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Survey results regarding uptake and impact of synthetic digital mammography with tomosynthesis in the screening setting

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Introduction

Digital breast tomosynthesis (DBT) has been shown to decrease recall rates and increase cancer detection rates compared to screening with digital mammography (DM) alone.^{1–6} A two-dimensional image is an important component of the DBT exam; readers use the 2D image to assess breast density, symmetry between breasts, and compare to prior 2D images.⁷ Additionally, characterization of calcifications is felt to be better on 2D images rather than on the reconstructed images from the DBT acquisition.^{8–10} However, the combination dual exam of digital mammography (DM) with DBT results in a two-fold increase in radiation dose per exam compared with DM alone.^{11–13}

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The majority of practices responding to the survey screening with DBT have SM capability; however, SM usage with DM in DBT screening is varied as is radiologist satisfaction.

Synthesized mammographic imaging (SM) was created to maintain the benefits of combined 2D and DBT imaging while decreasing patient dose. The synthetic 2D-like image is created by summing the DBT slices, similar to a maximum intensity projection or “MIP” reconstruction where 2D slices from a 3D data set are combined into a single image.¹⁴ High-density lesions, such as calcifications and ligaments, may be enhanced by the imaging algorithm and made more conspicuous to the radiologist.¹⁴ In early reader studies and population-based studies, SM, when used in place of DM in DBT screening, had similar or improved performance with stable or decreased recall rates and increased overall cancer detection rates.^{11–13,15–17} Despite these promising results, concerns remain regarding replacing DM with SM in DBT screening, as a few studies have reported a decrease in DCIS detection compared to screening with DM, raising concern over the ability to detect and characterize calcification-only DCIS lesions.^{5,14,16,18,19}

In the setting of the rapid uptake of DBT imaging, reported as increasing from 29.9%²⁰ in November 2012 to 68.6%²¹ in February 2016, the utilization of SM in DBT screening is not well known. A study performed shortly after FDA approval of SM in May 2013 found that while 59% of breast imagers reported having SM technology, only 24% were using SM instead of DM in DBT screening.²¹ The purpose of this survey was to assess changing utilization patterns and attitudes among breast imagers regarding SM more than five years after FDA approval.

Materials and Methods

This anonymous prospective study was determined to be exempt from human subject review by one of our institution’s IRB. In June 2018, an online 20-question survey via REDCAP²² was sent to all active members of the Society of Breast Imaging (SBI) to assess their use of SM in DBT screening. Over a four-week period, the invitation was sent to the member listserv for a total of four times: twice as a stand-alone email, and twice as a reminder included in the general member newsletter. Respondents were asked to complete a survey (see Appendix) that included a combination of multiple choice and free text questions related to their use and opinion of SM in DBT screening. The survey employed branching logic questions; if respondents answered no to a key question in the survey, they were not presented with additional questions and the survey ended, as the remaining questions would not be relevant to their practice.

Respondents were asked to describe their practice setting, questions about DBT capability and usage, how many screening mammograms they performed in a year, and if they had SM capability. Respondents who did not have SM capability were asked why not and what barriers may exist in acquiring SM. If respondents continued the survey, they were asked questions about SM usage and outcomes of SM screening (cancer detection rate and recall rate) as well as overall satisfaction of SM imaging and observed benefits and disadvantages of SM use.

When respondents gave a range as the answer for a question about a number or percentage, the midpoint was used for analysis. Free text responses were analyzed by grouping responses into themes. Responses regarding barriers to SM acquisition and use were

grouped as related to cost and administrative concerns, lack of evidence and perceived quality concerns, and not answered or, not applicable. Responses regarding advantages of SM were grouped into themes including decreased dose, increased conspicuity, increased throughput, decreased recall rate, marketing/patient preference, and no advantages or not applicable. For responses regarding disadvantages of SM, themes included faulty calcification characterization (both missed calcifications and overcall of calcifications), quality of the images, no disadvantages, lack of comparisons, learning curve, missed lesions, increased time for interpretation, administration and billing issues, lack of evidence, and overcall of lesions. If respondents gave more than one free text answer, all were used in analysis.

