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Application of MRI-ultrasound Image Fusion Targeted Puncture in Suspicious Breast Lesions

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Abstract

Based on the existing studies using MRI-ultrasound (MRI-US) image fusion for targeted biopsies of suspicious breast lesions, this paper summarises their progress and achievements. Combining high-resolution anatomy derived from MRI scans with

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excellent soft-tissue resolution in ultrasound images, thus achieving an accurate biopsy-targeting method by fusing both sets of information. Methodically search the databases and rigorously screen the contents of the clinical studies. MR-IU fusion has a high detection rate and low false-negative possibility than MR or US alone; also, the procedure is safer with MRI-US fusion. Technical restrictions of the following type: poor image alignment; variability among algorithm outcomes; accessibility issues remain present. Currently, the trend is to expand its usage. Future directions also include integrating artificial intelligence (AI), achieving automatic analysis, protocol standardisation, reduced costs, and increased global accessibility. Breast cancer is an aggressive tumor disease that has become a global accessibility in the last century; there are also many new drugs being developed today.

Keywords

MRI-ultrasound fusion; breast lesions; targeted biopsy; image registration; diagnostic accuracy.

1. Research Background and Significance

Breast cancer ranks first in global deaths from malignancies and top among all forms of cancer for female patients worldwide. Nowadays, there are still many effective diagnosis tools at different stages for breast diseases with high precision and non-invasiveness involved. Methods of image acquisition generally include: mammography, breast ultrasound and adjacent areas' colour doppler ultrasound scanning, etc. Nevertheless, there are inherent limitations; mammography has a very low sensitivity in densely populated breasts; Ultrasound is highly dependent on the operator and cannot discover lesions that can be observed by MRI. MRI can display the details of breast lesions well because they are highly specific for detecting multiple small areas or even one lump within a group (highly sensitive). MRI-guided biopsy is expensive, inaccessible, takes a long time and causes discomfort to patients because they are in an uncomfortable position. A shortcoming urgently needs addressing in a method to achieve high sensitivities with MRI image technology and practicality through ultrasound examination [1].

MRI-USB-image fusion-based targeted puncture technique has been proposed to address the above problems. Through spatial alignment of preoperative MR imaging with real-time Ultrasound Image, it projects MR-defined suspicious areas on to the Ultrasound screen for subsequent evaluation via US-guided Biopsy. Second-look ultrasound (SLUS), traditional second-look ultrasound technology, fusion technique, reduces the dependence of physicians on subjective experience, lowers medical costs, improves patient comfort, MRI-guided biopsy.

Therefore, from an internal reference perspective in medicine for MR-US fusion imaging technology that aims to increase patient trust in diagnosing mild lesions through accurate biopsy identification. Additionally, combining this with reducing patients' waiting time and starting treatment faster by significantly shortening examination time when combined with US-guided interventional operation triggering points-and-clicks-based automatic diagnostic assistance function [2].

Traditionally, because MRI can detect suspicious breast lesions and ultrasonic examination has been used more often in subsequent checks. SLUS could identify abnormalities in about 30%-80% of the cases. However, the identification rate for different types of lesions, breast density, operator experience, and other factors may vary. Overcoming these shortcomings, subsequently, software-based MRI- US fusion systems became available. Early systems used strict registration; with the advancement of technology, deforming registration algorithms were introduced to adjust tissues due to posture change or probe deformation caused displacement [3]. Furthermore, DWI and ADC sequence functional magnetic resonance imaging

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techniques also participated in fusion for enhancing the specific nature of lesion characterisation to a greater extent. Pilot studies have shown that the fusion-targeted Ultrasound can accurately locate the incidental breast lesions found in chest CT images. Then, follow-up study results showed that fused-guided biopsy outperformed MRI-guided biopsy clinically by improving patient adherence. Magnetic resonance imaging (MRI) US fusion target biopsy can be divided into five stages; that is, firstly acquire and interpret breast MRI, including DCE-DWI sequences; secondly carry out lesions annotation and 3D position in the MRI image; third, realize spatial registration between MRI volume and real-time ultrasound through a specific system; finally, conduct ultrasound score-biopsy, vacuum-assisted biopsy based on this registered information.

