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ORIGINAL RESEARCH

Preliminary Clinical Experience with Digital Breast Tomosynthesis in the Visualization of Breast Microcalcifications

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ABSTRACT

Objectives: To compare the visualization and image quality of microcalcifications imaged with digital breast tomosynthesis (DBT) versus conventional digital mammography. **Materials and Methods:** Patients with microcalcifications detected on full field digital mammography (FFDM) recommended for needle core biopsy were enrolled in the study after obtaining patient's consent and institutional review board approval ($n = 177$ patients, 179 lesions). All had a bilateral combination DBT exam, after undergoing routine digital mammography, prior to biopsy. The study radiologist reviewed the FFDM and DBT images in a non-blinded comparison and assessed the visibility of the microcalcifications with both methods, including image quality and clarity with which the calcifications were seen. Data recorded included patient demographics, lesion size on FFDM, DBT, and surgical excision (when applicable), biopsy, and surgical pathology, if any. **Results:** Average lesion size on DBT was 1.5 cm; average lesion size on FFDM was 1.4 cm. The image quality of DBT was assessed as equivalent or superior in 92.2% of cases. In 7.8% of the cases, the FFDM image quality was assessed as equivalent or superior. **Conclusion:** In our review, DBT image quality appears to be comparable to or better than conventional FFDM in terms of demonstrating microcalcifications, as shown in 92.2% of cases.

Key words: Breast imaging, digital breast tomosynthesis, digital mammography, microcalcifications

INTRODUCTION

Digital breast tomosynthesis (DBT) is a new technology in the field of breast imaging. The technology has shown promise in reducing recall rates due to its ability to view the layers of the breast, thus minimizing tissue overlap. Studies have shown promising results, demonstrating tomosynthesis to be comparable to Full Field Digital Mammography (FFDM).[1-9] Research by Poplack in 2007 compared the image quality of digital breast tomosynthesis (DBT) with that of conventional mammography (CM) and found that out of 99 recall cases in 98 women, DBT image quality was equivalent to CM in 51, and superior in 37. Additionally, this study had a 40% reduction in recalls.[1] Breast microcalcifications are frequently overlooked findings at screening mammography,

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and can account for a substantial number of missed cancers. While FFDM has been proven to do very well at visualizing microcalcifications, there are varying reports in regards to the ability of DBT at visualizing microcalcifications.[1,2,10-12] Kopans and colleagues in 2011 published findings comparing the clarity with which microcalcifications were seen on CM with DBT.[2] Results showed that in 41.6% of the cases, microcalcifications were seen with superior clarity with DBT; 50.4% of the cases visibility was the same for both DBT and CM; and 8% of cases microcalcifications were seen with greater clarity on CM. Though Kopans had promising findings, Spangler and colleagues had differing results. Their 2011 study determined that FFDM was slightly more sensitive than tomosynthesis for the detection of microcalcifications.[10] As characterization and detection of microcalcifications with DBT has not definitively reached a consensus in the recent literature, we decided to review our cases, with the purpose of comparing the visualization and image quality of microcalcifi cations imaged with DBT mammography and conventional FFDM.

MATERIALS AND METHODS

Case selection

All cases used in this study analysis were acquired under Institutional Review Board (IRB) approval. For the purpose of this review, patients with microcalcifications detected on FFDM recommended for needle core biopsy were selected and comprise the study cohort. A total of 200 examinations with 202 findings were collected. Twenty-three cases were excluded from this analysis due to incomplete data, resulting in 177 examinations with 179 findings as the basis of this study.

Image acquisition

Informed consent was obtained from each patient. All subjects underwent Full-Field Digital Mammography (FFDM) imaging performed on one of our standard systems (Selenia, Hologic Inc; Senographe Essential, GE). The DBT examination was performed prior to recommended biopsy on each patient on a research DBT unit (Dimensions, Hologic Inc.). A bilateral combination FFDM with DBT examinations in the standard 2-view - Craniocaudal (CC) and, Mediolateral oblique (MLO) projections (total of four combination FFDM and DBT datasets) were performed by a registered radiologic technologist with expertise in radiography and mammography. The study technologists received applications training prior to the start of the study. The FFDM images and the DBT images were acquired under the same compression to provide for direct comparison between the two imaging methods. Fifteen low dose projection images were acquired for each view. Once the images were acquired, the projections were then reconstructed into a series of images at 1 mm intervals, spanning the entire breast thickness.

Core needle biopsy

Core needle biopsy was performed with stereotactic guidance, or occasionally under ultrasound guidance based on visibility of microcalcifications on ultrasound and patient limitations such as inability to lie on a prone stereotactic table and body habitus. Stereotactic biopsy or ultrasound-guided biopsy was performed utilizing vacuum assistance.

