RESEARCH PAPER

ROLE OF FNAC IN THE DIAGNOSIS OF BREAST LESIONS

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ABSTRACT

Introduction: Fine Needle Aspiration Cytology (FNAC) constitutes one of the most commonly used methods for the diagnostic evaluation of breast lesions as it is minimally invasive, gives rapid results, and cost effective.

Objective: This systematic review was undertaken to evaluate the diagnostic accuracy, benefits, limitations and current role of fine needle aspiration cytology (FNAC) in the diagnosis of lesions in the breast.

Methods: A systematic literature search was carried out by using Google Scholar and PubMed. Fifteen studies published between 2022 and 2026 were selected according to pre-defined inclusion and exclusion criteria. We extracted and analysed data on diagnostic accuracy, clinical utility and comparison with alternative diagnostic techniques.

Results: The reviewed studies have demonstrated high specificity and overall diagnostic accuracy of FNAC in differentiating benign and malignant breast lesions. We found FNAC to be particularly useful in low resource settings.

Keywords: FNAC, Fine Needle Aspiration Cytology, Breast lesions, Breast cancer diagnosis, Diagnostic accuracy, Cytopathology, Systematic review.

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Introduction

Breast Lesions denote a huge spectrum of pathological situations growing from benign inflammatory and proliferative disorders to the malignant neoplasms. Breast cancer is known as one of the most common diagnosed cancers among women throughout the world and also a cause of cancer centric mortality. Early and correct diagnosis of breast lesions is important for accurate clinical management, on time treatment and upgraded patient outcomes. Similarly, trustworthy diagnostic processes play a pivotal role for differentiating benign lesions from the malignant situations. The evaluation of breast lesions mostly relies on the triple assessment approach, which integrates clinical evaluation, radiological imaging along with the pathological analysis. Fine Needle Aspiration Cytology has become a significant component of the treatment process for its simplicity, rapidity and cost effectiveness and also for its less invasive nature. FNAC helps to gather the cellular material from the masses of breast for the cytological examination, hence helps the pathologist to build a preliminary diagnosis and guide for the subsequent management decisions.

Studies have shown that FNAC contains huge accuracy for the treatment, sensitivity and particularly, when done by the experienced pathologists and analysed for clinical and radiological findings. Additionally, FNAC can decrease the unnecessary surgical biopsies and offer rapid results especially, in a limited setting of healthcare. But challenges like improper sampling, dependency on operators, and difficulties in distinguishing certain borderline or invasive lesions can impact the treatment process. The function of FNAC at the time of core needle biopsy and upgraded diagnostic technologies, the systematic review properly analyzes the current evidence on the utility of diagnosis, correctness, advantages and limitations of FNAC for the treatment of breast lesions.

Methods

- **Design of the study**

The study is completed with the help of descriptive systematic review design to evaluate the function of FNAC in the treatment process of breast lesions. A systematic review process is chosen as it helps for the proper structural identification, analysis and synthesis of current studies which is aimed to synthesise and analyse the knowledge about diagnostic correctness, clinical utility, advantages and limitations of FNAC in breast lesion diagnosis (Gomes Pinto and Schmitt, 2024) . The review emphasised on analysing the evidence from the existing studies instead of collecting or preparing primary data.

- **Search strategy**

An integrated literature search was done with the implementation of electronic databases which includes Google Scholar. These databases were chosen due to their wider access to peer reviewed medical and healthcare literature. The search was done between May and June 2026.

The search process consists of several keywords and Boolean operators to find out related studies. The significant search terms are “Fine Needle Aspiration Cytology”, “FNAC”, “Breast Lesions”,” Breast Lump”, “Breast Cancer”, “Diagnostic Accuracy”, “Breast Cytology”, “Histopathological Correlation”, “Fine Needle Aspiration Biopsy”, “Benign Breast Disease” and “Malignant Breast Lesions”. Several combinations of such keywords were implemented with the operators AND and OR to enhance the extraction of authentic articles (Kim, Lee and Kim, 2025). In addition, the reference list of chosen studies were manually reviewed to find out the further related publications.

