Original Article

Digital breast Tomosynthesis vacuum assisted biopsy for Tomosynthesis-detected Sonographically occult lesions

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ABSTRACT

Purpose: To assess the utility and pathological results from DBT VAB for lesions occult on 2D mammography and breast ultrasound (US).

Materials and methods: A retrospective review of 1116 consecutive stereotactic biopsies was performed over 27 months. DBT VAB was performed for 38 non-calciﬁed lesions which were solely detected using DBT. Imaging findings and pathology results were reviewed.

Results: Pathologic ﬁndings were malignant in 8 of 38 lesions [masses (5) and distortion (3)]. High-risk ﬁndings found in 14 lesions.

Conclusion: DBT VAB is easily performed and the majority of cases yield actionable pathologies. Therefore, perform DBT VAB primarily when available.

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Keywords: Digital breast Tomosynthesis, Breast, Biopsy

1. Introduction

The latest major shift in screening mammography has been the addition the digital breast tomosynthesis (DBT). This technology allows the reader to navigate the breast tissue in thin slice reconstructed images and provides signiﬁcant gains in the detection of masses and architectural distortion, which may be obscured on standard 2D projections [1]. Previous studies have demonstrated an increase in cancer detection rate which has solidiﬁed this technology in the frontline of breast imaging techniques [1,2].

In a typical work-up, a non-calciﬁed lesion appreciated on DBT either at the time of screening or diagnostic evaluation, is followed by an ultrasound (US) to help localize the lesion and determine if biopsy will be required [3]. DBT-detected architectural distortions have been shown at surgery to have a high rate of malignancy when wire localized and surgically excised [4]. At our institution, when a DBT-detected lesion meets the mammographic standards for biopsy and is occult on a targeted US, we proceed to digital breast tomosynthesis vacuum assisted biopsy (DBT VAB). The purpose of this study is to present our initial findings over a 27-month study period, to examine the presentation of DBT-detected lesions that then necessitated DBT VAB and the types of pathologies found using this biopsy method.

2. Materials and methods

An IRB waiver was obtained for this retrospective review of a prospectively- maintained database. DBT VAB was performed at two outpatient facilities between December 2012 and February 2016 by two breast fellowship trained radiologists of ﬁve and thirteen of experience and one interventional radiologist with sixteen years of experience reading mammography and performing breast procedures. All readers were certiﬁed in tomosynthesis interpretation through proctored review of at least 100 cases and had been reading tomosynthesis for one year.

We reviewed 1116 consecutive stereotactic biopsies assessed as Breast Imaging Reporting And Data System (BI-RADS) category 4 or 5 that were imaged with both conventional digital mammography and DBT during the second and third years that tomosynthesis imaging was available at our institution.

Two independent breast radiologists separately reviewed each case for technical feasibility, for sampling under DBT VAB, for lesions lacking calciﬁcation and not seen on standard 2D views, versus conventional stereotactic prone biopsy. They agreed that there was no appropriate sonographic target seen on targeted US, which was ﬁrst performed by a breast sonographer and then followed by a radiologist-performed US. None of the lesions were clinically palpable. All masses were measured in their largest dimension on DBT images and shape and margins were characterized and recorded according to the BI-RADS lexicon.

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All the cases of DBT VAB were drawn from DBT-detected lesions on screening mammography utilizing the CC and MLO Combination mode of the Selenia Dimensions (Hologic, Bedford, MA). A 90-degree lateral view with DBT was performed for the purposes of localization and biopsy planning prior to DBT VAB.

2.1. DBT vacuum assisted biopsy

The Eviva and Affirm Breast Biopsy systems (Hologic, Bedford, MA) were used for all DBT VAB. The lesion was targeted in the projection where the target was best seen and the biopsy needle would traverse the least amount of breast tissue. Patients were positioned seated or in a lateral decubitus position (Fig. 1).

