

Original Research Article

Ultrasound evaluation of biopsy proven malignant breast mass

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ABSTRACT

Background: Breast cancer is the most common malignancy in female worldwide. Ultrasound (US) is a safe and easily available modality for evaluation of breasts in females of all age groups. It can detect characteristic features of breast malignancy with high degree of accuracy. This study was undertaken with the aims to evaluate the ultrasonographic features of malignant breast mass, to identify the most commonly encountered gray scale ultrasound findings and to study the role of Doppler ultrasound in those cases.

Methods: The study was conducted in Dr B. Borooah Cancer Institute, Guwahati from January 2018 to January 2019. Gray scale ultrasound including Doppler study was done in all the female patients coming with palpable breast lump or with nipple discharge and images were archived. The archived images of a total number of 108 patients with biopsy report positive for malignancy were retrospectively studied and the ultrasound findings were evaluated.

Results: Most common gray scale ultrasound features for malignant breast masses were hypoechoic mass, taller than wide, irregular shape, having spiculated margins, neither posterior acoustic enhancement nor shadowing, presence of intralesional microcalcifications and surrounding echogenic halo. Hypervascularity, noticeable difference in waveform pattern between central and peripheral vessels, high resistance flow pattern with absent or reversal of diastolic flow were the common Doppler findings.

Conclusions: Combination of Doppler with gray scale ultrasound has emerged as a very important technique in diagnosing malignant breast mass with high accuracy.

Keywords: Breast mass, Colour doppler, Invasive Ductal Carcinoma, Malignant, Pulsed doppler, Ultrasound

INTRODUCTION

Breast cancer is the most common female cancer worldwide representing nearly a quarter (25%) of all cancers.¹ It has ranked the number one cancer among Indian females.¹ Unlike other cancers, breast cancer is eminently treatable if detected at an early stage.²

Ultrasound is currently the first line of investigation in detection and characterization of breast lesions as well as in evaluation of breast cancer. The use of ultrasound to examine the breast was first described in 1951.³ Improvement in technology over decades have made real

time ultrasound an important imaging tool for evaluation of breast lumps and detection of breast cancer.

Aims and objectives of the study was to evaluate the ultrasonographic features of malignant breast mass, to find out the most commonly encountered gray scale ultrasound features in malignant breast mass, to study the role of Doppler ultrasound in malignant breast mass.

METHODS

It was a retrospective study conducted from January 2018 to January 2019 in authors institute.

Inclusion criteria

- Female patients of any age group having breast lump or history of nipple discharge who came for ultrasound examination of breast to Radiodiagnosis department were included in this study.

Exclusion criteria

- Male patients with similar clinical history were excluded from the study.

Ultrasound was done and images were archived. Some of the cases had biopsy reports done outside. Histopathological review of these cases was further done by pathologists of authors institute. For the remaining cases with lesions suspicious for malignancy on ultrasound, biopsy was done in the institute.

According to literature, Invasive Ductal Carcinoma (IDC) is the most common type of breast cancer. About 80% of all breast cancers are Invasive Ductal Carcinomas.⁴ IDC was the biopsy report in majority of patients. Authors have included a total number of 108 female patients with biopsy proven IDC for this study.

Gray scale ultrasound examination was done in Logic E9 ultrasound machine using 6 to 15 MHz transducers depending upon the depth of the lesion. Ultrasound examination was performed in supine position for examining the inner quadrants of breast. For examining the outer quadrants, the patient was rolled into a contralateral posterior oblique position to some extent with ipsilateral arm raised above the head. This position flattens the breast and reduces the thickness of the quadrant being scanned.

The visualized mass on ultrasound was scanned in longitudinal, transverse and radial planes. This was followed by Color Doppler ultrasound in every case to assess vascularity of the mass. When vascularity was detected, the vessels were studied with Pulsed Doppler ultrasound to know the pattern of spectral waveform.

The masses were evaluated according to their shape, margin, echotexture, posterior acoustic features, intralesional microcalcifications, boundary, orientation and vascularity.

RESULTS

The study included a total number of 108 patients, all of them were female.