Clinical studies have proven to be reliable in terms of both stability and practicability for such a pathway: the technical success rate exceeded 90%; pathology-confirmed agreement reached between 92%-98%. In addition, fused technologies can also be applied to the identified lesions in CEM for a general multimodal tracking system [4]. Current academic research focuses on three directions: (1) evaluate the effectiveness of fusion technology in different patient groups or areas; (2) optimize registration algorithms to reduce deformations and motion errors; (3) introduce deep learning combined with artificial intelligence for automatic tumor segmentation, registration, and diagnosis. Some lesions still do not have good sonographic evidence after merging; the registration accuracy differs among institutions; there is a large learning curve; and the cost of equipment restricts its promotion at general hospitals [5]. In the future, it is expected that there will be some new directions of application for surgical robots.

2. Literature Review

2.1. Search and Collection Strategy

Based on an integrated search for medical literature across PubMed, Embase, Web of Science and the Cochrane library databases. Most of the included literature are clinical trial results, retrospective analyses, systematic reviews, meta-analyses, and other technical documents concerning MRI-US fusion-guided breast biopsies [6]. Search terms include MR- ultrasound fusion, breast lesion; target biopsy, image registration, second-look ultrasound, MRI-guided biopsy, multimodal Imaging, artificial intelligence.

Inclusion criteria were as follows: (1) clinical study on adult women with a suspicion of breast lesions; (2) studies that used MRI-US fusion to intervene or be compared with each other; (3) the study reported clearly results such as the detection rate, diagnostic accuracy, false-negative rate or technical success; (4) peer-reviewed full-text papers published in English. Excluding: (1) basic experimental study without clinical data; (2) single-case report or small-sample research lacking statistical analysis; (3) reviews without original data; (4) studies unrelated to breast lesions.

After a strict screening process, the following summary integrates evidence from more than 20 high-quality studies: prospective controlled trials, large-sample retrospective cohorts, etc. Literature has covered technical principles, workflows, clinical effects, safety, economic evaluations, and development directions for MRI-US fusion; it is comprehensive and representative [7].

2.2. Screening and Evaluation Criteria

Evaluating the quality of each included study from several dimensions: research design; size of sample; control settings; indicator for outcomes; statistical method. Prospective multi-centre trials are at the top of the evidence hierarchy; then follow individual centre prospective, large-sample retrospective, systematic review levels. Key evaluation indicators included:

Technical success rate of image registration;

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Detection rate of sonographic correlates for MRI-detected lesions;

Sensitivity, specificity, positive predictive value, negative predictive value, and AUC;

Concordance rate with pathological results or MRI-guided biopsy;

Procedure time, patient tolerance, and incidence of complications;

Cost-effectiveness compared with traditional methods.

Through systematic analysis, this review confirms that MRI-US fusion has stable and reliable diagnostic performance, with overall superiority over second-look ultrasound and non-inferiority to MRI-guided biopsy [8]. There is also a difference in registration software, operator experience, lesion selection criteria and outcome definition among the studies; Therefore, more standardised protocols need to be formed before being widely promoted.

3. Key Theories and Research Findings

3.1. Major Theoretical Frameworks

The core theoretical basis of MRI-US fusion targeted puncture is multi-modal medical image registration. Image registration is an operation for finding corresponding points among several images taken under different circumstances to determine whether these body parts are the same one. To align preoperative MRI in the prone position not subjected to compression with interventional ultrasound performed at a supine position after probe compression to eliminate posture, tissue displacement and scanning parameters differences [9].

Rigid registration algorithms, as well as deformable registration algorithms. Rigid registration is only translation and rotation; when there is a slight tissue displacement in the scene, this method may be inappropriate. Deformable registration adjusts for local tissue displacement by applying an elastic transformation or using a biomechanical model [10]. Theoretical strength refers to the transformation of cognitive correlation (subjective judgment) into digital spatial correlation (object-based position) and thus avoiding errors made by humans, and to improve accuracy.

From a clinical theoretical perspective, MRI-US fusion bridges the complementary advantages of two modalities:

MRI: high sensitivity, clear display of non-mass enhancement and multifocal lesions, functional parameters such as DWI/ADC;

Ultrasound: real-time operation, low cost, no radiation, convenient biopsy, good patient tolerance.

Complementarily aligns with the development direction of precision medicine in terms of sensitivity of imaging tests for diagnosis and convenience of use for treatment; maximize the effectiveness and cost-effectiveness of diagnosis [11].

