ISSN: 2476-2377

Research Article

International Journal of Cancer Research & Therapy

Mammographic Breast Density: it's Role in Tumor Size Assessment with Imaging Techniques

Izquierdo M*, Browne J, Garcia S, Rodriguez I, Tresserra F, Garcia M, Baulies S, Ara C, Pascual MA, and Fabregas R

Breast Cancer Unit, Dexeus University Hospital, Carrer de Sabino Arana, 5, 19, 08028 Barcelona, Spain

***Corresponding author**
Izquierdo M, Breast Cancer Unit, Dexeus University Hospital, Carrer de Sabino Arana, 5, 19, 08028 Barcelona, Spain, E-mail: izquierdo_en@wanadoo.es

Submitted: 04 Mar 2019; **Accepted**: 11 Mar 2019; **Published**: 20 Mar 2019

Abstract

Aims: *To study the visual and automatic measurement of mammographic breast density (MBD) and its implications in tumor size assessment using distinct imaging techniques.*

Methods: *Retrospective, observational study of the visual and automatic measurement of mammographic breast density according to the breast imaging data system (BI-RADS) in 212 patients with invasive unifocal breast cancer, excluding microinvasive lesions, who did not receive neoadjuvant chemotherapy. Tumor size assessment is compared using a linear regression according pathologic size with mammographic, US and MR size. The influence of MBD in each technique of pathologic size was seen by Bland-Altman plot.*

Results: *Patient's mean age was 55, 7±9.9 year-old. The mean size of the lesion stablished by mammography was 16.8± 10.4 (4 -70) mm, by US was 13.6±7.2 (5 – 55) mm and by MR 17.2 ±9.9 (5 – 66) mm. Mean pathologic size was 12.6 ±8.1 (0.3 – 55) mm. Automatic MBD mean was 25.2±16.78. BIRAD assessment with visual and automatic MBD measurements were correlated with a tendency of tumor size overestimation with visual method. Linear regression of tumor size according image techniques with pathologic size showed an adjusted r-square of 27.3% for mammography, 41.8% for US and 51.7% for MR. The best correlation was seen with MR although has a tendency to overestimate tumor size. Only tumor size assessed by mammography was influenced by MBD. With this technique, tumor size was best adjusted for those breasts with lower MBD.*

Conclusion: *Visual measurement overestimates MBD versus automatic measurement according BIRADS categories. MR is the more accurate breast imaging technique for assessing tumor size independently of the BMD, which only influences in the mammographic tumor size estimation.*

Keywords: Breast, Density, Mammography, Tumor, Size

Introduction

The breast is a dynamic organ that changes over time, with the menstrual cycle, age and particularly after the menopause. In the breast the glandular tissue and the fibrous tissue are monographically dense tissues, with similar attenuation coefficients of the mammography and quite different from the fat. Breast mammographic density will be determined by fatty tissue and dense tissue [1-8].

These two types of breast tissue, fatty tissue and dense tissue, allow the development of mathematical models that quantify the volumes of fatty tissue and dense tissue [6-11]. Volume Breast Density (%) = Vol. Dense tissue (cm^3) / vol. dense tissue (cm^3) + vol. fatty tissue (cm^3).

The radiological mammary density is assessed by the BIRADS classification, which has undergone several modifications, the 3rd BIRADS classified the density into 4 categories (in descriptive terms) [12]:

BIRADS 1 Fatty
BIRADS 2 Scattered density
BIRADS 3 Heterogeneously dense
BIRADS 4 Extremely dense

In 2003, in the 4th BIRADS edition, percentages were added to each category in an effort to try to make the evaluation of the density more objective [13]:

- BIRADS 1 <25%
- BIRADS 2 25% - 50%
- BIRADS 3 51% - 75%

• BIRADS 4> 75%

In 2013, the American College of Radiology (ACR), reiterated that breast density is an evaluation of the volume of dense tissue in the breast and the subjective estimates of a 2D mammogram are inaccurate indicators of volume, the density category changed from 1-4 to AD to avoid confusion with the BI-RADS anomaly scale. Deleted the quantitative element in the fifth edition of BI-RADS, ACR does not believe that there are substantial changes in the classification [14]. (Table 1)

