Original Article

Role of Resistance Index in Differentiation of Benign and Malignant Breast Masses Compared with Histopathological Diagnosis

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Abstract

Background*: Breast tumor remains a worldwide public health problem for women. Linear array sonography is currently one of the main diagnostic methods for detecting breast lumps. Duplex color Doppler sonography has been helpful to distinguish malignant from benign breast disease and also to predict the disease prognosis.* ***Objectives****: The purpose of this study was to evaluate the role of spectral Doppler as a method to measure the vascular resistance index in differential diagnosis between the benign and malignant breast neoplasm.* ***Materials and Methods****: This cross-sectional study was carried out in department of Radiology & Imaging of Enam Medical College & Hospital during January 2015 to December 2017. Sonography was done in 153 women having breast lumps. Among them histopathology was done in 105 cases. Ultrasonographic findings and histopathological report analyses were done using SPSS 13.0.* ***Results****: The study was done in 105 women with mean age 31.6 ± 4.5 years. On ultrasonogram, lesions were diagnosed as benign in 65 (62%) cases and malignant in 40 (38%) cases. Out of sonographically diagnosed 65 benign lesions having peripheral vascularity and decreased RI, 63 (97%) were proved benign histopathologically. With these criteria for diagnosis of benign lesion, sensitivity was 94%, specificity 92%, positive predictive value 95%, negative predictive value 89% and accuracy 93%. Sonographically 40 lesions were diagnosed as malignant. Among them 37 (92.5%) cases were proven malignant histopathologically and showed central vascularity and increased RI having sensitivity of 92%, specificity 94%, positive predictive value 89%, negative predictive value 95% and accuracy 93%.* ***Conclusion****: The analysis of vascular resistance index combined with findings on grayscale sonographic images correlates well with histopathological reports and can be of great assistance in the assessment of breast masses with high sensitivity and specificity.*

Key words*: Benign; Malignant; Doppler; Resistance index*

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Introduction

Ultrasonography is currently one of the main diagnostic methods for diagnosing breast disease. Most breast lumps are noncancerous, which means they are benign. However malignant lesions are not rare though these are the leading cause of cancer death among women accounting for 23% of all cancer cases and 14% of cancer deaths globally.[1]

Mammography is considered as the primary screening tool for breast cancer.[2] However, the sensitivity of mammography declines with increased density of breast tissue and it is observed that in women with dense breasts, the sensitivity of mammography decreases to 30–48% and it has been revealed that supplemental ultrasound can detect small breast

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cancers not detected by mammography.[3,4] A study has shown that using ultrasound in addition to mammography increases the sensitivity to 77.5% compared to that of mammography alone (50%) in women with dense breasts and increased risk of breast cancer.[5]

The use of color Doppler ultrasonography for characterizing breast masses has increased in recent years. Doppler criteria such as resistive index (RI) are used to distinguish benign from malignant lesions.[6,7] Most of the studies are based on RI comparison between malignant and benign lesions. However, different sensitivities, specificities, and positive and negative predictive values have been reported.[8,9]

The aim of this study was to assess the value of RI in evaluating solid breast masses, to compare it with histopathology results, and to evaluate its potential role in differentiating benign from malignant breast lesions.

Materials and Methods

This cross-sectional study was carried out in the Department of Radiology & Imaging of Enam Medical College & Hospital from January 2015 to December 2017. Patients were referred for breast ultrasound for a variety of standard indications. High resolution US was done in 153 patients. Among them 105 cases were included in the study as these patient groups had histopathological reports for review.

Patients were evaluated via superficial ultrasound as clinically indicated. The scans were performed using 7.5 MHz USG machine. Color Doppler interrogation was used during the study period and RI of the vessels in the lesion was measured.

We analyzed these women by recording age and clinical symptoms. Sonographic and Doppler findings were recorded. Histopathology reports were collected and correlated with resistivity indices.

Results

A total 105 cases were included in this study. Age of the patients ranged from 21 to 45 years with mean age 31.6 ± 4.5 years. The largest group was of age 31−35 years contributing 41% of total cases in the study (Table I). Table II shows distribution of respondents according to clinical features.

Table I: Distribution of respondents according to age (n=105)

Age	Number	Percentage
21−25	16	15
26−30	29	28
31−35	43	41
36−40	15	14
41−45	2	2

Table II: Distribution of respondents according to clinical features (n=105)

Clinical features	Number	Percentage
Lump	50	48
Lumpiness	33	31
Mastalgia	16	15
Nipple discharge	7	7
Alteration of size and shape of breast	13	12
Regular check up	11	10

Sonographically, benign lesions were diagnosed in 65 cases. Common sonological criteria were ─ well defined margin in 50 (77%) cases, 45 (69%) cases were hypoechoic and 15 (23%) cases were more hypoechoic in echotexture, oval and round shape was present in 46 (71%) cases and homogeneous internal echo was seen in 42 (65%) cases. Thirty four (52%) cases showed bilateral edge shadow whereas only 12 (18%) cases showed no compressibility. Architectural disruption was present only in 20 (31%) cases and absent in 45 (69%) cases (Table III).

