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# Application of AI-assisted Breast Ultrasound Technology in Breast Cancer Screening

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**Abstract:** To explore the application effect of artificial intelligence-assisted breast screening ultrasound technology in breast cancer screening. Methods 170 suspected breast cancer patients who underwent breast ultrasound examination in our hospital from July 2022 to June 2024 were retrospectively analyzed, and the results of breast biopsy were taken as the gold standard by physician analysis, artificial intelligence analysis, and combined artificial intelligence analysis. To compare the application effect of ultrasonography in breast cancer screening in three ways. Results Among 170 suspected breast cancer patients, 132 were positive, 38 were negative, 113 were true positive, and 29 were true negative. Sensitivity was 85.61%, specificity was 76.32%, consistency was 83.53%, positive predictive value was 92.62%, and negative predictive value was 60.42%. There were 124 true positive cases and 33 true negative cases, the sensitivity was 93.94%, the specificity was 86.84%, the consistency was 92.35%, the positive predictive value was 96.12%, and the negative predictive value was 80.49%. The results showed that 131 cases were true positive, and 37 were true negative. The sensitivity was 99.24%, the specificity was 97.37%, the consistency was 98.82%, the positive predictive value was 99.24%, and the negative predictive value was 97.37%. Taking the results of breast puncture biopsy as the "gold standard," the diagnostic sensitivity, specificity, consistency, positive predictive value, and negative predictive value of physician-combined artificial intelligence analysis were significantly higher than those of physician-only analysis or artificial intelligence analysis. Conclusion The application of AI-assisted breast screening ultrasound technology to breast cancer screening in our hospital not only helps to realize the consistency and accuracy of early identification and diagnosis of breast cancer so that patients can get more accurate treatment but also helps to reduce the workload of radiologists.

**Keywords:** Artificial Intelligence; Ultrasound Technique for Breast Screening; Breast Cancer; Screening Work.

## 1. Introduction

Breast cancer is the most common malignant disease in female mammary glands in China. It is a malignant phenomenon in which cells proliferate out of control under the action of a variety of carcinogens in the lobular or ductal epithelium of the mammary gland. Breast lumps, orange skin changes, nipple position changes, discharge, and other symptoms usually occur [1-2]. The cause of breast cancer is not clear, mainly due to genetics, environment, sex hormones, lifestyle, dietary habits, and other factors superposition, so the incidence of breast cancer is on the rise, and the age of onset is becoming younger. The early symptoms of breast cancer do not have typical characteristics, and if not screened in time, it is usually in the advanced stage at the first diagnosis. The cancer cells have metastasized to the brain, lung, bone, and other tissues or organs, missing the best treatment opportunity and posing a significant threat to the life and health safety of women [3]. In recent years, China has continuously increased its attention to preventing and treating "two cancers," and the public's health awareness has also been enhanced. Some studies have shown that early identification, diagnosis, and effective treatment of breast cancer have positive significance in prolonging the survival period of patients and improving the quality of prognosis [4-5]. At present, the methods of breast cancer diagnosis include magnetic resonance imaging, breast biopsy, X-ray examination, ultrasound examination, etc. Among them, ultrasound examination is an ideal means of screening for early breast cancer, which is non-invasive, economical, repeatable, convenient to operate, and can clearly show the size and shape of the lesion. However, the screening results are easily affected by subjective factors such as sonographers' technical level and experience [6]. Artificial intelligence technology has gradually emerged in the medical field with the iterative update of computer technology, bringing new opportunities for auxiliary breast screening ultrasound technology. Therefore, this paper will randomly select 170 suspected breast cancer patients who went to our hospital for breast ultrasound examinations from July 2022 to June 2024. To explore the application effect of artificial intelligence-assisted breast screening ultrasound technology in breast cancer screening.

## 2. Methodology

### 2.1. General Information

The primary data of 170 suspected breast cancer patients who underwent breast ultrasound examination in our hospital from July 2022 to June 2024 were retrospectively analyzed, with the age range of 35 to 69 years old, average age of (49.96±2.87) years old, weight of 42 to 83kg, average weight of (60.15±3.36) kg. We used the doctor's analysis, the artificial intelligence analysis, and the doctor's joint artificial intelligence analysis. The Ethics Committee of our Institute has approved this study.

Inclusion criteria: (1) All enrolled patients came to the hospital for breast ultrasound due to symptoms such as breast tenderness, local mass, nipple discharge, and orange peel skin changes and voluntarily underwent breast puncture biopsy for further confirmation; (2) The patient is informed of the

purpose and content of the study and signs the informed consent; (3) The patient had complete clinical data and no diagnostic contraindications. Exclusion criteria: (1) pregnant or lactating women; (2) There are prostheses in the breast; (3) did not receive relevant surgery, chemoradiotherapy and other intervention treatment before examination; (4) severe liver, kidney and other organ dysfunction; (5) Ultrasonic image quality does not meet diagnostic requirements; (6) The same section contains multiple lesions or one section cannot show complete lesions; (7) Mental dysfunction, poor compliance.