Evaluation of the masses on gray scale ultrasound was done for shape, margins, echotexture, posterior acoustic features, microcalcifications, boundary and orientation. This was followed by Doppler ultrasound in every case. Results of the study will be discussed under following headings.

Shape

Breast masses encountered in this study had irregular (Figure 1A), oval (Figure 1B) and round shapes. Out of 108 cases, 92(85.18%) had irregular shape, 10(9.26%) oval and the rest 6 cases (5.55%) were round in shape.

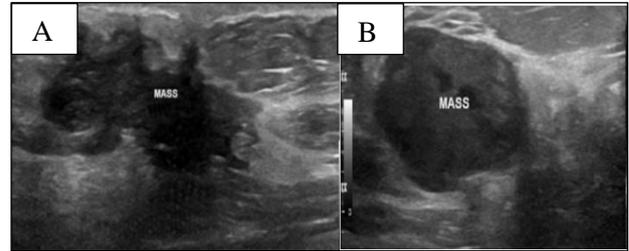


Figure 1: US images of breast mass with (A) irregular shape (B) oval shape.

Majority of the irregular masses showed duct extension (Figure 2A). Authors also encountered irregular masses with branching pattern in few cases (Figure 2B).

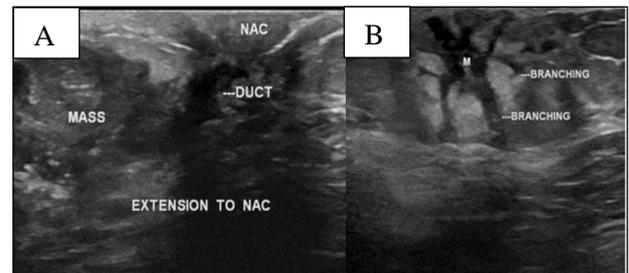


Figure 2: In US irregular breast mass with (A) duct extension (NAC - Nipple areolar complex) (B) branching pattern.

Margins

Spiculated margin was most commonly found in this study with 35 cases (32.4%) (Figure 3).

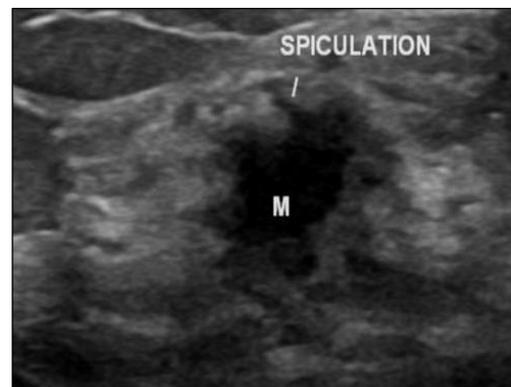


Figure 3: US of breast mass with spiculated margins.

This was followed by angular margin in 28 cases (25.93%) (Figure 4A), indistinct margin in 19 cases

(17.59%) (Figure 4B), micro lobulated in 16 cases (14.81%) (Figure 4C) and circumscribed in 10 cases (9.26%) (Figure 4D).

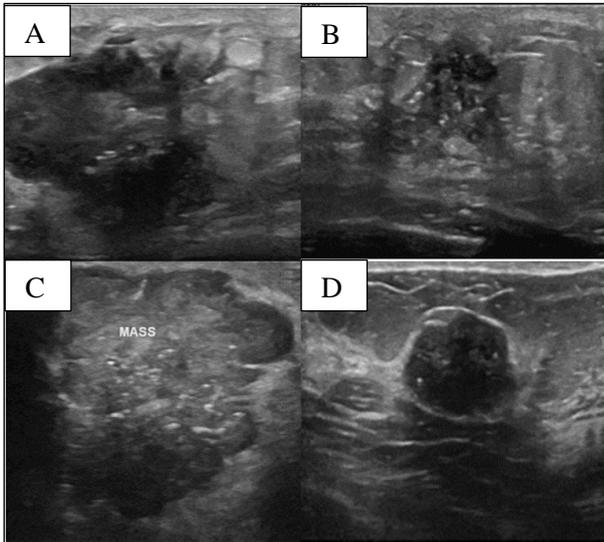


Figure 4: US (A) Angular margins in a breast mass (B) Breast mass with indistinct margin (C) Marginal microlobulations. (D) Circumscribed breast mass.

