Role of Ultrasound-guided Tru-cut Needle Biopsy in the Diagnosis of Suspicious Breast Masses at South Valley University Hospitals

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Abstract

Background: The global increase in breast cancer emphasizes early detection through screening and improved molecular subtype understanding. Mammography and ultrasound identify non-palpable lesions, and core needle biopsy aids in definitive surgery planning.

Objectives: Evaluate ultrasound-guided Tru-cut needle biopsy in suspicious breast masses, analyzing procedure results, histopathological findings, and their correlation with imaging data.

Patients and methods: A cross-sectional study at Qena University Hospitals focused on females aged 20-70 with clinically suspected breast lesions. Ultrasound using a 7.0-MHz transducer examined variables, and core needle biopsy data included coagulation tests, needle details, and Stereotactic Biopsy Device usage.

Results: Participants (mean age 50.9 ± 10.1 years) had palpable masses (96%), mainly on the right, and 84% used ultrasound. Lesions (16.5 ± 14.5 cm) were often in the upper outer quadrant, with 76% malignant (invasive duct carcinoma). Needle types included semi-automatic 14 G (56%). Biopsies yielded 4.5 ± 1.0 cores. Histopathology showed 24% benign lesions and 76% malignant. Ultrasound demonstrated 94.7% sensitivity, 100% specificity, and 95% accuracy.

Conclusion: Ultrasound-guided Tru-cut needle biopsy is vital for diagnosing breast tumors, demonstrating high sensitivity, specificity, and accuracy, supporting its role in timely and precise breast cancer diagnosis, influencing patient management and treatment decisions.

Keywords: US-guided; True-cut; Needle biopsy; Breast masses.

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Introduction

Regular screening has increased early-stage breast cancer diagnosis despite rising worldwide incidence. An improved knowledge of cancer molecular subgroups has led to better therapies and a decrease in breast cancer mortality **(Kashyap et al., 2022; Ginsburg, 2020).**

Early diagnosis of precancerous lesions before clinical symptoms allows for less harsh but more successful therapy. Mammography, which detects micro-calcifications, asymmetries, and nodules, helps find non-palpable breast lesions. Mammary ultrasonography (US) is also used to characterize mammographic results and investigate dense breasts. If suspicious lesions indicate malignancy, minimally invasive techniques like FNAB or core biopsy are indicated for further examination **(Cechanovičiūtė and Cechanovičiūtė, 2022).**

US-guided biopsy distinguishes benign, malignant, and inconclusive (grey zone) breast lumps or localized lesions seen by physical examination, mammography, or other imaging investigations. An expert radiologist uses a minimally invasive approach to obtain a tiny core tissue sample from a questionable breast region for histological evaluation **(Al-Ismaeel et al., 2021).**

Tru-cut biopsy, commonly known as core needle biopsy (CNB), is a modern histological diagnostic method. A simple outpatient technique, it reduces needless excisional biopsy. The tru-cut biopsy's decreased insufficiency rates, ability to apply auxiliary treatments, and ability to grade and type malignancy aid decisive surgical planning **(Ariizumi et al., 2022).**

The main aim of the study was to evaluate the ultrasound-guided Tru-cut needle breast biopsy in suspicious breast masses results regarding the procedure and the histopathological findings and their correlation with the imaging data.

Patients and methods

We performed the cross-sectional research at the Department of Intervention and Diagnostic Radiology at Qena University Hospitals, South Valley University,. The research included female patients aged 20–70 with clinically suspected breast lesions, omitting tiny inaccessible lesions, BIRADS I and II breast masses, and blood coagulation abnormalities. Ethical approval: SVU-MED-RAD028-1-22-2-342.

Patient selection and clinical assessment at Qena University hospitals were included. Age, palpable or non-palpable mass, mass location, personal or family cancer history, imaging modality, lesion size, and BI-RADS categorization were study factors. For optimal imaging, patients were supine with elevated arms during ultrasounds using 7.0-MHz linear electronically focused transducers.

Gel application for optimum skin-transducer contact, breast-specific transducer selection, and thorough quadrant evaluation were performed. Breast visualization was done using real-time imaging. Breast tissue and axillary lymph nodes were examined for malignant spread.

