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ORIGINAL ARTICLE.

In Screening Breast Program: Can Automated Breast Ultrasound (ABUS) Have a Role in The Future?

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ABSTRACT

Background: Recent imaging modality named automated breast ultrasound was encountered for mammographic substitution. Our study aims to compare ABUS and mammography as screening modalities with special concern to dense breasts.

Method: Eighty participants from our breast screening program were examined with mammography and ABUS. The patient's mean age is about 46 years ranging from 32 to 67 years. The study was carried out during the period from September 2020 to October 2021.

Results: The percentage of lesions detection in BIRAD II and BIRAD III in mammograms was 31.25% and 12.5%, however, in ABUS, it was 32.5% and 11.25%, respectively. Also, in BIRAD IV and BIRAD V lesions were detected in mammogram in 20% and 11.25% of cases, and there is an increase using ABUS to about 22.5% and 12.5%, respectively; thus, ABUS is a valuable tool in detecting benign, probably benign and malignant lesions in comparison to the mammogram. Also, it was noted that in participants with dense and extremely dense breasts, ABUS has significantly more added value over mammography in picking breast lesions with a statistically significant difference. ABUS was about 100% sensitive meaning that ABUS can detect all cases found in the mammogram study without significant change, but it was about 85% specific.

Conclusions: ABUS is a scientific improvement in breast radiology with the advantage of innovative diagnostic precision of breast pathologies in terms of initial recognition, better classification, and meticulous evaluation. It is operator independent, saves time, and permits whole breast assessment with no radiation hazard, improved picking of few millimeters' pathologies, particularly in dense breast parenchyma. ABUS plus mammography will be augmented
in the future breast screening program.

Keywords: Mammography, Automated breast ultrasound, Dense breast.

INTRODUCTION

Breast cancer is the furthermost frequently detected malignancy in females globally. Early recognition of breast cancer enriches outcomes. Screening plans for identifying initial phase breast cancer are now available [1]. Mammography is yet prevailing in breast cancer picking and reduces breast cancer death by about 30% via discovering minor cancers at an initial phase [2]. Among 10 to 50% of breast cancers remain nonobvious with mammography [3]. Dense breast females are extra liable to have unobservable cancers on a mammogram [4]. Not only is cancer less clearly seen on mammograms for females with heterogeneously or very dense breasts, but these cases also have 4 to 6 folds augmented threat for cancer breast [5]. Radiation hazard is a foremost drawback of mammograms and the latest researches revealed approximately 43% diminution in screening programs for the phobia of radiation. Additional screening modalities embrace breast ultrasonography and breast MRI. Ultrasound is a tool of low cost in screening and is generally accessible in comparison to MRI, until now it is operator-dependent, time-consuming, and non-reproducible particularly in bulky breasts. ABUS is an innovative modality to stunned such difficulties [6]. Both handheld ultrasound (HHUS) and ABUS are highly sensitive

(100% for both) and highly specific (85.0% & 95.0%, correspondingly). Additionally, ABUS is more accurate (97.1%) than HHUS (91.4%) in the diagnosis of breast tumors [7]. Like common ultrasound techniques, ABUS uses sound waves of high-frequency that are directed to and reflected from the breast parenchyma; however, it creates a three-dimensional volume image of the entire breast at one time. This is greatly valuable for patients with high-density parenchyma as it elicits improved information and permits the radiologists to get the benefit of dissimilar angles and planes for assessment hence it allows superior analysis of the breast lesions. At the same time, ABUS consumes less considerable time compared to HHUS. Both breasts are scanned automatically by ABUS transducers, so it has much less operator dependence than HHUS [8].

Our study aims to compare ABUS and mammography as screening modalities with special concern to dense breasts.

METHODS

This prospective cross-sectional study included 80 patients who underwent breast screening with mammography. The patient's mean age is about 46 years ranging from 32 to 67 years. The study was carried out during the period from September 2020 to October 2021, they presented for our screening program. Informed consent was signed by each participant that was approved by the institutional review board of our university hospital.

Full history was taken from all cases (name, age, and marital status) positive family history, history of breast lesions, and hormonal drug intake. Also, any prior imaging investigation if exist would be notified. Reassurance and clarification of the stages of the study in detail to patients. Informed consent was obtained from all cases. Mammography study, automated breast ultrasound, was done in all cases. Histopathology was done in some cases as a gold standard to verify the diagnosis.

