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Original Article

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Impact of Breast Tomosynthesis for Evaluating Specimen of Breast Carcinoma: Initial Results

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BACKGROUND/AIMS
To evaluate the impact of digital breast tomosynthesis (DBT) for assessing specimens of breast carcinoma (BCa) in terms of comparing with other diagnostic tools.

MATERIALS and METHODS
Between November 2014 and May 2015, patients who underwent wire-guided breast biopsy with mammography (MG), specimen radiography (RG), and digital specimen tomosynthesis (DST) examinations were evaluated. Two breast radiologists retrospectively assessed the results in consensus. Breast lesions were classified according to the Breast Imaging Reporting and Data Systems (BI-RADS). In mass described cases, the longest axes of the masses were measured; and in calcification described cases, the longest axes of the calcifications were measured. All findings were compared with macroscopic measurements. Statistical analyses were performed; $p<0.05$ was considered significant.

RESULTS
In total, 85 specimens were evaluated. The mean age was 54.2±10.8 years. Of the 85 specimens, 46 lesions were malignant and 39 lesions were benign. The average mass sizes were 14±9.7 and 13±6.8 mm in diagnostic MG and DBT, respectively. In specimen RG and DST, the average mass sizes were 12±6 mm and 12±6.2 mm, respectively. The mean macroscopic mass size was 12±6.3 mm. There was a statistical significant difference between diagnostic MG and specimen RG-DST findings regarding mass sizes ($p=0.02$ and $p=0.01$, respectively). BI-RADS evaluations of specimen RG and diagnostic and specimen TS were similar but different from those of diagnostic MG ($p<0.001$).

CONCLUSION
The exact detection of BCa specimen and its BI-RADS features can be diagnosed using DST; lesion size, with specimen and diagnostic DBT. Additionally, DBT can help diagnose preoperative structural distortion or asymmetric densities.

Keywords: Breast carcinoma, digital breast tomosynthesis, digital specimen tomosynthesis

INTRODUCTION

Breast carcinoma (BCa) is the most common cancer and the second leading cause of death in women worldwide (1). Early detection of BCa can help decrease mortality and morbidity (2). Mammography (MG) is a prevailing imaging method for determining early BCa (3-5). However, the superimposition of dense breast tissue on MG is a significant handicap for diagnosis (6, 7). To solve this obstacle, additional diagnostic methods such as MG follow-up, ultrasonography, and magnetic resonance imaging are used (8). All these are mostly used for benign lesions and can cause anxiety with high health care costs. In recent years, digital breast tomosynthesis (DBT) is an emerging diagnostic tool to be used to overcome overlapping the breast tissue (8). The DBT system acquires multiple projection images by a rotating X-ray tube around a digital detector. Three-dimensional (3D) images are derived from the reconstruction of two-dimensional (2D) data (8).

Of 25%-35% of early BCas, the tumor is nonpalpable at the time of diagnosis (9). These lesions are defined as asymmetric densities, deep seated lesions, and calcifications (10). Current published literature suggests breast-conserving therapy, including lumpectomy or wide-to-local excision together with adjuvant radiotherapy to the tumor bed in patients with nonpalpable lesions

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(11). Breast-conserving surgery is considered the reference standard treatment for early BCa (12). Irradical resection of nonpalpable lesions varies between 13% and 58% (10). The most commonly used, oldest, and reference standard method for resection with minimal but sufficient margin is wire-guided needle biopsy (13). Specimen radiography should be performed and the findings of specimen radiography should be evaluated with preoperative MG. This evaluation provides us to confirm the exact localization of excised lesion and to determine whether complete resection is realized during operation.

Tumor size is commonly measured on MG and/or ultrasonography. However, these techniques are valuable in patients who have dense breast tissue and underestimate tumor size. Breast structures are superimposed on to 2D plane; therefore, tumor outlines might be obscured in MG examination (14). Some of the studies recently published pointed out that the application of DBT might improve lesion margin visibility; as a result, it is an effective method for lesion characterization and diagnosis of early BCa (15-17). Despite all these proven data, there is a lack of study including DBT features on removed breast tissue during the operation in terms of comparing with other diagnostic tools in the published literature.

We aimed to evaluate the characterization of tumors using the Breast Imaging and Reporting Data System (BI-RADS) classification and to compare the tumor sizes in preoperative diagnostic MG and DBT, perioperative specimen radiography, digital specimen tomosynthesis (DST), and pathologic findings using breast specimens. To the best of our knowledge, this is the first study to compare specimens from the published literature.

