

# Muscle Edema - Recognizing Patterns and Associated Causes

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# Disclosures

The authors do not have a financial relationship with a commercial organization that may have a direct or indirect interest in the content.

# Goals and Objectives

- Educational review of muscle edema patterns and distribution
  - Emphasis on findings seen on magnetic resonance imaging (MRI)
- Correlate muscle edema patterns with relevant clinical history
  - Clinical data often helps in narrowing a differential or in making an accurate diagnosis
- Discuss relevance of other imaging modalities and usefulness of intravenous contrast

# Introduction

- Muscle edema is seen secondary to multiple etiologies including trauma, infectious and inflammatory processes, autoimmune disorders, neoplasms, and denervation injuries
- On MRI muscle edema is characterized by increase in free water within the muscle
- Muscle edema is seen on MRI as increased signal on fluid sensitive sequences

## T2 FS

- Higher signal to noise ratio
- Specific fat suppression
- Susceptible to inhomogeneous fat suppression

## STIR

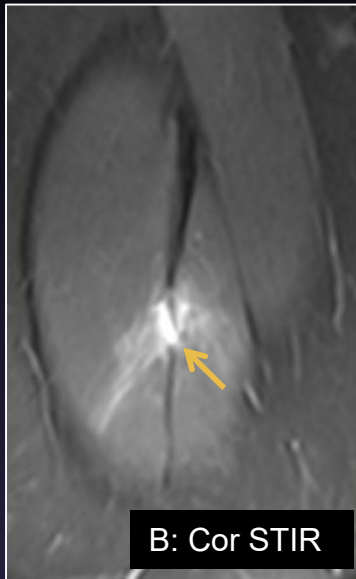
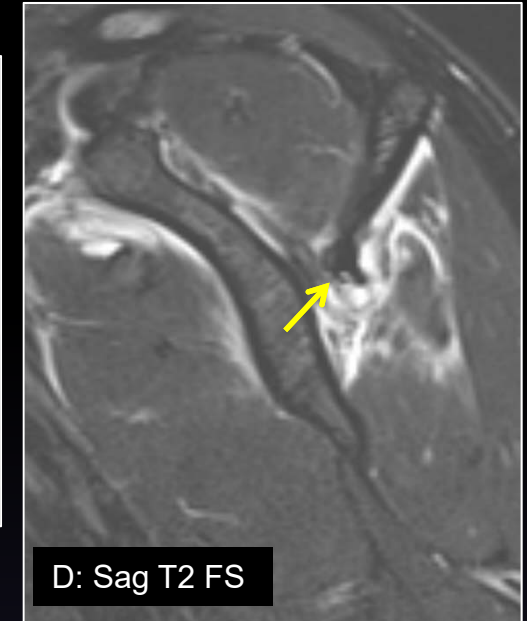
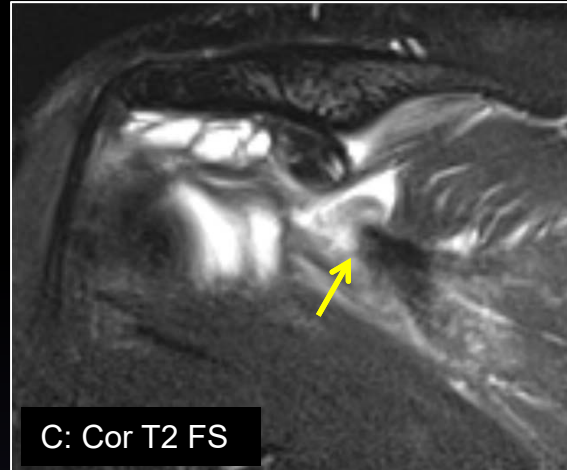
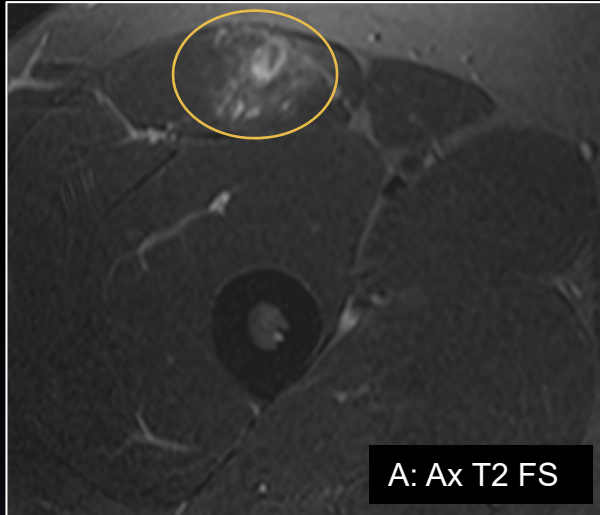
- Lower signal-to-noise ratio
- Homogenous fat suppression

- T1 weighted images useful for evaluating
  - Fatty atrophy of muscle
  - Subacute hemorrhage in presence of methemoglobin
- Contrast useful for evaluating for underlying infarction, tumor or abscess

