Clinical Value of True 3D Breast Tomosynthesis
An evaluation of recent studies
Digital Mammography has improved the detection of breast cancer immensely. However, as 2D mammography is a projection image, overlying tissue structures result in difficulties in interpretation, giving rise to limitations in sensitivity as well as false-positive findings, which in turn increase recall rates. The limitations caused by overlying tissue become even more relevant as breast tissue density increases.

Digital Breast Tomosynthesis (DBT) makes it possible to acquire and display 3D volumes of the entire breast. These are displayed in slices to reduce the impact of overlapping tissue. The angular range and the number of projections in the volume acquisition is the key to the system’s ability to reduce the impact of overlapping tissue. Various commercially available systems use angles between 15 to 50 degrees, while the number of projections taken differs from 9 to 25. Siemens Mammomat Inspiration offers the largest angular range with 50° and the highest number of projections at 25.

This paper presents the results of recent studies performed with Siemens Mammomat Inspiration and summarizes their key findings.

This paper addresses the following questions:

• How does tomosynthesis affect the detection rate and type of cancers found?
• Does tomosynthesis lead to a reduction in recall rates?
• What effect does tomosynthesis have on Mean Glandular Dose and are there differences in the biological effects?
• Does it help in the characterization of lesion type and size?
• How can reading time be reduced without compromising image quality?
• Is it possible to reduce the compression force to improve patient comfort without compromising image quality?
• Is tomosynthesis only for diagnostics or does it have a place in screening?
• How does it perform in comparison to other breast imaging modalities?
Detection rate

As Full Field Digital Mammography (FFDM) alone misses approximately 30% of breast cancers\(^{[18]}\), especially in dense breasts, tomosynthesis may be one way to overcome this limitation. Digital Breast Tomosynthesis shows a significant improvement in the detection of breast cancer and can detect breast cancer at earlier stages. It is less affected by breast density than FFDM and can be used as a stand-alone technique or as an adjunct to Full Field Digital Mammography.

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<tr>
<th>Reference</th>
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<tbody>
<tr>
<td>Zackrisson et al.</td>
<td>Sweden</td>
<td>2014</td>
<td>One-view DBT alone increased breast cancer detection rate by 43% compared to 2-view FFDM. The results suggest that 1-view DBT may be feasible as a single screening modality.</td>
</tr>
<tr>
<td>Extano et al.</td>
<td>Spain</td>
<td>2013</td>
<td>DBT is useful in ACR III-IV dense breasts as well as for scattered fibroglandular breasts (ACR II), increases sensitivity compared to FFDM and detects more invasive cancers, in particular tubular cancers.</td>
</tr>
<tr>
<td>Uchiyama et al.</td>
<td>Japan</td>
<td>2012</td>
<td>DBT + FFDM detect more cancers than FFDM alone. DBT as an adjunct to FFDM was able to detect early-stage breast cancer and is not affected by breast density.</td>
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Recall rate

False-positive recalls result in unnecessary additional costs and anxiety in patients. Recall rates are therefore an important factor when evaluating a screening modality. Digital Breast Tomosynthesis can improve the characterization of lesions, reducing false-positive findings and recall rates.

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<td>Galati et al.</td>
<td>Italy</td>
<td>2014</td>
<td>The combination of two-view FFDM and one-view DBT increased concordance between readers for the BIRADS classification and reduced recalls.</td>
</tr>
<tr>
<td>Bick et al.</td>
<td>Germany</td>
<td>2014</td>
<td>In screening, DBT improved cancer detection rates while at the same time reducing recalls for false-positives.</td>
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Dose

Breast tissue is sensitive to radiation and screening examinations are performed on healthy women. It is therefore immensely important to obtain the highest possible image quality at the lowest achievable dose. An independent study confirms Siemens Mammomat Inspiration operates at a lower dose than another vendor. Another study found that the dose required for Digital Breast Tomosynthesis may result in less DNA damage compared to standard mammography and therefore may be biologically safer.

Germany 2013 Mammography induces a small but significant increase of γ-H2AX foci in patients’ systemic blood lymphocytes. This indicator of DNA damage was less prominent after DBT than FFDM.

Dance et al. “Comparison of breast doses for digital tomosynthesis estimated from patient exposures and using PMMA breast phantoms”[7]
UK 2012 The results conclude that the dose for tomosynthesis with the Siemens Mammomat Inspiration system is lower than other vendors.

Specificity

It is often difficult to characterize a lesion as benign or malignant with FFDM. This results in an incorrect BIRADS categorization and tends to increase recall rates. Digital Breast Tomosynthesis improves the lesion characterization and diagnostic performance.

Galati et al. “Added value of one-view DBT combined with DM according to readers’ concordance – changing in BIRADS rate and follow-up management: A preliminary study”[8]
Italy 2014 The combination of two-view FFDM and one-view DBT increased concordance between readers for the BIRADS classification and reduced recalls.

Heywang-Köbrunner et al. “Use of Tomosynthesis for the assessment of screen-detected lesions”[9]
Germany 2013 Due to higher specificity, diagnostic performance is improved if DBT replaces additional 2D FFDM views.