Sonographically malignant masses were diagnosed in 40 cases having following common criteria – ill-defined margin in 32 (80%) cases, irregular shape in 32 (80%) cases, hypo to anechoic echogenicity in 33 (82%) cases, heterogeneous internal echoes in 25 (62%) cases, and bilateral edge shadow and compressibility were seen only in 5% cases (Table IV).

With morphological sonographic criteria, benign masses were diagnosed in 65 cases. Among them 63 (97%) cases showed peripheral vascularity and decreased RI (0.58 ± 005) whereas among sonographically diagnosed 40 cases of malignant masses, 37 (92.5%) cases showed central vascularity and increased RI (0.76 ± 0.03) (Table V).

Table III: Distribution of respondents according to morphological sonographic features of benign masses (n= 65)

Morphological sonographic criteria	Number	Percentage
Margin		
Well defined	50	77
Ill defined	15	23
Echogenicity		
Hypoechoic	45	69
Isoechoic	3	5
Hyperechoic	2	3
More hypoechoic to anechoic	15	23
Shape		
Oval and round	46	71
Irregular	19	29
Internal echoes		
Homogeneous	42	65
Heterogeneous	23	35
Architectural disruption		
Present	20	31
Absent	45	69
Bilateral edge shadow		
Present	34	52
Absent	31	48
Compressibility		
Absent	12	18
Present	53	82

Table IV: Distribution of respondents according to morphological sonographic features of malignant masses

Morphological sonographic criteria	Number	Percentage
Margin		
Well-defined	8	20
Ill-defined	32	80
Echogenicity		
Hypoechoic	7	18
Hypoechoic to anechoic	33	82
Shape		
Oval and round	8	20
Irregular	32	80
Internal echoes		
Heterogeneous	25	62
Homogeneous	15	38
Bilateral edge shadow		
Present	2	5
Absent	38	95
Architectural disruption		
Absent	0	0
Present	40	100
Compressibility		
Present	2	5
Absent	38	95

Table V: Distribution of respondents according to vascular distribution and spectral Doppler RI arteries in and around the breast lesions

Vascular distribution and spectral Doppler findings	Benign masses (n=65) Number (%)	Malignant masses (n=40) Number (%)
Peripheral vascularity	63 (97)	3 (7.5)
Central vascularity	2 (3)	37 (92.5)
Decreased RI	63 (97)	3 (7.5)
Increased RI	2 (3)	37 (92.5)

Figures 1, 2, 3 and 4 showed decreased RI in benign breast mass (histopathologically proved fibroadenoma), increased RI in benign breast mass (histologically proved abscess), increased RI in malignant breast mass (histologically proved ductal cell carcinoma) and decreased RI in malignant breast mass (histologically proved abscess) respectively.

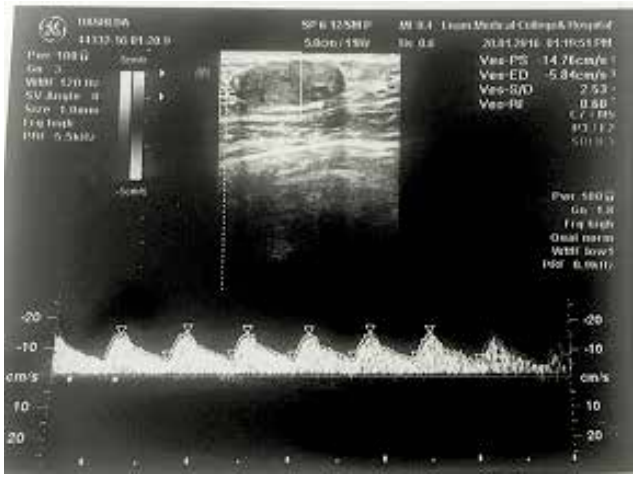

Fig 1. Decreased RI in benign breast mass (histopathologically proved fibroadenoma)