Technological ecology: diagnosis and imaging of breast disease form an organised hierarchical system as follows: conventional screening (mammography, ultrasound); advanced detection (MRI, CEM); precise intervention (fusion biopsy, MRI-guided biopsy). MRI-US fusion plays an important role at present as it resolves issues of connecting with high sensitivity of detection and cost-effectiveness of intervention [12].

First, MRI and MRI-US fusion have the highest sensitivity, which is crucial for early and occult lesions. Second, high-access and low-cost techniques are responsible for population-based screening, while high-precision techniques are used for suspicious cases. Third, MRI-US fusion eliminates the weaknesses of second-look ultrasound (instability) and MRI-guided biopsy (high cost), achieving a balance in accuracy, efficiency, and economics. Fourth, AI and multi-modal integration are becoming the core driving forces for technological upgrading, which will further improve the clinical application value of fusion systems.

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Table 1. Breast Cancer Diagnostic Techniques Comparison

Technique	Sensitivity	Key Limitations	Core Advantages	Cost & Accessibility	Clinical Use Case
Mammography	↓ (dense breasts)	Low sensitivity in dense breasts	Widely adopted	↑↑ (high access, low cost)	Routine screening
Conventional US	→	Misses non-visible lesions	Real-time characterization	↑↑ (high access, low cost)	Lesion evaluation
MRI	↑↑	High cost; no real-time biopsy	Detects occult lesions	↓↓ (low access, high cost)	High-risk patients
MRI-guided Biopsy	↑	Costly; uncomfortable; slow	Accurate for MRI-only lesions	↓↓ (very high cost)	Occult lesions
Second-look US	→	Variable detection rate	Low-cost correlation	↑↑ (high access, low cost)	MRI follow-up
MRI-US Fusion	↑↑	Registration challenges	High accuracy; patient-friendly	→ (moderate cost)	Targeted biopsy
CEM	↑	Requires contrast	Strong in dense breasts	→ (moderate access)	Dense-breast diagnosis
CEUS	→	Adjunct use	Supports fusion targeting	→ (moderate cost)	Targeted guidance
AI-Integrated Systems	↑	Requires validation	Reduces operator dependence	→ (variable cost)	Diagnostic support
Portable Impedance	→	Screening only	Low-cost, portable	↑↑ (high access)	Prescreening

3.2. Review of Key Findings

3.2.1. Diagnostic Efficacy

Many clinical studies have confirmed that MRI-US fusion significantly improves the detection efficiency of sonographic correlates for MRI-detected lesions [13]. Compared with second-look ultrasound, fusion technology increases the detection rate by 15%-30% and reduces the false-negative rate by about 19%. The concordance rate between fusion-guided biopsy and pathological results or MRI-guided biopsy is 92%-98%, indicating equivalent diagnostic accuracy.

For MRI-only lesions (occult on conventional ultrasound), fusion-guided biopsy achieves a diagnostic success rate of more than 80%, and the positive rate of malignant pathology is consistent with expected clinical risk. Functional MRI showed that a higher specificity (from 0.83 to 0.92) was obtained by integrating DWI/ADC parameter differences with fused-navigate technology; thus, the number of biopsies needed for differentiation between benign and malignant lesions was reduced accordingly.

3.2.2. Technical Feasibility and Safety

MRI- US fusion registration has a technical success rate over 90 per cent. Within about half an hour, it's typically finished more quickly than MRI-guided biopsies [14]. The patients are lying

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flat to reduce discomfort and complications such as hematoma formation, pain and infections. Many sites of damage can be obtained in a single visit.

The clinical two technical routes are as follows: electromagnetic or optical tracking-based fusion; and freehand-image-based fusion. Tracker-based fusion has good robustness and learning curves, but it is expensive; Freehand Fusion requires no extra equipment to assist, thus being relatively low-cost while having comparable accuracy when used by an expert.

3.2.3. Value of AI and Functional Imaging

AI technology is profoundly changing the development of fusion systems. Deep learning models can automatically divide the lesions on MRI images. Optimise the setting of Registration parameters. Classify benign and malignant tumours in an instant, etc. According to the proactive research, AI support can improve diagnostic performance of breast ultrasound imaging by radiographers without sufficient experience; diagnostic accuracy, sensitivity, and specificity have both improved notably. Explainable AI provides a visualised decision-making tool to increase clinical acceptability and practicality [15].

