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The Application of Dynamic Artificial Intelligence-Assisted Ultrasound Examination in the Diagnosis of Breast Lesions

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Abstract: Early accurate diagnosis of breast lesions is the core link to reducing the harm of malignant breast lesions and improving patients' prognosis. Relying on deep learning, real-time image recognition, and dynamic image analysis technologies, dynamic artificial intelligence-assisted ultrasound examination can intelligently analyze dynamic breast ultrasound images, automatically locate lesions, extract imaging features of lesions, and assist in differentiating benign and malignant lesions, making up for the inherent shortcomings of traditional ultrasound examination from a technical perspective. On this basis, this paper studies the application of dynamic artificial intelligence-assisted ultrasound examination in the diagnosis of breast lesions, analyzes the practical problems existing in traditional ultrasound examination for breast lesion diagnosis, explains the clinical application value of dynamic artificial intelligence-assisted ultrasound examination, and puts forward targeted application countermeasures for technical popularization, so as to promote the steady development of breast lesion diagnosis toward standardization, precision and high efficiency.

Keywords: Dynamic artificial intelligence; Ultrasound examination; Breast lesions; Clinical diagnosis; Auxiliary application

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1. Introduction

Breast diseases are common illnesses among contemporary women. As the main clinical manifestation of hyperplasia of mammary glands, nodules, tumors, and other pathological changes, the benign and malignant identification results of breast lesions directly affect the formulation of patients' treatment plans and the protection of physical and mental health. Breast diseases are characterized by insidious onset and atypical early symptoms, and most malignant lesions evolve from benign lesions. Only through early screening, early identification, and early diagnosis can the risk of severe breast diseases be reduced at the source and the health of female groups be safeguarded. With unique clinical advantages, ultrasound examination meets

the breast screening demands of women of all ages, and is especially suitable for lesion detection in dense breast tissue. It can clearly display the organizational structure of mammary glands, lesion morphology, and the correlation with surrounding tissues, and has long occupied an irreplaceable position in the initial screening and routine diagnosis of breast lesions [1]. Therefore, exploring the application of dynamic artificial intelligence-assisted ultrasound examination in the diagnosis of breast lesions is of great significance.

2. Problems of traditional ultrasound examination in the diagnosis of breast lesions

2.1. Prominent subjectivity in diagnosis and excessive dependence on personal experience

The whole process of traditional breast ultrasound examination centers on manual operation, lacking rigid objective standards for image acquisition quality, identification of lesion features, and judgment of benign or malignant tendency, which leads to strong subjectivity. Sonographic manifestations of breast lesions are diverse and complicated, and the sonographic features of benign and malignant lesions overlap greatly without obvious dividing lines, putting forward high requirements for doctors who need sufficient summarization capability to make accurate disease identification. Due to discrepancies in practical experience and professional knowledge, different doctors may draw vastly different conclusions for the same image. Junior physicians struggle to distinguish subtle structural changes of tumors and are prone to misdiagnosis; senior physicians with abundant experience tend to form fixed thinking modes in diagnosis in the absence of unified criteria [2]. In addition, doctors' working status and psychological factors can influence their image interpretation, making it hard for traditional ultrasonic diagnosis to maintain objectivity and rigorousness all the time, and resulting in unstable overall diagnostic quality.

2.2. Insufficient identification of tiny and occult lesions and limited capacity for early diagnosis

Early breast lesions mostly present as tiny and occult lesions featured by small volume, atypical echo characteristics, indistinct boundaries with normal surrounding mammary gland tissues, and absence of typical signs such as obvious calcification and abnormal blood flow. Conventional manual ultrasonic scanning relies on naked-eye observation and manual inspection by physicians, which hardly captures subtle structural differences in images and easily leads to missed diagnosis. Besides, some lesions are hidden in special positions such as the breast margin and deep gland layers; incomplete scanning range or improper probe angle adjustment by physicians may cause lesion omission. Traditional ultrasound has poor recognition performance for atypical early lesions and lesions with low malignant tendency, and can only detect typical lesions with obvious features, failing to realize ultra-early screening of breast diseases and delaying the optimal diagnosis and treatment timing.