Table 1: MBD classified by BIRADS

BIRADS 4th	BIRADS 5th
1.- Almost entirely fat <25%	A – Almost completely fat
2.- Scattered fibroglandular density (25% - 50%)	B- Scattered areas of fibroglandular density
3.- Heterogeneously dense (51% - 75%)	C- Heterogeneously dense
4.- Extremely dense (75%)	D- Extremely dense

DMR decreases the sensitivity of mammography, diagnosing tumors at a more advanced stage [15,16].

The question is whether automated reading is more objective because it eliminates the subjectivity of the radiologist as supported by various authors [17-21]. Another controversial aspect is whether the DBR is related to the prognostic factors of developing breast cancer.

The objective is to study the visual and automatic measurement of mammographic breast density (MBD) and its implications in tumor size assessment using distinct imaging techniques.

Material and Methods

Retrospective and observational study of the visual and automatic measurement of mammographic breast density according to the breast imaging data system (BI-RADS) in 212 patients with invasive unifocal breast cancer, excluding microinvasive lesions, who did not receive neoadjuvant chemotherapy. Tumor size assessment is compared using a linear regression according pathologic size with mammographic, US and MR size. The influence of MBD in each technique of pathologic size was seen by Bland-Altman plot. A Chi-Square test was used when comparing categorical variables.

Results

Patient's mean age was 55, 7±9.9 year-old. The mean size of the lesion stablished by mammography was 16.8± 10.4 (4 -70) mm, by US was 13.6±7.2 (5 – 55) mm and by MR 17.2 ±9.9 (5 – 66) mm. Mean pathologic size was 12.6 ±8.1 (0.3 – 55) mm. Automatic MBD mean was 25.2±16.78. BIRAD assessment with visual and automatic MBD measurements were correlated with a tendency of tumor size overestimation with visual method (Table 2,3). Linear regression of tumor size according image techniques with pathologic size showed an adjusted r-square of 27.3% for mammography , 41.8% for US) and 51.7% for MR (Table 5). The best correlation was seen with MR although has a tendency to overestimate tumor size. Only tumor size assessed by mammography was influenced by MBD. With this technique, tumor size was best adjusted for those breasts with lower MBD (Table 4). Prognostic factors was not influenced by MBD. (Table 6)

Table 2. BIRAD assessment with visual and automatic MBD measurements

Visual Birads				Automatic Birads							
	1				2		3		4		Total
	n	%	n	%	n	%	n	%	n	%	
1	1	0	0	20	30’8	24	36’9	21	32’3	65	
2	59	58’4	41	40’6	1	1	0	0	101	47’64	
3	4	14’3	14	50	9	32’1	1	3’6	28	13’20	
4	0	0	0	0	5	62’5	3	37’5	8	3’77	
	132	62’3	61	28’8	15	7’1	4	1’9	212		
p<0’001											

Table 3: BMI and BIRADS MBD classification

Visual Birads					BMI						
			<18’5		18’5-24’9		25-29’9		> 30		
			n	%	n	%	n	%	n	%	
		1	0	0	20	30’8	24	36’9	21	32’3	65
		2	4	4’2	60	62’5	29	30’2	3	3’1	96
		3	4	14’8	19	70’4	4	4’8	0	0	27
		4	1	16’7	5	83’3	0	0	0	0	6
			9	4’6	104	53’6	57	29’4	24	12’4	194
P<0’0001											

Automatic Birads					BMI					
	<18’5		18’5-24’9		25-29’9		≥30			
	n	%	n	%	n	%	n	%	Total	
1	1	0’8	49	41’2	46	36’7	23	19’3	119	
2	3	5’2	43	74’1	11	19’0	1	1’7	58	
3	3	21’4	11	78’6	0	0	0	0	14	
4	2	66’7	1	33’3	0	0	0	0	3	
	9	4’6	104	53’6	57	29’4	24	12’4	194	
P<0’0001										