In addition, multi-modal fusion has expanded from MRI-US to CEM-US and CEUS-US. CEUS can enhance the recognisability of tumours on ultrasound and thus increase the accuracy of fused biopsies. An unenhanced MRI fusion image (DWI + T2WImax) is also available in these cases of contraindication against Gadolinium-based contrast agents.

3.2.4. Challenges and Constraints

Although the efficacy is clear, clinical promotion still faces challenges:

(1) Tissue deformation and registration error: breast shape differs greatly between prone MRI and supine ultrasound, leading to positioning deviation.

(2) Invisible lesions: some non-mass enhancements and extremely small lesions still lack sonographic correlates.

(3) Operator dependence: registration quality and targeting accuracy are affected by experience.

(4) Cost and accessibility: high software and hardware costs limit application in low-resource areas.

(5) Lack of standards: no unified protocols for image acquisition, registration, quality control, and reporting.

3.2.5. Academic Value and Clinical Significance

From an academic perspective, MRI-US fusion represents a new model of interventional imaging based on multi-modal integration, breaking the boundaries of single-modality diagnosis and promoting the development of cross-disciplinary research including radiology, ultrasound, computer science, and artificial intelligence [16]. From a clinical perspective, this technology promotes the popularization of precision biopsy, reduces over-diagnosis and missed diagnosis, optimizes medical resource allocation, and ultimately benefits more patients.

4. Professional Expansion and In-depth Academic Analysis

4.1. Professional Knowledge Expansion: Image Registration Principles and Mathematical Models

Image registration is the core technical support of MRI-US fusion, which can be further subdivided into four levels from the professional perspective of medical imaging engineering:

(1) Feature space: including anatomical landmarks, voxel gray value, edge contour, texture feature, etc.

(2) Search space: including rigid transformation (6 degrees of freedom), affine transformation, projective transformation, and deformable transformation.

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(3) Similarity metric: including mutual information, normalized cross-correlation, gradient difference, and statistical distribution matching.

(4) Optimization strategy: including gradient descent, particle swarm optimization, and greedy algorithm.

Deformable registration of breast-fusion applications primarily relies on biophysical models to represent tissue deformation. The model assumes that breast tissue is an inelastic material, establishes its physical field equation for calculating the deformation of tissue under postural changes and probe compressions; thus, obtaining high precision spatial fit [17]. The improvement in target selection for non-mass-enhancement lesions and deep lesions directly achieved by this specialisation.

4.2. Professional Knowledge Expansion: DWI/ADC Quantitative Application in Fusion Navigation

According to the view that function-imaging studies have provided some quantitative indicators in this study:

Low ADC value: indicates high cell density, high probability of malignancy.

ADC histogram parameters: mean, median, percentile, kurtosis, etc., can improve the specificity of lesion characterization.

In the fusion workflow, ADC mapping can be used to:

Assist in defining the scope of lesions on MRI.

Predict the visibility of lesions on ultrasound.

Evaluate the adequacy of biopsy sampling.

Monitor early response after neoadjuvant therapy.

This quantitative expansion makes the fusion technology move from simple anatomical positioning to functional positioning, which is an important direction of precision diagnosis.

4.3. In-depth Academic Analysis: Comparative Effectiveness and Evidence-Based Medicine

Table 2. Comparative study of MRI-US fusion vs. second-look ultrasound vs. MRI-guided biopsy

Indicator	MRI-US Fusion	Second-look Ultrasound	MRI-guided Biopsy	Evidence Level
Detection rate of MRI lesions	80%-95%	30%-80%	95%-100%	High
Diagnostic accuracy	92%-98%	75%-90%	95%-100%	High
Procedure time	15-30 min	10-20 min	45-90 min	Medium
Patient tolerance	Good	Good	Poor	High
Cost level	Moderate	Low	High	High
Operator dependence	Medium	High	Medium	Medium
Suitable for non-mass lesions	Moderate	Low	High	Medium

From the perspective of evidence-based medicine, MRI-US fusion has achieved a balanced advantage in accuracy, efficiency, and economics. It is superior to second-look ultrasound in stability and detection rate, and superior to MRI-guided biopsy in cost and comfort [18]. It is especially suitable for large-scale promotion in general hospitals and breast centers. The core

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academic value lies in solving the long-standing clinical problem of "MRI can detect but cannot conveniently intervene."

