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The contribution of ultrasonography and sonoelastography in assessment of myositis

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Abstract

Aims: To analyze the utility of ultrasonography (US) in the assessment of inflammatory miopathies, and of sonoelastography in the assessment of the elasticity of skeletal muscle in myositis. **Material and methods:** The study group comprised 24 patients with musculoskeletal pathology examined using Hitachi 8500 EUB equipment with a 6.5-13 MHz transducer and software for elastography. The images were analyzed in conjunction with clinical and biochemical data. Using dedicated software for color information from the elastographic images, the average values for color intensity, hue and dispersion were calculated. **Results:** After the correlation of US images with clinical and paraclinical data the highest average values for color parameters were encountered on the superior third of the thigh. There was a proportional concordance between the average values of the color parameters and serum creatine kinase and serum lactic dehydrogenase and there was no significant agreement between the average values of the color parameters and the erythrocyte sedimentation rate, positive rheumatoid factor or positive antinuclear antibody. **Conclusions:** The correlation between the quantitative colour parameters from the elastographic images and the laborator studies suggest that sonoelastography could be an important tool in the management of the patients with myositis.

Keywords: ultrasonography, sonoelastography, myositis, elasticity

Rezumat

Scop: De a analiza masura in care ultrasonografia (US) este utila in evaluarea miopatiilor inflamatorii, iar sonoelastografia in evaluarea elasticitatii musculaturii scheletice in miozite. **Material si metoda:** Lotul de studiu a fost alcatuit din 24 de pacienti cu patologie musucloscheletala, examinati utilizand un ecograf Hitachi 8500 EUB cu transductor cu frecventa 6.5-13 MHz si software pentru elastografie. Imaginile au fost analizate in concordanta cu datele clinice şi biochimice. Au fost calculate, cu un software dedicat pentru informatiile color de pe imaginile elastografice, valorile medii pentru intensitatea culorii, nuanta si dispersie. **Rezultate:** Au existat corelatii intre imaginile US si datele clinice si paraclinice, cele mai mari valori ale parametrilor color fiind intalnite la nivelul treimii superioare a coapsei. A fost evidentiata o concordanta proportionala intre media valorilor parametrilor de culoare de pe imaginile elastografice si nivelul seric al creatinkinazei si dehidrogenazei lactice, neexistand o corelare semnificativa intre valorile medii ale parametrilor de culoare si valoarea vitezei de sedimentare a eritrocitelor, a prezentei factorului reumatoid sau a anticorpilor antinucleari. **Concluzii:** Corelarea intre parametrii cantitativi de culoare de pe imaginile elastografice si datele biochimice ne permit sa afirmam ca sonoelastografia ar putea reprezenta o metoda de investigatie importanta in managamentul pacientilor cu miozita.

Cuvinte cheie: ultrasonografie, elastografie, miozita, elasticitate

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Introduction

Inflammatory myopathies represent a group of disorders characterized by the alteration of the muscular structure and changes of some specific lab tests. In this group are included idiopathic inflammatory myopathies and myopathies which appear in other disorders that affect the musculoskeletal system, such as mixed conjunctive tissue disease (MCTD), rheumatoid arthritis (RA),

systemic lupus erythematosus (SLE), and thyroid disorders.

Polymyositis (PM), dermatomyositis (DM), and inclusion body myositis (IBM) are the major entities of a group of skeletal muscle diseases called „Idiopathic inflammatory myopathies" [1].

Clinical symptoms, characteristic muscle biopsy findings, immune markers, and morphopatological aspects differentiate these diseases. No strictly defined diagnostic criteria for PM or DM exist; however, Bohan and Peter [2] proposed the criteria most widely cited. These criteria include the typical rash of DM, findings at history and physical examination that reveal symmetric proximal muscular weakness, elevated serum muscle enzyme levels, electromyographic evidence of myopathic abnormalities, and characteristic findings at muscle biopsy [2,3].

