SURGERY IN LOW AND MIDDLE INCOME COUNTRIES

Low-Cost Vacuum Assisted Core Needle Biopsy Technique for Breast Lumps

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Abstract

Background Core biopsy has replaced fine needle aspiration cytology in the assessment of breast lumps to diagnose malignancy and is now standard of care in developed countries. Unfortunately, cost of core biopsy system is a major limitation in low-and middle-income countries (LMICs). This prompted us to devise and appraise a low-cost technique of core biopsy using negative pressure.

Methods We devised and prospectively evaluated a simple model of core biopsy (vacuum assisted core needle biopsy-VACNB) using a 50 ml syringe, a 10 ml syringe and a 14G needle.

Results 57 consecutive women (median age 42.66 years) with breast lumps (median diameter 5.2 cm) underwent VACNB. The sensitivity for diagnosing malignancy was 92%, specificity was 100%, and diagnostic accuracy was 92.98%. The positive predictive value of this technique was 100%, and negative predictive value was 63.64%. The cost ($\sim$ 5.5 USD) of the system was significantly less than the cost of core biopsy needle ($\sim$ 41.00 USD) and vacuum assisted breast biopsy needle ($\sim$ 341.00 USD) in India.

Conclusion Frugal innovations are needed to overcome cost constraints in LMICs. Our low-cost VACNB technique is easy to use and accurate.

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Introduction

Currently, breast cancer is the most common cancer affecting women in India and accounts for 25–32% of female cancers in all cities across the country [1]. As the third wing of triple assessment of any breast lump, core needle biopsy (CNB) has become the standard of care over fine needle aspiration cytology (FNAC) across all surgical guidelines. However, many centers in low-and middle-income countries (LMICs) have been unable to replace FNAC with automated CNB and newer techniques like vacuum assisted biopsy (VAB) due to the lack of availability and affordability [2]. This prompted us to devise and appraise a low-cost technique of core needle biopsy utilizing vacuum created by two syringes.

Methods

This prospective validation study was conducted in the Department of General Surgery Government Netaji Subhash Chandra Bose Medical College, Jabalpur, India between January 2020 and May 2021. Consecutive patients with palpable breast lumps and having an indication for surgery were included in the study. A sample size of 52 was calculated a priori [3].

The ethics committee of the institute approved the research protocol. American College of Radiology (ACR) guidelines for Breast Imaging-Reporting and Data System (BI-RADS) were used for assigning categories by Ultrasound or Mammography. As the Mammography facility is not available at our center, it was performed in only those patients who could afford it from a private hospital.

Inclusion criteria

Patients with palpable breast lump with clinical and radiological indication for surgery were included.

Exclusion criterion

Non-palpable lumps, benign breast disease on clinical and radiological evaluation or a definitely benign lesion e.g., cyst (BI-RADS 2) on radiology and where surgical excision was not required were excluded from the study.

Intervention

A new economical device for core biopsy was devised by one of the authors (SKY); consisting of two syringes of 50 and 10 ml and a 14G needle (Fig. 1). The 14 gauge needle is attached to a 50 ml syringe and is advanced in the breast lump under aseptic precautions. The plunger of 50 ml syringe is then withdrawn, and a 10 ml syringe is fitted between the withdrawn plunger and the syringe base. Continued high pressure suction thus created leads to lump

breaking into small pieces by a "to and fro" movement of the needle which is then sucked out into the syringe. Visual assessment of the cores obtained with this technique was done based on size, consistency and whether the complete cores sank in the formalin jar (Fig. 2). Minimum of five good cores in each patient were taken. The cost of this VACNB system was approximately 5.5 USD (Supplementary Video SV).

Final diagnosis was established after comparing the results of biopsy with clinical and imaging findings. Those with malignant diagnosis on clinical, radiological and histopathological assessment were offered definitive treatment. In patients where biopsy results using VACNB were indeterminate, suspicious or had radiological-histopathological discordance, a re-biopsy using commercially available core biopsy system (Bard, Arizona, Franklin, IN, USA) was done. Patients having clinical, radiological and histopathological benign lesions were advised three monthly follow-up. For patients undergoing surgery, histopathology of the excised specimen was considered as final diagnosis and for patients under follow-up, three month clinical and radiological diagnosis was considered final.

