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The Role of Mammography and Ultrasonography in the Evaluation of Breast Masses

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Abstract
Background: *To evaluate the palpable breast masses using mammography and sonography independently and in combination and to evaluate the additional advantage of Doppler sonography when used in conjunction with grayscale sonography.*
Methods: *The study was carried out in the department of Radiodiagnosis, Medical college, Kottayam for a period of 18 months in female patients complaining of breast lump. All patients were evaluated with both es showed Doppler vascularity. mammography and sonography independently and in combination. Histopathology follow up was obtained by FNAC/BIOPSY and the results were correlated with mammographic and sonographic findings.*
Results: *A total of 150 female patients were included in the study. 68 (45.3%)cases were malignant and 82 (54.7%)were benign. Infiltrating ductal carcinoma accounted for 91.1% of malignant mass. Combined mammography and ultrasonography showed more sensitivity (92.6%) and negative predictive value (92.4%) than either modality alone. Among malignant lesions 66.2% show Doppler vascularity whereas only 25.6% of benign cases showed Doppler vascularity.*
Conclusion: *Sensitivity of mammography was found to decease with increase in breast density. Combined mammography and ultrasonography play an important role in better characterization of breast masses and thereby avoiding unnecessary biopsies in benign lesions.*
Keywords: *breast masses, mammography, ultrasonography.*

INTRODUCTION

Breast cancer is the most common cause of cancer death in women and overall 5th common cause of cancer deaths in the world[1]. Delay in the detection causes malignancy to progress to advanced stage.

Mammography was used primarily for early detection of malignancy in their curable stages, and to decrease malignancy related mortality. Its role in screening remains unchallenged. Diagnostic mammography has high accuracy to detect cancers in a fatty breast but may have limitations in dense breasts. It should be emphasized that a normal mammogram at any age does not eliminate the need for further evaluation of a palpable breast mass.

Ultrasound plays a vital role in the assessment of breast masses. Its primary use has been for the differentiation of solid from cystic masses and as guidance for interventional procedures. It also plays an important role in characterizing solid masses. It has evolved as an indispensable problem solving tool in patients with dense breasts, post-radiation breasts, women less than 35 years of age, pregnant and lactating patients. However, in recent years, ultrasound as an adjunct to mammography has improved the accuracy in the diagnosis of breast cancer[2]. As it has become more widely utilised, studies have shown that the most beneficial role of ultrasound may lie in the evaluation of a mammographic mass that is partially obscured or in dense breast tissue where mammography is unable to fully characterise or detect a lesion.

Determining the pattern of vascularity of breast masses on Doppler ultrasonography may help to predict the likelihood of malignancy when used with other sonographic features.

An efficient and accurate evaluation can maximize cancer detection and minimize unnecessary testing procedures.

An attempt was made to evaluate various breast masses using ultrasonography and mammography separately and in combination and the advantage of Doppler in the evaluation of breast masses.

AIMS AND OBJECTIVES OF STUDY

1. To evaluate the palpable breast masses using mammography and ultrasonography independe-ntly and in combination.
2. To evaluate whether there is any additional advantage when Doppler sonography is used in conjunction with ultrasonography.

MATERIALS AND METHODS

The prospective study was conducted in the department of Radiodignosis, Govt. Medical College, Kottayam for a period of 18 months extending from April 2013 to September 2014 in 150 female patients complaining of breast lump

PROCEDURE IN DETAILS

After obtaining acceptance from institutional research committee we commenced our study. Well informed written consent was obtained from the patients and a structured pre - prepared case proforma was used to enter the patient details.

Patients were subjected at first to a diagnostic mammography study which included both craniocaudal and mediolateral oblique views. Supplementary views were taken when necessary. The mammogram was evaluated before sonographic evaluation. Mammography was performed with Hologic ASY- 00534 equipment.

Following mammography, ultrasonography was done. The entire breast was examined with particular attention paid to the region that contained the detected clinical abnormality. Patients were examined in supine position and with ipsilateral arm behind the head. Along with greyscale ultrasonography, colour and pulse Doppler analysis were done on the patients and morphological characteristics and spectral waveform datas were recorded. Sonography was performed with a 4-7MHz linear array transducer of MindrayDC7.