## 2.2. Specific Methods

Color Doppler ultrasound diagnostic instrument (produced by Royal Philips of the Netherlands, model:) used by doctors who have worked in the hospital for more than five years EPIQ7) for the examination of the patients in the study, the patients were placed in a supine position with their hands above the head, to fully expose their lower neck, bilateral underarms, and breasts. The probe frequency was set at 7 ~ 12MHz, and the probe with coupling agent was directly contacted with the patients' skin, starting from the direction of 12 o 'o'clock of the breast. Transverse, longitudinal, and sector sections were scanned successively. When an abnormal echo signal or mass phenomenon was detected, the mode was switched (3D), the patient was told to hold his breath for about 10 seconds, and the lesion was further examined with the probe to ensure the 3D volume image was generated clearly. The uniformity of the internal echo, maximum diameter line, edge clarity, morphological regularity, and mass blood flow were recorded. Finally, the obtained images and data are fully imported into the storage instrument, which is convenient for subsequent reference.

With the results of breast puncture biopsy as the "gold standard," two imaging doctors with less than five years of experience (less than five years) independently read and interpreted the results of breast ultrasound detection of enrolled patients. If there are differences of opinion, the two doctors will discuss it together and reach a unified conclusion. The images and data obtained by color ultrasound were imported into the artificial intelligence system, and the results of breast ultrasound detection of enrolled patients were interpreted by it. After a 4-week washout, the two physicians who participated in the film reading were analyzed by artificial intelligence and re-interpreted the film independently. Three kinds of interpretation results were compared and analyzed: sensitivity, specificity, consistency, positive, and negative.

## 2.3. Observation Indicators:

Compared with the results of breast puncture biopsy, the number of actual positive cases and true negative cases of breast cancer detected by ultrasonography assisted by three screening methods (physicians, artificial intelligence, and physician-combined artificial intelligence analysis and reading) were recorded. The sensitivity, specificity, consistency, positive predictive value and negative predictive value of the three methods were compared and analyzed.

## 2.4. Statistical Methods

The study data were input into SPSS24.0 for analysis. Measurement data conforming to normal distribution were represented by mean ± standard deviation (x±s), and T-test was used to compare groups. The ratio of counting data (%) was represented by the X2 test, and $P < 0.05$ was considered statistically significant.

# 3. Results and Discussion

## 3.1. The Use of Sections to Divide the Text of The Paper is Optional and Left as a Decision for the Author

Where the author wishes to divide the paper into sections, the formatting shown in Table 2 should be used.

Comparison of the diagnostic results with those of breast puncture biopsy Among 170 suspected breast cancer patients, 132 cases were positive, 38 cases were negative, 113 cases were confirmed positive, and 29 cases were true negative after breast biopsy. The sensitivity was 85.61%, the specificity was 76.32%, the consistency was 83.53%, the positive predictive value was 92.62%, and the negative predictive value was 60.42%. See Table 1.

**Table 1.** Comparison between the diagnostic results of doctor's analysis and the results of breast puncture biopsy

| Methods | | Breast puncture biopsy results | | Number |
|---|---|---|---|---|
| | | Positive | Negative | |
| diagnose | Negative | 113 | 9 | 122 |
| | Positive | 19 | 29 | 48 |
| Number | | 132 | 38 | 170 |

## 3.2. Artificial Intelligence Analysis of the Diagnostic Results and Breast Biopsy Results Compared

**Table 2.** Comparison between AI analysis image diagnosis results and breast puncture biopsy results

| Methods | | Breast puncture biopsy results | | Number |
|---|---|---|---|---|
| | | Positive | Negative | |
| **AI medical image analysis** | Positive | 124 | 5 | 129 |
| | Negative | 8 | 33 | 41 |
| Number | | 132 | 38 | 170 |

Taking breast puncture biopsy as the "gold standard", 124 cases of true positive and 33 cases of true negative were diagnosed by artificial intelligence analysis, with sensitivity of 93.94%, specificity of 86.84%, consistency of 92.35%, positive predictive value of 96.12% and negative predictive value of 80.49%, as shown in Table 2.

### 3.3. The Doctor Combined with AI to Analyze the Diagnostic Results of Reading Medical Image and Compare the Results of Breast Puncture Biopsy

Taking breast puncture biopsy as the "gold standard," 131 cases of true positive and 37 cases of true negative were diagnosed by physicians combined with artificial intelligence analysis, with sensitivity of 99.24%, specificity of 97.37%, consistency of 98.82%, positive predictive value of 99.24% and negative predictive value of 97.37%, as shown in Table 3.