The use of the appropriate laboratory tests could facilitate early diagnosis and afterwards management [4]. Increased levels of serum creatin kinase (CK), aldolase, serum myoglobin, lactate dehydrogenase (LDH), aspartat aminotransferase (ASAT) and alanine aminotransferase (ALAT) could be found. In clinical practice, usually only CK and LDH, sometimes aldolase, are determinated. CK serum level is the most sensitive and specific, being usually 5-50 times the normal level. A level greater than 100 times the reference level is rare and is a signal for other diagnosis. The erythrocyte sedimentation rate (ESR) usually is elevated. Myoglobinuria may be present. Positive rheumatoid factor and leukocytosis are found in more than 50% of patients. Positive antinuclear antibodies (ANAs) results are found in less than 50% of patients. Serum muscle enzyme levels determination and urinary creatinine excretion are useful for the managment of PM and DM [3,4].

Positive muscular biopsy can prove the cause of myopathic inflammation, to exclude a motor neuron lesion, and to appreciate the severity of the disease, which is very important for the prognosis [4].

Noninvasive diagnostic methods such as ultrasonography (US), magnetic resonance (MRI) and computer tomography (CT) visualize muscular oedema, fluid collections, adipose infiltration, atrophy, fibrosis and calcifications [5,6].

Though MRI is the method of choice in these diseases, the low availability, patients' discomfort and the contraindications of MRI examination, represent disadvantages of this imaging method [7,8,9].

Muscles are the best superficial structures which can be assessed by US. Widespread availability and its easy facility has made US a preferable imaging method [7,10]. Muscular aspects in inflammatory diseases are discrete, usually and consist of increased thickness and reduced ecogenicity of the skeletal muscles. US aspects can be diffuse or focal [11,12].

Ultrasonic elastography (Sonoelastography) measures tissue deformation as a response to an external force, assuming that the deformation is lower in rigid tissues, compared with the elastic, soft tissues. This method is based on comparing the radiofrequency of ultrasonic waves obtained before and after an easy made compression with a conventional transducer, using a free hand technique [13].

Assessment of musculoskeletal pathology is one of the first applications in vivo of ultrasonic elastography providing quality information of the soft tissues by assessment of the tissue's elasticity with clinical significance in diagnosis and monitoring of the musculoskeletal injuries. Elastography offers a good functional evaluation by measuring the stiffness /elasticity of the muscles [13].

There are only a few studies in the literature which have attempted to present the muscular appearance of the muscle structures' elasticity [14]. It is known that the muscular elasticity is modified in myopathies and sonoelastography can be a useful method for its assessment [13].

The objectives of this study were to evaluate the contribution of US and sonoelastography in the assessment of inflammatory myopathies, especially idopathic ones, and to evaluate the contribution of information obtained by processing sonoelastographic images using a dedicated software (ImageProcessing).

Patients and methods

Our study was performed in the Emergency Clinical County Hospital, Cluj. The study comprised 24 patients with muscular pathology from the Rheumatology Clinic directed for ultrasonographic evaluation to the Radiology Clinic - Ultrasonography Department, between May 2007 and October 2008. The study was approved by the Ethical Comittee of the university. All the patients presented clinical evaluation and lab tests for muscular inflammatory disease: symetric and proximal muscular weakness, increased values of the nonspecific inflammatory markers (ESR, positive C reactiv protein - CRP) and increased levels of serum muscle enzyme and ANAs. Surgical muscular biopsy was performed in all our patients before US examination. We excluded from the study patients with extramuscular manifestations of the disease.

All the patients were examined using a Hitachi EUB 8500 equipment with 6.5-13 MHz transducer. Examination was performed in real time, using transversal and sagittal sections of the thigh, arms and leg superior, medium and inferior muscular groups, with patient in dorsal decubitus, neutral position and with relaxed muscles. 2D US criteria for inflammation included muscular fibers

hyperecogenicity, hypoecogenicity of the fibroadipose septe and increased muscular diameter. Criteria for atrophy included increased ecogenicity of the muscles and reduced diameter of the fibers [7,11]. For each patient a US examination result was written. All patients gave their informed consent.