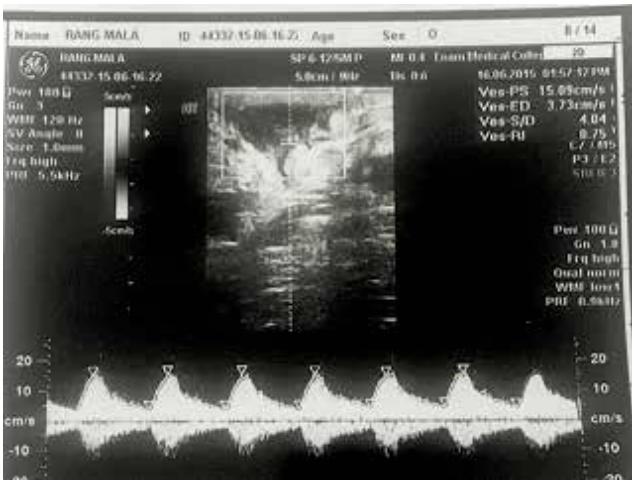

Fig 3. Increased RI in malignant breast mass (histologically proved ductal cell carcinoma)

Fig 2. Increased RI in benign breast mass (histologically proved abscess)

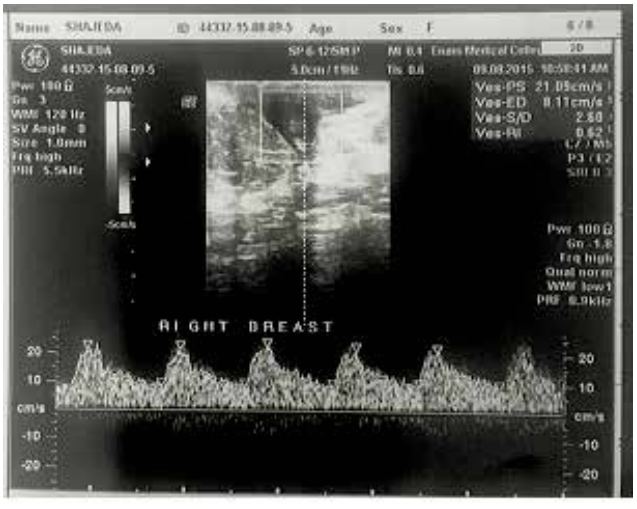

Fig 4. Decreased RI in malignant breast mass (histologically proved abscess)

The Doppler criteria used for diagnosing benign masses were peripheral vascularity and spectral Doppler showing decreased RI (0.58 ± 0.05). After histopathological correlation with these criteria 60 cases were found true positive, 33 cases were true negative, three cases were false positive and four cases were false negative giving a sensitivity of 94%, specificity of 92%, positive predictive value of 95% and negative predictive value of 89%. Overall diagnostic accuracy of the test was 93%.

Similarly, Doppler criteria used for diagnosing malignant masses were central vascularity and spectral Doppler showing increased RI (0.76 ± 0.03). After histopathological correlation with these criteria, it was found to be true positive in 33 cases, true negative in 60 cases, false positive in 4 cases and false negative in 3 cases giving a sensitivity of 92%, specificity of 94%, positive predictive value of 89% and negative predictive value of 95%. Overall diagnostic accuracy of the test was 93%.

Discussion

Tumor angiogenesis plays an important role in the growth of neoplasm. Malignant breast neoplasms need angiogenesis for further growth and metastasis.[7] The increased size of a neoplastic lesion requires the formation of new vessels. Malignant masses secrete

angiogenic factors required for new vessel formation for tumoral enlargement. Thus, a technique such as Doppler sonography with the ability to visualize the blood vessels might be useful for differentiating benign and malignant breast lesions. This study was designed to determine the value of Doppler sonography and RI in distinguishing benign from malignant breast lesions.[8]

This study showed that malignant breast lesions are more vascular than the benign lesions. These findings are found in some other studies.[9-14] In this study, central blood vessels were detected in 92.5% of the malignant group and only 3% of the benign group. This difference was statistically significant.

Several imaging methods have been used to differentiate between benign and malignant lesions with varying success. We conducted this study to evaluate the role of color Doppler in the differentiation between benign and malignant breast masses. It increases the accuracy of diagnostic tests and that might help in decision making and patient counseling.

The most common clinical presentation in our study was having a lump in 50 (48%) cases followed by feeling of lumpiness in 33 (31%) cases and mastalgia in 16 (15%) cases. Seven (7%) cases presented with nipple discharge and 13 (12%) cases presented with alteration of size and shape of breast. Eleven (10%) cases had come for regular check-up. Similar results were also obtained by other studies.[7,10] In the study done by Duijim et al[10], the most common presentations were lump 1712/6864 (24.9%) followed by mastalgia 1029/6864 (17.9%).