2.3. Inconsistent implementation of diagnostic criteria and poor consistency of clinical diagnosis

Though unified clinical grading diagnostic criteria for breast imaging are available, their implementation varies greatly under traditional manual ultrasonic diagnosis. Medical institutions and clinicians differ in their understanding and judgment of grading standards, lacking unified evaluation criteria for indicators, including lesion boundary regularity, morphological normality, internal echo, and peripheral adhesion. Different diagnosis results for identical ultrasound images are commonplace: the same breast ultrasound

image may obtain totally different grading results and treatment suggestions from different physicians. Such a situation not only causes overdiagnosis of benign lesions, increasing patients' psychological stress and medical expenses, but also may result in missed diagnosis and misdiagnosis of malignant diseases, delaying treatment. Furthermore, ultrasound equipment from different manufacturers adopted in various hospitals brings about inconsistent examination outcomes, hindering data sharing, patient referral, and subsequent follow-up [3].

3. Application value of dynamic AI-assisted ultrasound in breast lesion diagnosis

3.1. Effectively improving overall diagnostic accuracy

Trained by massive breast ultrasound image data, the algorithm of dynamic artificial intelligence-assisted ultrasound examination can build a standardized database of lesion features and get rid of over-reliance on personal experience in manual diagnosis. The system captures and displays real-time images of all scanning phases, automatically marks suspicious areas, and precisely extracts diversified image information, including morphology, marginal features, echo intensity, calcification, and blood flow, detecting subtle abnormalities invisible to human eyes [4]. With unified algorithm-based data processing and benign-malignant risk analysis free from doctors' emotions, experience deviation, and visual fatigue, the intelligent system provides objective and standardized diagnostic references. Combined with patients' clinical symptoms and past medical history, clinicians make comprehensive judgments to effectively lower misdiagnosis and missed diagnosis rates and realize precise, refined, and reliable diagnosis of breast lesions [5].

3.2. Simplifying diagnosis and treatment procedures

Traditional manual breast ultrasound involves cumbersome steps of manual scanning, frame-by-frame image reading, and manual data recording and analysis, consuming a long time for single-case inspection. It cannot satisfy the efficiency demand of large-scale physical examination and mass breast screening for women, causing long waiting queues and insufficient screening coverage. Dynamic artificial intelligence-assisted ultrasound realizes integrated intelligent processing of scanning, imaging, analysis, and annotation, completes standardized full-breast scanning automatically, and generates image analysis reports instantly, greatly simplifying manual workflow and shortening single inspection duration. Operating stably without interruption regardless of human physical limits, the intelligent system efficiently undertakes large-scale screening tasks, expands the coverage of general breast screening, and promotes regular early screening of breast diseases [6].

3.3. Standardizing clinical diagnosis and treatment

Embedded with standardized diagnostic models complying with breast imaging grading specifications, dynamic artificial intelligence-assisted ultrasound quantifies and standardizes the evaluation of various lesion indicators to unify diagnostic criteria among medical institutions of different regions and grades. Both community clinics and large general hospitals can implement diagnosis following unified standards with auxiliary intelligent equipment to eliminate inconsistent interpretation and ambiguous criteria of traditional ultrasound. Meanwhile, the system dynamically monitors scanning procedures and image quality, standardizing probe scanning paths and shooting angles to ensure uniform image collection. Intelligent diagnostic reports support one-click filing and classified archiving for medical record inquiry, inter-hospital

consultation, and follow-up tracking, laying a foundation for programmed, standardized, and normalized development of breast ultrasound examination [7].

4. Application strategies of dynamic AI-assisted ultrasound in breast lesion diagnosis

4.1. Standardizing diagnostic procedures and strengthening whole-process quality control

In accordance with the technical characteristics of dynamic artificial intelligence-assisted ultrasound, the full diagnostic workflow of breast lesions is standardized to strengthen quality management and ensure all diagnostic links conform to clinical specifications [8]. Firstly, formulate standardized diagnostic processes covering ultrasonic scanning of lesion sites, image acquisition, artificial intelligence processing, physician diagnosis, result feedback, and document archiving for future reference. Standardize probe operation routes and manipulation to achieve full coverage of suspicious areas and avoid diagnostic omission or error for a higher lesion detection rate [9]. Secondly, construct a quality assessment system for lesion detection, assign special teams to audit the intelligent system's differential diagnosis capacity and physicians' diagnostic results, especially for small and atypical lesions so as to correct wrong diagnoses timely; standardize medical record contents with mandatory items including lesion features, AI analytical conclusions and doctors' interpretation opinions to form unified and complete documents supporting subsequent clinical treatment and follow-up. Unified standards for dynamic lesion observation are set up to realize dynamic comparison via data storage function for reexamination and curative effect evaluation, forming a closed-loop management system covering screening, diagnosis, and follow-up [10]. Moreover, strengthen supervision over technical application in medical institutions and urge standardized implementation of examinations in line with industrial codes to facilitate normative development of dynamic artificial intelligence-assisted ultrasound technology [11].

