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ORIGINAL ARTICLE

The Role of Doppler Sonography in Distinguishing Malignant from Benign Breast Lesions

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Background: The use of color Doppler ultrasound (CDUS) for characterizing breast lesions has increased in recent years. The aim of this study was to assess the value of CDUS and resistance index (RI), in evaluating solid breast masses.
Methods: In total, 38 cases with one or more solid breast masses were enrolled. CDUS was performed for each participant, evaluating RI, and all of them underwent a tissue biopsy. The results were categorized and compared with pathology results.
Results: Malignant breast lesions were more vascular than the benign lesions. Blood vessels were detected in 97.4% of the malignant group and only 35% of the benign group. The mean values of RI in benign lesions and malignant lesions were 0.65 ± 0.065 (range, 0.52—0.89) and 0.71 ± 0.093 (range, 0.57—0.75), respectively. The difference was just short of statistical significance ($p = 0.061$).
Conclusion: Hypervascularity of a breast mass is the most reliable sign in Doppler ultrasound to predict its possibility of malignancy. However, it appears that the use of RI alone has little value in differentiating between malignant and benign breast lesions. Pathological findings are still the gold standard for diagnosing the type of breast nodules.

Conflicts of interest: All contributing authors declare no conflicts of interest.

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Introduction

Breast cancer, the most frequently diagnosed cancer and the leading cause of cancer death among women accounts for 23% of all cancer cases and 14% of cancer deaths globally [1,2]. In Iran, the age specific rate for breast cancer, the fifth cause of cancer death, is 27.15 in 100,000 people [3].

Mammography is considered the primary screening tool for breast cancer [4,5]. However, the sensitivity of mammography declines with increased density of breast tissue and it is estimated that in women with dense breasts, the sensitivity of mammography decreases to 30–48% [6,7]. Although, there is no recommendation for routine ultrasound imaging currently, it has been revealed that supplemental ultrasound can detect small breast cancers not detected by mammography [8–12]. A study has shown that using ultrasound in addition to mammography increases the sensitivity to 77.5% compared to that of mammography alone (50%) in women with dense breasts and increased risk of breast cancer [13].

The use of color Doppler ultrasonography (CDUS) for characterizing breast lesions has increased in recent years. The presence and distribution of blood vessels associated with malignant lesions is visualized by CDUS. Doppler criteria such as resistive index (RI), pulsatility index, and flow velocity are used to distinguish benign from malignant lesions. Most of the studies are based on RI comparison between malignant and benign lesions. However, different sensitivities, specificities, and positive and negative predictive values have been reported. [14].

The aim of this study is to assess the value of CDUS and RI, in evaluating solid breast masses, to compare it with pathology results, and to evaluate its potential role in differentiating benign from malignant breast lesions.

Materials and methods

In a period of 1 year, a total of 38 patients with one or more solid breast mass who were candidates for breast biopsy were enrolled in this prospective cohort study. Age of the patients ranged from 28 years to 66 years. The study was approved by the Mashhad University of Medical Sciences Ethics Committee (Mashhad, Iran) and informed written consent was obtained from all patients. Clinical examination, ultrasound examination, and CDUS were performed for each participant. All of the examinations were performed by one qualified radiologist using an LN5-12 linear transducer with a SonoAce X8 machine (Samsung Medison, Seoul, South Korea). Doppler criteria including the size of the lesion, presence or absence of blood vessel, degree of vascularity compared with the surrounding normal tissue and RI of the vessels in the lesion were evaluated. All the participants underwent a tissue biopsy and the samples were reviewed twice by a consultant pathologist who was not aware of the Doppler sonographic data.

Chi-square test, Fisher's exact test, Student *t* test, Mann–Whitney *U* test, Pearson correlation test and analysis of variance were used for statistical analysis. A p value of < 0.05 was considered statistically significant. Statistical analysis was performed using SPSS version 14.0 (SPSS, Chicago, IL, USA).

Results

All 38 enrolled patients completed the course of the study. Patients were divided into two groups based on pathology results, benign (20 cases) and malignant (18 cases). The mean age of the patients was 43.68 ± 10.61. There was no statistical difference between the mean age of the two groups diagnosed as benign and malignant ($p = 0.85$). Likewise, there was no statistical association between the malignancy and site ($p = 0.329$) or side of the mass ($p = 0.745$).

The mean size of the tumor (height $\times$ width) was 156.59 ± 72.7 mm^2 in the benign group and 266.75 ± 153.29 mm^2 in the malignant group. This difference in the size of the lesions was statistically significant ($p = 0.012$).

When all the benign and malignant lesions were pooled, the r value (correlation coefficient) was 0.399 ($p = 0.066$). When we analyzed malignant and benign lesions separately the correlation between the size and RI for the benign lesions was 0.133 ($p = 0.777$) and that of malignant lesions was 0.319 ($p = 0.246$).

Doppler characteristics of the lesions were compared between the two groups. Among the 18 malignant lesions, 17 (94%) showed vascularity and all were hypervascularized when compared with the normal surrounding tissue.

In the benign group, vascularization was detected only in seven lesions (35%): three with hypervascularity, two with hypovascularity, and one showed no difference between vascularity of the lesion and the normal surrounding tissue. Mann–Whitney was used to analyze the difference of vascularity between the two groups. The difference was statistically significant ($p < 0.05$). Fisher exact test was also used between the groups for the degree of vascularity, which was also statistically significant, as shown in Table 1.

The positive and negative predictive values of vascularity for detecting malignancy were 70% and 92%, respectively.

The mean values of RI in benign lesions and malignant lesions were 0.65 ± 0.065 (range, 0.52–0.89) and 0.71 ± 0.093 (range, 0.57–0.75), respectively. Receiver operating characteristic analysis was used to calculate RI. The difference was just short of statistical significance ($p = 0.061$; Table 1). A threshold RI value of 0.625 was obtained from this analysis. Based on this value, sensitivity and specificity of RI values were 88% and 57%, respectively, to predict malignancy.

Histological examinations revealed that 70% of the benign lesions, were fibroadenoma and 83.3% of the malignant lesions were invasive ductal carcinoma.

Blood vessels were detected in 93% of the cases of invasive ductal carcinoma and all were associated with increased vascularity. In 36% of fibroadenomas, blood vessels were also detected, 60% of which showed increased vascularity.

Discussion

Malignant neoplasms, including those of breasts, need angiogenesis for further growth and metastasis. Thus, a technique such as Doppler sonography with the ability to