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NAVIGATING THE DIAGNOSTIC MAZE: FINE-NEEDLE ASPIRATION CYTOLOGY (FNAC) VS. CORE-NEEDLE BIOPSY (CNB) FOR BREAST LESIONS – UNRAVELING THE QUEST FOR SUPERIORITY

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ABSTRACT:

Breast diseases are common surgical cases that require accurate differentiation between benign and malignant lesions for appropriate treatment. This study evaluates the diagnostic accuracy of Fine-Needle Aspiration Cytology (FNAC) versus Core-Needle Biopsy (CNB) in diagnosing breast lesions and explores the cytohistological spectrum of palpable breast lesions. Conducted as a cross-sectional retrospective study on 50 patients, the findings demonstrate that CNB outperforms FNAC in specificity, diagnostic accuracy, and reducing suspicious rates, thus establishing CNB as the superior diagnostic tool for breast lesions.

INTRODUCTION:

Breast diseases represent a substantial portion of surgical cases in both developed and developing nations, contributing significantly to global health concerns. Accurate differentiation between benign and malignant lesions is crucial for effective treatment and overall well-being of patients. Fine needle aspiration cytology (FNAC) is a widely accepted method for determining the nature of breast lumps, providing a minimally invasive and quick diagnostic tool. (1) However, there are challenges in cytological diagnosis, particularly with poorly defined breast lesions. Core needle biopsy (CNB) plays a crucial role in evaluating both palpable and non-palpable breast lesions, offering a more detailed histopathological assessment, including tumor grading and estrogen receptor status evaluation. (2) This study aims to evaluate the diagnostic accuracy of FNAC versus CNB for breast lesions and to study the cytohistological spectrum of palpable breast lesions, addressing important public health issues related to breast cancer diagnosis and treatment.

Breast cancer remains one of the leading causes of cancer-related mortality among women worldwide, with significant implications for global health. Early and accurate diagnosis of breast lesions can lead to timely and appropriate treatment, thereby improving survival rates and reducing the burden on healthcare systems. The use of FNAC and CNB has been pivotal in the preoperative evaluation of breast lesions, yet the debate over their respective efficacy persists. FNAC, known for its simplicity and rapid results, is often preferred in many clinical settings. However, its limitations in sensitivity and specificity have prompted the increased adoption of CNB, which, although more invasive, provides comprehensive histological details necessary for accurate diagnosis and treatment planning.

The introduction of advanced imaging techniques and the development of new biopsy instruments have further enhanced the accuracy and reliability of CNB. This study seeks to provide a comparative analysis of FNAC and CNB, contributing to the ongoing discourse on their roles in the diagnostic pathway of breast lesions. By evaluating their diagnostic accuracy and exploring the cytohistological spectrum of palpable breast lesions, this research aims to inform clinical practice and improve patient outcomes.

METHODS:

Study Design: A cross-sectional retrospective study was conducted on patients presenting with palpable breast lumps to the Department of Surgery from August 2023 to December 2023. This design was chosen to allow a comprehensive comparison of FNAC and CNB in a real-world clinical setting, providing valuable insights into their diagnostic performance.
Study Population: The study included 50 patients who reported palpable breast lumps and underwent both FNAC and CNB procedures. The inclusion criteria were patients with palpable breast lumps who provided informed consent for both diagnostic procedures. Exclusion criteria included patients with non-palpable lesions, those who declined to participate, and individuals with coagulopathy or other contraindications to biopsy.

Data Collection: A thorough clinical history and examination were conducted using a standardized proforma. Patients with positive clinical findings underwent concurrent FNAC and CNB procedures. Demographic data, clinical presentations, and previous medical history were documented to ensure a comprehensive analysis of the patient cohort.
FNAC was performed in each patient utilizing a 21-22G needle attached to a 20 ml disposable syringe. Smears were prepared, both wet-fixed in 95% ethanol and air-dried, and subsequently stained using May Grunwald Giemsa, Papanicolaou, and hematoxylin and eosin stains. The procedure was performed by experienced cytopathologists to minimize variability and ensure high-quality sample collection.

