ISSN- O: 2458 - 868X, ISSN –P: 2458 - 8687

International Journal of Medical Science and Innovative Research (IJMSIR)

IJMSIR : A Medical Publication Hub

Available Online at: www.ijmsir.com

Volume – 2, Issue –6, November – December - 2017, Page No. : 163 - 169

Role of B-Mode, Doppler Ultrasonograghy and Spectral Wave Analysis in Differentiating Benign From Malignant Musculoskeletal Soft Tissue Masses

Ashok Verma[1], Rahul Chavhan[2], N C Yadav[3], Rajlakshmi Yadav[4]

[1]Assistant Professor and Head of Department, Department of Radiodiagnosis, GSVM Medical College, Kanpur

[2]Junior Resident, Department of Radiodiagnosis, GSVM Medical College, Kanpur

[3]Professor, Department of Radiodiagnosis, GSVM Medical College, Kanpur

[4]Junior Resident, Department of Radiodiagnosis, GSVM Medical College, Kanpur

Correspondence Author: Rahul Chavhan, Junior Resident, Department of Radiodiagnosis, GSVM Medical College, Kanpur.

Conflicts of Interest: Nil.

Abstract

Introduction: Musculoskeletal soft tissue can be defined as the periskeletal non-epithelial connective tissue of the body exclusive of reticuloendothelial system. Various benign and malignant lesions are seen to arise from musculoskeletal soft tissue. Ultrasonography is usually performed as a first step in the assessment of musculoskeletal soft tissue masses. Using B-mode, Doppler ultrasonograghy and Spectral wave analysis we can differentiate benign from malignant musculoskeletal soft tissue masses.

Aim: to study the role of b-mode, doppler ultrasonograghy and spectral wave analysis in differentiating benign from malignant musculoskeletal soft tissue masses.

Methods: Fifty patients with musculoskeletal soft tissue masses (28 benign, 22 malignant) prospectively evaluated using B-mode, doppler ultrasonograghy and spectral wave analysis to assess their role in differentiating benign from malignant lesions. Later the findings obtained were confirmed by histopathological study of masses.

Results and Discussion: B- Mode ultrasonography showed 47.5% sensitivity, 80.8% specificity, 78.3% positive predictive value, 62.3% negative predictive value and 62% accuracy in differentiating benign from malignant lesions. Color doppler and spectral wave analysis showed 76.4% sensitivity, 76.4% specificity, 76.1% positive predictive value, 83.7% negative predictive value and 76% accuracy in differentiating benign from malignant lesions. Our study showed that conventional sonography reliable for diagnosing malignancy, it has good accuracy, good specificity and good positive predictive value, however has equivocal sensitivity and negative predictive value. Color Doppler and spectral wave analysis are reliable tools and show good accuracy, sensitivity, specificity, positive predictive value and negative predictive value in diagnosing and differentiating benign from malignant soft tissue masses.

Conclusion: Color and spectral Doppler assessment of musculoskeletal soft tissue masses might represent an important supplement to B-mode sonography and should always be performed when evaluating the same by ultrasonography.

Keywords: Doppler ultrasonography; Spectral wave analysis; Musculoskeletal soft tissue masses; Tumors vascularization.

Introduction

Musculoskeletal soft tissue can be defined as the periskeletal non-epithelial connective tissue of the body exclusive of reticuloendothelial system. It is represented by the voluntary muscles, fat and fibrous tissue along with the vessels serving these tissues. By convention, it also includes the peripheral nervous system because tumors arising from nerves present as soft tissue masses and pose similar problems in differential diagnosis and therapy.

Soft tissue tumors are highly heterogenous group of tumors that are classified by line of differentiation according to adult tissue they resemble. For example, Lipoma and liposarcoma are tumors that recapitulate to a varying degree normal fatty tissue.

Ultrasonography is usually performed as a first step in the assessment of musculoskeletal soft tissue masses. Historically, diagnostic ultrasound imaging has been utilised in medicine since the early 1950's. In the following decades, diagnostic ultrasound imaging became well-established in clinical obstetrics, gynaecology and cardiology. In 1972, the first clinically significant application of diagnostic ultrasound imaging was used in musculoskeletal medicine; where it was used to differentiate Baker's cysts from thrombophlebitis. Ultrasonography has been widely applied in the musculoskeletal system over the past three decades and is very useful in evaluating the nature of musculoskeletal soft tissue masses.

