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PATTERN OF INFLAMMATION PLAYS IMPORTANT ROLE: MUSCLE MRI IN IIM EVALUATION

Introduction

Magnetic resonance imaging (MRI) achieves superior soft tissue contrast and hence the preferred modality for muscle imaging over computed tomography (CT) or Ultrasound during evaluation of a suspected idiopathic inflammatory myositis (IIM). MRI is a sensitive modality but has poor specificity. Muscle MRI can delineate-pattern of muscle involvement, guide muscle biopsy and assess therapeutic response.

Normal muscle shows intermediate signal intensity, higher than bone, lower than fat and marrow on T1 weighted (T1W) sequences; in T2 weighted (T2W) sequences fat and fluid are of higher intensity than muscles. Areas with edema, a sign of active disease in IIM are hyper intense in T2W and STIR (short tau inversion recovery); unaffected areas remain of lower intensity. STIR is preferred over T2 because fat also appears hyper intense in T2W images; fat is suppressed in STIR; hence only muscle edema contributes to muscle hyper intensity in STIR images. Contrast enhancement does not add to the IIM diagnosis- may be of importance if muscle infarction, infection or malignancy is suspected. Fatty infiltration and atrophy are best detected by T1W sequence.

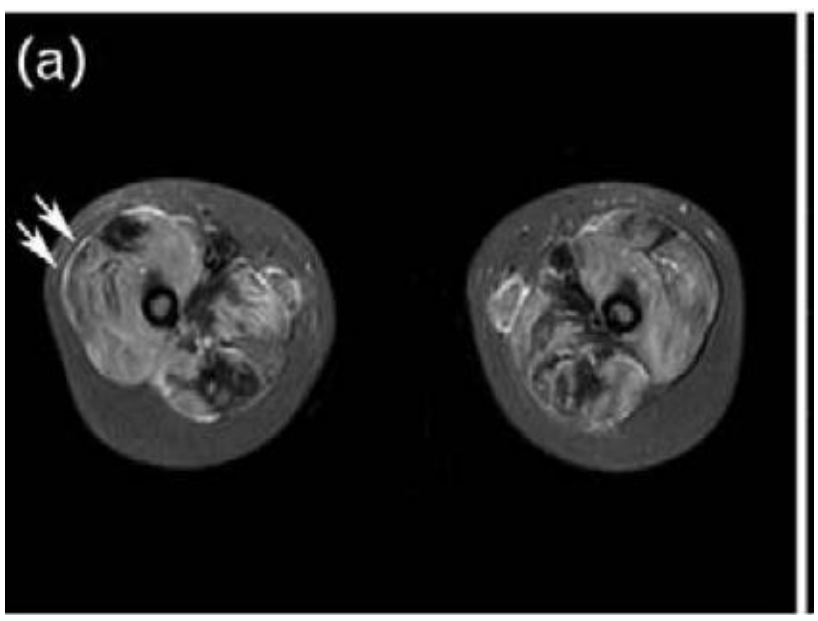
MRI sequences	Muscle edema	Fat
T2 W	Hyperintense	Hyperintense
STIR	Hyperintense	Hypointense
T1 W	Hypointense	Hyperintense
T1 post Gadolinium	Hyperintense	Hyperintense

Sensitivity of muscle MRI in detecting muscle edema in active myositis is 80-90%. In the setting of suspected IIM despite normal strength and creatinine kinase(CK) it may be of particular benefit- the concept of clinically amyopathic dermatomyositis (CADM) was proposed in this regard where MRI evidence of myositis may be found in a patient with DM specific skin lesions without clinical weakness. Intramuscular edema is nonspecific and it needs to be interpreted in the clinical context. Diagnostic gold standard of IIM remains muscle biopsy. The differentials for intramuscular edema are intense muscle exercise, infection, early neuropathy, ischemia, neoplasm, injury, radiation, compartment syndrome, non-inflammatory myopathies.