A tomosynthesis localization series was obtained and a cursor was placed on the lesion in the appropriate DBT slice. Coordinates were sent to the biopsy unit. Under sterile technique and local lidocaine anesthesia the 9 G needle was introduced and positioning was confirmed with pre- and post-fire 2D stereotactic pair images. Twelve core biopsy samples were obtained. A specimen radiograph was not performed. A biopsy clip was left at the site of biopsy and confirmed with a final set of tomosynthesis images. The duration of the procedure was measured from the time of the first scout image to the time of the post biopsy clip image taken immediately after clip deployment. After the procedure, the patient underwent full CC and ML imaging of the biopsied breast to confirm clip placement at the site of the original DBT-detected lesion.

DBT VAB was performed in 38 consecutive patients for non-calcified lesions detected solely on DBT and not observed on targeted diagnostic US. The age range of the women who underwent the procedure was between 38 and 76 years with a mean of 55 years old. In one case, ultrasound biopsies were first attempted which did not correlate with the site of the originally detected tomosynthesis-detected architectural distortion (Fig. 2a-f). This patient then proceeded to DBT VAB on the same date.

In another case, the biopsy target was attempted under standard prone 2D stereotactic biopsy and could not be performed due to inability to visualize the target. Therefore, the procedure was converted to a DBT VAB. The remainder of the cases proceeded directly from diagnostic mammogram recommendation to DBT VAB.

2.2. Data collection

All DBT images, pathology reports, patient history, and mammographic, US, and MRI reports were reviewed by one author (NSA). Breast parenchymal density information was collected from the screening report and classified according to the Breast Imaging Reporting and Data System lexicon, 4th edition. Density measurements were confirmed with automated software (Volpara, Rochester, NY).

The radiologist who performed the biopsy reviewed the pathology reports (CBL Pathology, Rye, NY) for concordance. All malignant cases were considered concordant and sent for surgical excision. All high-risk lesions (radial scars, lobular carcinoma in situ, atypical papillomas, atypical ductal hyperplasia and atypical lobular hyperplasia) were considered concordant and sent for surgical consultation. All benign lesions were considered concordant and reassessed in six months and subsequent annual screening exam to assure proper target sampling. Procedures were reviewed for complications, including hematoma or infections.

Breast MRI was obtained in 2 patients after DBT VAB for preoperative evaluation of extent of disease.

2.3. Statistical analysis

The percentage of cases falling into malignant, high risk or benign categories was calculated according to the pathology report from the biopsy. PPV 3 was defined as the percentage of all known biopsies done because of positive screening or diagnostic examinations or additional imaging evaluations of positive screening examinations that resulted in a tissue diagnosis of cancer within 1 year. First, a lesion-level analysis of PPV 3 of DBT VAB was calculated as the number of malignancies on histologic examination of the specimen from DBT VAB divided by the total number of lesions that underwent DBT VAB. Excised high-risk lesions were followed up for their final pathological result to obtain an upgrade rate and a final PPV 3 for this DBT VAB cohort. Analyses were performed using statistical software (Stata version 14).

3. Results

DBT VAB procedures accounted for 3.4% of the total stereotactic procedures reviewed during the exam period (38 of 1116). Technical success was obtained in 38 of the 38 lesions targeted using DBT VAB. The average procedure time was 15 min (range 10–51, median 13 min). One outlier case with duration of 51 min was due to a vasovagal episode after initial positioning and patient anxiety before resuming procedure.

Procedure reports revealed one moderate post biopsy hematoma after DBT VAB. At the time of 6-month follow up in this patient, who had a benign biopsy result, there was no significant residual collection or symptoms at the biopsy site.

Breast density distributions are presented in Table 1.

Upon review of the clinical history for past high risk lesion or breast cancer among the DBT biopsy patients, only one patient had a previous history of atypical lobular hyperplasia (ALH) and one patient had a previous history of DCIS. Four of 38 patients (11%) had a 1st degree relative with history of breast cancer and seven of 38 patients (18%) reported a 2nd degree relative with history of breast cancer.

