





Patella Instability

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Patella Instability

- Presentations:
 - Subluxation or Dislocation
 - Maltracking with Anterior knee pain

Lateral Patellar Dislocation

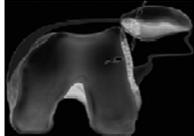


- Anteroposterior radiograph of the knee showing a laterally dislocated patella. The patella usually spontaneously reduces and this appearance is rare.
- The patella is reduced, but note the osteochondral fragment adjacent to the medial patella and the small concave defect at the medial patellar margin.



Patella Dislocation Secondary signs

- Bone bruising medial patella
- Impaction fracture
- Bone bruising lateral femoral condyle
- Torn medial patelofemoral ligament
 - Avulsion from femoral attachment
 - Edema surrounding the distal vastus medialis obliquus muscle
- Osteochondral avulsion medial patella
- Cartilage injury lateral facet patella

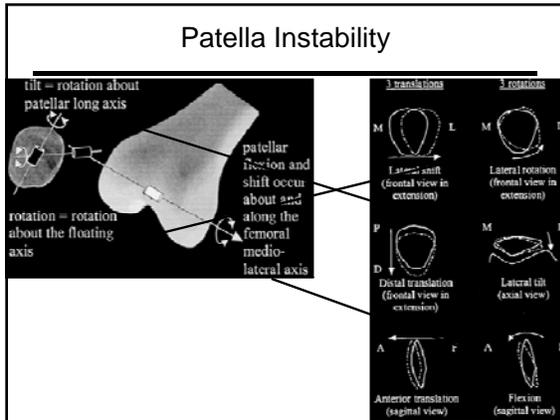
Patellar Instability

- Patellar dislocation occurs in 5.8 per 100,000 in all ages, and in the ten to seventeen year old group, 29 per 100,000. Reportedly up to 55% of patients fail to return to the same level of sports activity after primary patellar dislocation

Dejour and Le Coultre

Patella Instability Internal factors

- Trochlear dysplasia
 - Trochlear depth <4mm
 - Crossing sign
 - Trochlear bump >3mm
- Patella dysplasia
- Quadriceps dysplasia / Deficient medial stabilizers
 - Torn patelofemoral ligament
 - Weak Vastus medialis obliquus
 - Patella tilt >20%
- Excessive lateral pressure syndrome
 - Lateral fibrous bands
- Patella alta
- Genu valgus
 - Q angle
 - Tibial tuberosity trochlear groove displacement
 - >20mm
 - Tibial external rotation
 - Femoral anteversion
 - Lateral tibial tubercle



Patellar tracking

- First 20 degrees of flexion
 - Tibia derotates (internally)
 - Q angle decreases
 - Patella enters trochlea laterally
- 20 - 30 degrees of flexion
 - Patella lifts away from trochlea
 - Patella most prominent
- Above 30 degrees of flexion
 - Patella settles into trochlea

Patellar tracking

- 30 - 90 degrees of flexion
 - Stability rarely a problem
 - Instability seen with anatomic derangement
- 90 - 135 degrees of flexion
 - Patella shift laterally
 - Patella rotates (pronates)
- Full flexion
 - Further lateral shift

History

- Skeletal findings prove that the knee joint has been in existence for over 320 million years
- The Eryops, the ancestors of the reptiles, birds and mammals, seems to be the first creature in the animal kingdom with a bicondylar knee joint.
- The patellofemoral joint, however, only began to develop some 65 million years ago.

Patella Facets

- The posterior surface of the patella articulates with the trochlear groove along the anterior surface of the femoral condyles to form the patellofemoral joint.
- The posterior patella has a medial and lateral facet. A variable, usually small, odd facet lies along the medial border of the patella.

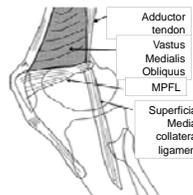
Patellar facets

Lateral	
Medial	
Odd	

Passive Stabilizers

- The patellar ligament and the medial and lateral patellar retinacula form the passive stabilizers of the patella.
- The retinacula have deep and superficial layers and can have a bilaminar appearance.
- The retinacula provide significant stabilizing support to the patella.

