High Resolution Ultrasound in Cutaneous and Subcutaneous Lesions

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ABSTRACT

Introduction: In the evaluation of cutaneous lesions, High Resolution Ultrasonography (HRUS) with color Doppler is useful as a safe, noninvasive, economical, and repeatable diagnostic procedure that can reduce and replace invasive procedures like fine needle aspirations and biopsies. Analysis of the skin surface allows the investigation of tumor and inflammatory diseases, the measurement of skin thickness. The objective of this study was to evaluate the role of HRUS in cutaneous lesions with histopathological correlation wherever possible.

Material and Methods: A prospective study of 100 patients with skin lesions based on clinical data were subjected to HRUS examination. Collected data was analysed by descriptive statistics.

Results: The study comprised of a total of 100 patients, out of which 75 were non-neoplastic and 25 were neoplastic lesions. The non-neoplastic lesions included Psoriasis, edema, lymph nodes and vascular malformations. The neoplastic lesions included 16 benign and 9 malignant cases. The observed HRUS and Doppler characteristics of these lesions are discussed in detail.

Conclusion: HRUS is non-invasive, affordable, easily available, rapid imaging technology. It can be used to localize the skin lesion, generate differential diagnosis and to follow up known lesion.

Key words: High Resolution Ultrasonography, Cutaneous Lesions, Psoriasis, Vascular Malformations, Benign, Malignant

INTRODUCTION

Ultrasound imaging has been used in dermatology for nearly 30 years. In 1979, Alexander and Miller first introduced ultrasonography (USG) as a noninvasive technique to measure normal skin thickness, and in the 1980s and 1990s, high-resolution ultrasonography (HRUS). The requirements for the noninvasive ultrasonic investigations of human skin from the dermatologist point of view are defined as it is expected to determine the size, contour, structure, penetration, depth of skin lesions. In the evaluation of cutaneous lesions, HRUS with color Doppler is useful as a safe, noninvasive, economical, and repeatable diagnostic procedure that can reduce and replace invasive procedures like fine needle aspirations and biopsies. Ultrasonography with frequency more than 7 MHz allows the observation of the skin and its appendages, subcutaneous tissue. The development of devices with frequencies above 15 MHz allowed the differentiation of skin layers, increasing considerably its use in dermatology. By analyzing the skin surface in three dimensions, the HFUS, associated with color Doppler, allows the investigation of tumor and inflammatory diseases, the measurement of skin thickness. Color Doppler is able to increase significantly the specificity of sonography in the evaluation of skin nodules.

High resolution ultrasonography allows the identification of macular and nodular pigmented lesions located up to 1.5 cm in depth. Cutaneous ultrasound can be used as a screening method for pigmented lesions while providing valuable information concerning therapeutic approach. High resolution ultrasonography, using 20 – 50 MHz transducers, is a novel diagnostic procedure for the investigation of the skin and its specific conditions. The objective of this study was to evaluate the role of HRUS in cutaneous lesions with histopathological correlation wherever possible.

MATERIAL AND METHODS

A prospective study of 100 patients in all age groups with skin lesions based on clinical data who presented to Bowring and Lady Curzon Hospital, Victoria Hospital and Vani Vilas hospital attached to Bangalore Medical College and Research Institute, Bengaluru, from November 2014 to May 2015 were subjected to HRUS examination.

Study design: It was a Cross sectional study. Totally 100 patients were studied from November 2014 to May 2016. Inclusion criteria: All clinically suspected patients with superficial skin lesions. Exclusion Criteria: Patients with trauma. After taking Informed consent, all patients included
in the study underwent 2D grey scale real time HRUS of skin lesion, using a linear probe of 7–20 MHZ coupled with colour Doppler equipment, in Philips IU22 ultrasound machine, and characteristics of the lesion were assessed. Compression was avoided in superficial lesions because this may result in a false thinning or superficial nodules might move outside the field of view.3

Specifications of the ultrasound machine
Image storage: Hard disc.
Type of transducer: Linear array. Frequency of transducer: 7–20 MHz

STATISTICAL ANALYSIS
Collected data was analysed using descriptive statistics (Percentages and proportions).

RESULTS
The study comprised of a total of 100 patients, out of which 75 were non-neoplastic and 25 were neoplastic lesions. The non-neoplastic lesions included Psoriasis (29 cases), edema (21 cases), lymph nodes (15 cases) and vascular malformations (10 cases). The neoplastic lesions included 16 benign and 9 malignant cases. Lipomas were the most common (12 cases). The other neoplastic lesions included Hemangioma (3 cases), neurofibroma (1 case), basal cell carcinoma (6 cases) and melanoma (3 cases).

