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Comparison of Breast Density Assessment by Visual and Quantra software

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Abstract
Aim: *To compare the breast density assessment visually and by Quantra software.*
Materials and Methods: *Digital mammographic exams of (771 right breast, 796 left breast, total 1567 examinations) women participating in breast cancer clinic (age 30–83 years) were included from October 2018 to march 2019. Breast density was assesed visually as per Breast Imaging Reporting And Data System (BIRADS 5th edition) and compared with automated Quantra software (Hologic, selenia) and to establish the role of the software in clinical practice. kappa value was calculated to assess the degree of agreement among visual and Quantra assessment. Chi-square test is used to assess the significance in the distribution of different breast densities in different age groups.*
Results: *The distribution of density was significantly different by Visual assessment and by quantra except BIRADS category D. Quantra assessed BIRADS A,B category (24.9% in right side, 29.9% in left side) less compared to visual assessment (33.8%in right side , 35.0% in left side) and more of C category (63.0%n right side,60.9%in left side) than visual (54.10% in right side,52.90 % in left side).The different density patterns of breast in each age group are statistically significant in both visual assessment and quantra.*
Conclusion: *More number of visual fat densities (category A) were assessed as scattered fibroglandular densities (category B) by Quantra. Visual scattered fibroglandular densities (category B) were assessed as heterogenous fibroglandular densities (category C) by Quantra .These are the reasons for the disagreement among visual and Quantra assessment. Quantra assessed breast density is reproducible, and is preferred to visual assessment in risk assessment.*
Keywords: *Mammography, BI-RADS breast density category,automated volumetric breast density measurement, quantra ,screening mammography.*

Introduction

Breast cancer is one of the most common types of cancer in women. It is well established that increased density of breast parenchyma correlates with an increased incidence of breast cancer[1]-[3]. Density of breast is due to the fibroglandular tissue. The sensitivity of screening mammogram is decreased in dense breast[4]. There may be variation in assessing the breast density between radiologists, particularly type 2 and 3 .Prior to the development of Quantra software, no consistent breast density assessment method were available. Clinical assessment methods do not offer a consistent result, as they focus on human eye balling technique rather than numeric values of density[5]. Hologic's R2 Quantra is a software

application for assessing breast density. It estimates fibroglandular tissue volume and total breast volume by which volumetric breast density is obtained.[6] Many studies were done to assess the reproducibility of volumetric assessment of breast tissue.[7]

Materials and Methods

Digital mammographic examinations were performed with mammography unit (Lorad Selenia, Hologic) equipped with selenium detectors . Standard craniocaudal and mediolateral oblique views were only included. The exclusion criteria were -previos history of surgery, radiotherapy /chemotherapy, breast implantations. Each mammogram was visually assessed followed by Quantra for breast density according to the BI-RADS categories. The following BI-RADS categories for breast density were used for mammographic interpretations: category A, almost fatty; category B- scattered areas of fibroglandular densities; category C-

heterogeneously dense; and category D,-extremely dense[8],[9]. A weighted kappa value (κ) was calculated to assess the proportion of agreement between the visual assessment and volumetric measurements by quantra according to the BI-RADS category.

Statistical Analysis
Right Quantra

771 breast were assessed by quantra in right side (Table-1). Among them 157 (20.4%) belong to <40years, 352(45.7%) belongs to 41-50years, 196(25.4%) belongs to 51-60 years, 51(6.6%) belongs to 61-70years and 15(1.9%) belong to >70 years. The total fat density breasts are 9 (1.2%), mild fibro glandular densities are 183 (23.7%), moderate fibroglandular densities are 486 (63%) and dense breasts are 93 (12.1%). The majority of our patients were in the age group of 41 to 60 years 548 (71.1%). The glandular assessment of the majority of the patients were in the moderate fibro glandular 486 (63%).