MATERIALS and METHODS

This study included a retrospective view of prospective recorded data. Radiology and pathology database of Dokuz Eylül University School of Medicine were investigated. All data were recorded. The study was approved by the Institutional Review Board of our institute. The protocol number of noninterventional investigation ethical committee approval was 2828 and decision number was 2016/21-02. Signed consent forms were obtained from all patients. Exclusion criteria were ultrasonography-guided wire biopsy patients and irregular and missing data.

Data Collection

Between November 2014 and May 2015, patients who underwent breast wire-guided biopsy with MG and specimen radiography tomosynthesis examinations were evaluated. The review was retrospectively performed by two breast radiologists (one senior and one junior) in consensus. Data collection was performed using Picture Archiving and Communication System (ISite Radiology 4.1.11.0.0, Philips, Koninklijke, The Netherlands). MG and specimen radiography tomosynthesis were performed using digital MG and DBT device (Selenia® Dimensions®, Hologic, Marlborough, MA, USA). Each case had four images in standard modalities (i.e., one craniocaudal and one mediolateral oblique view of the left and right breast), with additional positions if needed, preoperative wire-marked breast image with wire, postoperative specimen radiography and tomosynthesis. In mass described cases, the longest axis of the masses was measured; and in calcification described cases, the longest axis of the calcifications was measured. The findings were compared with macroscopic measurements. Breast lesions were characterized according to the BI-RADS classification. The imaging findings before and after wire-guided biopsy are shown in Figure 1-3.

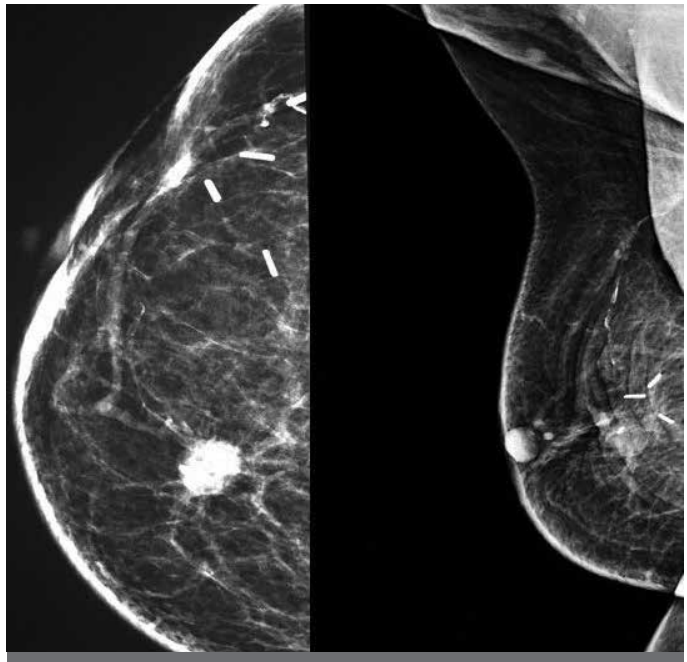

FIGURE 1. In a 79-year-old female patient, a round-shaped, spiculated margined BI-RADS 5 lesion is observed in her right breast, at inner quadrant, 3 o'clock localization