Results are presented as descriptive statistics and proportions; the denominator notes the number of respondents to the specific question. Not all respondents answered every eligible question. Primary outcomes in our analysis included the use of SM in screening, reasons for not using SM, and satisfaction with SM use. Secondary outcomes included type of SM use (alone or in combination with DM), perceptions in change in recall and cancer detection rates, and perceptions regarding advantages and disadvantages of SM use. Chi-square tests, which are appropriate for comparing categorical response data, were used to compare response frequencies across groups.²³ P-values less than 0.05 were considered statistically significant.

Results

Practice Characteristics and DBT Usage

312 of 2600 SBI members responded to the survey (response rate = 12%). Per the Society of Breast Imaging, 1,237 members opened the first email, of which there were 202 responses for an adjusted response rate of 16% (202/1237). 67% (312/466) of members who opened the survey completed the survey (466 is the number of unique survey clicks from all four email inquiries). The majority (196/312, 63%) of respondents identified as being a part of a private practice (Table 1). 96% of respondents reported DBT capabilities (299/312) with the median time of DBT use as 4 years and the median number of DBT units per practice of 4. The reported number of screening examinations performed per year in each radiologist's practice varied widely – 10,000 to 350,000 – with a median of 19,000 exams. 98% of practices with DBT capability performed DBT screening (292/299). Among practices using DBT for screening, the percent of screens that included DBT varied from 1–100% with a majority (158/292, 54%) reporting greater than 76% of screens performed with DBT.

Characteristics of lack of SM use

17% of respondents with DBT capabilities do not use SM in their practice (50/299). The most commonly cited reasons were the cost of the software upgrade (16/50, 32%) and concerns over image quality (16/50, 32%). Less commonly cited reasons for not having SM were lack of evidence, administrative hurdles for approval, lack of experience using the modality, and vendor incompatibility (each reason with 4 or less respondents).

Characteristics of SM use

Among practices with SM capability, SM usage in screening was varied as was satisfaction with the technology. 83% of respondents with DBT capability have SM capability in their practice (249/299; Table 2). The median length of time of SM experience was 2 years (range 0 – >3 years). Use of SM without DM in DBT screening was split with 40% of the respondents reporting continued combination DM/DBT (98/246) and 52% reporting greater than 76% replacement of DM with SM (128/246) (Figure 1). There was no difference in this distribution when comparing baseline screening exams and screening exams with prior images (all versus baseline $p = 0.30$, all versus priors $p = 0.97$, priors versus baseline $p = 0.30$).

Satisfaction of SM

The average overall satisfaction of SM was 3.4/5 ($n=239$, 1–5 scale), (table 3). There was no difference in overall satisfaction when comparing by practice type ($p=0.81$), number of DBT units ($p=0.62$), or number of screening examinations performed in a year ($p=0.45$). When stratifying by years of SM experience, however, there was a statistically significant difference in those with less than 1 year of experience versus those with more than 1 year of experience ($p=0.001$). Those with less than 1 year of experience had much lower satisfaction with SM (2.9/5) versus those with greater than 1 year of experience (3.5/5).

Perception in change of Recall Rate and Cancer Detection Rate with SM

Perception regarding recall rate (RR) with the addition of SM was split with 31% reporting a decrease (73/236), 33% reporting stability (79/236), 30% unsure of a change (71/236) and 6% reporting an increase (13/236). Perception regarding cancer detection rate (CDR) with SM in screening was mixed with 44% of respondents unsure if CDR changed (104/238), 34% reporting stable CDR (81/238), 21% reporting an increase in CDR (50/238) and 1% reporting a decrease (3/238). There was a statistically significant increase in those who reported perceiving favorable detection rates of invasive cancer versus DCIS: IC 20% improved (47/239) versus DCIS 5% improved (13/239), IC 27% stable (64/239) versus DCIS 35% stable (83/239), IC 53% unsure (126/239) versus DCIS 56% unsure (134/239), and IC <1% decreased (2/239) versus DCIS 4% decreased (9/239), $p<0.001$.

