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# To Explore the Differential Effect of High-frequency Ultrasound on Breast Fibroma and Breast Cancer

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## Abstract

**Objective:** The diagnosis of breast cancer (BC) lesions is a major factor influencing the treatment of neoadjuvant chemotherapy (NAC). This study evaluated the accuracy of Mammography (MG), ultrasound (US), and magnetic resonance imaging (MRI) in detecting BC lesions during NAC treatment for BC. **Methods:** Our study selected 226 cases of BC patients who were treated and discharged from our hospital between 2021 and 2023 as subjects. The primary diagnosis of these subjects was invasive ductal carcinoma of the breast. They all received NAC and surgical treatment during their hospitalization. Immunohistochemistry was used to determine the molecular type of BC in the subjects. MG, US, and MRI were employed to assess tumor size preoperatively. ROC curves and Pearson correlation analysis were used to evaluate the clinical diagnostic accuracy and significance of the differences. **Results:** In comparison with pathology, the three imaging modalities showed significant differences ($p<0.001$) in detecting tumor size in all tumor groups, HR-/HER2+ groups, and HR+/HER2+ groups. Regarding accuracy, the highest accuracy rates were observed in the HR+/HER2- group, with respective percentages of 86% (nMG=86/108), 85% (nUS=92/108), and 83% (nMRI=89/108). In the HR+/HER2+ group, overestimation of tumor size was more common with MRI and US (48%, 27%). In the TNBC group, underestimation of tumor size was more common with MG (19%). For clinical diagnostic efficacy, ROC curves confirmed that the AUC values of all curves were greater than 0.5. Moreover, the sensitivity of MRI and US was similar to and higher than that of MG detection. The correlation between pathological tumor size and MRI or US was highest in the HR+/HER2+ group ($r=0.767$, $r=0.792$). **Conclusion:** The accuracy and relevance of MG, US, and MRI vary for patients with different molecular types. Compared to MG and US, MRI has a higher correlation with pathology and greater accuracy for various types of patients. Therefore, preoperative MRI examination is more important.

## Keywords

High-frequency ultrasound; Breast fibroma; Breast cancer; Identification effect

Breast fibroma and breast cancer are two major threats to women's breast health. Mammary fibroma is a common benign tumor that is usually not life-threatening but still requires close attention for its changes [1]. Breast cancer is one of the malignant tumors that seriously affects women's physical and mental health and even endangers their lives, with [2] in women aged 45 to 55. Early and accurate identification of breast fibroma and breast cancer is crucial for the development of an appropriate treatment plan and prognosis judgment. High-frequency ultrasound is a non-invasive, painless, radiation-free examination method, that shows the morphology and structure of breast tissue through high-frequency sound waves and can detect breast lesions or abnormal conditions [3]. It usually showed regular

morphology, oval shape, uniform internal echo, and low blood flow signal, while breast cancer showed irregular morphology, unclear boundary, uneven internal echo, rich blood flow, and other signal features [4]. This study aims to deeply explore the differential effect of high-frequency ultrasound on breast fibroma and breast cancer. The report is as follows.

## 1. Data and methods

### 1.1 General information

Thirty-eight patients treated from March 2023 to March 2024 were included in the study, and the patients were divided into a control group (patients with breast cancer) and 19 patients in each group. This study was reviewed and approved by the Medical Ethics Committee of our hospital. The mean body mass index of the control group was (22.74 ± 0.75) kg/m$^2$ (range 19.43~24.87kg/m$^2$); the mean age was (48.52 ± 4.47) (range 25-58 years); 3 junior high school education, 6 high school and technical secondary school education, and 10 college education or above. The average body mass index of the observation group was (22.80 ± 0.69) kg/m$^2$ (range 19.31~24.92kg/m$^2$); the average age was (47.85 ± 4.16) (range 24-59 years); 2 junior high school, 8 high school and technical secondary schools, and 9 college or above. The basic data of the two groups were compared (P> 0.05), and the balance was comparable. Inclusion criteria: the control group was diagnosed as breast fibroma by pathological examination, and the observation group was diagnosed as breast cancer by pathological examination; the clinical data were complete; the patient or family members signed an informed consent. Exclusion criteria: patients with breast hyperplasia and mastitis; pregnant and lactating women; patients with heart disease, liver, kidney, and lung diseases.

