Muscle Mayhem: MR Imaging Patterns of Myositis

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INTRODUCTION

There are many causes of childhood myositis. MR findings are nonspecific and demonstrate high signal intensity in the affected muscle groups on fat saturated (FS) T2 weighted images (WI). The pattern and distribution of signal abnormality within muscle and surrounding tissues may be helpful in distinguishing between the various causes of myositis. We have reviewed our experience with seven patients and present our findings.

BENIGN ACUTE CHILDHOOD MYOSITIS (BACM)

BACM is a self-limiting process characterized by the sudden onset of calf pain and difficulty walking. It most frequently involves the gastrocnemius and soleus muscles and most commonly occurs in the first or second decade with a mean age of 9 years. A viral prodrome has been reported.

MR findings

- -Affected muscle may be enlarged; T1 –isointense, FS T2 –hyperintense (to surrounding muscle)
- -Deep fascial, superficial fascial, and subcutaneous edema localized to the tissues overlying the involved muscles
- -Uniform enhancement of affected muscle(s) following gadolinium
- -Unilateral involvement

Case 1: Benign Acute Childhood Myositis
17 year old male with right calf pain, swelling, and difficulty walking for one day. No prodromal illness.

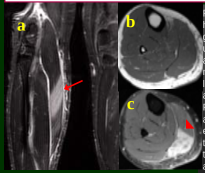


Figure (a): Coronal FS T2 WI; There is hyperintense signal in the gastrocnemius muscle (arrow) with unusually sharp margins between the affected and unaffected portions of the muscle. Subcutaneous edema which is localized to the area overlying the affected muscle.
Figures (b) and (c): Axial T1 WI pre(b) and post (c) gadolinium; There is enhancement of the affected portion of the gastrocnemius muscle (arrowhead), the subcutaneous tissues and the deep and superficial fascia.

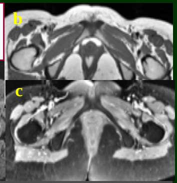
GRAFT VERSUS HOST RELATED MYOSITIS

Graft Versus Host Related Myositis (GVHM) is an uncommon complication occurring in up to 40% of patients undergoing allogenic bone marrow transplantation. In GVHM, alloreactive and autoreactive T- lymphocytes act against the patient's myocytes, resulting in a granulomatous inflammation of the affected muscles. It most commonly affects proximal muscle groups, and responds rapidly to steroid therapy.

MR findings:

- -Affected muscle FS T2- hyperintense
- -Hyperintense signal in the deep fascial planes on T2 FS, no abnormal signal in the subcutaneous tissue and superficial fascia
- -Enhancement of involved muscle groups and deep fascia following gadolinium.
- -Often unilateral.; asymmetric, when bilateral

Case 2: Graft versus Host Related Myositis
18 yo female with ALL and stem cell transplant 3 months prior to admission, presents with sudden bilateral leg pain.



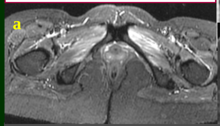


Figure (a): Axial FS T2 WI; There is asymmetric, bilateral, hyperintense signal in the pelvic muscles and deep fascial planes. The subcutaneous tissues are not involved. Figures (b) and (c); Axial T1 WI pre(c) and post (d) gadolinium administration ; There is muscle and fascial enhancement without enhancement of the subcutaneous tissues.

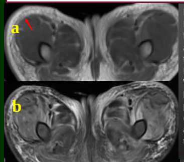
RHABDOMYOLYSIS

Rhabdomyolysis is defined as the breakdown of skeletal muscle secondary to muscle injury. Causes include trauma, shock, sepsis, seizures, drug abuse and extreme exercise. Rhabdomyolysis may be complicated by compartment syndrome secondary to muscle edema, as well as renal failure due to the accumulation of myoglobin in the renal tubules.

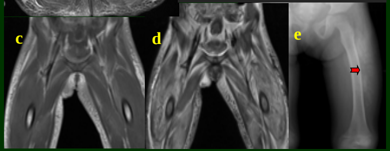
MR findings:

- -Affected muscles enlarged; T1-heterogeneous/homogeneous hypointensity, FS T2- heterogeneous/homogeneous hyperintensity
- -Extensive deep and superficial fascial edema and subcutaneous edema
- -Diffuse, often heterogeneous enhancement of muscle, subcutaneous tissues and fascia following intravenous gadolinium.
- -Often bilateral

Case 3: Rhabdomyolysis
3 year old girl brought to ER in full cardiac arrest.



Figures (a) and (c): Axial and coronal T1 WI ; Edema of the subcutaneous tissues of both thighs is noted (arrow). There are subtle areas of heterogeneous signal abnormality in the muscles.
Figures (b) and (d): Axial and coronal FS T2 WI; There is extensive, heterogeneous hyperintensity in the thigh muscles, fascial planes, and subcutaneous tissues, Figure (e): Frontal view of thighs two months after admission demonstrate calcification in the soft tissues of the thigh (arrow).



