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Breast cancer diagnosis: The role of stereotactic vacuum-assisted aspiration biopsy

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ABSTRACT

Aim: The aim of this study is to evaluate the diagnostic accuracy and impact of the stereotactic vacuum-assisted aspiration biopsy (VAB) as a surgical treatment for non-palpable breast lesions.

Methods: A retrospective analysis of the diagnostic and therapeutic management of lesions having undergone VAB treatment was conducted. From February 2003 to September 2007, 525 stereotactic VABs were performed on 504 women using an 11-gauge needle device. Of these, 201 lesions were treated surgically. The concordance between VAB results and final pathology report after surgical excision was evaluated. Also examined was the impact of VAB on the quality of the surgical treatment.

Results: Stereotactic VABs performed with an 11-gauge device showed an underestimation rate of 23.8% for atypical ductal or lobular hyperplasia (AH). For ductal carcinoma *in situ* (DCIS) the underestimation rate was 31% and the underestimation rate for lobular carcinoma *in situ* (LCIS) was 14%. Only 38.2% of the patients with non-palpable lesions (201/525) were treated surgically and only 4% (20/504) of the patients underwent more than one surgical intervention. The VAB underestimation caused mistakes in the planning of the surgical therapy in only 9 out of 201 interventions (4.4%).

Conclusions: This study confirms the efficacy of the VAB procedure in the diagnosis of non-palpable breast lesions and demonstrates its usefulness in therapeutic surgical planning. VAB treatment allows for the reduction of the number of surgical procedures required to diagnose and treat non-palpable breast lesions.

1. Introduction

Due to the increased use of mammography as a result of organized screening programs or technical improvements, the diagnosis of non-palpable breast lesions has dramatically increased. In the past, the approach for non-palpable breast lesions was either clinical follow-up or open surgical biopsy, even if surgical biopsy was and is considered expensive, invasive and may cause intense psychological stress to the patient. Moreover, 90% of the breast abnormalities detected by mammography correspond to benign lesions.[1] Therefore in 90% of the cases, surgical biopsy would be useless and could be considered an overtreatment. As a result, in the 1990s several percutaneous breast biopsy devices for histological examination were developed. In the presence of non-palpable breast lesions, not detected by ultrasound (US), stereotactic VAB is considered a reliable alternative to surgical biopsy.[2–8]

2. Patients and methods

In this study, 504 women with an average age of 57.2 years and ranging from 32 years to 88 years old underwent vacuum-assisted breast biopsies (VABs) and were enrolled from February 2003 to September 2007, at the Department of Surgery of the University of Insubria, in Varese, Italy. Out of the 525 stereotactic VABs performed on the 504 women, 21 patients had double procedures. Eleven patients were excluded because of incomplete data.

In all cases the biopsy was performed using the 11-gauge Mammotome instrument associated with the Fischer prone-biopsy table (Fischer Mammotest Plus/S Mammovision®; Ethicon Endosurgery, Cincinnati, OH, USA).

Those patients with non-palpable breast lesions that were discovered with mammography and not detected by US, were

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referred to stereotactic vacuum-assisted breast biopsy (VAB) as a procedure. When the lesion was visible by US, a stereotactic guide was avoided and in order to study the lesion fine-needle aspiration cytology (FNAC) or US-guided core-needle biopsy (CB) was used.

Patients with whom the mammographic finding of the lesions was surely malignant or benign were excluded. In these cases FNAC was performed to achieve the histological diagnosis. In the case of dubious results, VAB was performed as an additional level of study.

Days before the VAB procedure took place, the surgeon thoroughly explained the technique to the patient and obtained informed consent. Preoperative analyses (blood samples) were performed a few days before the biopsy was done.

All VABs were performed in an ambulatory setting and the patients were observed for a period of 4–5 h after the procedure was completed. The average duration of the biopsy was 35 min, ranging from 18 to 65 min.

The day following the procedure, the patient was invited to the center for dressing removal and clinical evaluation. Furthermore, a week after this visit the patient underwent an additional clinical evaluation and unilateral mammogram.