Recent advances in ultrasound technology have enabled the echotexture of soft tissue tumors to be presented in greater detail. It enables the differentiation of benign and malignant masses and the detection of many different types of histology in musculoskeletal soft tissue masses. Comparative angiographic and pathologic studies have demonstrated that newly formed tumor vessels show distinct features (abnormal vessel arrangement, abrupt variation in calibre of vessels, tortuosity, arteriovenous shunting); such features and the resulting blood flow abnormalities can readily be detected by use of color Doppler and Spectral Wave Analysis.

The purpose of this study is to evaluate the role of color Doppler and Spectral Wave Analysis in the differential diagnosis of benign from malignant musculoskeletal soft tissue masses, in order to assess whether these methods are able to increase the diagnostic accuracy of B-mode ultrasonography.

Materials and Methods

This prospective study was conducted in Department of Radiodiagnosis in collaboration with Department of Surgery and Department of Pathology, G.S.V.M. Medical College, Kanpur. Patients with palpable soft tissue masses of all age groups and both gender were included. Cases with Inflammatory masses (like abscesses, cellulitis, and pyomyositis) and trauma were excluded from the study.

All patients were examined by means of available equipment SonoSite FUJIFILM EDGE, MICROMAXX Ultrasound System, SonoSite Inc., Bothell, WA 98021 USA. Depending on the size and depth of the lesion, curved array or linear probes were used 5-1 MHz and 15-6 MHz, respectively.

Color Doppler parameters were optimized for low blood flow velocities. Power Doppler was also used for showing more clearly the number and course of afferent and intralesional vessels. For spectral analysis, low values of PRF were used; when necessary, the PRF was adjusted for medium to high blood flow velocities. Sample volume was adjusted to the vessel size. Waveforms were recorded at different sites within each mass; for each lesion. Whenever possible, absolute velocities were calculated after correcting for the angle of incidence. When different peak systolic values were found within the same lesion, the highest values were considered for evaluation.

Sonographic features evaluated were growth pattern, margins, echogenicity, and internal texture. Growth pattern was defined as expansive (rounded or ovoid lesion compressing adjacent structures), infiltrating (poorly detectable lesion distorting normal structures), or mixed (association of both aspects). Margins were defined as regular (smooth), irregular (shaggy), or blurred (poorly defined). Echogenicity was defined as hypoechoic, hyperechoic, or isoechoic relative to adjacent muscle tissue. Internal texture was defined as homogeneous, heterogeneous, or complex (mixed, with fluid components). Malignancy was suspected on the basis of the following criteria: infiltrating or mixed tumor growth, irregular margins, hypoechoic pattern, heterogeneous texture.

On Color Doppler examination, the extent and configuration of tumor vascularity were assessed on the basis of the following features: presence or absence of flow signals, vessel arrangement within the lesion (regularly distributed or randomly dispersed), vessel course (linear or tortuous), and presence or absence of abrupt variations in calibre (greater than 50%). Malignancy was suspected on the basis of the following criteria: randomly dispersed arrangement of tumor vessels, tortuous vessel course, or presence of abrupt variations in calibre.

On pulsed Doppler evaluation, the following parameters were measured: peak systolic and end diastolic velocities, Resistive Index (RI). A threshold value of 0.50 for RI was arbitrarily assumed as a criterion for discriminating benign from malignant lesions (0.50 or less than 0.50 = malignant ; greater than 0.50 = malignant. Definitive diagnosis was provided by histologic study for all 50 patients.