Table- 1

AGE GROUP		QUANTRA RIGHT				
		FATTY BREAST	MILD FIBROGLANDULAR	MODERATE FIBROGLANDULAR	DENSE BREAST	Total
		A	B	C	D	
<=40	Count	0	15	108	34	157
	% of Total	0.00%	1.90%	14.00%	4.40%	20.40%
41-50	Count	1	64	236	51	352
	% of Total	0.10%	8.30%	30.60%	6.60%	45.70%
51-60	Count	6	75	111	4	196
	% of Total	0.80%	9.70%	14.40%	0.50%	25.40%
61-70	Count	2	23	24	2	51
	% of Total	0.30%	3.00%	3.10%	0.30%	6.60%
>70	Count	0	6	7	2	15
	% of Total	0.00%	0.80%	0.90%	0.30%	1.90%
Total	Count	9	183	486	93	771
	% of Total	1.20%	23.70%	63.00%	12.10%	100.00%
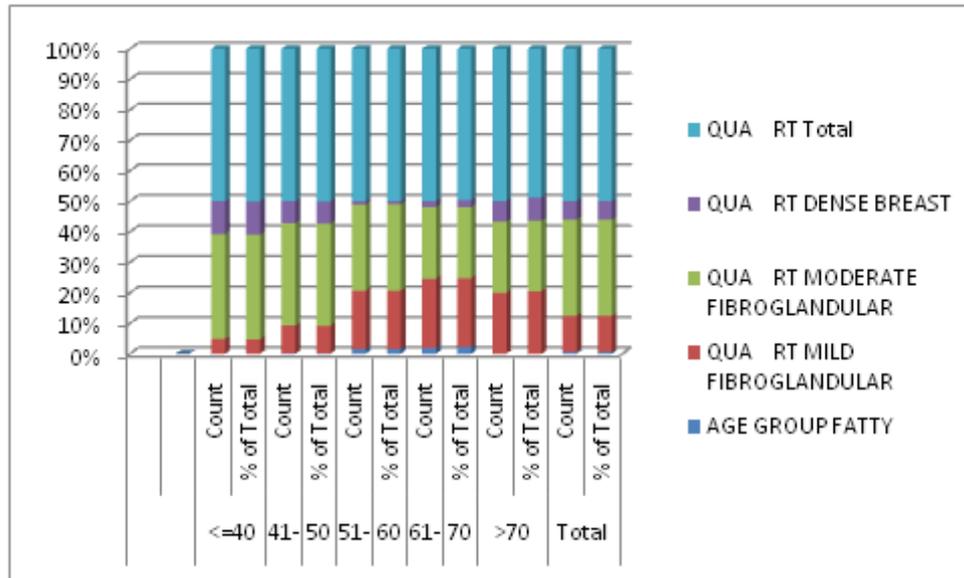
Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	99.023[a]	12	.000
Likelihood Ratio	105.747	12	.000
N of Valid Cases	771		

Right visual

771 breast were assesed visually on right side. The total fat density breasts are 87 (11.3%), mild fibro glandular densities are 175 (22.1%), moderate fibroglandular densities are 417 (54.1%)

and dense breasts are 92 (11.9%). The glandular assessment of the majority of the patients were in the moderate fibro glandular 417 (54.1%), as described in table 2.

Table-2

AGE GROUP	YEARS	VISUAL ASSESMENT RIGHT				
		Fatty	Mild fibroglandular	Moderate fibroglandular	Dense breast	Total
<=40		3	25	91	38	157
	% of Total	0.40%	3.20%	11.80%	4.90%	20.40%
41-50		24	71	207	50	352
	% of Total	3.10%	9.20%	26.80%	6.50%	45.70%
51-60		42	62	89	3	196
	% of Total	5.40%	8.00%	11.50%	0.40%	25.40%
61-70		13	13	25	0	51
	% of Total	1.70%	1.70%	3.20%	0.00%	6.60%
>70		5	4	5	1	15
	% of Total	0.60%	0.50%	0.60%	0.10%	1.90%
Total		87	175	417	92	771
	% of Total	11.30%	22.70%	54.10%	11.90%	100.00%
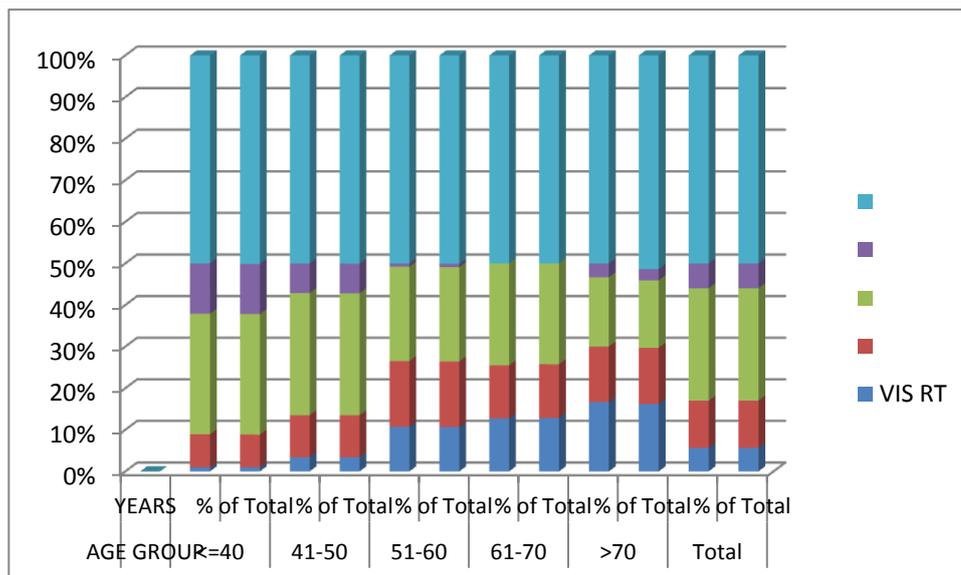
chi-square test