**Table 3.** Comparison between AI analysis image diagnosis results and breast puncture biopsy results

| Methods | | Breast puncture biopsy results | | Number |
|---|---|---|---|---|
| | | Positive | Negative | |
| **AI- medical image analysis** | Positive | 131 | 1 | 132 |
| | Negative | 1 | 37 | 38 |
| Number | | 132 | 38 | 170 |

### 3.4. Comparison of Diagnostic Efficacy of Doctor's Analysis of Medical Image and AI Analysis of Medical Image

Taking the results of breast puncture biopsy as the "gold standard," the diagnostic sensitivity, specificity, consistency, positive predictive value, and negative predictive value of physician-combined artificial intelligence analysis were significantly higher than those of physician-only analysis or artificial intelligence analysis, as shown in Table 4.

**Table 4.** Comparison of diagnostic efficacy of medical images analyzed by physicians and artificial intelligence (e.g., %)

| Methods | Sensitivity(%) | Specificity(%) | Consistency(%) | Positive predictive value(%) | Negative predictive value(%) |
|---|---|---|---|---|---|
| Doctor | 85.61(113/132) | 76.32(29/38) | 83.53(142/170) | 92.62(113/122) | 60.42(29/48) |
| AI | 93.94(124/132) | 86.84(33/38) | 92.35(157/170) | 96.12(124/129) | 80.49(33/41) |
| Combination of both | 99.24(131/132) | 97.37(37/38) | 98.82(168/170) | 99.24(131/132) | 97.37(37/38) |

### 3.5. Discussion

Breast cancer is a malignant disease, the early symptoms of the disease are hidden, often found in the late stage, cancer cells can metastasize, resulting in damage to multiple organs or tissues, threatening women's life and health safety, therefore, early detection, early diagnosis, early treatment is the key to reduce mortality. At present, ultrasonography is an ideal means of screening for early breast cancer. However, the long training cycle of ultrasonographers leads to shortage of human resources, heavy workload, and uneven technical level and experience of physicians, which makes the coverage of early screening relatively limited and prone to errors in screening results [7]. With the iterative update of computer technology, emerging artificial intelligence has gradually emerged in the medical field due to its advantages of automation, accuracy and rapid processing of large data sets, especially in imaging diagnosis. It collects massive data for deep learning through the comprehensive use of computer, statistics, mathematics, image processing and analysis and other technologies. By imitating human thinking information and intelligent behavior, imaging information can be automatically identified, and functions such as classification, quantification and prioritization can be quickly realized, which greatly alleviates the shortage of sonographers, reduces the differences among ultrasound operators, and improves the efficiency of film reading and screening accuracy [8-9].

## 4. Conclusion

In conclusion, our hospital selected suspected breast cancer patients for research, the research results showed that with the results of breast puncture biopsy as the "gold standard", doctors analyzed the film and diagnosed 113 cases of true positive and 29 cases of true negative, and artificial intelligence analyzed the film and diagnosed 124 cases of true positive and 33 cases of true negative. Doctors combined with artificial intelligence analysis of the diagnosis of true positive 131 cases, true negative 37 cases; The diagnostic efficiency of physicians combined with artificial intelligence is significantly higher than that of physicians alone or artificial intelligence alone. It can be seen from the results that AI can be an effective tool to assist in breast cancer screening. The reason for the analysis may be that Chinese women's mammary glands are usually relatively dense, ultrasonic examination to determine the physical properties of the mass is more accurate, two-dimensional ultrasonic judgment is mainly based on the shape, edge, internal echo, micro-calcification, etc., more dependent on the operator scanning techniques and experience, image acquisition is not standardized, poor reproducibility, so that when reading the

film later, It makes the image interpretation subjective, reduces the sensitivity and specificity of diagnosis to a certain extent, and thus affects the judgment result. Three-dimensional ultrasound based on the standardized scan can obtain three-dimensional volume imaging of the whole breast in a short time, generate multiple views, and further automatically identify and measure abnormal or suspicious lesion sites with the help of artificial intelligence image analysis system, help physicians optimize data quality, form a unified standard breast ultrasound diagnostic report, and realize cloud storage and remote image reading. Compared with simple physician reading, it has higher diagnostic sensitivity, specificity, consistency, and positive and negative predictive values [10]. However, artificial intelligence image processing technology still lacks a unified standard, and there are few available and high-quality imaging data, which are susceptible to complex and distorted glandular structures and incomplete contours of tumors. Therefore, there are certain false positives in breast cancer screening [11]. Physicians combined with artificial intelligence-assisted breast screening ultrasound technology can form complementary advantages, reduce the errors caused by different ultrasound operation physicians, assist junior physicians in improving the efficiency of film reading and diagnostic accuracy, and reduce unnecessary biopsies and operations to benefit the breast cancer screening population based on ensuring the quality of screening.

To sum up, AI-assisted breast screening ultrasound technology has a good application effect in breast cancer screening, which not only helps to achieve the consistency and accuracy of early identification and diagnosis of breast cancer so that patients can get more accurate and timely treatment, but also helps to reduce the workload of radiologists and provide valuable information for further clinical diagnosis and treatment, which is worth promoting and applying.

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