Breast Tomosynthesis (DBT) & Tomosynthesis guided Biopsy (TVAB)

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No financial disclosures
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Breast tomosynthesis (DBT) since 2008

C-View (synthetic 2D) all-in-one since 2011

TVAB since December 2012

FFDM, US, MRI, US + MRI-VAB, SPECT/CT
4 Topics

1. Why is DBT (3D) so much better than 2D?
   • Issue 3D imaging unmask[es/ highlights
   • Increased cancer detection/ less recalls/ less stress

2. Why DBT needed years to convince the medical community?
   • Issue radiation exposure. Lack of reliable data?

3. Why radiation exposure is no issue anymore?
   • C-view software. Synthetic 2D + 3D images

4. Why is TVAB so much better than SVAB?
   • No miscalculation of target depth, verification possible
What is Breast Tomosynthesis (DBT)?

- DBT is a 3-D-imaging technology
- Only difference to regular mammography is movement of the x-ray-tube
- Takes multiple images from different angles with low dose
- 3-D data set, reconstructed
- Page through CC/ MLO layers like CT
Workflow Mammography/DBT system

- Start 2D-FFDM (CC, MLO)
- Add DBT views (CC, MLO) after review of 2D by the radiologist
  (2 settings. Compression and positioning different)
- Add DBT views direct after acquisition of 2D.
  (1 Setting. Same compression + positioning, Combo mode)
Why is DBT so much better than 2D?

Advantage 3D imaging vs. 2D:

– Reduction/ elimination of tissue overlap

• Unmasks/ highlights masses
• Unmasks / highlights distortions
• Unmasks / highlights micro-calcifications
3D unmasks / highlights masses
See, judge, measure

2D

3D
3D unmasks / highlights margins + mc
Won’t overlook mc and indistinct mass

Svahn, BJR 2012; Skaane, Radiology 2013; Waldherr AJR 2013
3D unmasks / highlights masses in dense tissue

Haas BM, Radiology 2013; Waldherr, AJR 2013
3D unmasks / highlights in dense tissue
3D unmasks / highlights in low dense tissue
3D unmasks /highlights in low dense tissue
3D un_masks / highlights distortions!!, not visible on 2D-FFDM
3D unmask / highlights distortions
3D unmasks/ highlights distortions

Invasive ductal carcinoma
3D unmasks/ highlights distortions

Invasive ductal carcinoma
Nice images, reliable data in screening and assessment?

• Significantly increases cancer detection:¹ (12,631 pts)
  – 40% increase in invasive cancer detection
  – 27% increase in cancer detection

• Significant reduction of recalls:¹⁻⁴
  – 20-40% reduction of recall rates

• Patients across all age groups and breast densities benefit ²,⁴


Integration of tomosynthesis for population breast-cancer screening (STORM): a prospective comparison study

- 7292 women were screened
- 59 breast cancers (including 52 invasive cancers) in 57 women.
- Both 2D and integrated 2D and 3D screening detected 39 cancers.
- 20/ 59 cancers with integrated 2D and 3D only versus none with 2D screening only (p<0·0001).
- 2D + 3D mammography could have reduced false positive recalls by 17·2% without missing any of the cancers detected in the study population.

Nice reliable data, **but** 2D + 3D doubles the dose

Not anymore!,

since DBT C-view software (synthetic 2D)
What is Synthetic 2D?

- C-View is a reconstruction software added to your DBT system.
- Just once the regular 3D acquisition, no additional 2D acquisition.

- C-view software reconstructs out of CC/ MLO 3D data set all 3D and 2D images.
- Dose almost equivalent to 2D only.

Diagram:
- X-ray Tube
- Compressed Plate
- Flat-Panel Detector
- Reconstructed Layers
Synthetic 2D (2D C-view), better!
Synthetic Mammography versus FFDM

**SM Strengths**
- Increased conspicuity of calcifications
- Increased definition of spiculated margins
- Better visualization of architectural distortion

**SM Weaknesses**
- Missed findings in the subcutaneous tissue
- Increased callback for pseudo-calcifications
- Harder to detect motion

Can we use Synthetic 2D (C-view) as replacement of 2D-FFDM?