Each lesion was interpreted on the basis of mammography and sonographic findings and were categorised as benign and malignant using BIRADS mammographic and sonographic scoring system.

The lesions were confirmed on histopathology (FNAC/biopsy).The tissue diagnosis results were correlated with mammographic and sonological findings by statistical analysis independently and in combination.

DATA MANAGEMENT AND STASTICAL ANALYSIS

The data were entered in Excel and further analysis was done using the software SPSS. P value of < 0.05 was considered significant and p value of < 0.01 was considered highly significant. The value of sensitivity, specificity, positive predictive value and negative predictive values for

mammography and ultrasonography were obtained separately and in combination.

RESULTS

Table 1: Mammographic parenchymal pattern in our study and distribution of malignant and benign breast masses

Density	HPR		total
	Malignant	Benign	
fatty	14(73.7%)	5(26.3%)	19(100%)
Scattered fibroglandular	36(53.7%)	31(46.3%)	67(100%)
Heterogeneously dense	18(31%)	40(69%)	58(100%)
dense	0(0%)	6(100%)	6(100%)
Total	68	82	150

Apperance of mass lesion in Mammography and Ultrasound

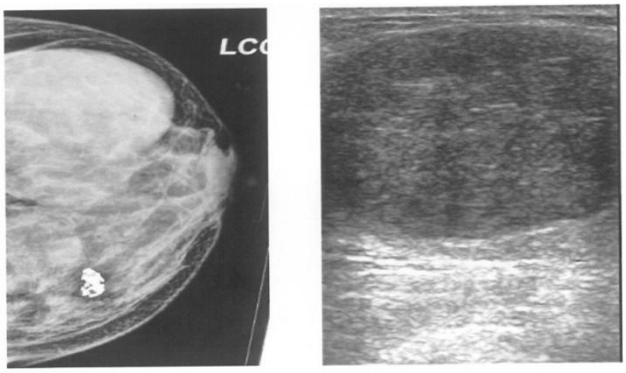

Figure 1: A case of fibroadenoma and another involuting fibroadenoma. (a)Mammography shows a well circumscribed lesion with lobulated margin and another lesion with popcorn calcific-ation (b) USG reveals well defined hypoechoic lesion with posterior acoustic enhancement

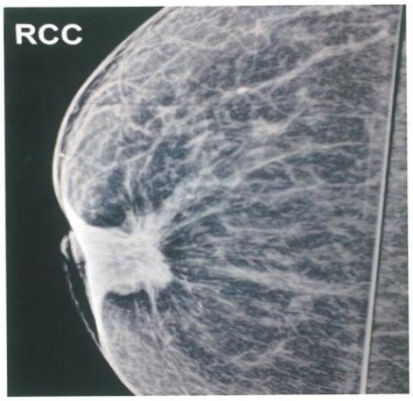

Figure 2: A case of 59 yr old female infiltrating ductal carcinoma. Mammography shows a lesion with irregular spiculated margin with nipple retraction and skin thickening consistent with malignancy

Table 2: Showing Orientation of benign and Malignant lesion in Sonography and benign masses

Orientation	HPR		Total
	Malignant	Benign	99
Taller than wide	35(51.5%)	3(3.7%)	38
Wider than tall	33(48.5%)	79(96.3%)	112

P value 0.001 significant

Taller than wide ratio was more favouring malignant lesions (35/68 malignant cases) and width more than height was favouring benign lesions (79/82 benign cases).

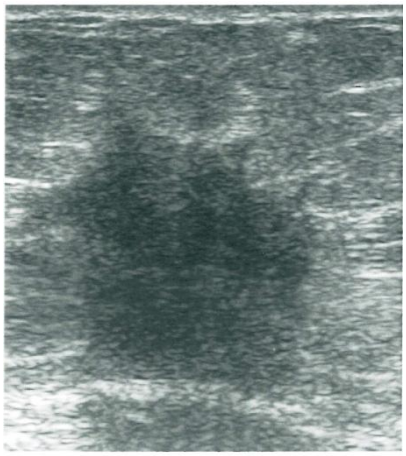

Figure 3: A case of infiltrating lobular carcinoma in a 49 year old female ultrasonography shows irregular mass with spiculated margin

Table 3: Posterior features of malignant and benign breast masses in USG

Posterior features	HPR		Total
	Malignant	Benign	
Posterior shadow	23(92%)	2(8%)	25(100%)
Posterior enhancement	14(19.7%)	57(80.3%)	71(100%)
No posterior features	31(57.4%)	23(43.4%)	54

P value 0.001 significant

92% cases with posterior shadowing were malignant and 80.3% with posterior enhancement were benign.

