ScientificScholar®
Knowledge is power
Publisher of Scientific Journals

www.clinicalimagingscience.org

Journal of Clinical Imaging Science

Original Article

Brightness Mode and Color Doppler Ultrasound in Differential Diagnosis of Breast Lesions in Saudi Females

Hashim A. Hashim[1], Mustafa Z. Mahmoud[2], Batil Alonazi[2], Hassan Aldosary[1], Jameelah S. Alrashdi[1], Fahad A. Alabdulrazaq[1], Anood H. Almowalad[1]

[1]Radiology and Medical Imaging Department, King Fahad Medical City, Riyadh, Saudi Arabia, [2]Radiology and Medical Imaging Department, College of Applied Medical Sciences, Prince Sattam bin Abdulaziz University, Al-Kharj, Saudi Arabia.

***Corresponding author:**
Dr. Mustafa Z. Mahmoud,
Radiology and Medical Imaging Department, College of Applied Medical Sciences, Prince Sattam bin Abdulaziz University,
PO Box 422, Al-Kharj 11942,
Saudi Arabia.

m.alhassen@psau.edu.sa

Received : 01 June 19
Accepted : 15 June 19
Published :

DOI
***

Quick Response Code:

ABSTRACT

Objective: The aim of the study was to identify the pathological characteristics of benign and malignant breast lesions among Saudi females using brightness mode (B-mode) and color Doppler ultrasound (US).

Materials and Methods: This study was retrospectively carried out in a single center in the Radiology and Medical Imaging Department, King Fahad Medical City, Riyadh, Saudi Arabia. A convenient method of sampling was used to include all patients referred for different diagnosis during the period of January 2016 and December 2018. A sample size of 100 cases was selected with 50% of the cases being benign breast lesions, while the rest were malignant. The data collection instruments comprised data collection sheets, while a Philips US system with a 9 MHz linear probe was used to give the differential results. The results were considered significant when $P < 0.05$. The statistical diagnostic test was used to detect sensitivity, specificity, and accuracy of US in the differential diagnosis of breast lesions in Saudi females.

Results: B-mode and color Doppler US findings of breast mass measurements, shape, echotexture, and the presence and absence of vascularity present a sensitivity, specificity, and accuracy of 97.09%, 80.65%, and 93.28% in the diagnosis of benign and malignant breast masses.

Conclusion: In Saudi females with dense breasts, the risk of breast cancer development is increased. Moreover, B-mode in combination with color Doppler US was highly determined the results of differential diagnosis for any breast lesions.

Keywords: Color Doppler ultrasound, Brightness mode ultrasound, Mammography, Neoplasms

INTRODUCTION

The process of diagnosing breast cancer has widely improved due to the development of high-resolution ultrasound (US) devices. Conventionally, US was only applied in cases of diagnosis of cysts.[1] The current developments have shown that US helps improve the differential diagnosis of benign and malignant lesions, local preoperative staging, and guided interventional diagnosis. Mammography tests have also been used even though they have the setback of having low sensitivities, especially in dense breasts.[2] Women with dense parenchyma have been depicted to have increased risks of breast cancer development, which calls for a model with high sensitivities to diagnose lesions present. Recent research has shown that there is an increase in the levels of detection in patients with small cancers up to 3.5 cancers per 1000 women who do not show symptoms in mammography or clinical abnormalities.[3] It has also been shown that the stages of distribution of the mammographically and sonographically detected carcinomas are similar, while, breast density is not a factor of consideration while diagnosing patients with benign and malignant lesions. Screening projects have been carried out in different parts of the world, where preliminary data show that there has been an improvement in the detection and differentiation of diagnosis of benign and malignant lesions with the adoption of the high-resolution US.[4]

The role of US for improving the system of differential diagnosis has been investigated for the past 20 years. The case numbers of the studies have been small, while the equipment quality has always been variable, making the diagnostic criteria for the lesion descriptions to be non-standard. The first large studies involved 750 patients, where the diagnostic procedure involved the application of modern high-resolution US equipment, which was followed by the publication of standardized diagnostic criteria. US was found to differentiate malignant from the benign lesions with a sensitivity of 98.4%, while the negative predictive values were found to be 99.5%.[4]