Participant enclosure criteria were females more than 30 years old, dense breast by mammography. ***Patient exclusion criteria*** were women rejected to involve in the research, pregnant lady to prevent the radiation threats to the fetus and, patients with painful breasts as they can't bear mammographic firmness for long period. Also, patients with breast surgery for breast cancer or benign causes (breast implants) or breast radiotherapy in the preceding 12 months.

Mammography modality:

Mammography was done with Sonographer Essential, GE healthcare Full Field Digital Mammography machine. Eighty participants did mammography with basic views, craniocaudal (CC), and mediolateral oblique (MLO) views.

Automated Breast Ultrasound (ABUS) technique:

The assessment was performed by an ABUS system (GE health care, Invenia ABUS).

Procedure: We performed the evaluation in supine posture by raising the same side arm directly above the head. A supporting cushion was put beneath the shoulder girdle of the participant to preserve the breast steady with the nipple directed upwards. A hypoallergenic cream was distributed over the breast with an added quantity on the nipple region to prevent air bubbles. Soft pressure was performed by a disposal sheath, permitting better penetration keeping the patient comfortable. The scanning by ABUS was automatic and continuous. During the examination, patients were enquired to be quiet with easy breath. The axial plane was used to attain volume acquisitions and started from the lower part of the breast with reconstruction in both coronal and sagittal planes. Image data automatically acquired a 15.4 x 17 cm volume extending from the skin to the chest wall up to 5 cm deep with 0.2 mm width for each slice. It generated 3 volumes for each breast, the central (anteroposterior), the lateral, and the medial volumes.

A nipple marker was placed in every examination for perfect co-ordinance. After finalizing the image data, the volumes were transported to a unique workstation for reading.

The diagnosis was established by pathological correlation for 28 patients, follow-up was done to probably benign lesions (BIRADS III) for 9 patients.

Statistical analysis

IBM computer analyzed the data by the use of SPSS (Statistical Program for Social Science version 20). Descriptive statistics were used as the number of participants and percentages. Chi-square and t test calculated to compare the imaging findings of histopathology diagnosis as a gold standard.

RESULTS

In our research, eighty patients with a mean age of 46.33 years and a standard deviation of ± 10.32 were assessed by the ABUS system and mammography (Table1). The percentage of picked lesions by mammography in cases of BIRAD II and BIRAD III was 31.25% and 12.5%, while, in ABUS, it amplified to 32.5% and 11.25%, correspondingly. Also, the

percentage of picked lesions in cases of BIRAD IV and BIRAD V by mammography was 20% and 11.25%, while, in ABUS, it augmented to 22.5% and 12.5%, correspondingly; consequently, ABUS is a convenient modality in the picking of benign, probably benign and malignant lesions over the mammogram (Tables 2, 3, 4).

Eighteen participants (22.5%) with dense parenchyma were ACR C and D (Table S1). The additional value of ABUS over mammography in picking breast lesions recorded in participants with dense and extremely dense parenchyma as a statistically significant difference was instituted with a p-value equaled 0.0001(Table S2).

The ABUS is about 100% sensitive, and this explains, in almost all the outcomes of the mammography reading, ABUS can distinguish it without significant variation, while the ABUS was approximately 85% specific (Table S3).

Table (1): Demographic characteristics of the study population

Demographic data	Cases (n = **80**)
Age (Years)	
Min. – Max.	32.0 – 78.0
Mean ± SD.	46.33 ± 10.32
Median (IQR)	43.0 (39.0 – 51.0)

Table (2): Results of Mammography examination of our participants

	Cases	
BIRADS	**No.**	**%**
I	20	25
II	25	31.25
III	10	12.5
IV	16	20
V	9	11.25
Lesion classification by mammography		
Negative (BIRADS I)	20	25
Positive (BIRADS II-III-IV-V)	60	75