Results

Histologic examination showed the presence of 28 benign and 22 malignant lesions. Among the benign lesions the histologic diagnoses were benign arteriovenous malformation (n = 12), benign spindle cell tumor (n = 8), intramuscular lipoma (n = 2), giant cell tumor of tendon sheath (n = 1), desmoids tumor (n = 1), schwannoma (n = 1), neurofibroma (n = 1), benign fibrohystiocytic lesion (n = 1), and benign hemorrhagic cystic lesion (n = 1). Among the malignant lesions the histologic diagnoses were malignant round cell tumor (n = 6), soft tissue sarcoma (n = 4), synovial sarcoma (n = 3), ewings sarcoma (n = 3), metastatic adenocarcinoma (n = 3), synovial chondrosarcoma (n = 2), and fibrous histiocytoma (n = 1).

Among the features examined (growth pattern, margins, echogenicity, texture)— except for echogenicty, mixed kind of growth pattern and complex internal texture of the lesion all other morphologic criteria showed significant (p-value <0.05)(heterogenous internal texture and blurred margins) and highly significant (p-value <0.001)(irregular and regular margins, expansive and infiltrating kind of growth pattern, homogenous and heterogenous texture) correlation with there respective kind of nature of the lesion(benign/malignant). B-Mode ultrasonography showed 47.5% sensitivity, 80.8% specificity, 78.3% positive predictive value, 62.3% negative predictive value and 62% accuracy in differentiating benign from malignant musculoskeletal soft tissue masses.

Features that showed significant or highly significant correlation with malignant nature of the lesion include irregular margins, infiltrating kind of growth pattern and heterogenous internal texture.

Features that showed significant or highly significant correlation with benign nature of the lesion include regular margins, expansive kind of growth pattern and homogenous internal texture.

Echogenicity of the lesion (hypoechoic, isoechoic, hyperechoic), mixed kind of growth pattern and complex internal texture showed nonsignificant (p-value >0.05) correlation with benign/ malignant nature of the lesion.

All Color Doppler and spectral wave analysis data showed highly significant (p-value < 0.001) correlation with their respective kind of nature of the lesion (benign/malignant). A regularly distributed arrangement of vessels with linear course and lesser than 50% abrupt variation in calibre of vessels showed highly significant correlation with benign nature of the lesion. In contrast, randomly dispersed arrangement of vessels with tortuosity and greater than 50% abrupt variations in calibre of vessels showed highly significant(p-value <0.001) correlation with malignant nature of the lesion.

With regards to spectral wave analysis, resistive index was quite useful in the differential diagnosis between benign and malignant lesions; in our series, this was a reliable parameter for discriminating benign and malignant lesions. A threshold of 0.50 was best suited for distinction of benign from malignant tumors.

In our study Resistive index = or < 0.50 showed significant(p-value <0.05) correlation with malignant nature of the lesion with 50% sensitivity, 96% specificity, 91.6% positive predictive value, 71 % negative predictive value and 76% accuracy.

Diagnostic accuracy was improved by combining sonographic findings with color and pulsed Doppler data.

Discussion

Ultrasonography is an established technique for examining superficial structures, such as the breast, skin, tendons, or thyroid, and usually it is the initial imaging study. Its role in the study of musculoskeletal soft tissue masses is, however, impaired by its poor specificity and lack of panoramic representation of compartmental anatomy. Conversely, since color Doppler imaging can show the tumor vascularity and flow, it provides information that can be used in distinguishing benign from malignant lesions. Pathologic and microangiographic studies have demonstrated that malignant tumors can have a variable degree of neovasculogenetic activity. Compared with normal tissue, such newly formed vessels have a different internal structure, characterized by lack of smooth muscle in arterial walls, arteriovenous fistulae, and large sinusoids. In this regard, color Doppler imaging and spectral analysis offer unique information that cannot be obtained by other imaging techniques and that might prove useful in diagnosis.

Our study was undertaken with the objectives of determining the diagnostic accuracy of B- mode, Doppler ultrasonography and spectral wave analysis in assessment of musculoskeletal and masses and to evaluate B-mode, Doppler ultrasonography and spectral wave analysis as tools in differentiating benign from malignant musculoskeletal soft tissue masses.

B- Mode ultrasonography showed 47.5% sensitivity, 80.8% specificity, 78.3% positive predictive value, 62.3% negative predictive value and 62% accuracy. Color doppler and spectral wave analysis showed 76.4% sensitivity, 76.4% specificity, 76.1% positive predictive value, 83.7% negative predictive value and 76% accuracy.