Guided biopsies:

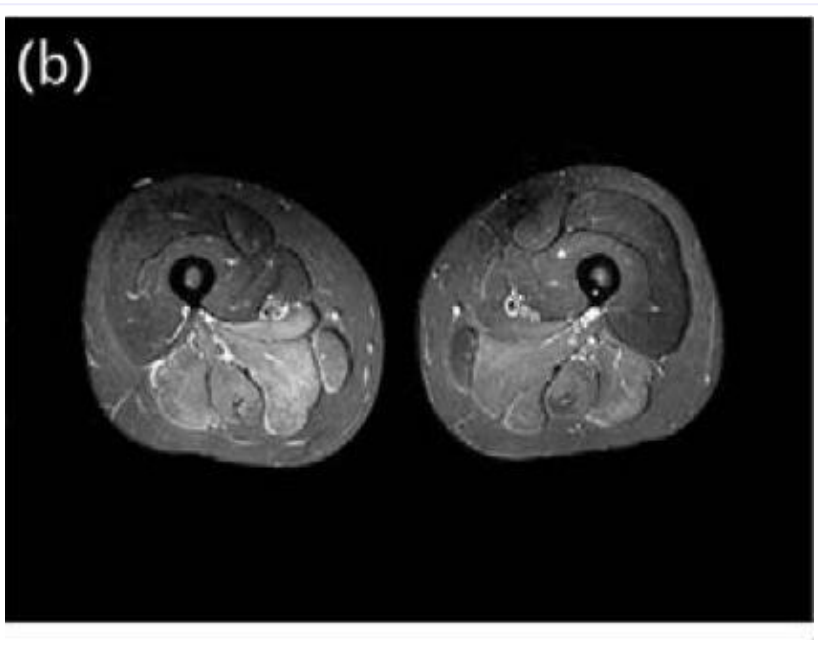
The false negative rate (FNR) of blind biopsies is 10-45% even amongst those with clinically active IIM - may arise due to sampling error since inflammatory infiltrate in IIM tends to be patchy. Guided biopsies are best done in sites involving muscle edema but minimal fatty infiltrate. FNR was reduced by guided biopsies (23% vs 19%) in a prospective study of 48 patients, however cost effectiveness of this approach needs further evaluation.

Pattern of involvement in IIMs (Adapted from (1))



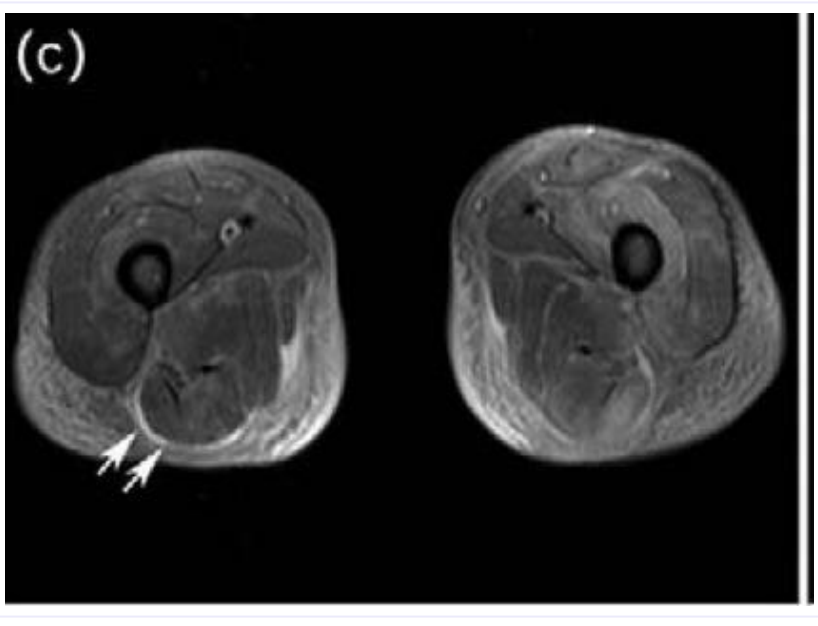
(a) Dermatomyositis-(STIR) fascial edema demonstrated by linear signal hyperintensity (double arrow). Subcutaneous tissue edema in the adjacent area and prominent symmetrical edema especially in the anterior compartment.

• Peripheral distribution and honey combing pattern are other features described to associated with DM.