# Causes of Muscle Edema

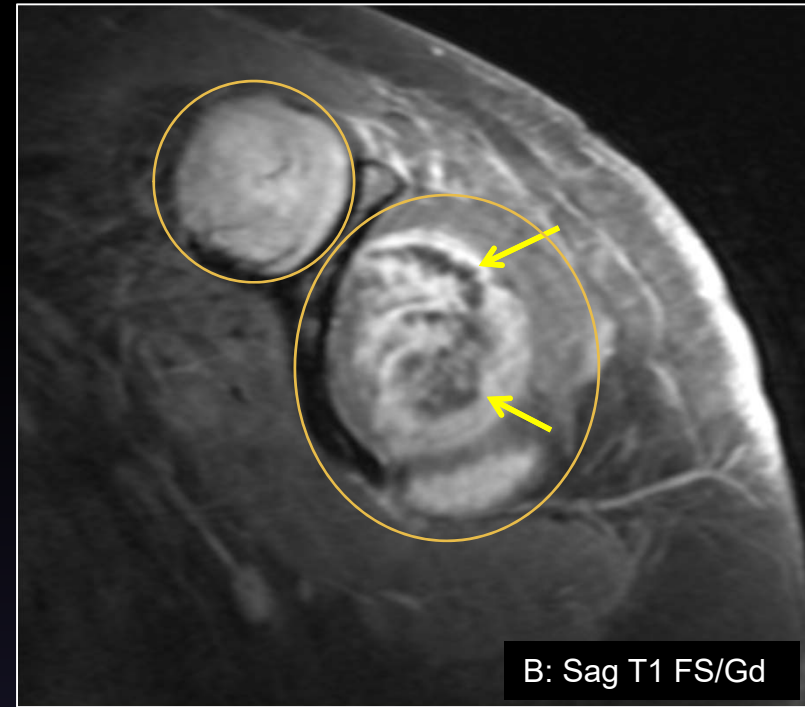
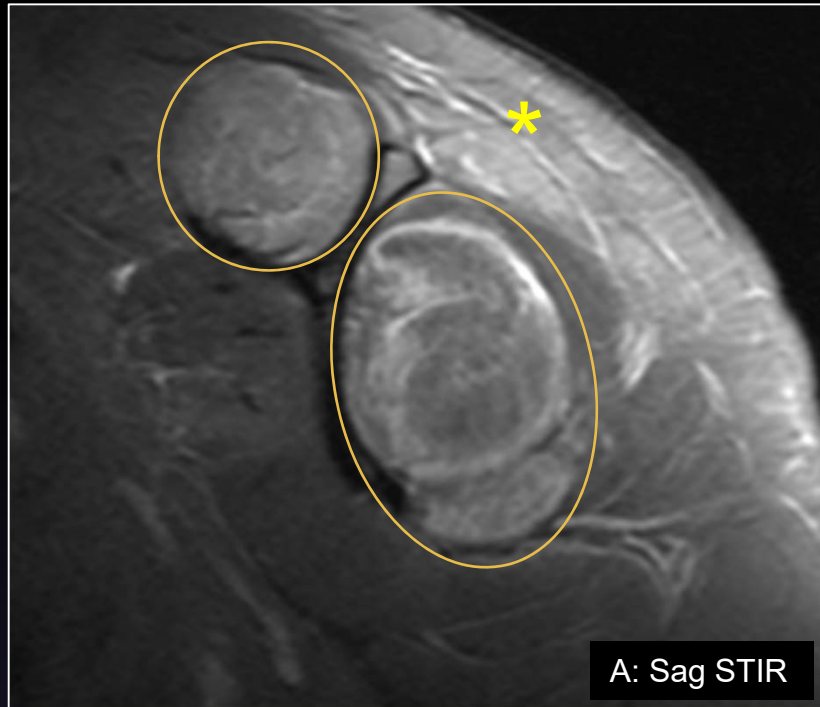
- Trauma
  - Strain
  - Contusion
  - Laceration
- Denervation
- Rhabdomyolysis
- Delayed onset muscle soreness
- Infection
  - Pyomyositis
  - Necrotizing fasciitis
  - Viral myositis
- Inflammatory myopathies
  - Dermatomyositis
  - Polymyositis
  - Connective tissue disorders
- Primary or metastatic tumor
- Radiation induced
- Medication related myopathy
- Vascular
  - Myonecrosis
  - Diabetic muscle infarction

# Muscle Strain



- Muscle strain injuries at the myotendinous junction
  - caused by forceful muscle contraction
- Most common in muscles that cross two joints
  - contain fast-twitch fibers and contract during elongation
- Muscle strain immediately painful
- More gradual development of pain with Delayed Onset Muscle Soreness
- A-B: Tear of the rectus femoris tendon centered along myotendinous junction
- C-D: Complete rupture of myotendinous junction of infrapatellar with extensive associated muscle edema

# Muscle Contusion with Ischemia/Necrosis



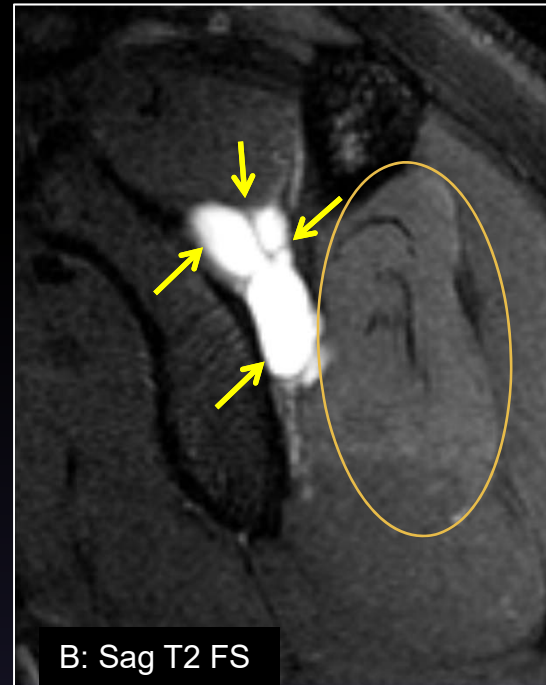
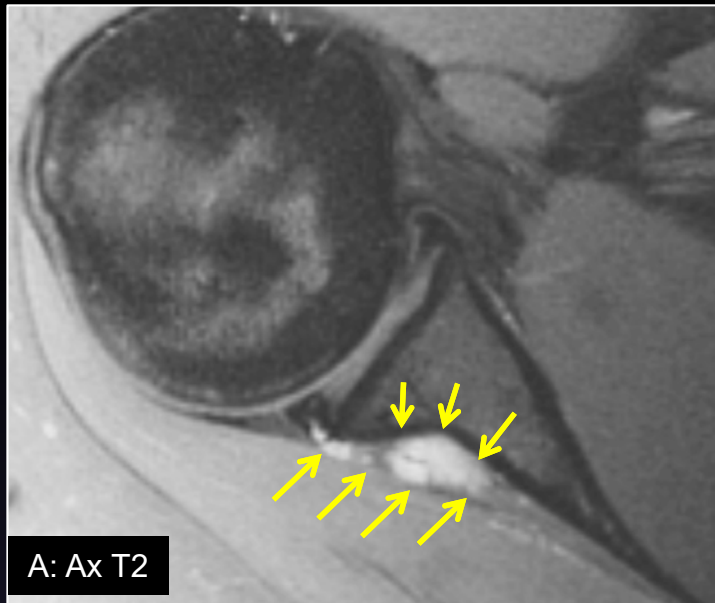
- Muscle contusion results from direct injury, usually following blunt trauma
- Note feathery pattern of muscle edema and enhancement (ellipses) in patient with history of recent fall
  - also note adjacent subcutaneous edema (\*)
- Areas of non enhancement (arrows) suggestive of underlying ischemia/necrosis

# Denervation

- First few days
  - imaging studies are often normal
- Late acute stage
  - Earliest sign is increased signal in muscle on T2 weighted images
- Subacute stage
  - Progressive muscle atrophy but muscle edema may still persist
- Chronic stage
  - Muscle atrophy dominant finding – fatty infiltration
- Affected muscles will follow the distribution supplied by the affected nerve
- Potential mechanisms of denervation
  - Spinal cord injury, poliomyelitis, peripheral nerve injury or compression
- MR imaging may identify a correctable cause of nerve compression such as a prominent osteophyte or ganglion cyst



