ORIGINAL RESEARCH ARTICLE

High Resolution Ultrasound of Vastus Lateralis and Deltoid Muscles in Evaluation of Inflammatory Myopathies

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ABSTRACT

Introduction: Inflammatory myopathies are diagnosed based on history and clinical examination, biochemical parameters, electromyography and muscle biopsy. Among the imaging tools, Magnetic resonance imaging remains the gold standard in assessing inflammatory myopathies. High-resolution ultrasound is emerging as an alternative imaging tool both for evaluation and follow-up in cases of IM. Our study aimed to evaluate the echogenicity and vascularity of vastus lateralis, the thickness of the superficial fascia overlying the vastus lateralis and deltoid muscles using High resolution ultrasound in cases of inflammatory myopathies with proximal muscle involvement and compare these findings with those of healthy controls.
Material and Methods: This is a prospective study conducted in the department of Radiology at Nizam's Institute of Medical Sciences, Hyderabad, between February 2018 and September 2018. Thirty patients of inflammatory myopathies with proximal muscle involvement were enrolled along with thirty age and sex matched controls. The echogenicity and vascularity of vastus lateralis was evaluated. The thickness of the overlying superficial fascia of vastus lateralis and the deltoid muscles was evaluated.
Results: Out of 30 cases of inflammatory myopathy, 27 patients showed sonographic changes in the muscle, either in the form of increased echogenicity and/or power Doppler score. In comparison, only 5 cases among the controls showed any such changes. The overlying superficial fascia over the vastus lateralis and deltoid muscles was significantly thickened in cases of inflammatory myopathies when compared with healthy controls.
Conclusion: High resolution ultrasonography has very high sensitivity in detecting skeletal muscle changes and associated fascitis in inflammatory myopathies.

Keywords: High Resolution Ultrasound (HRUS), Inflammatory Myopathies, Vastus Lateralis, Deltoid and Superficial Fascia

INTRODUCTION

Inflammatory myopathies (IM) are a rare heterogeneous group of autoimmune disorders that are characterised by long-standing muscle inflammation which clinically present with slow and progressive muscle weakness that usually starts in the proximal muscles, but can involve any other muscle of the body. Due to the systemic inflammatory nature of the disease extramuscular manifestations involving skin, lungs, heart and joints may also occur.[1,2]

Concomitant fasciitis has been reported in several subtypes of IMs[3,4] with certain studies speculating that inflammation begins around blood vessels in the fascia and spreading into the muscle and interfascicular septum.

IMs can be classified based on current EULAR/ACR criteria into the following subgroups: polymyositis (PM), inclusion body myositis (IBM), dermatomyositis (DM), amyopathic DM, juvenile dermatomyositis (JDM), and juvenile myositis other than JDM.[2]

Clinically patients were considered to have myositis if they reported persistent disabling muscle weakness (of proximal and/or distal mass muscles in upper and lower limbs) in combination with elevated levels of creatine phosphokinase (CPK) (normal values 60–190 UI/l) and abnormal electromyography (EMG).[5] Muscle biopsy remains the "gold standard" for diagnosis.[1] Both EMG and muscle biopsy are painful and invasive tests and muscle biopsy maybe normal in some cases due to patchy nature of inflammation in myositis.[6]

Imaging plays an important role as an adjunct to the clinical and biochemical parameters in the diagnosis of IM. It is also useful in guiding the sites for biopsy and for assessment of disease activity.[2]

Muscles can be imaged by MRI or Ultrasound. Both modalities are non-invasive, painless and radiation free. MRI is considered as the "gold standard" in muscle imaging and its role in inflammatory myopathies has been well described in literature. It scores over other modalities due to its inherently superior soft tissue resolution, multiplanar imaging capabilities and the ability to use specialized

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sequences to differentiate between fat and water based pathologies.[7] Many studies have documented the diagnostic sensitivity and specificity of MRI in myopathies. However, MRI is expensive, difficult for some patients to tolerate, and contraindicated in those with pacemakers, aneurysm clips, and other ferromagnetic biomedical implants.

HRUS is an alternative approach to imaging the muscular system. It is a non-invasive, relatively inexpensive technique that offers real time imaging with high spatial resolution. It has virtually no contraindication and serial examinations can be performed for follow-up.[2]

HRUS uses high frequency (5-15 MHz) linear array transducers to image the superficial skeletal muscles. In the transverse plane the normal skeletal muscle appears hypoechoic with speckled appearance due to the echogenic perimysial connective tissue. In the longitudinal plane the skeletal muscle appears fascicular with linear, pennate or triangular configurations due to the reflections from the perimysial connective tissue. The fibroelastic epimysium surrounding the muscle appears hyperechoic[2,8] [Fig 1].