Table 4: Tumor size adjusted by MBD

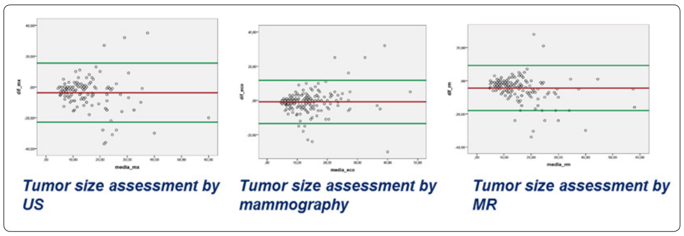

Table 5: Lineal Regresion pT by size Taking into account the BDEN

REGRESSION	R2 AJDJUSTED	COMMENTS
pT=CLIN C SIZW + BDEN	29.6%	Significant density
pT=MAMOGRAPFIC Size+BDEN +BDEN*TMX	27.3%	Significant density with interaction
pT=US Size+ BDEN	41.8%	Density not significant
pT=RM Size+ BDEN	51.7%	Density not significant

Table 6: Prognostic factors and MBD

BIRDS-Prognostic Factors					
	Visual BIRDS 1		Automatic BIRDS		
	1-2	3-4	1-2	3-4	
RE-	8	2	9	1	
RE+	168	34	184	19	p=ns
RP-	34	5	37	2	
RP+	142	31	156	17	p=ns
HER2-	161	28	173	16	
HER2+	15	8	20	3	p=ns
p53-	136	28	148	16	
p53+	38	8	43	3	p=ns
ki67<10	80	19	89	10	
ki67 10-15	55	10	59	6	
ki67<15	40	7	44	3	p=ns
GH 1	144	28	126	16	
GH 2	56	8	61	3	
GH 3	6	0	6	0	p=ns

Discussion

Mammographic Breast Density (MBD) is determined by fibroglandular tissue and fatty tissue. Dense breast has much fibroglandular tissue and little fatty tissue, and fat breast has little fibroglandular tissue and more fatty tissue [22]. With this model of two kinds of tissue, mathematical models that quantify the volumes of fat and dense tissue have been developed [23-24].

Our Digital mammography has a software that calculates total area of the breast, the total area of dense tissue and the percentage area of dense tissue, and it allows us to obtain the MBD directly, being able to compare the results with the BIRADS clinical estimate.

When we compared automated with visual evaluation, we see a tendency of tumor size overestimation with the visual method was detected and it was statistical significance.

MBD is influenced by BMI, a higher visual and automatic BIRADS is associated with a lower BMI, and a lower visual and automatic BIRADS is associated with a higher BMI. When we studied the tumor size and the MBD in the different diagnostic techniques (mammography, ultrasound and magnetic resonance), the best correlation was seen with MR and US. Although MR has a tendency to overestimate tumor size. Only tumor size assessment by mammography is influenced by MBD, with this technique, tumor size was best adjusted for those breasts with a lower MBD.

Conclusion

Visual measurement overestimates MBD compared to automatic measurement according to BIRADS categories. Magnetic resonance and ultrasound are the more accurate breast imaging techniques for assessing tumor size independently of BMD that only has influence in the mammographic tumor size estimation.

Acknowledgement

Thanks to all the members of the Department of Gynecology Obstetrics and reproduction of the Hospital Universitario Dexeus

References

1. Johns PC, Yaffe MJ (1985) Theoretical optimization of dual-energy x-ray imaging with application to mammography. Med Phys 12: 289-296.
2. Johns P, Yaffe M (1987) “X-ray characterization of normal and neoplastic breast tissues,” Phys Med Biol 32: 675-695.
3. Van Engeland S, Snoeren P, Huisman H, Boetes C, Karssemeijer N (2006) Volumetric breast density estimation from full-field digital mammograms. IEEE Trans Med Imaging 25: 273-282.