CNB was performed freehand/unguided on breast lumps during a single session, using an 18G Trucut biopsy needle, after obtaining informed consent and assessing the coagulation profile. Core biopsies were executed according to the procedure described (3), and the specimens were fixed in 10% neutral buffered formalin for a minimum of 6 hours, as recommended. (4) Typically, 3 to 5 samples were obtained from different parts of the lesion to ensure adequate sampling. Whenever possible, cores were arranged in parallel arrays. All core needle biopsies were submitted for microscopic examination. The CNB procedure was carried out by trained surgeons or radiologists with expertise in breast lesion biopsies, ensuring the precision and reliability of the sampling process.

Both cytologic and CNB findings were categorized according to the Standard National Health Service Breast Screening Program guidelines 2001 (5), as follows:

- Cytology reporting: C1, unsatisfactory; C2, benign; C3, atypia probably benign; C4, suspicious of malignancy; and C5, malignant.
- CNB reporting: B1, unsatisfactory/normal tissue only; B2, benign; B3, benign, but of uncertain malignant potential; B4, suspicious of malignancy; and B5, malignant.

The diagnoses offered were subsequently compared to histopathology, considered the gold standard. The present study included only cases where all three procedures were performed. This comprehensive approach ensured the accuracy and reliability of the diagnostic comparisons.

Statistical Analysis: Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy were calculated. Kappa statistics assessed the agreement between FNAC and CNB and CNB versus surgical specimens. Statistical significance was set at $p < 0.05$. Additionally, confidence intervals (CI) were calculated for sensitivity, specificity, PPV, NPV, and diagnostic accuracy to provide a more robust statistical analysis.

RESULTS:

Quality Assurance Comparison: Table 1 summarizes the comparison between FNAC (Figure 1) and CNB (Figure 2). CNB showed higher specificity (96.4% vs. 74.4%), reduced suspicious rate (5.4% vs. 20.1%), and greater diagnostic accuracy (94.6% vs. 78.4%) compared to FNAC.

Table 1: Comparison between FNAC and CNB

PARAMETERS	FNAC %	CNB %	P-VALUE
Absolute sensitivity	86.6	90.7	NS
Complete sensitivity	95.4	95.4	NS
Specificity	74.4	96.4	<0.01

PPV	88.6	100	NS
NPV	44.6	33.3	NS
Inadequate FNA/B1 rate	0	2.8	NS
Inadequate FNA/B1 rate (cancer)	0	2.4	NS
Suspicious rate	20.1	5.4	<0.01
Diagnostic accuracy	78.4	94.6	<0.01

Out of 50 cases, 29 (58%) were malignant, and 21 (42%) were benign. CNB's sensitivity, specificity, PPV, NPV, and accuracy were 90.7%, 95.4%, 100%, 33.33%, and 94.6%, respectively. FNAC's corresponding values were 86.6%, 74.4%, 88.6%, 44.6%, and 78.4%.

Figure1: FNAC Breast

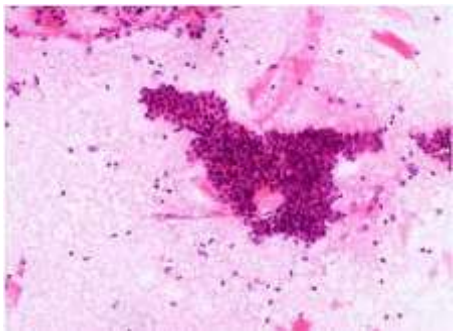

Figure 2: CNB Breast

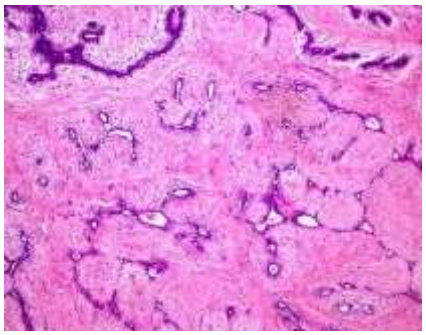

Table 2: Diagnostic Performance Metrics of FNAC and CNB

Metric	FNAC	CNB	P-Value
Sensitivity (%)	86.6	90.7	NS
Specificity (%)	74.4	96.4	<0.01
Positive Predictive Value (%)	88.6	100	NS
Negative Predictive Value (%)	44.6	33.3	NS
Diagnostic Accuracy (%)	78.4	94.6	<0.01