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	114.837[a]	12	.000
Likelihood Ratio	126.085	12	.000
N of Valid Cases	771		

Left quantra

796 breast were assessed by quantra on left side side. The total fat density breast densities are 17 (2.1%), mild fibro glandular densities are 221 (27.8%), moderate fibroglandular densities are 485 (60.9%) and dense breast densities are 73(9.2%). The glandular assessment of the majority of the patients were in the moderate fibro glandular category 485 (60.9%), as described in table 3.

Table-3

AGE GROUP			QUANTRA LEFT			
		FATTY BREAST	MILD FIBROGLAN DULAR	MODERATE FIBRO LANDULAR	DENSE BREAST	TOTAL
<=40	Count	2	26	109	30	167
	% of Total	0.30%	3.30%	13.70%	3.80%	21.00%
41-50	Count	2	76	234	36	348
	% of Total	0.30%	9.50%	29.40%	4.50%	43.70%
51-60	Count	7	88	111	5	211
	% of Total	0.90%	11.10%	13.90%	0.60%	26.50%
61-70	Count	5	21	27	1	54
	% of Total	0.60%	2.60%	3.40%	0.10%	6.80%
>70	Count	1	10	4	1	16
	% of Total	0.10%	1.30%	0.50%	0.10%	2.00%
Total	Count	17	221	485	73	796
	% of Total	2.10%	27.80%	60.90%	9.20%	100.00%
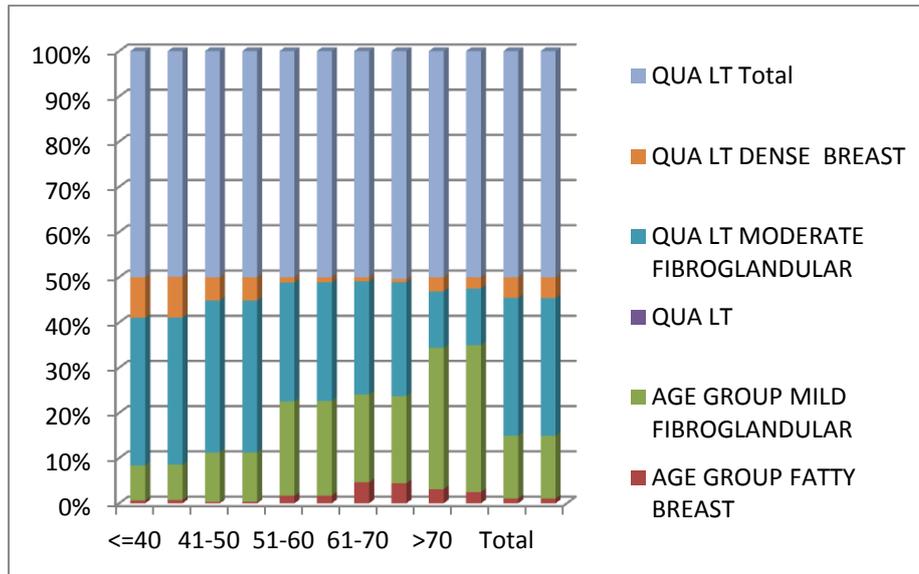
Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	95.804[a]	12	.000
Likelihood Ratio	93.086	12	.000
N of Valid Cases	796		

Left visual

796 breasts were assessed visually on left side. The total fat density breasts are 94(11.8%), mild fibro glandular densities are 185 (23.2%), moderate fibroglandular densities are 421 (52.9%) and dense breast is 96(12.1%). The glandular assessment of the majority of the patients were in the moderate fibro glandular 421 (52.9%) as described in table 4.