Breast lumps and suspicious spots were examined for size, shape, borders, and interior echo patterns. The research also gathered biopsy data, including coagulation tests, needle gauge selection, the Stereotactic Biopsy Device utilized for Core Needle Biopsy (CNB), and operation length.

Coagulation tests measured blood clotting, and needle gauge selection evaluated lesion characteristics, patient variables, and pathology. The stereotactic biopsy device used automated and semi-automatic needles to take tissue cores and fix them in formaldehyde. The average CNB time was 15–30 minutes.

CNB histology comprised diagnosis, tumor type, grade, hormone receptor status, margins, and lymphovascular invasion. BI-RADS criteria (0–6) were used to evaluate breast imaging lesions. Lidocaine 1% infiltration provided local anesthetic after ultrasonic scanning, cleaning, and asepsis. Histopathological results were matched to US findings **(D'Orsi et al., 2018).** (**Table.1 & Fig.1).**

Table 1. BI-RADS Categorization and Probability of Malignancy

BI-RADS Category	Assessment	Probability of Malignancy
0	Incomplete evaluation, further imaging required	N/A
1	Negative examination	0
2	Consistent with benign findings	0
3	Probably benign, follow-up needed	<2%
4 (a)	Low probability of malignancy	2% - 10%
4 (b)	Intermediate probability of malignancy	10% - 50%
4 (c)	High probability of malignancy	50% - 95%
5	Highly suggestive of malignancy	>95%
6	Pathology-proven malignancy	100%

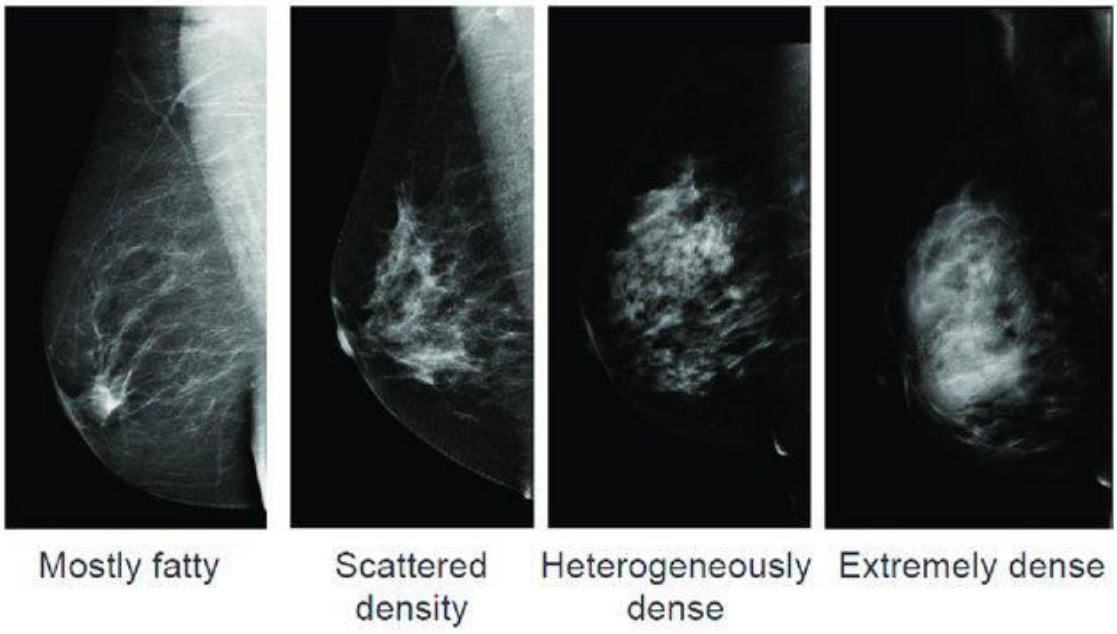


Fig.1. American College of Radiology Breast Imaging Reporting and Data System (BI-RADS) classification system of 4 density categories: "Mostly fatty", "Scattered density", "Heterogeneously dense", and "Extremely dense" **(Ingman et al., 2020).**