Images obtained were initially saved in the memory of the machine for the possibility of further review and processing.

Sonoelastographic examinations were performed using the same equipment, in real time, and using the same sections such as 2D US, with graduated compression of the muscular structures and the transducer perpendicular on the skin. A box of elastography was set to include interested muscle structure and adjacent structures. Slight compression was achieved with a frequency vibrational maintained at 3-4 scale displayed on the monitor. The color gain was set at 26%, the density at 2 lines of information and the frequency of the images to „high".

The patients were assessed by 2D US and elastography of the superior, medium and inferior muscle structures of the thighs and arms, left-right comparative. 2 patients included in the study presented weakness in the upper and medium leg region muscles, and in these cases that region was also evaluated.

Sonoelastographic images obtained were analysed using a dedicated software with the aim of obtaining objectives and quantifiable data, useful for establishing an exact imaging diagnosis and for monitoring of this disease. Image Processing software version 2.8 was used, developed by Technical University of Cluj-Napoca. The quantitative parameters followed on the selected sonoelastographic images were represented by the average numerical values of colours, colour intensity, colour dispersion, hue and hue dispersion.

Obtained data were analyzed using Microsoft Excel software tests and the results were graphically represented.

Results

From the total of 24 patients with inflammatory muscle disease wich were sent for ultrasound evaluation, 18 were female and 6 male. Patients examined were aged between 24 and 67 years. 42% were aged between 51 and 60 years while 33% were aged between 61 and 70 years Patients' clinical data and lab tests are presented in table I.

Table 1. Patients clinical data and lab tests

Sex	Age	Diagnosis	CK	LDH	ESR	CRP	ANAs
M	48	Thyroid myopathy	215	480	64	4.8	0
F	55	MCTD	263	618	32	2.4	0
F	64	SLE	213	540	28	1.7	1/160
F	32	MCTD	213	540	31	1.8	1/320
F	56	SLE	293	1110	38	1.2	1/640
F	42	PM	295	380	10	0	0
F	62	DM	480	553	10	0.9	1/160
F	56	PM	145	215	8	0	0
F	55	DM	64	712	26	1.4	1/160
F	61	PM	663	1211	34	4.2	1/160
F	24	PM	663	1461	32	0.8	0
F	57	Localized myopathy	150	613	17	0.8	0
F	60	DM	130	760	17	0.8	1/180
F	67	RA myopathy	115	463	86	3.8	1/160
F	63	DM	245	528	23	1.6	1/160
M	52	DM	3560	4715	88	9.6	1/640
F	63	PM	490	1106	22	2.2	0
F	60	DM	130	760	17	0.8	1/180
F	56	LES	263	1200	42	1.2	1/640
M	56	PM	295	380	10	0	0
F	60	Localized myopathy	150	317	6	0	0
M	56	PM	295	380	10	0	0
M	58	PM	120	220	12	0.7	0
M	52	DM	3560	4715	88	9.6	1/640

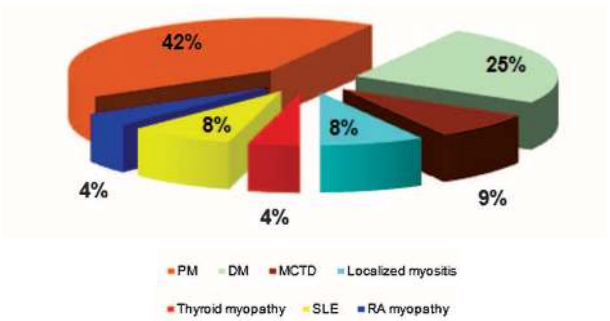

Fig 1. Distribution of diagnosis by type of inflammatory muscles diseases (PM – polymiositis, DM – dermatomyositis, MCTD – mixed conjunctive tissue disease, SLE – systemic eritematous lupus, RA myopathy – rheumathoid arthritis myopathy)

Diagnosis established for patients included in the study are illustrated in fig 1. The majority were represented by patients with PM and DM.