Echotexture

Maximum number of cases in this study were hypoechoic which comprised of 89 cases (82.41%) (Figure 5A). 17 cases (15.74%) were solid cystic (Figure 5B) and 2 cases (1.85%) were isoechoic masses. No hyperechoic mass was found in this study.

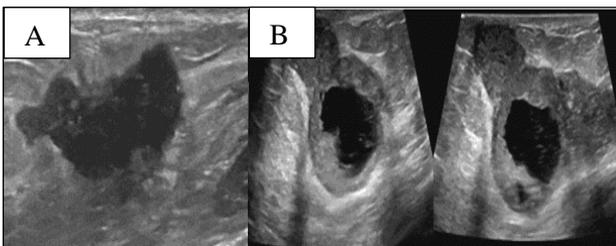


Figure 5: US images of (A) hypoechoic breast mass (B) solid cystic breast mass.

Posterior acoustic features

Total number of cases showing neither posterior acoustic enhancement nor posterior shadowing were 63(58.33%). 37 cases (34.26%) showed posterior shadowing (Figure 6A) and 8 cases (7.41%) showed posterior acoustic enhancement (Figure 6B).

Microcalcifications

In 77 cases (71.30%) there was intralesional microcalcifications (Figure 7). No calcification was seen in 31 cases (28.70 %).

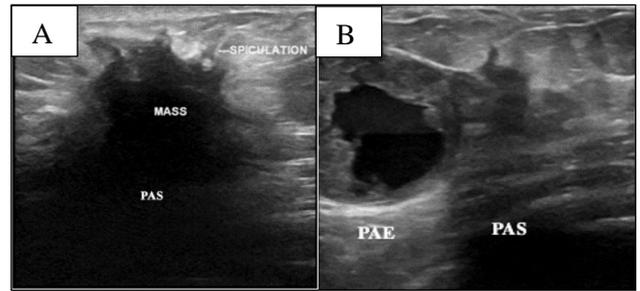


Figure 6: US (A) Spiculated breast mass with strong Posterior Acoustic Shadowing (PAS). (B) Posterior Acoustic Enhancement (PAE) from cystic part and Posterior Acoustic Shadowing (PAS) from solid part of a solid cystic breast mass.

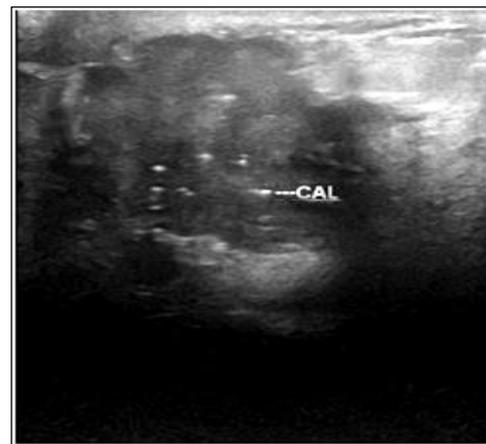


Figure 7: US with intralesional microcalcifications within a lobulated breast mass (CAL - Calcification).

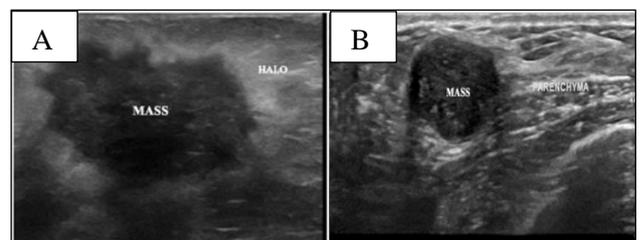


Figure 8: US images with (A) Breast mass with echogenic halo (B) Round shaped breast mass showing abrupt interface with the surrounding breast parenchyma.

Boundary

An echogenic halo as a boundary was seen in 73 cases (67.59%) of breast masses (Figure 8A). Rest of 35 cases (32.41%) showed abrupt interface with the surrounding normal breast tissue (Figure 8B).

