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Comparison Ultrasound-Guided Handheld Vacuum Assisted Breast Biopsy and Core Biopsy in Breast Cancer

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Abstract

Introduction. Needle biopsy, including core needle biopsy (CNB) and vacuum-assisted breast biopsy (VABB) with or without radiological support) is the initial investigative method of choice for the preoperative diagnosis of breast lesions. Ultrasound-guided VABB (US-VABB) has become widely accepted because of its high accuracy. In this review, the diagnostic performance indices of CNB were compared with US-VABBB techniques.
Method. A literature search proceeded in online databases compiling studies from the last 20 years in the PubMed, EBSCOhost, ScienceDirect, and ProQuest databases. Eighteen eligible studies compared US-VABB and CNB for diagnostic accuracy. All studies were cohort retrospective. This literature search proceeded according to the PRISMA.
Results. Eighteen retrospective studies in three categories: comparative studies of US-VABB and CNB and the diagnostic accuracy of US-VABB and CNB. The studies showed that US-VABB has higher sensitivity and specificity than CNB but lower inadequacy and underestimation rates in the comparative studies group. In addition, the diagnostic accuracy of US-VABB is higher than CNB when comparing the other two subgroups (sensitivity and specificity: 94.4%-100% vs. 82%-90% and 98%-100% vs. 96%-98%, respectively).
Conclusion. US-VABB has higher overall diagnosis accuracy than CNB.

Keywords: breast cancer; breast biopsy; vacuum-assisted breast biopsy; core needle biopsy; ultrasound-guided vacuum-assisted breast biopsy

Introduction

The breast consists of three main parts, lobules (milk-producing glands), ducts (tubes that carry milk through the nipples for secretion), and connective tissue (composed of fibrous tissue and fat) surrounding and providing support to the breast. Breast tumors could be benign or malignant (cancer). Most breast cancers are found in the excretory ducts or lobules.[1] The average woman's risk of developing breast cancer is 13%, which means that 1 in 8 women will develop breast cancer at some point in their lives. According to Globocan, the incidence of breast cancer is 20% of all malignancies. In Indonesia, breast cancer is the most common cancer, and it is estimated that there are more than 65,000 cases and about 22,000 deaths due to breast cancer. This cancer is a significant burden in Indonesia, with more than 50% of breast cancer patients in Indonesia in an advanced stage.[2]

Early diagnosis of breast cancer is still necessary. Various methods have yielded satisfactory results, such as mammography, fine-needle aspiration biopsy (FNAB), and core needle biopsy (CNB).[3] CNB is the most commonly used diagnostic method for nonpalpable and palpable lesions worldwide for its high accuracy, cost-effectiveness, low complication rate, and convenience. Despite these advantages, it is not an anti-failure method because of the high rate of false-negative findings and misclassification, which were inevitable because the procedure involves sampling merely a small part of the target rather than the entire lesion.[4,5]

Recent advances in ultrasound diagnostics allowed early detection of nonpalpable malignant lesions measuring less than 1 cm, contributing to increased breast cancer survival rates. Vacuum-assisted breast biopsy (VABB), also known as mammotomy biopsy, has been accepted as a safe and effective procedure. Such a procedure maximizes diagnostic accuracy by performing excisional biopsies for most breast diseases while minimizing post-procedural scarring and complications. In addition, the method provides clinical benefits as it can proceed under the guidance of sonography, mammography, or magnetic resonance imaging.[4] Ultrasound-guided procedures remain discussed to replace surgical biopsy for nodular lesions and even surgical excision of benign lesions. This review aimed to compare the diagnostic accuracy between ultrasound-guided vacuum-assisted breast biopsy (US-VABB) and CNB, as well as their applicability and complication rate.

Method

A literature search proceeded on the PubMed, EBSCOhost, ScienceDirect, and ProQuest databases. Keywords used were following the Medical Subject Headings (MeSH) terms: breast cancer or breast calcification and ultrasound and vacuum assisted biopsy or mammotome or EnCor and large needle core biopsy or needle core biopsy. The reference of the relevant articles was also screened to identify eligibility. The inclusion was prospective, and retrospective studies focused on the diagnostic accuracy of US-VABB and CNB published between January 2001 to December 2021; patients with ductal carcinoma *in situ* (DCIS) were diagnosed with USG–guided VAB or core needle stereotactic. These articles were screened based on title and abstract and then appraised for validity, importance, and applicability using specific tools: the cohort, case series, and case report were each appraised using Joanna Briggs Institute, Faculty of Health and Medical Sciences, checklist for cohort, case series, and case reports studies (critical appraisal tools). The literature search proceeded according to the PRISMA (Figure 1)

Results

Of one hundred seventy identified articles in the four databases, 156 were screened, and eighteen met the criteria. All were retrospective cohorts comprised of three categories: comparative studies of US-VABB and CNB (4 articles), studies related to the diagnostic accuracy of US-VABB (9 articles), and studies related to the diagnostic accuracy of CNB (5 articles).

