Intramuscular Edema and Enhancement

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Case Presentation
A 21-year-old male presented with a 2 week history of increased proximal left leg swelling. He had a history of recent cervical spinal cord injury with tetraplegia, but no prior medical conditions. Erythrocyte sedimentation rate (ESR) was mildly elevated and he reported no fevers. White blood cell (WBC) count was normal. Lower extremity ultrasound was negative for DVT and initial radiographs showed only soft tissue swelling. MRI was performed (Fig. 1) and repeated 2 months later (Fig. 2).

Figure 1: Coronal T2-weighted STIR image of the pelvis and proximal thighs demonstrates left thigh swelling with diffuse high T2 signal and enlargement of the gluteus, iliopsoas, and quadriceps muscles. There is a small left hip joint effusion. A lesser amount of high T2 signal is present in the right gluteus and quadriceps muscles.

Figure 2: Follow-up axial T2-weighted STIR image (A) 2 months later demonstrates mild increased T2 signal in the left iliac bone with adjacent gluteus and iliacus muscle high signal. There is also high signal of the right gluteus and paraspinal muscles. A small amount of linear and lobular low T2 signal is present in the left iliacus muscle. Post contrast axial T1 image with fat suppression (B) more inferiorly demonstrates rim-enhancing areas anterior to the left hip displacing the left rectus femoris laterally and superficial to the right greater trochanter. Coronal T2 STIR image from the same exam shows left iliac bone and extensive muscular increased signal with laminar and lobular low T2 signal in the iliac fossa and anteromedial to the femur new from the prior exam.
Key clinical finding(s)
Unilateral proximal leg swelling
Paralysis with tetraplegia

Key imaging finding(s)
Abnormal intramuscular signal and enhancement

Differential diagnoses
Heterotopic ossification
Pyogenic myositis
Sarcoma

Discussion
The primary diagnostic considerations for intramuscular edema and enhancement include post-traumatic, infectious/inflammatory, and neoplastic etiologies. As the imaging appearance of these entities often overlap, clinical history and patient demographics are useful discriminators. In the setting of trauma, intramuscular edema and enhancement may be seen initially but should decrease or resolve over time, unless complicated by etiologies such as heterotopic ossification. Patients with myositis often present clinically with pain, fever, and elevated ESR and WBC. Localized erythema, skin ulcerations, or a sinus tract may occasionally be seen. Neoplastic processes typically present insidiously with chronic symptoms, unless complicated by pathologic fracture. In cases where imaging appearance and clinical history are not characteristic of a specific diagnosis, follow-up imaging or biopsy may be necessary.

Heterotopic Ossification: Heterotopic ossification (HO) is the formation of bone in soft tissue and is attributed to mesenchymal metaplasia. A history of local trauma is elicited in 60% of cases. Other risk factors include immobilization, paralysis, and burn injury. HO develops in >20% of spinal cord injury patients, most commonly around the hips, and is frequently bilateral. Patients may have fevers and an elevated ESR. Radiographs and CT are extremely helpful in demonstrating a zonal pattern of calcification with maturing bone over time. The soft tissue calcifications are initially observed between 4 weeks and 6 months after antecedent trauma, but may develop over many years. The MRI appearance of HO is non-specific and can be confused with inflammatory or infectious myositis and sarcoma. MRI will show extensive muscle edema becoming more mass like and decreasing in T2 signal over time. In those with spinal cord injury, there is a distinct predilection for occurrence anterior to the hip joint capsule and superficial to the greater trochanter with involvement of the iliopectos and trochanteric bursae. Enhancement is diffuse or rim-like. Fluid-fluid levels, marrow edema, periostitis and reactive joint effusions have been described. Calcification will appear as areas of low T1 and T2 signal with fibrosis also contributing to low signal areas. In mature HO, the MRI appearance is the same as that of cortical bone with central fatty marrow.

Pyogenic Myositis: Initially described as a tropical disease, bacterial myositis with abscess is increasingly seen in HIV/immunocompromised patients. Diabetes, local trauma, and insect bites are also reported risk factors. Intramuscular involvement is often due to hematogenous spread from a distant infection; however, direct spread, as is seen with disc-osteomyelitis, is not uncommon. Patients often present with fever, erythema, elevated ESR, and elevated WBC. Localized erythema is commonly seen. Staphylococcus aureus is the cause in >75% of cases. MRI demonstrates muscle enlargement and diffuse increased T2 signal which may involve one or more muscles. Enhancement pattern is typically diffuse initially with rim-enhancement occurring in the setting of abscess formation. The quadriceps, gluteus, and iliopectos are most commonly involved. Myonecrosis without infection can be seen with diabetes, sickle cell disease, and compartment syndrome.

Sarcoma: Ewing’s sarcoma is the second most common primary malignant bone tumor under age 30. Patients often present with fever and elevated ESR, in addition to pain and a mass. The pelvis is the second most common site of occurrence after the femur. There is a trend from (meta)diaphyseal long bone involvement to increasing flat bone involvement with increasing age. Lytic bone destruction is permeative often with a sclerotic component of reactive bone. Periosteal reaction is
spiculated or laminated/onion-skinned. A large soft tissue mass is frequently present with extensive increased T2 signal infiltrating the bone and adjacent muscle. Enhancement is avid and heterogeneous. When abundant, periosteal reaction will appear as laminar or spiculated low T2 signal locally. Differentiation from osteomyelitis is often difficult. Pretreatment soft tissue calcification is present in <10% of cases and is not extensive.  

**Diagnosis**
Heterotopic ossification (HO)

**Summary**
Primary diagnostic considerations for intramuscular edema and enhancement include post-traumatic, infectious/inflammatory, and neoplastic etiologies. As the imaging appearance of these entities overlap, clinical history is helpful. This case demonstrates characteristic as well as less common MRI findings of heterotopic ossification with expected evolution over time. Eliciting a history of trauma with spinal cord injury, in combination with the imaging findings, was useful in making the correct diagnosis in this case. At times, a specific diagnosis cannot be made initially, warranting follow-up imaging or biopsy as necessary.

**References**