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Comparison of Two-Dimensional and Three-Dimensional Ultrasound Mammography to Characterize Benign and Malignant Breast Masses

Authors

Dr. Mwahib Sid Ahmed¹, Mohamed Osman Aldosh²

Ph. D, Assistant Professor, Radiological Sciences Department

Applied Medical College - Najran University- Kingdom of Saudi Arabia

ABSTRACT

The increased quality of images obtained with ultrasound has allowed investigators to define the characteristics of specific breast masses. Although various Classifications are in use ,most investigators agree to characterize masses using four categories: shape of the lesion, margin characteristics, depth : width ratio and internal echogenicity. Within these categories, individual features show variable diagnostic value, as there is known overlap between benign and malignant characteristics. In this study the value of these criteria in discriminating between benign and malignant masses were assessed. The main aim of this study is to compare and identify better diagnostic accuracy of ultrasonography, two-dimensional and three-dimensional mammography that represents an interesting adjunct to the characterization of breast lesions. And also to describe the appearance of normal breast tissue and breast masses with different ultrasound modality to evaluate the contribution of this to the diagnosis of breast masses.

Keywords: Breast cancer; Diagnostic imaging; Ultrasonography; Mammography;Two-dimensional; Three-dimensional; benign ; malignant

INTRODUCTION

The goal of any breast imaging modality is to improve the early detection of tumors and to improve the differentiation between benign and malignant lesions. Although x-ray mammography

is efficacious in detecting and diagnosing a high percentage of breast masses, it also produces a high rate of false-positive findings 1,2. The percentages of breast biopsies that actually yield malignant findings vary between 10% and 35%.

Thus, a technique that reliably differentiates between malignant and benign masses in all types of breasts would improve the diagnosis of breast cancer and, therefore, should reduce the number of negative biopsy results. Sonographic imaging is primarily used as an adjunct to mammography. It quite easily differentiates between cystic and solid lesions (unlike mammography) and can also be used to guide biopsies in real time 3,4. Moreover, sonographic imaging improves the characterization of solid breast lesions as benign or malignant. Some previous study indicated that, 3-dimensional (3D) sonographic imaging should be better suited than 2-dimensional (2D) imaging to demonstrate the breast cancer 5.

Ultrasound is also a good tool which is used to diagnose young women with symptoms of a breast cancer. This is according to study that was published in the American Journal of Roentgenology in April 2013. The study found that ultrasound detected breast cancer better than mammography in young women who had breast cancer symptoms.

Thus, this study compared the ability of gray scale imaging as well as 2D and 3D sonographic imaging, with and without contrast enhancement, to differentiate between benign and malignant breast masses relative to mammograph.

MATERIAL AND METHODS

Ultrasonographic mammography equipments of two-dimensional and three-dimensional analysis includes planar images with selected orientations, were used for imaging of breast masses. A total of 150 patients women over 21 years of age having a

breast mass or an abnormality without a mass resulting in scheduling of a decisional breast biopsy. were examined in our university hospital - ultrasound clinic by both methods. The three-dimensional sonographic images were obtained experimentally, using a standard two dimensional sonographic system coupled to a position sensing device⁷. Ductal invasive carcinomas appeared as irregular, urchin-like masses. Most importantly, margin jaggging extended over the entire periphery of the mass. In contrast, fibroadenomas were imaged as smooth structures, surrounded by a hyperechoic rim. Rim continuity appeared as an essential characteristic in distinguishing benign masses from malignant tumors. The difference in echogenicity between the mass and the surrounding tissue results in sharp margins; however, there is no wall. All lesions were analyzed by histology, except that clinical characteristics of two-dimensional ultrasound mammography and X-ray mammography supported the diagnosis of fibroadenoma. No tissue sampling was performed in these cases. The tissue specimens submitted for histological analysis were obtained either by core-needle biopsy under sonographic guidance or by open biopsy.

RESULT

In the present study, the stromal organization was fully apparent on parallel planar reformatted sections obtained with three-dimensional analysis. Two major patterns of stromal tissue organization were distinguished. The compressive pattern was associated with benign lesions with higher

specificity and higher positive predictive value than on two-dimensional analysis. In contrast, the converging pattern appeared highly characteristic of malignant masses. Therefore, in the presence of a mass where the index of suspicion for malignancy is low, the presence of a compressive pattern on three dimensional analysis is an additional argument to alleviate diagnostic.

In summary, the present study indicates that three dimensional ultrasound mammography represents an interesting adjunct to the characterization of breast lesions investigations.

DISCUSSION

In the present study, The planar reformatted sections reconstructed along planes perpendicular to the surface of the skin closely resembled the original two-dimensional images. A typical example for normal breast tissue is shown in Figure 1. The skin, subcutaneous fat layer, mammary layer, retromammary fat layer and the pectoralis major were readily visible and similar to their usual appearance with two-dimensional ultrasound mammography.