- **Inclusion Criteria**

The following criteria were implemented for choosing the studies:

- Studies analysing the functions of FNAC for the diagnosis of breast lesions
- The studies which have been published between 2022 and 2025.
- Articles must be written in English language
- Authentic research studies, retrospective studies, prospective studies, case series, systematic reviews and meta analysis.
- Studies which are reporting the findings for the diagnostic accuracy, sensitivity, specificity, predictive values or histopathological correlation.
- Full text articles must be available for the review.

- **Exclusion Criteria.**

Few studies have been excluded as they do not satisfy the below mentioned criteria

- Conference abstracts, editorials, commercials and letters addressed to editors
- Publications which are not written in English.
- Studies which are not related to breast lesions or FNAC
- Duplicate publications which are noticed at the time of screening
- Where the full text articles are unavailable.

- **Data Collection**

By implementing the inclusion and exclusion criteria, suitable studies were chosen for an in detail review. Data was gathered systematically from every article and recorded in the data extraction table. The gathered data have author name, publication year, design of the study, size of the sample, study population, diagnostic results, sensitivity, specificity, positive predictive value, negative predictive value, histopathological correlation, and key findings which are connected to FNAC.

As a whole 15 studies have been used for the final review. The gathered data were properly organised and evaluated with the help of narrative synthesis to find the common findings, trends and evidence for the diagnostic role of FNAC in breast lesions. This procedure eases the comprehensive analysis of the positive impact and clinical relevance of FNAC in the similar breast pathology practices.

Results

- **Selection of study**

The literature search finds out the studies which evaluate the role of FNAC for the treatment of breast lesions. Once the screening of titles, abstracts, and full text articles are extracted according to the inclusion and exclusion criteria, a total of 15 studies were involved in the final review. The chosen articles consist of actual research studies, retrospective analysis, prospective investigations, case series, systematic reviews and meta analysis which are published between 2022 and 2025. These studies have been analysed totally for evaluating the diagnostic performance, clinical utility, histopathological correlation, advantages and limitations of FNAC in different breast lesions.

The included studies differentiate the geographical settings and healthcare systems, and offer a wider perspective on the implementation of FNAC in breast pathology. Different studies which have been compared with the FNAC findings with the histopathological evaluation which are also considered as gold standard for the treatment (Zheng et al., 2023). Another few studies analysed FNAC in the context of triple assessment for diagnosis or compared its functionality with core needle biopsy. The inclusion of primary studies and evidence analysis offers an integrated assessment of the contemporary function of FNAC in the breast lesion treatment.

- **Features of included studies**

The studies included in this review show a considerable variation of design, sample size, and clinical objectives. Some studies emphasise on the treatment accuracy of FNAC in breast lumps and some have found out particular implementations like axillary lymph node assessment, cytological reporting process, benign breast lesions or comparison with the optional biopsy technique.

A prospective study was done by Pangotra et al. which analyzed 289 patient data with palpable lumps on

breast. The study states that benign lesions comprise the majority of cases, which accounts for around 68.5% of treatment when malignant lesions show around 10.01% of cases. Fibroadenoma was noticed as the most frequent benign lesions, compared to 20.1% of all breast lesions evaluated. The authors show the value of FNAC as a fast and cost effective diagnostic modality capable of distinguishing breast lesions correctly. Another retrospective study includes 101 breast lump cases in comparison with FNAC findings with histopathological outcomes. Fibroadenoma was again found as the most common benign lesion when infiltrating ductal carcinoma showed the most frequent malignant lesion (Nikas et al., 2023). Histopathological correlation shows a huge diagnostic correctness of 96.1% which offers the clinical dependency of FNAC routine breast lesion analysis. The reviewed literature also involves studies which analyse the findings of special diagnostic scenarios. A case series analysis of benign lesions shows that FNAC can successfully point out the features of cytological changes and avoid the wrong treatment of malignancy when analysed by experienced and skilled cytopathologists. These findings focussed on the importance of cytological expertise in critical breast lesions (Sharma, Ojha and Sharma, 2024).

Different review articles emphasized on the changing functionality of FNAC in modern breast pathology. These studies show in spite of the emerging preference for one needle biopsy in different healthcare systems, FNAC is considered as highly connected for its less invasiveness, less cost, rapid turnaround time, and suitability of outpatient settings. Review evidence also shows that FNAC play an important role in low resource healthcare environments where access to upgraded diagnostic technologies is limited (Raymond and Kleinig, 2022). The included studies also show the constant developments in breast cytology. Current publications analysed the adoption of the International Academy of Cytology Yokohama System which standardizes reporting and upgrades the communication among pathologists and clinicians. In addition, studies have explored the implementation of immunocytochemistry, molecular diagnostics and AI to increase the diagnostic capacity of FNAC specimens.