Table-4

	AGE	VISUAL LEFT				
		FATTY BREAST	MILD FIBROGLANDULAR	MODERATE FIBROGLANDULAR	DENSE FIBRO GLANDULAR	TOTAL
<=40	Count	4	32	93	38	167
	% of Total	0.50%	4.00%	11.70%	4.80%	21.00%
41-50	Count	28	64	204	52	348
	% of Total	3.50%	8.00%	25.60%	6.50%	43.70%
51-60	Count	44	72	92	3	211
	% of Total	5.50%	9.00%	11.60%	0.40%	26.50%
61-70	Count	13	13	27	1	54
	% of Total	1.60%	1.60%	3.40%	0.10%	6.80%
>70	Count	5	4	5	2	16
	% of Total	0.60%	0.50%	0.60%	0.30%	2.00%
Total	Count	94	185	421	96	796
	% of Total	11.80%	23.20%	52.90%	12.10%	100.00%
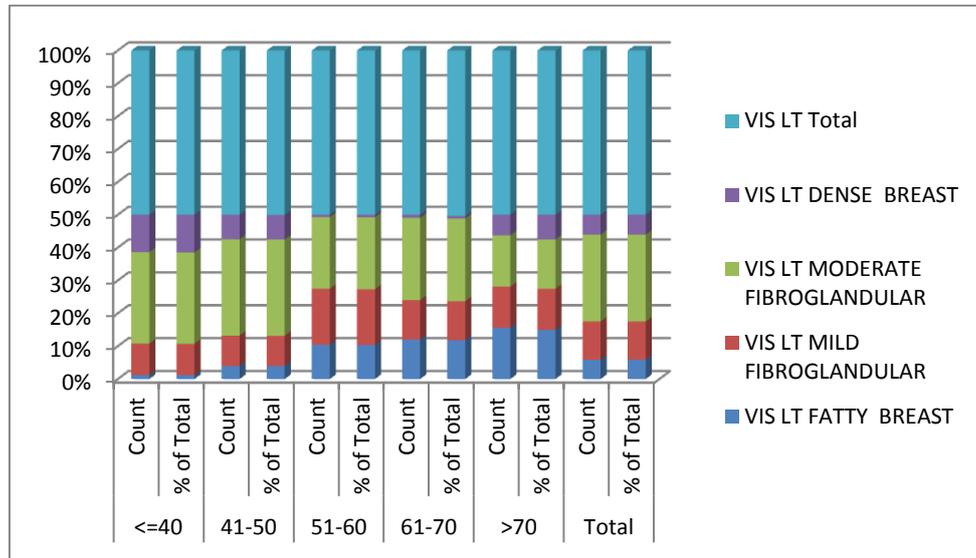
Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	108.881[a]	12	.000
Likelihood Ratio	120.373	12	.000
N of Valid Cases	796		

VISUAL LEFT		QUANTRA LEFT				
		FATTY BREAST	MILD FIBROGLANDULAR	MODERATE FIBROGLANDULAR	DENSE BREAST	Total
FATTY BREAST	Count	14	59	21	0	94
	% of Total	1.80%	7.40%	2.60%	0.00%	11.80%
MILD FIBROGLANDULAR	Count	2	95	82	6	185
	% of Total	0.30%	11.90%	10.30%	0.80%	23.20%
MODERATE FIBROGLANDULAR	Count	1	65	330	25	421
	% of Total	0.10%	8.20%	41.50%	3.10%	52.90%
DENSE BREAST	Count	0	2	52	42	96
	% of Total	0.00%	0.30%	6.50%	5.30%	12.10%
Total	Count	17	221	485	73	796
	% of Total	2.10%	27.80%	60.90%	9.20%	100.00%

Mass-On both breasts total of 129 malignant breast lesions were found. Of which 67(8.7%) on right side 62(8.0%) on left side in table 5 and 6.

Table 5

AGE GROUP		MASS-RT		Total
		NO	YES	
<=40	Count	152	5	157
	%ofTotal	19.70%	0.60%	20.40%
41-50	Count	323	29	352
	%ofTotal	41.90%	3.80%	45.70%
51-60	Count	179	17	196
	%ofTotal	23.20%	2.20%	25.40%
61-70	Count	39	12	51
	%ofTotal	5.10%	1.60%	6.60%
>70	Count	11	4	15
	% Total	1.40%	0.50%	1.90%
Total	Count	704	67	771
	% of Total	91.30%	8.70%	100.00%

