Patellar pathology: mechanical and congenital

Poster No.: P-0044
Congress: ESSR 2015
Type: Educational Poster
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Keywords: Anatomy, Musculoskeletal bone, Musculoskeletal joint, CT, MR, Conventional radiography, Diagnostic procedure, Education, Congenital, Pathology
DOI: 10.1594/essr2015/P-0044

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Learning objectives

The authors propose to illustrate the radiologic aspects of congenital patellar abnormalities and mechanical abnormalities.

Despite being a "special bone", the patella may be affected by a wide spectrum of normal and abnormal conditions that this work will try to illustrate.

Background

- Patellar problems are the most frequent type of knee complaints in adolescents and young adults. Patellar pathology manifests itself in different clinical entities, ranging from isolated anterior knee pain to dislocation.
- Congenital patellar abnormalities may lead to instability.
- Embedded within the quadriceps muscle, patella is the largest sesamoid bone in the body, usually ossified from multiple centers. It is mainly composed of trabecular bone and its posterior surface is covered by articular cartilage.
- Maintenance in place is due to patellar and quadriceps tendons and retinacular ligaments. Patella works primarily as an anatomic pulley for the quadriceps muscle.
- Patellar dislocation is characterized by the complete loss of contact between the patellofemoral joint surfaces. Chronic patellar instability, if not treated, may lead to severe arthritis and chondromalacia.
- The articulation and path of motion of the patella is complex, with the joint vulnerable to instability.
- There are three main groups responsible for stability: active stabilizers (particularly the quadriceps), passive stabilizers (retinacula) and static stabilizer (articular surfaces). Patellofemoral instability may result when the normal relationships are disturbed.

Patellar abnormalities:

1. Congenital
2. Mechanical

1. Congenital
• Aplasia/entire hypoplasia-patella "parva"
• Partial hypoplasic patella
• Multipartite patella (bipartite; tripartite)
• Duplication

2. Mechanical
• Trochlear morphology
• Patellar morphology
• Vertical plane (patella alta; infera)
• Patellar tilt and subluxation
• Lateralization of the tibial tuberosity (TA-GT distance)

Imaging findings OR Procedure Details

CONGENITAL

- Aplasia/entire hypoplasic-patella "parva" (Fig.1)
  • Rare pathology.
  • Usually associated with nail-patella syndrome (onychoosteodysplasia), coursing with wasting of quadriceps and hypoplasia of femoral condyles.

- Partial Hypoplastic patella (Fig.2)
  • It can be an isolated phenomenon or a part of a generalized dysplasia.
  • Usualy causes instability and retropetallar pain
  • Most of the abnormal cases involve the medial facets.
  • Wiber classification is widly accepted and is based upon the radiologic form on the axial view. The type 3 of Wiberg classification is associated with a dysplastic form. The type 2 (Fig.3) is the most common patellar morphology present in the population, followed by type1.

- Multipartite Patella
  • Congenital abnormalities that represent normal variant pathology and result from a failure ossification during development.
  • The majority are asymptomatic but direct trauma may disrupt the synchondroses resulting in symptoms.
  • The most common type of segmentation results in separation of the superolateral quadrant of the patella, which is called bipartite patella (Fig.4). Rarely there may be a third segment resulting in a tripartite patella (Fig.5).

- Double patella (Fig.6)
• Rare pathology
• Maybe associated with multiple epiphseal dysplasia
• Two forms may be found: coronal type, also known as double-layered patella, and a transverse form.

MECHANICAL

• Patellar instability is a morphologic abnormality in patellofemoral joint which leads to a recurrent patellar dislocations.
• The two main causes of patellar instability are traumatic and congenital abnormalities.
• Malalignment- translation or rotational deviation of the patella to any axis
• Instability- distinct condition characterized by slipping, subluxation or dislocation of the patella (alta; baja; lateral or medial subluxation)

- Trochlear Dysplasia

• Abnormal morphology of the femoral trochlea. Is the single most important factor implied in the genesis of patellar instability.
• Signs of trochlear dysplasia are found in more than 85% of the patients with patellar dislocation.
• Abnormal trochlear morphology has been classified in four types by Dejour (Fig.7)
• X-ray have an important role in that characterization.

- Lateral view: "Crossing sign" (Fig.8), whis is a line represented by the deepest part of the trochlear groove crossing the anterior aspect of the condyles; "Double contour sign" (Fig.9): is a double line at the anterior aspect of the condyles and is seen if the medial condyle is hypoplasic.

- Merchant view (Fig.10): helpful for assessing the sulcus angle. Normal range should be less then 145º. Increasing sulcus angles correlate with trochlear dysplasia.

- Patellar dysplasia (already discussed in the congenital pathology-Fig.2)

- Verticle plane (patella alta; baja)

• Several methodos based on the position of the patella in lateral radiographic projection are used to assess patella’s position ( Insall-Salvati; Blumensaat; Labelle and Laurin).
• Insall-Salvati evaluate the ratio of patella tendon length (TL) to the length of the patella (PL).
- Patela alta- TL/PL more then 1,2 *(Fig.11)*

- Patella baja/infera- TL/PL less then 0,8 *(Fig.12)*

- Normal range between 0,8 and 1,2
  
  - Patella alta is often associated with recurrent lateral patellar subluxation, chondromalacia, Sinding-Laurden-Johansson, joint effusions.
  - Patella baja is often associated with neuromuscular disorders and surgical procedures such as transfer of the tibial tuberosity.