Image review

The study physician, board certified with 20 years of mammography experience, performed a non-blinded review of the research images. An 8 hour training course in DBT was completed by the study radiologist prior to initiation of image interpretation. Study images were reviewed on a research workstation (SecurView, Hologic, Inc.). A set hanging protocol was used to view all cases; both the FFDM and DBT images were displayed. The radiologist had available prior images and reports. The radiologist subjectively rated the image quality, by stating either the FFDM was better, DBT was better, or both FFDM and DBT were equivalent. This was a subjective assessment to rate how well the calcifications were seen with each modality by evaluating the sharpness, contrast, and diagnostic image quality. The pathological findings, in the case of biopsy, or 1-year follow-up data result served as ground truth for benignity or malignancy.

RESULTS

The image quality of the DBT was equivalent in 95 cases. superior in 70 cases. In combination, DBT was equivalent or suprerior in 165 cases (92.2%).

There were a total of 50 histology proven malignancies, 13 atypical findings, and 116 benign findings. Of the 50 malignancies, DBT was rated as having superior image quality in 52% (n = 26), equivalent image quality in 44% (n = 22), and FFDM image quality being superior in 4% (n = 2). For the benign lesions, DBT image quality was rated superior in 35% (n = 40), and image quality was equivalent in 57% (n = 66). In the assessment of the atypical lesions, DBT and FFDM performed equally in 54% (n = 7) and DBT was superior in 31% (n = 4). Average lesion size on DBT was 1.5 cm (range 0.2-12 cm); average lesion size on FFDM was 1.4 cm (range 0.2-11 cm).

Surgical size was available for 43 cases. Size was determined to be comparable when within 1 cm. Tomosynthesis and FFDM

had comparable size measurements in 39 cases. In three cases, FFDM measured closer in size to the size measured on surgical excision and in one case DBT measured closer.

DISCUSSION

The evaluation of DBT in the clinical setting is ongoing as early adopters publish their findings. In this review, calcifications were visualized as well as or better than FFDM in 92.2% of cases [Figure 1]. Similar to results obtained in our study, an evaluation by Kopans and colleagues concluded that in 92% of the cases, the clarity with which calcifications were seen on DBT was equal to or better than for CM and in almost half the cases, the clarity on DBT was judged to be better than for CM.[2] Other published studies have had varying results. Image quality of DBT has been reported to be inferior to FFDM primarily in the characterization of microcalcifications.[1] Spangler reported that overall FFDM detection sensitivity was higher than for DBT (84% and 75%, respectively).[7] The authors do cite several technical factors that could have contributed to the higher sensitivity of FFDM in comparison to DBT, including longer acquisition time with an earlier prototype of DBT which may have resulted in motion. In addition the authors discuss that, because the technology was still in the research phase at the time of their study, exact exposure parameters, processing algorithms, display, and workstation functionality were continually upgraded. Our study utilized a shorter acquisition time with DBT which may explain the improved visualization of microcalcifications on DBT versus FFDM that we found. A more recent publication found a nonsignificant increase in diagnostic accuracy for microcalcification cases by using digital mammography plus DBT and further discusses that because DBT reduces tissue overlap, the ability to better depict breast lesions is greater for noncalcified lesions, such as masses and architectural distortions.[5] The ability to visualize microcalcifications is reduced to a lesser degree by tissue overlap, thus a significant increase in detection for these lesions is not expected. The expectation would be then that microcalcifications can be seen to an equivalent degree compared with conventional 2D digital mammography.

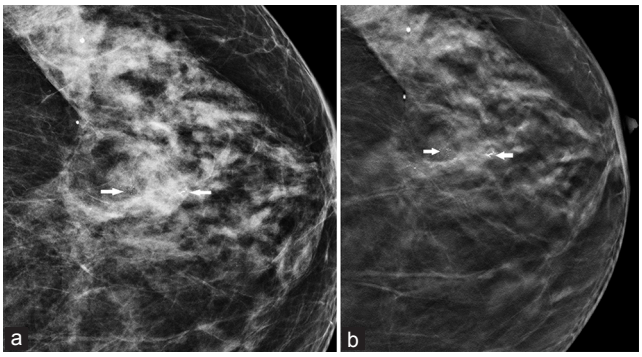

Figure 1: (a) Craniocaudal full field digital mammogram zoomed in shows calcifications diagnosed as ductal carcinoma *in situ* (arrows). (b) Zoomed craniocaudal three-dimensional (3D) digital tomosynthesis shows reconstructed slice.

Limitations

There were limitations with our study. Non-blinded image interpretation was performed by the study radiologist, specifically the radiologist had access to the FFDM exam, prior reports, and prior mammography imaging at the time of the interpretation of the DBT exam. Additional reads by other radiologists may have shown differing results and a study including additional radiologists may eliminate the subjectivity of our preliminary study.

CONCLUSION

The findings of this small study show promise for DBT. Microcalcifications that were detected on FFDM were also seen on DBT in 100% of cases. Calcifications were demonstrated as well as or better than FFDM in 92.2% of cases. These results support that DBT has the potential to replace conventional FFDM. Multi-institutional studies of patients with microcalcifications may be helpful to validate these initial results from our single facility, as well as to determine the best utilization of this new technology.

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