Passive Stabilizers



- On the medial side, the medial patellofemoral ligament has been shown to be the major passive restraint preventing lateral patellar dislocation
- The medial patellofemoral ligament arises between the adductor tubercle (the insertion of the adductor magnus tendon), and the medial epicondyle (the site of origin of the tibial collateral ligament).
- The ligament then runs forward just deep to the distal vastus medialis obliquus muscle to attach to the superior two thirds of the medial patella margin.

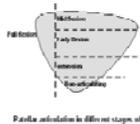
Dynamic Stabilizers



The four quadriceps muscles form the active stabilizers of the patella.

The inferior portions of the vastus medialis and lateralis muscles form small muscle groups with a distinct oblique orientation of their fibers, the vastus medialis obliquus and the vastus lateralis obliquus muscles.

Biomechanics



- In the fully extended knee the patella lies superior to the trochlear cartilage.
- As the knee flexes to 30°, the patella begins to engage with the trochlea.
- Between 30 and 90° of flexion, first the inferior and then the superior patella cartilage articulates with the trochlear cartilage.
- Beyond 120°, contact is reduced between the patella and trochlea.

Anterior Knee Pain

- Patellofemoral pain syndrome
- Trauma-Dislocation
- Osteoarthritis
- Cartilage abnormalities
- Osteochondritis dissecans
- Bipartite patella-Dorsal defect of the patella
- Synovial Plica
- Extensor mechanism tears
- Bursitis
- Osgood-Schlatter Disease.
- Excessive lateral pressure syndrome
- Sinding-Larsen-Johannson

Patellofemoral Pain Syndrome

- Loosly used term to describe anterior knee pain that is thought to be due to malalignment and maltracking issues.
- Symptoms include anterior knee pain and giving way.
- Most common diagnosis in outpatients presenting with knee pain
- 16-25 % of injuries in runners
- 11% of musculoskeletal complaints in the office

Definitions

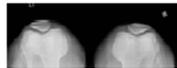
- Patellofemoral alignment refers to the static relationship between the patella and the trochlea at a given degree of knee flexion.
- Patellofemoral tracking refers to the dynamic patellofemoral alignment during knee motion.

Limitations of Radiology

- Measures of alignment will vary depending on the degree of knee flexion.
- Imaging studies of the patellofemoral joint for tracking should focus on the first 30-45 degrees of flexion. In early flexion is when anatomical factors such as patella alta, trochlear dysplasia and abnormalities of the soft tissue restraints of the patella have the most pronounced effect in producing abnormal tracking.

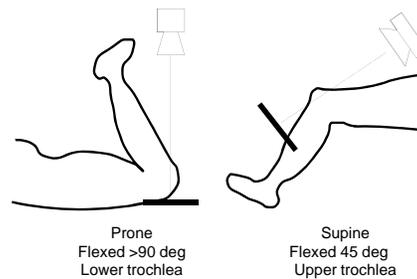
Tangential views of Patella

- AKA Axial
- Merchant
 - Supine, 40° flexion, Craniocaudal, Beam 10° to tibia, Bilateral
- Hughston
 - Prone, 55° flexion, Beam 10° to tibia, Caudocranial, Unilateral
- Settegast, Sunrise or Skyline
 - Prone, Maximum flexion, Beam 15-20° to tibia, Caudocranial, Unilateral



Patellofemoral radiography

Sunrise vs Merchant



Trochlear Dysplasia

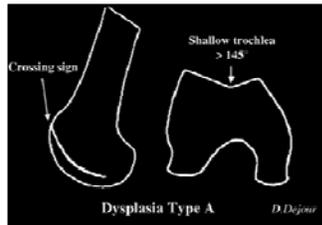
- 96% of patients with true patellar dislocation had evidence of trochlear dysplasia. Only 3% of normals had trochlear dysplasia