In the present study, hypoechoic skin lesions were most common, followed by hyperechoic lesions and then anechoic lesions. [Table -1, figure 1-5] Benign tumors showed minimal internal vascularity, whereas the malignant tumors showed increased vascularity. On the other hand, lymphatic malformations showed no significant vascularity. [Table -2] HRUS of psoriatic skin showed thickened epidermis and dermis, absence of involvement of the subcutaneous tissue and increased vascularity on Doppler study. All 21 patients in the present study with edema showed decrease in echogenicity with minimal internal vascularity. In the present study 15% of the skin lesions were lymph nodes. In

![Figure-1: Fairly defined hypoechoic lesion with internal vascularity, consistent with BCC (Grey scale and color Doppler image)](image1)

![Figure-2: Fairly defined heterogenous predominantly hypoechoic lesion with internal vascularity,consistent with melanoma (Grey scale and color Doppler image)](image2)

![Figure-3: Thickening of the skin with mild increase in echogenicity, consistent with psoriasis (Grey scale, color Doppler)](image3)
Therefore, the continuous hyperechoic layer with uniform thickness, while HRUS of the normal skin shows epidermis as a thin layer examination for both thickness and characterization of cutaneous malignant melanoma. Compared with a physical examination, HRUS is very effective in the early detection of lymph node metastases. The presentation of arterial and AVMs on B-Mode ultrasound is quite variable. Typically located superficially in the subcutaneous tissue, they may result in thickening of the skin and subcutis. A nest of anechoic ducts can usually be detected, even though in some cases an anechoic pseudocystic appearance can be encountered. Additionally, a mixed pattern composed by hyperechoic vascular stroma and anechoic vascular channels of different size and diameter may be found. The overall appearance of AVMs can be quite inhomogeneous, especially because of the different amount of arterial and venous elements inside the lesion. Typically arterial malformations and AVMs do not have a soft-tissue component. AVMs often have indistinct outer borders and sometimes the vessels inside an AVM are so small that they are hardly seen with B-Mode ultrasound, and only detected when color Doppler ultrasound is applied.

Venous malformations are anechoic or slightly hypoechoic, sponge-like structures on B-mode sonograms and they consist of multiple blood-filled caverns of different sizes. Typically venous malformations have only little fibrous stroma, but the walls of the individual caverns range from very thin septae to thick fibrous bridges, which is why approximately 80% of venous malformations are somewhat inhomogeneous on B-mode with a mixture of hypoechoic caverns and sometimes hyperechoic septations. Tiny roundish calcifications resembling phleboliths inside thrombosed caverns are a diagnostic hallmark of venous malformations but are seen in only 20% of lesions. A color Doppler ultrasound compression test is a comparable and important equivalent test for the diagnosis of a venous malformation. With correct color Doppler ultrasound settings, the signal inside the blood-filled caverns shows a change from red to blue and vice versa during transducer pressure/release of pressure on the malformation. No flow is detected in approximately 15–20% of lesions; this may be due to either thrombosis, substantially low flow inside the malformation, or due to inappropriate Doppler settings. Venous malformations do not harbour arteriovenous shunts, therefore, it is important to search for regions with aliasing

**DISCUSSION**

HRUS is an invaluable tool for imaging in dermatology. It can provide crucial preoperative information by serving as a first-line examination for both thickness and characterization of cutaneous malignant melanoma. Compared with a physical examination, HRUS is very effective in the early detection of lymph node metastases. HRUS of the normal skin shows epidermis as a thin continuous hyperechoic layer with uniform thickness, while the dermis appears relatively less echoic and subcutaneous tissue is characteristically hypoechoic. Main HRUS feature of psoriatic skin are thickened epidermis and dermis, absence of involvement of the subcutaneous tissue and increased vascularity on Doppler study.