HRUS allows precise assessment of muscle bulk, echogenicity, calcifications and mesenchymal abnormalities. In addition, HRUS can also detect fascial thickening, which indicates presence of associated fasciitis. Addition of power Doppler sonography allows ultrasound to further characterize normal and pathologic states. Our study aimed to evaluate the echogenicity and vascularity of vastus lateralis, the thickness of the superficial fascia overlying the vastus lateralis and deltoid muscles using High resolution ultrasound in cases of inflammatory myopathies with proximal muscle involvement and compare these findings with those of healthy controls.

MATERIALS AND METHODS

The study was reviewed and approved by our Institutional Review Board prior to enrolling patients in the project. Written informed consent of the patients or patient's relatives and controls was taken for their inclusion in the study.

In this study we investigated the role of HRUS in various inflammatory myopathies by evaluating the muscle echogenicity and vascularity of vastus lateralis muscle. We also evaluated the muscle fascia thickness adjacent to vastus lateralis and deltoid muscles to look for associated fasciitis. These muscles were chosen for the purpose of convenience and familiarity with normal findings.

An age and sex matched control group of healthy volunteers were also included in our study for comparison of muscle echogenicity and power Doppler scores and to calculate the normal reference values for muscle fascial thickness.

The study was performed using Esaote Mylab™ Seven Ultrasound system, using a 10-5 MHz linear array transducer and copious amount of clear ultrasound gel to minimize transducer pressure on skin.

A total of 30 cases of inflammatory myopathies with proximal muscle weakness diagnosed in the department of Rheumatology of our institute using Bohan and Peter criteria[9] were evaluated during this period. A control group consisting of age and sex matched healthy volunteers were studied simultaneously during the same period. Patients who underwent recent muscle biopsy and those who did not give consent to undergo HRUS were excluded from the study.

All subjects were examined in the supine position with the arms and legs extended and the muscles completely relaxed. A generous amount of contact gel was used to minimize transducer pressure on the skin.

The vastus lateralis on both sides were evaluated on the anterolateral aspect of the thigh at a point two thirds of the distance from the anterior superior iliac spine to the upper edge of the patella in the transverse plane. Qualitative visual analysis grading was done after visualising the muscle using the Heckmatt scale [Table 1], which is based on the degree of muscle echogenicity and visualization of the deep bony structures [Fig 2].[2,10]

Muscle vascularity, as an indicator of hyperaemia and inflammation, was assessed during a continuous sweep over each muscle scanned in cross section. Vascularity was assessed by using Power Doppler mode and graded according to Power Doppler vascularity grading scheme [Table 2], [Fig 3][11].

Based on muscle echogenicity and power Doppler score; cases were classified into four broad groups:

- Normal muscle echogenicity (grade I) with normal PDS (0 and 1) – Normal muscle.
- Normal muscle echogenicity (grade I) with increase in PDS (2, 3 and 4) - Acute muscle changes (Inflammation of muscle)
- Increase in muscle echogenicity (grade II, III and IV) with increased PDS (2, 3 and 4) - Acute on chronic muscle changes (Inflammation of muscle).
- Increase in muscle echogenicity (grade II, III and IV) with normal PDS (0 and 1) - Chronic Inflammatory Myositis (Fibrosis of muscle).

Superficial fascia overlying the vastus lateralis muscle at the aforementioned site and the deltoid muscle at a point a quarter of the distance from acromion to the lateral epicondyle was visualised using a 2-fold magnification and a minimum of four measurements of fascial thickness were obtained for each case. All measurements were performed by the same observer [Fig 2].[3]

STATISTICAL ANALYSIS

Data analysis was done using Microsoft excel and SPSS VERSION 17 IBM statistics software package. Statistical data was presented as sensitivity, specificity, positive and negative predictive values.

An independent samples t-test was used to compare the mean fascial thickness values derived from healthy controls with that of IM patients. Patients with increased fascial thickness (defined as >2 SD above normal) were considered to have fascitis.

RESULTS

Study group comprised of thirty patients (n=30) of inflammatory myositis, out of which 27 (90%) were females and 3 (10%) were males. The mean age group of the study population was 33 years with majority of the patients belonging to age group of 30-39 years (50%). Aetiologically the study group comprised of 9 cases of Dermatomyositis, 9 cases of SLE with myositis, 3 cases of MCTD with myositis,

3 cases of SSC with myositis, 2 cases of scleroderma with myositis, 1 case of SLE with secondary APS, 1 case of DM overlap and 1 case of Anti synthetase syndrome.