The areas with suspected changes were found more often in the muscle structures of the thigh, followed by arms and only a small percentage of those in the legs. Most affected muscle structures were in the middle part of the thighs and arms.

2D US examinations revealed that different types of inflammatory myopathies show typical, but nonspecific aspects: in cases with PM- increased ecogenicity and muscle atrophy and in cases of DM- rare muscle atrophy and increased ecogenicity in arm muscles. The global ecogenicity was decreased in DM compared to that of PM (fig 2, fig 3)

Fig 2. Polymyositis: M, 63 years - atrophy and important increase of ecogenicity at the anterior-superior region of right thigh

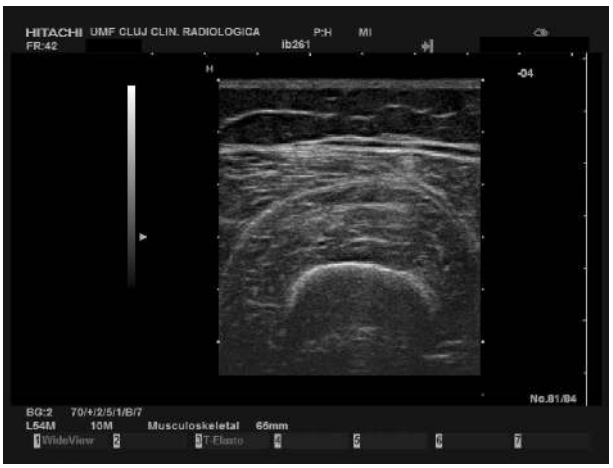

Fig 3. Dermatomyositis: F, 54 years - moderate increase of the ecogenicity, with conserved the muscle structure of the medium third of the right thigh

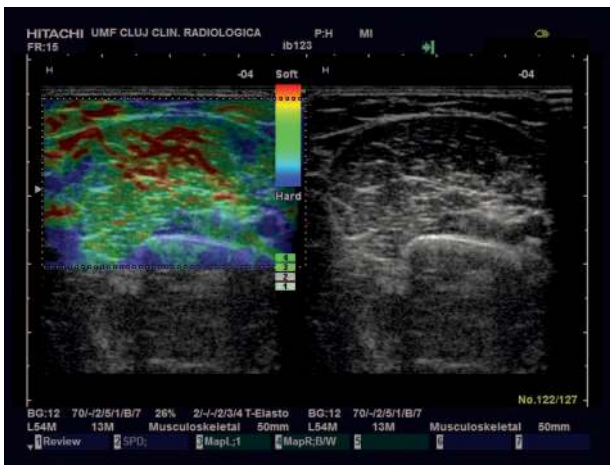

Fig 4. Elastographic appearance of the normal muscle at the third medium arm level

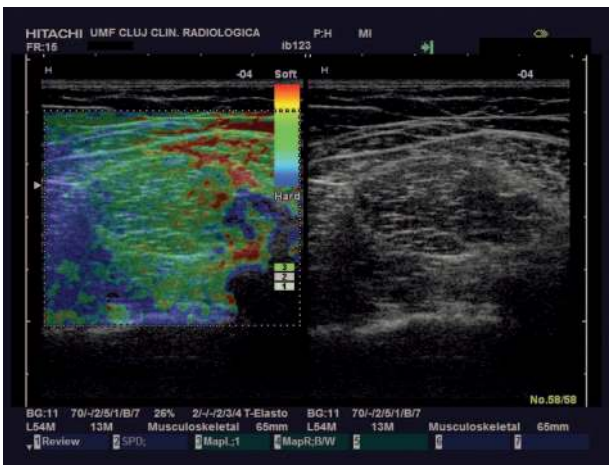

Fig 5. Elastographic appearance of the normal muscle at the third medium thigh level

Elastography was performed by examining the degree of elasticity of thighs, arms and legs muscle structures, left versus right, PM and DM versus healthy subjects (fig 4-7).

