The postoperative knee

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Objectives

indication	Clinical needs versus artifacts
interpretation	Patterns of graft and ware failure
diagnosis	Potential causes of posttraumatic synovitis

40 ys male with recent trauma, ACL repair two years ago
Significant synovitis

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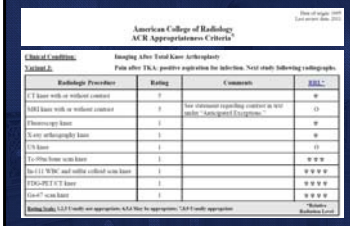
MRI is important, but with view on the clinical findings



American College of Radiology
ACR Appropriateness Criteria®

Clinical Condition: Imaging After Total Knee Arthroplasty
Variant 2: Pain after TKA: positive aspiration for infection. Next study following radiographs.

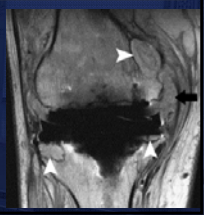
Radiologic Procedure	Rating	Comments	RRL*
CT knee with or without contrast	9		*
MRI knee with or without contrast	9	See statement regarding contrast in MSK under "Anticipated Exceptions."	O
Fluoroscopy knee	7		*
X-ray arthrography knee	5		*
US knee	5		O
Tc-99m bone scan knee	5		* * *
In-111 WBC and sulfur colloid scan knee	5		* * * *
FDG-PET CT knee	5		* * * *
Ga-67 scan knee	5		* * * *

Rating Scale: 1,2,3 usually not appropriate; 4,5,6 May be appropriate; 7,8,9 usually appropriate

*Relative Radiation Level

Indications for postoperative imaging

- Re-injury after arthroscopy
- Persisting pain after arthroscopy
- Periprosthetic infection (?)



chronic indolent infection superimposed on particle disease 26 months after TEP Potter HG, Foo LF. Magnetic resonance imaging of joint arthroplasty. *Orthop Clin North Am* 2006; 37(3):361

Artifacts that are increased at 3T: avoidance by careful sequence design

- Motion artifacts
  as the better resolution with 3T will also result in a "better" display of motion artifacts. Sequences have to be performed in a fast way and with proper patient positioning.

  Avoidance
  - Careful patient preparation
  - Postprocessing of images with „smoothing"
- Chemical shift
  increases linearly with field strength and, therefore, is more problematic at 3T

  Avoidance
  - Increase bandwidth and/or decrease pixel size
  - Use fat-suppression
- Susceptibility artifacts
  signal loss around regions of susceptibility difference

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indication	
interpretation	Patterns of graft and ware failure: • ACL reconstruction • the postoperative meniscus • cartilage repair
diagnosis	

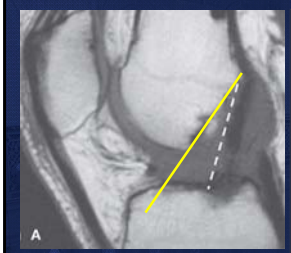
Types of grafts

ACL reconstruction

- Autografts:
  patellar
  distal semitendinosus, gracilis tendons: may have layered appearance as they are sutured together, sometimes with small fluit between bundles
- Synthetic grafts, e.g. Lars ligament, in rare and selected cases

White L et al. postoperative knee. Skeletal Radiol 2005

ACL: Tunnel positioning



Posteriorly positioned reconstructed ligament (White L et al. Skel Radiol 2005)

Tunnel positioning:
- femoral tunnel: for isometry
- tibial tunnel: for impingement

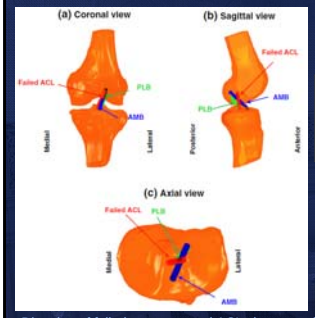
Blumensaat's line (intercondylar roof) crossing the tibial border as important marker:

Tibial tunnel:
- anterior positioning: impaired flexion
- posterior positioning: laxity and ligament degeneration

Femoral tunnel
- posterior to Blumensaat's line

Coronal images
- less than 75 degrees to horizontal line

Assess graft position in all three planes



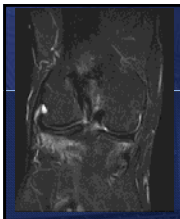
Direction of failed reconstructed ACLs in comparison to normal course of anteromedial and posterolateral bundles

The importance of tunnel positioning

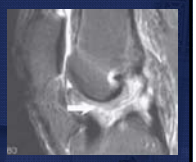
„we could not conclude that a nonanatomical tunnel placement/graft orientation will definitely lead to ACL reconstruction failure."

