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Application Value of Combined Conventional Ultrasonography and S-Detect in Diagnosis of Benign and Malignant Breast Tumors

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Abstract

The breast cancer has become a malignant tumor of the highest incidence among women in China [1]. Early detection and early diagnosis are crucial to reduce the mortality of breast cancer patients [2-3]. Mammography and ultrasonography are the most effective methods to examine breast diseases. The latter is more convenient and affordable than the former and has no risk of radiation. Therefore, the ultrasonography is widely used in breast cancer screening. However, it shows specific differences in screening and high dependence on operators, which are to be solved urgently. S-Detect is big data based on the results of 10,000 cases, and it provides suggestions for judgment of benign or malignant tumors according to selected images of clinical examination using deep learning algorithms. Less dependent on operators, S-Detect offers a new diagnostic method for the breast cancer. This technology is non-invasive, non-radioactive, simple and easy to operate. However, it is still in the exploratory stage, and needs more research to confirm its value. This study explored the application value of combined conventional ultrasonography and S-Detect in diagnosis of benign and malignant breast tumors upon comparison of pathological results.

1. Materials and Methods

1.1 General data

We selected 99 female patients aged (44.2+12.0) who had undergone breast ultrasonography in our hospital from November 2018 to January 2019, and obtained pathological results by puncture or surgery, with a total of 108 lesions. The lesions ranged from 4mm to 68mm in diameter, with an average of (17.7+11.4) mm. Ten patients who received neoadjuvant chemotherapy and one patient with large calcification in front of lesions that could not be assessed were excluded. At last, the study was carried out on 98 lesions in 88 patients.

1.2 Methods

The Samsung RS80A color ultrasonic device with a L3-12 probe of a 5-13MHz frequency was used, supported by S-Detect software. Patients were required to lie on their back, or on their left or right side where necessary, with upper limbs extended outward, to fully expose the breast. Scanning was made radially with nipples at the center. First, two sonographers (2 years and 30 years of experience respectively) performed conventional ultrasonography, and gave a conclusion according to the lesion size, internal echo, edge, shape, capsule, whether there was internal calcification, whether the posterior echo was attenuated, internal and peripheral blood supply, as well as the medical history and clinical palpation. Then they selected two vertical sections of the largest tumor and pressed the S-Detect button on the touch screen to automatically outline the lesion area. After the lesion area was confirmed by doctors, the software was started to generate the lesion features and diagnostic classification (Figure 1) and automatically output the benign or malignant result of the lesion while maintaining the S-Detect diagnostic result. When the diagnosis of two sections was inconsistent, the lesion would be regarded as malignant.

With reference to the diagnostic criteria of Zhan Weiwei [4], breast lesions are classified as follows according to the breast imaging report and data system (BI-RADS) obtained by the conventional ultrasonography: class 3 - benign lesions; class 4a -

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one malignant sign, class 4b - two malignant signs, class 4c - three malignant signs; class 5 - three or more malignant signs; class 6 - malignant pathological diagnosis. Lesions above class 4a (including 4a) are seen as malignant.

Figure 1. **When diagnosing a breast tumor, S-Detect automatically outlines the lesion area of the tumor, and analyzes the tumor as a malignant tumor with low echo, irregular shape, parallel growth, clear edges, and acoustic shadow in the rear.**

When jointly using the conventional ultrasonography and S-Detect to diagnose whether a breast tumor is benign or malignant, upon comparison of diagnostic results with pathological results, if any one of the diagnostic results shows malignant, the tumor will be classified as malignant; if both diagnostic results show benign, the tumor will be classified as benign.

1.3 Statistical analysis

With pathological results as the gold standard, SPSS22.0 statistical analysis software was adopted to calculate the sensitivity, specificity and accuracy of diagnosis by conventional ultrasonography, S-Detect, and combined use of the said two methods, respectively.

2. Results

2.1 Pathological results

Among the 98 lesions in 88 patients, 56 were benign lesions, including 44 fibroadenomas, 1 fibrous tissue proliferation, 4 duct dilation, 2 gland hyperplasia, 1 hemangioma, 2 inflammations, 1 intraductal papilloma, and 1 benign phyllodes tumor; 42 were malignant lesions, including 1 invasive micro-papillary carcinoma, 1 tubular carcinoma, 1 primary breast cancer, 25 invasive ductal carcinomas, 3 intraductal carcinomas in situ, 1 invasive non-specific ductal carcinoma, 1 solid papillary carcinoma, and 1 non-specific invasive carcinoma.

