Original Article

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Radiology Section

Sonoelastography and Dynamic Magnetic Resonance Mammogram in the Evaluation of BIRADS III and above Breast Lesions Categories- A Prospective Cohort Study

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ABSTRACT

Introduction: Breast cancer has become a major health hazard in society. Early diagnosis of breast cancers plays a vital role in its management and control. Sonoelastography and Magnetic Resonance (MR) mammography are non invasive imaging methods in the diagnosis of breast lesions.

Aim: To determine the accuracy of sonoelastography and dynamic MR mammogram in the evaluation of breast masses of Breast Imaging Reporting and Database System score (BIRADS)-III and above (BIRADS-IV, V and VI) lesion categories.

Materials and Methods: The present prospective cohort study conducted in the Department of Radiodiagnosis at Bowring and Lady Curzon Medical College and Research Institute and Prestige Medical Health Sciences, Bangalore, India from June 2019 to March 2020. A total of 60 female cases clinically and histopathologically diagnosed with breast cancers above 28 years of age were recruited. All the subjects underwent conventional B mode ultrasonogram. Cases with BIRADS-III and above lesion category were assessed through sonoelastography and dynamic contrast enhances MR mammogram. MR mammogram was performed by using 1.5 tesla GE Magnetic Resonance Imaging (MRI). The sequences like axial and sagittal Time (T)1 Weighted (W)1 and T2 WI, Diffusion Weighted Imaging (DWI), axial Short Inversion Time Inversion Recovery (STIR) were performed. The Chi-square test was used to compare the difference between study variables.

Results: A total of 60 female cases, clinically and histopathologically diagnosed with breast cancers above 28 years of age were included in the study with maximum in age range of 41-50 years. The dynamic MRI curve category sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and diagnostic accuracy as 91.8%, 95.3%, 96.3%, 92% and 94.8%, respectively. The study showed sonoelastography sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy as 79.8%, 93%, 88.6%, 82.2% and 84%, respectively.

Conclusion: The MR mammogram and sonoelastography are effective methods in the diagnosis of breast lesions; however, MR mammography has higher sensitivity, specificity and diagnostic accuracy.

Keywords: Accuracy, Breast cancer, Breast imaging reporting and data system, Predictive validity

INTRODUCTION

Breast cancer is a leading cancer type, representing 27.7% of all cancer types and accounts 11.1% of cancer deaths in India [1]. Even though, in every four minutes one woman in India diagnosed with breast cancer and in every 13 minutes one woman dies with breast cancer [2]. Breast cancer is the first or second leading cancer type among women with an estimated 2.3 million new cases and accounting 6.9% of total cancer deaths in females (1.8 million deaths) worldwide [3].

Different diagnostic modalities are available for the early diagnosis of breast cancer. Among them, few methods were used for screening the conditions, few used for diagnosis of disease severity and few used as adjunctive for evaluation. Adjunctive diagnostic methods provide additional confirmatory information to clinicians in the disease diagnosis [4]. Various methods like breast ultrasound, Computed Tomography (CT), Magnetic Resonance Imaging (MRI), mammography, thermography, optical imaging, and Positron Emission Tomography (PET) are widely used in the screening and diagnosis of breast cancers [5].

The MR mammography is non invasive breast imaging technique that depicts high quality images and has better sensitivity (over 90%) and moderate specificity (72%) for differentiating malignant and benign breast lesions [6-10]. The contrast-enhanced MRI determines tumour extent more accurately than mammography and ultrasound [11]. Ultrasonography has better sensitivity but has poor specificity. To overcome the downsides, above mention modalities Ultrasound (US) elastrography was introduced. US elastography is a non invasive widely accepted as a standard imaging diagnostic procedure for breast lesions and assesses tissue deformity by providing information on the elasticity [12]. The sonoelastography and B mode Ultrasonography (USG) together can effectively enhance the size while lesion demonstration and increase the specificity and positive predictive value in distinguishing the breast lesions.