Hosseini A et al. Tunnel position and graft orientation in failed anterior cruciate ligament reconstruction: a clinical and imaging analysis. International Orthopaedics (SICOT) (2012) 36:845

Re-injury: after 1 year ACLs are very stable



19 ys male: MR arthrogram with rupture of reconstructed ACLMeyers A et al. AJR 2010, 194.



45 ys male with ACL reconstruction 2 ys ago, now recent trauma: no tear

Graft re-tear (White L et al. Skel Radiol 2005)

Types of graft failure I

42 ys male with graft impingement

- Graft impingement (initial decreased range of motion with eventual graft failure). Notchplasty may be preventive
- Tibial tunnel enlargement secondary to graft laxity and knee instability.
  With endobutton fixation increased risk of cystic graft degeneration and of tunnel widening due to the so-called "windshield wiper" effect of the graft
- Screw-loosening with movement of screw

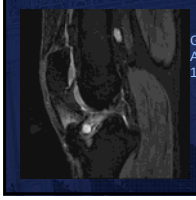
42 ys male with slightly widened tibial tunnel

Scar formation with reduced movements

Types of graft failure II

- Arthrofibrosis: rare
  Cyclops lesion: focal pseudotumor ventral to ACL graft (may be due to residual old ACL)
- postoperative Hoffitis

Cyclops lesion (Gnannt R et al. JMRI 2011)



Ganglionic cyst after ACL reconstruction in 1974

Hoffa's fat pad with proliferative synovitis

Hyperintense signal within 6 - 12 months is normal

The ligamentization of the ACL

Different stages have been described but no agreement exists about the time frames within 2 years after surgery:

- Early period (1 – 12 months)
- Remodelling (2 – 18 months)
- Maturation (3 – 49 months)

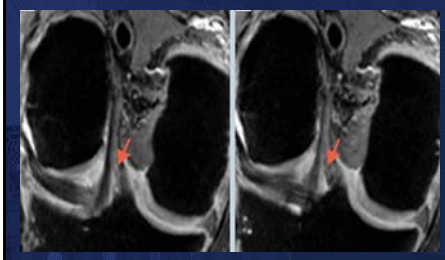
Problematic direct transmission of animal data to the human situation

DDx secondary degeneration due to malpositioning

Claes S et al. The "Ligamentization" Process in Anterior Cruciate Ligament Reconstruction: a systematic review. Am J Sports Med 2011

Graft is enveloped by synovial tissue with graft vascularization: mild increased signal intensity on T1- and T2 during next 12–18 months. Following which, the signal intensity characteristics approach those of native ACL.

Anterior cruciate ligament: 3D oblique reconstruction



Horng A et al. 2009

Cruciate ligaments: normal anatomy of double bundles

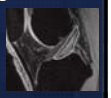
Starman JS et al.,
Knee Surg Sports Traumatol Arthrosc, 2007

26 ys male with two separate bundles: norma variant

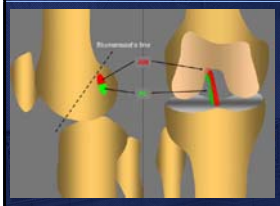
ACL

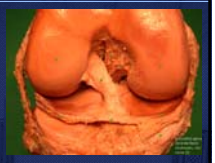
- Anteromedial bundle:
  taut in flexion:
  isometric
  > 45º flexion important for translation of tibia
- Posterolateral bundle:
  taut in extension
  less isometric
  important in low-degree flexion