Figure 1 Benign Fibrohystiocytic Lesion

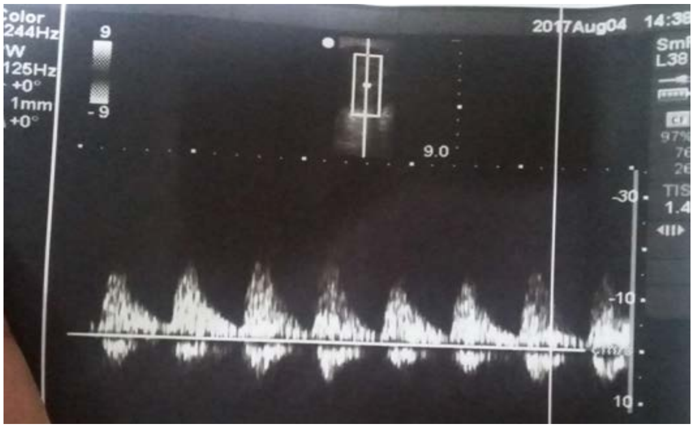

Figure 2 High Resistance Wave Form in Lesion In Figure 1.

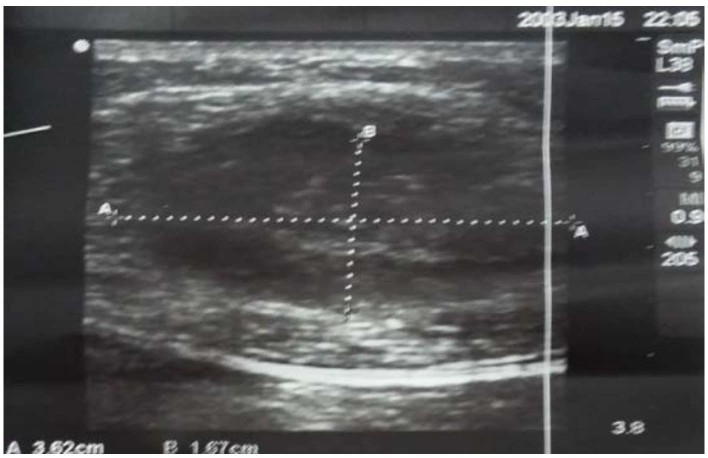

Figure 3 Benign Nerve Sheath Tumor.

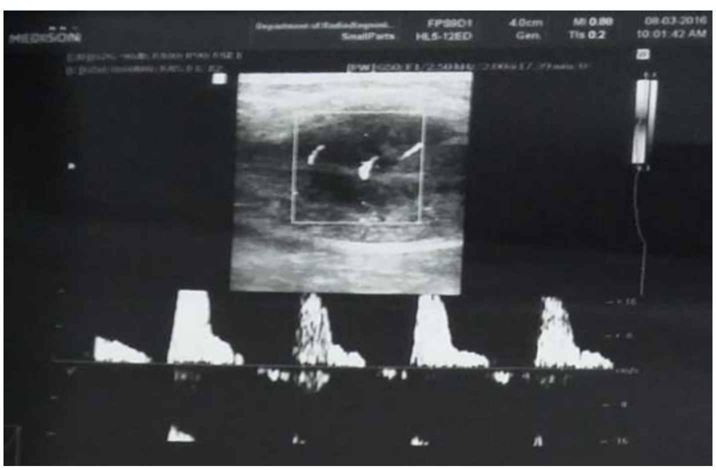

Figure 4 High Resistance Wave Form In Lesion In Figure 3.

Figure 5 gaint cell tumor of tendon sheath

Figure 6 Malignant Round Cell Tumor

Figure 7 Irregular Vascular Distribution In Lesion Shown In Figure 6.

Figure 8- Ewings Sarcoma/Pnet

Figure 9 Irregular Distribution Of Vessels In Lesion Shown In Figure 10.