Table 4: Edge shadowing in malignant and benign breast masses in US

Edge shadowing	HPR		Total
	Malignant	Benign	
Present	20(57.1%)	15(42.9%)	35
Absent	48(41.7%)	67(58.3%)	115

P value 0.109 not significant

Some features were not reliable in differentiating benign and malignant lesion. For e.g., the effect of edge shadowing was not a useful determinant.

Table 5: Incidence of vascularity in malignant and benign breast masses on Doppler US

Vascularity	HPR		Total
	Malignant	Benign	
With vascularity	45(66.2%)	21(25.6%)	66(44.3%)
Without vascularity	23(33.8%)	61(74.4%)	84(55.7%)
Total	68(100%)	82(100%)	150(100%)

p value - 0.001 significant

Presence of vascularity within the lesion was found to be more favouring a malignant lesion. 66.2% of malignant cases show Doppler vascularity whereas only 25.6% of benign cases show Doppler vascularity.

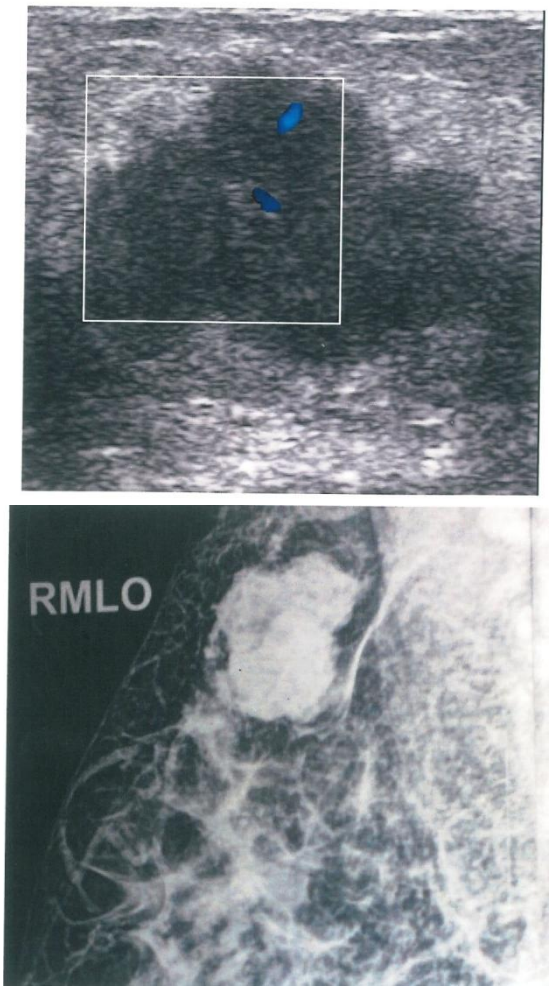

Figure 4: A case of infiltrating ductal carcinoma in a 59 yr old female. (a)Mammography shows a well defined lesion with lobulated margin (b) b) USG shows an irregular lesion with lobulated (macro and microlobulation) margin with central vascularity

Table 6: Minimum, maximum and mean value of PI and RI

Variables	Minimum	Maximum	Mean	SD	tvalue	pvalue
PT	0.00	2.9	0.69	0.85	5.738	0.001
RI	0.00	1.9	0.337	0.408	5.842	0.003

Table 7: Statistical indices of diagnostic accuracy of PI>/= 1.135

PI	HPR		TTotal
	Malignant	BENIGN	
>/=1.135	37(54.4%)	19(23.2%)	56
.000-1.134	31(45.6%)	63(76.8%)	94
Total	68	82	150

When >/= 1.135 was taken as the cut-off value for PI, 37 cases out of 68 malignant
cases could be picked up.
Sensitivity-54.4%
Specificity-76.8%
Positive predictive value - 66
Negative predictive value -67%