-Patellar tilt and subluxation *(Fig.13;14;15;16;17)*

  - Patellar tilt and subluxation refers to abnormal position of the patella in relationship to the trochlear groove.
  - Tilt refeer to an increased lateral inclination of the transverse diameter of the patella.
  - Subluxation refers to an abnormal mediolateral displacement of the patella in relation to the trochlea.
  - Trochlear and patellar abnormalities have a fulcral role in the patellar tilt and subluxation.
  - There are some conventional radiology methods to evaluated tilt and subluxation in the axial view (Merchant).

- **Congruence angle**(Fig.13) (to evaluat the presence of subluxation):after measuring the sulcus angle, two other lines are drawn from its vertex, one bisecting the sulcus angle (reference angle) and the other to the apex of the patella. The angle between these two lines is the congruence angle, which is considered positive if the line to the patellar apex is lateral to the reference line. The average congruence angle is 6 degrees (SD +/- 11 degrees).

- **The lateral patellofemoral angle (Laurin)** *(Fig.14)* (to evaluate the patella tilt) is formed by one line connecting the highest points of the medial and lateral facets of the trochlea, and another tangent to the lateral facet of the patella. In normal patella this angle should open laterally.

- **CT patellar tilt evaluation (Lyon protocol)** *(Fig.15)* The angle formed by the transverse axis of the patella and a tangent to the posterior femoral condyles. It must be measured with and without quadriceps contraction, which can be accomplished either with 2 superimposed cuts or with a single cut that images both references.

-Lateralization of the tibia *(Fig.18)*

  - Distance from the tibial tubercle to trochlear groove - TA-GT
• The distance from the tibial tuberosity to the trochlear groove is measured parallel to the tangential line through posterior femoral condyles. A distance of less than 15mm is considered normal, 15 to 20mm is considered borderline and a distance greater than 20mm is considered abnormal.

Images for this section:

![Image of lateral knee and axial view showing hypoplastic patella and small ossification focus.](image_url)

**Fig. 1:** Lateral knee and axial (Merchant) view showing an hypoplastic patella. There are also some very small ossification focus.
*Tipologia e Morfologia Patellar (Wiberg)*
**Fig. 2:** Wiberg patellar classification Type1: Both facets are gently concave, symmetrical, and roughly the same size, although slight lateral predominance is common. Type2: The medial facet is distinctly smaller than the lateral. The lateral facet remains concave, whereas the medial is either flat or slightly convex. This is the most common patellar form. Type3: The medial facet is considerably smaller, with marked lateral predominance, which leads to instability.

**Fig. 3:** Axial patellar-Merchant view Wiberg Type2, the most common patellar morphology
Fig. 4: Bipartite patella AP view: typical accessory nucleus with sclerotic rounded margins in the supero-lateral corner.
**Fig. 5**: Tripartite patella Coronal T2-weighted gradient echo showing a double accessory ossification center at the supro-lateral aspect of the patella. Subarticular bone edema is seen (arrow).
Fig. 6: Axial CT and sagittal T1 MRI showing a bilateral double layered patella

Fig. 7: A: normal shape but shallow trochlear groove. B: markedly flattened or even convex trochlea C: facet asymmetry, with too high lateral facet and hipoplastic medial facet. D: type C plus proeminent bone protusion (“cliff pattern”).
Fig. 8: Lateral knee X-Ray. Crossing sign (arrow) representing a shallow trochlea.
Fig. 9: Lateral x-ray: it is possible to observe a "double contour" which represents the hypoplastic medial trochlear facet
Fig. 10: Merchant view Normal trochlear sulcus angle
**Fig. 11:** Lateral view of the knee in a patient with "patella alta"
**Fig. 12:** Lateral radiograph of a patient with poliomyelitis sequels and shows an inferior positioning of the patella.

**Fig. 13:** Congruence angle. Merchant view. Line AO - bisector of the angle ABC Line AD- passes through the lowest point on the median ridge of the patella. Angle OAD is the congruence angle that is preserved in this case.
Fig. 14: Merchant view. The lateral patellofemoral angle (Laurin) preserved. This angle, in the absence of tilt, should open laterally
**Fig. 15:** CT axial tilt evaluation: Values above 20 degrees are considered abnormal. This axial CT images show trochlea dysplasia with lateral subluxation and tilt of the right patella.

**Fig. 16:** Axial patellar view. Bilateral patellar luxation
**Fig. 17:** Axial CT Sequel of a previous lateral subluxation with a bone fragment adjacent to the medial aspect of the patella, intimate to medial retinaculum.
Fig. 18: CT evaluation of the distance between the tibial tubercle and trochlear groove
Normal values of TA-GT distance.
Conclusion

Congenital and mechanical abnormalities are closely linked and can lead to a patellar instability.

Raiologists have an important role and should be able to identify their imaging and clinical characteristics. Familiarity with the range of imaging appearances of patellar normal and abnormal conditions is essential to avoid pitfalls and make a correct diagnosis when pathology is present.

References


Personal Information