Opinions of SM use

The most commonly cited advantages of SM were decreased dose (182/215, 85%), increased lesion conspicuity (58/215, 27%), and increased throughput of exams (41/215, 19%). The most commonly cited disadvantages of SM were faulty calcification characterization (68/220, 31%), both overcalling “pseudocalcs” (52/220, 24%) and missing true calcifications (42/220, 19%), and decreased overall image quality (68/220, 31%).

Discussion

DBT is rapidly becoming the new standard of care in mammographic screening. A 2D exam continues to be a necessary component of the DBT examination to assess breast density, compare with prior studies, and evaluate symmetry between breasts. Combination dose-DM and DBT screening over the lifetime of a screened women will result in more radiation dose

than screening with DM alone. Thus, it would be most beneficial to patients if the “dose DM” portion of a DBT screen is replaced by an acceptable SM image so that the benefits of DBT could be maintained at a lower radiation dose than DM/DBT screening.

Reasons for not adopting SM included cost of the upgrade, administrative concerns, and quality concerns. SM technology is rapidly evolving; early iterations of the technology may have been perceived as of decreased in quality by radiologists. However, newer versions of SM have improved contrast, resolution, and increased spatial resolution with an appearance more similar to DM. As the technology improves and imaging units are upgraded, concerns over image quality will hopefully be alleviated.

The majority of practices with DBT have SM capability; however, SM usage is varied as is satisfaction regarding the modality (reporting overall satisfaction as a 3.4/5). While there is no difference in SM satisfaction when comparing by practice type, number of exams performed per year, and number of DBT units, there was a statistically significant lower reported satisfaction with SM in those with less than 1 year of experience using the modality compared to those with more experience. This indicates that there may be a learning curve in adopting the new technology and that with more experience, satisfaction with synthetic imaging may increase.

It is important to note that both single center population based studies and early reader studies have found similar or improved performance of SM when used in place of DM in DBT screening with stable or decreased recall rates and increased cancer detection rates.^{11–13,15–17} However, many breast imagers continue to have concerns about image quality, particularly as it relates to calcification characterization.^{5,14,18,19} Detecting calcification-only lesions is important as they may be the earliest sign of both DCIS and early stage invasive breast cancer. Accurately characterizing calcifications and avoiding callbacks of pseudo-calcifications is also important so as to not increase patient anxiety, radiation dose and unnecessary examinations, as well as health care spending.

While our study reveals that radiologists continue to report some difficulty with calcification characterization, very few respondents reported increased recall rates (6%) or decreased cancer detection rates (1%). Most respondents either did not know if there was a change in these metrics or reported positive outcomes. It is important to note that our results are “perceived” metrics and not necessarily empiric outcomes. Actual RR and CDR outcomes may be very different from what radiologists perceive them to be.

Additionally, the concerns regarding the disadvantages of SM and perceived adverse screening outcomes are not clearly supported by the evidence from the existing studies examining screening outcomes from DM/DBT versus SM/DBT. These concerns may be based on early research regarding calcification detection in SM.^{5,14,18,19} As discussed above, newer iterations of SM technology have improved imaging quality and calcification characterization and, with new algorithms, the quality of SM calcification reconstruction may improve. Future research will be necessary to compare new algorithms and the long-term screening outcomes of SM/DBT screening, including the evaluation of false negative cancers by lesion type.

Our study has limitations. Our response rate was low (12%, adjusted response rate 16–67%), noting that other web-based surveys of radiologists had similar response rates.^{24,25}; a larger sample may be more representative of the population of DBT users. Additionally, our questions were asked of members of the Society of Breast Imagers. This may not reflect the attitudes of all radiologists who practice breast imaging. Additional viewpoints from radiologists that are not members of the society are therefore not included. Further research could be conducted via surveying larger professional societies, such as the Radiologic Society of North America, to include more views from other radiologists. Our survey was sent to individual members and not practices; we may have overrepresentation from larger practices. Additionally, our survey did not ask respondents what DBT vendor or vendors they had available at their institution. As some vendors do not have SM capability, some potential respondents may have chosen not to participate in the survey for this reason which potentially could confound our results.