Statistical analysis

Data was input and analyzed using SPSS 23. Statistical methods were utilized to assess qualitative variables using numbers and percentages, and quantitative elements using mean ± standard deviation. Student "t" test for independent group means, Mann-Whitney test for differences in non-normally distributed quantitative variables across groups, and Chi-square test for row and column variable associations were used for comparison. Cohen's kappa was used to

measure agreement between raters or observers classifying items into mutually exclusive categories. A significance threshold of 5% (P-value) was used for all statistical tests, with a P value > 0.05 indicating non-significant and < 0.05 indicating significance. Lower P values indicate more relevance.

Results

(**Table.2**) provides a comprehensive overview of demographic and clinical data for all patients in the study. The mean age of participants was 50.9 ± 10.1 years, ranging from 26 to 69 years. Family history of malignancy was observed in 4% of patients, while 8% had a personal history of malignancy. Regarding clinical data, 96% of patients had palpable masses, primarily located on the right side (60%). Ultrasonography (US) was the predominant imaging modality (84%), with 16% using both US and mammography. Lesions were commonly found in the upper outer quadrant (76%), with a mean size of 16.5 ± 14.5 cm. Borders were ill-defined in 64% and well-defined in 36% of cases, while echogenicity varied, with 64% hypoechoic, 8% hypo-to-isoechoic, and 28% isoechoic. Calcifications were present in 20% of cases. The mean distance from the skin was 1.5 ± 0.7 cm, ranging from 0.5 to 3 cm.

Table 2. Description of demographic and clinical data in all studied patients

Variables		**Studied patients (N = 25)**	
Age (years)	**Mean ±SD**	50.9 ± 10.1	
	Min - Max	26 – 69	
Family history of malignancy	**No**	24	96%
	Yes	1	4%
Personal history of malignancy	**No**	23	92%
	Yes	2	8%
Palpable mass	**No**	1	4%
	Yes	24	96%
Site	**Right**	15	60%
	Left	10	40%
Imaging used	**US**	21	84%
	US & mammography	4	16%
Quadrant	**At scar site**	1	4%
	LOQ	4	16%
	UOQ	19	76%
	Axillary tail	1	4%
Size	**Mean ±SD**	16.5 ± 14.5	
	Min - Max	3 - 72	
Border	**ill-defined speculated**	16	64%
	regular well-defined	9	36%
Echogenicity	**Hypo echoic**	16	64%
	hypo-to-isoechoic	2	8%
	Isoechoic	7	28%
Calcifications	**No**	20	80%
	Yes	5	20%

Distance from skin	**Mean ±SD**	1.5 ± 0.7
	Min - Max	0.5 - 3

(**Table.3**) provides a comprehensive overview of radiological and histopathological data for all participants. Regarding BIRADs classification, 28% had BIRADs III, 4% had BIRADs IV, 8% had BIRADs IVa, 24% had BIRADs IVb, 20% had BIRADs IVc, and 16% had BIRADs V. The needle types used included semi-automatic 14 G in 56% of cases, semi-automatic 16 G in 28%, and semi-automatic 18 G in 16%. The mean number of cores obtained was 4.5 ± 1.0, ranging from 4 to 9. Histopathological analysis revealed that 24% of patients had benign lesions, including fibrocystic disease (66.6%), phyllode tumor (16.7%), and breast tissue (16.7%). Malignant lesions were identified in 76% of patients, with 89.4% having invasive duct carcinoma, 5.3% invasive lobular carcinoma, and 5.3% duct carcinoma in situ.

Table 3. Description of radiological and histopathological data in all studied patients.