Different Types of Trochlear Dysplasia

- Type A: the normal trochlear morphology is preserved, but the trochlea is shallow (>145 degrees)
- Type B: Flat or convex trochlea
- Type C: The lateral femoral condyle is convex anteriorly and the medial femoral condyle is hypoplastic (giving the double contour)
- Type D: Also has a hypoplastic anterior surface of the medial condyle, but there is a more vertical link between the medial and lateral facets (cliff pattern), also called a lateral spur

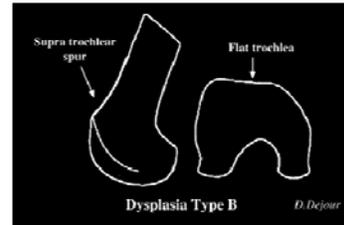
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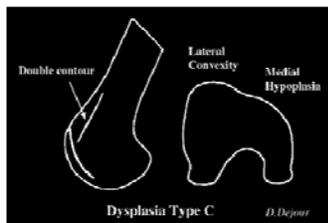
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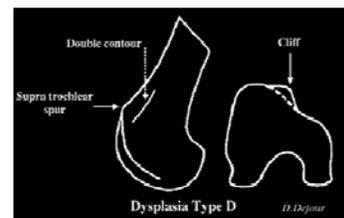
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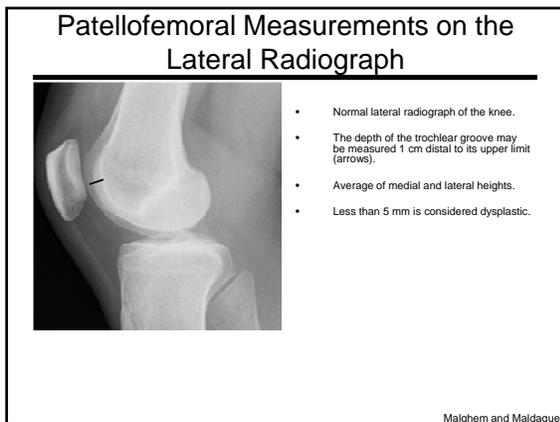
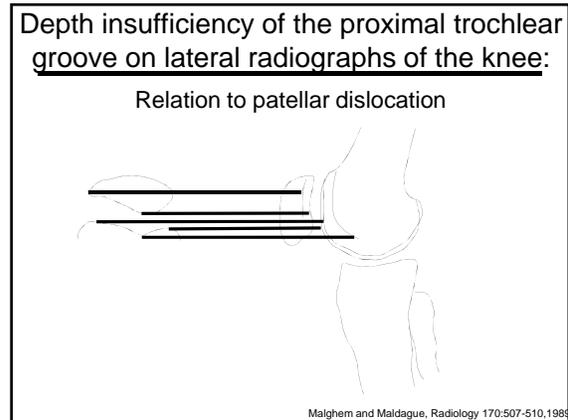
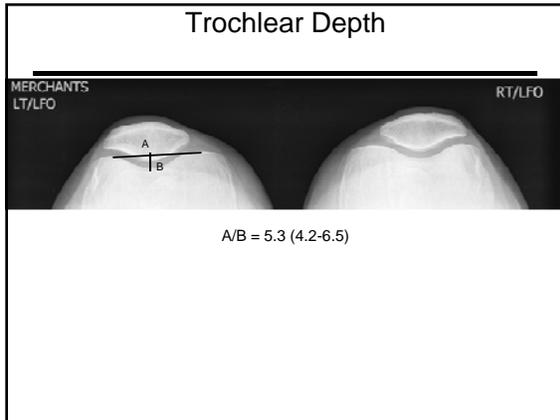
Trochlear Depth Sulcus Angle



- A line is drawn from the lowest point of the intercondylar sulcus, B, to the highest points of the lateral and medial femoral condyles, A and C. The angle between lines AB and BC is the sulcus angle.
- Normal range 136+/-6°
- >145 associated with recurrent dislocation