Table (3): Results of ABUS examination of our participants

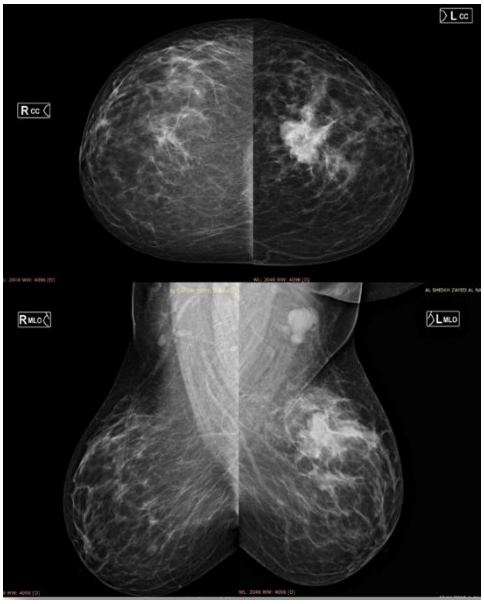
	Cases	
BIRADS	**No.**	**%**
I	17	21.25
II	26	32.5
III	9	11.25
IV	18	22.5
V	10	12.5
Lesion classification by ABUS	**No.**	**%**
Negative (BIRADS I)	17	21.25
Positive (BIRADS II-III- IV-V)	63	78.75

Table (4): Comparison between detected positive and negative lesions by mammography and ABUS.

ABUS		Negative mammogram No.	%	Positive mammogram No.	%	Test value	P value	Sig.
	Negative	17	85	0	0.0			
	Positive	3	15	60	100.0	13.280	0.00	highly

P value less than 0.01 highly significant.

Figure (1): 35 years old female patient presenting with a painful left breast lump, with negative family history. **(a)** Mammography CC and MLO views show ACR B breast density and obscured margins irregular hyper dense mass lesion in the left upper outer quadrant, associated with pleomorphic micro-calcifications and architecture distortion coded as BIRADS V. Ancillary finding is left axillary rounded lymph nodes with lost fatty hilum (suspicious lymph node).



(b)ABUS image of the left breast (sagittal, coronal, and axial views) show irregular predominant hypo echoic mass lesion with speculated margins and posterior acoustic shadow, antiparallel to the skin surface at 1: 00 o'clock, 2 cm from skin, 10 cm to the nipple, measuring about 46 X 44 mm coded as BIRADS V (confirmed by biopsy as invasive duct carcinoma grade III).

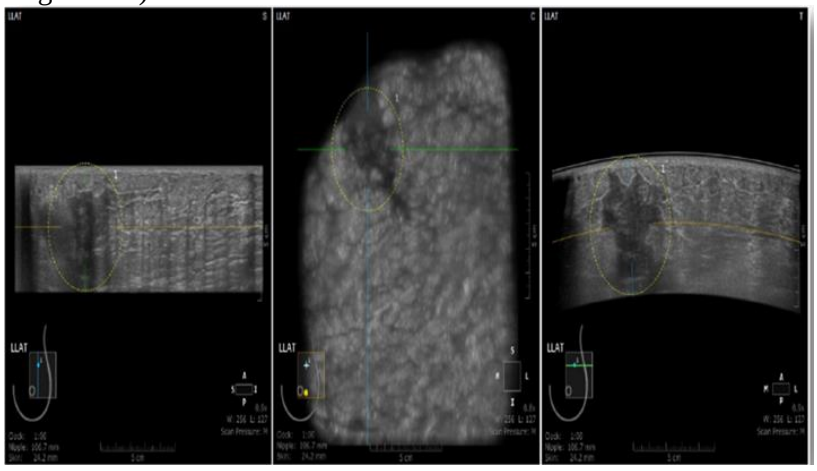
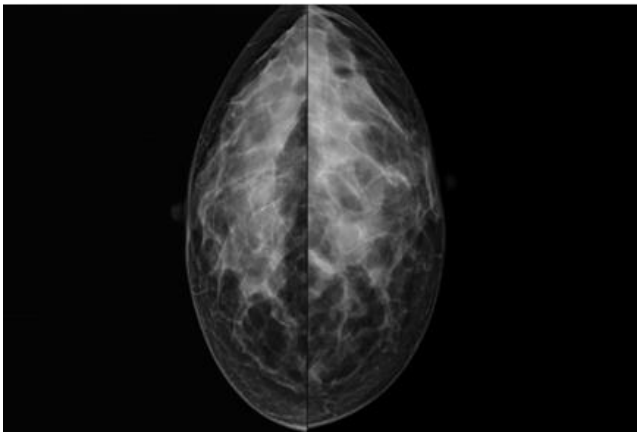


Figure (2): 39 years old patient, comes for screening with negative family history.
(a) Mammography CC and MLO showing ACR: C, no definite mass, asymmetry, parenchymal distortion, or calcification; coded as BIRADS I.