These results were later verified in subsequent studies, which prompted the American College of Radiology (ACR) to form an international expert working group that could evaluate the role of breast US as well as the development of standardized diagnostic criteria.[2] The development of US imaging was defined by the development of the imaging report and data system, which was a catalog that was published in 2003. The sensitivity for the diagnosis of cancer has been shown to increase by 15% with US when compared to the mammography tests alone.[5] On the contrary, the specificity is varied, where there has been an inverse correlation between the age and accuracy of US compared to mammography.[2,4,5]

Most of the studies on female breast pathologies in Saudi Arabia are focused primarily on malignant neoplasms. The literature addressing the patterns of breast diseases remains scant.[6] Very few studies have been found to focus on the profile of breast diseases. The spectrum of female breast lesions found in females includes benign, which is 56.87%, while malignant lesions make up 32.42% of the cases of female breast lesions.[7] The rest was known to be inflammatory lesions, which comprise 10.7% of the total cases of female lesions. An analysis of the Abha region in Saudi indicates that the inflammatory lesions are reported to have the highest incidences, while the mean age of fibrocystic change [Figure 1] has been reported to be higher among females in the western parts of Saudi.[3,8] The variations in the incidence rates are highly attributed to the predisposing factors, which, among others, include human behavior such as smoking and family history.[7,8]

The risk of breast cancer development related to the genetic orientation of the patients increases with the number of affected relatives, the specific lineage, and the age at the time the disorder is diagnosed.[9] It is imperative that the younger the age at the time of diagnosis, the more likely that the genetic component is involved, while more than 10% of the infections are thought to be linked to mutation of certain genes among the patients.[4] The most common genes are the breast cancer gene 1 and breast cancer gene 2, where women with these mutations have a higher risk of infection from breast cancer during their lifetimes.[10] In addition, breast cancers [Figure 2] that occur by chance do not have specific known causes in as much as the environment and hormones are attributed to contributing to such types of cancerous cells.[4,10]

US imaging is a tool that helps to determine if an abnormality is solid, in which case, the abnormality may be a non-cancerous lump of tissue or a cancerous tumor.[11] Much more, if the tumor is fluid filled, it is highly associated with being a benign cyst, while the malignant lesions are marked by the abnormal change in a tissue or organs that

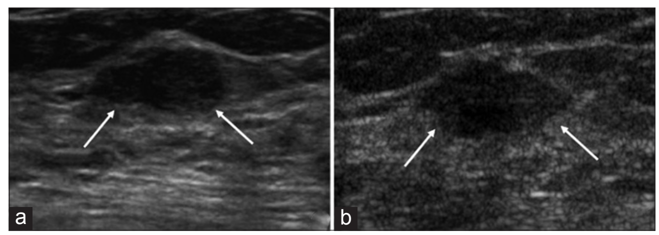

Figure 1: A 45-year-old woman with a mass detected on the screening breast ultrasound (US) in the right breast, upper outer quadrant. (a) Initial US image showed a 1.2 cm oval circumscribed isoechoic mass in the right upper outer quadrant, corresponding to category 3 (arrows). (b) On the 12-month follow-up US, the margin of the mass changed into more microlobulated and indistinct and was assessed as category 4 (arrows). US-guided core needle biopsy was performed and fibroadenoma was confirmed.[3]

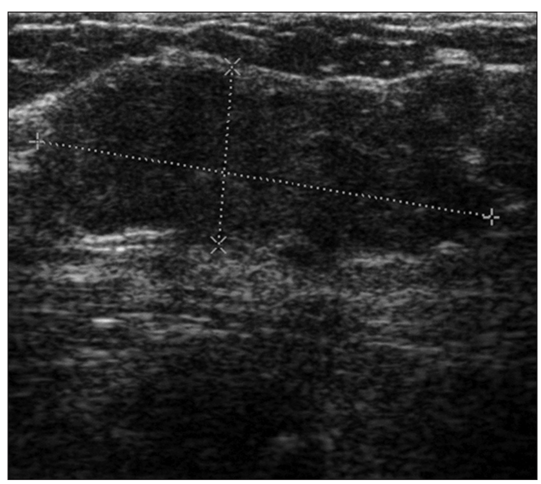

Figure 2: A 44-year-old woman with triple-negative invasive ductal carcinoma (high grade). US image shows lobulated, circumscribed hypoechoic mass with posterior enhancement in the left upper breast.[10]

are cancerous.[12] Benign breast lesions are found to grow in non-cancerous areas which result in the abnormal growth of the breast cells. The major question under study is the factor that determines the prevalence rates of benign and malignant lesions among Saudi women.[13] This leads to the main objective of the study, which was to identify the pathological characteristics of benign and malignant breast lesions among Saudi females using B-mode and color Doppler US.