Outcome measures

The results were compared with the gold standard of paraffin histopathology of surgical biopsy specimen. Secondary outcomes were haematoma and infection rate. True positive (TP) for breast malignancy was considered when histopathology on both VACNB and excised specimen was malignant. If histopathology on both VACNB and excised specimen was benign for operated patients or stable at three month follow-up on imaging for patients under observation then it was taken as true negative (TN). Breast lesions for which the VACNB was indeterminate but repeat core needle biopsy/surgical excision showed that malignancy were taken as false negative (FN). False-positive (FP)

Fig. 1 a Assembly of device using 50 ml syringe and 14G needle **b** assembly device **c** biopsy being taken
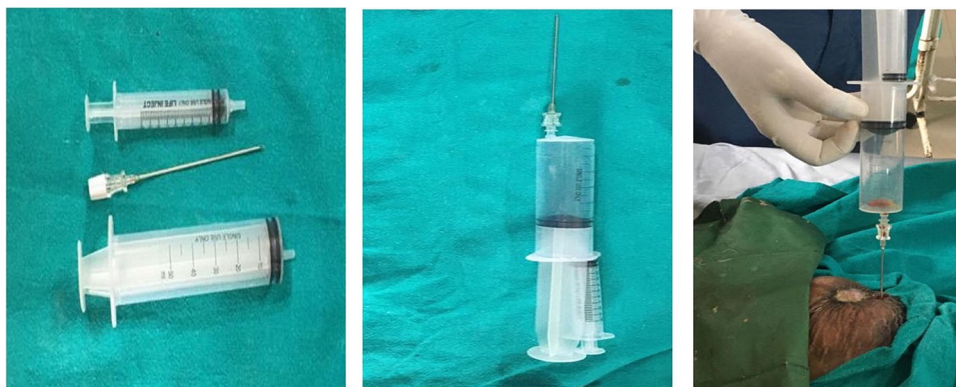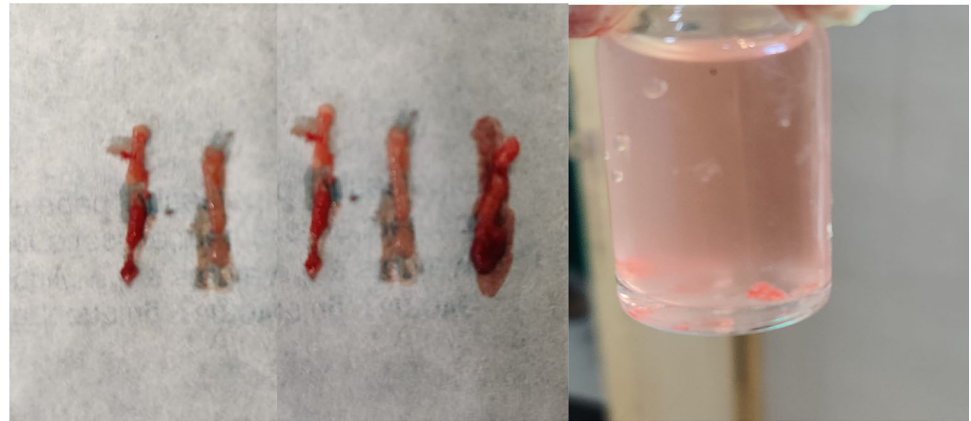
Fig. 2 Specimen of cores obtained with VACNB

patients were those when histopathology on VACNB was a cancer but on excised specimen it was benign.

Statistical analysis

SPSS software (SPSS for Windows version 16, Inc., Chicago, USA) was used for the calculation of technical success, sensitivity, specificity, false-positive rate, false negative rate and diagnostic accuracy of VACNB.

Results

A total of 57 consecutive women meeting the inclusion criteria were included in the study. Median age was 42.66 years (Range 13–69 years). Mammography could be done only in 24/57 women. Rest 33/57 patients did not undergo Mammography as 11 patients were younger than 30 years of age, and 22 patients could not afford it. These 33 patients were assigned BI-RADS categories using breast ultrasound. BI-RADS 4 or 5 lesions were present in 52 patients. Five patients having BI-RADS 2 or 3 lesions underwent biopsy in view of large size of the breast lump. Median diameter of breast lumps was 5.2 cm (range 3.5–16 cm).