Table-6

AGE GROUP		MASS-LT		
		NO	YES	Total
<=40	Count	146	11	157
	% of Total	18.90%	1.40%	20.40%
41-50	Count	336	16	352
	% of Total	43.60%	2.10%	45.70%
51-60	Count	173	23	196
	% of Total	22.40%	3.00%	25.40%
61-70	Count	41	10	51
	% of Total	5.30%	1.30%	6.60%
>70	Count	13	2	15
	% of Total	1.70%	0.30%	1.90%
Total	Count	709	62	771
	% of Total	92.00%	8.00%	100.00%
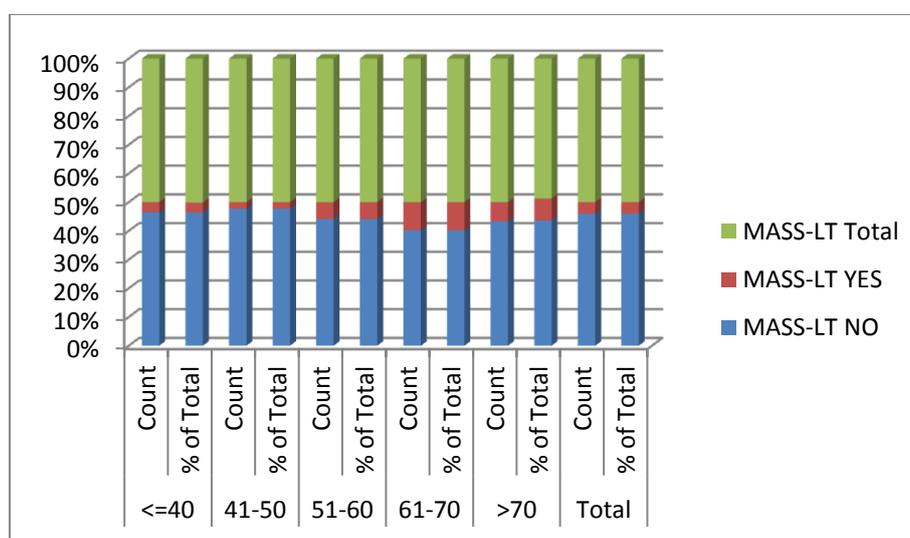
Results

Kappa statistics was used to calculate agreement between visual assessment and by quantra software.. The kappa value for the left side is 0.340 .The kappa value for right side is0.311 .It indicates no agreement between visual assessment and by quantra software. The distribution of density was significantly different by Visual and by quantra. Quantra assessed BIRADS A,B category (24.9% in right side, 29.9% in left side) less compared to visual(33.8%in right side, 35.0% in left side) and more C category ((63.0%n right side,60.9%in left side) than visual (54.10% in right side,52.90 % in left side)are the reasons for disagreement. Chi-square test is used to assess the significance in the distribution of different breast densities in different age groups. Chi-square test values were 0.000 in both sides and in both the assessments. It indicates the different density patterns of breast in each age group are statistically significant in both visual assessment and quantra assessment.

Discussion

According to WHO breast cancer is the leading cause of death, claiming thousands of lives in women. The term breast density refers to epithelial and stromal tissue elements compared with the amount of radiolucent fatty elements. Density is directly correlated with number of ducts and lobes. Increased breast density is at risk of developing cancer greater than other known risk factors (eg) family history. Assessing the density of breast in mammogram is an essential tool to calculate the risk. In mammogram fat appears radiolucent, stromal and epithelial tissues

as radioopaque. According to the amount of stromal and glandular tissue the density is classified as either fatty, scattered fibroglandular, heterogenously dense or extremely dense as per BIRADS 5th edition.

Over past few years the density of breast in mammogram was assessed visually .There was inter and intra reader disagreement in assessment .The sensitivity of radiological diagnosis is inversely correlated with density, such that the the sensitivity is decreased in patients with high density breast masking the lesions. When 3 dimensional breast is imaged in 2 dimensional plane, superimposition of over laping breast shadows can mask the underlying cancer.[10]. Attempts have been made to replace the visual assessment by computerized assessment of breast densities[11]-[13]. QUANTRA is a fully automated, software developed by the Hologic, USA. It takes into account filter and target materials, parameters like kV, mAs, and parenchymal thickness to calculate density of breast.[14]

In our study for764 patients both breasts were studied.39 unilateral breasts (7right and 32 left) were studied. Total of 1567 breast examinations were done and densities were assessed both by visual and quantra. The results were tabulated. 127 biopsy proven malignant masses detected in 1567examinations, of which more than 70% belong to C and D category, necessitating the need of quantitative assessment of dense breast.

Conclusion

More number of visual fat densities (category A) were assessed as scattered fibroglandular densities (category B) by Quantra. Visual scattered fibroglandular densities (category B) were assessed as heterogenous fibroglandular densities (category C) by Quantra .These are the reasons for the disagreement among Quantra and visual. Quantra assessed breast density is reproducible and is preferred to visual assessment .Quantra volumetric measurements would be easy to implement in screening programmes as it tends to be less time-consuming rather than visual

assessment which is variable and may cause discrepancies with BI-RADS breast density.

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