- Differentiation of bundles with 3 T is significantly better
- ACL-injured subjects have smaller ligaments than matched controls - a MRI study:
  Chaudhari A et al., Am J Sports Med, 2009

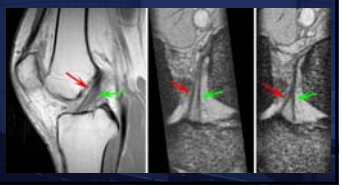


3 T of ACL: clinical impact

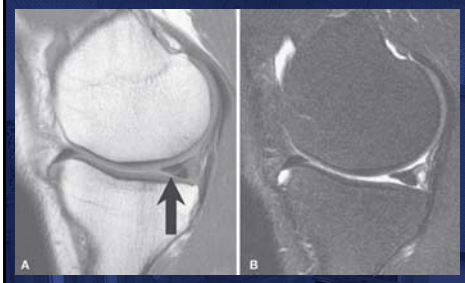




Pöllinger A et al. Magnetic resonance imaging of double-bundle anterior cruciate ligament reconstruction. Skelet Radiol 2009

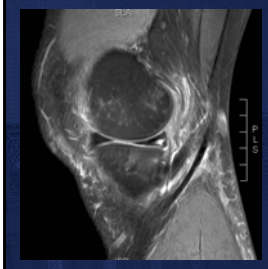


The postoperative meniscus



Scar after arthroscopy, no re-tair (proven by 2nd look arthroscopy; White L et al. Skel Radiol 2005)

The postoperative meniscus



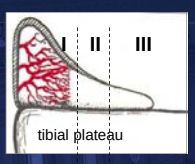
menisceal suture

DDx postoperative scar vs re-tear

- Fluid signal within meniscus indicates re-tear
- MR-arthrography may be helpful
- In the context with clinical findings conventional MRI is highly sensitive (White L et al.)

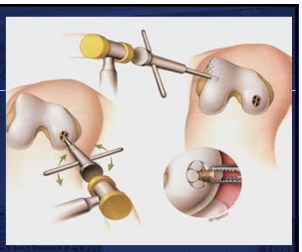
Meniscus: anatomy and normal variants

- Congenital variants:
  aplasia: especially posterolateral horn; DDx meniscectomy
  hypoplasia: common in anterolateral horn
  hyperplasia: common in posterior horn
  discoid meniscus
- Vascular supply:

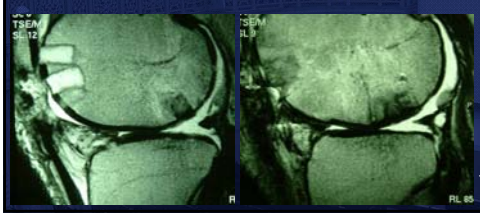


} Low quality tissue

Cartilage transplantation



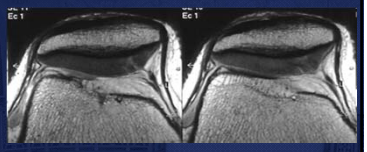
autologous osteochondral transplantation (AOT)



postop.
normal

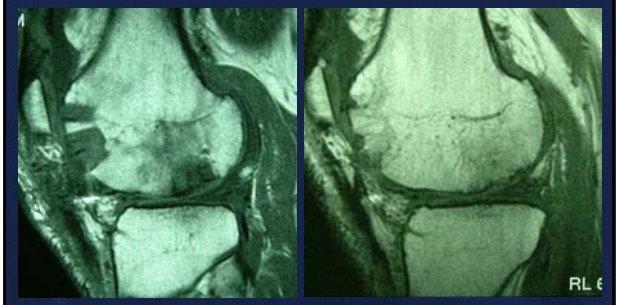
T2-FSE

Cartilage sensitive sequences



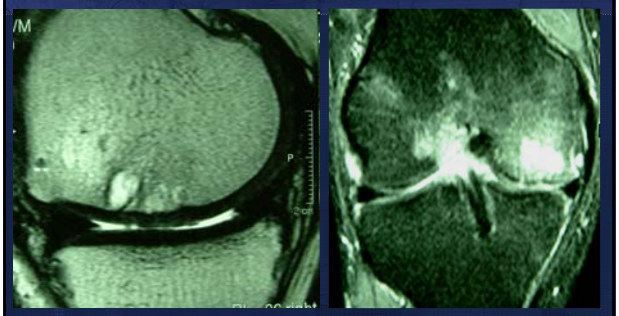
- for pre- and postoperative diagnosis:
- MR-arthrography
  Mathieu L et al. Knee MR-arthrography in assessment of meniscal and chondral lesions. Orthop Traumatol Surg Res. 2009:40-47
- CT-arthrography