On sonography, edema usually appears as anechoic fluid between the lobules of the subcutaneous tissue. In cases with lymphedema there is thickening of all the cutaneous layers, hypoechoicogenicity of the dermis, and increased echogenicity of the subcutaneous tissue in addition to the anechoic fluid between the fatty lobules of the hypodermis. Echogenic hilus is a normal sonographic feature of most of the normal cervical lymph nodes (86%), and it is commonly seen in larger nodes. Although metastatic, lymphomatous and tuberculous nodes tend to have absent hilus, they may present with an echogenic hilus in their early stage of involvement in which the medullary sinuses have not been sufficiently disrupted to eradicate it. Therefore, the presence/absence of echogenic hilus should not be the sole criterion in the diagnosis. The presentation of arterial and AVMs on B-Mode ultrasound is quite variable. Typically located superficially in the subcutaneous tissue, they may result in thickening of the skin and subcutis. A nest of anechoic ducts can usually be detected, even though in some cases an anechoic pseudocystic appearance can be encountered. Additionally, a mixed pattern composed by hyperechoic vascular stroma and anechoic vascular channels of different size and diameter may be found. The overall appearance of AVMs can be quite inhomogeneous, especially because of the different amount of arterial and venous elements inside the lesion. Typically arterial malformations and AVMs do not have a soft-tissue component. AVMs often have indistinct outer borders and sometimes the vessels inside an AVM are so small that they are hardly seen with B-Mode ultrasound, and only detected when color Doppler ultrasound is applied.

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USG may help in determining the best treatment approach by preoperative assessment of cutaneous neoplasms, usefully integrating clinical findings, and is also helpful in the follow-up of the patients after surgery, cryotherapy, or laser treatment. \textsuperscript{4,5,20}

Francesco Giovagnorio et al evaluated 71 consecutive visible and palpable nodules of the skin from 51 patients. They found the four patterns of vascularity. These observations may suggest that the type IV pattern (hypervascular with internal vessels) is typical of a malignant tumor without necrosis, whereas the type III (hypervascular with multiple peripheral poles but no internal vessels) corresponds to a tumor with central necrosis. The type I (avascular nodule), on the other hand, is the least specific because it can be observed both in totally necrotic malignant tumors and in benign tumors (which are generally vascularized by one or two small peripheral arteries with a perfusion pressure too low to be effectively detected), so concluded that, color Doppler was able to increase significantly the specificity of sonography in the evaluation of skin nodules, but the availability of well-known and affordable gold standards, such as physical examination and biopsy, will probably limit its diagnostic role to some well-defined fields.\textsuperscript{5}

Basal cell carcinoma has been characterized as masses of epidermis, dermis and subcutaneous cellular tissue which are hypoechoic with irregular edges and increased vascularity. \textsuperscript{21}

On sonography, melanomas usually appear as well defined, oval- or fusiform-shaped, homogeneous, hypoechoic lesions with smooth borders, increased acoustic transmission, and variable degrees of vascularity, even though they commonly show hypervascularity on color Doppler imaging. Sonography has been proved useful for discriminating melanomas thicker and thinner than 1 mm which is relevant for deciding the performance of a sentinel node procedure. The vessels are commonly located within the lesion and may also be tracked using contrast-enhanced ultrasound. Assessment of the vascularity, including the peak systolic velocity of the arterial vessels, may provide an idea of the angiogenic power of the tumor that can correlate with the metastatic potential. In cases with ulcerations, the epidermis can show irregularities or discontinuities, and increased echogenicity in the subcutaneous tissue may also be found. Because melanomas can show asymmetry in their thickness, the sonographic measurements should be performed at the deepest point. In the vicinity of the primary lesion, satellite lesions (arising greater than 2 cm away from the primary tumor) or in transit metastasis (arising within 2 cm from the primary tumor) can be detected. Usually, there is increased vascularity within the metastases on color Doppler imaging, although the presence of internal vessels can show a variable appearance that can go from hypo- to hypervascular. Occasionally, these metastases can present an irregular appearance and anechogenicity and can be sonographically misdiagnosed as abscesses. This challenging anechoic appearance has been reported as related more to hypercellularity and not as a result of necrosis. The balloon shape, nodular thickening of the cortex, and loss of hyperechogenicity of the medullae are signs of malignant infiltration in regard to nodal infiltration. The use of lower frequency probes in bulky primary melanomas may help...
to reach to the bottom of the lesion and provide a better definition of the extension.\textsuperscript{22,23,24,25,26}

**CONCLUSION**

HRUS is non-invasive, affordable, easily available, rapid imaging technology. It can be used to localize the skin lesion, generate differential diagnosis and to follow up known lesion. Differentiation of skin lesions is possible on the basis of echogenicity, margins, vascularity of the lesion but for confirmation of the diagnosis clinical features, histopathological examination is needed. Though HRUS helped in differentiating the benign from malignant lesion, particular HRUS findings did not help in the diagnosis of lesion. So, large study with more sample size is needed to find the particular HRUS findings.

**REFERENCES**