Orientation

The orientation of breast mass perpendicular to the longitudinal plane of the breast i.e. antiparallel with taller

than wide appearance was the most common finding in 105 cases (97.22%) (Figure 9A).

Mass growing along the longitudinal plane of breast i.e. parallel orientation was seen in only 3 cases (2.78%) (Figure 9B).

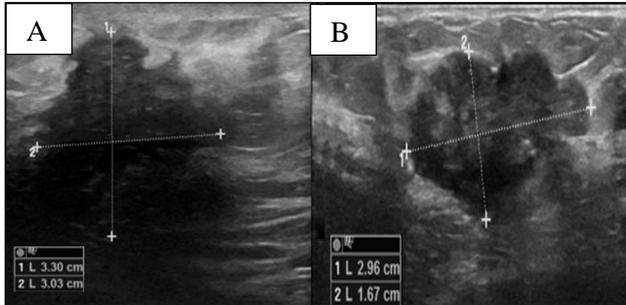


Figure 9: US images of breast mass with (A) antiparallel orientation (taller than wide) (B) with parallel orientation.

Other gray scale sonographic features that authors have encountered with malignant breast mass were thickening of Cooper’s ligament (Figure 10), thickening of subcutaneous tissues and skin (Figure 10), nipple retraction, architextural distortion and axillary lymphadenopathy.

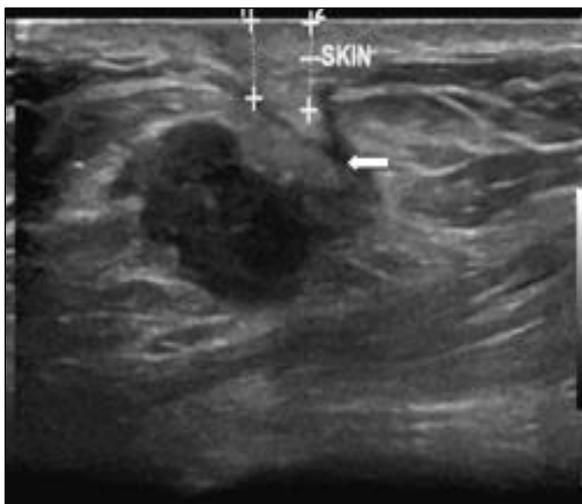


Figure 10: US with lobulated breast mass with thickening of the Cooper’s ligament and associated thickening of overlying skin. (white arrow - Cooper’s ligament).

Doppler ultrasound

Vascularity was found in 91% of cases on Color Doppler (Figure 11) and no detectable vascular flow in remaining 9% of cases. Both central as well as peripheral vascularity were seen in majority of cases (Figure 12A). Feeding vessel penetrating into a mass with irregular chaotic branches was also seen (Figure 12B).

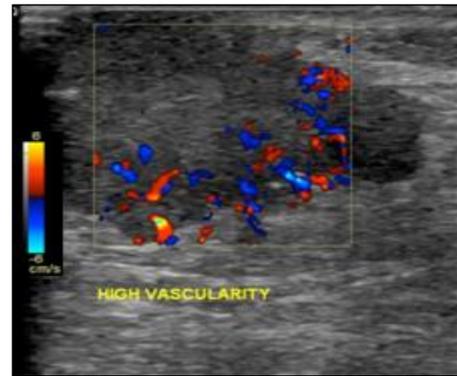


Figure 11: Irregular breast mass with high vascularity on colour doppler.

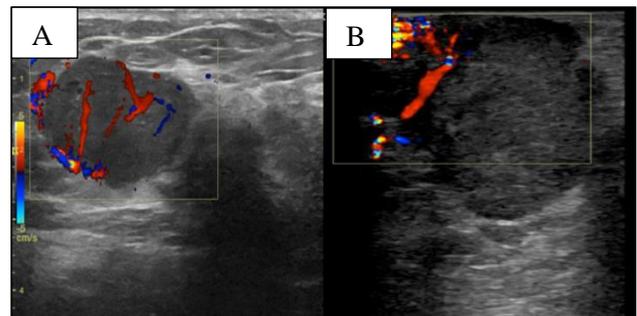


Figure 12: Colour doppler image (A) irregular central and peripheral vessels. (B) large feeding vessels with irregular chaotic branches within a breast mass.