# Suprascapular Nerve Entrapment

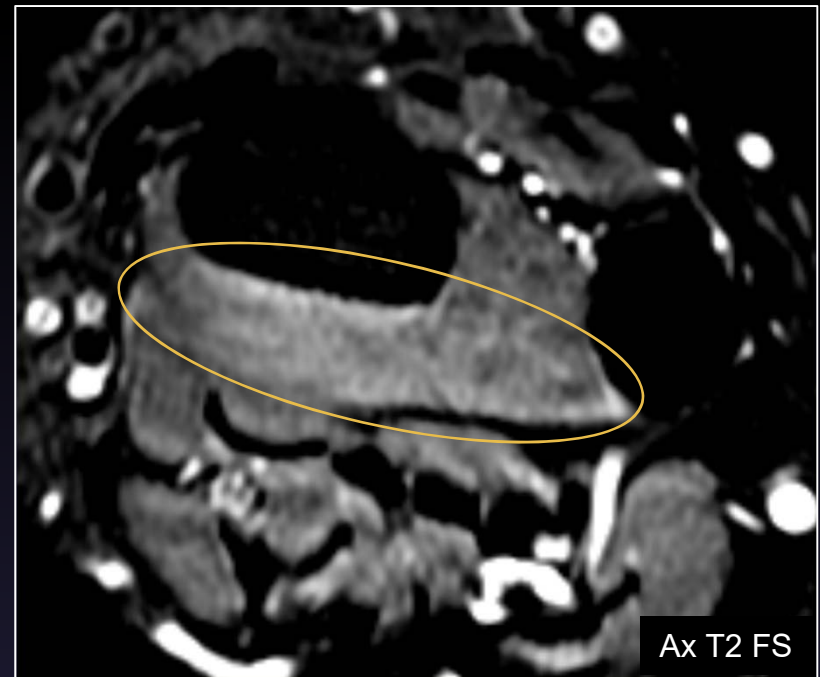


A-B: Note paralabral cyst (arrows) extending to spinoglenoid notch and resulting infraspinatus muscle edema (ellipse)

- Suprascapular nerve compressed at:
  - Suprascapular notch – affects supraspinatus and infraspinatus muscles
  - Spinoglenoid notch – affects only infraspinatus muscle
- Patients present with non-specific posterior shoulder pain and weakness
- Causes include masses (paralabral or ganglion cysts), traction injury or trauma

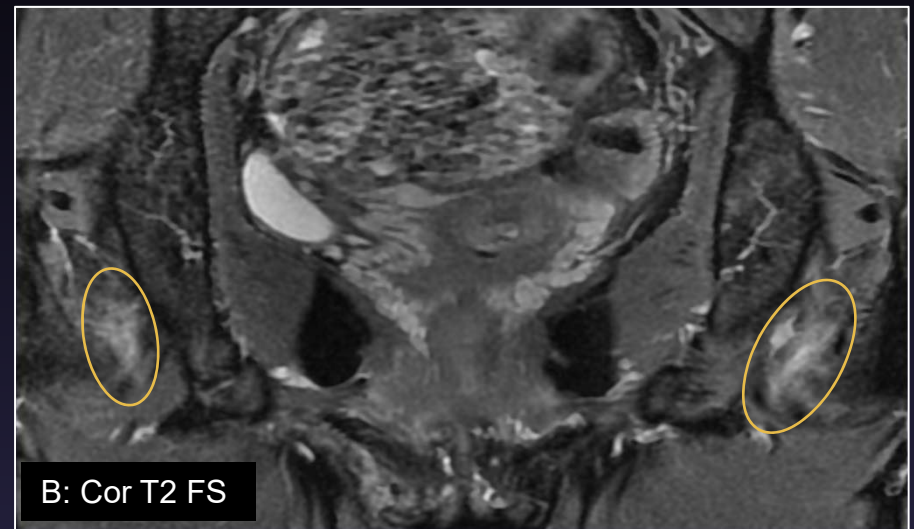
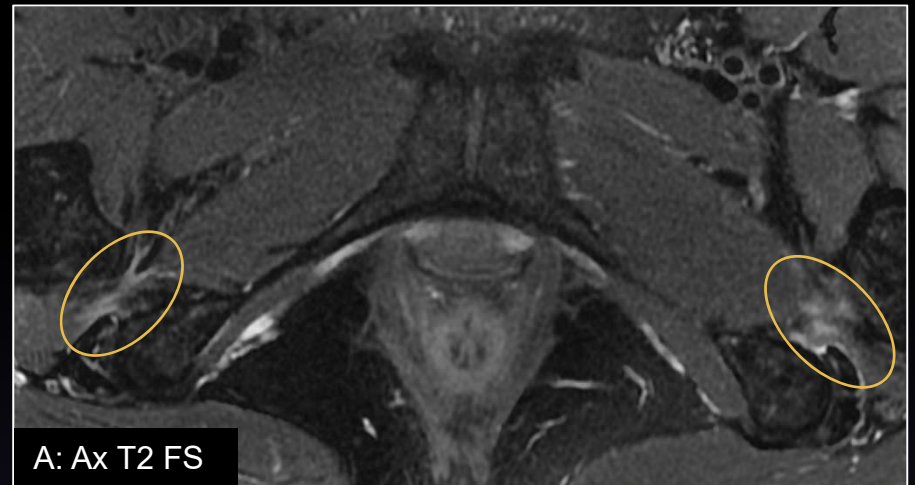
# Anterior Interosseous Nerve Syndrome

- Anterior interosseous nerve
  - Arises from the median nerve
  - Pure motor nerve
  - Supplies radial half of flexor digitorum profundus, flexor pollicis longus and pronator quadratus muscles
- Pronation weakness
- Pinching deformity due to weakness in thumb and index finger
- Edema and atrophy of the muscles
- Edema in pronator quadratus muscle (ellipse)
  - most reliable sign

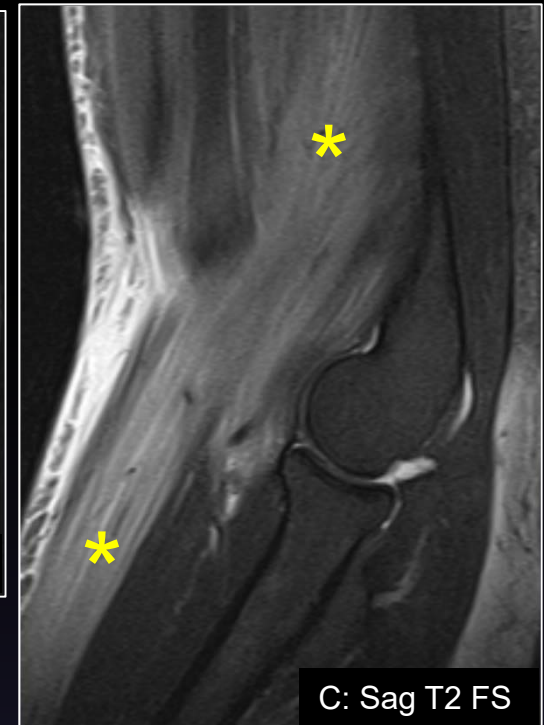
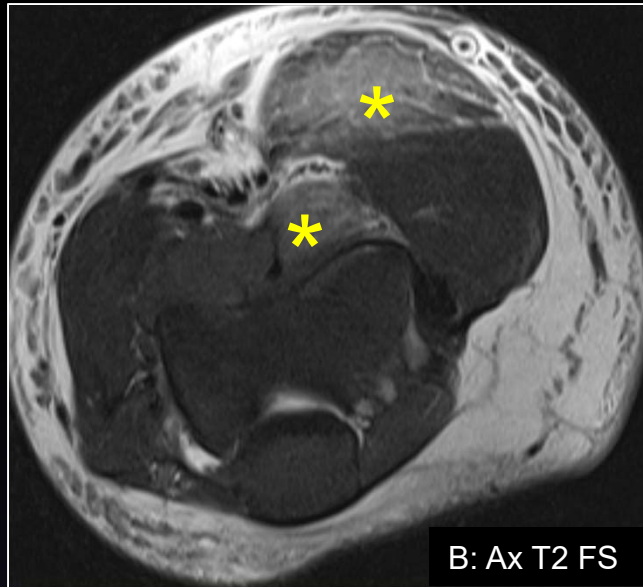
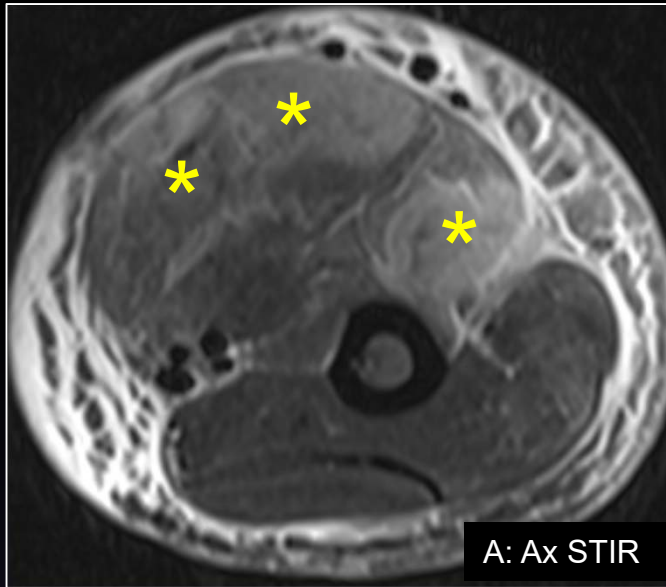