(b) ABUS Left breast (axial, coronal, and sagittal view) shows the irregular shape, hypo-echoic solid mass lesion with speculated margins and anti-parallel to skin surface noted at 11:30 o'clock, 12.9 mm from the skin and 72.9 mm from nipple coded as BIRADS IVC (confirmed by biopsy as Infiltrating duct carcinoma grade II).

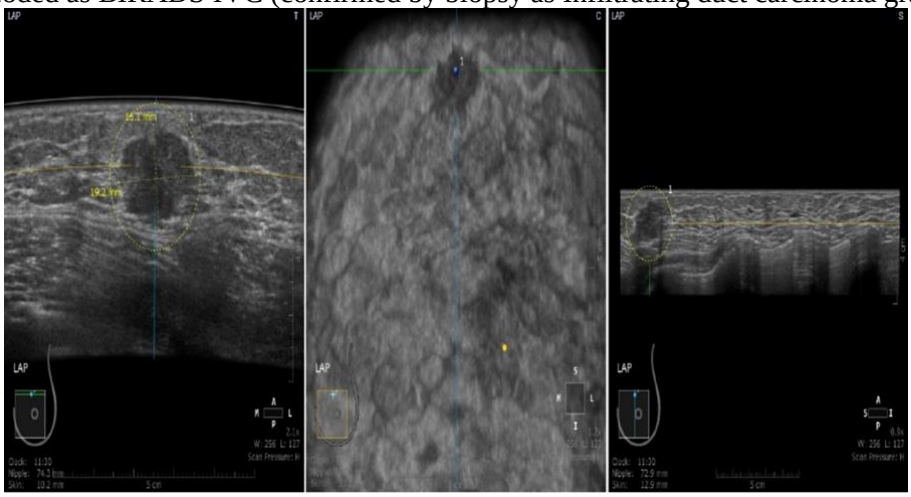


Figure (3): Patient 46 years old comes for screening with negative family history.
(a) Bilateral breast mammography MLO view showed ACR D breast density without any suspicious masses or micro calcifications coded as BIRADS I.

(b) ABUS of right breast coronal and sagittal showed small oblong-shaped homogenous hypoechoic, parallel mass lesion (white arrow) at 12:30 O'clock, 4 cm from the skin and 2 cm from the nipple. It measures about 11 x 4 mm coded as BIRADS III for follow-up after 6 months.

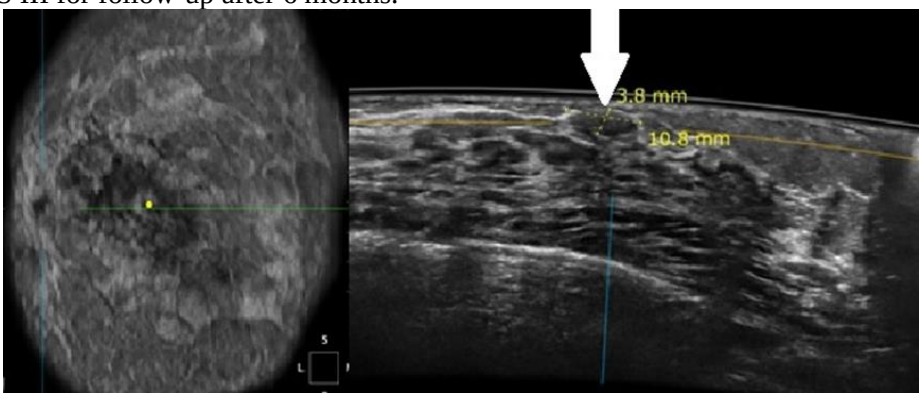


Table S1: Comparison of accuracy measures of ABUS and mammography.

	Sens%	Spec%	PPV%	NPV%	Accuracy %
Mammography	67.4	85	90.6	80.8	83.8
ABUS	100.0	85	95.24	100.0	96.25

Table S2: participants mammographic breast density

ACR breast density	Number of participants	Percentage
ACR A	22	27.5
ACR B	40	50
ACR C	4	5
ACR D	14	17.5

Table S3: Dense breasts (ACR C and D) and detection of the lesions by comparing ABUS with mammography.

Dense breasts	participants	Lesions picked only by mammography	Lesions picked only by ABUS	p value
ACR C (dense)	4	2	3	0.13
ACRD (extremely dense)	14	8	12	0.0005
C and D	18	10	15	0.0001

(p value less than 0.05 was significant).