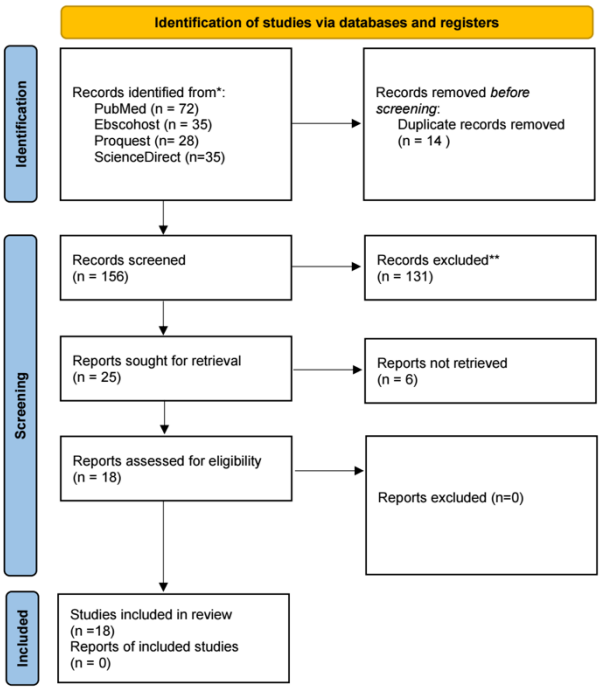

Figure 1. The literature searching process and results using Prisma flow 2020.

Table 1. Characteristics of Comparative Studies

Author (Year)	Study Design	Diagnosis	Age	Samples	Biopsy Methods	Biopsy Needle	Guidance	Reference Standard	Outcome	Complication
Ciatto (2007)[6]	Retrospective Study	DCIS	NA	1391 (US-VABB) 2646 (CNB)	US-VABB CNB	11 14	Ultrasound	Histopathological Diagnosis	Inadequacy Rate US-VABB = 0.29% CNB = 0.72%	NA
Lacambra (2011)[7]	Retrospective Study	DCIS	NA	285 (US-VABB) 179 (CNB)	US-VABB CNB	11 14	Ultrasound	Histopathological Diagnosis	Sensitivity US-VABB = 96% CNB = 99% Specificity US-VABB= 100% CNB = 100%	NA
Suh (2012)[8]	Retrospective Study	DCIS	NA	56 (US-VABB) 138 (CNB)	US-VABB CNB	11 14	Ultrasound	Histopathological Diagnosis	DCIS US-VABB = 16.1% CNB = 47.8%	No complications for both device
Ye (2013)[9]	Retrospective Study	DCIS	NA	54 (US-VABB) 98 (CNB)	US-VABB CNB	11 14	Ultrasound	Histopathological Diagnosis	DCIS US-VABB = 16.6% CNB = 45.9%	NA

Note: DCIS: ductal carcinoma *in situ*; NA: not available; US-VABB: ultrasound guided vacuum assisted breast biopsy; CNB: core needle biopsy

Table 2. Characteristics of ultrasound guided VAB Studies

Author (Year)	Study Design	Diagnosis	Age	Samples	Biopsy Needle Size	Reference Standard	Guidance	Sensitivity	Specificity
Hung (2001)[14]	Retrospective Study	DCIS	NA	49	11	Histopathological Diagnosis	Ultrasound	100%	100%
Meloni (2001)[15]	Retrospective Study	DCIS	30-77	73	11	Histopathological Diagnosis	Ultrasound	95%	100%
Bonifacino (2005)[16]	Retrospective Study	DCIS	40-50	146	11	Histopathological Diagnosis	Ultrasound	100%	99%
Vag (2007)[17]	Retrospective Study	DCIS	NA	65	10	Histopathological Diagnosis	Ultrasound	97%	100%
Cassano (2007)[18]	Retrospective Study	DCIS	NA	266	11	Histopathological Diagnosis	Ultrasound	97%	100%
Shin (2008)[19]	Retrospective Study	DCIS	NA	123	8	Histopathological Diagnosis	Ultrasound	100%	100%
Abbate (2009)[11]	Retrospective Study	DCIS	NA	138	11	Histopathological Diagnosis	Ultrasound	94.4%	100%
Pan (2014)[10]	Retrospective study	DCIS	16-73	5232	8	Histopathological Diagnosis	Ultrasound	100%, diagnostic accuracy 100%	NA
Nicosia (2021)[20]	Retrospective Study	DCIS	NA	168	13 and 10	Histopathological Diagnosis	Ultrasound	97.5%	98%