Variables		**Studied patients (N = 25)**	
BIRADs	**III**	7	28%
	IV	14	56%
	V	4	16%
Needle used	**Semi-automatic 14 G**	14	56%
	Semi-automatic 16 G	7	28%
	Semi-automatic 18 G	4	16%
Number of cores	**Mean ±SD**	4.5 ± 1.0	
	Min - Max	4 - 9	
Histopathology diagnosis	**Benign**	6	24%
	Malignant	19	76%
Benign lesions (n = 6)	**Fibro cystic disease**	4	66.6%
	Benign phyllodes tumor	1	16.7%
	Breast tissue	1	16.7%
Malignant lesions (n = 19)	**Invasive duct carcinoma**	17	89.4%
	Invasive lobular carcinoma	1	5.3/%
	Duct carcinoma in-situ	1	5.3%

(**Table.4**) shows highly statistical significant **(p-value > 0.05)** concordance of US diagnosis in relation to pathology **(k = 0.89)** as there were 6 patients (100%) true negative, 18 patients (94%) true positive, 1 patient (5.3%) false negative with no patients with (0%) false positive. Thus, the U/S guided true cut had the sensitivity of 94.7%, specificity of 100%, PPV of 100%, NPV of 85.7% and accuracy of 95% in diagnosis of malignancy.

Table 4. Diagnostic performance and concordance of US in relation to pathology.

Variables		Pathology				Stat. test	P-value
		benign (N = 6)		Malignant (N = 19)			
U/S	Benign	6	100%	1	5.3%	k = 0.89	< 0.001 HS
	Malignant	0	0%	18	94.7%		

Sensitivity	specificity	PPV	NPV	Accuracy
94.7%	100%	100%	85.7%	96%

k: measurement of agreement (Kappa).HS: p-value < 0.001 is considered highly significant.

Cases:

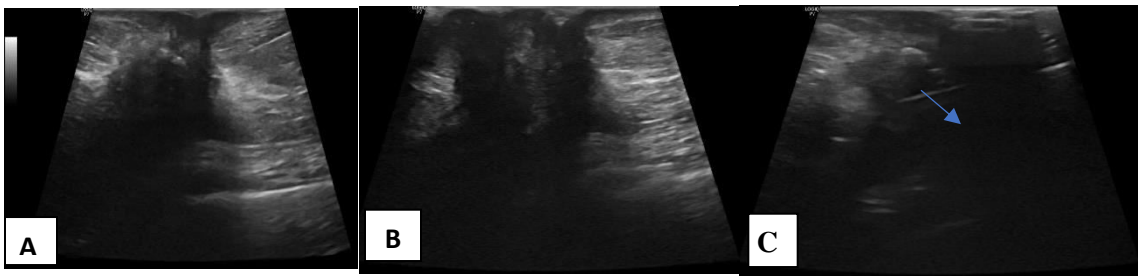
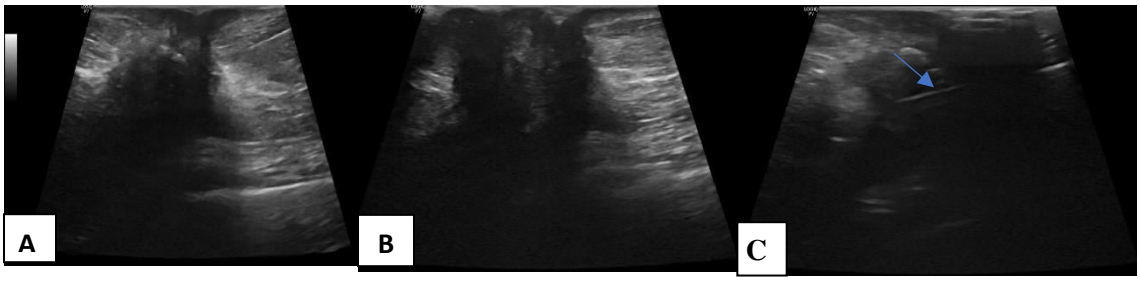


Fig.2. 58-years-old female presented by a right breast mass of 4 months duration, with no family history of breast cancer, breast ultrasound was done and revealed an ill-defined hypoechoic mass lesion with speculated margins at the UOQ, with posterior acoustic shadowing and no calcifications (BIRADS IVc), ultrasound guided core needle biopsy was performed using a semi-automatic needle (16 G), the histopathology resulted in Invasive Ductal Carcinoma. (Figure III): **A&B)**Showing malignant featuring breast mass on ultrasonography, **C)**The blue arrow indicates the needle within the lesion during biopsy taking.