MATERIALS AND METHODS

Description of participants

This study was retrospectively carried out in a single center in the Radiology and Medical Imaging Department, King Fahad Medical City, Riyadh, Saudi Arabia. Approval of this study was obtained from the local ethics committee of the institutional review board (Number: 18–100). A convenient method of sampling was used to include all patients referred for different diagnosis during the period of January 2016 and December 2018. A sample size of 100 cases was selected with 50 cases or 50% of the cases being benign breast lesions, while the rest were cases of malignant breast lesions. The criteria for selection were limited to include only Saudi females who had attained the age of puberty. The exclusion criteria were based on characteristics such as postmenopausal cases, where females who had attained the age of menopause were not included in the study. The ethnic background was not considered as a factor for the exclusion of the participants, who were all females who met the inclusion criteria participated in as long as they are residents of Saudi.

Breast ultrasound imaging protocol

The data collection instruments comprised data collection sheets, while a Philips US system with a 9 MHz linear probe with the brightness mode (B-mode) and color Doppler mode at the area of study was used to give the differential results that were later recorded on the data sheet. Each obtained breast sonogram was correlated with clinical signs and/or symptoms and with mammography and other appropriate breast imaging studies. If sonography has been performed previously, the current examination was compared with prior sonograms, as appropriate. A lesion or any area of the breast being studied was viewed in two perpendicular projections and real-time scanning by the interpreter is encouraged. The images were labeled as to the right or left breast, and the location of the lesion was recorded using clock face notation, distance from the nipple, and the orientation of the transducer with respect to the breast (e.g., transverse or longitudinal, radial, or antiradial). It was also shown on a diagram of the breast. Distance from the nipple was measured from the edge of the areola but from the nipple itself, as areolar width is variable. The size of a lesion was determined by recording its maximal dimensions in at least two planes; orthogonal planes were recommended. At least one set of images of a lesion was obtained without calipers. A set of images of the lesion with color/power Doppler to assess/document vascularity of the lesion was also recommended.[14]

Sonographic features are important in accurately characterizing breast masses. These feature categories and their descriptors were as that listed and exemplified in the ACR Breast Imaging Reporting and Data System (BI-RADS). The BI-RADS sonographic categories used include shape, orientation, margins, echo pattern, posterior acoustic features, special characteristics, vascularity, and surrounding tissue.[15] A mass characterization with ultrasonography is highly dependent on technical factors. Thus, breast US in this study was performed with a high-resolution scanner and transducer. Gain settings, focal zone selections, and field of view were optimized to obtain high-quality images. The patient was positioned to minimize the thickness of the portion of the breast being evaluated. For evaluation of lesions in, on, or just beneath the skin, a standoff device or thick layer of gel was applied.[14]

Statistical analysis

The process of analyzing data was carried out using the Statistical Package for the Social Sciences version 20 for Windows (IBM Corporation, Armonk, NY, USA), while the layout of the results was initially summarized in a comparison table. The results were considered significant when $P < 0.05$. The statistical diagnostic test was used to detect sensitivity, specificity, and accuracy of US in the differential diagnosis of breast lesions in Saudi females.

RESULTS

The first area of study concentrated on the demographic characteristics such as the age, the marital status, location in Saudi Arabia, and family history of breast masses. The results showed that there was a differential diagnosis between the females with benign breast masses and females with malignant breast masses for young women aged ≤50 years in Saudi Arabia. Furthermore, other factors such as marital status, the location, and family history with breast masses did not show great significance in the differential diagnosis of the benign and malignant breast lesions. Table 1 shows the results for the demographic characteristics of females with benign and malignant breast masses.

The second analysis was based on the clinical indications for US for benign and malignant breast masses. The differential diagnosis between the benign mass and malignant mass was significant based on most of the clinical indicators with the highest level of variation being depicted for the breast mass and lump. For instance, there were 33 cases of benign mass

Table 1: The demographic characteristics of females with benign and malignant breast masses.