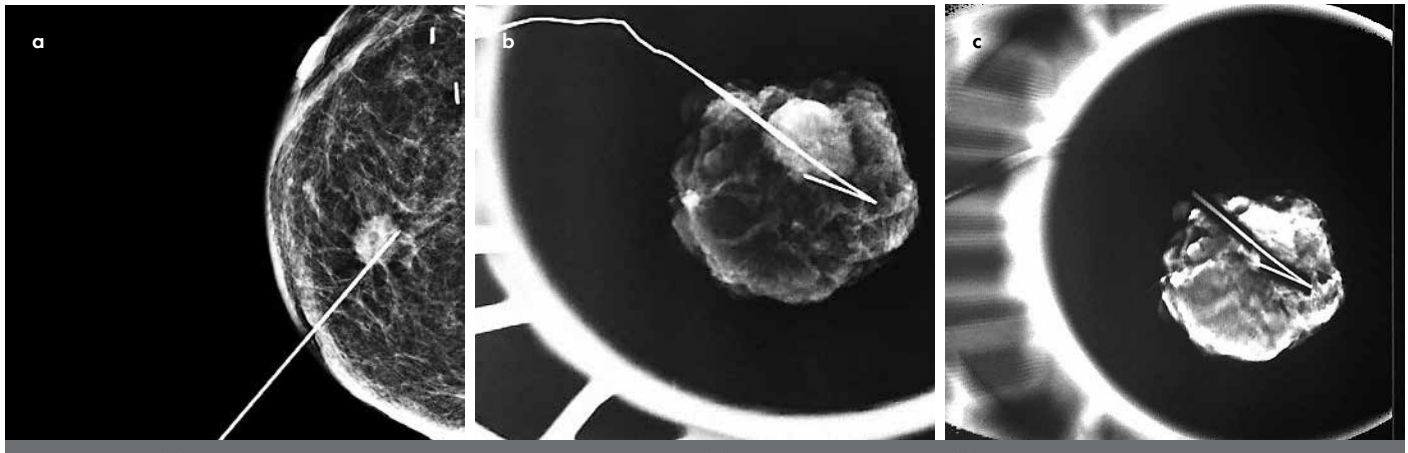

FIGURE 2. a-c. (a) Wire-guided biopsy with mammography is performed, (b) specimen radiography, (c) tomosynthesis images

Breast Imaging Reporting and Data System

All patients were reviewed according to the recent BI-RADS (5th edition, 2013) lexicon of MG and examination. All patients underwent preoperative MG and DBT, and the specimens were preoperatively evaluated with radiography and tomosynthesis.

Statistical Analyses

All statistical analyses were performed using Statistical Package for Social Sciences version 22.0 (IBM Corp.; Armonk, NY, USA) software. The sizes, measured in all examinations and pathologic evaluations, were compared with one-way analysis of variance test. Independent variables were compared with paired t test, and $p<0.05$ was accepted as statistically significant.

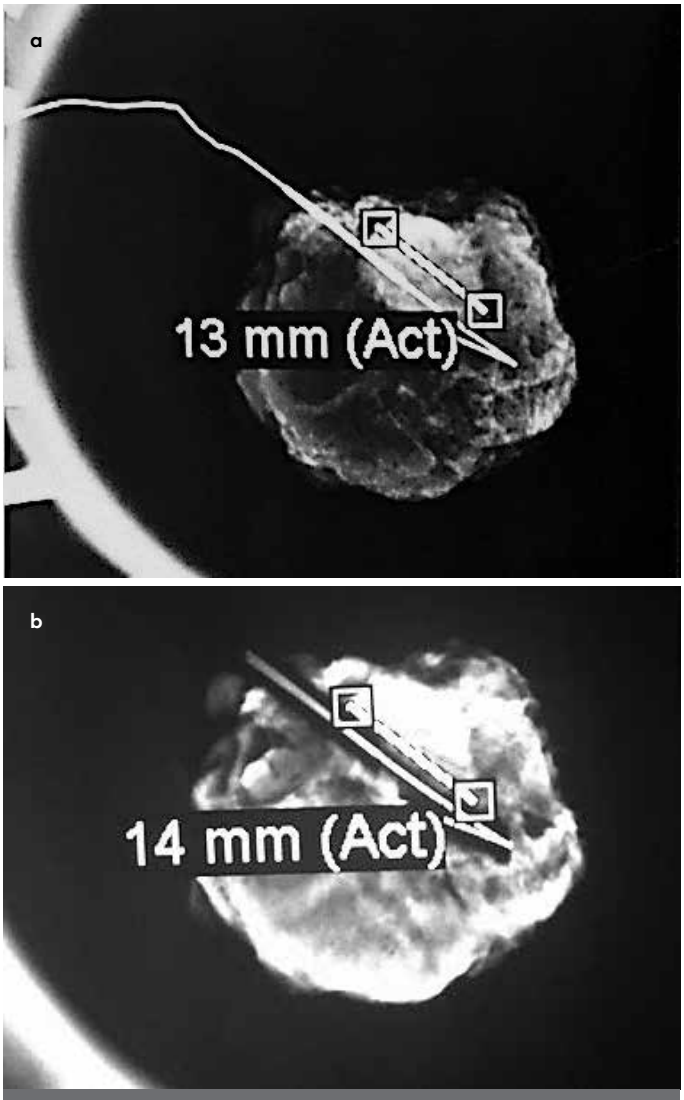

Figure 3. a, b. (a) The size of the mass in specimen radiography was 13 mm, (b) the size of the mass in tomosynthesis was 14 mm (*Histopathology: Invasive ductal carcinoma*)

RESULTS

Results of Demographic Data

The total number of patients was 85, and the mean age was 54.2±10.8 years. Forty-six (54%) lesions were malignant, and 39 (45%) lesions were benign. According to the longest axis evaluation, the average mass sizes were 14±9.7 and 13±6.8 mm in diagnostic MG and DBT, respectively. In specimen radiography and specimen tomosynthesis, the average mass sizes were 12±6 and 12±6.2 mm, respectively. The macroscopic average mass size was 12±6.3 mm. When average sizes were compared, there was no statistical significance between specimen radiography and tomosynthesis findings. All these results are summarized in the cross-correlation table (Table 1).