No significant intolerance of this procedure or pain was reported, apart from one patient who asked to interrupt the procedure.

3. Results

Of the 525 VABs performed, 305 (58.5%) were mammographically detected as foci of microcalcifications. Table 1 shows in detail the types of breast mammographic abnormalities detected in this study.

Most of the lesions were localized in the upper outer quadrant (UOQ) or at the junction of the upper quadrants. Tables 2 and 3 show the localizations of all the breast lesions per quadrant. In this study, the localization of four lesions was unknown. No significant difference was observed among any sides of the breast lesions that were biopsied: in 251 cases (47.8%) the right breast was involved and in 274 cases (52.2%) the left breast had abnormalities.

3.1. Outcomes of stereotactic vacuum-assisted breast biopsy

Table 4 shows the final pathologic outcomes of the breast lesions obtained with VAB procedure. Of the 163 malignant lesions excised by the VAB technique, there were 97 invasive carcinoma (ductal or lobular) and 65 carcinoma *in situ* (58 ductal and 7 lobular). One lesion was diagnosed as an intraparenchymal lymph node involved by breast MALT-type lymphoma. In 21 cases the lesions contained foci of atypical ductal or lobular hyperplasia (AH).

3.2. Surgical intervention

The surgical treatment of VAB was offered to all the patients with the diagnosis of epithelial malignancy or atypical hyperplasia (AH). The patient diagnosed with the primary breast lymphoma received only chemotherapy treatment, and no surgery was performed.

The surgical interventions were performed using needle-localization or radio-guided occult lesion localization (ROLL) techniques. In total 201 surgical interventions were performed to treat 166 malignant lesions, 21 AH and 14 benign lesions. Specifically, 130 quadrantectomies, 36 mastectomies, 31 surgical biopsies, 2 ductectomies and 2 nodulectomies were performed. Additionally among the mastectomies, 18 sentinel lymph node biopsies (SLNB) were performed during the same intervention. In 3 of the 18 cases (16.7%) axillary lymphadenectomies became necessary due to positive intraoperative diagnosis of the SLN. In the subgroup of the mastectomy patients, no additional surgery was required.

Simple quadrantectomies were performed in 21 cases and this decision was made based on the pathology report of the VAB showing carcinoma *in situ* in this group of patients. In total 109 quadrantectomies with SLN biopsies were performed and for 104 cases two procedures were performed during the same operation. In this group, 8 cases had positive SLN, which necessitated axillary lymphadenectomies. In one case the axillary lymphadenectomy was performed during a second operation due to a final pathology report of the SLN, where metastasis was missed in the previous intraoperative evaluation. Due to the underestimation of the lesion from the VAB and a pathology diagnosis of carcinoma *in situ*, in two cases it was necessary to amend the original therapeutic strategy by undergoing a simple quadrantectomy. Furthermore, the final pathology report of both cases showed invasive carcinoma, necessitating a SLNB, one of which was followed by an axillary lymphadenectomy due to intraoperative metastatic disease of the SLN.

The staging of the axillary lymph nodes was performed in a separate surgical setting before the quadrantectomy for three patients, due to the inability to perform an intraoperative examination of the SLN. It was determined where to perform a lymphadenectomy during a second surgical setting to treat the lesion once the outcome of the SLNB was received. Nine quadrantectomies with SLNB needed a second surgical procedure as the surgical resection margins were positive for carcinoma.

3.3. Pathologic outcomes after VAB procedure

In total, 164 malignant lesions were diagnosed by surgical excisions resulting in 114 invasive carcinomas, 41 DCIS, 7 LCIS and 2 ductal-lobular carcinomas *in situ* (Table 5). In addition, 22 benign lesions and 15 AH were also detected.

Among the 341 benign lesions found on stereotactic VAB, 18 were referred to surgical intervention. In 5 cases, the clinical diagnosis of the VABs proved to be underestimated. Of the 18

Table 1
Mammographic abnormalities.