Pulsed Doppler ultrasound was done in all the lesions showing vascularity. Spectrum of findings revealed on Pulsed Doppler can be categorized as follows: Low impedance pulsatility signal (in the peripheral vessels) (Figure 13), high impedance pulsatility signal (in central vessels) with absent or reversed diastolic flow (Figure 14 A, B). Turbulent flow with high velocity and significant broadening of Doppler spectrum was also found in some of the cases. At least one or more spectral patterns were detected in a single mass in majority of the cases.

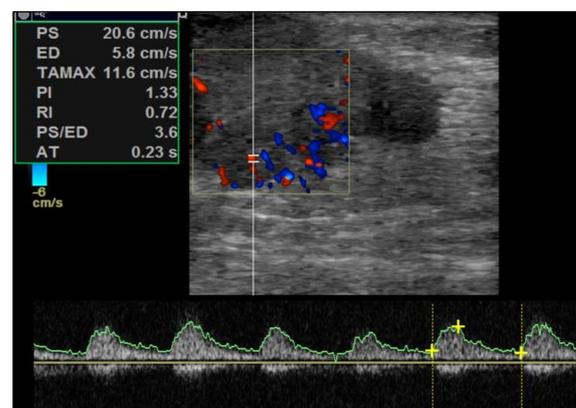


Figure 13: Pulsed doppler of a peripheral vessel in a breast mass showing low impedance pulsatility signal.

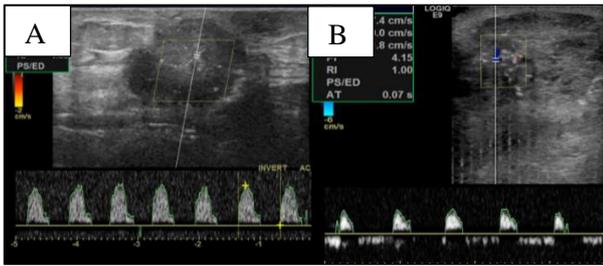


Figure 14: High impedance pulsatility signal with (A) absent diastolic flow in a central vessel of a breast mass (B) reversed diastolic flow in central vessel of another breast mass.

DISCUSSION

In this study authors have included 108 female patients with biopsy proven IDC. These patients came with the complaint of either palpable breast lumps and/ or nipple discharge. Gray scale and Doppler ultrasound were done for the breast masses in every case and the findings are discussed as follows.

Shape

This study showed that 92 cases (85.1%) of the malignant breast masses had irregular shape. An irregular mass lacks smooth contour like a round or oval mass. It was the commonest shape that authors have encountered in malignant breast masses. Gupta et al, in their study on IDC of breast also found that most common shape of malignant breast mass was irregular comprising of 78.6%.⁵

Majority of the irregular masses showed duct extension. Duct extension is seen as projection from a nodule which extends radially within or around a duct towards the nipple.⁶

When the intraductal mass completely fills up the duct, extends into branch duct or outside the duct it is strongly suggestive of malignancy. Most common symptoms of malignant intraductal mass is nipple discharge, followed by palpable mass. Authors also encountered irregular shape with branching pattern in few cases. Branching pattern is seen as multiple projections from the nodule within or around ducts extending away from the nipple, usually in larger tumours.⁶

Besides lesions with irregular shape, authors found 10 cases having oval shape and 6 having round shape. Though round and oval shapes are commonly encountered in benign cases literature shows high rate of malignancy in such lesions following biopsy.

Margins

Margins of malignant breast mass may be circumscribed or non-circumscribed.

Circumscribed margins are well defined, with abrupt zone of transition between the lesion and the surrounding tissue. They may have smoothly margined macrolobulations.