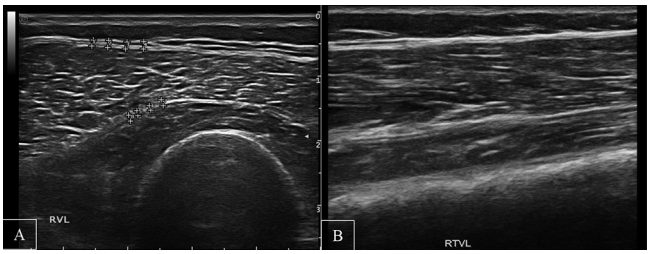

Figure-1: Grey scale HRUS image showing normal appearance of Vastus Lateralis muscle. Transverse image [A] showing hypoechoic muscle fascicles separated by echogenic fibro adipose or perimysial connective tissue (white arrow). Image also shows technique of measurement of fascial thickness. Longitudinal image [B] showing linear appearance of the hypoechoic fascicles.

In study group 27 out of 30 IM cases showed muscle changes on HRUS either in the form of increase in echogenicity or PDS (true positives), 3 cases showed normal muscle pattern (false negatives). In control group 5 out of 30 cases showed muscle changes (false positives) and 25 cases were normal (true negatives). The results of muscle echogenicity grading and PDS of both vastus lateralis are as depicted in Table 3.

The mean value of fascial thickness among controls in right vastus lateralis in mm was 1.4368, left vastus lateralis is 1.4363, right deltoid is 0.9668 and left deltoid is 0.9394 with standard deviations of 0.2711, 0.2990,0.2705 and 0.1782 respectively. The mean values of fascial thickness in mm of the IM group was; right VL 1.7639, left VL 1.7993, right deltoid 1.1136 and left deltoid 1.1208 with standard deviations of 0.5165, 0.5098, 0.4419 and 0.3678 respectively. The mean value of fascial thickness in Healthy Controls

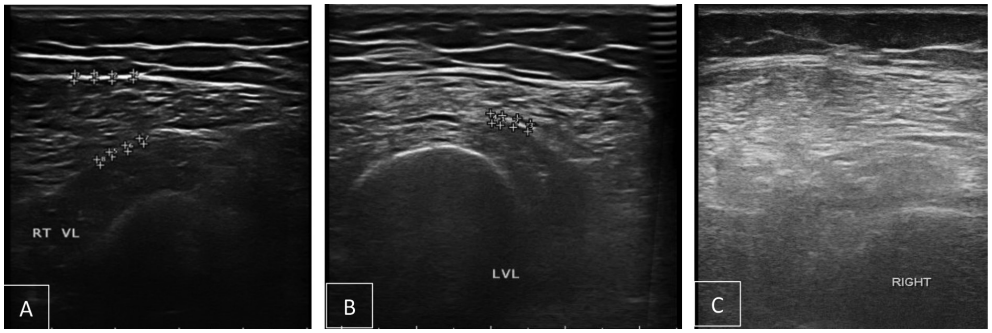

Figure-2: Transvese grey scale HRUS image showing the grading of muscle echogenicity based on Heckmatt scale. [A] Grade 1 change [B] Grade 2 change [C] Grade 3 change.

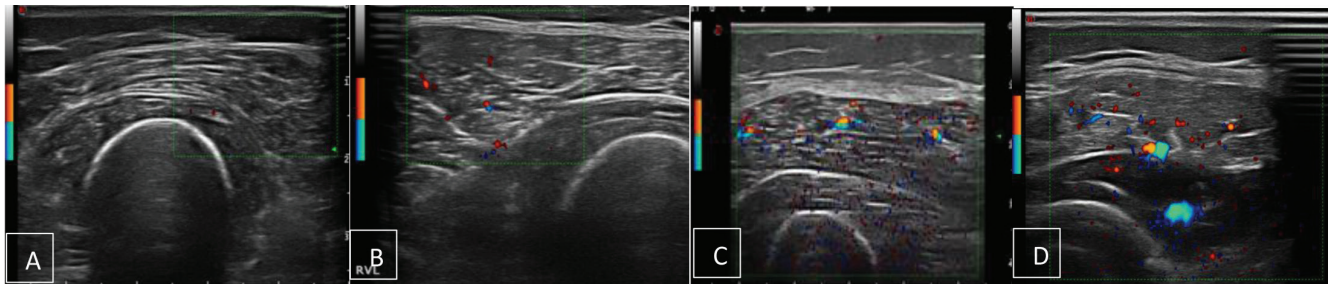

Figure-3: Transverse power Doppler ultrasound image showing the power Doppler vascular grading. [A] Grade 1, at least one intramuscular vessel is seen [B] Grade 2, > 5 small intramuscular vessels seen [C] Grade 3 > cluster of grade 2 vessels seen [D] Frank blush or indistinguishable vessel boundaries.

Grade I	Normal echo of muscle with lamellar pattern and strong bone echo.
Grade II	Increased muscle echogenicity with distinct bone echogenicity.
Grade III	Marked increased muscle echogenicity with reduced bone echogenicity.
Grade IV	Very strong muscle echogenicity and complete loss of bone echogenicity.