Trochlear dysplasia

- On the merchant's view, there is a shallow trochlear angle of >145 degrees (some say >150 degrees)

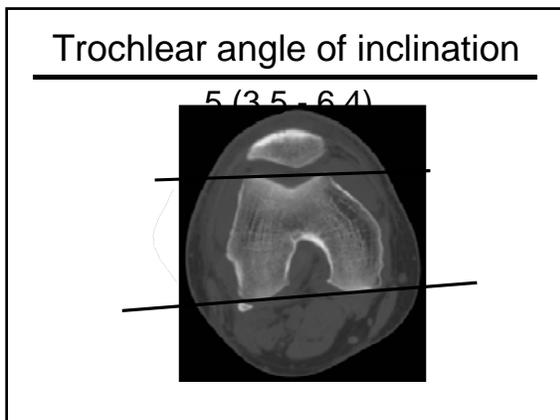


Trochlear groove depth

Lateral x-ray: 1 cm below its upper margin

	Depth
Normal	6 mm (+/- 1.7)
Symptomatic: No subluxation	5.8 mm (+/- 1.5)
Symptomatic: Subluxation	3.8 mm (+/- 1.1)
Operated on for subluxation	2.7 mm (+/- 1.4)

Malghem and Maldague, Radiology 170:507-510,1988



- ### CT Technique
- 1. Flexion views:
 - Mid patella single 2.5/3mm axial view @ right angles to patella articular surface (will need to angle gantry) @ 0, 15, 30, 45 degrees knee flexion, toes pointing straight up, feet together. The degree of flexion can be eyeballed with experience, or a goniometer may be employed. The angle can be checked on the lateral scout. Send only bone algorithm.
 - The following 3 radiologist measurements are made on 30 degree angle view only.
 - Patella tilt:
 - Lateral trochlear angle:
 - Subluxation:

CT Technique Lateral trochlear angle

- 30° flexion view
- Femoral condyles base line
- Line on lateral side of trochlear groove
- Angle greater than 11 degrees is good



Trochlear dysplasia

- Radiographic signs on the lateral include:
 - Crossing sign: this is from the deepest part of the trochlear groove crossing the anterior aspect of the condyles
 - Supratrochlear spur
 - Double Contour: due to a hypoplastic medial condyle

Trochlear depth Crossing sign

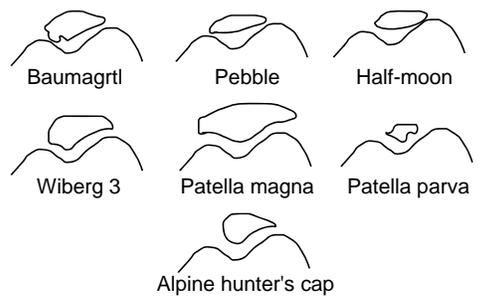
- Need to work out which is medial and lateral condyles on a lateral view
- Notch method
 - Lateral notch posterior to Blumenstats line
 - Medial notch anterior to Blumenstats line
- Congruence method
 - Medial tibial plateau concave superiorly
 - Lateral femoral condyle convex superiorly



Patellar morphology Wiberg classification

Type	Incidence	Features
1	10%	 Both facets concave Medial = lateral
2	65%	 Lateral facet concave Medial facet flat or convex Lateral > medial
3 (Predisposed to sublux)	25%	 Lateral facet concave Medial facet convex Lateral >>> medial

Patellar dysplasias



Baumagrtl Pebble Half-moon

Wiberg 3 Patella magna Patella parva

Alpine hunter's cap

Quadriceps dysplasia Congruence Angle



- Used to measure lateral patellar displacement
- To measure the congruence angle (curved arrow) in (a), the sulcus angle is bisected to produce a reference line, and the angle is measured between this reference and a line joining the apex of the sulcus, B, and the lowest point of the patellar articular surface, D.
- In the normal knee, point D should lie no more than 16° lateral to the bisected sulcus angle.
- >23 associated with patella dislocation

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Quadriceps dysplasia Patella Tilt

- Lateral Patellofemoral Angle
- The angle between a line joining the apices of the femoral condyles and a line joining the limits of the lateral patellar facet. The angle is taken to be normal when it opens laterally, and abnormal when it opens medially.