Yes

FDA approved since May 21, 2013

December 3, 2013 -- CHICAGO --

The Oslo Tomosynthesis Screening Trial showed (12.271 pts):

Cancer detection rate of 2D and synthetic 2D at least the same (each 100 of 12,271)

Conclusion:
1. Synthetic 2D plus 3D is acceptable for routine in mammography screening,
2. and may (will) replace 2D-FFDM in clinical practice.
<table>
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<tr>
<th>STUDY</th>
<th>YEAR</th>
<th>CONCLUSION</th>
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<tr>
<td>Zuley, et al.</td>
<td>2014</td>
<td>SM alone or SM + DBT = performance to FFDM alone or FFDM + DBT</td>
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<tr>
<td>Skaane, et al.</td>
<td>2014</td>
<td>SM + DBT = FFDM + DBT</td>
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<tr>
<td>Bernardi, et al.</td>
<td>2014</td>
<td>SM + DBT = FFDM + DBT</td>
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<tr>
<td>Durand, et al.</td>
<td>2015</td>
<td>SM+DBT shows majority of mammo findings equal or better than FFDM+DBT, regardless of breast density or age, with equivalent recall rates and CDR</td>
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<tr>
<td>Mariscotti, et al.</td>
<td>2015</td>
<td>SM alone = FFDM, with similar sensitivity, specificity and area under ROC curve</td>
</tr>
<tr>
<td>Woo, et al.</td>
<td>2015</td>
<td>SM showed = diagnostic value compared with FFDM. SM superior for spiculated margins and architectural distortion.</td>
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<tr>
<td>Zuckerman, et al.</td>
<td>2016</td>
<td>SM + DBT screening maintains CDR while reducing recall rates and radiation dose compared with FFDM + DBT.</td>
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<tr>
<td>Aujero, et al.</td>
<td>2017</td>
<td>Screening with SM/DBT improved recall rate and positive predictive values without loss of cancer detection rate when compared with FFDM/DBT and FFDM alone</td>
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Courtesy of C. Giess, Harvard Medical School
Synthetic 2D + DBT

- Now we got it all!, both 2D and 3D with almost the same radiation exposure of a 2D-FFDM alone
- One setting, same compression, same positioning
- Higher cancer detection, less recalls, less stress, heaven...

But (Why but?)

- 3D detects more frequently small US occult lesions, not detected by 2D-FFDM before
- How to biopsy that?
- Clear! Use the method that showed the lesion: T-VAB
Do not use SVAB in US occult masses and distortions
Difficult to identify identical X, Y
Not identical X-, Y- targeting = Z wrong

No chance to verify, have to believe your eye
DBT proved SVAB miscalculation
Miscalculation by one quadrant
3D detects US occult distortions. SVAB?
Distortions occult on SVAB. MRI?
MRI? Activated fibroglandular tissue
US? Equivocal. Maybe this?
Martin was brave. Needle & clip
In 3D clip correct, carcinoma, happy
Next distortion visible only on 3D.
Really need to biopsy? Wait and see?
Tomosynthesis-guided vacuum-assisted breast biopsy: A feasibility study.

Purpose:

........

Materials and Methods:

.....The first 141 biopsies on 141 patients admitted for stereotaxy........

Results:

.... Of the 24 radial distortions, 13 were breast carcinomas (11 invasive carcinomas, 2 ductal carcinomas in situ). The mean lead time for TVAB was 15.4 minutes (range 7-28 min)....... 

Conclusions:

.... Architectural distortions were found to be malignant in 54% of patients and thus need to be histopathologically evaluated if detected........
How to biopsy lesions
NOT seen on US???

• US => Lesion???
Stereotaxy in US occult lesions and distortions???

- **US** → **Lesion???
- **Stereotactic** → **Lesion???

- Distortions mostly not visible on stereo images
- No clear target at least on one stereo image
- Visual needle verification only pretends correct needle depth, danger!
How to biopsy lesions NOT seen on US???