Figure 1 Normal breast tissue ultrasound

All the masses diagnosed with the two-dimensional technique were visible on three-dimensional reconstructions. Orthogonal planar reformatted sections of the four major types of breast masses closely resembled the respective original two-dimensional images. Despite variation in the terminology used to describe the respective signs, there is now general agreement on the relevant two-dimensional ultrasonographic characteristics of breast carcinomas. Peripheral spiculation (or margin jaggging, or indistinct margins, or indistinct boundary with jagged contour) has the highest discriminating value in characterizing malignant masses⁷⁻⁹. Moreover, this sign has its highest value when margin jaggging extends around the lesion, including its posterior and anterior borders^{7,8}. When present, the echogenic halo is another presentation of the peripheral spiculations^{9,14}. The results of the present investigation further emphasize the high diagnostic value of complete margin jaggging. When carcinomas were analyzed, margin jaggging was present on the parallel planar reformatted sections, confirming the presence of margin jaggging over the surface of breast carcinomas. This observation was also in accordance with our previous observations of surface characteristics of breast masses using three-dimensional surface rendering reconstruction⁷. Figure 2

Using two-dimensional ultrasound mammography, dystrophic nodules are characterized by jaggging of the lateral borders, with normal, well-defined anterior and posterior margins. The fact that three-dimensional, parallel planar reformatted sections did not provide

additional information was thus predictable, as three-dimensional parallel planar reformatted sections provide additional information on the lateral borders of a mass, and not on its anterior or posterior walls.



Figure 2 Ultrasound breast image with digital mammogram shown in Dual View

The continuity of the peripheral wall is highly specific for fibroadenomas. However, as a consequence of the mechanism by which the ultrasound image is provided, wall continuity is difficult to ascertain by two-dimensional examination in the lateral borders of the mass, even using the technique of ‘rocking, heeling and toeing the probe’ advocated by Stavros and colleagues¹⁰. Three-dimensional analysis proved of high value in that case. When orthogonal and parallel planar reformatted sections were computed, wall continuity surrounding the fibroadenoma became easy to demonstrate. On two-dimensional ultrasound mammography, a lesion with a shape that is taller than wide (or that has a major axis oblique or perpendicular to the surface of the skin, or a depth : width ratio of ≥ 1) is highly predictive of a malignant mass^{11,12}. The

depth : width ratio was 1.3 in a series of 125 carcinomas³. Indeed, it would be more appropriate to state that a shape wider than tall is associated with a benign condition, as the absence of a major axis (round lesions) is also suggestive of a malignant mass^{8,9}. With three-dimensional analysis, benign or malignant masses usually presented with a circular shape on parallel planar reformatted sections, irrespective of the pathological diagnosis. A tentative explanation of this unexpected finding might be the absence of deformability of malignant masses compared with benign masses or normal breast tissue^{13,14}. Benign masses tend to flatten when compressed between the probe and the chest wall. Thus, they show a decreased depth when analyzed in orthogonal planes (two-dimensional ultrasound mammography or orthogonal planar reformatted sections). Compression results in increased width in all directions, the tumor shape remaining round with parallel planar reformatted sections. In contrast, malignant masses resist any deformation imposed by the probe.

In the present study, the stromal organization was fully apparent on parallel planar reformatted sections obtained with three-dimensional analysis. Two major patterns of stromal tissue organization were distinguished. The compressive pattern was associated with benign lesions with higher specificity and higher positive predictive value than on two-dimensional analysis. In contrast, the converging pattern appeared highly characteristic of malignant masses. Therefore, in the presence of a mass where the index of suspicion for malignancy is low, the presence of a compressive

pattern on three-dimensional analysis is an additional argument to alleviate diagnostic investigations. Larger series are needed for full validation of these results. Furthermore, all the lesions diagnosed in this study had tubular, lobular or mixed tubulolobular histology. The present series included no carcinoma of the uncommon types, and this represents a limitation to any extension that might be drawn from the present conclusions.



Figure 3 Ultrasound mammography Unit

CONCLUSIONS

In summary, the present study indicates that three dimensional ultrasound mammography represents an interesting adjunct to the characterization of breast lesions. Parallel planar reformatted sections, i.e. reformatted sections obtained in planes parallel to the skin surface, provide two types of information in addition to that of the usual sonographic analysis. First, mass margins are analyzed with higher accuracy. Wall continuity in benign tumors and complete margin jaggling in malignant tumors are clearly apparent.

Second, parallel planar reformatted sections allow precise study of the tissue surrounding the central lesion. A converging pattern of the peripheral tissue is highly suspicious of a carcinoma, and a compressive pattern is almost always associated with a benign lesion. The converging/compressive pattern of the peripheral tissue has a higher specificity than the usual two-dimensional characteristics. However, it has lower specificity, and therefore cannot be used independently to defer tissue sampling in the presence of a suspicious two-dimensional image.

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