	Number
Microcalcifications	305
Parenchymal distortions	111
Nodules	94
Parenchymal thickening	8
Parenchymal distortions with microcalcifications	1
Nodule with microcalcifications	1
Nodule with parenchymal distortions	1
Unknown	4
Total	525

Table 2
Localization of the breast lesions.

	Number
Upper outer quadrant	243
Upper inner quadrant	26
Lower outer quadrant	22
Lower inner quadrant	43

Table 3
Localization of the breast lesions.

	Number
Junction of outer quadrants	19
Junction of inner quadrants	19
Junction of upper quadrants	73
Junction of lower quadrants	18
Region under areola	58

Table 4
Final pathology after VAB procedure.

	Number
Benign	341
Invasive mammary carcinoma	97
Ductal carcinoma *in situ* (DCIS)	58
Atypical ductal or lobular hyperplasia (AH)	21
Lobular carcinoma *in situ* (LCIS)	7
Lymphoma	1
Total	525

lesions clinically diagnosed as benign, 3 were found by VAB to be invasive carcinoma, one as AH and one as DCIS at the surgical excision. The AH did not change the therapeutic management, hence the real underestimation rate of benign lesions was 22.2% (4/18).

Findings from the 21 AH surgical excisions showed five patients (23.8%) with an upgraded diagnosis: three patients were found to have invasive carcinoma and two patients were found to have DCIS; in 5 lesions no residual AH was found (Table 6).

Among the 58 DCIS lesions found on stereotactic VAB, 18 (31%) previously sampled sites were upgraded to invasive carcinoma. LCIS clinical underestimation occurred only in one case out of 7 (14%). Among invasive carcinoma lesions found on VAB, the surgical excision confirmed the diagnosis in 89 out of 97 cases (91.7%). In 8 cases, VAB had removed all the invasive components, therefore 7 cases only showed DCIS in the surgical excision, and for one case no residual malignancy was found.

4. Discussion

The awareness on the part of the female population regarding breast cancer prevention brings millions of asymptomatic women to undergo mammography screening each year. These screenings generate a significant increase in the diagnosis of non-palpable breast lesions, some of which are not classified with certainty by mammography and need further investigation to be precisely identify.

When facing a suspicious breast lesion it is necessary to obtain a confirmation by using cyto-histological diagnostic tools that permit the lowest possible invasiveness. In fact, the histological diagnosis of breast lesions is mandatory in order to plan the most appropriate therapeutic strategy for each patient. The aim is to avoid both the excessive use of surgery and the failure to treat a breast cancer diagnosis, which has been clinically misinterpreted.

With the number of women who undergo screenings and the potential psychological distress of false-positive diagnosis and general overall cost, mini-invasive procedures, like VAB, are required to quickly assess breast abnormalities diagnosed with mammography without having to perform surgical biopsies in every case.

In the past, the gold standard reference test has been the open surgical breast biopsy. The accuracy of open biopsy is high, estimated as between 96% and 99%.[9,10] However, today minimally invasive biopsies have replaced open excisional biopsies for most patients with an unclear mammographic finding. Needle-localized breast biopsies for non-palpable lesions is not 100% reliable. In 2–7% of cases, surgical excisions miss the lesions.[9,11,12] ROLL has been advocated as an alternative to the hooked-wire technique[13] and is also considered easier to perform and less painful to the patient. However, the two techniques are similar from the point of view of accuracy: in a randomized trial of ROLL versus wire localization, in 2% of the ROLL patients the procedure missed the lesion.[14] For this reason, percutaneous image-guided breast biopsy is being increasingly used to diagnose breast lesions. Furthermore, percutaneous biopsies are faster, less invasive, and less expensive than surgical biopsies. Less tissue is removed, resulting in no deformity in the breast and minimal to no scarring on subsequent mammograms.[6] Percutaneous breast biopsies allow one to achieve histological diagnosis reserving any subsequent surgery to definitive treatment of the lesion (therapeutic instead of diagnostic intervention). In comparison to open excisional biopsy, minimally invasive techniques have the same or better precision, decrease the psychological burdens of the patients, and reduce costs. In fact they decrease the number of surgical procedures required in patients with non-palpable breast lesions compared to diagnostic open surgery.[15,16] Reliable cyto-histological diagnosis allows the scheduling of a surgical treatment in a unique approach avoiding further re-interventions.

