Magnetic Resonance Imaging of Injuries of the musculotendinous Unit in Elite Athletes

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- Outpatient Imaging Center, Marienplatz
- 1,5 / 3T MRI, Müller-Wohlfahrt Orthopedic Center
- Department of Rad & Nuc, Rot-Kreuz Hospital
- Imaging Center at Martha-Maria Hospital
- Imaging Center, Garmisch-Partenkirchen
- Cooperations:
  - Breast Imaging Center: Technical University & Radiologie am Prinzregentenplatz
  - PET-CT: Neuwittelsbach Hospital
Teaching

- Charité, Berlin
- University of Latvia, Riga
- Dresden International University
- 2005 Foundation of the German-Latvian Society for Radiology & Nuclear Medicine
Böck JC, Mundinger P, Luttke G.

Magnetresonanztomografie.


Dr. Müller-Wohlfahrt: Responsible physician of FC Bayern München & German National Football Team
Why Magnetic Resonance Imaging?

- Visualization & documentation of all structures affected by sports injuries
- Therapy planning
- Prognosis
- Documentation & evaluation of the healing process
Why Magnetic Resonance Imaging?

- Radiation exposure:
  - MRI: none
  - Ultrasound: none
  - X-ray: relatively low
  - CT: relatively high
Muscle-tendon-bone-interface: weakest points

- Adult athletes
  - Musculotendinous junction
- Adolescent athletes
  - Apophysis
- [Elderly]
  - Tendon (on the basis of preexisting chronic-degenerative damage)
Musculotendinous lesions

- Excentric contraction
  (= sudden strain of a contracted muscle)

- Typical: Muscles that course over two joints
  - Rectus femoris muscle
  - Hamstring muscles
  - Gastrocnemius muscle

- Less typical: Muscles that course over one joint
  - Adductor muscles (Adductor longus muscle)
Arbitrary („old“) classification

- Grade I: „Small“, edema, intact function
- Grade II: Partial muscle tear
  - Grade IIa: < 1/3 of cross-sectional area
  - Grade IIb: 1/3 – 2/3
  - Grade IIc: > 2/3
- Grade III: Complete muscle tear

More physiologic classification - morphologic subjunit of muscle

- Secondary muscle fiber („meat fiber“)
  - Diameter 1-2 mm, in athletes up to 5 mm
  - Intact → Functional lesion
- Rupture
  - Muscle fiber rupture (< 5 mm)
  - Muscle bundle rupture (≥ 5 mm)
  - Muscle rupture (complete)
Classification of muscle lesions
(Müller-Wohlfahrt et al, Thieme, 2010)

- Painful induration (Type I)
- Muscle strain (Type II)
- Muscle fiber rupture (Type IIIa)
- Muscle bundle rupture (Type IIIb)
- Muscle rupture (Type IV)
Strain - fiber rupture – bundle rupture

- Muscle strain (Type II)
  - Increasing pain
  - Game continues
  - No fibers ruptured
Strain - fiber rupture – bundle rupture

- Muscle fiber rupture (Type IIIa)
  - Increasing pain
  - Game continues +/-
  - Fiber rupture: Axial Ø < 5 mm

- Muscle bundle rupture (Type IIIb)
  - Intense sudden pain
  - Game over (immediately)
  - Fiber rupture: Axial Ø ≥ 5 mm
Visualization of intact secondary muscle fibers

Left: After i.m. infiltration of rectus femoris muscle

Right: Normal
Significance of spatial resolution

Biceps femoris muscle:

Differentiation edema, hematoma, muscle lesion
Muscle strain (Type II)

Soleus muscle, musculotendinous junction

Intact secondary muscle fibers
Muscle fiber rupture (Type IIIa)

Adductor longus muscle

Discontinuity of individual secondary muscle fibers
Muscle bundle rupture (Type IIIb)

Adductor longus muscle:

- Rupture of numerous secondary fibers
- Hematoma
- Distal retraction
- Elongated course
Muscle bundle rupture at the musculotendinous junction

Biceps femoris muscle: Musculotendinous stump, retraction with bundle deviation, gap, hematoma
Muscle bundle rupture at the musculotendinous junction

Gap, hematoma; distal musculotendinous stump
Muscle bundle rupture

Gastrocnemius medialis muscle: Partial rupture of the musculotendinous junction: gap, retraction
Prognosis and time course under therapy

- Prognostic criteria:
  - Pathologic MRI-findings are associated with poor prognosis
  - Cross sectional area (IIIa vs. IIIb vs. IV)
  - Longitudinal extent of lesion

- Evaluation and documentation of individual healing process, complications
Muscle bundle rupture: Healing

Biceps femoris muscle
Extensive muscle bundle rupture - Partial muscle rupture: Healing

Rectus femoris muscle: Rupture of approximately 1/3 of the cross sectional area
Extensive muscle bundle rupture - Partial muscle rupture: Healing

Evolution under adequate therapy:
After 7 weeks minimal residual seroma
Old muscle lesions

- Risk factor for second muscle lesion
- Risk correlates with extent of old lesion
- Second lesion frequently more extended
- Magnetic Resonance Imaging:
  - Visualization of old and new lesions
Old muscle lesion

Rectus femoris muscle: Posttraumatic fibrosis
Lesions of the bone-tendon interface

- Partial avulsion of tendon
- Complete avulsion of tendon
- Bony avulsion
- Partial apophyseolysis
- Complete apophyseolysis
Partial avulsion of tendon

Adductor longus muscle: Lateral fascicle and fascicle to arcuate ligament intact
Complete avulsion of tendon

Adductor longus muscle:
Retraction, cortical bone intact
Bony avulsion

Adductor longus and brevis muscles:
Bony defect and fragment, retraction
Traumatic apophyseolysis: Healing

Rectus femoris muscle:
Hematoma, dislocation of apophysis

after 6 weeks
MRI for the assessment of muscle injuries: Summary

- Exact evaluation of lesions of muscle, tendon and apophysis
- Degree of previous lesions
- Associated lesions (bone, joint)
- Prognosis, therapy planning
- Evaluation of healing process
- Objective documentation
Thank you
for your kind attention

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