Demographic characteristics	Females with benign breast masses (n=50)	Females with malignant breast masses (n=50)	P-value
Age (mean±SD) (years)	34.5±8.3	39.4±5.5	0.0008*
Marital status			
Single	44%	46%	<0.05**
Married	56%	54%	<0.05**
The location in Saudi Arabia			
Center	80%	86%	<0.05**
North	4%	4%	<0.05**
East	0%	0%	-
West	2%	2%	<0.05**
South	14%	8%	<0.05**
Family history of breast masses			
+ve	28%	16%	<0.05**
−ve	72%	84%	<0.05**

*=Significant; **=Not significant

and 47 cases of malignant mass, which represented a variation of 28% between the cases presented. Other factors that were considered included the breast pain and redness, with benign mass 6 (12%) and the malignant mass 1 (2%). Other clinical indicators that showed minimal variations included the nipple retraction 2%, nipple discharge 4%, parenchymal distortion 2%, and regional lymph enlargement 6% [Table 2].

The next area of study concentrated on the US findings for the B-mode and color Doppler in benign and malignant breast masses. In this case, the B-mode was tested for features such as the mass measurements, the mass shape, and the echotexture. The results showed variations in features such as mass and height for the benign breast masses, which was greater than that of the malignant breast masses. The B-mode US also showed greater numbers of oval, lobulated, and well-defined benign masses as compared to the malignant breast masses. Moreover, the B-mode scored higher for benign masses when defining characteristics such as the hypoechoic and heterogeneous, while it was lower for benign in shadowing. Color Doppler findings showed a higher percentage of the malignant breast masses compared to the benign breast masses in the area of vascularity. Table 3 gives a summary of the results for the different modes of US applied.

The analysis of the levels of the performance of each of the US modes shows that the level of sensitivity highly determines the level of detection of a model for differential diagnosis of breast cancers among females. US findings of all cases in this study have been supported with the confirmation of true cut biopsy reports that have been performed in the same center [Table 4].

DISCUSSION

The results from the demographic characteristics of females with benign and malignant breast masses show how different characteristics such as the age, marital status, location, and family history affect the prevalence of benign and malignant breast masses. The first demographic characteristic is the age, where the females with benign (n=50) aged 34.5±8.3 (mean±SD) years and females with malignant breast masses (n=50) aged 39.4±5.5 (mean±SD) years were found to have P = 0.008. P-value, in this case, helps to determine the significance of the results.[16] In this case, the hypothesis test is used to test the validity of the claim that is made about the Saudi females as the population under consideration. The hypothesis states that US improves the differential diagnosis of benign and malignant lesions. The results are in agreement with the hypothesis, where P = 0.008 is statistically significant.[17] This helps in the conclusion that the sensitivity of US increases with the higher breast density, considering that more than half of the young women aged 50 years and below have heterogeneously dense 50–75% or very dense >75% glandular breast tissue.[3] Furthermore, the results were insignificant for other demographic factors such as the marital status, the location, and family history of breast masses. This showed that the differential diagnosis of benign breast masses and malignant breast masses using US is highly dependent on the age of the Saudi females as opposed to other factors such as the marital status since the age determines the density of the breast masses.

The results also showed a differential diagnosis between the benign and malignant breast masses using US on the basis of the clinical indications. For instance, there were more cases of breast pain and redness for benign mass 6 (12%) as compared to the malignant mass 1 (2%). The other clinical indications were the breast mass and lump, where malignant mass cases were more 47 (94%) compared to the benign mass cases 33 (66%). None of the cases of parenchymal distortion were detected in the malignant mass using US screening process, while only one benign case was reported when parenchymal

Table 2: Clinical indications in US for benign and malignant breast masses.

Clinical indication for US	Benign masses; *n* (%)	Malignant masses; *n* (%)
Breast pain and redness	6 (12)	1 (2)
Breast mass and lump	33 (66)	47 (94)
Nipple retraction	1 (2)	0 (0)
Nipple discharge	1 (2)	3 (6)
Parenchymal distortion	1 (2)	0 (0)
Follow-up and further assessment	10 (20)	8 (16)
Regional lymph node enlargement	1 (2)	5 (10)

Table 3: US findings (B-mode and color Doppler) in benign and malignant breast masses.