DISCUSSION

Malignant breast lesion is a foremost global health issue as it is public cancer in females. It represents 37.7% of whole women cancers in Egypt and 29.1% of cancer-associated demise [9]. The purpose of initial distinguishing breast cancer is to lower the morbidity and mortality ratios [10]. The imaging tool for screening and initial recognition of breast cancer is the mammogram [11]. Automated breast ultrasound technology is believed to be a unique supplement in breast screening modalities proposed to overwhelm various limitations of mammography

screening [12]. ABUS has a traditional plan for acquiring images that demand brief teaching by the medical staff carrying out it without the attendance of the qualified radiologists contrary to the HHUS. 3D ABUS eradicates the operator-dependent issue and allows duplicability (13). This study included 80 female patients who came for breast screening, their mean age is about 46 years ranging from 32 to 67 years. In the current research, conferring to mammography assessment there were 20 (25%) with BIRADS I, 25 (31.25%) with BIRADS II, 10 (12.5%) with BIRADS III, 16 (20%) with BIRADS IV, and 9 (11.25%) with V, conferring to lesion sorting there were 20 (25%) with negative findings (BIRADS I) and 60 with positive findings (BIRADS II, III, IV, and V) (75%), this is going nearly with Abdelkhalek et al [13] who stated that negative cases with mammography were 8 cases(32%)while positive cases were 17(68%).In the recent study according to ABUS examination, there were 17 (21.25%) with BIRADS I, 26 (32. 5%) with BIRADS II, 9 (11.25%) with BIRADS III, 18 (22.5%) with BIRADS IV, and 10 (12. 5%) with V, according to lesion sorting there were 17 (21.25%) with negative findings (BIRADS I) and 63 with positive findings (BIRADS II, III, IV, and V) (78.75%). In the current study, the ABUS had 100% sensitivity while specificity was 85% for both, increased PPV for ABUS which was 95.24% compared to mammography who had PPV of 90.6%, NPV was 100% for ABUS while 80% for mammography and accuracy was 96.25%for ABUS while 83.8% for mammography. This is going with many studies which revealed increased sensitivity for using ABUS with mammography against mammography alone in screening campaigns. In the multicenter research published by Kelly et al [14] involving 4,419 dense breasts participants and/or at increased hazard of breast cancer, The diagnostic accuracy of mammography alone was compared to that of ABUS plus mammography. This resulted in increased sensitivity from 50% to 81%, as well as the number of recognized cancer cases improved in 63% of cases. Giuliano [15] achieved that mammogram with added ABUS picked 12.3 per 1,000 breast cancers, on the contrary mammography alone picked 4.6 per 1,000 through research included 3,418 symptomless participants with mammographically dense breast parenchyma. Amin et al [16] proved that there is increased sensitivity of ABUS about (60%) which is more than that of mammograms (30%) in mammographically dense breast. Mostafa et al [17] stated that mammography alone picked 24 lesions out of 40 cases with positive results while adding ABUS to mammography elevated the accuracy of picking more lesions about 38 out of 40 cases. A statistically significant difference with calculated p-value =0. 0001. The additional value of ABUS to mammogram in picking breast pathologies was greatest in dense and extremely dense breast parenchyma (ACR C and D). The difference was statistically significant with a p-value of about 0.0001. Via using mammogram alone, 20 out of 36 pathologies were noticed which raised to 34 pathologies out of 36 when ABUS was added. This is in agreement with our study as there is increased detection of a lesion in the dense breast by ABUS rather than by mammography with a P-value was less than 0.05 which is considered significant.

Restrictions of this research comprise the relatively minor sample volume, the relative bias in sample collection, and that ABUS is a lately presented imaging tool in our country with a restricted quantity of apparatuses and workstations.

CONCLUSIONS

ABUS is a scientific improvement in breast radiology with the advantage of innovative diagnostic precision of breast pathologies in terms of initial recognition, better classification, and meticulous evaluation. It is operator independent, saves time, and permits whole breast assessment with no radiation hazard, improved picking of few millimeters' pathologies, particularly in dense breast parenchyma. ABUS plus mammography will be augmented in the future breast screening program.

Conflict of interest: All the authors confirm that they have no any Conflict of interest with other persons or organizations that could influence the work inappropriately.

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