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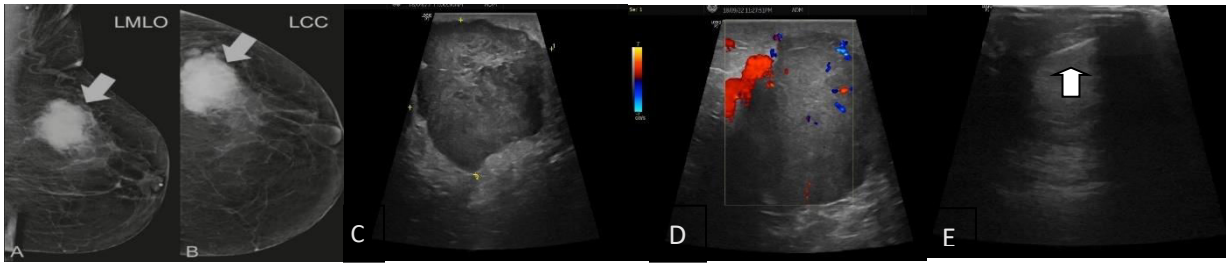

Fig.3. 53-years-old female presented by a left breast mass of 1 month duration, breast ultrasound was done and showed a well-defined hypo echoic mass lesion at the UOQ with internal vascularity (BIRADS IV), Ultrasound guided core needle biopsy was performed using a semi-automatic needle (16 G), the histopathology proved Invasive Ductal Carcinoma . (Figure II): **A&B)**Mammography showing an irregular shaped mass with speculated margins, **C)**ultrasonography showing malignant featuring breast mass, **D)**show color doppler vascularity, **E)**semi-automatic needle inserted within the left upper part of the mass during biopsy taking (echogenic linear line (arrowed).

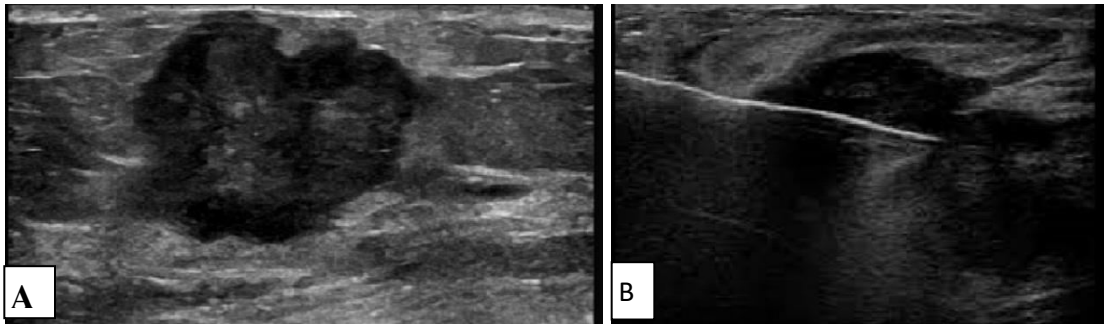

Fig.4. 49-years-old female presented by a right breast mass, with no family history of breast cancer. Breast ultrasound was done and revealed irregular hypo echoic mass lesion at the UOQ

(BIRADS IVc), ultrasound guided core needle biopsy was performed using a semi-automatic needle (18 G), the histopathology resulted in Ductal Carcinoma Insitu. (Figure IV): **A)**ultrasound showing malignant featuring breast mass, **B)**semi-automatic needle seen as white echogenic line inserted within the lesion during biopsy taking .