4.4. In-depth Academic Analysis: Clinical Value and Health Economics

From the perspective of health economics, MRI-US fusion has obvious advantages:

(1) Reduce the number of expensive MRI-guided biopsies by 50%–70%.

(2) Shorten the time from imaging to pathological diagnosis.

(3) Reduce the number of re-biopsies caused by inaccurate targeting.

(4) Improve patient satisfaction and medical experience.

(5) Optimize the allocation of medical imaging resources.

Academic studies have shown that the use of fusion technology can reduce the per capita diagnostic cost of patients with MRI-detected lesions by about 30%, which has significant social and economic benefits.

4.5. In-depth Academic Analysis: Limitations and Academic Controversies

Current academic controversies mainly focus on:

(1) Registration error: breast contouring is still relatively lacking in technology currently.

(2) Non-mass enhancement lesions: the sonographic correlation rate is still low.

(3) Learning curve: it takes 50–100 cases to achieve stable operation.

(4) Equipment threshold: it has a large starting-out cost.

These controversies reveal which directions to pursue in subsequent research. More rigorous deformable registration, AI-assisted diagnosis, simple devices and standardised training.

5. Research Methods

5.1. Commonly Used Methods Overview

MRI-U-S fusion-guided biopsy targeting, as an interventional medical imaging technology with clear operating procedures and operational experience. To establish the spatial coordinates of the imaging data obtained in various scanning directions using image-registered technology, and then guide Ultrasound accurately reach the disease target specified by MRI.

Commonly used registration methods include:

(1) Landmark-based registration: anatomise points such as the nipple, vessel bifurcation and cyst to facilitate spatial registration.

(2) Intensity-based registration: use voxel grayscale features to calculate the optimal transformation.

(3) Feature-based registration: extract structural features such as edges and textures for matching.

(4) Biomechanical model-based deformable registration: simulate breast tissue compression and deformation to improve accuracy.

According to hardware configuration, it is divided into:

Tracker-based fusion: give a correct result to verify that it differs from the previous inaccurate results.

Freehand fusion: based on software algorithm, no tracking device, low cost, high flexibility.

The standard clinical procedure is:

(1) Complete breast MRI (DCE and DWI sequences) and determine suspicious lesions (BI-RADS 4 or 5).

(2) Import MRI data into the ultrasound fusion workstation and mark the lesion area.

(3) Perform ultrasound scanning under supine position and complete image registration.

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(4) Under fusion navigation, locate the lesion on ultrasound and perform core needle or vacuum-assisted biopsy.

(5) Record pathological results and evaluate registration accuracy and diagnostic efficacy.

5.2. Application and Comparative Analysis

5.2.1. Comparison with Second-look Ultrasound

The second-time ultrasound simply relies on the operator's memory and anatomic judgment; therefore, it is highly inconsistent. MRI-UF fusion technology integrates digital spatial registration, ensuring target localization accuracy to enhance stability and reliability of diagnosis for non-segmentable small, deeply lesioned areas [19].

5.2.2. Comparison with MRI-guided Biopsy

MRI-guided biopsy is the gold standard for MRI-only lesions, but high cost, long time, prone position, and low patient tolerance. Fusion-guided biopsy has equivalent accuracy, with lower cost, shorter time, better comfort, and wider application scenarios.

5.2.3. Comparison with CEM and CEUS

CEM has high sensitivity in dense breasts, but biopsy still needs ultrasound or mammography guidance [20]. CEUS can improve lesion visualization on ultrasound. MRI-US fusion can be combined with CEM and CEUS to form a multi-modal diagnostic and interventional platform, further improving diagnostic confidence.

5.2.4. Clinical Applicability Analysis

MRI-US fusion is suitable for:

Lesions detected by MRI but not found by conventional ultrasound

BI-RADS 4 lesions requiring pathological confirmation

Dense breast patients with high risk

Patients intolerant to MRI-guided biopsy

Preoperative localization and minimally invasive treatment guidance

It is not suitable for lesions that are still invisible after fusion or patients unable to cooperate with ultrasound scanning.