# Ischiofemoral Impingement

- Impingement of soft tissues between the ischial tuberosity and lesser trochanter
- May present with hip pain
- Middle age to elderly females
- Bilateral 25-40%
- Narrowed ischiofemoral space <15 mm and quadratus femoris space <10 mm
- Muscle edema within the quadratus femoris muscle (ellipses)



# Delayed Onset Muscle Soreness

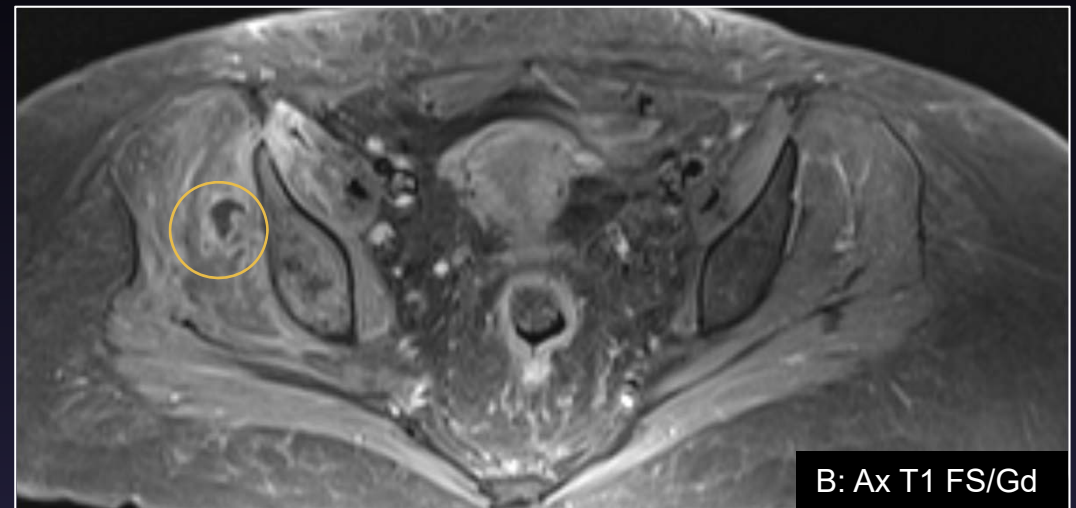
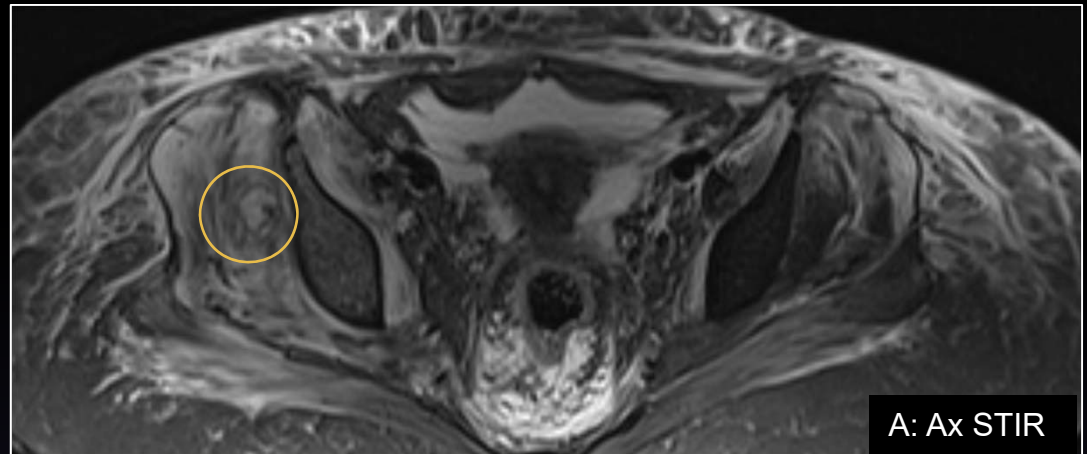


- Clinical syndrome with gradual muscle pain
- May take hours to days following strenuous exercise to develop symptoms
- Associated with exercise involving eccentric muscle contraction
- Edema signal on MRI of the involved muscle groups
- Elevated creatinine kinase (CK) levels
- Signal intensity correlates with serum CK levels