4.2. Developing hierarchical professional training to improve practitioners' application capability

The medical staff's operating ability directly determines the clinical application effect of dynamic artificial intelligence-assisted ultrasound, which requires systematic hierarchical training to improve professional skills. First of all, hospitals formulate targeted training plans based on actual conditions for ultrasound practitioners to realize capability matching. For newly employed and junior medical workers, popularized training focuses on intelligent equipment operation, basic image reading, intelligent report interpretation, and common lesion identification to help them master core techniques for routine examination and preliminary diagnosis. For senior radiologists and backbones, training highlights algorithm principles, intelligent result analysis, human-machine collaborative reading, and differential diagnosis of complicated lesions, guiding rational utilization of AI tools without blind dependence or complete rejection of intelligent assistance to maximize the value of artificial intelligence while improving personal diagnosis level [12]. In addition, organize training through seminars, case discussions, practical operations, and remote teaching with lectures delivered by specialists from the medical imaging and artificial intelligence industries; display typical clinical cases and provide human-machine interactive experience of AI-assisted diagnosis to accelerate practitioners' proficiency in relevant technology. Build WeChat groups for doctors to exchange experiences and solve

practical problems together, and create a mutually improving working atmosphere. Incorporate technical proficiency into performance appraisal to motivate active learning and fully release the application value of the technology [13].

4.3. Promoting multidisciplinary collaboration to expand technical application scope

As an independent diagnostic tool, dynamic artificial intelligence-assisted ultrasound needs multidisciplinary cooperation to integrate medical resources, expand applicable scenarios, and elevate clinical value. Firstly, boost interdisciplinary collaboration between the ultrasound department and breast surgery, pathology, medical imaging, oncology, and other disciplines to build multidisciplinary treatment (MDT) teams. Integrate real-time AI-assisted ultrasonic diagnosis data with pathological examination, mammography, breast MRI, and other inspection results for comprehensive assessment to improve diagnostic accuracy and formulate individualized treatment plans. Combined application of multiple testing methods overcomes the limitations of a single examination and improves the overall diagnosis and treatment level of breast diseases [14]. Secondly, expand application scenarios beyond routine breast lesion screening and diagnosis to follow-up monitoring and curative effect evaluation. The technology dynamically tracks changes in lesion size and hemodynamic parameters to assess treatment outcomes and adjust therapeutic regimens in a timely manner for scientific evidence of subsequent treatment. It is also applicable in regular screening of high-risk groups with family inheritance history and endocrine disorders to increase the early detection rate of breast cancer and realize early diagnosis and treatment. Thirdly, facilitate the technical integration of artificial intelligence, 5G, big data, and telemedicine to realize remote diagnosis, automatic follow-up tracking, and case sharing, popularize the technology, especially in grassroots hospitals, and comprehensively improve the diagnosis and treatment capacity of breast diseases [15].

5. Conclusion

In summary, as an important integration achievement of smart medical care and medical imaging, dynamic artificial intelligence-assisted ultrasound examination has outstanding clinical advantages in improving diagnostic accuracy, boosting screening efficiency, unifying diagnostic criteria, and standardizing treatment procedures, providing an innovative technical route for early screening and precise diagnosis of breast lesions, and bearing practical significance for protecting women's breast health. Relevant authorities should improve industrial specifications, optimize equipment algorithms, implement hierarchical professional training, and strengthen data privacy protection to promote standardized clinical promotion of this technology. In future development, artificial intelligence technology shall be further integrated into a multidisciplinary diagnosis mode and applied throughout the whole chain of breast lesion screening, diagnosis, follow-up, and efficacy evaluation.

Disclosure statement

The authors declare no conflict of interest.

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