Breast Imaging Reporting and Data System

Breast Imaging and Reporting Data System classifications intended for the lesions and calcifications were separately performed for all three imaging tools. In MG examinations, one patient was evaluated as BI-RADS 3 and 78 were evaluated as BI-RADS 4 (39- BI-RADS 4A, 27- BI-RADS 4B, and 12- BI-RADS 4c). Six patients were diagnosed as BI-RADS 5. In DBT, one patient was detected as BI-RADS 3 and 74 were diagnosed as BI-RADS 4 (36- BI-RADS 4A, 19- BI-RADS 4B, and 19- BI-RADS 4C). Ten patients were evaluated as BI-RADS 5. Specimen radiography examination revealed that two patients were BI-RADS 3 and 80 were BI-RADS 4 (51- BI-RADS 4A, 23- BI-RADS 4B, and 6- BI-RADS 4C). In DST, two patients were evaluated as BI-RADS 3 and 78 were evaluated as BI-RADS 4 (39- BI-RADS 4A, 27- BI-RADS 4B, and 12- BI-RADS 4C). Six patients were diagnosed as BI-RADS 5.

Breast Imaging and Reporting Data System evaluations of specimen radiography, specimen tomosynthesis, and DBT were similar. However, these findings were different from those of diagnostic MG. When BI-RADS 3 lesions were accepted as benign, BI-RADS 4 and 5 lesions were accepted as malignant between DBT and specimen tomosynthesis; and there was statistical significance for diagnostic MG findings ($p<0.001$) (Table 2).

Comparison of Diagnostic Tools

When the pathologic sizes of the lesions were considered, we found a statistical significance between diagnostic MG, specimen radiography, and specimen tomosynthesis findings

TABLE I. Comparison of mammography, tomosynthesis, specimen radiography, and pathology sizes in cross-correlation table

Parameter	Mean size in MG 14±9.7	Mean size in DBT 13±6.8	Mean size in specimen RG 12.2±6	Mean size in DST 12±6.2	Mean size in pathology 12.4±6.2
Mean size in MG 14±9.7	-	p=0.2	p=0.02*	p=0.01*	p=0.08
Mean size in DBT 13±6.8			p=0.1	p=0.06	p=0.2
Mean size in specimen RG 12.2±6				p=0.1	p=0.7
Mean size in DST 12±6.2					p=0.5

MG: mammography; DBT: digital breast tomosynthesis; RG: radiography; DST: digital specimen tomosynthesis
Paired t test was used.
*Statistical significant p value

TABLE 2. Breast Imaging and Reporting Data System (BI-RADS) comparison according to different methods in the same patient group

Parameters	BI-RADS score	N	p
MG	3	1	<0.001*
	4A	39	
	4B	27	
	4C	12	
	5	6	
DBT	3	1	
	4A	36	
	4B	19	
	4C	19	
	5	10	
Specimen RG	3	2	
	4A	51	
	4B	23	
	4C	6	
	5	3	
DST	3	2	
	4A	39	
	4B	27	
	4C	12	
	5	6	

MG: mammography; DBT: digital breast tomosynthesis; RG: radiography; DST: digital specimen tomosynthesis
*Statistical significant p value

(p=0.02 and p=0.01). However, there was no statistical significant difference among DBT, specimen radiography, specimen tomosynthesis, and the results with pathologic average sizes. All these results are summarized in the cross-correlation table (Table 1).

DISCUSSION

Digital breast tomosynthesis is a diagnostic modality for BCa and its screening (8, 18). It is a 3D imaging technique obtained by reconstruction of 2D images during standard mammographic compression. Thus, the interference of breast tissue overlapping can be reduced by this way. Additionally, as it provides conspicuity of invasive cancers, false-positive results can be reduced (8, 18). The present study aimed to characterize the tumors using BI-RADS classification and to compare the tumor sizes in preoperative MG and DBT, perioperative specimen radiography, specimen tomosynthesis, and pathologic findings using breast specimens. When BI-RADS 3 lesions were accepted as benign, BI-RADS 4 and 5 lesions were accepted as malignant; there was statistical significance between DBT specimen tomosynthesis and diagnostic MG findings. The BI-RADS evaluations of specimen radiography, specimen tomosynthesis, and DBT were similar. When the pathologic sizes of the lesions were considered, there were statistical significances among diagnostic MG, specimen radiography, and specimen tomosynthesis findings; there was no statistical significance between specimen radiography and specimen tomosynthesis findings.