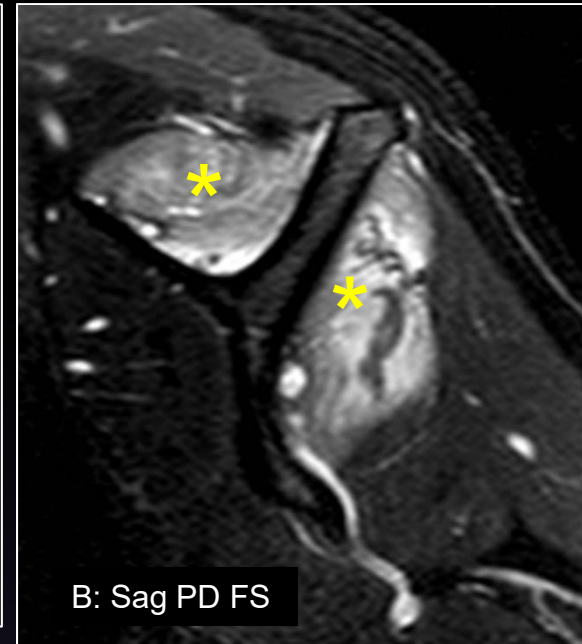
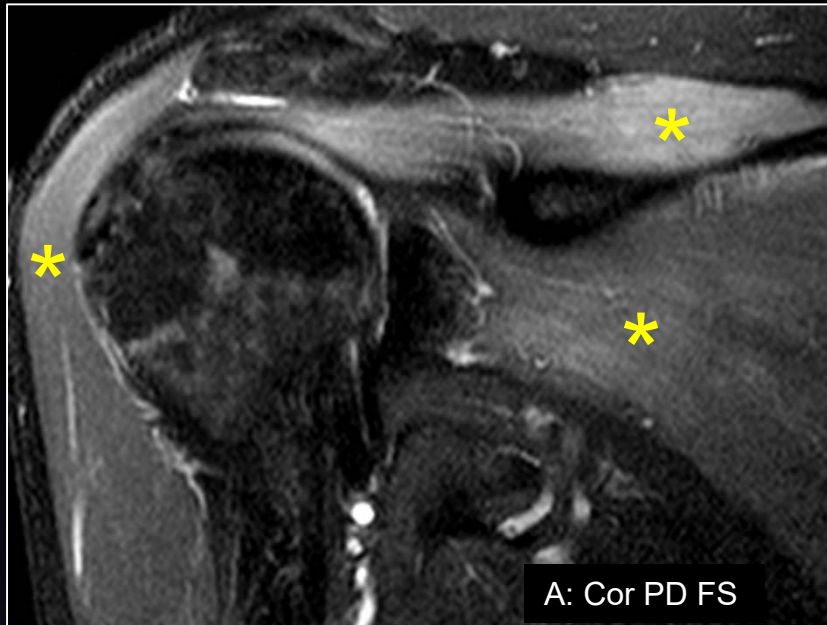
A-C:  
Note extensive muscle edema (\*) in patient who presented with severe pain and elevated CK levels 3 days after a 2 hour strenuous upper body work out

# Pyomyositis

- Bacterial muscle infection
  - most commonly by *Staph Aureus*
- Many patients have underlying systemic illness causing immunosuppression
- Generally involves a single muscle group
- May be multifocal
- Abscess - rim enhancing fluid collection (circle) within areas of muscle edema and enhancement



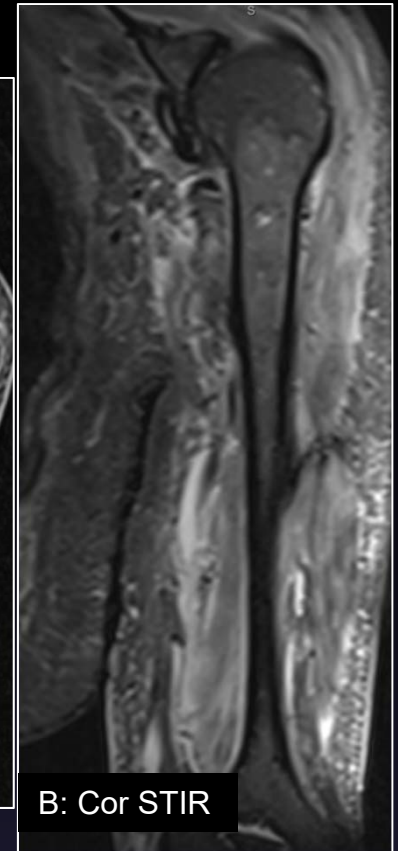
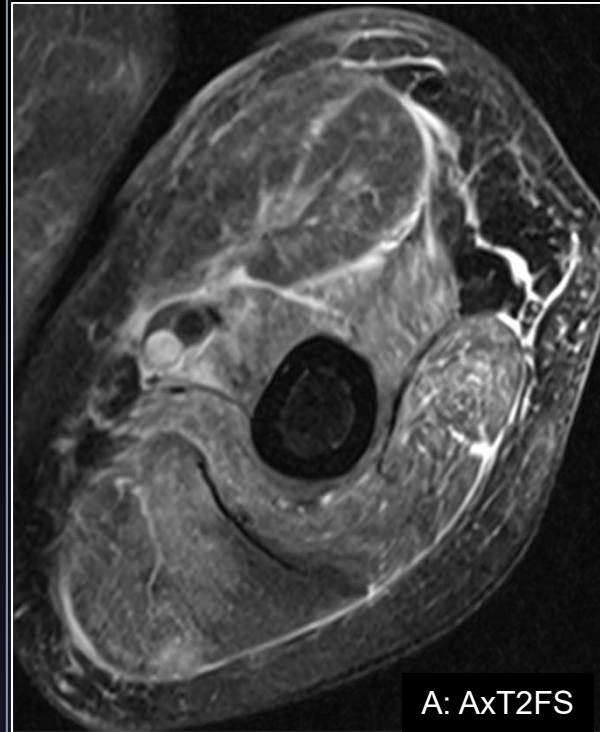
# Parsonage Turner Syndrome



- Acute idiopathic brachial neuritis
- Sudden onset of shoulder pain and/or weakness of shoulder girdle musculature
- Exact etiology uncertain
  - viral or autoimmune process suspected
- Supraspinatus and infraspinatus muscles frequently involved followed by the deltoid muscle
- Prolonged course can lead to muscle atrophy
- A-B: Note muscle edema (\*) in the supraspinatus and infraspinatus muscles and to a lesser extent in the lateral aspect of deltoid muscle

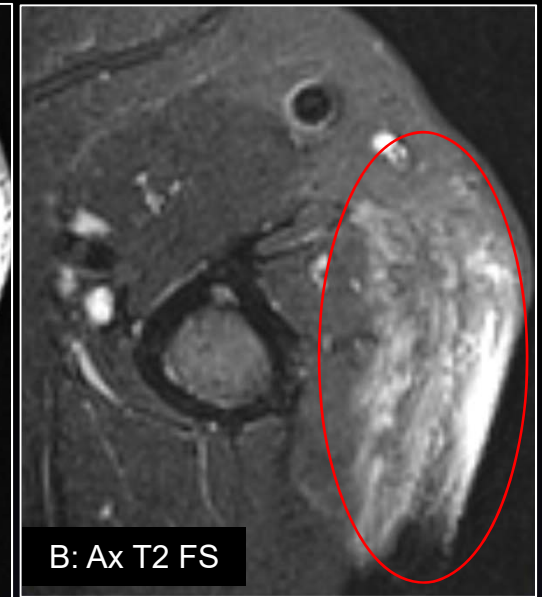
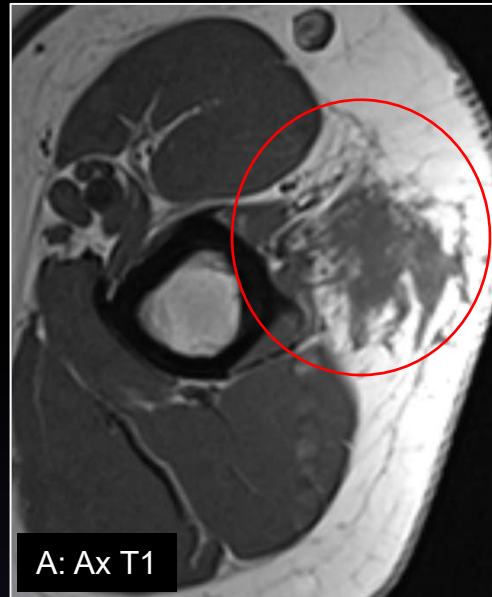
# Polymyositis and Dermatomyositis