Note: DCIS: ductal carcinoma *in situ*; NA: not available; VAB: vacuum assisted biopsy

Table 3. Characteristics of CNB Studies

Author (Year)	Study Design	Diagnosis	Age	Samples	Biopsy Needle Size	Reference Standard	Guidance	Sensitivity	Specificity
White (2001)[21]	Retrospective Study	DCIS	NA	802	14	Histopathological Diagnosis	Stereotactic	89%	96%
Verkooijen (2002)[22]	Retrospective Study	DCIS	NA	1029	14	Histopathological Diagnosis	Stereotactic	97%	99%
Leifland (2003)[13]	Retrospective Study	DCIS	NA	448	14	Histopathological Diagnosis	Stereotactic	90%	98%
Kyung-Han (2003)[23]	Retrospective Study	DCIS	NA	271	14	Histopathological Diagnosis	Stereotactic	82%	NA
Huang (2011)[12]	Retrospective Study	DCIS	NA	218	14	Histopathological Diagnosis	Stereotactic	Diagnostic Accuracy 84%	NA

Note: DCIS: ductal carcinoma *in situ*; NA: not available; CNB: core needle biopsy

Comparison of diagnostic accuracy between US-VABB and CNB

Four retrospective studies comparing the diagnostic accuracy of US-VABB with CNB had different effect sizes.[6-9] Ciatto (2007) compared the inadequacy rate of the two biopsy techniques. The sample inadequacy rate has defined the lack of the number of cells identified to reach a diagnostic conclusion.[6] In this case, insufficient samples may be caused by several factors, including tumor characteristics, method of guiding, preparation or biopsy techniques, and skills. In the Ciatto study, the rate of inadequate specimens was lower in US-VABB than in CNB, indicating a lower likelihood of false-negative results.[6] In the study by Lacambra (2012), the accuracy of diagnosis is determined by sensitivity and specificity. The results showed that US-VABB has better sensitivity and specificity than CNB.[7] In the studies by Suh (2012) and Ye (2013), both of which used the underestimation rate of ductal carcinoma in situ (DCIS), US-VABB was found to perform better than CNB.[8,9] Almost all studies reported no complications in their results; only the study by Suh (2012) stated that there were no complications, such as bruises or bleeding with either VAB (47.8%) or CNB (16.1%).[8]

US-VABB diagnostic accuracy in breast cancer

Nine studies reported on the diagnostic accuracy of US-VABB compared with histopathologic diagnostic tests. Five studies (55.5%) used 11G biopsy needles, two studies (22.2%) used 8G, one study (11.1%) used 10G, and the other used 10 and 13G (11.1%). Eight studies (88.9%) reported US-VABB sensitivity ranging from 94.4% to 100% and specificity ranging from 98% to 100%. The study by Pan (2014) did not report study specificity but reported a sensitivity of 100% and overall diagnostic accuracy of 100% in a large cohort (n = 5232).[10] Most studies did not report the complications proportion associated with this procedure; however, Abbate (2009) reported a mild complication rate of 16.1%, with the majority of complications being hematoma, venous bleeding, clip misplacement, and procedure interruption. No significant complications were reported in any of the studies.[11]

CNB diagnostic accuracy in breast cancer

Five studies reported the diagnostic accuracy of CNB, which was also compared with histopathological diagnosis. All studies used 14G biopsy needles. Four studies (80%) reported CNB sensitivity in the range of 82to 90%, and three (60%) reported CNB specificity in the range of 96 to 99%. The study by Huang (2011) reported an overall diagnostic accuracy of CNB of 84%.[12] Similar to the US-VABB study, most studies did not report the percentage of complications of the procedure. In the study conducted by Leifland (2003), hematomas were reported in 2 of 488 (0.4%) procedures.[13] Huang (2011) did not mention the incidence of complications but noted that ecchymosis, hematoma, and pain sensations could not be avoided. However, their series showed no significant complications such as uncontrolled bleeding, severe postprocedural inflammation, abscess formation, or skin retraction.[12]

Discussion

Open surgical biopsy remains the gold standard for determining the pathologic features of breast calcification. Nevertheless, percutaneous breast biopsy (CNB) and VABB have emerged as reliable alternatives to open surgical biopsy because of their relatively high accuracy, cost savings, shorter recovery time, and overall better cosmetic outcome. Currently, both CNB and VABB have gained precision and are used more frequently than open biopsy.[11]