There were equal numbers of masses and architectural distortions, which were pure distortions without mass. The average mass size was 5.8 mm (range 2 to 8 mm) and the morphologies were well circumscribed oval (10), irregular spiculated (5), and irregular microlobulated (1). There were 6 one-view asymmetries appreciated in only 1 DBT projection.

3.1. Pathologic evaluation

DBT VAB of 38 lesions showed 8 malignancies (5 invasive ductal carcinomas, 1 invasive lobular carcinoma, 2 DCIS). The PPV 3 was 21%.

Fourteen of the 38 DBT VAB yielded high risk lesions, atypical ductal hyperplasia (ADH), ALH, lobular carcinoma in situ (LCIS), papillomas with atypia and radial sclerosing lesions (RSL), which were recommended for surgical consultation. One patient opted for 6 month follow-up for RSL and three additional patients did not undergo surgery due to other medical conditions, after meeting with a surgeon. Of the
10 high-risk lesions that were excised, two lesions, an atypical papilloma and RSL with LCIS, were upgraded to malignancy, yielding an upgrade rate of 14%. The atypical papilloma presented as a new well circumscribed mass and the RSL with LCIS presented with architectural distortion (Fig. 3).

When these two upgraded lesions were added to the DBT VAB biopsied malignancies, the total lesion level PPV 3 is 26%. DBT VAB yielded actionable pathologies, including high risk lesions and malignancies, in 57.9% of cases (22 of 38), requiring a surgeon’s consultation or excision.

Fig. 2. a 57-year old female presents for screening mammogram. Standard CC view shown. b CC DBT image from screening reveals architectural distortion. c Scout image from DBT VAB demonstrates 2 existing biopsy clips at site of attempted US biopsies which did not correlate to the DBT-detected architectural distortion. d e Post fire images of needle in place at the target, difficult to appreciate on standard stereotactic pair and further obscured given presence of lidocaine anesthetic. f Post clip deployment, hourglass clip at the site of DBT VAB. f Pathology from DBT VAB revealed invasive ductal carcinoma (H&E stain).
Sixteen of 38 DBT VAB resulted in benign pathology (42%). All lesions were interpreted as concordant by the performing radiologist. Specifically, the two cases of benign architectural distortion yielded fibroadenomatous hyperplasia with stromal sclerosis (fibrosis) and fat necrosis respectively. None of the benign biopsies or non-resected high risk lesions had evidence of additional or new malignancy at subsequent post biopsy follow up imaging at 6 months and 1 year.

Breast MRI was performed for two patients with malignancy found on DBT VAB. Both MRI exams found no other additional disease beyond the sites of DBT-detected malignancy and did not alter surgical management.

All of the malignant lesions presented as either irregular masses or architectural distortion. Fig. 4 demonstrates how the lesions presented when contrasted with their final pathology.

As shown, all six lesions that were defined as 1 view asymmetries, seen only in one tomosynthesis projection, but not in the orthogonal view, were found to be benign.

4. Discussion

The purpose of this study was to present the results of DBT VAB performance for DBT-detected, sonographically occult lesions. A majority of the pathologies from DBT VAB reviewed in this study yielded actionable results, including malignancies and high-risk lesions, requiring a surgeon’s attention, affirming this easily performed technique in the expeditious management of these patients. These findings are similar to other investigations of DBT-detected lesions without sonographic correlate, which have found positive predictive values of up to 47%, specifically for DBT-detected architectural distortions [3,4,5,6].

The vast majority of all cancers detected on screening mammography present with masses or distortion, which are then found with a carefully performed targeted US using location data enhanced by DBT, allowing for US biopsy, or these suspicious lesions contain calcifications allowing for conventional stereotactic biopsy [1,6,7]. Therefore, our PPV 3 of 26% for DBT VAB remains reasonable considering these factors. Published guidelines have established the average PPV 3 fall within a range of 26–32% [8,9,10].