US B-mode findings	Benign breast masses	Malignant breast masses
Mass measurements (cm)	**mean±SD**	**mean±SD**
Mass height	3.7±3.1	3.6±2.5
Mass width	1.7±1.1	2.5±1.8
Mass shape	***n* (%)**	***n* (%)**
Well-defined (regular)	25 (50)	4 (8)
Oval	18 (36)	3 (6)
Lobulated	14 (28)	4 (8)
Irregular	21 (42)	33 (66)
Mass echotexture	***n* (%)**	***n* (%)**
Hypoechoic	36 (72)	35 (70)
Heterogeneous	16 (32)	15 (30)
Shadowing	9 (18)	13 (26)
No shadowing	41 (82)	37 (74)
Color Doppler findings	**Benign breast masses; *n* (%)**	**Malignant breast masses; *n* (%)**
Vascularity	22 (44)	36 (72)
No vascularity	28 (56)	14 (28)

Table 4: Performance of B-mode and color Doppler ultrasonography in the diagnosis of benign and malignant breast masses.

Absence or presence of benign and malignant breast mass		Number of cases (*n*)
True positive		100
True negative		25
False positive		6
False negative		3
Performance of B-mode and color Doppler ultrasonography in the diagnosis of benign and malignant breast masses	**Value**	**95% CI**
Sensitivity (%)	97.09%	91.72%–99.40%
Specificity (%)	80.65%	62.53%–92.55%
Positive likelihood ratio	5.02	2.44–10.30
Negative likelihood ratio	0.04	0.01–0.11
Benign and malignant breast masses prevalence (%)	76.87%	68.80%–83.71%
Positive predictive value (PPV) (%)	94.34%	89.03%–97.16%
Negative predictive value (NPV) (%)	89.29%	72.95%–96.26%
Accuracy	93.28%	87.63%–96.88%

distortion was used as the basis for the determination of clinical indicators.[17] Moreover, a follow-up and further assessment showed that benign cases were more 10 (20%) as compared to the cases of malignant lesions 8 (16%).

Another study, about the pre-operative diagnosis of a breast hydatid cyst using fine-needle aspiration cytology.[18] They stated that sonographic appearance of mammary hydatid cysts may be similar to those observed in benign cysts, showing a well-defined, lobulated mass of heterogeneous echogenicity that may contain multiple cystic areas. Thus, Fine-needle aspiration cytology is an accurate and safe technique that can allow surgery to be avoided, especially in older patients or patients with high surgical risk.[18] However, the greatest variation was found in the cases where the mass, shape was lobulated with 14 cases being reported in the benign and 4 cases being reported for the malignant breast masses.[19] Similarly, there were variations in the cases of benign breast masses and malignant breast masses using the color Doppler mode with higher cases of benign being evident for vascularity, while lower cases were seen in cases being recorded in the absence of vascularity compared to the malignant breast masses. The variations have highly attributed the performance of the two modes, where the results showed that there is a positive correlation between the sensitivity and the differential diagnosis of breast lesions.[18,19]

As a limitation, there were specific threats to validity in this study such as non-ignorable existing measurement errors resulting from the retrospective assessment which are addressed using this design, which makes it suitable for studying Saudi females. Among the advantages are that the cross-sectional cohort design offers in this study were that there was a long interval between exposure and outcomes, where the results can be accurately assessed retrospectively.

CONCLUSION

It is imperative that in Saudi females with dense breasts, the risk of breast cancer development is increased, while US improves the differential diagnosis of the lesions bearing in mind that it has higher sensitivities. The research has also shown that since the breast mass is dependent on the age with Saudi females aged 50 years and below having higher breast mass densities, the differential diagnosis between the benign and malignant lesions among these demographics is higher as compared to other demographics such as the location. For example, there was no statistical significance of the results when investigating the differential diagnosis of benign and malignant lesions among Saudi females living in the central and western parts of the country. Moreover, the sensitivity of the mode of US used highly determines the results of differential diagnosis of the breast cancer lesions with the sensitivity being in correlation with the rate of differential diagnosis.