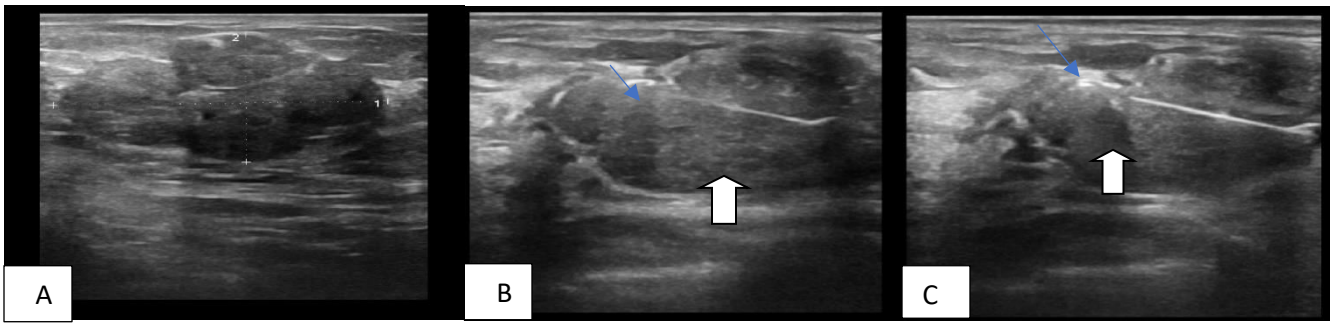

Fig.5. 26-year-old female presented by palpable left breast mass, with no family history of breast cancer, breast ultrasound was done and revealed irregular iso-echoic mass lesion at the UOQ, with no internal vascularity or calcifications (BIRADS III), ultrasound guided core needle biopsy was performed using a semi-automatic needle (16 G), the histopathology resulted in benign fibrocystic disease. (Figure V): **A)** ultrasound showing mildly suspicious breast mass, **B&C)** showing the Semi-automatic needle inserted within the lesion during biopsy taking (blue arrows).

Discussion

Our study had patients of varied ages, with a mean age of 50.9 ± 10.1 years. Personal malignancy was 8%, family 4%. Clinically, 96% had palpable masses, 60% right, 40% left. Ultrasound (84%) and US and mammography (16%) dominated imaging. Masses averaged 16.5 ± 14.5 cm, primarily in the top outer quadrant (76%), with 64% ill-defined boundaries and 36% well-defined. 20% calcified echogenic, 64% hypoechoic. Distance from skin averaged 1.5 ± 0.7 cm.

Our findings corroborated **Mohamed et al. (2023),** who compared ultrasound observations to ultrasound-guided Tru-Cut biopsy histology data to determine if ultrasound may detect suspicious breast cancers. The demographics of benign and malignant breast mass patients were investigated. Participants with benign masses averaged 44.33 years (SD=10.12), whereas those with malignant masses averaged 47.16 years (SD=8.99), with no significant difference (p=0.606). Breast cancer family history was related with malignant masses, with 29.7% having a negative history and 70.3% a positive one (p=0.037).

Aswad and Abedtwfeq, (2023) examined core needle biopsy precision, ultrasound-histopathology agreement, and radiologists' difficulties. The trial involved 50 14–72-year-olds, average 48. Sixteen (32%), including 10 (62%), have family cancer history: breast cancer. Content requires study results.

Our study discovered numerous patients with palpable breast lumps, suggesting they were easily identifiable. Palpable breast lumps or thickening. The high rate of UOQ masses matches breast tissue distribution. UOQ glands are more numerous. The closeness of axillary lymph nodes makes breast pathology prevalent **(Huang et al., 2022).**

The uneven boundaries are linked to aggressive or invasive breast cancers, raising

cancer concerns. In most breast cancer patients, hypoechoic echogenic masses are ultrasonographically common. Hypoechoic ultrasound imaging is darker, indicating higher bulk density or lower sound wave transmission. Breast imaging hypoechoic masses are typically linked to malignant tumors because cancer cells reflect less sound and are more densely packed **(Awad et al., 2023, Penny, 2021).**

Our results matched **Suhas et al. (2023).** The top outer 43.80% quadrant was most damaged, followed by the upper inner (21.30%) and bottom outer (15.00%).

Mohamed et al. (2023) investigated 40 breast lesions. The upper inner (47.5%) and outer (42.5%) quadrants have the most lesions. Well-defined margins reduced lesions by 22.5% (77.5%).

BIRADS III scores of 28% indicated benign tumors or cysts in our investigation. A semi-automatic 14 G needle is used in 56% of biopsies, depending on lesion characteristics and clinician preference. Needle size enhances sample quality and patient comfort. **Yeniceri et al. (2015)** found that 42% of patients had BIRADS III, 19% IV, and 39% V, with core counts averaging 4.5 (range: 4 to 9). Our research detected 28% BIRADS III, whereas this found 42%.