Despite these limitations, our study included a substantial number of radiologists from diverse practice types and a wide range of DBT experience. Our results reveal that DBT is now widely used by most breast imagers and in most breast cancer screening studies. The majority of practices responding to the survey screening with DBT have SM capability; however, SM usage with DM in DBT screening is varied as is radiologist satisfaction. Future research studies will be necessary to evaluate the continually evolving platform of synthetic imaging and the long-term outcomes of screening with SM/DBT.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Key Points

- Synthetic mammography (SM) is utilized by most practices performing DBT screening.
- Of those with SM, 40% have not replaced DM with SM.
- The most cited reasons for lack of SM/DBT implementation were cost/administration and image quality concerns.
- Many respondents continue to have concerns regarding image quality with SM, specifically surrounding the characterization of breast calcifications.

Chart 1:
Distribution of percentage of screening exams in which synthetic mammography (SM) replaces digital mammography (DM), stratified by availability of comparisons.

Table 1.

Practice characteristics and DBT usage

Type of Practice			
	Academic		19% (59/312)
	Private Practice		63% (196/312)
	Hybrid Practice		13% (41/312)
	Other		5% (16/312)
Practices with DBT capability			96% (299/312)
	Years of DBT use		
		2	19% (56/299)
		2–4	39% (117/299)
		4–6	26% (77/299)
		6+	11% (34/299)
		Not answered	5% (15/299)
	Number of DBT units		
		1–3	44% (132/299)
		4–6	27% (82/299)
		7–9	13% (38/299)
		10+	15% (45/299)
		Not answered	<1% (2/299)
	Screening examinations performed per year		Median = 19,000 (10,000–350,000)
	Percentage of practices that perform screening with DBT		98% (292/299)
	Percentage of screens that use DBT		
		<25%	8% (24/292)
		25–50%	15% (44/292)
		51–75%	21% (61/292)
		76–100%	54% (158/292)
		Not answered	2% (5/292)

Table 2.**SM usage**

Respondents with both DBT and SM use		83% (249/299)
Years of SM use		
	1 year	24% (59/249)
	1–2 years	27% (68/249)
	2–3 years	25% (63/249)
	>3 years	21% (53/249)
	No response	2% (6/249)
Advantages to SM use *		
	Decreased Dose	85% (182/215)
	Increased conspicuity of lesions	27% (58/215)
	Increased throughput	19% (41/215)
	Decreased recall rate	7% (16/215)
	No advantages or n/a	5% (10/215)
	Patient Preference/Marketing advantage	2% (5/215)
Disadvantages to SM use *		
	Calcification characterization	61% (135/220)
	Missed calcifications	19% (42/220)
	Overcalling “pseudocalcs”	24% (52/220)
	Quality of the images	31% (68/220)
	No disadvantages	10% (22/220)
	Difficult to compare SM and DM	9% (20/220)
	Learning curve	9% (19/220)
	Missed cancers (asymmetries, masses)	6% (14/220)
	Increased interpretation time	5% (11/220)
	Administration/Billing issues	2% (4/220)
	Lack of evidence	2% (4/220)
	Overcall distortion	0.5% (1/220)

* Some respondents gave more than 1 advantage or disadvantage. Each response was counted individually. Number of responses is greater than number of individuals who responded, thus the percentages add up to greater than 100%. Some respondents did not list any disadvantages or advantages.

Table 3.

Satisfaction of SM Use

Overall Satisfaction of SM Use (1–5 scale)		
	1	10% (23/239)
	2	15% (35/239)
	3	22% (53/239)
	4	36% (86/239)
	5	18% (42/239)
Average Satisfaction by Practice type		
	Academic	3.3 (47/239)
	Hybrid/Other	3.4 (38/239)
	Private Practice	3.4 (154/239)
Average satisfaction by number of DBT units		
	3	3.4 (103/237)
	4–7	3.2 (77/237)
	8	3.6 (57/237)
Average satisfaction by number of screening exams per year		
	10,000	3.4 (65/222)
	10,001 – 25,000	3.5 (69/222)
	25,001–49,999	3.2 (45/222)
	50,000	3.3 (43/222)
Average satisfaction by number of years of SM experience		
	1	2.9 (53/233)
	1–2	3.5 (67/233)
	2–3	3.5 (61/233)
	> 3	3.6 (52/233)