In this study common morphological sonographic criteria for diagnosis of benign masses were well-defined margins in 50 cases (77%), round or oval shaped in 46 (71%) cases, presence of homogeneous internal echoes in 42 (65%) cases, bilateral edge shadow in 34 (52%) cases and hypoechoic lesions in 45 cases (69%). Similarly while imaging malignant masses, ill-defined margins were seen in 32 (80%) cases, heterogeneous internal echoes in 25 (62%) cases, irregular shape in 32 (80%) cases and hypo to anechoic echogenicity in 33 (82%) cases. No pseudocapsule was seen in any lesion. These results are comparable with another studies.[6] Another study had shown age of patient, size of the mass, location, multiplicity in favor of the diagnosis of benign and malignant lesions.[14]

We compared blood vessel distribution (peripheral or central) for both benign and malignant masses with Doppler study. The Doppler criteria used for diagnosing benign lesion were peripheral vascularity and spectral Doppler showing decreased RI (0.58±005) in 63 (97%) cases out of 65 cases diagnosed as benign sonographically. After histopathological correlation with these criteria it was found true positive in 60 cases, true negative in 33 cases, false positive in 3 cases and false negative in 4 cases giving a sensitivity of 94%, specificity of 92%, positive predictive value of 95% and negative predictive value of 89%. Overall diagnostic accuracy of the test was 93%.

Similarly Doppler criteria used for diagnosing malignant masses was central vascularity and spectral Doppler showing increased RI (0.76 ± 0.03) in 37 (92.5%) cases out of 40 cases diagnosed as malignant sonographically. After histopathological correlation with these criteria, it was found true positive in 33 cases, true negative in 60 cases, false positive in 4 cases and false negative in 3 cases giving a sensitivity of 92%, specificity of 94%, positive predictive value of 89% and negative predictive value of 95%. Overall diagnostic accuracy of the test was 93.8%. It was in agreement with other studies, which revealed that malignant lesions had randomly scattered vessels or intratumoral signals while benign masses usually had peripheral scattered or outer feeding vessels.[6,7,11,19]

Our results were also comparable to those of Ozdemir et al[6] in which peripheral location of vessels in the benign lesions was 60% while in the malignant group 14%, scattered location of vessels were 12% in benign and 70% in malignant lesions. In their study, Cho et al[19] found that malignant lesions were characterized by the presence of diffuse vessels while benign tumors had flow aligned along the margin, appearing on imaging as a vascular ring.

In this study, we found a higher RI in the malignant group. The RI of 0.65 was identified as a threshold with 92% of sensitivity in diagnosing malignancy. Lee et al[11] reported that RI of 0.78 was a suitable threshold for distinguishing malignant from benign tumors.

Choi et al[19] observed that, in more than 80% of malignant breast nodules, the RI exceeded 0.70 with

a sensitivity of 80.9% and specificity of 89.1%.[15] However, they also concluded that this threshold could not be used alone and a biopsy is the gold standard for diagnosis. Peters-Engl et al[12] have also reported that RI of 0.70 is the best cut-off value for differentiating malignant nodules, with 82% sensitivity, 81% specificity, 70% positive predictive value and 89% negative predictive value. Davoudi et al[13] and Madjar et al[16] reported that a threshold of 0.75 and 0.7 were the suitable cut-offs respectively.

The difference between the cut-off points of RI and the discrepancy between sensitivity and specificity proposed in different studies and our study could be explained by the fact that the behavior of a tumor depends on its vascularity. The fact that the majority of our cases were invasive ductal carcinoma and most of the benign lesions were fibroadenoma could be responsible for the disparity between the results of our study and those of the prior ones. Nevertheless, a larger size study with a greater number of variants of malignant and benign tumors could have a better insight on the effect of tumor types on RI. Further studies with larger sample sizes and covering more factors using multivariate logistic regression are needed.

Kristine et al[17] reported that MRI was significantly better than ultrasound in characterization of benign and malignant lesions. Furthermore, cost and time consuming procedures of MRI have made it impossible to use it as a routine examination in practice. USG has been proven to be a helpful tool in diagnosis of benign and malignant lesions.[9,10,13] The use of color Doppler provided new parameters such as blood flow impedence and power imaging, in addition to gray-scale ultrasonography.[11,14] The reliability was better than that of using morphological criteria alone.[18]

According to our study color Doppler sonography has significant sensitivity, specificity, accuracy, positive predictive value and negative predictive value in differentiating benign and malignant breast masses. Our study was also comparable to other similar studies.[15,20,21]

Doppler study is a useful tool in predicting malignancy in breast lesions. Our study showed that in addition to the morphological criteria, hypervascularity and increased RI of a breast mass are the most reliable signs in Doppler ultrasound to predict malignancy. Though pathological findings are still the gold standard for diagnosing the type of breast masses, RI helps the radiologists in distinguishing between malignant and benign breast lesions for making the decision for biopsy recommendation.

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