Quadriceps dysplasia Patella Tilt

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- The angle between a line joining the apices of the femoral condyles and a line joining the limits of the lateral patellar facet. The angle is taken to be normal when it opens laterally, and abnormal when it opens medially.

Patellofemoral index

$A/B < 1.6$ (at 20 degrees flexion)

- A Shortest distance from lateral edge of medial facet to medial condyle
- B Shortest distance between lateral facet and lateral condyle

Quadriceps dysplasia Lateral Patellar Displacement

- Measured by drawing a line joining the summits of the medial and lateral femoral condyles and dropping a perpendicular to this at the level of the summit of the medial condyle. The distance of the medial margin of the patella from this perpendicular is measured (arrowheads).
- In the normal knee the medial patellar margin should lie no more than 1 mm lateral to the perpendicular.

Quadriceps dysplasia Lateral Patellar Displacement

- Measured by drawing a line joining the summits of the medial and lateral femoral condyles and dropping a perpendicular to this at the base of the trochlear groove. The distance of the apex of the patella from this perpendicular is measured.
- In the normal knee the patellar median ridge should lie no more than 5 mm lateral to the perpendicular.

Patellofemoral Measurements on the Lateral Radiograph

- In grade I alignment (normal) the median ridge of the patella (open arrow) lies posterior to the lateral facet (curved arrow). On a lateral radiograph the median ridge and lateral facet form two separate borders which appear slightly concave.
- With mild patellar tilt (grade II) the median ridge and lateral facet line up on the lateral views so that only one border is seen.
- With further tilt (grade III), the lateral facet projects posterior to the median ridge and appears convex.

CT Technique

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 - The following 3 radiologist measurements are made on 30 degree angle view only.
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 - Lateral trochlear angle:
 - Subluxation:

CT Technique Patella tilt

- Base line is line between posterior femoral condyles.
- Line on lateral facet of patella.
- If angle between these is less than 10 degrees then abnormal.

CT Technique Subluxation

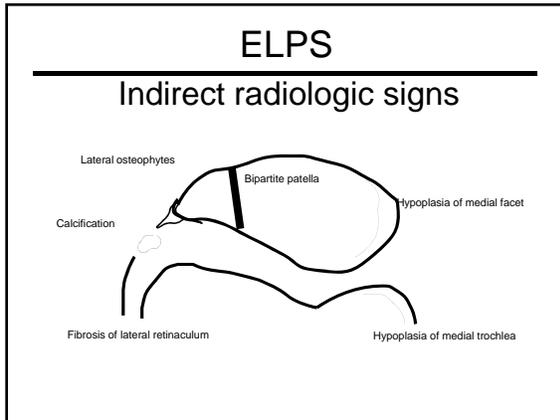
- Measured in mm.
- Draw lines down either side of trochlear groove.
- Draw bisector of this angle from its apex.
- Measure distance of patella apex from this line.

Fulkerson Classification

- Type I: Subluxation alone
- Type II: Subluxation and tilt
- Type III: Tilt alone
- Type IV: no malalignment