The images obtained from elastography were processed using Image Processing software. The average color (blue, green, red), color intensity, hue, and the average dispersion values were calculated with the Image Processing software menu option Elasto Measurements. In all affected regions, we found increased minimum, maximum and average hue values (table II, fig 8). The highest average values are recorded in the upper third of the thigh.

The correlation between the average hue values and serum CK values is illustrated in fig 9 (there is a proportional correlation between the hue average values and CK serum level).

LDH presented increased values and the correlation between hue mean values and LDH serum level, are presented in fig 10 (there is a proportional correlation between hue average values and LDH serum level).

The correlation between ESR hue average values is shown in fig 11 (there is no proportional correlation) and between CRP serum level and the hue average values in fig 12.

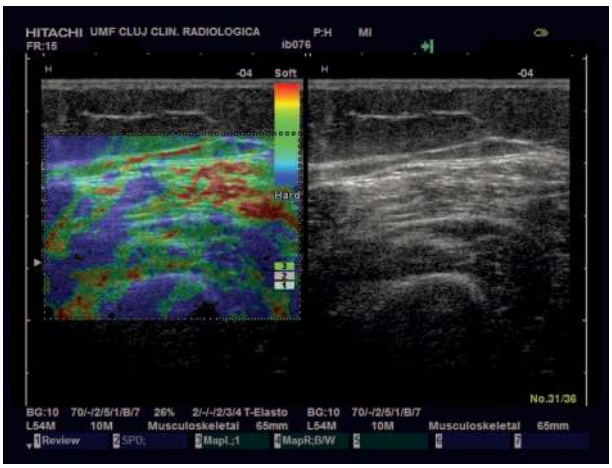

Fig 6. Polymyositis: F, 55 years - elastography at the medium third of the thigh (alteration of normal striated appearance, with important reduced elasticity in the intern part of the muscle)

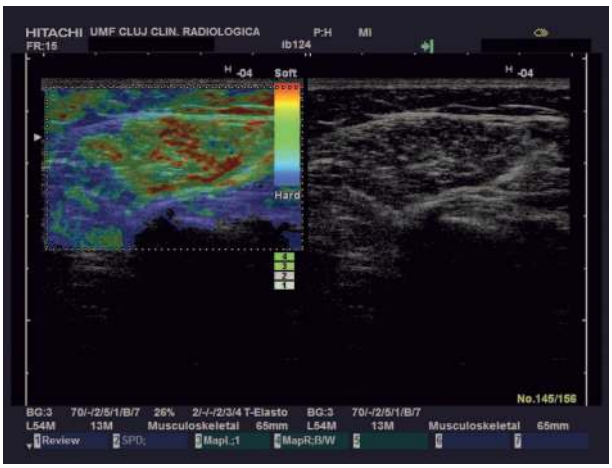

Fig 7. Dermatomyositis: F, 60 years - elastography at the superior third of the arm (alteration of normal striated appearance, with increased elasticity)

Table 2. The average, minimum and maximum hue values in the examined regions

Region examined	Avg Hue	Hue Min	Max Hue
Upper third arm	127.6472	92.3533	162.397
Medium third arm	138.4934	111.64	182.141
Lower third arm	129.732	128.542	130.36
Upper third thigh	158.5564	132.33	182.998
Medium third thigh	134.2443	79.2525	227.919
Lower third thigh	116.5809	99.0824	138.615
Upper third calf	126.9853	115.123	142.949
Medium third calf	130.659	128.108	134.747

