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QUANTITATIVE ULTRASOUND ANALYSIS FOR CLASSIFICATION OF CYST AND SOLID BENIGN BREAST ABNORMALITIES

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ABSTRACT

Ultrasound is an important adjunct to mammography in detection and characterization of breast lesions especially in mammographically dense breasts. It has been especially useful in distinguishing cysts from solid tumors. This study was aimed to determine Q-values and to classify benign breast abnormalities in ultrasound images based on the Q-values. QLAB region of interest (ROI) provides time-intensity curves (data sets) from multiple ROIs applied to the images. Mean intensity of the selected ROIs are known as Q-values. Five established criteria namely outline, perinodular cuffing sign, posterior shadowing, edge shadowing and color flow, based on shape, texture and region characteristics of the breast masses were extracted for cyst and solid classification. The results show that Q-values covering range from 2.61 to 25.81 for cyst and from 19.82 to 77.24 for solid. In conclusion, the Q-values range is defined whose numerical values will help to classify between cyst and solid benign breast abnormalities.

Keywords: Breast Ultrasound; Ultrasound Images; Q-values; Benign; Classification

INTRODUCTION

Breast cancer is the second leading cause of cancer death, following lung cancer [1,2]. Breast cancer was also diagnosed at younger age among women in India, Taiwan, Malaysia and Singapore [3,4]. It can be treated most effectively when detected in its early stage. Therefore, population-based screening for early detection of breast cancer is the primary strategy for reducing breast cancer mortality. Mammography as the gold standard, however, has low sensitivity of about 30% to 48% especially in dense-breast women [5]. Ultrasound has become an important adjunct to mammography in breast cancer detection due to its higher sensitivity in dense breast women. Preliminary studies suggest possible roles of breast ultrasound in breast cancer screening or evaluation of breast calcifications identified on mammography [6]. Stavros et al. [7] proposed several ultrasound characteristics to describe a mass and achieved a sensitivity of 98.4 % (123 of 125) and a specificity of 67.8 % (424 of 625) for the classification of 750 solid breast masses. In 2003, Breast Imaging Reporting and Data System (BI-RADS) lexicon was developed to provide the descriptors for tumor characterization on breast ultrasound

[8]. The BI-RADS lexicon defined for ultrasound findings in masses includes shape, orientation, margin, lesion boundary, echo pattern, and posterior acoustic features. This paper focuses on the quantitative ultrasound analysis for the purpose of classification of cyst and solid benign breast abnormalities using ultrasound images.

METHODOLOGY

Patients
This study was approved by the ethics committee of our institution during the period between January 2013 and December 2013. Patients presented for breast imaging at National Cancer Society (NCS), Kuala Lumpur between April and December 2013 were enrolled in this study. The age of patients ranged 35-73 years. All mammograms were obtained with digital technique using dedicated Hologic 3D Selenia Dimensions mammographic unit and patients were categorized according to their BIRADS breast density groups (1, 2, 3 and 4). All patients included in this study had mammographically dense breast parenchymal pattern (BIRADS 2, 3 and 4). Patients of BIRADS 1 category was excluded. After these exclusion, 190 patients were included in this study.

Ultrasonographic Examination
The conventional position for breast ultrasound examination places the patient supine with the arm of the side being examined raised above the head. In this position, a high-resolution linear transducer, 7.5 MHz adequately penetrates to the chest wall. For ultrasound of the breast, the linear array transducer was used because the large flat footprint of the transducer maintains good contact with the skin. The ultrasound scan was performed in a radial pattern, beginning at the periphery of the breast and moving inward. Each quadrant was scanned with overlap at the 12-, 3-, 6- and 9- o'clock positions to complete the assessment. All ultrasound images were acquired with *Philips HD15 PureWave* machine.

In principle, an echo is created when a sound wave emitted by a transducer travels to two tissues with an acoustic mismatch and a portion of the sound wave is reflected back. This echo is then converted to an image that may be visualized on the ultrasound monitor. Ultrasound images are correlated with the relative intensities of their echoes on the basis of a "gray scale." High-amplitude echoes are those echoes created from a large acoustic mismatch and are displayed in a light shade of gray or even white. Conversely, an echo that results from an acoustic interface with a small mismatch may be displayed as a darker shade of gray or even black. When clinicians refer to images on the ultrasound monitor, tissues are compared based on their relative ability to produce echoes. Something is referred to as isoechoic if its echogenicity is similar to surrounding tissues. Anechoic areas have no internal echoes, and are thus very dark or even black. Most fluid-filled cysts, particularly in the breast, will be anechoic on ultrasound. If something is hypoechoic it appears darker than the surrounding tissues. Most solid lesions of the breast are hypoechoic relative to the surrounding breast parenchyma [9].