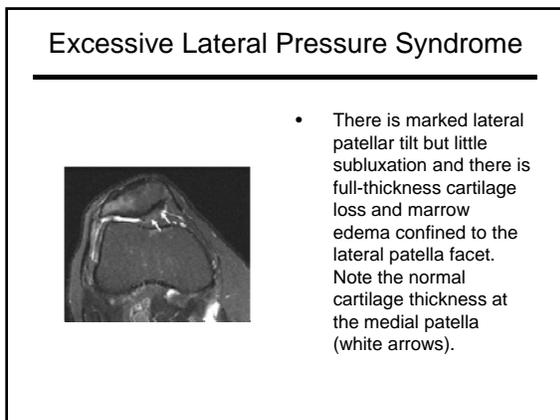
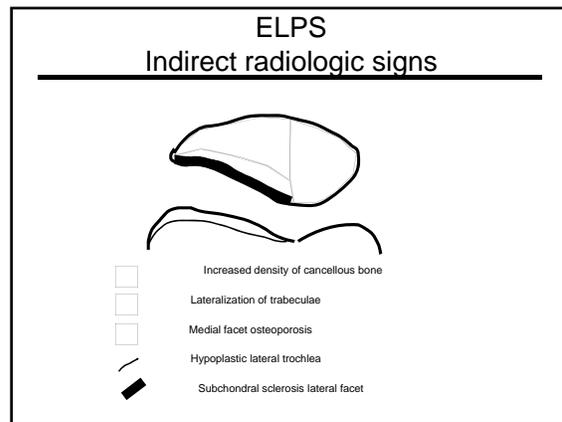
Excessive lateral pressure syndrome ELPS

- Clinical-Radiologic entity
- Characterized clinically by pain
- Characterized radiographically by lateral patellar tilting without subluxation
- Patella stable and well-centered in trochlea but functionally lateralized onto lateral facet



- ### ELPS
-
- Transverse play limited with particular restriction of medial mobility
 - Hypermobile patella may be present
 - Treatment consists of lateral release and cartilage debridement if OA has developed

- ### Etiology of ELPS
-
- Excessive lateral ligament tension
 - Congenital band
 - Developmental genu valgus
 - Post-traumatic
 - Skeletal abnormalities
 - Trochlear protrusion
 - Convex patella
 - Disruption of medial stabilizers
 - Medial retinaculum
 - Vastus medialis



- ### Excessive Lateral Tension Syndrome
-
- Progressive fibrosis of lateral retinaculum causes thickening and retraction of retinaculum, often palpable clinically
 - Tightening of lateral retinaculum can affect movement mostly in flexion
 - Predisposing factors: Congenital patellar abnormalities, possibly bipartite patella
 - With progressive increase in tensile forces can lead to fragmentation of developing ossification center
 - MRI: thickening of lateral retinaculum, bipartite patella, and absence of patellar tilt/subluxation

Excessive Lateral Pressure Syndrome

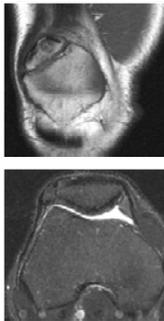
- Normally located patella, but patellar tilt is present
- Loss of articular cartilage in lateral facet of patella and/or trochlea
- Possible causes include breakdown of structures responsible for medial stability of the patella (medial retinaculum) or abnormalities of lateral retinaculum (ELTS) or lateral patellar facet
- Findings: Cartilage loss lateral facet of patella and trochlea +/-sclerosis and cystic change

Dorsal Defect of the Patella



- Defect in the subchondral bone of the superior patella.
- Note that the overlying cartilage is thickened over the defect to produce a near normal articular surface

Bipartite Patella



- Accessory ossification center at the superolateral patella.
- Axial fat-saturated T2-weighted image demonstrates that the overlying cartilage appears intact.

Patella alta

- Recurrent effusions
- Recurrent patellar subluxation
- Chondromalacia
- Sinding-Larsen-Johanssen

Patellofemoral contact

- In full extension, articulates with supratrochlear fat pad
- Contacts trochlea at 10-20 degrees flexion
- With patella alta, additional flexion necessary to establish contact and achieve stability

Patella Height Modified Method Insall-Salvati

- Knee 20-30 of flexion
- Superimposition of condyles posteriorly
- Patella index AT/AP
- Less sensitive to variation in patella morphology
- >2 (alta) associated with instability