Table 5
Type of epithelial malignancy.

	Number
Invasive mammary carcinoma	114
Ductal carcinoma *in situ* (DCIS)	41
Lobular carcinoma *in situ* (LCIS)	7
Lobular and ductal carcinoma *in situ*	2
Total	164

Table 6
Outcomes of excised AH lesions found on stereotactic VAB.

	Number
AH (confirmed)	11
Benign (therapeutic)	5
Ductal carcinoma *in situ* (DCIS)	2
Invasive mammary carcinoma	3
Total AH lesions on VAB	21

An increasing number of needle and biopsy probes are available that enable the retrieval of breast tissue either from stereotactic or US or MRI-guidance. These tools include small-gauge needles and cutting needles used in combination with guns and directional vacuum-assisted devices. The operator must not only decide which of these technologies to use, but also which size of needle or probe is the most appropriate in each case. Cost, clinical context, and likely diagnosis should influence the decision process.[17] The choice of stereotactic versus US-guidance depends on several factors including equipment availability, lesion visibility and accessibility, and preferences of operator and patient. The stereotactic guidance may be used for all types of mammographic lesions that are not detected by US, such as parenchymal distortions and microcalcifications, but it requires dedicated equipment. The stereotactic biopsy is essential in the study of non-palpable breast lesions because microcalcifications (detectable only with mammography) are a characteristic feature of DCIS, which represents 20–40% of all non-palpable breast cancers and 25% of breast cancers found in screening procedures.[18] Stomper et al.[19] reported on 100 DCIS cases: 72% of these cases presented solely as microcalcifications by mammography, whereas in this present study 92% of cases had microcalcifications.

Fine-needle aspiration (FNA) is a common and inexpensive diagnostic method; however, limitations of this technique have been demonstrated in several studies. The frequency of insufficient samples ranges from 8.5% to 46%.[17] In the literature considerable variability is highlighted in the sensitivity of FNAC (63–99%)[20–22] and a high rate of false negatives that ranges from 0% to 10%.[23–25] The diagnostic accuracy for DCIS and AH is low.[26–28] The high frequency of insufficient samples of FNA biopsy and its low accuracy are substantial limitations, and have led to the increasing use of larger tissue-acquisition devices for percutaneous biopsy of the

breast, such as the automated guns used to perform large-core needle biopsy (CNB) and the directional vacuum-assisted devices used for VAB.

Validation studies showed 87–96% concordance between results of stereotactic 14-gauge CNB and surgery.[29,30] Although the 14-gauge CNB is an excellent tool, it has some limitations. Obtaining each specimen requires a separate insertion and removal of the needle. If multiple specimens are obtained, the later samples are often composed predominantly of blood rather than breast tissue. Retrieval of calcifications may also be difficult. For a lesion to be retrieved with the automated needle, it must be along the line of fire of the needle; this can be particularly difficult for small lesions or microcalcifications. For some lesions with complex histology (such as calcifications containing AH and DCIS or DCIS and invasive carcinoma) the CNB may provide incomplete characterization of the histological findings.[6,17]

Directional VAB devices have several advantages compared with automated needles. The vacuum can be used to suck the blood out of the cavity during and at the end of the biopsy procedure. Because of the use of vacuum, tissue can be acquired at a distance from the probe, not just within the line of fire. The probe needs only to be inserted once; multiple specimens can be obtained from that single insertion. Specimens are larger than those obtained with 14-gauge CNB. Many authors have shown VAB to be superior to 14-gauge CNB. With VAB, microcalcification retrieval is significantly improved. In fact the retrieval can be confirmed histologically in 91–100% of the specimens obtained with VAB, while it is only seen in 86–94% of those obtained with CNB.[6] VAB also results in more accurate characterization of lesions with complex histology,[31,32] thanks to the ease of obtaining multiple specimens and a larger volume of tissue. For subsequent operative planning, the histological differences between invasive carcinoma, DCIS and AH is of major significance. Despite the relatively large biopsy specimen, VAB cannot completely avoid the problem of lesion upgrade in the operative specimen. Nevertheless, several studies have documented the precision of VAB compared with CNB.