Acknowledgments

The authors would like to thank the staff of the Department of Radiology and Medical Imaging in King Fahad Medical City and King Khalid University Hospital for their cooperation and support.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given her consent for her images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Sheybani F, Sarvghad M, Naderi HR, Gharib M. Treatment for and clinical characteristics of granulomatous mastitis. Obstet Gynecol 2015;125:801-7.
2. Pollán M, Ascunce N, Ederra M, Murillo A, Erdozáin N, Alés-Martínez J, *et al.* Mammographic density and risk of breast cancer according to tumor characteristics and mode of detection: A spanish population-based case-control study. Breast Cancer Res 2013;15:R9.
3. Nam SY, Ko EY, Han BK, Shin JH, Ko ES, Hahn SY, *et al.* Breast imaging reporting and data system category 3 lesions detected on whole-breast screening ultrasound. J Breast Cancer 2016;19:301-7.
4. Moon WK, Lo CM, Chen RT, Shen YW, Chang JM, Huang CS, *et al.* Tumor detection in automated breast ultrasound images using quantitative tissue clustering. Med Phys 2014;41:42901.
5. Boyd NF, Huszti E, Melnichouk O, Martin LJ, Hislop G, Chiarelli A, *et al.* Mammographic features associated with interval breast cancers in screening programs. Breast Cancer Res 2014;16:417.
6. Gunduz Y, Altintoprak F, Tatli Ayhan L, Kivilcim T, Celebi F. Effect of topical steroid treatment on idiopathic granulomatous mastitis: Clinical and radiologic evaluation. Breast J 2014;20:586-91.
7. Kim J, Han W, Moon HG, Ahn S, Shin HC, You JM, *et al.* Breast density change as a predictive surrogate for response to adjuvant endocrine therapy in hormone receptor positive breast cancer. Breast Cancer Res 2012;14:R102.
8. Leong LC, Gogna A, Pant R, Ng FC, Sim LS. Supplementary breast ultrasound screening in Asian women with negative but dense mammograms a pilot study. Ann Acad Med Singapore 2012;41:432-9.
9. Joshi S, Dialani V, Marotti J, Mehta TS, Slanetz PJ. Breast disease in the pregnant and lactating patient: Radiological-pathological correlation. Insights Imaging 2013;4:527-38.
10. Çelebi F, Pilancı KN, Ordu Ç, Ağacayak F, Alço G, İlgün S, *et al.* The role of ultrasonographic findings to predict molecular subtype, histologic grade, and hormone receptor status of

breast cancer. Diagn Interv Radiol 2015;21:448-53.
11. Huo CW, Chew GL, Britt KL, Ingman WV, Henderson MA, Hopper JL, *et al.* Mammographic density a review on the current understanding of its association with breast cancer. Breast Cancer Res Treat 2014;144:479-502.
12. Kim SJ, Park YM, Jung SJ, Lee KH, Kim OH, Ryu JH, *et al.* Sonographic appearances of juvenile fibroadenoma of the breast. J Ultrasound Med 2014;33:1879-84.
13. Du J, Wang L, Wan CF, Hua J, Fang H, Chen J, *et al.* Differentiating benign from malignant solid breast lesions: Combined utility of conventional ultrasound and contrast-enhanced ultrasound in comparison with magnetic resonance imaging. Eur J Radiol 2012;81:3890-9.
14. American College of Radiology (ACR). ACR Practice Parameter for the Performance of a Breast Ultrasound Examination; 2018. Available from: https://www.acr.org/-/media/ACR/Files/Practice-Parameters/US-Breast.pdf?la=en;%202018. [Last accessed on 2019 Apr 16].
15. Mendelson EB, Böhm-Vélez M, Berg WA, Whitman GJ, Feldman MI, Madjar H, *et al.* ACR BI-RADS ultrasound. In: D'Orsi CJ, Sickles EA, Mendelson EB, Morris EA, editors. ACR BI-RADS Atlas: Breast Imaging Reporting and Data System. 5th ed. Reston, VA: American College of Radiology; 2013.
16. Altaf FJ, Mokhtar GA, Emam E, Bokhary RY, Mahfouz NB, Al Amoudi S, *et al.* Metaplastic carcinoma of the breast: An immunohistochemical study. Diagn Pathol 2014;9:139.
17. Li J, Szekely L, Eriksson L, Heddson B, Sundbom A, Czene K, *et al.* High-throughput mammographic-density measurement: A tool for risk prediction of breast cancer. Breast Cancer Res 2012;14:R114.
18. Cancelo MJ, Martín M, Mendoza N. Preoperative diagnosis of a breast hydatid cyst using fine-needle aspiration cytology: A case report and review of the literature. J Med Case Rep 2012;6:293.
19. Giess CS, Smeglin LZ, Meyer JE, Ritner JA, Birdwell RL. Risk of malignancy in palpable solid breast masses considered probably benign or low suspicion: Implications for management. J Ultrasound Med 2012;31:1943-9.

How to cite this article: Hashim HA, Mahmoud MZ, Alonazi B, Aldosary H, Alrashdi JS, Alabdulrazaq FA, *et al.* Brightness mode and color Doppler ultrasound in differential diagnosis of breast lesions in Saudi females. J Clin Imaging Sci 2019;9:xx.