Non circumscribed lesions have ill-defined margin. They include microlobulated, indistinct, angular and spiculated. Microlobulated margins have short-cycle undulations (more than three) with a scalloped appearance.⁷

Lesions having increased number of lobulations, each measuring few millimeters should be suspected for malignancy.⁸ Indistinct margins are not clearly demarcated from the surrounding tissue.

An angular margin demonstrates sharp corners, often with acute angles.⁷

In spiculated margins strands of tissues are seen radiating out from an ill marginated mass producing a stellate appearance.⁸ Spiculations represent retraction of tissue strands towards the tumor due to fibrosis - as a result of desmoplastic reaction.⁸

Angular and spiculated margins are associated with malignancy rates of 60 % and 86 % respectively.⁷ Spiculated and angular margins were the most common marginal pattern observed in this study consisting 32.4% and 25.93% respectively.

Echotexture

Majority of cases 89(82.41%) in this study were hypoechoic, 17(15.74%) solid cystic and 2(1.85%) were isoechoic masses. Authors did not come across any hyperechoic mass in this study.

Solid cystic appearance could be due to a solid mass within a grossly dilated (cystic appearing) duct. It may also be related to presence of necrotic areas, low fibrous tissue and more cellular contents within a mass.

Posterior acoustic features

Posterior acoustic features may be in the form of enhancement, shadowing, combination of both or none of the above.

In this study most common posterior acoustic feature was neither posterior enhancement nor posterior shadowing which included 63 cases (58.33%). Gupta et al, in their study found 40% of mass without posterior enhancement or acoustic shadowing.⁵ 37 cases (34.26%) showed posterior shadowing and 8 cases (7.41%) posterior acoustic enhancement.

Posterior acoustic properties of a mass are based on multiple factors like cellular components, stromal reaction and number of histological interfaces between fibrous and cellular components.⁵

Fine strands of cancer cells infiltrating into the surrounding tissue appeared to cause backscattering, resulting in posterior shadowing.⁹

Posterior enhancement is usually due to fluid component within a mass. Some of the solid cystic malignant masses were seen to be accompanied by both enhancement (from cystic part) and shadowing (from the solid component).

Posterior acoustic enhancement in a solid mass is due to the intratumoral hypercellularity.¹⁰ In this study authors have not found any solid lesion with posterior acoustic enhancement.

Microcalcifications

Microcalcifications refers to tiny flecks of calcifications that resemble grains of salt. Microcalcifications within or outside a mass is reported to be associated with high grade tumour.⁵

In this study in 77 cases (71.30%) there was microcalcifications. No calcification was seen in 31 cases (28.70 %).

Boundary

An echogenic halo was seen in 73 cases (67.59%) of malignant breast masses. Rest of 35 cases (32.41%) showed abrupt interface.

Dense fibrous tissue around a mass suggests echogenic halo which is produced by desmoplastic stromal reaction of the surrounding breast tissue. Sharp demarcation between the lesion and surrounding tissue suggests abrupt interface.

Poorly proliferative IDC is accompanied by an echogenic halo at the boundary of the lesion. Better differentiation the tumor is, greater is the stromal reaction. Conversely with highly proliferative IDC there is little or no peripheral stromal reaction. Therefore, such lesions have abrupt boundary and they grow by pushing the surrounding tissues.

Orientation

Authors have found that antiparallel is the most common orientation of malignant breast mass which was the finding in 105 cases (97.22%). Parallel orientation was seen in only 3 cases (2.78%).

On two-dimensional ultrasound, an antiparallel lesion is taller than wide. It has a major axis oblique or perpendicular to the surface of the skin or a depth: width ratio of >1.

If this ratio is quite high the possibility of being analyzing a malignant mass increases since this reflects that the nodule is growing across normal tissue planes.¹¹

Other commonly associated ultrasound features that authors have encountered in malignant breast masses were thickening of Cooper's ligament (seen as hypoechoic lines near the mass coursing towards the skin), thickening of subcutaneous tissues and skin, nipple retraction, architextural distortion and axillary lymphadenopathy.

Thickening of the Cooper's ligaments is an imaging finding suggestive of breast edema, usually occurring secondary to dilated lymphatics.

