ISSN 2618-1584 Vol. 6, Issue 9: 33-37, DOI: 10.25236/FMSR.2024.060905

The application of ultrasound automatic volume imaging in detecting breast tumors

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Abstract: *Based on the experiment to evaluate the diagnostic value of automated breast ultrasound (ABUS) for breast tumors, this study needs to review and collate the case data of 96 patients with breast tumors who received surgical treatment for breast tumors in the oncology Department of our hospital during the two-year period from January 2022 to January 2024. In addition, all patients underwent routine and ABUS examinations at the time of ultrasound examination, with surgical pathological results as the gold standard. The results of breast tumor detection by ABUS and conventional ultrasound were compared and analyzed. The results showed that 140 breast tumors were detected, of which 74 were malignant and 66 were positive. With surgical pathology as the gold standard, routine ultrasound detected only 52 malignant cases and 45 benign cases. ABUS detected 72 malignant cases and 65 benign cases. The positive predictive value (98.63%), negative predictive value (97.01%), specificity (98.48%), sensitivity (97.30%), and accuracy (97.86%) of ABUS were significantly higher than those of conventional ultrasound (71.23%, 67.16%, 68.18%, 70.27%, 69.29%). The difference was statistically significant ($P < 0.05$). The results show that ABUS has a high diagnostic efficiency for breast tumors and has a guiding role in the clinical differentiation of benign and malignant breast tumors, which is worthy of recommendation.*

Keywords: *Breast tumor; Breast ultrasound automated volumetric imaging; Diagnostic value*

1. Introduction

Breast tumors are common tumors in women, mainly manifested as palpable breast nodules, breast lumps, breast pain, etc. Its occurrence is affected by many aspects, such as irregular living habits, mental pressure, genetic factors, etc. [1-2]. Breast tumors can be divided into benign and malignant; if the benign tumor is not found in time and timely treatment, it can easily develop into a malignant tumor and seriously endanger the lives of women. Therefore, early detection, early diagnosis, and treatment of breast tumors are of great significance to improve the survival rate of patients. In the past, conventional ultrasound diagnosis was mainly used in clinical practice. This method has specific diagnostic importance for early detection of breast tumors, but it has particular application limitations in differentiating benign and malignant tumors [3]. In recent years, with the continuous progress of ultrasonic diagnostic technology, ABUS has been popularized, making up for the shortcomings of conventional ultrasound in differentiating benign and malignant breast tumors. ABUS is a new three-dimensional ultrasound imaging technology formed by combining traditional mammography and ultrasound imaging technology, which realizes the full volume scan of three vertical sections of the female breast and has a broader scanning range [4]. In view of this, this study took 96 patients with breast tumors as examples and further confirmed the diagnostic value of ABUS by comparing the diagnostic results of conventional ultrasound and ABUS for breast tumors.

2. Data and Methodology

2.1 Dataset

The data in this paper are from the case data of 96 patients with breast tumors who received surgical treatment for breast tumors in the oncology Department of our hospital during the two years from January 2022 to January 2024. All the data were confirmed by surgery and pathology, and a total of 140 breast masses were found. Patients with skin ulceration or bleeding, patients with mental illness, patients with

ISSN 2618-1584 Vol. 6, Issue 9: 33-37, DOI: 10.25236/FMSR.2024.060905

other malignant tumors, and patients with poor compliance have been excluded. All the patients were female. The youngest was 35 years old, the oldest was 68 years old, and the mean age was (48.22±6.23) years old. The shortest course of the disease was four years, the longest was eight years, and the average course was (6.23±4.23) years. The diameter of the lesions ranged from 0.35 to 4.11cm, with an average diameter of (1.87±0.36) cm. All patients were diagnosed by conventional ultrasound and ABUS, and the image data were complete.

2.2 Methodology

96 patients with breast tumors (140 breast masses) were diagnosed by conventional ultrasound and ABUS. Before diagnosis, all patients avoided menstruation, maintained a relaxed mood and a light diet. On the day of diagnosis, wear a comfortable jacket that can quickly reveal the location of the test. (1) Routine ultrasound diagnosis: The patient is supine, and the tested site is fully exposed according to the instructions of the diagnostic staff. Diagnostic equipment selected color Doppler ultrasound diagnostic instrument (model: Siemens Acuson S2000), the probe is 14L5, and probe frequency is 5~14MHz. The long axis of the probe was parallel to the direction of the milk duct, and continuous sagittal and transverse scans were performed on the suspected lesion area.