- Autoimmune inflammatory conditions
- Gradual onset of muscle weakness affecting proximal pelvic girdle
- Later involves proximal muscles of upper limbs
- Degree of muscle edema correlates with disease activity
  - can direct muscle biopsy
- Polymyositis only involves skeletal muscle
- Dermatomyositis also involves the skin
- Adult onset dermatomyositis associated with increased prevalence of malignancy
- Sheet-like calcifications may develop in dermatomyositis
- A-B: Note diffuse muscle and subcutaneous edema in upper extremity of patient with dermatomyositis



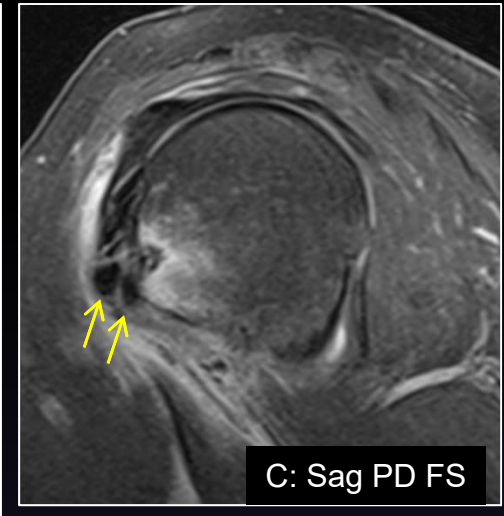
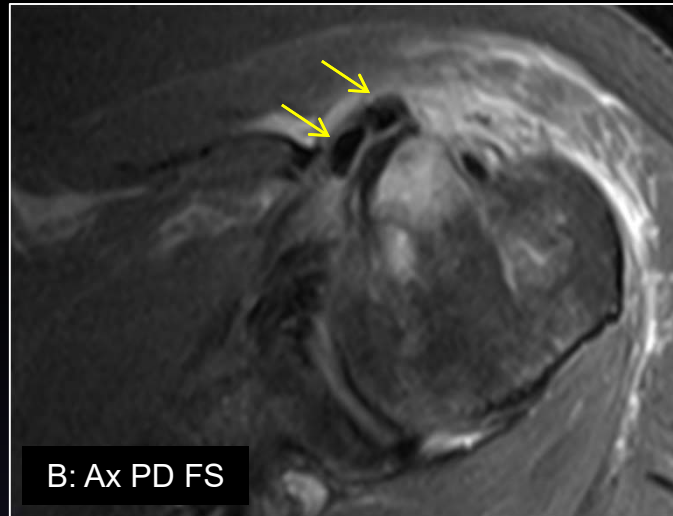
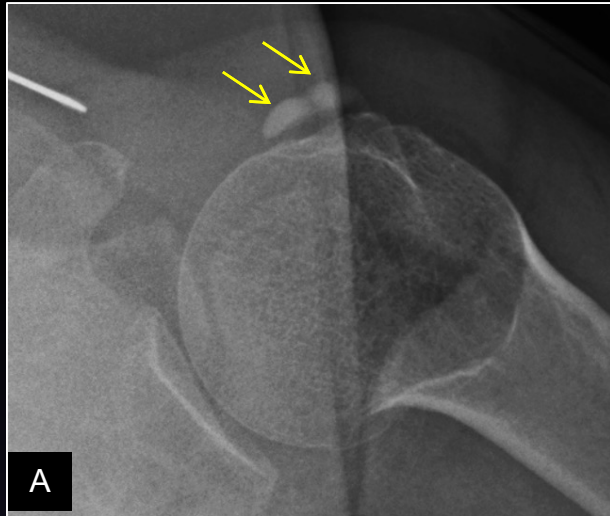
# Sarcoidosis

- Uncommon
- Myopathic or nodular types
- Myopathic type
  - Symmetric proximal muscle atrophy
  - Increased signal intensity of involved muscle on T2 weighted images
- Nodular type
  - Focal intramuscular masses, usually at myotendinous junction
  - Have appearance described as “dark star” with central areas of low signal indicating fibrosis
- May be difficult to see on radiographs





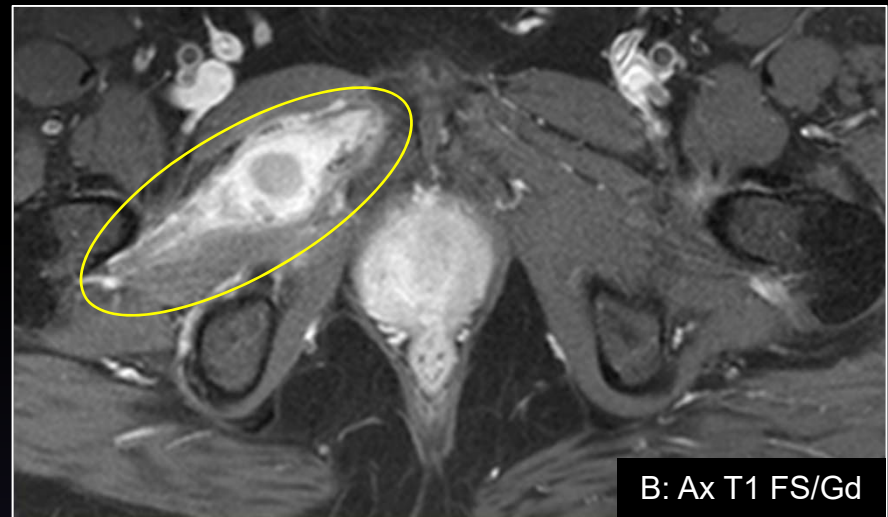
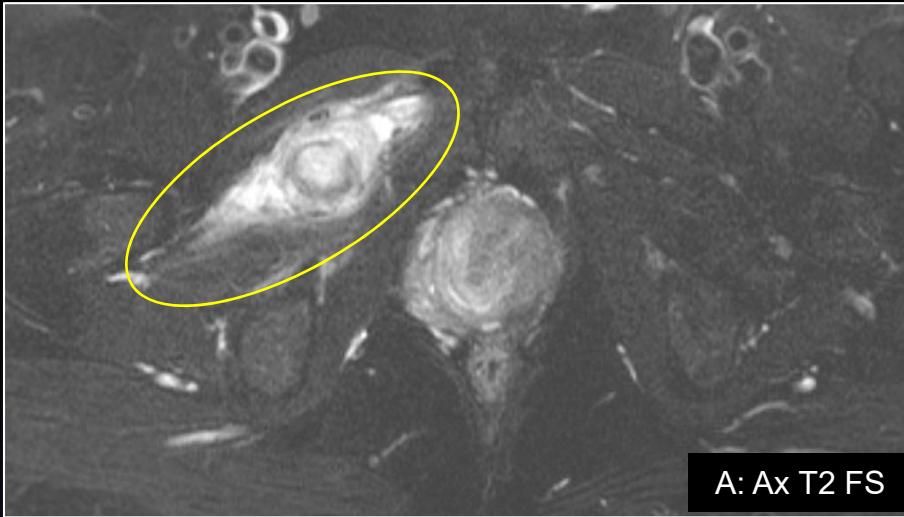
# Calcium Hydroxyapatite Deposition Disease