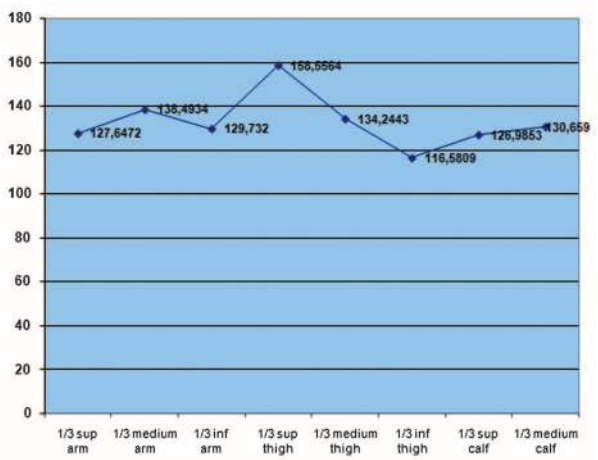

Fig 8. Distribution of hue average values depending on the region examined

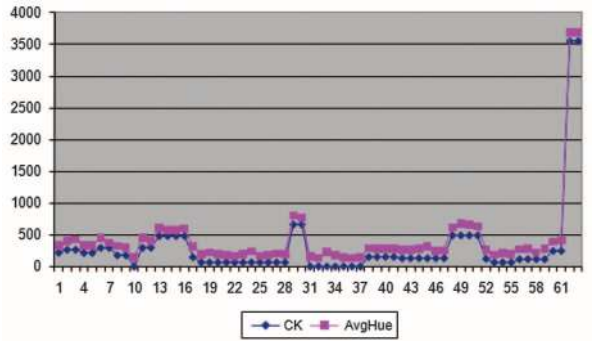

Fig 9. Comparative distribution of hue average values and CK serum level

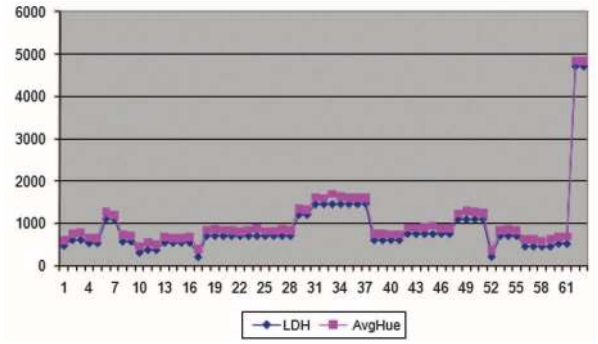

Fig 10. Comparative distribution of hue average values and LDH serum level

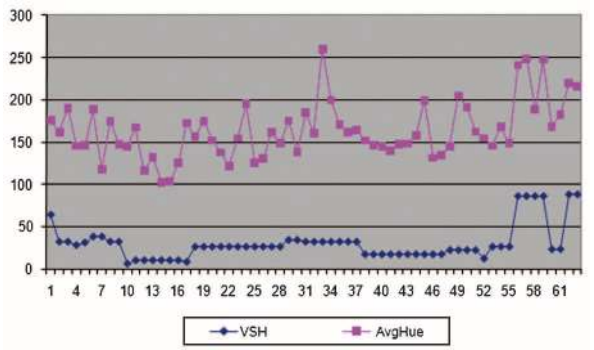

Fig 11. Comparative distribution of hue average values and ESR level

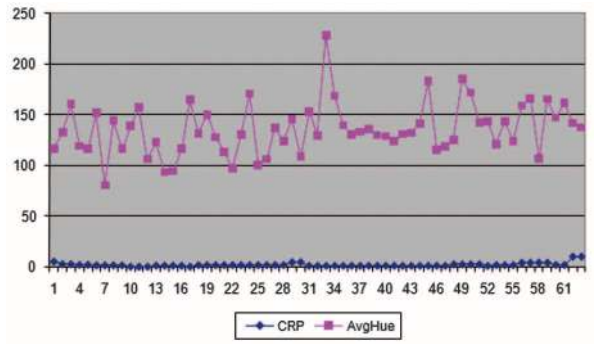

Fig 12. Comparative distribution of hue average values and CRP serum level

Discussion

US and elastography exams evidence the advantages and limitations known and considered for patients with muscle disease management, by contributing to the diagnosis and following-up the evolution under treatment.