### 1.2 Methods

The high-frequency ultrasound examination method is as follows: the probe frequency is set between 9 and 12 MHz. During the examination, the patient was asked to lie in a supine position to fully expose the breast area and bilateral axilla. Scan in multiple directions, including longitudinal, transverse, and oblique cuts. Observe and record the characteristics of the lesion, including the size of the lesion, lesion location, calcification, boundary clarity, internal echo, capsule integrity, etc., and observe the blood flow of the patient within and outside the lesion. Meanwhile, the lymph nodes in the axilla were examined, focusing on the blood flow signal of the lymph nodes as well as the internal morphological structure.

### 1.3 Observing indicators

(1) Statistical accuracy of high-frequency ultrasound diagnosis of breast fibroma and breast cancer. (2) Comparison of high-frequency ultrasound examination characteristics between the two groups. It includes marginal echo, rear echo, internal echo, tumor morphology, resistance index, and beat index.

### 1.4 Statistical treatment

The statistical software SPSS 26.0 is adopted to analyze the data, and the measurement index (resistance index, beat index) is expressed by mean ± standard deviation ($\bar{x} \pm s$), and tested by t-test. Count index (accuracy, edge echo, rear echo, internal echo, tumor morphology ratio). The number of cases/percentage (n /%) is expressed, $\chi^2$- test was used; P <0.05 indicates statistical significance.

## 2. Results

### 2.1 Statistical accuracy of high-frequency ultrasound diagnosis of breast fibroma and breast cancer

By high-frequency ultrasound, 18 of 19 patients in the control group had breast fibroma with a diagnostic accuracy of 94.74%; 17 of 19 patients in the observation group had breast cancer with a diagnostic accuracy of 89.47%.

### 2.2 Comparison of high-frequency ultrasound examination characteristics in the two groups

Compared with the control group, the marginal echo was not smooth, the rear echo was not changed, the internal echo was uneven, and the proportion of tumor morphology was higher (P <0.05); the resistance index and beat index were higher than the control group (P <0.05). As shown in Table 1.

**Table 1. Comparison of high-frequency ultrasound examination characteristics in the two groups**

| Group | Case Number | Margin Echo (n, %) | | Posterior Echo (n, %) | | | Internal Echo (n, %) | |
|---|---|---|---|---|---|---|---|---|
| | | Smooth | Irregular | Unchanged | Enhanced | Attenuated | Homogeneous | Heterogeneous |
| Observation Group | 19 | 1 (5.26) | 18 (94.74) | 11 (57.89) | 6(31.58) | 2(10.53) | 3(15.79) | 16(84.21) |
| Control Group | 19 | 17 (89.47) | 2 (10.53) | 4 (21.05) | 12(63.16) | 3(15.79) | 15(78.95) | 4(21.05) |
| $\chi^2/t$ | - | 27.022 | | 5.467 | | | 15.200 | |
| $P$ | - | 0.000 | | 0.065 | | | 0.000 | |

**Table 1 Continued**

| Group | Case Number | Tumor Morphology (n, %) | | Resistance Index (RI) ($\bar{x} \pm s$) | Pulsatility Index (PI) ($\bar{x} \pm s$) |
|---|---|---|---|---|---|
| | | Regular | Irregular | | |
| Observation Group | 19 | 2 (10.53) | 17 (89.47) | 0.83 ± 0.19 | 1.74 ± 0.26 |
| Control Group | 19 | 16 (84.21) | 3 (15.79) | 0.60 ± 0.16 | 1.31 ± 0.22 |
| $\chi^2/t$ | - | 20.689 | | 4.036 | 5.503 |
| $P$ | - | 0.000 | | 0.000 | 0.000 |

### 2.3 Image characteristics of high-frequency ultrasound

When identifying breast fibroma, the image characteristics of the mass are as follows: regular morphology, no burr or spike, clear boundary from surrounding tissue; round or oval, smooth surface and clear outline; uniform internal echo, low echo or equal echo, rear echo enhancement phenomenon; blood flow signal is not rich, and no blood flow in and around the lesion or only point and rod blood flow signal. The blood flow is abundant in a few masses, mostly in the vigorous growth period; the tumor with focal infarction.