Data acquisition, feature extraction and image interpretation
Images were collected in the form of cine and analyzed using QLAB 7.1 quantification software. There were 175 masses (75 cysts and 100 solids) assessed by the radiologist. For each mass, the Q- values were measured and calculated. A key goal of quantitative ultrasound is to infer physiologic characteristics of different regions of tissue. To achieve this, it is necessary to define regions of interest (ROI) for detailed analysis. Each breast masses have to be segmented first for feature extraction. The method used was shown in Fig. 1. With the specification of mass area, two- dimensional (2D) spatial information was employed for image interpretation. To classify the breast masses, there were four descriptive categories including outline, perinodular cuffing sign, posterior shadowing and edge shadowing evaluated.

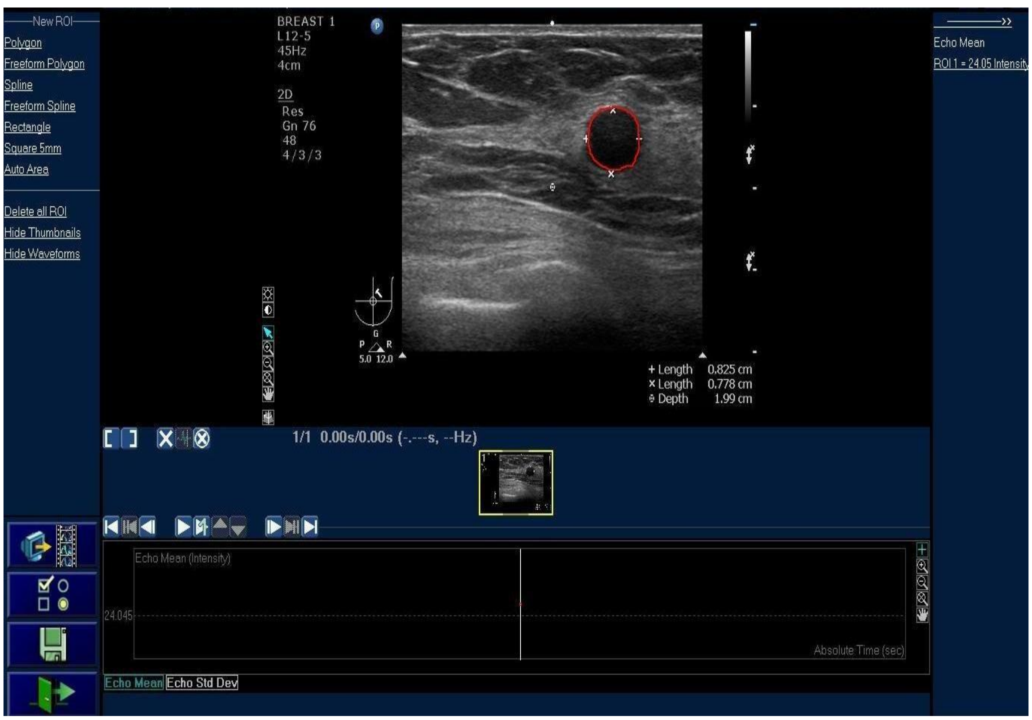

Figure 1: Selection of region of interest (ROI) of breast masses

RESULTS AND DISCUSSION

The objective of the present study was to classify cyst and solid benign breast abnormalities based on the Q-values. The distribution of Q-values for cyst and benign breast abnormalities were illustrated in Figure 2 and Figure 3 respectively. The results show that Q-values range from 2.61 to25.81 for cysts and from 19.82 to 77.24 for solids. Cystic masses shows lower value compared to solid masses. Based on the range of the Q-values, the result suggested that the Q-values would be useful to classify cyst and solid.

This study denotes that ultrasound is a useful tool for differentiating cystic and solid masses in the breast has been suggested by several authors [10,11]. The development of ultrasound instruments with high frequencies and more widespread use by physicians have increased the accuracy of ultrasound in breast screening. Ultrasound has also become a routine diagnostic tool in breast diseases and can differentiate between benign and malignant tumors based on tumor shape, margin, echogenicity, internal echo pattern, retrotumor acoustic shadowing, compressibility and microcalcification [12,13]. The use of ultrasound in the evaluation of suspected clinical and mammographic abnormalities can reduce the false-positive rate by demonstrating benign characteristics, thus reducing the rate of biopsies for benign lesions.

This study had several weaknesses. First, only one radiologist involved in interpreting the ultrasound images of the breast masses. Though the radiologist had more than 20 years experiences, but more radiologists should evaluate the images for better accuracy. Second, this study included a relatively small number of patients. Further study is needed to confirm these results.