2.2 Detection results of conventional ultrasonography, S-Detect, and combined ultrasonography and S-Detect (see Table 1)

Compared with postoperative pathological results, the diagnostic sensitivity of conventional ultrasonography was 78.6%, namely, 33 of 42 malignant breast lesions were found; the specificity was 96.4%, namely, 54 of 56 benign lesions were found; and the accuracy was 88.8%. The sensitivity of S-Detect was 83.3%, namely, 35 of 42 malignant breast lesions were found; the specificity was 98.2%, namely, 55 of 56 benign lesions were found; and the accuracy was 91.8%. When the said two methods were used together, 27 malignant lesions were detected by both of them, 6 were detected only by the conventional ultrasonography, and 8 were detected only by S-Detect. A total of 41 malignant lesions were detected, thus the net sensitivity was 97.6%; 53 benign lesions were detected; thus, the net specificity was 94.6%; and the accuracy was 95.9%.

3. Discussion

The conventional ultrasonography is based on using and image post-processing of amplitude signals of the original radio frequency (RF) signal echoes, but other frequency signals related to micro-tissues contained in the RF signals are often ignored [5]. S-Detect uses deep learning algorithms for data mining of ultrasonic RF signals.

Currently, breast cancer screening methods include mammography and ultrasonography. The ultrasonography has advantages of non-invasive, non-radioactive, simple and easy to operate, and is thus more widely used in breast cancer screening. However, the conventional ultrasonography, no matter it is color Doppler ultrasound, three-dimensional ultrasound, elastography or contrast-enhanced ultrasound, is highly dependent on operators and requires operators' rich experience

to make the most accurate judgment. Studies have shown that [6], S-Detect reduces the dependence on operators to the extent that sonographers, especially those young doctors with little experience can make the most accurate judgment and standardizes the ultrasonic description of breast tumors.

Table 1. **Comparison of detection results of conventional ultrasonography, S-Detect, and combined ultrasonography and S-Detect**

Methods and results		Pathological results		Total	Accuracy
		Malignant	Benign		
Conventional ultrasonography	Malignant	33 (78.6%)	2	35	87 (88.8%)
	Benign	9	54 (96.4%)	63	
S-Detect	Malignant	35 (83.3%)	1	36	90 (91.8%)
	Benign	7	55 (98.2%)	62	
Combined ultrasonography and S-Detect	Malignant	41 (97.6%)	3	44	
	Benign	1	53 (94.6%)	54	94 (95.9%)
Total		42	56	98	

Note: The number in brackets in the malignant column represents the sensitivity of separate detection and combined detection of the two methods, and that in the benign column represents the specificity.

Among the 98 breast lesions in this study, 56 were benign, and 42 were malignant. The sensitivity of the conventional ultrasonography, S-Detect, and combined conventional ultrasonography and S-Detect was 78.6%, 83.3%, and 97.6%, respectively, indicating that the combined application of conventional ultrasonography and S-Detect can improve the diagnosis rate of malignant breast lesions, thus increasing the survival rate of patients, for patients can receive clinical treatment as early as possible. Moreover, the ultrasonography is non-invasive, and can more effectively detect diseases if combined with S-Detect. The specificity of conventional ultrasonography was 96.4%, the specificity of S-Detect was 98.2%, and the net specificity of combined method was 94.6%. When the specificity of combined method decreases, the misdiagnosis rate will increase, causing waste of medical resources and anxiety of patients. The accuracy of combined method was 95.9%, higher than that of conventional ultrasonography and S-Detect (88.8% and 91.8%, respectively), indicating that the combined method can enhance the diagnosis rate of benign or malignant breast tumors.

At the same time, the sensitivity, specificity and accuracy of S-Detect are higher than those of conventional ultrasonography, indicating that this technology has a high value in diagnosis of benign or malignant breast tumors. However, the S-Detect can only evaluate the shape, direction, edges, posterior features, and echoes of tumors, and cannot tell the dilation of surrounding ducts, the changes in the adjacent tissues and skins, and vascular conditions based on the medical history. In addition, it is not sensitive to calcifications inside tumors. Studies have shown that microcalcification within tumors is a reliable sign for diagnosis of breast cancer [7]. The S-Detect is still in the exploratory stage and needs more experimental investigations to confirm it. This study was mainly completed by physicians with 30 years of diagnostic experience. More studies need to be conducted to confirm whether the combined method is applicable to young physicians with little experience.

To sum up, S-Detect, as a new type of image-aided diagnosis technology, can increase the detection rate of malignant breast tumors if used together with the conventional ultrasonography, which help clinically develop treatment plans, to truly realize the early detection and early treatment.

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