However, US elastrography is operator dependent and there may be interobserver variability in the data interpretation [13]. BIRADS is a classification system proposed by American college of Radiology. It is implemented to standardise risk assessment and quality control for mammography and provide uniformity in the reports. BIRADS score includes 0-6 categorisation, BIRADS 0 refers incomplete evaluation, BIRADS 1 refers negative examination, BIRADS 2 is consistent with benign findings, BIRADS 3 refers probably benign, BIRADS 4 refers chance of benign malignant, BIRADS 5 is highly suggestive of malignancy >95% and BIRADS 6 refers malignancy [14].

With above literature support, the present study was designed to evaluate efficacy of sonoelastography and dynamic MR

mammogram in the evaluation of breast masses of BIRADS-III and above lesion categories.

MATERIALS AND METHODS

The present prospective cohort study was conducted in the Department of Radiodiagnosis in association with Department of General Surgery at Bowring and Lady Curzon Medical College and Research Institute, Bangalore and Prestige Medical Health Sciences and Allied Health Sciences, Bangalore, India, from June 2019 to March 2020. A total of 60 female cases clinically and histopathologically diagnosed with breast cancers approached the department during study period were recruited. Cases above 28 years of age were considered because no reported cases found below that age group. After basic clinical examination and local palpation of the breast mass, Real-time conventional B-mode ultrasonography examination was performed to categorise BIRADS III and above lesions [13]. Informed consent was obtained from all the study participants and study protocol was approved by Institutional Ethics Committee (IEC/IRB NO: PMHS/IEC/05/09).

Inclusion criteria: Cases with BIRADS III and above lesion categories, >5 mm lesion in the mammary gland and cases willing to participate in the study were included.

Exclusion criteria: Cases with BIRADS I and II lesion categories, those with non solid breast lesions and the ones not willing to participate in the study were excluded from the study.

Study Procedure

All the subjects underwent sonoelastrogram and strain wave elastrogram with linear array transducer. MRI mammogram was performed by using 1.5 Tesla GE MRI. The sequences like axial and sagittal T1 Weighted Image (T1WI) and T2 Weighted Image (T2WI), Diffusion-Weighted Imaging (DWI) and axial Short Inversion Time Inversion Recovery (STIR) were performed. The elastography box was arranged to cover the whole lesion. The box was placed under the skin and subcutaneous tissue above, pectoralis major muscle below and 5 mm away on either sides of the lesion. Based on visual colour coding Tsukuba elasticity score 1-5 was implied to interpret the lesions [15]. MRI mammogram curves were reported as type 1, type 2 (Plateau pattern) and type 3 (Washout pattern) [16]. (Progressive Score 1 or 2 are considered as benign lesions, score 3 considered as probably benign and score 4 or 5 are considered as malignant lesions pattern). US elastrography and MRI mammogram images of study participants were reviewed by four radiologists (senior specialists in the departments) and they were unaware of Histopathological Examination (HPE) results and BIRADS category.

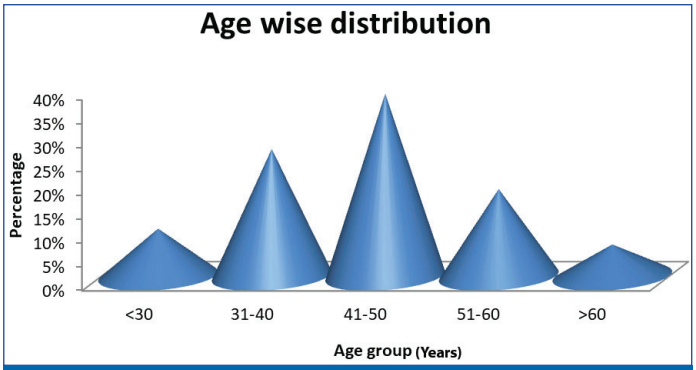
STATISTICAL ANALYSIS

The Statistical Package for Social Sciences (SPSS) version 23.0 software was used to carry out statistical analysis relevant to the study. Descriptive statistics were used to represent demographic and clinical characteristics in the form of frequency and percentages. Chi-square test was used to compare the difference between study variables. The predictive validity of MR mammography and US elastography against HPE expressed with 95% confidence interval. The p-value of <0.05 was considered as statistically significant.