Uchiyama et al. “Diagnostic Impact of Adjunction of Digital Breast Tomosynthesis (DBT) to Full Field Digital Mammography (FFDM) and in Comparison with Full Field Digital Mammography (FFDM)”[3]
Japan 2012 DBT + FFDM detect more cancers than FFDM alone. DBT as an adjunct to FFDM was able to detect early-stage breast cancer and is not affected by breast density.
Reading Time

As DBT consists of volume sets rather than single images, it takes more time to review than FFDM. New techniques such as slabbing will reduce reading times without compromising on image quality and detection rate.

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<td>Dustler et al.</td>
<td>“Image Quality of Thick Average Intensity Pixel Slabs Using Statistical Artifact Reduction in Breast Tomosynthesis”[10]</td>
<td>Sweden</td>
<td>2014</td>
<td>It is possible to review DBT volumes with 2 mm slabs without compromising image quality and the visibility of micro-calciifications is improved.</td>
</tr>
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</table>

Compression Force

The need for compression with mammography is a cause of patient discomfort and one reason for reduced compliance in breast screening. If breast compression can be reduced without compromising image quality, this will improve patient comfort and maybe increase screening participation rates. The studies indicate that it is possible to reduce compression force with DBT, offering patients a more comfortable screening experience without loss of image quality.

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<tr>
<td>Förnvik et al.</td>
<td>“The effect of reduced breast compression in breast tomosynthesis: human observer study using clinical cases”[13]</td>
<td>Sweden</td>
<td>2010</td>
<td>No difference in image quality was evident with reduced compression, indicating that DBT can be performed with substantially less compression force compared with 2D mammography. The majority of women examined felt that half compression was more comfortable than full compression.</td>
</tr>
<tr>
<td>Saunders et al.</td>
<td>“Can compression be reduced for breast tomosynthesis? Monte Carlo study on mass and microcalcification conspicuity in tomosynthesis.”[14]</td>
<td>USA</td>
<td>2009</td>
<td>For constant glandular dose, mass and microcalcification conspicuity remained constant at decreased compression levels.</td>
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Field of Application

Several studies have shown that tomosynthesis is a promising modality for screening, diagnostics and monitoring therapy. DBT is not only useful in screening and diagnostics, but also in therapy planning and control.

<table>
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<th>Study Reference</th>
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<th>Findings</th>
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| Schulz-Wendtland et al.  
“Full Field Digital Mammography (FFDM) versus CMOS Technology, Specimen Radiography System (SRS) and Tomosynthesis (DBT) – Which System Can Optimise Surgical Therapy?”[15] | Germany | 2013 | Mammomat Inspiration tomosynthesis system had the highest sensitivity of the three systems tested. The rate of re-excisions was reduced compared to results from FFDM systems. |
| Van Ongeval et al.  
“Is DBT the new standard in diagnostic imaging? How to implement in specialist training?”[16] | Belgium | 2014 | DBT has the best diagnostic accuracy and the best early detection rate for breast lesions and is more accurate in determining lesion size compared to DM and US. |
| Heywang-Köbrunner et al.  
“Use of Tomosynthesis for the assessment of screen-detected lesions”[9] | Germany | 2013 | Diagnostic performance is higher due to higher specificity if tomosynthesis replaces additional views. |
| Uchiyama et al.  
“Usefulness of Adjunction of Digital Breast Tomosynthesis (DBT) to Full-Field Digital Mammography (FFDM) in Evaluation of Pathological Response after Neoadjuvant Chemotherapy (NAC) for Breast Cancer”[17] | Japan | 2012 | The adjunction of DBT to FFDM combined with other diagnostic modalities contributes to more accurate assessment of response to NAC. The adjunction of DBT to FFDM improves the assessment of lesions and their margins without utilizing a contrast medium. |
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References

[1] Zackrisson et al., Performance of one-view breast tomosynthesis versus two-view mammography in breast cancer screening – First results from the MALMÖ Breast Tomosynthesis Screening Trial; Presentation at the ECR 2014, March 6 – 10, Vienna/Austria;
[2] Extano et al., The additional role of tomosynthesis after normal mammography according to ACR density patterns; Presentation at the ECR 2013, March 7 – 11, Vienna/Austria;
[4] Galati et al., Added value of one-view DBT combined with DM according to readers concordance – changing in BI-RADS rate an follow-up management: A preliminary study.; Personal Correspondence;
[5] Bick et al., Tomosynthesis and the impact on patient management; Digital Breast Tomosynthesis Course at EUSOBI 2014, 4 – 5 March, Vienna/Austria;
[8] Galati et al., Added value of one-view DBT combined with DM according to readers concordance – changing in BI-RADS rate an follow-up management: A preliminary study.; Personal Correspondence;
[9] Heywang-Köbrunner et al., Use of Tomosynthesis for the assessment of screen-detected lesions; Screening Assessment course at the ECR 2013, March 7 – 11, Vienna/Austria;
[12] Lang et al., Breast Tomosynthesis in Screening; Presentation at EUSOBI 2014, March 4 – 5, Vienna/Austria; Presentation at EUSOBI 2014, March 4 – 5, Vienna/Austria;
[14] Saunders et al., Can compression be reduced for breast tomosynthesis? Monte carlo study on mass and microcalcification conspicuity in tomosynthesis; Radiology. 2009 Jun;251(3):673-82;
[16] Van Ongeval et al., Is DBT the new standard in diagnostic imaging? How to implement in specialist training?; Siemens Breast Care Day at the ECR 2014, March 6 – 10, Vienna/Austria;

For more information about the benefits of True 3D Breast Tomosynthesis visit www.siemens.com/be-sure.
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