- **Diagnostic accuracy of FNAC**

Diagnostic correctness was one of the most commonly found results across the involved studies. As a whole, the evidence constantly shows that FNAC contains huge sensitivity, specificity and diagnostic correctness when connected with clinical and radiological findings.

A meta analysis critically assessed the International Academy of Cytology Yokohama System shows a pooled risk of malignancy of 1% for benign categories and 100% for malignant categories. When suspicious and malignant analyses are noticed for the positive results, the increased sensitivity touched 91% when the false positive rate stays low at 2.33%. The pooled area under the receiver operating feature curve was noted as 97.3% shows remarkable diagnostic performance (Pinto and Schmitt, 2022). Additional studies in comparison with FNAC with histopathological evaluation shows similar favourable outcomes. One retrospective analysis shows a specificity of 100% positive predictive value of 100%, negative predictive value of 95.9% and as a whole accuracy is 96.1%. But the reported sensitivity was less than 50% this exhibits primarily to limited histopathological monitoring and variability of sampling instead of inherent limitations of FNAC itself.

More studies stated huge and stable performance indicators. Sharma et al said that FNAC sensitivity of 93.9%, specificity of 100%, positive predictive value of 100%, negative predictive value of 93.1% and as a whole accuracy of 96.7% when calculated against histopathology. These findings show that FNAC stays as a highly reliable treatment modality in differentiating the benign from malignant breast lesions. The evidence also shows the functionality of FNAC within the triple assessment structure. Studies have shown that integrating the clinical evaluation, and FNAC notably upgraded the diagnostic confidence and decreased the necessity for unnecessary surgical processes (Silva, Meschter and Tan, 2023). In many cases, concordance among these three modalities shows the result near complete diagnostic certainty.

The high specificity report in different studies is significant as it reduces the false positive treatment and holds the wrong treatment. Similarly constant huge predictive values enable the dependency on FNAC in finding the malignant lesions. These findings show that FNAC is an important first step investigation in patients with breast lump.+

- **Advantages of FNAC**

Numerous advantages of FNAC were noticed throughout the reviewed literature. One of the most common benefits is its less invasive nature. FNAC needs only a thin needle to get the cell material which causes less discomfort among the patients and it also causes less complication as well. Cost effectiveness is another major advantage. Different studies have focussed that FNAC is comparatively less expensive instead of surgical biopsy and core needle biopsy which makes it specifically valuable in the limited resources of the healthcare system. The process can be done in outpatient settings without the necessity of operation theatres hence also decrease the healthcare expenses and also improve the accessibility.

Rapid diagnostic turnaround was also noticed. Cytological analysis can be done in a short span which helps the clinicians to make decisions on time (Pangotra, Aithmia and Atri, 2022). This rapidity is significant for the patients with the anticipated malignancy where late diagnosis can negatively impact the results.

The reviewed studies also show that FNAC is important for analysing palpable breast masses, axillary lymph nodes, recurrent lesions and metastatic disease. It can also offer material for the ancillary investigations, which include immunocytochemistry and molecular testing when correct specimen handling skills are implemented.

- **Limitations of FNAC**

In spite of having many positive aspects, there are few limitations. A significant challenge was improper or insufficient sampling. Poor cellular samples can give inconclusive findings and it creates the urgency of repeat process or additional treatment findings.

Dependency on operators is also an important matter. The correctness of FNAC is strongly impacted by the skill of the clinician who performs the aspiration and the skill of the cytopathological expert who interpretes the result. Variability in technique can give false negative or indeterminate outcomes. Different studies also have highlighted the distinguishing features of certain lesions especially ductal carcinoma in situ from the invasive carcinoma (Sachdeva et al., 2026). Cytological specimens may not have the architectural data and have limited capacity to analyse the tissue invasion correctly. These limitations also analyse the emerging preference for core needle biopsy in the clinical settings.