Table 8: Statistical indices of diagnostic accuracy of RI >/= 0.55

RI	HPR		Total
	Malignant	Benign	
>/=0.55	44(64.7%)	16(19.5%)	60
0.00-0.549	24(35.3%)	66(80.5%)	90
Total	68	82	150

When >/= 0.55 was taken as the cut off, 44 out of 68 malignant cases were picked up.
Sensitivity-64.7% [J]
Specificity-80.5%
Positive predictive value -73.3%
Negative predictive value -73.3%

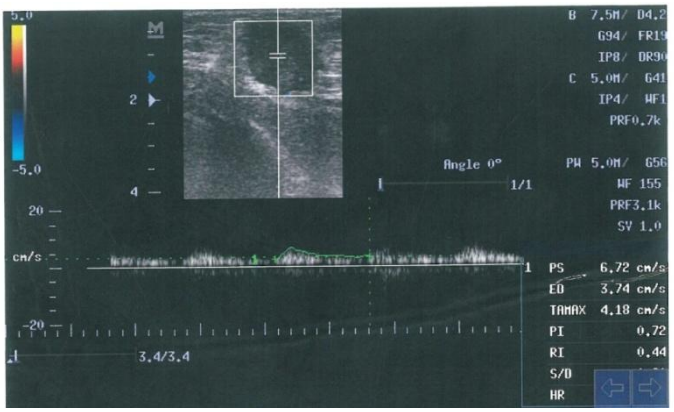

Figure 5: 82 yr old patient with infiltrating ductal carcinoma showing low resistant flow pattern (PI-0.72,RI-0.44)

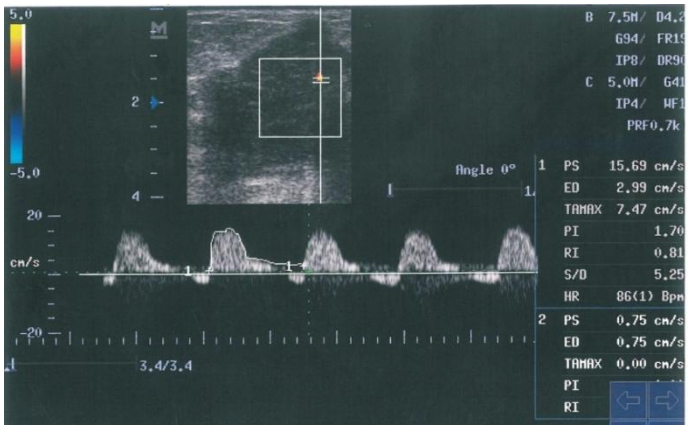

Figure 6 : A case of infiltrating ductal carcinoma. An irregular hypoechoic mass with high resistant flow pattern (PI-1.7 and RI-0.81) consistent with malignancy.

Table 9: Sensitivity and Specificity of combined mammography and ultrasonography

	HPR Malignant	HPR Benign	Total
Combined Mammography & USG Malignant	63(92.6%)	21(25.6%)	84
Co*mbined Mammography & USG Benign	5(7.4%)	61(74.4%)	66
Total	68	82	150

Sensitivity - 92.6%
Specificity - 74.4%
Positive predictive value - 75%
Negative predictive value - 92.4%

DISCUSSION

In our prospective study carried out in the Department of Radiodignosis, Govt. Medical College, Kottayam during the period April 2013 to September 2014 on female patients with palpable breast lump, out of total 150 patients, there were 45.3% malignant masses and 54.7% benign masses. Infiltrating ductal carcinoma accounted for 91.1% of malignant breast mass. This was comparable to study by Rahbar et al (81.5%)[3].

Comparative analysis of mammography and ultrasonography

Mammography, the primary method of detection and diagnosis of breast diseases has a proven sensitivity of 85-95%[4]. In our study, the sensitivity of mammography was only 72%. The main reason for the decreased sensitivity of mammography in our study could be due to the slightly high percentage of heterogenously dense breast (38.7%). Mammographic sensitivity declines significantly with increasing breast density[5].It decreases to as low as 30-48% in patients with dense breast[6].

The specificity in our study was 84% which was comparable with the specificity of 88% in a study by Barlow et al[7].

The false negative rate in our study was as high as 27.9% which were comparable with the,reported false negative rate of 16.5% in a study by Kolb et al[8].