The scan results of multiple layers were recorded, and the maximum diameter of the tumor was taken from the most significant section. (2) ABUS diagnosis: ABUS diagnosis is performed after the above conventional ultrasonic diagnosis, and the color Doppler ultrasonic diagnosis instrument is connected (Model: The ABUS system of Siemens Acuson S2000 was used to select a 14L5BV high-frequency linear array probe with a probe frequency of 5~ 14MHz, the field of view width and scanning length of 15.4cm and 16.8cm, respectively, and the maximum scanning depth was adjusted according to the maximum tumor diameter. The patient was prone, and the scanning position was determined: the lateral, medial, and anterior positions of both mammary glands. The upper and lower scans should be increased if the breast was larger. The layer spacing of the acquired images is 0.5cm, and all the images obtained by scanning are uploaded to the ABUS workstation, which automatically performs a three-dimensional reconstruction of the multifaceted images and generates three-dimensional breast images.

2.3 Data Indicators

The pathological results of the operation were taken as the gold standard, and the diagnostic results of routine ultrasound and ABUS were analyzed according to the pathological results. The diagnostic efficiency of the two diagnostics was compared, and the positive predictive value, negative predictive value, specificity, sensitivity, and accuracy of the two diagnostics were calculated.

2.4 Statistical

All diagnostic data of 96 patients with breast tumors were included in SPSS23.0 for statistical analysis, and the diagnostic efficacy was all counted data expressed as a percentage (%). The diagnostic efficacy of the two groups of diagnostic was compared by Chi-square x2, and the test standard $P < 0.05$ was statistically significant.

3. Experimental result

3.1 The diagnostic results of routine ultrasound

Table 1: Routine Ultrasound resul

		Standard		Number
		Malignant	**Benign**	
Routine Ultrasound	**Malignant**	52	21	73
	Benign	22	45	67
Number		74	66	140

ISSN 2618-1584 Vol. 6, Issue 9: 33-37, DOI: 10.25236/FMSR.2024.060905

Using surgical pathological results as the gold standard, only 52 cases of malignant and 45 cases of benign were detected by conventional ultrasound, and the diagnostic accuracy was 69.29% (52+45) /140. (Table 1)

3.2 The diagnostic results of ABUS

According to the pathological results, 72 malignant cases and 65 benign cases were detected by ABUS, and the diagnostic accuracy was 97.86% (72+65) /140. (Table 2)

Table 2: ABUS resul

		Standard		Number
		Malignant	Benign	
ABUS	Malignant	72	1	73
	Benign	2	65	67
Number		74	66	140

3.3 Comparison of diagnostic efficiency of two diagnostic

The positive predictive value (98.63%), negative predictive value (97.01%), specificity (98.48%), sensitivity (97.30%), and accuracy (97.86%) of ABUS were significantly higher than that of conventional ultrasound (71.23%, 67.16%, 68.18%, 70.27%, 69.29%). There was statistical significance ($P < 0.05$). (Table 3)

Diagnostic Positive predictive value Negative predictive value specific sensitivity accuracy

Table 3: Comparison of diagnostic efficiency between the two diagnostics

	Diagnostic	Positive predictive	Negative predictive	specific sensitivity	accuracy
Routine Ultrasound	0.7123	0.6716	0.6818	0.7027	0.6929
ABUS	0.9863	0.9701	0.9848	0.973	0.9786
x2	29.329	30.295	33.046	26.889	29.731
P	0.00	0.00	0.00	0.00	0.00

4. Discussion

Breast cancer is a common malignant tumor that threatens women's health and is known as the "number one killer of women" [5]. Breast cancer is a kind of malignant tumor occurring in female mammary epithelial tissue. According to the latest epidemiological statistics, the incidence of this malignant tumor ranks first in female malignant tumors, and its mortality ranks fourth in female malignant tumors [6]. There are many clinical for early diagnosis of breast tumors, including traditional ultrasound, nuclear magnetic resonance, molybdenum target photography, etc. Among them, ultrasound diagnosis is one of the most commonly used diagnostics for this disease and plays a vital role in the early diagnosis of breast cancer [7]. Ultrasound technology is currently the preferred imaging method for clinical diagnosis of breast diseases. Conventional ultrasound diagnosis of breast diseases is mainly based