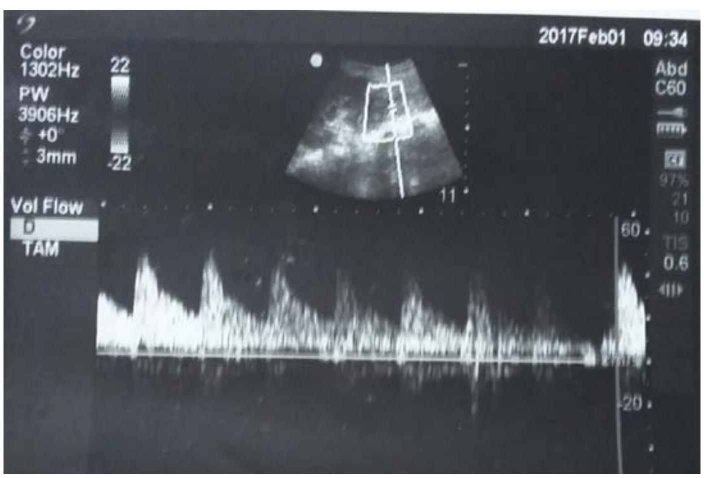

Figure 10 Low Resistance Waveform in Lesion Shown In Figure 8.

Conclusion

By our study we concluded that we can use B-mode, color Doppler ultrasonography and spectral wave analysis for assessing musculoskeletal soft tissue masses with good accuracy, sensitivity, specificity, positive predictive value and negative predictive value.

We can reliably differentiate benign from malignant soft tissue masses by using morphological as well as color Doppler features.

Low Resistive indices (= or less than 0.5) of the internal vessels within the tumors also showed significant correlation with the malignant nature of the lesion. Thus spectral wave analysis can reliably differentiate benign from malignant soft tissue masses on the basis of resistive indices.

We acknowledge that Doppler assessment of tumor vascularity has inherent limitations: variations in results and diagnostic errors can be expected owing to the complex vasculature of neoplasms and the potential sources of error involved in Doppler assessment. First, tumor size and anatomopathologic changes of tumor vascularization may affect hemodynamic patterns. Tumor vascularity varies during different phases of tumor growth, since with progressive enlargement, areas of hypoxia and necrosis occurs, so that both hyperemic and avascular areas can be found within the same lesion. Second, Doppler calculation of systolic velocity can be impaired when angle correction is impossible because the vessel course cannot be identified (as in spot flow signals). Notwithstanding such limitations, in our experience color and pulsed wave Doppler findings allowed the assessment of tumor vascularity, providing information which led to the identification of some typical malignant patterns. The detection of multiple afferent vessels, irregular vascular arrangement, and abrupt variation in size and course on color Doppler imaging combined resistive index (0.5 or less) on spectral wave analysis allowed us to diagnose malignancy with good reliability in most cases. Our conclusions are based on a limited number of patients and should be validated on a larger series. In addition, the study population represented only some of the many different types of soft tissue tumors that can be encountered.

Color and spectral Doppler assessment might represent a useful adjunct to B-mode sonography and should be routinely performed when evaluating musculoskeletal soft tissue masses by ultrasonography.

References

[1] Roberto Lagalla, A. Lovane, G. Caruso, M. Lo Bello & L. E. Derchi. Colour Doppler ultrasonography of soft tissue masses, Acta Radiologica 1998; 39:4: 421-426.

[2] Paolo Belli, Melania Costantini, Paoletta Mirk, Giulia Maresca, Francesco Priolo, Pasquale Marano. Role of Colour Doppler Sonography in the assessment of Musculoskeletal Soft Tissue Masses. J Ultrasound Med 2000; 19: 823-830.

[3] Gerd Bodner, Michael F. H. Schocke, Franz Rachbauer, Klaus Seppi, Siegfried Peer, Anke Fierlinger, Tarek Sununu, Werner R. Jaschke. Differentiation of Malignant and Benign Musculoskeletal Tumors: Combined Color and Power Doppler US and Spectral Wave Analysis. Radiology RSNA 2002; 223:410-416.

[4] Shaifali Kaushik, Theodore T. Miller, Levon N. Nazarian, William C. Foster. Spectral Doppler Sonography of Musculoskeletal Soft Tissue Masses. J Ultrasound Med 2003; 22:1333-1336.