In 31 patients, VACNB was reported as infiltrating duct carcinoma (IDC; $n = 23$), rhabdomyosarcoma ($n = 01$), fibroadenoma ($n = 05$), idiopathic granulomatous mastitis ($n = 01$) and inconclusive ($n = 01$). Five fibroadenomas, twelve early IDC and one rhabdomyosarcoma patients were operated upfront, and the diagnoses were confirmed on final histopathology. In one inconclusive patient, a repeat core biopsy was confirmatory for IDC. The remaining twelve IDC patients had locally advanced breast cancer and were referred for Neo-adjuvant Chemotherapy (NACT). Three patients had complete clinical response, and hence, histopathological diagnosis on VACNB was considered as final diagnosis in them, and rest nine had residual disease confirmed after surgery. One patient had idiopathic granulomatous mastitis on VACNB which was confirmed on core needle biopsy; she responded to steroid therapy (Fig. 3).

Twenty-six patients were referred to us after receiving NACT based on clinical, radiological and FNAC diagnosis. All had residual lumps from which VACNB was performed before surgery. For three out of 26 patients, VACNB report came as either inconclusive or suspicious. Diagnosis was confirmed on final histopathology in all. Immunohistochemistry was possible in all breast cancer patients diagnosed by VACNB (Table 1). There was no hematoma or wound infection in any patient.

The sensitivity of VACNB for diagnosing malignancy was 92% (95% CI 80.77–97.78%),

Specificity 100% (95% CI 59.07–100.00%), Diagnostic accuracy 92.98% (95% CI 83–98.05%), Positive Predictive Value (PPV) 100% and Negative Predictive Value (NPV) was 63.64% (95% CI 40.60–81.70%) (Table 2). Repeat biopsy rate (04 of 57, 7.01%) was low and mainly due to inconclusive (03 of 04) or imaging-histologic discordance (01 of 04). VACNB also had low false negative rate (7%). There was no incidence of hematoma or wound infection. None of the patients reported pain or inconvenience. All patients were prescribed non-steroid anti-inflammatory drugs SOS for pain; however, none of them reported back with pain.

Discussion

In this prospective validation study of a low-cost VACNB technique, average number of cores obtained, quality of cores and no significant complication suggests that this technique is technically feasible. This study shows that the results of the low-cost VACNB technique for palpable breast lumps in terms of sensitivity, specificity, repeat biopsy rates, false negative rates and negative predictive
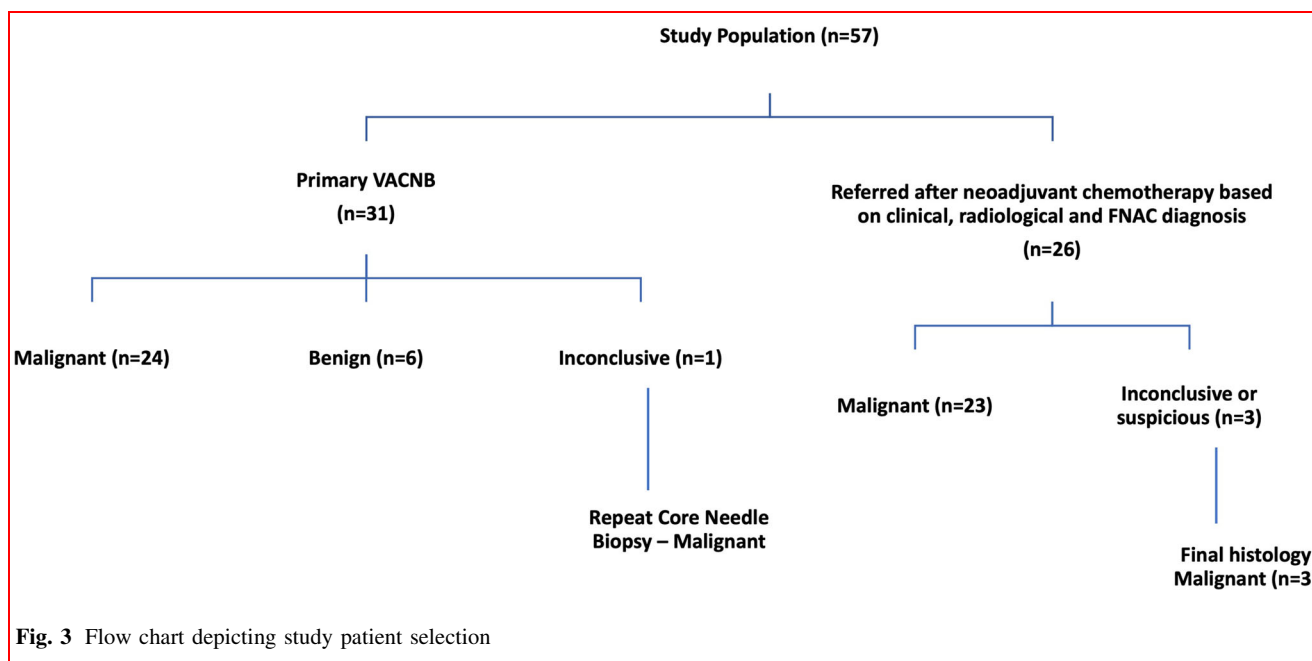
Fig. 3 Flow chart depicting study patient selection