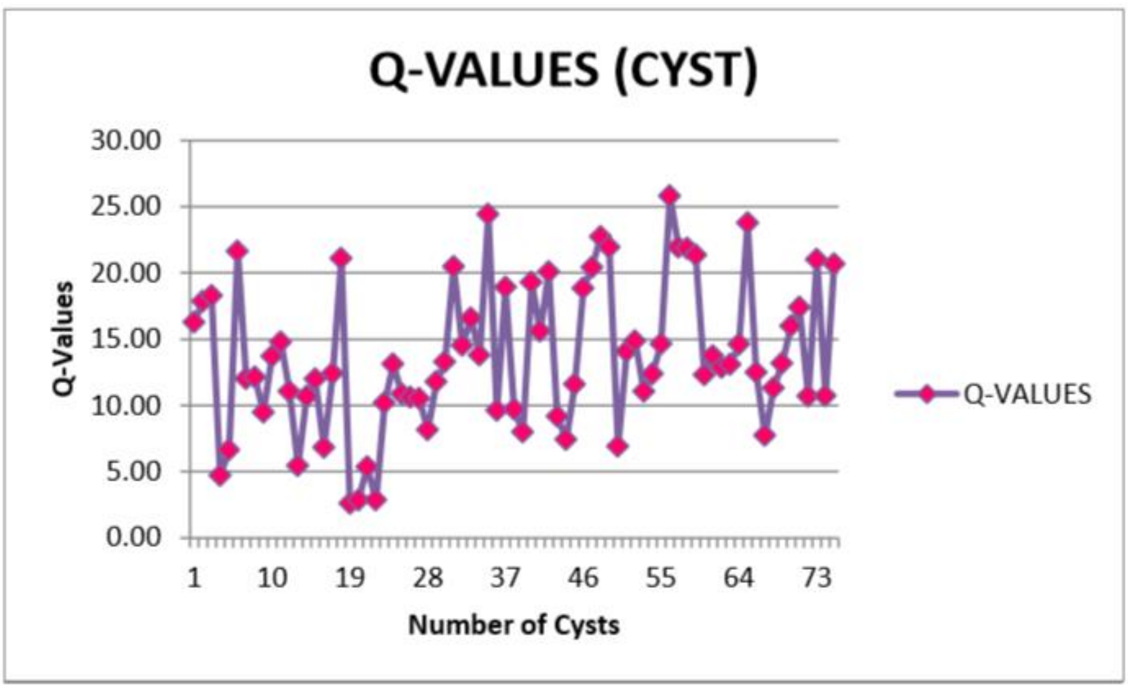

Figure 2: Distribution of Q-values for Cyst

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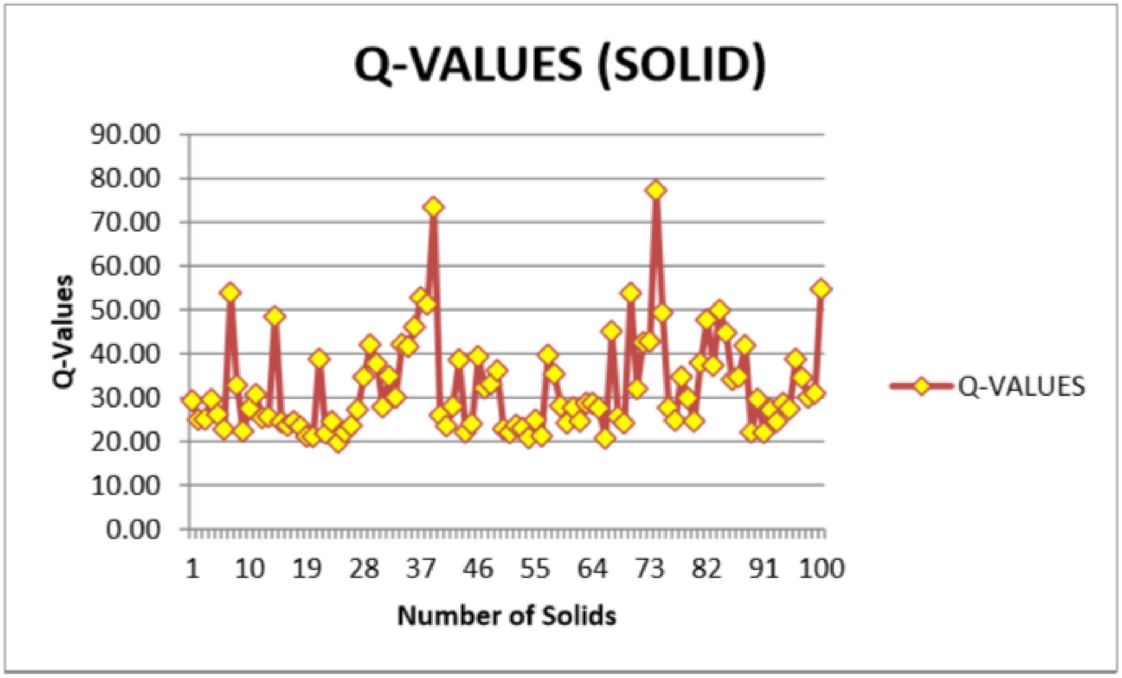

Figure 3: Distribution of Q-values for Solid

CONCLUSION

The Q-values has the potential to be used in classifying cyst and solid benign breast abnormalities. However, a further study needs to be done to see if it actually does impact decision making clinically.

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