 are the fat saturated T2 weighted MR images. Fig. 7 and 8 showing impaction fracture of the inferomedial portion of the patella and multiple marrow fat droplets in the suprapatellar pouch. There is lateral tilt of patella. Fig. 9 showing kissing oedema in the lateral femoral condyle. All these features are suggestive of recent lateral dislocation of the patella.
Fig. 9: Fig. 7, 8 and 9 are the fat saturated T2 weighted MR images. Fig. 7 and 8 showing impaction fracture of the inferomedial portion of the patella and multiple marrow fat droplets in the suprapatellar pouch. There is lateral tilt of patella. Fig. 9 showing kissing oedema in the lateral femoral condyle. All these features are suggestive of recent lateral dislocation of the patella.
Conclusion

MR imaging is the imaging modality of choice in patients in whom patellar dislocation is suspected. MR imaging allows evaluation of typical injury patterns and can be used to diagnose anatomic variants contributing to the development of patellofemoral instability. Different surgical options are available to stabilize the patellofemoral joint and correct predisposing factors. Imaging findings help physicians in selecting the optimal treatment. A wide variety of measures and techniques are available to evaluate the underlying anatomic structures. To ensure the best diagnostic yield, the radiologist should select the most suitable evaluation parameters in consultation with the referring orthopedic surgeon.

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References