RESULTS

A total of 60 female cases clinically and histopathologically diagnosed with breast cancers above 28 years of age were recruited. Majority cases were in between 41-50 years [Table/Fig-1]. Bilateral lesions were more common (91%).

BIRADS type III (45%) and IV (35%) lesions were more common than BIRADS type V (15%) and VI lesions (5%) [Table/Fig-2]. HPE findings showed malignant lesion in 37% cases and benign in 63%. The comparison of HPE findings with sonoelastography



[Table/Fig-1]: Age wise distribution of study participants.

(p-value 0.00158) and MR curve category (p-value 0.0021) was statistically significant [Table/Fig-3].

Findings	Frequency	Percentage
Type of MRI curve		
Type 1	28	46.7%
Type 2	12	20%
Type 3	20	33.3%
Score by sonoelastography		
Score 2	17	28.3%
Score 3	21	35%
Score 4	20	33.3%
Score 5	02	3.33%
BIRADS classification		
III	27	45%
IV	21	35%
V	09	15%
VI	03	5%

[Table/Fig-2]: Radiological findings in cases with breast lesions.
MRI: Magnetic resonance imaging; BIRADS: Breast imaging reporting and data system

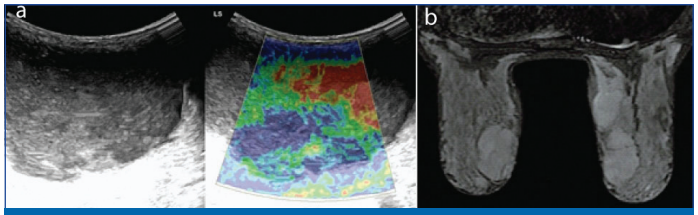
HPE findings	MRI curve category		Sonoelastography grading	
	Malignant	Benign	Malignant	Benign
Malignant	19	03	16	03
Benign	03	35	06	35
Chi-square value	31.74		20.422	
p-value	**0.0021***		**0.00158***	

[Table/Fig-3]: Comparison of HPE findings with sonoelastography and MR curve category.
*Chi-square values of representing the comparison between variables. p-value <0.05 is statistically significant

The predictive validity of MRI curve category showed sensitivity 91.8%, specificity 95.3%, positive predictive value (96.3%), negative predictive value (92%) and diagnostic accuracy (94.8%). The sonoelastography findings had sensitivity 79.8%, specificity 93%, positive predictive value 88.6%, negative predictive value 82.2% and diagnostic accuracy 84% [Table/Fig-4].

Predictive validity	MRI curve category			Sonoelastography grading		
	Outcome value	95%CI		Outcome value	95%CI	
		Upper	Lower		Upper	Lower
Sensitivity	91.8%	100%	77.22%	79.8%	91.22%	55.8%
Specificity	95.3%	99.9%	80.45%	93%	99.9%	84%
PPV	96.2%	100%	85.30%	88.6%	100%	71.56%
NPV	92%	100%	84.68%	82.2%	95.6%	68.17%
Accuracy	94.8%	100%	85.98%	84%	95.24%	75.68%

[Table/Fig-4]: Comparison of predictive validity among sonoelastography and MRI curve category findings with HPE findings.
HPE: Histopathological examination; MRI: Magnetic resonance imaging; PPV: Positive predictive value; NPV: Negative predictive value



[Table/Fig-5]: A 29-year-old female case reported breast lesion on left side. a) USG image showing huge hypoechoic mass lesion and US elastrogram image representing lesion with elasticity score 3 (blue, green and red colour assorted amid); b) MR T2WI image representing bilateral hyper intense lesion with clear lesion limitations.