- Systemic disease of unknown etiology
- Periarticular or intra-articular deposition of calcium hydroxyapatite crystals
  - Along tendons, capsule, ligaments or bursae
  - Can erode into the bone
- Localized pain, swelling and tenderness
- Can resolve over a few months
- Shoulder is the most commonly affected region
  - Especially the supraspinatus tendon

- Radiographs
  - Lobular soft tissue calcifications (arrows)
- MRI
  - Low signal on all sequences (arrows)
  - In acute phase can result in significant muscle edema
    - May be mistaken for a neoplasm
  - Correlation with radiographs or CT important to avoid misdiagnosis

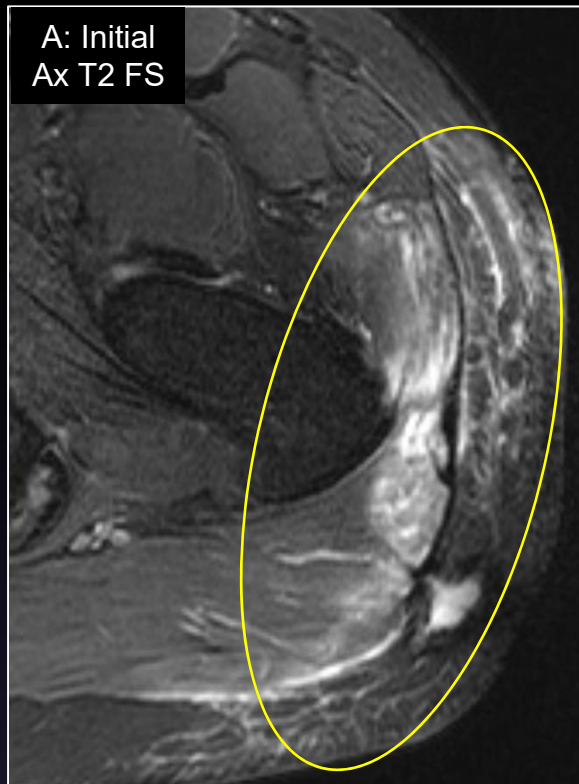
# Primary Soft Tissue Neoplasm



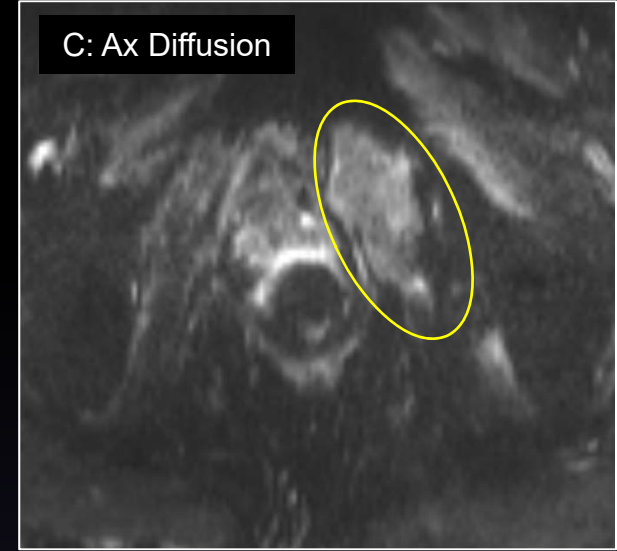
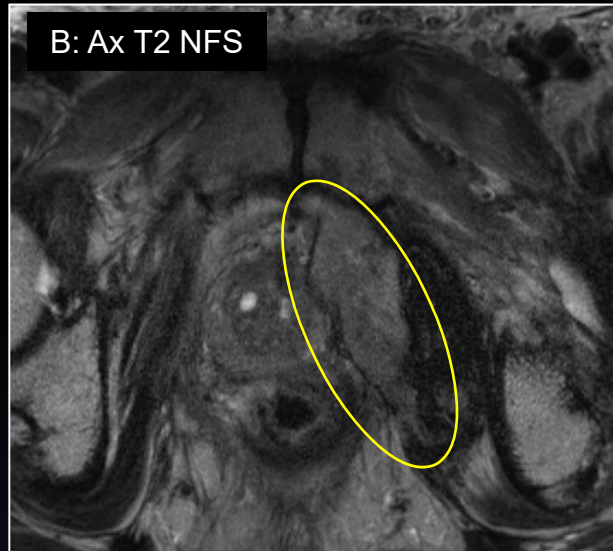
- Usually appears as a focal enhancing mass
- May be associated with
  - Peri-tumoral edema
  - Internal hemorrhage/necrosis
- Muscle edema may be seen with benign and malignant tumors

# Post Radiation Therapy

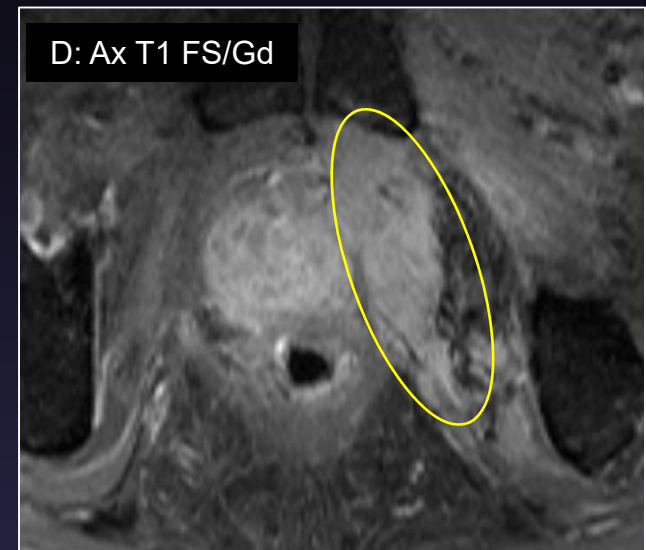
- Causes vasculitis and tissue injury
- Edema throughout the radiation field
  - Uniform muscle edema
  - Geometric margins
  - Extends uninterrupted across muscle and subcutaneous fat
- Edema signal
  - Can increase over 12-18 months
  - Can persist for many years