Bone integration normal



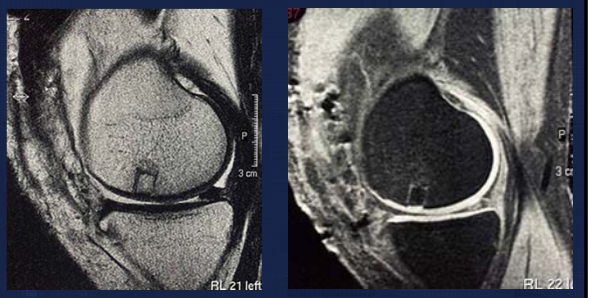
3 months p.s. T1-SE 24 months p.s.

Bone integration abnormal

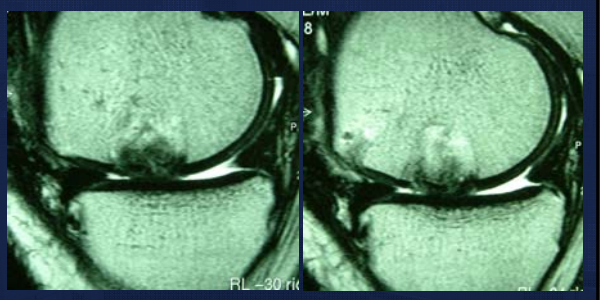


T2-FSE 24 months STIR-TSE 24 months

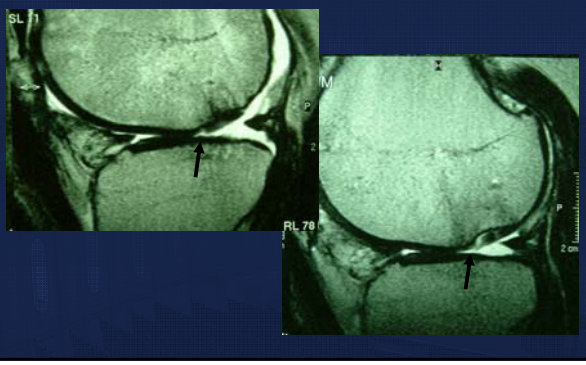
Cartilage integration normal



Hypertrophy of the graft



Partial delamination of cartilage



Incorrect Surgical Technique

Improper positioning of osteochondral cylinders

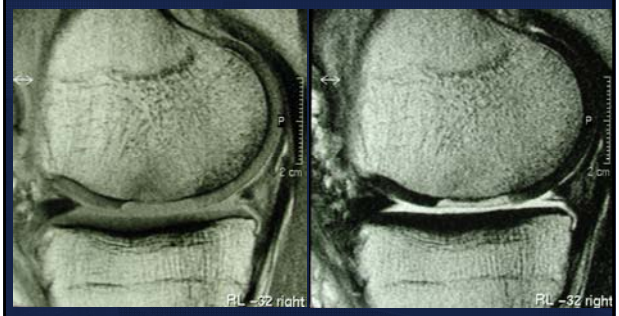
Matrix-associated ACI

Two-stage procedure:

1. Biopsy of 200mg cartilage
   Extraction of chondrocytes
   Grown in culture,
   Transferred on biomaterial
2. Miniarthrotomy
   Transplant trimmed into defect
   Edges fixed with fibrin glue

Matrix-associated ACI

4 weeks



PD-sequence: WNL within normal limits

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Indications	MRI provides added value only in context with clinical investigatioin
Interpretation	Increase in signal intensity is not always normal
Diagnosis	Posttraumatic synovitis: an underestimated entity Return to play Future aspects: muscle strength of quadriceps and hamstrings