4. Highnam R, Brady M (1997) Mammographic Image Analysis. Kluwer Academic, Dordrecht. European Journal of Radiology 24: 20-32.
5. Byng JW, Mainprize JG, Yaffe MJ (1998) "X-ray characterization of breast phantom materials." Phys Med Biol 43: 1367-1377.
6. Hammerstein GR, Miller DW, White DR, Mary Ellen Masterson, Helen Q. Woodard, et al. (1979) Absorbed radiation dose in mammography. Radiology 130: 485-491.
7. Geise RA, Palchevsky A (1996) "Composition of mammographic phantom materials. Radiology 198: 347-350.
8. Yaffe M (2008) Mammographic density. Measurement of mammographic density. Breast Cancer Res l10: 209.
9. Geise RA, Palchevsky A (1996) "Composition of mammographic phantom materials. Radiology 198: 347-350.
10. Yaffe M (2008) Mammographic density. Measurement of mammographic density. Breast Cancer Res l10: 209.
11. R Highnam (1992) Model-based enhancement of mammographic images. Ph.D. thesis, Oxford University.
12. ACR, Breast Imaging Reporting and Data System (BI-RADSR), 3rd ed. (American College of Radiology, Reston, VA, 1998).
13. ACR, Breast Imaging Reporting and Data System® (BI-RADS®), 4th ed. (American College of Radiology, Reston, VA, 2003).
14. 14. ACR, Breast Imaging Reporting and Data System® (BI-RADS®) Atlas, 5th ed. (American College of Radiology, Reston, VA, 2014).
15. Rosenberg RD, Hunt WC, Williamson MR, Gilliland FD, Wiest PW, et al. (1998) Effects of age, breast density, ethnicity, and estrogen replacement therapy on screening mammographic sensitivity and cancer stage at diagnosis: review of 183,134 screening mammograms in Albuquerque, New Mexico. Radiology 209: 511-518.
16. Buist DSM, Porter PL, Lehman C, Stephen H Taplin, Emily White, et al. (2004) Factors that contribute to the failure of mammography to detect breast cancer in women aged 40-49 years. J Natl Cancer Inst 96: 1432-1440.
17. Masmoudi AD, Ben Ayed NG, Masmoudi DS, Riad Abid, et al. "LBPV descriptors-based automatic ACR/BIRADS classification approach," EURASIP J. Image Video Proc 2013: 19.
18. Percha B, Nassif H, Lipson J, Burnside E, Rubin D (2012) "Automatic classification of mammography reports by BI-RADS breast tissue composition class" J Am Med Inf Assoc 19: 913-916.
19. Marias K, Linguraru MG, Gonzalez Ballester MA, Petroudi S, Tsiknakis M, et al. (2005) "Automatic labelling and BI-RADS characterisation of mammogram densities," in Proceedings of IEEE Engineering in Medicine and Biology Society (IEEE, Piscataway, NJ, 2005) 6: 6394-6398.
20. Oliver A, Freixenet J, Marti R, Pont J, Perez E, et al. (2008) "A novel breast tissue density classification methodology," IEEE Trans Inf Technol Biomed 12: 55-65.
21. Bosch A, Muoz X, Oliver A, Marti J (2006) "Modeling and classifying breast tissue density in mammograms," in IEEE Computer Society Conference on Computer Vision and Pattern Recognition, edited by A. Fitzgibbon, C. J. Taylor, andY. LeCun (IEEE Computer Society, NewYork, NY, 2006) 2: 1552-1558.
22. Kwan-Hoong Nga, Susie Lau (2015) Vision 20/20: Mammographic breast density and its clinical applications. Med Phys 42: 7059-7077.
23. Highnam R, Brady M (1997) Mammographic image analysis. Kluwer Academic, Dordrecht.
24. Highnam RP, Brady JM, Shepstone BJ (1994) "Computing the scatter component of mammographic images." in IEEE Transactions on Medical Imaging 13: 301-313.