Patella Height Blumensaat method

- Blumensaat line should fall below the inferior surface of the patella

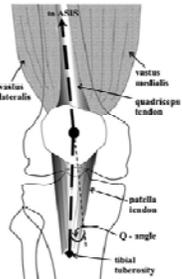


Q-angle

- Measured supine with the knee fully extended
- Normal 15°

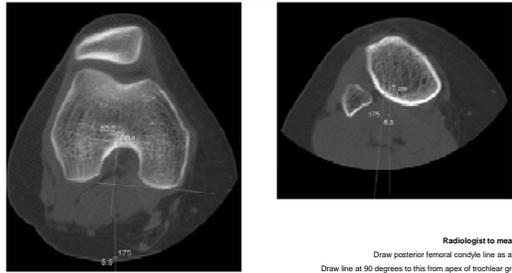


Genu Valgus Q Angle



- The Q angle is formed between a line joining the anterior superior iliac spine and the center of the patella, and a line joining the center of the patella and the tibial tuberosity.
- Normal angle 10-12 degrees in males and 15-18 in females
- Questionable validity

Genu Valgus Tibial tubercle to trochlear groove displacement



Radiologist to measure
 Draw posterior femoral condyle line as above.
 Draw line at 90 degrees to this from apex of trochlear groove.
 Transpose parallel lines to tibial tuberosity.

Measure distance difference of the two intersecting points along the line of the condylar line to a fixed point such as the edge of the film and subtract.

In other words what is the lateral distance between these two parallel lines one from the tibial tubercle, one from the apex of the trochlea notch, both at right angles to the line between the posterior femoral condyles.

Genu Valgus Femoral anteversion

- 30-40° at birth
- 8-14° in adults
- Men average 8°
- Women average 14°
- Cause of intoeing

Treatment

- Conservative: Physical therapy is used not for primary treatment of dislocation, but for better recovery
- Operative: more than 100 operations described, but no gold standard for operative treatment has been established

Operative treatments

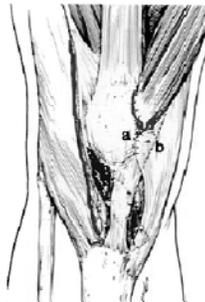
- Lateral release: the only treatment that has actually been shown to be definitively **INEFFECTIVE**.
- Medial repair: can result in excessive medialization and poor tracking; studies have found mixed results.
- Trochleoplasty: supposed to deepen and recreate normal trochlear groove by removing cancellous bone and repositioning the cortical bone; again this produced mixed results. It has limited use in the US due to concerns about irreversible articular and subchondral injury.

Treatment Modified Roux-Goldthwait

- Transfer of the lateral half of the patellar tendon medially
- Indications
 - maltracking or subluxation without arthrosis
 - maltracking or subluxation in immature patients

Modified Roux-Goldthwait

- Procedure
 - Lateral patellar retinacular release
 - Medial transfer of the lateral aspect patellar tendon
 - Plication of the medial retinaculum
 - Advancement of the vastus medialis

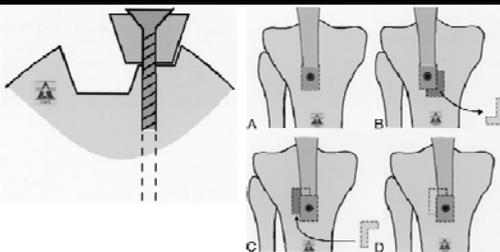


Treatment Fulkerson osteotomy

- Otherwise in pts with patellofemoral tracking and subluxation/dislocation with **ARTHROSIS**
- Perform osteotomy (ie. Maquet, Elmslie-Trillat, or Fulkerson) Fulkerson preferred with increased flexibility.
- Fulkerson is anteromedial tubercle transfer.



Treatment Fulkerson osteotomy



Conclusion

- Discuss basic anatomy and biomechanics of the patellofemoral joint
- Understand imaging methods and limitations of these imaging methods used to assess the patellofemoral joint.
- Be familiar with basic terminology and measurements used to describe the patellofemoral joint in order to communicate with the clinicians accurately and effectively.
- Have a working differential diagnosis of anterior knee pain