In this study 18 of 341 benign lesion diagnosed with VAB underwent surgical intervention, and in 4 cases (22.2%) the lesions were upgraded at the surgical specimens evaluation. With regard to the underestimation of AH and DCIS, the results of the present study are in agreement with the previously published works. In the literature the underestimation rate of DCIS varies from 0% to 35.7%, whereas this study found an underestimation rate of 31% (18/58).

In our study all 58 patients with a diagnosis of DCIS performed with VAB underwent surgical intervention. Among this group a second surgical procedure was required in two cases. In one case the surgical resection margins were positive for disease therefore a second look was necessary in order to achieve surgical clearance. In the second case the underestimation of DCIS caused a mistake in the surgical planning: the pathologic discovery of invasive carcinoma in the surgical specimen necessitated a SLNB for a complete staging of the axillary lymph nodes.

In the literature AH lesions represent 2–11% of the non-palpable lesions evaluated with VAB.[33] In this study AH lesions were 4% of the total, and in 23.8% of cases the histological examination of the surgical specimen upgraded the lesion to invasive cancer. Several authors stress the need for surgical intervention in the case of diagnosis of AH to VAB, given the frequent and persistent diagnostic error associated with this type of lesion.

In the present study all patients with AH lesions diagnosed with VAB were referred to surgical intervention. Re-intervention for surgical clearance was performed in those patients with underestimated AH lesions.

With the conventional approach adopted in the past, all 504 patients recruited in this study had undergone at least one surgical procedure for diagnosis: the excisional biopsy. For all patients that were diagnosed with malignancy via an excisional biopsy, further therapeutic action was necessitated. Due to underestimation of lesions with VAB, in nine patients the previously planned surgical therapy proved to be inadequate and needed to be modified to achieve the therapeutic goal. For eight patients only one other surgical procedure was required and only in one case did the patient undergo three surgical interventions. In 11 cases a two-step surgical approach was also required if the therapeutic plan proved to be correct and the VAB diagnosis confirmed. In total, only 4% of the patients (20/504) underwent more than one surgical procedure.

In this study about 60% of patients were not subjected to any surgical intervention. In a recent study, Sigal-Zafrani et al.[34] compared the surgical management of patients who underwent VAB, CNB and surgical biopsies for breast microcalcifications. In the case of the surgical biopsy group, all of the patients were operated on at least once, 22% were operated on twice and 0.5% of the patients were operated on three times. In the VAB subgroup, 54% of patients were not subjected to any intervention, 9% of patients were operated on twice, and only 1% three times. Other studies have shown that 67–84% of biopsies with suspicious lesions diagnosed via VAB required only one surgery, versus 25–36% in cases diagnoses by open biopsy surgery.[4,5,35]

5. Conclusions

This study confirms that, for non-palpable breast lesions, VAB is a viable alternative to surgical biopsy in terms of diagnostic performances. The VAB procedure was well tolerated in the present study and no serious complications were observed. For its safety, tolerability and reliability, VAB has an important role in the diagnostic protocol of non-palpable breast lesions. The importance of mini-invasive biopsy techniques, such as CNB and VAB, is essentially strategic, because it helps to plan the most appropriate surgical strategy by providing an accurate and reliable pathological diagnosis. The VAB avoids surgery for most benign lesions and reduces the number of surgical procedures in cases with malignant lesions. This allows for treatment to be provided in a single step. Thanks to histological preoperative diagnosis with VAB, it is possible to offer a surgical treatment of higher quality, dramatically reducing the number of re-interventions for oncological staging and clearance.

Conflict of interest
None declared.

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Ethical approval
Not required.

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