Table 1 Biopsy results for VACNB (*n* = 57)

No of patients (*n* = 57)	Histopathological report by VACNB	Final histopathological report	Comments
46	Infiltrating ductal carcinoma	Infiltrating ductal carcinoma	IHC possible in all
4	Negative	Infiltrating ductal carcinoma	One index patient, three post-NACT
5	Fibroadenoma	Fibroadenoma	
1	Rhabdomyosarcoma	Rhabdomyosarcoma	
1	Idiopathic granulomatous mastitis	Idiopathic granulomatous mastitis on repeat core biopsy	Patient responded to steroids

IHC Immunohistochemistry, *NACT* Neo-adjuvant Chemotherapy

Table 2 Accuracy (%) of VACNB for correct diagnosis of malignancy (*n* = 47)

Parameter	Result
Sensitivity	92% (95% CI 80.77–97.78%)
Specificity	100% (95% CI 59.07–100.00%)
Diagnostic accuracy	92.98% (95% CI 83–98.05%)
Positive predictive value for malignancy	100%
Negative predictive value for malignancy	63.64% (95 CI 40.60–81.70%)

True positive-43, False negative-04

value are similar to CNB and better than FNAC with added advantage of possibility of IHC [4–6].

The long-debated issue of FNAC or CNB for the diagnosis of breast lumps has been settled in the developed countries, and CNB is now considered the procedure of choice. However, the cost of core needle biopsy is a major limiting factor for routine use in LMICs. The Breast Health Global Initiative which focuses on feasible, cost-effective and culturally specific guidelines for LMICs recommends that the choice of sampling procedure (FNAC or CNB) for

breast lumps should be based on the cost-effectiveness, availability, access, training and experience of cytopathologists [7]. FNAC is a good tool to diagnose malignancy in a breast lump. But, beyond categorization of a lump as malignant or benign it does not assist in planning of therapy for breast cancer patients. In today's world when biomarker assessment of all breast cancers is recommended before starting of any therapy, the practice all over world has shifted from FNAC to biopsy [8]. This biopsy is usually done via an automated/ semi-automated core biopsy gun, but we have developed a similar and low-cost effective alternative. The tissue obtained can be used for histological and immunohistochemical studies, similar to the tissue obtained via the commercially available automated/ semi-automated guns. One of the settings where this low-cost technique can be used is if pathology and IHC services are available and cost is the only factor in selecting FNAC over core needle biopsy.

The practice of breast surgery in low resource setting is challenging at times. Many patients recruited in this study were started on systemic therapy without undergoing any tissue biopsy at other centers/ departments. This is not something we recommend or practice, and hence, all these patients underwent a core biopsy for determination of histological subtype and immunohistochemistry for estrogen receptor, progesterone receptor, HER-2/neu receptor and ki-67, when they consulted us. Molecular profiling of the tumor helps in deciding the type of preoperative systemic therapy (chemotherapy/hormone therapy/ anti-HER-2 therapy), prognostication and planning of adjuvant therapies. Hence, it is needless to say that it is unavoidable, more so in cases of LABC where if it is not done prior to neo-adjuvant systemic therapy, the information can be lost forever if there is a complete pathological response to the therapy. Our patients present in advanced stage, and screen detected breast cancer is extremely rare. The rate of sensitivity, specificity and false negativity for FNAC and CNB is variable in literature depending on the type of setting (palpable vs non-palpable or USG guided vs stereotactic biopsy). In our setting, these parameters are better than FNAC and comparable to CNB [9].

Limitations of our study include that it is a small cohort and single center study, differences between diagnostic capabilities (viz. sensitivity, specificity and accuracy) of VACNB and Core needle biopsy were not compared, and non-palpable breast lumps were not sampled. All the procedures were performed by two experienced personnel, and average breast lump size was high. Hence, its reproducibility in different settings and in larger cohorts needs to be established.

Conclusion

Frugal and effective innovations are needed to safeguard the poor from catastrophic healthcare expenditure. Our low-cost core biopsy technique is technically feasible with acceptable diagnostic accuracy.

Declarations

References

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