False negative results are also a matter of concern especially in lesions with less cellularity, extended fibrosis or errors in sampling. Lobular carcinoma and few critical lesions have been considered as potential diagnostic pitfalls. Additionally insufficient specimens can cause a delay in treatment and need further investigation (Chaudhari et al., 2024).

Discussion

- **Diagnostic performances**

The findings of this review shows that FNAC shows a steady treatment process in the analysis of breast lesions. Most studies state high levels of specificity and overall treatment accuracy and also ensure the utility of FNAC in differentiating benign from malignant breast conditions. The reviewed evidence has reported that treatment accuracy sometimes crosses 90% when specificity reaches to 100%. This findings states that FNAC is specially impactful for the confirmation of malignancy and also decreases the unnecessary surgical procedure (Bisht et al., 2022). The dependency on FNAC is increased when it is analysed with clinical examination and radiological findings as an integrated part of the triple assessment approach.

- **FNAC vs Core Needle biopsy**

The comparison among FNAC and Core Needle Biopsy is an important area regarding the discussion in breast pathology. CNB has achieved popularity as it offers tissue architecture in addition to cellular morphology which show a detailed evaluation of tumor subtype, invasion status and biomarker expression (Xue et al., 2022). This data is important for the diagnosis planning and prognostic analysis. The reviewed studies show that FNAC provides notable advantages. FNAC is considered as less invasive and less painful as well, easy to perform and cost effective than CNB. It also needs certain resources and can be done in outpatient settings by causing less discomfort to the patients.

- **FNAC in low resource setting**

One notable finding about this review is the connectivity of FNAC in low resource healthcare settings. In many modern and developed countries a certain amount of access is specialised in pathology services, imaging facilities and upgraded biopsy techniques hold the accessibility of comprehensive diagnostic services. Under this situation, FNAC offers an affordable, feasible and practical solution for analysing the breast lesions (Ali and Abdullah, 2024). The process needs less equipment and can be done on an outpatient basis and offer rapid diagnostic results. These features make the FNAC important in the rural and underdeveloped regions where a limited healthcare service is available. The early diagnosis boosted by FNAC can decrease the unnecessary delay in the diagnosis process and provide satisfaction to the patients.

- **Emerging developments**

Recent studies have shown that the function of FNAC is changing in reaction to upgrades in breast pathology. The introduction of the International Academy of Cytology Yokohama Reporting System has modified the standard of breast cytology reporting and increased communication between the pathologists and clinicians. This reporting structure has influenced continuously in treatment and risk stratification. In addition, advancements in immunocytochemistry have extended the diagnostic implementation of FNAC by helping the assessment of significant biomarkers related to FNAC specimens, which offer a customized approach for the patient treatment (Jiwa et al., 2022). Growing technologies like digital pathology and AI have the credibility to

upgrade the diagnostic accuracy and less observer variability.

Literature Gap

A huge number of studies have analysed the treatment performance of FNAC in breast lesion, different gaps are there in the existing literature. Many studies have stated that single center or limited settings with less sample size can offer generic findings. There are a certain number of considerable variations which are present in methods, diagnostic criteria, and study designs, which makes a comparison among the studies and makes it challenging. While current research has discovered the Yokohama Reporting system and the combination of ancillary techniques like immunocytochemistry and molecular testing, evidence about their scheduled applications. Another few studies have emphasised initially on the accuracy of diagnosis with minimal attention provided to long term clinical results, cost management and patient centered measures. A lack is noticed in prospective multicenter studies if compared FNAC with the similar diagnostic process in a diverse clinical setting. Addressing the gaps will offer strong evidence about the changing functionality of FNAC in the modern breast lesion diagnosis.

Conclusions

FNAC is a significant diagnostic tool used for analyzing the breast lesion for its simplicity, cost effectiveness and rapid turnaround time and is less invasive in nature. The studies have shown that FNAC offers accuracy, diagnosis, sensitivity and specificity when it is used for the clinical evaluation and imaging as a part of the triple assessment approach. But besides all these positive aspects, few limitations are there like errors in sampling and operator dependency. FNAC plays a pivotal role for differentiating benign from malignant breast lesions. Future research needs to emphasise on standard report systems, huge multicenter studies and combination of advanced diagnostic techniques for increasing its clinical utilisation.

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