Imaging of Myopathies
(with focus on MRI)

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Skeletal Muscle Disease Evaluation

Clinical

• Painful, tender
• Difficulty with tasks
• Systemic manifestations
Skeletal Muscle Disease Evaluation

**Clinical**
- Painful, tender
- Difficulty with tasks
- Systemic manifestations

**Radiological**
- Anatomical location
- Extent
- Severity
Abnormal Muscle on MRI

- Trauma
- Infection
- Inflammation
- Neurologic
- Neoplastic
- Iatrogenic

Resulting in:
- Edema pattern
- Fatty infiltration ± muscle atrophy
- Mass lesion
Conventional MRI of Muscle

T1-weighted
- Muscle bulk
- Anatomy (anomalous, herniation)
- Hyperintense: hemorrhage, fat
Conventional MRI of Muscle

Water-sensitive

- T2 (generally with fat suppression)
- Inversion recovery
Caution!

- Fatty infiltration on "fat suppressed" T2 can mimic muscle edema
Caution!

- Subtle muscle edema can be overlooked on inversion recovery!
Conventional MRI of Muscle

- Gradient echo (hemorrhage, mineralization)
- Intravenous contrast (masses, infection)
1. Edema pattern

2. Fatty infiltration ± muscle atrophy

3. Mass lesion
1. Edema pattern

2. Fatty infiltration
   ± muscle atrophy

3. Mass lesion
Edema Pattern
Muscle Trauma

• Injury initiates rapid invasion by inflammatory cells: days to weeks
• Repair, regeneration, and growth
• ± Eventual fibrosis
• Grades:
  – I (strain – microscopic injury)
  – II (partial thickness tear)
  – III (complete tear)
Edema Pattern
Muscle Trauma
Grade I: Strain
Edema Pattern
Muscle Trauma
Grade III: complete tear
Edema Pattern
Exertion

• Delayed Onset Muscle Soreness (DOMS)
  – Unaccustomed exertion
  – Reversible injury
  – 1-2 days after exercise, peaks 2-3 days
  – Interstitial edema ± fascial edema (like grade I strain)
Edema Pattern
DOMS
Edema Pattern
Infection

- Hematogenous, 90% *Staph aureus*
- Often with abscess formation
  - Immunodeficiency
  - Trauma
  - Concurrent infection
  - Tropical pyomyositis
Two weeks later

T1 + Gd
Edema Pattern
Inflammation

• Idiopathic
  – Juvenile dermatomyositis
    • microangiopathy of skin and muscle
    • Symmetric, progressive proximal muscle weakness
    • Cutaneous manifestations
    • ± Calcinosis
  – Polymyositis
    • No cutaneous manifestations
Juvenile Dermatomyositis

- Rash
  - Heliotrope periocular discoloration, malar
  - Erythematous, scaly, papules (Gottron’s)
- Elevated muscle enzymes
Edema Pattern
Inflammation

• Duchenne Muscular Dystrophy
  – X-linked
  – Symmetric
  – Proximal muscle weakness
  – Early inflammation, later fatty infiltration
  – Gluteus maximus most, gracilis least severely affected
Duchenne Muscular Dystrophy
Edema Pattern

Denervation

• Almost any voluntary muscle
• Trauma, neuropathy, mass, vasculitis, vascular compression
• Acute/subacute: hyperintense signal
  – Shift of intra- to extracellular water?
  – Not associated with fascial edema
• Chronic: muscle atrophy, fatty infiltration
Edema Pattern
Acute/Subacute Denervation
Edema Pattern
Radiation Therapy - Induced

- Vasculitis, tissue injury
- Straight border (muscle and fat)
- Distribution of radiation field
- Peaks 12-18 months after external beam
Edema Pattern
Rhabdomyolysis

- Weakness, myalgia, dark urine (classic triad)
- Renal failure less common
- Trauma (abuse) infection, inherited disorders
- Asymmetry, myonecrosis
15-year old boy s/p extensive multi-ligament knee repair
1. Edema pattern

2. Fatty infiltration 
   ± muscle atrophy

3. Mass lesion
1. Edema pattern

2. Fatty infiltration
   ± muscle atrophy

3. Mass lesion
Fatty Infiltration

- Abnormal deposition of fat in muscle
- Usually associated with atrophy
- Chronic insults, late stage pathology
- Irreversible muscle injury
Fatty Infiltration
Chronic Denervation

• Fat replacement and diminished bulk
Fatty Infiltration
Myopathy
Duchenne Muscular Dystrophy
Fatty Infiltration/Atrophy
Sequela of high grade myotendinous injury

2 years later
Fatty Infiltration
Fatty Masses
1. Edema pattern

2. Fatty infiltration ± muscle atrophy

3. Mass lesion
1. Edema pattern

2. Fatty infiltration ± muscle atrophy

3. Mass lesion
Mass Lesion

- Infection
- Trauma (hematoma)
- Neoplasm
- Iatrogenic
Mass Lesion
Infection
Mass Lesion
Trauma
Mass Lesion
Neoplasm
Current Advances:
Quantitative MRI of Muscle
T2 Relaxation Time Mapping

- Water and fatty content (no FS)
- Water content (with FS)

Courtesy: Dr. Hee Kyung Kim
Diffusion Tensor Imaging

- Fiber tracking of skeletal muscle
- Sensitive to directionality of diffusion
- Assessment of muscle architecture

Courtesy: Dr. Hee Kyung Kim
MR Elastography

- Active and passive properties of muscle
  - Muscle tension
  - Shear stiffness increases with muscle tension/load
- Functional analysis

Courtesy: Dr. Mariappan Y, Ehman RL at Mayo clinic
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