US and elastography facilitate diagnosis of inflammatory myopathies by the assessment of the skeletal muscle state and also by the possibility of appreciating the appearance of muscle structure (muscle, fascia, adjacent fat), the echogenic changes, and the elasticity. These exams are important in monitoring patients with inflammatory muscle diseases by assessing the response to therapy, evolution and appearanc of any complications.

It is important to perform a correct 2D US and elastographic examination, by a specialist in musculoskeletal US. The normal US appearance of the muscle structure must be very well known in order to recognize the incipient and minimal changes that can appear in the incipient studies of the disease. In sonoelastography the examiner must be careful with the pressure and angulation of the transducer and with the movement, in order to obtain a proper image.

Also, ultrasound-guided muscle biopsy is an alternative to consider, if we take into consideration the degree of patient discomfort when high invasive surgical biopsies are performed.

The possibility of assessing the degree of tissue elasticity by elastography brings extra information, useful not only for diagnosis, but also for the follow-up of the dynamic structural changes in the involved muscles. In many cases, ultrasound is the first intention exam, sometimes the only imaging investigation [3,4,7,10].

As can be seen in table 1, in the studied sample there was a preponderance of female patients – 66%. This is due to the higher incidence in females of this condition. Regarding the age of patients enrolled in the study, ages 51-60 years and 61-70 years respectively were predominant, which is consistent with data described in the literature regarding the relationship between disease incidence and age groups most frequently affected. Most of the cases were also investigated for PM (43%) and DM (25%); those pathological entities represent, as described in literature, most cases of inflammatory myopathies.

In almost all 2D US examined cases, changes were observed in the structure or in the muscle ecogenicity. In PM increased echogenicity and muscle atrophy appear due to reduced muscle fibers and increased conjunctive tissue, which are more important in PM compared with DM and other inflammatory disorders.

Elastography examination revealed changes in muscle elasticity, decreased in most cases, probably by the appearance of fibrosis and atrophy changes. Increased elasticity and„soft" look appearance muscular structures encountered in some cases can be explained probably by fatty infiltration of the muscle.

Elastography imaging with Image Processing 2.8 software provided the opportunity to quantify and demonstrate the information. The color index represented values that vary with the pixel number of red, yellow, green or blue from the sonoelastographic image. Thus, looking at the minimum, maximum and average color parameters the highest values were recorded in the upper third of the thigh, in the middle third of the arm, followed by middle third of the thigh, proving proximal muscle regions involvement.

Correlation of hue and color parameters obtained by elastography together with the results of laboratory tests aimed to assess the contribution of elastography in diagnosis, staging and monitoring of patients with inflammatory myopathies. The correlation between the average values of hue and CK, LDH, ESR, respectively CRP serum levels was analysed.

CK and LDH serum levels represent lab tests which are specifically increased in inflammatory myopathies. The values of color parameters vary directly proportionally with the CK and LDH serum levels. This correlation could provide in elastography the degree of confidence required to introduce this technique in the morphological evaluation of the affected muscle structures in inflammatory myopathies. In terms of the average connection between hue average values and mean ESR, a wider range distribution of hue mean values were recorded, while ESR presented more linear variations. Comparative distribution of hue mean values and CRP level showed a minimum variation of CRP levels, while the hue presented a much wider range. In our opinion the hue represents an important parameter to follow-up in inflammatory muscle disease

Discrepancies in this study could be the lack of reference data in literature, too small a patient group introduced in the study, and reduced time to assess the dynamics in all patients. The overall study group, however, was quite heterogeneous in terms of the possibility to analyse statistically. All of these should be considered as limitations of this study.

However, the study offers interesting information, which may constitute a basis for further investigation.

Conclusions

Correlation between quantitative parameters obtained from elastography and biochemical test provide confirm the accuracy of ultrasound examinations of muscular structures. Analysis of the color information from elastography could be a reliable method for the management of patients with idiopathic inflammatory myopathies.

Competing interest

No conflict of interest.

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