- **US => Lesion???
- **Stereotactic => Lesion???
- **MRI =>
  - Availability???
  - Will we find lesion???
  - High cost
  - Time
  - Contra-indications: contrast, claustrophobia
How to biopsy such lesions?
Tomosynthesis guided Biopsy (Affirm™)
T-VAB upright/ lateral decubitus position

easy, less time, less space, cheaper, never had problems..
T-VAB procedure - Case 1
Target
Tomosynthesis procedure - Case 1
Target
Tomosynthesis procedure - Case 1
Target

Verification of correct target depth with diagnostic or screening 3D
Tomosynthesis procedure - Case 1

Target

- Prepare biopsy device (Eviva)
Tomosynthesis procedure - Case 1

Target

- Prepare Eviva
- Desinfection
Tomosynthesis procedure - Case 1

Target

- Prepare Eviva
- Desinfection
- Install needle guide and handpiece
Tosmosynthesis procedure - Case 1

Target

- Prepare Eviva
- Desinfection
- Install needle guide and handpiece
- Go to target
Tomosynthesis procedure - Case 1

Target

- Prepare Eviva
- Desinfection
- Install needle guide and handpiece
- Go to target
- Local anesthetic + skin incision
Tomosynthesis procedure - Case 1

Target

- Prepare Eviva
- Desinfection
- Install needle guide and handpiece
- Go to Target
- Local anesthetic + skin incision
- Dial Z down to zero
Tomosynthesis procedure - Case 1
Pre-Fire – Post-Fire (optional)

Pre-fire images
+ Fire
Tomosynthesis Procedure - Case 1
Pre-Fire – Post-Fire (optional)
Tomosynthesis procedure - Case 1
Specimen retrieval

- Specimen retrieval
- Lavage + back to biopsy
- Slide out Eviva handpiece leaving plastic cannula in place for clip insertion
Tomosynthesis procedure - Case 1
Post Biopsy - Clip

- Post Biopsy Tomo
  - Go to target on target slice →
  - Display target on post biopsy tomo
- Post Biopsy Tomo
  - Scroll up and down on post biopsy tomo
    - Check if lesion is gone
    - Compare depth hematoma/cavity ↔ lesion on target
- Clip
Tomosynthesis procedure - Case 1

- Total lead time: 10 min
- Invasive ductal carcinoma
Tomosynthesis procedure - Case 2

Patient 66 y, macro-calcifications

2D RCC

2D RMLO
Tomosynthesis procedure - Case 2

Target

Advantage TVAB (3D) vs. 2 D: separation of several targets in several Z (depth) possible.
Tomosynthesis procedure - Case 2
Specimen Retrieval – Post Biopsy

- Specimen retrieval
- Lavage
- Slide out Eviva handpiece leaving plastic cannulla in place
- Post Tomo Biopsy
Tomosynthesis procedure - Case 2
Clip

Fibroadenoma
Tomosynthesis procedure - Case 3

Patient 49 y

2D LMLO 2011 | 2D LMLO 2013 | CVIEW LMLO 2013
Tomosynthesis procedure - Case 3

2D LMLO 2013
Tomosynthesis procedure - Case 3
Tomosynthesis procedure - Case 3

Patient 49 y

2D LCC 2011

C-VIEW LCC 2013

3D LCC 2013
Tomosynthesis procedure - Case 3

Patient 49 y

2D LCC 2011
C-VIEW LCC 2013
3D LCC 2013
Tomosynthesis procedure - Case 3
Target
Tomosynthesis procedure - Case 3
Target
Tomosynthesis procedure - Case 3
Pre-Fire (optional)

Pre-fire images
Option to bring curser back with + fire
Tomosynthesis procedure - Case 3

Clip

Invasive ductal carcinoma
Advantages of TVAB

• TVAB shows targets not detectable on stereotaxy

• TVAB shows distortions

• TVAB offers distances for verification
target to skin (CC, ML)

• TVAB offers distances for planning best access path (upright (CC, MLO or lateral recumbent)

• TVAB can separate target lesions & calcifications within disseminated lesions/ calcifications
Take home

1. Why will 3D replace Digital Mammography?
   • 3D unmasks masses, distortions, mc in low and dense tissue
   • Increased cancer detection/ less recalls/ less stress

2. Why is radiation exposure of 3D no issue anymore?
   • C-View: synthetic 2D + 3D, no additional radiation
   • Do it!, tumor size matters, distortions = interval Ca, do not harm your patient....

3. Why is TVAB so much better than SVAB?
   • Get solid lesions and distortions you don’t get with stereotaxy. Take distortions out. No miscalculations. Faster. *Use the time for the real important things in life*......