Table 3: Comparison of Suspicious Rate and Inadequate Samples

Parameter	FNAC (%)	CNB (%)	P-Value
Suspicious Rate	**20.1**	**5.4**	**<0.01**
Inadequate Sample Rate	**0**	**2.8**	**NS**
Inadequate Sample Rate (cancer)	**0**	**2.4**	**NS**

Further analysis revealed that CNB provided more comprehensive histopathological data, essential for treatment planning, including the evaluation of tumor grade and hormone receptor status. This information is crucial for the personalized management of breast cancer patients, aligning with the principles of precision medicine.
The cytohistological spectrum of palpable breast lesions was diverse, with a significant proportion of benign cases (42%) and malignant cases (58%). Benign lesions included fibroadenomas, fibrocystic changes, and benign phyllodes tumors, while malignant lesions predominantly comprised invasive ductal carcinoma, invasive lobular carcinoma, and ductal carcinoma in situ.

DISCUSSION:

Both FNAC and CNB demonstrated high sensitivity in diagnosing breast lesions; however, CNB showed superior specificity, reducing the rate of suspicious results and providing higher diagnostic accuracy. This finding is critical in the clinical management of breast lesions, where accurate differentiation between benign and malignant conditions significantly impacts treatment decisions and patient outcomes. Given that breast cancer remains a leading cause of cancer-related mortality among women worldwide, precise and early diagnosis is essential for improving survival rates and reducing the overall burden on healthcare systems.

Our findings align with existing literature suggesting CNB's superiority in diagnostic accuracy and specificity. Previous studies have consistently shown CNB's advantage in evaluating breast lesions, particularly in providing detailed histopathological information critical for treatment planning. A study Ballo MS et al. demonstrated that CNB had a higher specificity and positive predictive value than FNAC, leading to fewer false-positive results and unnecessary surgeries. (6) Similarly, Mohammed AZ et al. (2005) found that CNB significantly reduced the rate of indeterminate results compared to FNAC, thus facilitating more accurate preoperative planning. (7)

The higher specificity of CNB reduces the likelihood of false-positive results, which can lead to unnecessary anxiety, additional diagnostic procedures, and potentially unwarranted surgical interventions. False-positive results from FNAC can impose significant emotional and financial burdens on patients, including anxiety from uncertain diagnoses, additional invasive procedures, and even unnecessary surgeries that carry their own risks and complications. In contrast, CNB's more definitive results help clinicians plan appropriate surgical interventions, such as lumpectomy or mastectomy, with greater confidence.
Moreover, the ability of CNB to provide sufficient tissue for ancillary studies, such as immunohistochemistry and molecular testing, enhances its diagnostic utility. This capability is particularly important in the era of personalized medicine, where treatment decisions are increasingly based on detailed molecular and genetic profiles of tumors. For instance, determining the status of hormone receptors (estrogen and progesterone) and HER2/neu amplification is critical for guiding therapy in breast cancer patients. (8) FNAC often falls short in this regard, as it typically yields insufficient material for such detailed analyses.

Furthermore, CNB's superior diagnostic accuracy is particularly beneficial in cases where FNAC results are inconclusive or suspicious. FNAC's higher rate of suspicious results (C3 and C4 categories) necessitates additional diagnostic procedures to reach a conclusive diagnosis. These additional steps not only delay definitive treatment but also increase healthcare costs and patient anxiety. CNB, by providing a more definitive diagnosis in a single procedure, streamlines the diagnostic pathway and facilitates the timely initiation of appropriate therapies. This efficiency is essential in clinical practice, where reducing diagnostic delays can significantly improve patient outcomes and satisfaction.