PYOMYOSITIS

Pyomyositis is an acute infection of skeletal muscle usually caused by Staphylococcus aureus. Symptoms include acute swelling and induration, pain and fever.

MR findings:

- -Involved muscle(s) enlarged; FS T2-hyperintense, may have central collection(abscess)
- -Hyperintense signal in the subcutaneous tissue, superficial and deep fascia skin on FS T2. Skin thickening may be present.
- -Enhancement of involved muscle groups, deep fascia, superficial fascia, and subcutaneous tissue following gadolinium. Rim enhancement of abscess collection, if present.
- -Unilateral, usually focal
- -Associated abnormalities such as septic joint or osteomyelitis may be present

Case 4: Pyomyositis
15 yo female with two weeks of worsening wrist swelling and erythema; no prior trauma

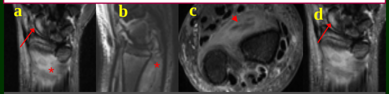


Figure (a) and (b): Coronal and sagittal FS T2 WI; There is inhomogeneous, hyperintense signal in the enlarged pronator quadratus muscle (asterisk), subcutaneous tissue and fascial planes. Figures (c) and (d): Coronal and axial T1 WI following gadolinium demonstrate enhancement of the pronator and the surrounding soft tissues. An area within the muscle shows no enhancement, consistent with a small abscess collection (arrowhead). High signal within the scaphoid (long arrow) on T2 WI and post contrast images suggests concurrent osteomyelitis.

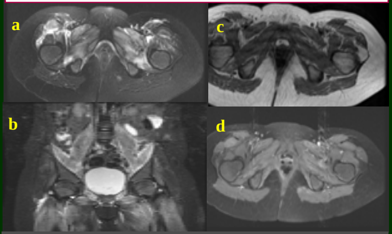
DERMATOMYOSITIS

Juvenile dermatomyositis is the most common type of idiopathic inflammatory myopathy in children. Patients present between 5-14 yrs with progressive symmetric proximal muscle weakness.

MR findings:

- -Often pelvic and thigh musculature; T1 may be helpful in determining fatty degeneration of affected muscles groups in patients with long standing disease; FS T2 - hyperintensity
- -Degree of muscle edema correlates with disease activity; MR useful in directing biopsy site and monitoring response to therapy.
- -Hyperintense signal on FS T2 in skin, subcutaneous tissue, and deep and superficial fascia is present to a lesser degree than in the involved muscles .
- -Muscle enhancement following intravenous gadolinium.
- -Bilateral and symmetric; may be patchy.

Case 5: Dermatomyositis
7 yo female with dermatomyositis who presented with pain and weakness in her lower extremities.



Figures (a) and (b): Axial and coronal FS T2 WI; There is symmetric, bilateral, diffuse high signal on FS T2 WI in the thigh and pelvic musculature. Deep fascial edema, with little superficial fascial and subcutaneous edema is present.
Figure (c) and (d). Axial T1 WI pre(c) and post (d) gadolinium administration demonstrates symmetric and uniform muscle enhancement.

DEEP CELLULITIS

Cellulitis is an acute bacterial infection of the connective tissue of the skin, most commonly secondary to staphylococcus and streptococcus. Deep cellulitis (non-necrotizing soft-tissue infections) involves the subcutaneous tissues and may be difficult to differentiate from necrotizing fasciitis. While deep cellulitis responds to antibiotic therapy, necrotizing fasciitis requires aggressive treatment including surgical debridement.

MR findings:

- -Hyperintensity in subcutaneous tissues and superficial fascia on FS T2, deep fascia less involved, muscle groups adjacent to soft tissue changes may demonstrates high signal
- -Enhancement of subcutaneous tissues and superficial fascia following intravenous gadolinium; +/- deep fascial enhancement secondary to adjacent inflammation (imaging findings may overlap with necrotizing fasciitis).
- -Unilateral

Case 6: Deep Cellulitis
2 year old girl with ALL who presented with severe diaper rash.

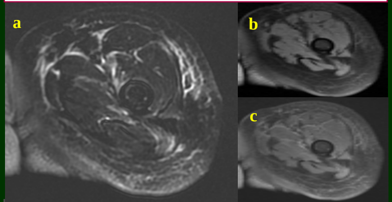


Figure (a): Axial FS T2 WI; There is hyperintensity in the superficial and deep fascial planes as well as in the subcutaneous tissues.The muscle groups are relatively spared.
Figure (b) and (c): Pre (b)and post gadolinium (c)T1 WI; Enhancement of superficial fascia and subcutaneous tissue is noted. Mild deep fascial enhancement is present which may reflect inflammation rather than deep fascial infection. There is no significant muscle enhancement.