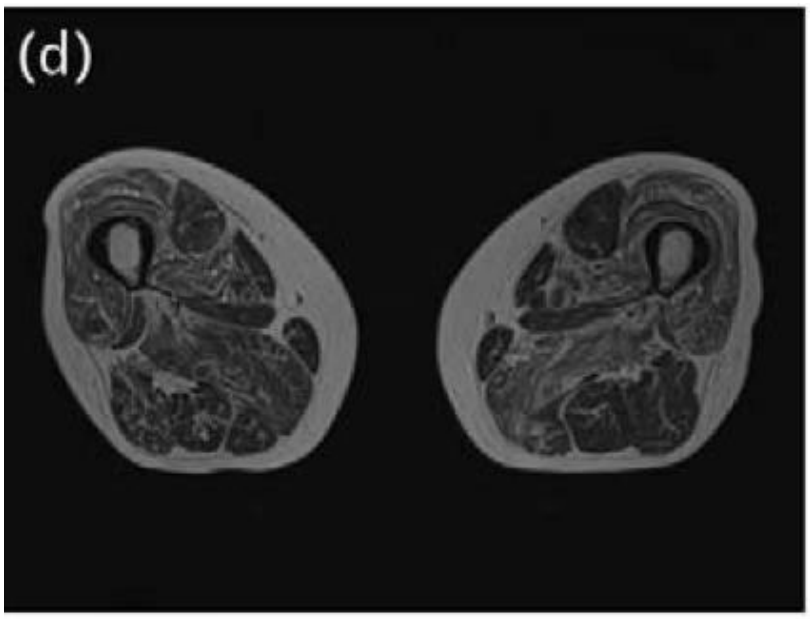


(b) Immune-mediated necrotizing myopathy - (STIR) Patchy involvement without fascial edema.

• Pelvic muscles and adductors were significantly more affected in immune mediated necrotizing myositis as compared to DM/PM.



(c) Antisynthetase syndrome- (STIR) Fascial edema (double arrow) similar to dermatomyositis with prominent subcutaneous tissue edema



(d) Inclusion body myositis (IBM) - (T2W) Fatty infiltration and atrophy of quadriceps with relative sparing rectus femoris.

Marked involvement in the form of fatty atrophy of flexor digitorum profundii, vasti (sparing rectus femoris), triceps surae and median gastrocnemius are features found in sporadic IBM.

Concomitant involvement of distal sartorius muscles and quadriceps is a useful clue to the diagnosis of sIBM since sartorius is often spared in adult onset myopathies. The diagnostic accuracy of MRI to detect IBM is 95%.

Selective involvement of certain muscles is well described in various muscular dystrophy. For example, Becker's muscle dystrophy and Limb girdle dystrophy may clinically mimic IIM. However, fatty atrophy is more pronounced in the biceps femoris, the semimembranous, and the adductors in comparison to sIBM.

Longitudinal imaging:

Distinguishing active inflammation from damage/steroid-induced myopathy is of paramount therapeutic implications. Clinical assessment of activity which involves muscle strength testing and muscle enzymes have their fallacies. Muscle strength testing is limited by the skill of examiner, patient effort, age related sarcopenia, associated arthritis/contractures, inability to distinguish damage related weakness. Muscle enzymes are known to remain near normal even in active disease in DM/IBM subsets.

MRI is helpful to gauge the relative degrees of disease activity/damage by its ability to distinguish between edema and fatty infiltration. Studies employing a combined scores of edema and fatty infiltration have correlated with muscle strength, since these two processes tend to co-occur

Table 2: Benefits and negatives of muscle MRI (Adapted from 4)

Benefits	Negatives
Non ionizing	Metallic implant precluded imaging
High sensitivity	Edema is non specific; adult onset muscle dystrophies are a differential
Detailed anatomical information	Radiological protocols and scoring is not standardized
Distinguish active disease vs damage	Expensive; not widely available
Guide biopsy	
Pattern of involvement of muscle groups	

Newer modalities of imaging

Muscle function and physiology based imaging- phosphorus magnetic resonance spectroscopy (MRS), diffusion weighted MRI, proton transverse T2 relaxation time, blood oxygen level dependent(BOLD) MRI are newer techniques require further studies in IIM patients.

Suggested reading:

1. Tanboon and Nishino . Classification of idiopathic inflammatory myopathies.Curr Opin Neurol 2019, 32:704 – 714 DOI:10.1097/WCO.0000000000000740

2. Britta Maurer1 & Ulrich AWalker Role of MRI in Diagnosis and Management of Idiopathic Inflammatory Myopathies .Curr Rheumatol Rep (2015) 17:67 DOI 10.1007/s11926-015-0544-x

3. Nicole Piptone .Value of MRI in diagnostics and evaluation of myositis .Curr Opin Rheumatol 2016, 28:625 – 630 DOI:10.1097/BOR.0000000000000326

4. Jessica Day, Sandy Patel, Vidya Limaye. The role of magnetic resonance imaging techniques in evaluation and management of the idiopathic inflammatory myopathies. Seminars in Arthritis and Rheumatism. 2016. http://dx.doi.org/10.1016/j.semarthrit.2016.11.001

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