Table-1: Showing Heckmatt scale of qualitative scoring

Grade 0	No vessels seen.
Grade 1	At least one intramuscular vessel seen.
Grade 2	≥ 5 small vessels seen in a 2 dimensional frame or a single large intramuscular vessel seen with cross section > 5 mm or segment length > 1.5 cm.
Grade 3	Vascularity rating of 2 with small clusters (≥ 3) of vessels.
Grade 4	Appearance of frank blush, or vessel boundaries not distinguishable.

Table-2: Showing power Doppler vascularity grading scheme

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Sl.no	Parameter	Normal	Acute	Acute on Chronic	Chronic
1.	Muscle Echo Grading Right VL				
	I	3	3	0	0
	II	0	2	8	10
	III	0	0	0	4
2.	Muscle Echo Grading Left VL				
	I	3	2	0	0
	II	0	3	7	10
	III	0	0	1	4
3.	PDS Right VL				
	0	3	0	0	6
	1	0	1	0	8
	2	0	3	4	0
	3	0	1	4	0
4.	PDS Left VL				
	0	0	0	0	5
	1	3	0	0	8
	2	0	4	4	1
	3	0	1	2	0
	4	0	0	2	0

Table-3: Muscle echogenicity grading and PDS of both vastus lateralis among cases of IM.

Sl. No	Parameter	Cases	Control	T test value	Degree of freedom	P value
1.	SFT Left VL	1.7993±0.5098	1.4363±0.2711	-3.443	58	0.0011
2.	SFT Right VL	1.7637±0.5165	1.4368±0.2990	-3.000	58	0.004
3.	SFT Left DL	1.1208±0.4419	0.9668±0.2075	-1.728	58	0.0893
4.	SFT Right DL	1.1136±0.3678	0.9394±0.1782	-2.335	58	0.0230

Table-4: Significance of Fascial Thickness in Healthy Controls vs. IM Patients

vs. IM Patients with standard deviation and statistical significance is depicted in Table 4.

DISCUSSION

Inflammatory myopathies are a rare heterogeneous group of disorders that pose a significant diagnostic challenge to the clinician due to their protean manifestations. Although imaging is presently not included in the classification of IM, it is an invaluable adjunct to the clinical and biochemical parameters in the diagnosis and assessment of disease activity. Among the imaging tools available, MRI is considered the gold standard in muscle imaging. Our study aimed at evaluating the potential role of HRUS as an alternative imaging tool in diagnosis and assessment disease activity in IM.

Thirty (30) patients of inflammatory myositis were studied, of these 27 (90%) were females and 3 (10%) were males, suggesting a strong female predominance. This was in concordance with previous studies done by Lynn SJ et al[12] and Shenavandeh et al.[13]

Based on the results of our study, 27 out of the 30 (90%) cases of IM showed changes either in the form of increase in echogenicity or vascularity (true positives). Based on the grey scale HRUS and PDS findings, 14 (46.6%) cases showed features of chronic inflammatory muscle changes, 8 (26.6%) cases showed features of acute on chronic inflammatory muscle changes and 5 (16.6%) cases showed features of acute inflammatory muscle changes. These observations were consistent with those made by Adler RS et al[14], where increased size, muscle echogenicity and blood flow was observed in acute myositis, whereas diminished size, with increased echogenicity and reduced perfusion were observed in chronic myositis.

Three cases out of thirty showed a normal muscle pattern (false negatives). These false negatives may be attributed to mild degree of inflammation or involvement of other group of muscles.

Using above the parameters in our study we found that HRUS had a Sensitivity of 90%, Specificity of 83.3%, Positive predictive value (PPV) of 84.4% and Negative predictive value (NPV) of 89.3 % in diagnosing inflammatory myopathies. This indicates a high sensitivity of HRUS in detecting muscle inflammation.

In IM cases statistically significant ($p \leq 0.05$) increase in mean thickness of vastus lateralis and/or deltoid fascial (fasciitis) was observed in cases of IM. Since there are no existing reference values for fascial thickness over vastus lateralis and deltoid muscles in the Indian population, we compared the results with age and sex matched controls. This observation implies that component of fasciitis usually coexists in IMs and can be assessed using HRUS. This is in agreement with the observations made by Yoshida et al[4] and Bhansing et al.[3]

CONCLUSION

Our study shows that HRUS is noninvasive, cost effective, widely available diagnostic tool with high accuracy in

assessing inflammatory myopathies. It can be used not only to establish the diagnosis, but to assess disease activity, guide biopsy and perhaps in the follow up of cases.

Limitations of our study was small sample size. Study on larger population would have made the statistical analysis more accurate.

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