Consistent with the two study subcategories below, the diagnostic accuracy of US-VABB was higher than that of CNB (82%-90% sensitivity; specificity 96%-99%) in the single-method studies (sensitivity 94.4%-100%; specificity 98%-100%). In addition, a study by Pan (2014) found that the diagnostic accuracy of US-VABB reached 100%, while Huang (2011) reported that the diagnostic accuracy of CNB was 84%.[10,12] Regarding complications, although most studies did not report their frequency, the studies that reported both methods had relatively low complication rates, with no significant complications reported in all studies.

Previous reports have highlighted the advantages of US-VABB biopsy compared with other methods, such as accuracy, simplicity, and fewer complications. The advantages of US-VABB are precise positioning and accurate puncture of the lesion, especially in deep and small tumors that are not clinically accessible, ensuring sufficient tissue samples for disease investigation and immunohistochemical detection.[4,24] This also results in a lower rate of inadequate samples at US-VABB compared with CNB in the study by Ciatto (2007). A sufficient specimen comprise of tissue or cells in the sample provides adequate pathologic information to initiate treatment and improve overall patient outcomes.[6]

In addition, the small puncture hole and cosmetic effect were satisfactory, with lesions approximately 3 to 5 mm in diameter, without sutures, and with minimal scarring. Multiple lesions of the same breast can be punctured through a single puncture hole. This procedure avoids incisions in the skin, subcutaneous tissue, and normal glands, so tissue damage is minimal and rapid recovery.[25] The choice of biopsy needle sizes is relatively wider for US-VABB than for CNB (8-11G versus 14G). Nevertheless, the underestimation rate of lesions is much lower, and diagnostic accuracy is higher with similar complications. In patients with deep breast masses and obesity, using US-VABB is more advantageous because larger specimens and potentially inadequate specimens can be obtained, resulting in better diagnostic accuracy.[26] The larger diameter of the specimen makes it easier for the pathologist to identify prognostic indicators. This is especially important in patients with locally advanced breast cancer, as these patients often have altered or changed molecular information after neoadjuvant therapy.[27,28] At the same time, US-VABB can diagnose and treat tumors simultaneously and has similar characteristics to minimally invasive and aesthetic procedures.

The findings in this review are the advantages and disadvantages of US-VABB over CNB regarding diagnostic accuracy and insufficient sample reduction. However, US-VABB is reported to have a higher cost burden than conventional CNB. For example, in the study by Mafarjeh et al., the cost of VAB ranged from 2.2 to 12.5 times that of CNB.[29] In Indonesia, US-VABB is not widely used despite the higher diagnostic accuracy of the cost of misdiagnosis and underestimation of breast cancer compared to CNB. Our study had several limitations. First, because this was a retrospective study, some selection bias for using biopsy devices could not be avoided. Therefore, we compared the DCIS underestimation between two biopsy device groups by lesion type to overcome possible selection bias. Second, the high percentage of mass lesions in our study population does not reflect the pattern of previous literature (we compared the DCIS underestimation rates of the two groups according to the lesion type to minimize the effects of lesion type on the results. Another possible limitation can be the small number of mass lesions with VAB to generalize our results. Finally, data analysis was performed only for the DCIS underestimation rate, not for other outcomes, such as the rebiopsy or false-negative rates.

Conclusions

Estrogen is not statistically associated with estrogen receptors in premenopausal breast cancer patients, thus illustrating that the prognosis of breast cancer patients is not related to the estrogen produced by the body. Therefore, based on these results, modifying estrogen to get a better breast cancer prognosis is not a solution.

The risk of breast cancer increases with increasing age. The correlation between age and estrogen receptors does not show statistical significance, but there is a clinical meaning. The younger the period, the lower the estrogen receptor. Therefore, it can be applied in daily health practice for premenopausal breast cancer patients to predict treatment options and prognosis. Meanwhile, the estradiol in this study showed normal premenopausal estradiol in breast cancer patients.

Disclosure

The authors declare no conflict of interest.

Role of authors

Conceptualization 1 and 2, data curation 1 and 2, formal analysis 1 and 2, funding acquisition 1 and 2, investigation 1 and 2, methodology 1 and 2, project administration 1 and 2, resources 1 and 2, software 1 and 2, supervision 1 and 2, validation 1 and 2, visualization 1 and 2, writing – original draft preparation 1 and 2, writing – review and editing 1 and 2.

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