76% of patients had malignant tumors, mostly milk duct carcinoma (89.4%). Fibrocystic disease caused fibrous and cystic breast tissue alterations that mimicked breast cancer in 66.6% of benign lesions.

We found histological and radiological concordance in BIRADS categories 2, 3, 4, and 5 lesions after core biopsy, similar to **Chaitanya et al. (2020).** Invasive ductal carcinoma (NST) was identified in 61% of patients, papillary carcinoma in 1%, DCIS in 3%, fibrocystic alterations in 7%, epithelial hyperplasia in 7%, fibroadenoma in 11%, fibroadenosis in 3%, inflammation in 5%, phyllodes tumor in 1%, and no apparent malignancy/hyalinization

Mohamed et al. (2023) examined breast histopathology. Five cases (12.5%) were benign and 35 (87.5%) malignant. From histology, malignant people had 10 (25.0%) invasive ductal carcinoma, 9 (22.5%) invasive lobular carcinoma, and 4 (10.0%) invasive mammary carcinoma.

We found good correlation between US diagnostic and pathological data ($k = 0.89$, $p > 0.05$). 100% of patients were true negatives, appropriately categorized as non-malignant, and 94% were true positives, clearly cancerous. Zero false positives, one false negative (5.3%). Ultrasound-guided Tru-cut biopsy detected breast cancer with 94.7% sensitivity, 100% specificity, 100% PPV and NPV, and 95% accuracy.

Our results matched. Core biopsy exhibited 94.64% sensitivity, 91.30% specificity, and 94.87% accuracy, according to Ahmed et al. (2016). Core biopsy can detect breast cancer, but ultrasound-guided Tru-cut needle biopsy may be more specific.

Core biopsy had 95.4% sensitivity, 100% specificity, 100% PPV, 96.1% NPV, and 98.9% diagnostic accuracy, according to **Altintas et al. (2019).** These findings support core biopsy breast cancer diagnosis accuracy.

Elverici et al. (2015) reported 38.7% PPV for BIRADS 4 lesions, whereas **Sarangan et al. (2017)** reported 56.25%. Excluding 4A lesions and comparing 4B and 4C histopathologically may improve BIRADS 4 PPV. We found 93.5% sensitivity for benign BIRADS lesions and 100% malignant specificity, matching **Sarangan et al. (2017).**

We found 100% sensitivity and 60% specificity for core biopsy, as did **Mohamed et al. (2023).**

Suhas and Amar (2023) examined palpable breast lump diagnosis using tru-cut

biopsy and FNAC. They favored Tru-Cut biopsy to FNAC for palpable breast lumps. ROC analysis indicated FNAC and Tru-cut biopsy detected cancer. FNAC has 90.6% accuracy, 92.31% sensitivity, 88.89% specificity. Tru-cut biopsy was more accurate (97.2%), sensitive (100%), and specific (94.34%). Tests and study groups were strongly correlated for malignant tumor detection. We confirm **Suhas and Amar (2023)** true biopsy breast cancer detection.

Krishna et al. (2020) showed that Tru-Cut biopsy for clinically palpable breast cancers confirmed our findings. Tru-Cut biopsy is 95.45% sensitive and 100% specific. Diagnostic accuracy was 98.14%, PPV 100%, NPV 100%. Our and these research show Tru-Cut biopsy detects breast cancer.

Conclusion

Our research concludes that ultrasound-guided Tru-cut needle biopsy is essential for diagnosing worrisome breast tumors. Histopathology results matched the method, proving its malignancy detection accuracy. With 94.7% sensitivity and 100% specificity, it accurately identified benign and malignant tumors. Its positive and negative predictive values were 100%, confirming its malignancy prediction capacity. The method was 95% accurate. These results highlight the importance of ultrasound-guided Tru-cut needle biopsy in breast cancer diagnosis, allowing timely and accurate diagnosis and patient management and treatment choices.

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