Predictive validity	US elastrography					MR mammogram				
	Present study	Parekh H et al., [17]	Shakweer MM et al., [20]	ElSaid NA and Mohamed HGE [21]	Ghazala S et al., [18]	Present study	Elmoneam GA et al., [19]	Ghazala S et al., [18]	Parekh H et al., [17]	ElSaid NA and Mohamed HGE [21]
Sensitivity	79.8%	87.5%	90%	83.3%	86.7%	91.8%	100%	66.7%	95.6%	84%
Specificity	93%	84.4%	85%	86.7%	87.8%	95.3%	92.3%	91.5%	91.3%	84%
PPV	88.6%	-	85.7%	-	94.6%	96.2%	-	95.4%	-	-
NPV	82.2%	-	89.4%	-	66.8%	92%	-	53.3%	-	-
Accuracy	84%	-	87.5%	-	85.2%	94.8%	96.8%	73.1%	-	-

[Table/Fig-6]: Comparison of predictive validity of present study with previous studies [17-21].

[Table/Fig-5] shows a young female case who reported breast lesion on left side. Ultrasonography image showed huge hypoechoic mass lesion and Ultrasound elastrogram showed lesion with elasticity score 3. The MR T2WI image of this patient represented bilateral hyper intense lesion with clear lesion limitations.

DISCUSSION

A total of 60 cases clinically and histopathologically diagnosed with breast cancers above 28 years of age were recruited. Majority cases were between 41-50 years (38.30%) followed by 31-40 years (26.7%), 51-60 years (18.3%), 28-30 years (10%) and above 60 years (6.67%) [Table/Fig-1]. In this study, 91% cases had breast lesions on bilateral side and 9% cases had unilateral breast lesions. A study by Parekh H et al., included 50 female cases between age group 20-60 years. Majority cases were in between 31-40 years (30%), followed by 41-50 (28%), 21-30 (22%) and above 50 years (20%) which is comparable with the present study [17].

Type 1 of MRI mammogram curve was seen in 46.7% cases, type 2 curve was seen in 20% cases and type 3 curve was seen in 33.3% cases. The sonoelastography grading showed that 28.3% cases had grade 2 score, 35% had grade 3 score, 33.3% had grade 4 score and 33.3% had grade 5 score. In this study, BIRADS-III category lesions was seen in 45% cases, BIRADS-IV in 35%, BIRADS-V in 15% and BIRADS-VI category in 5% [Table/Fig-2]. A study by Ghazala S et al., mammographic findings showed BIRADS-III category in 12 cases (probably benign-6, proved benign-5, malignant-1), BIRADS-IV category in 21 lesions (Malignant-19, benign-2) and BIRADS-V category in 3 lesion which are malignant in nature [18].

In this study, histopathological findings showed malignant lesions in 37% cases and 63% cases had benign lesions. A study by Ghazala S et al., found 19.4% cases had benign lesions and 77.5% cases had malignant lesions by HPE [18]. The HPE findings showed that 41.3% had benign lesion and 58.7% cases had malignant lesions in a study by Elmoneam GA et al., [19]. The predictive validity of MRI curve category and sonoelastography values of present study was compared with the findings of previous studies mentioned in the [Table/Fig-6] [17-21].

A study by Parekh H et al., concluded that MRI evaluation of mammary lesion delivered higher sensitivity and specificity values than USG and mammography [17]. A study by Ghazala S et al., concluded that MRI was the most sensitive imaging tool for the diagnosis of breast lesions with limited specificity due to overlap in features of benign and malignant lesions [18]. A study by Elmoneam GA et al., stated that dynamic MRI curve is more sensitive, specific and accurate than shear wave elastography [19]. A study by Shakweer MM et al., stated that sonoelastography and MR spectroscopy are effective non invasive diagnostic tools in the early diagnosis of breast malignancies [20]. The results of above studies were consistent with results of present study in which MR mammography has high predictive validity than US elastrography.

Limitation(s)

The present study was limited to BIRADS III and above lesion category with restricted number of participants for reliability and generalisability of the results.

CONCLUSION(S)

Sonoelastography and MR mammography are effective in differentiation of breast lesions, whereas Sonoelastography is a cost effective, specific and increase the diagnostic efficacy of breast lesion. The results of present study concluded that MR mammogram and sonoelastography are effective diagnostic tools in the diagnosis of breast lesions, whereas MR mammography has higher sensitivity, specificity and diagnostic accuracy. Further studies are required to evaluate the accuracy of MR mammography and US elastrography in breast lesion with larger sample size.

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