6. Current Status and Trends

6.1. Current Status and Critiques

At present, MRI-US fusion has been widely used in tertiary hospitals and specialized breast centers in Europe, America, and East Asia, and has been included in clinical guidelines by many radiology and ultrasound organizations as a recommended technique for MRI-detected lesions. Real-world data show that fusion technology reduces the number of MRI-guided biopsies by 50%-70%, improves diagnosis efficiency, and reduces medical costs [21].

However, there are still criticisms and controversies:

(1) Uneven clinical application: Operator experience varies greatly, and registration quality is unstable.

(2) Lack of real-world data in primary hospitals: Most of the research comes from major centres, lacking verification in communities.

(3) Difficulty in non-mass lesions: Non-mass-enhancement lesions cannot be seen clearly in Ultrasound imaging.

(4) Economic evaluation is insufficient: Long-term cost-effectiveness and health economic data need to be supplemented.

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6.2. Challenges and Issues

6.2.1. Technical Challenges

Breast deformation leads to registration error

Motion artifact affects stability

Some lesions have no sonographic correlates

Algorithm differences lead to inconsistent performance

6.2.2. Clinical Challenges

Operator learning curve is long

Standardized training system is incomplete

High equipment cost limits popularization

Lack of unified quality control standards

6.2.3. Academic Challenges

Methodological heterogeneity among studies

Lack of large-sample prospective randomized controlled trials

Insufficient research on AI integration and long-term prognosis

6.3. Future Directions and Trends

6.3.1. Intelligent Automation

It can achieve the entire process of automatic operation for lesions, automatic registration of images, automatic detection of sonographic visibility, etc., to improve doctors' workload and accuracy.

6.3.2. Deformable Registration Optimization

Biomechanical model building combined with artificial intelligence-assisted elastic re-optimisation to improve the accuracy of target location.

6.3.3. Multi-parametric and Multi-modal Fusion

Fusion of DWI, ADC, CEUS, CEM, and radiomics will provide comprehensive characterization and improve specificity.

6.3.4. Low-cost and Portable Solutions

Cloud computing, simplified software, and freehand fusion will reduce costs and promote application in primary hospitals and low-resource areas.

6.3.5. Standardization and Guideline Development

Global consensus protocols for acquisition, registration, quality control, and training will be established to promote standardized development.

6.3.6. Expansion to Therapeutic Applications

Fusion navigation will be used for minimally invasive ablation, intraoperative localization, lymph node mapping, and treatment response monitoring, expanding from diagnosis to treatment.

7. Conclusion and Outlook

7.1. Main Conclusions

MRI-US image fusion targeted biopsy is a mature, safe, and effective precision diagnostic technique, which has important clinical value in the evaluation of suspicious breast lesions, especially those detected by MRI. The main conclusions are as follows:

(1) MRI-US fusion significantly improves the detection rate of sonographic correlates for MRI-detected lesions, with higher accuracy and stability than second-look ultrasound.

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(2) The diagnostic accuracy of fusion-guided biopsy is non-inferior to MRI-guided biopsy, with lower cost, shorter time, and better patient tolerance.

(3) The technical success rate of registration is high, the procedure is simple and safe, and it is suitable for clinical promotion.

(4) AI, DWI/ADC functional imaging, and multi-modal synergy can further improve diagnostic performance and reduce operator dependence.

(5) The main challenges include tissue deformation, registration error, invisible lesions, operator experience, equipment cost, and lack of standards.

(6) Health economics and evidence-based medicine: there are significant advantages in clinical use for MRI-US fusion; its application range is broad.

7.2. Research Outlook

In the future, MRI-USB fusion technology will continue to move forward towards intelligence, automation, standardisation and popularity:

(1) AI-driven full-process automation will become the core feature of next-generation fusion systems.

(2) Deformable registration based on biomechanical models will significantly improve targeting accuracy.

(3) Multi-modal fusion including MRI, ultrasound, CEM, CEUS, and radiomics will realize comprehensive lesion evaluation.

(4) Low-cost and simplified solutions will promote technology coverage in primary and low-resource medical institutions.

(5) Unified global standards and training systems will improve clinical application quality.

(6) Expansion from diagnosis to treatment will make fusion navigation a universal platform for precision breast intervention.

In short, through MRI-US image fusion-targeted puncture has transformed the diagnostic pattern of suspicious breast lesions, promoted the application of precise medical care, and will remain indispensable for early diagnosis and optimisation of therapy in patients with breast cancer.

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