ISSN 2618-1584 Vol. 6, Issue 9: 33-37, DOI: 10.25236/FMSR.2024.060905

on handheld ultrasound, which can detect breast lesions at an early stage and has advantages such as economy and convenient operation. Still, it has application limitations, such as operator dependence and difficulty in identifying the degree of lesions [8]. It can be seen that only conventional ultrasound is far from enough for clinical diagnosis of breast diseases, and more effective diagnostics are needed to deepen the understanding of breast diseases. In recent years, with the advancement of ultrasound technology, ABUS has been applied to the clinical diagnosis of breast cancer, playing an essential role in diagnosis. ABUS has realized the scanning of the coronary section of the female breast and formed a three-dimensional scanning technology of multi-dimensional recombination, which provides an important guiding role for clinical doctors to understand patients' anatomical structure and pathological characteristics [9].

In this study, we collected the case data of 96 patients with breast tumors. In all patients, 140 breast masses (77 malignant and 66 benign) were detected by surgery and pathology. Analysis of the diagnostic results of routine ultrasound and ABUS showed that only 52 malignant and 45 benign cases were detected by routine ultrasound. ABUS detected 72 malignant cases and 65 benign cases. The positive predictive value (98.63%), negative predictive value (97.01%), specificity (98.48%), sensitivity (97.30%), and accuracy (97.86%) of ABUS were significantly higher than those of conventional ultrasound (71.23%, 67.16%, 68.18%, 70.27%, 69.29%). It is suggested that ABUS is more effective than conventional ultrasound in the diagnosis of breast tumors. The reason for the analysis is that conventional ultrasound is a two-dimensional ultrasound, which is suitable for screening breast diseases. The detection rate of small tumors is less than 1 cm, and minor calcification points are low.

The operator of conventional ultrasound is highly dependent, and the accuracy of the results is affected by the operator's experience and technical proficiency. In the operation process, the diagnostic doctor must optimize the patient's position to reduce the scanning artifacts. In addition, conventional ultrasound looks different for each normal breast, which makes small cancer foci challenging to detect. ABUS is different from conventional ultrasound, and this diagnostic technology is an upgraded version of conventional ultrasound, which upgrades two-dimensional ultrasound to three-dimensional ultrasound, making the scan scope more exhaustive, more three-dimensional, and more comprehensive. According to the results of this study, [10]ABUS has higher sensitivity, specificity, and accuracy for breast tumors and has higher diagnostic advantages compared with conventional ultrasound. Unlike conventional ultrasound, ABUS has better tumor location and image reproduction, and diagnostic physicians can observe and scan multi-faceted images and image characteristics, which makes up for the shortcomings of conventional ultrasound with significant operator dependence and makes diagnostic data more standardized. In addition, ABUS implements coronal imaging, which provides new lesion information for clinical breast diagnosis, especially for identifying small lesions. ABUS dramatically improves the detection rate and accuracy of breast tumors with high-frequency probes, which can meet the exploration of breast tissue in most patients. Shi Mingli et al. also indicated in their meta-analysis that ABUS is a new diagnostic mode that can provide storage and reconstruction of three-dimensional data, which can display complete breast images of female breasts, give diagnostic physicians a coronal perspective, and help surgeons obtain a high-precision surgical field of view. Abus has outstanding advantages in distinguishing benign and malignant tumors and has a higher viewpoint than these studies.

In conclusion, ABUS has high diagnostic efficiency in the diagnosis of breast tumors, which solves many shortcomings of conventional ultrasound, such as significant operator dependence, poor tumor localization, easy-to-miss small lesions, insensitivity to small calcification, and poor repeatability, and facilitates doctors to understand further the breast structure and lesion characteristics of female patients. In particular, it has a unique advantage in identifying benign and malignant tumors. It can be used as an essential method for early screening of breast cancer in women, which is worth recommending.

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