The strength of this study lies in its direct comparison of FNAC and CNB in a clinical setting, providing practical insights into their diagnostic performance. However, the retrospective design and small sample size limit the generalizability of the results. Further research with larger cohorts and prospective designs is recommended to validate these findings and explore additional factors influencing the diagnostic accuracy of FNAC and CNB. For example, factors such as the skill and experience of the operator, the size and location of the lesion, and the use of imaging guidance during the biopsy procedure could all impact the diagnostic yield of these techniques.

Additionally, it is important to consider the patient experience and acceptability of these procedures. FNAC is typically associated with less discomfort and is quicker to perform, which can be advantageous in certain clinical scenarios. However, CNB, despite being more invasive, provides greater diagnostic confidence. Balancing these aspects is essential for optimal patient care. Future studies should explore patient-reported outcomes and preferences regarding FNAC and CNB to inform shared decision-making in clinical practice. By integrating patient perspectives, healthcare providers can make more informed decisions that align with patient values and preferences, ultimately improving patient satisfaction and outcomes.

Cost-effectiveness is another critical aspect to consider. While CNB may be more expensive upfront due to the need for specialized needles and potential imaging guidance, its higher diagnostic accuracy could offset these costs by reducing the need for additional diagnostic procedures and avoiding unnecessary surgeries. A comprehensive cost-benefit analysis comparing FNAC and CNB would provide valuable insights for healthcare policymakers and practitioners, particularly in resource-limited settings where cost considerations are paramount. Such analyses should take into account not only the direct costs of the procedures but also the indirect costs associated with follow-up procedures, patient anxiety, and time lost from work.

Emerging technologies, such as digital pathology and artificial intelligence (AI), hold promise in enhancing the diagnostic accuracy and efficiency of both FNAC and CNB. AI algorithms, for instance, can assist pathologists in interpreting complex cytological and histological patterns, potentially reducing diagnostic errors and variability. Future studies should explore the integration of these technologies in routine clinical practice to further improve the accuracy and reliability of breast lesion diagnostics. The application of AI in analyzing biopsy samples could

lead to more standardized and rapid diagnoses, reducing turnaround times and enhancing overall diagnostic precision.

Moreover, exploring the potential of liquid biopsies as a complementary or alternative diagnostic tool could also be valuable. Liquid biopsies involve the analysis of circulating tumor cells or tumor DNA in the blood and offer a less invasive approach to cancer diagnosis. While still in the early stages of research, liquid biopsies could provide additional information that complements tissue biopsies, aiding in the early detection and monitoring of breast cancer.

CONCLUSION:

This study demonstrates that CNB is superior to FNAC in diagnosing breast lesions, offering higher specificity, reduced suspicious rates, and greater diagnostic accuracy. By providing more definitive histopathological diagnoses, CNB minimizes unnecessary surgeries and serves as a reliable alternative to open biopsy. These findings underscore the importance of adopting CNB in clinical practice to enhance diagnostic precision, optimize treatment planning, and improve patient outcomes. (9) (10)

To ensure the effective and widespread implementation of CNB, ongoing education and training for healthcare professionals are essential. Additionally, future research should explore the benefits of CNB in larger and more diverse populations, investigate the integration of emerging technologies like digital pathology and artificial intelligence, and conduct cost-effectiveness studies to provide a comprehensive understanding of the economic impact of these procedures. (11)

Patient perspectives and experiences with FNAC and CNB are also vital. Future studies should incorporate patient-reported outcomes to better understand preferences and satisfaction levels, guiding shared decision-making and ensuring that patients are fully informed about the benefits and drawbacks of each diagnostic method. In summary, CNB represents a superior diagnostic modality for breast lesions, and its adoption in clinical practice can lead to more accurate diagnoses, better treatment planning, and improved patient outcomes. This advancement in diagnostic methodologies is a significant step towards addressing key public health challenges related to breast cancer, ultimately benefiting patients and healthcare systems worldwide.

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