The mean duration of DBT VAB was 15 min (median 13 min), which is comparable to other feasibility studies of DBT VAB, which have found mean durations of 9 to 13 min with upright DBT VAB when compared with 29 min for conventional 2D prone biopsy [11,12]. The technique of DBT VAB allows radiologists to confidently target the DBT-detected abnormalities because the scout is an identical DBT-slice. The clear scout paddle allows a larger field of view than the conventional prone stereotactic biopsy unit, improving visualization of local anatomic landmarks. A prone DBT VAB table, which can aid in approach particularly for medial and inferior lesions, is also now commercially available. All localizations for biopsy using a DBT scout were successfully visualized on initial attempt. In a time when patient anxiety and resource utilization surrounding breast cancer screening is under constant scrutiny

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<td>Breast density distributions (Total number of patients = 38)</td>
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<td>Number of patients</td>
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<tr>
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- Fig. 3. a 42 year old female presents for screening mammogram. Standard MLO view shown. b MLO DBT image from screening reveals architectural distortion (arrow) in the superior breast. Pathology from DBT VAB yielded a radial sclerosing lesion with LCIS.

- Fig. 4. Bar chart demonstrating pathology type and type of lesion presentation on screening DBT on the x axis and number of patients on the y axis.
DBT VAB allows radiologists to efficiently and definitively take a patient from mammographic abnormality to diagnosis.

Other means to obtain pathologic diagnosis for DBT-detected lesions have been described, but each has limitations. Tomosynthesis-guided wire needle localization requires subsequent anesthesia and a surgical procedure—with all their inherent social and economic costs [5]. Breast MRI and consequent MRI biopsy is also a worthwhile consideration if DBT VAB is not available [4]. However, a suspicious finding on MRI in the vicinity on the DBT-detected lesion may not correlate following MRI biopsy and also may lead to additional false positive findings that require biopsy or short term MRI follow-up. In some areas, access to breast MRI remains limited and the time required to schedule and perform the diagnostic MRI and biopsy, contraindications such as metallic implants, inability for patient positioning, and claustrophobia remain barriers to this modality.

Lobular phenotypes of breast cancer, most commonly presenting as spiculated masses, asymmetry, or architectural distortion, remain elusive by conventional mammography and even breast MRI, however may be better appreciated with DBT [15,16,17]. DBT uncovers architectural distortion, which is a frequently missed sign of breast cancer that may be obfuscated by overlapping tissue, particularly in dense breasts [18]. Furthermore, DBT accentuates irregular margins of masses and spiculation caused by desmoplastic reaction which has been found to increase the specificity for BIRADS 4 and 5 lesions [1,19]. Therefore, given a DBT-detected true architectural distortion or spiculated mass, in the absence of conventional stereotactic or US correlate, we strongly advocate DBT VAB as the most straightforward method to reach important diagnoses.

There are several limitations to this study. In our institution, screening with DBT was offered to all patients however, was performed according to patient preference and availability. Consequently, our retrospective cohort was subject to the possibility of selection bias. Furthermore, we did not assess DBT-detected lesions with breast MRI prior to DBT VAB. MRI may have led to the detection of other important lesions elsewhere in both breasts and in a DBT-detected lesion with low suspicion lesion characteristics, such as well circumscribed margins or only seen in one DBT projection, one may have not proceeded with the DBT VAB. The correlation of DBT-detected lesions to MRI-detected lesions in a screening population has not yet been directly compared, although clinical trials are underway [20]. The potential complementary nature of these two modalities, and their respective modes of biopsy, warrant further study.

5. Conclusion

DBT VAB was easily and quickly performed in our patient population. No significant complications or discordant results were observed. The imaging findings of the malignancies and high risk lesions in our cohort were indistinguishable, and therefore tissue sampling was essential. DBT VAB is an excellent way to establish the pathologic diagnoses for DBT-detected suspicious lesions, particularly if US is negative and MRI is cost- or access-prohibitive. As DBT screening becomes more prevalent, the need for this mode of biopsy will become ever more compelling.

References