Therefore, malignancy cannot be excluded when mammographic findings of a palpable mass are negative. Sonography is used as an adjunct to further evaluate palpable masses, especially in women with mammographically dense breasts.

Ultrasound features most predictive of benignity were round/oval shape (97%), circumscribed margin (90%), wider > taller (96.3%) and posterior enhancement (80.3%). Ultrasound features most predictive of malignancy were irregular shape (89%), spiculation (88%), microlo-bulation (74%), angulation (81%), illdefined margins (77%), taller > wider (51.5%) and posterior shadowing (92%). These findings were comparable to the study done by Rahbaret al[9].

In our study, sensitivity of ultrasonography was significantly higher compared to sensitivity of mammography (89.7% versus 72%), which was comparable with the study by Stavros et al[10]. This could be attributed to the increased detection of lesions on ultrasonography in dense breast.

The negative predictive value (90.4%) of ultrasonography in our study was comparable to the study of Stavros et al (99.5%).

The sensitivity of combined mammography and ultrasonography in detecting breast masses in our study was 92.6%) (higher than either modalities used separately), this was comparable to study by Mebrahtu et al[11].

The false negative rate was found to be significantly reduced to 7% from 27.95% when mammography and ultrasonography were combined. This can reassure a woman with a suspicious palpable finding[12].

Though mammography and USG has their own advantage, no single investigation is 100%> sensitive but combination yield 92.6% sensitivity than when single modality mammography (72.1%) or USG (89.7%) was used. Combined imaging studies can distinguish benign from malignant lesions and help avoid unnecessary biopsies.

Regarding role of Doppler in breast masses

The rate of detection of vascularity by Colour Doppler ultrasonography in malignant breast masses was significantly higher than in benign tumours. Most common pattern of vascularity in malignant breast masses was found to be central pattern (40%) which was comparable with study by Razaet al[13].

In our study, 45 cases out of 68 malignant cases (60.2%) showed vascularity whereas only 21 cases out of 82 benign lesions (25.6%) showed vascularity. Doppler sonography had a sensitivity of 66.2% and specificity of 74.4%.This was comparable to study by del Cura et al (sensitivity - 68%, specificity - 64%, positive predictive value - 54% and negative predictive value - 73%)[14].

As there was overlap between the values of PI in benign and malignant tumours in the present study, the efficacy of PI in diagnosing malignancy was assessed with different cut-off values in the present study. When a value of PI more than or equal to 1.4, as suggested by delCura et al[14] was used to differentiate malignant tumours from benign ones, the sensitivity was found to be very low (45%). Analysis of ROC curve revealed that the ideal cut - off value of PI as test criteria was when PI >/= 1.135. This has sensitivity - 54.4%, specificity - 76.8%, positive predictive value - 66% and negative predictive value -67%. This finding was close to the suggested cut-off value of 1.1 for PI in the article by Mesakiet al[15].

The efficacy of RI in diagnosing malignancy was assessed with different cutoff values in present study. Analysis of ROC curve revealed that the ideal cut-off value of RI as test criteria was when RI >/= 0.55. The cut-off value has sensitivity - 64.7%, specificity - 80.5%, positive predictive value - 73.3% and negative predictive value - 26.6%.But when a value equal to or greater than 0.8 as suggested by del Curaet al[14] was used to differentiate malignant from benign tumours the sensitivity was unacceptably low.

CONCLUSION

The study was undertaken to evaluate the role of mammography and ultrasonography in palpable breast masses individually and in combination. The study included 150 female patients with palpable breast lumps. Out of 150 patients, 68 cases were malignant and 82 cases were benign.

Our results confirm that breast density is an important predictor of sensitivity of mammography. As the density increases, the sensitivity of mammography was found to decrease. Ultrasonography can be an effective adjunct imaging modality in the evaluation of women with dense breast tissue at mammography, evaluation of cystic lesions and intracystic masses. Combined mammography and ultrasonography play an important role in diagnosing palpable breast masses. It helps in

Better characterisation of breast masses

Avoiding unnecessary investigation/ biopsies in which imaging findings are unequivocally benign

Reassuring the patient as the negative predictive value in combined mammography and ultrasonography is very high.

Doppler sonography is, by itself, of little use for evaluating solid breast lesions. However, when it is used in conjunction with ultrasound examination, detection of vascularity is significantly linked with malignancy.

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