In our study, the average mass sizes of the lesions were 14±9.7 and 13±6.8 mm in diagnostic MG and DBT, respectively. In specimen radiography and specimen tomosynthesis, the average mass sizes were 12±6 and 12±6.2 mm, respectively. The macroscopic average mass size was 12±6.3 mm. The study published by Fornik et al. (19) concluded that DBT was superior to MG for evaluating both lesion measurement and stage. In the present study, we focused on comparing specimens. DBT, specimen radiography, specimen tomosynthesis, and the results with pathologic average sizes had no statistical significance. The average lesion sizes measured from specimen tomosynthesis were similar with avarage macroscopic sizes. Considering this, our findings were compatible with the literature (19).

The BI-RADS evaluations of specimen radiography, specimen tomosynthesis, and DBT were similar. However, these findings were different from those of diagnostic MG in our study. BI-RADS 3 lesions were accepted as benign. Conversely, BI-RADS 4 and 5 lesions were accepted as malignant. Thus, specimen tomosynthesis DBT and diagnostic MG findings had statistically significant differences. Raghu et al. (20) concluded that working up with DBT significantly improves diagnostic accuracy and confidence. Adding DBT to digital MG for screening can provide many benefits including greater sensitivity in dense breast tissue. After using DBT, the accuracy of MG and true BI-RADS characterizations of lesion pointed the visual separation of the overlapping tissues (21). Our results were compatible with their findings. Nevertheless, our findings and similar previous studies mentioned above should be checked again with high number of participants for providing more benefits on clinical usage of tomosynthesis.

The preoperative measurement of the exact lesion size in patients with BCa is very important in terms of clinical staging and decision of correct surgical treatment, specifically breast-conserving therapy (19). This is also one of the significant prognostic factors of BCa (22-24). Evaluation of specimens in perioperative process, detection of lesion extension, and measurement of lesion size are corner stones for making the decision in operative adequacy. In the current study, there was no statistical significance between specimen radiography and specimen tomosynthesis. All the measured sizes from the specimens were similar to the histopathologic results. Nevertheless, there is a very small difference, and specimen tomosynthesis findings were more similar than specimen radiography findings. This finding reveals that specimen tomosynthesis is more reliable in the decision of total lesion excision. Thus, preoperative specimen tomosynthesis may show a surgical way to determine the margins of cancer tissue.

There are some limitations to this study. The first one is small number of patients. However, our clinic is a reference clinic with high patient volume; we have performed many image-guided needle biopsy studies. Besides, the number of patients with all complete images was limited. Additionally, we performed specimen radiography for all needle-guided biopsy, and we excluded the patients who underwent ultrasonography-guided needle biopsy. Because of difficult measuring of specimen radiography, we also excluded some of the patients with microcalcifications in breast. Nonetheless, we focused on the importance of specimen tomosynthesis in patients with BCa. Although we noted some different statistically significant differences in this study, more studies are needed to evaluate clinical benefits.

Our study is the first and unique study that evaluated and compared the specimens in terms of lesion sizes and BI-RADS characterization in the published literature. Accurate evaluation of specimen will assure the surgeon for the adequacy of the surgery. Additionally, during the operation, this can provide them to make correct decisions for surgical techniques. As specimen tomosynthesis enables visual separation of the overlapping tissues, more accurate evaluation can be performed.

For surgical treatment, it is very important to determine the exact surgical margins of BCa. DBT can easily diagnose BCa and determine the precise location of lesion. More studies with high number of patients are needed for accurate diagnosis and determination of BCa lesion margins.

Ethics Committee Approval: Ethics committee approval was received for this study from the Institutional Review Board of Dokuz Eylül University School of Medicine (Decision No: 2016/21-02).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author contributions: Concept - I.B.A., P.B.; Design - P.B.; Supervision - I.B.A.; Resource - M.G.D., S.Ö.A.; Materials - S.Ö.A.; Data Collection and/or Processing - I.B.A., P.B., M.G.D.; Analysis and/or Interpretation - I.B.A., P.B., M.G.D.; Literature Search - K.Ç.T., N.S.G.; Writing - I.B.A.; Critical Reviews - P.B.

Conflict of Interest: No conflict of interest was declared by the authors.

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