# Post Radiation Sarcoma

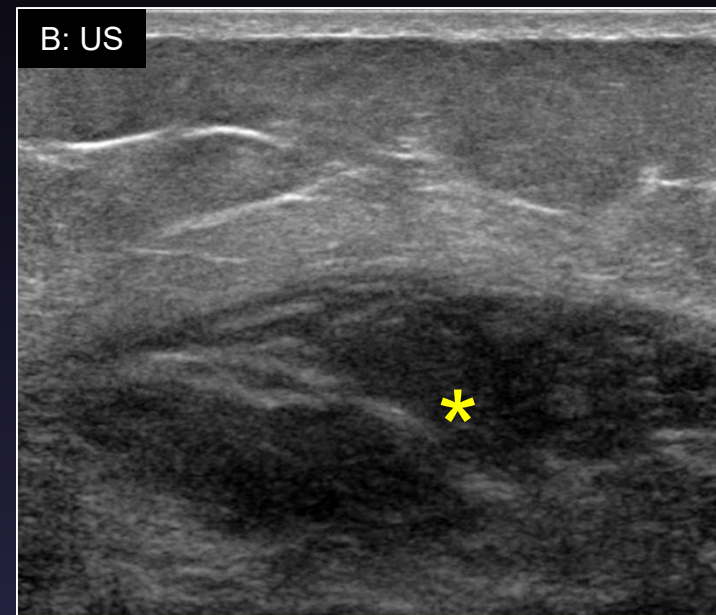
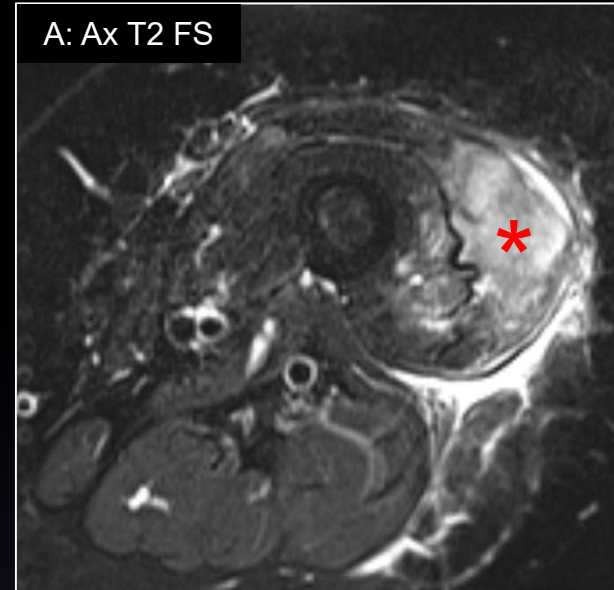


- Radiation induced sarcoma
  - can originate in irradiated bone or soft tissue
- Risk 0.05%
- Occurs after latency of around 14 years
- Can occur 3-4 years following radiation therapy
- Poor prognosis in comparison to primary sarcoma
- A-D: Sarcoma in patient with history of radiation treatment for prostate cancer



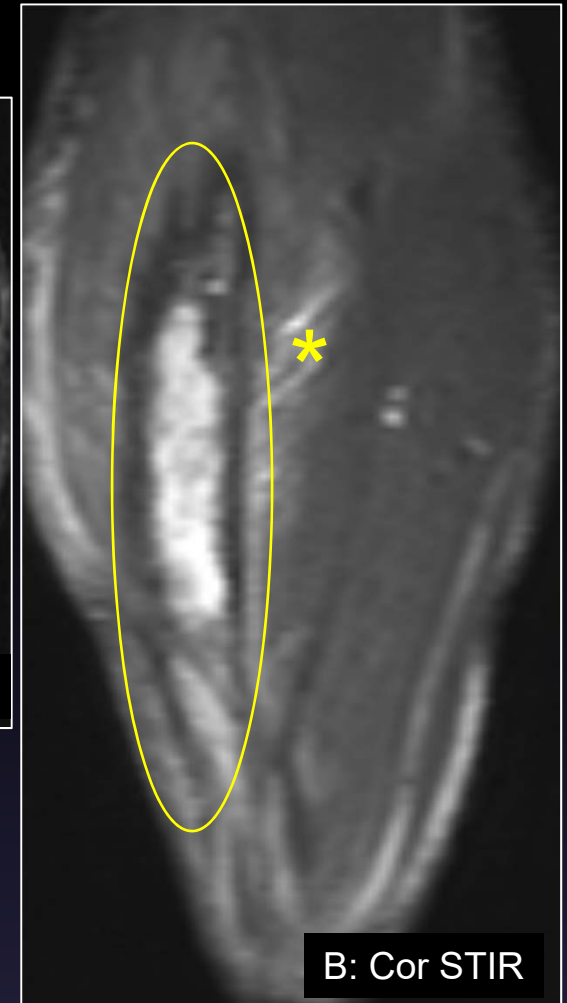
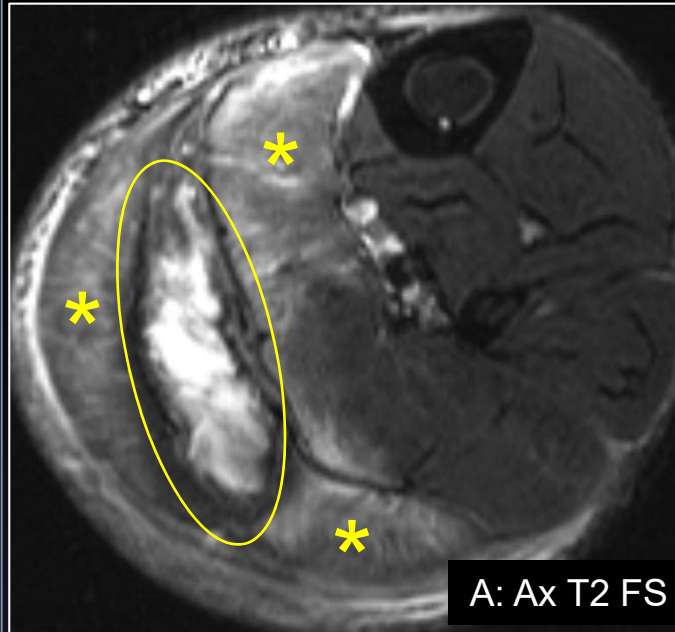
# Diabetes Related Muscle Infarct

- Long standing, poorly controlled diabetes
- Abrupt severe thigh or calf pain
- Possible low grade fever
- Pathogenesis uncertain
  - microangiopathy has been suggested
- Muscle enlargement with
  - muscle edema (\*)
  - fascial edema
- Diffuse heterogeneous muscle edema
- MRI
  - Increased signal on fluid sensitive sequences
  - Nonenhancing regions represent myonecrosis
- Ultrasound (US)
  - Heterogeneous hypoechoic muscle



# Ruptured Popliteal Cyst

- Fluid in the synovial lined gastrocnemius-semimembranosus bursa
- Complications of popliteal cyst
  - Dissection
  - Rupture
  - Compression
  - Hematoma
  - Compartment syndrome
  - Acute calf pain
  - Swelling
- Neoplasm with hemorrhage may have similar appearance
  - Follow up imaging may help to confirm resolution/improvement



A-B: Ruptured popliteal cyst with hemorrhage dissecting between soleus and gastrocnemius muscles (ellipse).  
Associated muscle edema (\*).

# Summary

- There are many causes of muscle edema signal on MRI exams
- These include trauma, infectious and inflammatory processes, autoimmune disorders, neoplasms, denervation injuries and iatrogenic etiologies
- Important for radiologists to recognize distribution and patterns of muscle edema and to correlate with clinical history in order to make a correct diagnosis
- In some cases correlation with CT and radiographs may also help in making an accurate diagnosis
- Delayed or misdiagnosis may result in delayed treatment or unnecessary intervention

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