### 2.4 Image characteristics of high-frequency ultrasound

When identifying breast cancer by high frequency ultrasound, the image features are as follows: the mass has an irregular shape and indistinct boundary from the surrounding normal tissue; the edge of the mass is blurred, irregular or burr protruding; the echo inside the mass is lower than the surrounding normal breast tissue, the echo is uneven, and small calcification points often appear inside the mass, and the calcification points are densely clustered together, forming a cluster or linear distribution; the blood flow within the mass is abundant.

## 3. Discussion

Mammary fibroma is a common benign breast tumor that forms [5] mainly by dysplasia of breast fibrocytes. It mostly occurs in women after puberty, especially [6] in young women aged from 20 to 30 years. Breast fibroma can lead to local swelling of the breast, a few patients may appear nipple discharge, breast skin depression or wrinkles. Breast cancer is a malignant tumor of the breast, forms [7] mainly by dysplasia of mammary epithelial cells. Breast cancer can invade the skin, leading to skin peel changes, dimples symptoms, etc., some breast cancer patients can appear nipple hemorrhage or purulent fluid [8]. It is important to distinguish breast fibroma and breast cancer, which can not only ensure timely, accurate and appropriate treatment, but also reduce the psychological burden of patients, prevent complications and recurrence, and improve the utilization efficiency of medical resources.

High-frequency ultrasound technology is based on the characteristics of different propagation speed of sound waves in different media. When the ultrasonic wave spreads inside the measured object, it will encounter different dielectric boundaries, part of the energy will be reflected back, and part of the energy will continue through the measured object [9]. By measuring the time and amplitude of the reflected sound waves, the internal structure and

properties of the measured object can be obtained. As a non-invasive examination modality, high-frequency ultrasound does not cause any harm to the patient. In the breast disease diagnosis, high-frequency ultrasound can clearly show the tiny structures and lesions within the breast tissue. The results of [10] show that using high-frequency ultrasound to diagnose early breast cancer can achieve high accuracy, specificity and sensitivity. The results of this study showed that the accuracy of high-frequency ultrasound was 94.74% and 89.47% of breast cancer. It can be seen that high-frequency ultrasound diagnosis of breast fibroma and breast cancer are relatively high accuracy. High-frequency ultrasound uses high-frequency sound waves for imaging, which can clearly show the subtle structure of breast tissue. Doctors can observe the size, shape, location and the distribution of blood flow signals in real time, which helps to improve the accuracy of diagnosis. The results of this study showed that compared with the control group, the marginal echo was not smooth, the posterior echo was uneven, and the proportion of tumor morphology was higher ($P < 0.05$); the resistance index and beat index were higher than the control group ($P < 0.05$). Breast cancer is usually characterized by irregular morphology, unclear boundary, uneven internal echo, and rich blood flow signals on high-frequency ultrasound images. Breast fibroma usually presents as a mass with clear border, regular morphology and homogeneous internal echo. The above characteristic differences provide an important diagnostic basis for high frequency ultrasound in distinguishing breast fibroma and breast cancer. As a non-invasive examination method, high-frequency ultrasound has no radiation damage to patients and is easy to operate, making it the preferred method for screening and diagnosis of breast diseases, especially for patients who need frequent monitoring of condition changes.

In conclusion, using high-frequency ultrasound to identify breast fibroma and breast cancer has a high value, which has different characteristics in terms of high-frequency ultrasound images.

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