NECROTIZING FASCIITIS

NF is a potentially life threatening, rapidly progressive polymicrobial infection of the soft tissues, commonly due to Group A streptococcus. In children, NF may be seen after varicella infection; other causes include trauma, surgery,burns, insect bite or omphalitis. The process begins in the superficial fascia and subcutaneous tissues. It rapidly extends along deep fascial planes to involve the underlying muscle. Imaging findings during the initial stages of the infection may be difficult to differentiate from deep cellulitis. Recognition of early signs and symptoms, and prompt surgical debridement of affected areas is essential to prevent significant morbidity or death. MR is helpful in evaluating the extent of the process.

MR findings:

- -Involved muscle(s) may be enlarged; FS T2 - hyperintense
- -Hyperintense signal in the subcutaneous tissue, superficial/deep fascia on FS T2
- -Enhancement of involved muscle, superficial/deep fascia following IV gadolinium
- -Unilateral

Case 7: Early Necrotizing Fasciitis
16 year old girl with multiple sclerosis with fever and right thigh pain one day after receiving an IM injection of interferon B1 into her thigh.

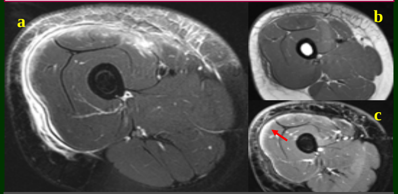


Figure (a): Axial FS T2 WI ;There is hyperintense signal in the deep and superficial fascial planes as well as in the periphery of the quadriceps muscle deep to the area of fascial involvement. Subcutaneous edema is also present . The process has poorly defined margins.
Figures (b) and (c): Pre and post contrast T1 WI ; the areas of high signal intensity on T2 WI demonstrate enhancement (arrow).

MR FEATURES OF MYOSITIS

	T2 WI				T1 WI POST CONTRAST				Unilateral vs
DIAGNOSIS	MUSCLE	DEEP FASCIA	SUPERFICIAL FASCIA	SUBCUT TISSUE	MUSCLE	DEEP FASCIA	SUPERFICIAL FASCIA	SUBCUT TISSUE	Bilateral Process
BACM	++	+	+	+	++	+	+	+	U
GVH related myositis	+	+	-	-	+	+	-	-	B
Rhabdomyolysis	+	+	+	+	+	+	+	+	B
Pyomyositis	++	+	+	+	++	+	+	+	U
Dermatomyositis	++	+	+/-	+/-	++	-	-	-	B
Deep Cellulitis	+/-	+/-	+	+	+/-	+/-	+	+	U
Necrotizing Fasciitis	+	+	+	+	++	+	+	+	U

CONCLUSION

- FS T2 WI and post contrast FS T1 WI are useful in demonstrating the extent of muscle and surrounding tissue involvement in children with myositis.
- While the MR findings are not specific, the pattern of signal abnormality on FS T2 weighted images is helpful in determining the cause of childhood myositis.
- GVH related myositis and dermatomyositis involve the superficial soft tissues to a lesser degree than the other causes of myositis.
- BACM, NF, dermatomyositis and rhabdomyolysis demonstrate significant enhancement of the affected muscle groups following gadolinium and all are associated with significant elevation of serum CPK .
- Dermatomyositis, GVH related myositis and rhabdomyolysis tend to be bilateral whereas pyomyositis, BACM, NF and deep cellulitis are unilateral.
- Deep fascial edema is nonspecific and may reflect infected necrotic tissue or noninfected inflammatory edema.
- Imaging features of deep cellulitis may overlap those of NF. MR aids in determining the extent of the process.

REFERENCES

1. Llauger J, Bague S, Palmer J (2002) Focal myositis of the thigh: unusual MR pattern. Skeletal Radiol. 31:307-310.
2. Fugitt JB, Puckett ML, Quigley MM, et al (2004) Necrotizing Fasciitis. Radiographics. 24:1472-1476.
3. Schmid MR, Kossman T, Duewell S (1998) Differentiation of necrotizing fasciitis and cellulitis using MR imaging. AJR. 170:615-620.
4. Kaushik S, Flagg E, Wise CM, et al (2002) Granulomatous myositis: a manifestation of chronic graft-versus-host disease. Skeletal Radiol. 31(4):226-229.
5. Karmazyn B, Kleiman MB, Buckwalter K et al (2006) Acute pyomyositis of the pelvis: the spectrum of clinical presentations and MR findings. Pediatr Radiol. 36(4):338-43.
6. Revelon G, Rahmouni A, Jazaerli N, et al (1999) Acute swelling of the limbs: magnetic resonance pictorial review of fascial and muscle signal changes. EJR. 30:11-21.
7. Hernandez RJ, Sullivan DB, Cenevert TL, et al (1993) MR imaging in children with dermatomyositis: musculoskeletal findings and correlation with clinical and laboratory findings. AJR. 161:359-366.
8. Panghaal V, Ortiz-Romero S, Lovinsky S, et al (2008) Benign acute childhood myositis: an unusual cause of calf pain. Pediatr Radiol.