Skin thickening is due to blockage of epidermal and subdermal lymphatics plexuses by neoplastic cells causing accumulation of lymph within the skin. In breast cancer, nipple retraction occurs when the tumor attacks the duct behind the nipple, pulling it in.

Architextural distortion occurs because invasive carcinoma distorts the interface between breast and normal parenchyma due to desmoplastic response of host tissue to the malignancy.⁸

Most commonly encountered gray scale ultrasonographic features for malignant breast masses in this study were hypoechoic mass, taller than wide with irregular shape and spiculated margins, having neither posterior acoustic enhancement nor posterior shadowing, presence of intralesional microcalcifications and surrounding echogenic halo. Other associated findings frequently noted were skin thickening, thickened Cooper's ligament, nipple retraction, architectural distortion and axillary lymphadenopathy.

Doppler ultrasound

For vascular evaluation of breast masses Doppler ultrasound was performed by use of Color Doppler and Pulsed Doppler.

Color Doppler study showed detectable vascular flow in 91 % of these cases. Cosgrove et al, found vascularity in 99% of malignant breast mass.¹²

There was no detectable vascularity in 9% of the cases. In general, vascularization is increased in high-grade high-cellular malignant tumors, which have special feeding vessels helping them grow and invade, while low-grade malignant tumors may have no detectable vascularity on Color Doppler examination.¹³

Hypervascularity is the common vascular pattern encountered showing central or internal type of vascularity with or without demonstrable penetrating vessel. In many cases vessels surround the tumor which is referred to as peripheral net of vessels. Associated irregular branching vessel morphology was also seen.

Malignant tumor secretes angiogenic factors to help the recruitment of new vessels that allow tumor

enlargement.¹⁴ This is reflected as increased vascularity in Color Doppler.

If intratumoral vascularity was found, then a study of the vessels detected was done using Pulsed Doppler ultrasound to obtain spectral waveform.

On Pulsed Doppler ultrasound, most commonly found spectrum of findings were:

1. Low impedance pulsatility signal (means low maximum velocity with gradual drop of velocity throughout the cardiac cycle, lacks systolic notch and have continuous diastolic flow).

2. High impedance pulsatility signal (means high initial systolic velocity, with sharp drop off in late systole, with little, absent or sometimes reversal of flow in diastole).

Central vessels within a mass usually showed high impedance pulsatility signal whereas peripheral vessels had low impedance pulsatility signal. So, in this study authors found combined Doppler waveform pattern in a single mass in a large number of cases.

A noticeable difference in waveform patterns between central and peripheral vessels is a strong predictor of malignancy.¹⁵

In case of low impedance pulsatility signal the resistive index was less than 0.8 in all the cases, whereas in high impedance pulsatility signal the resistive index was always more than 0.8 in this study. Majority of the lesions having resistive index more than or equal to 1 showed absent or in few cases reversal of diastolic flow. Stanzani et al, demonstrated that $RI \geq 0.73$ is significantly predictive of malignancy.¹⁶ Turbulent flow with high velocity and significant broadening of Doppler spectrum was also found in some of the cases due to presence of stenotic vessels.

Malignant new vessels are characterized by atypical branching, wall irregularity, stenosis, occlusion and AVF. This is the cause behind increased peripheral resistance reflected as increased RI, PI, absent or reversal of diastolic flow on Color Doppler. Characteristic features in the form of increased vascularity, noticeable differences in waveform between central and peripheral vessels, high resistance flow pattern with reversal or absent diastolic flow in a breast lesion on Doppler ultrasound point towards the possibility of malignancy.

Hence Doppler ultrasound acts as a complementary tool along with gray scale ultrasound in the evaluation of malignant breast mass.

CONCLUSION

From this study authors conclude that there are multiple gray scale ultrasonographic features which suggest

malignancy in a breast lesion. Combination of Doppler with gray scale ultrasound can give added information to suspect malignancy. Ultrasound can hence be effectively used as the primary detection tool for breast cancer. It is important to realize that the presence of a single malignant feature in an apparently benign looking breast mass necessitates biopsy.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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