An Innovative Mammographic biopsy technique to meet the challenges on a 3D Digital Breast Tomosynthesis detected lesion

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Nowadays, 3D Digital Breast Tomosynthesis (DBT) is getting popular in private screening sector.

Comparing with conventional 2D Full-Field Digital Mammography (FFDM), 3D DBT reduces the effect of tissue superimposition and may improve mammographic interpretation.\(^1\)

It reduces false positive call back rate by 14.5% and increase breast cancer detection rate by 24.5%.\(^2\)

<table>
<thead>
<tr>
<th>Method of Mammography</th>
<th>Total no. of women</th>
<th>No. of cancer detected</th>
<th>No. of cancer Detection per 1000 exam.</th>
<th>Cancer Detection Rate</th>
<th>No. of False positive call back per 1000 exam</th>
<th>False Positive call back Rate</th>
<th>Mean interpretation time</th>
</tr>
</thead>
<tbody>
<tr>
<td>2D FFDM</td>
<td>6000</td>
<td>39</td>
<td>6.4/1000 exam.</td>
<td>0.64%</td>
<td>61.1/1000 exam.</td>
<td>6.1%</td>
<td>45 sec</td>
</tr>
<tr>
<td>2D FFDM + 3D DBT</td>
<td>6631</td>
<td>53</td>
<td>8/1000 exam.</td>
<td>0.8%</td>
<td>53.1/1000 exam.</td>
<td>5.31%</td>
<td>91 sec</td>
</tr>
</tbody>
</table>

Table 1: Comparison of Digital Mammography alone and Digital Mammography plus Tomosynthesis in a population-based screening program. Radiology Vol.267:47-56.

DBT minimizes the effect of tissues overlapping within the breast.
DBT minimizes the effect of tissues overlapping within the breast

- With 3D images, lesions may actually locating on different individual slap layer.

Lesions superimposed in 2D Mammogram
3D images help in distinguish breast tumors from normal overlapping breast tissues
Any breast abnormality detected on mammogram, further workup is necessary.

Breast abnormalities including:

1. Suspicious mass
2. Micro-calcifications
3. Architectural distortion
4. Area of abnormal tissue changes

Images courtesy of TWGHs
- Architectural Distortion is the 3rd most commonly missed mammographic abnormality on false negative 2D Mammography.⁴
- More difficult to detect as it can be subtle and variable in mammographic presentation.
- It represents nearly 6% of abnormalities detected on screening mammography.
- It is associated with high predictive of malignancy.
- Architectural Distortion is one kind of lesions that would be identified more apparently in 3D DBT (73%) than that in 2D Mammography (21%).⁶

Comparison of Distortion in 2D & 3D image

Images courtesy of TWGHs
Comparison of Distortion in 2D & 3D image

Images courtesy of TWGHs
Stereotactic breast biopsy examination is a common procedure for the management of the mammographic detected lesions.

In 2016, 417 stereotactic examinations had been performed in KWH.

>82.5 % cases were referred from private mammography screening sectors.

90.5 % biopsy cases were scheduled for microcalcifications, 5.5% cases for mass lesion and 4% cases for distortion.

9.5% cases with suspicious lesions detected only from 3D images.
Basic theory of stereotactic examination

- It is a procedure that making use of two images taken at 30 degrees apart to locate a target in a 3-Dimensional space with the aid of computer.

- Based on the parallax shift of the target from the reference point to obtain the $x$, $y$, (entry point) and $z$ coordinates (depth) of the target.

![Diagram](http://pubs.rsna.org/dol/10.1148/radiographics.21.2.g01mr11463)

**Figure 1.** Diagram illustrates the relationship between a 3D object ($x$, $y$, and $z$ coordinates) and a 2D image ($u$, $v$ coordinates).
Work flow of stereotactic examination

Scout film to locate the target
Work flow of stereotactic examination

- Two stereo images taking at +/-15°
Work flow of stereotactic examination

- Two stereo images taking at +/-15°
- x, y, z co-ordinates can be determined with the aid of computer.

X-ray tube
Stereo imaging
Work flow of stereotactic examination

Y: Vertical
X: Horizontal
Z: Depth

Lesion
Depth
X ray tube

-15°
+15°
Work flow of stereotactic examination

Successful criteria based on identification of same target in the stereo image pair
Work flow of stereotactic examination

Inadequate lesion visualization in targeting accounted for 85% of biopsy failure \(^5\)

Correct x, y, z co-ordinates of the target cannot be obtained

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Digital Breast Tomosynthesis: Technology Advancement in Breast Imaging

Challenges at KWH
**Our Challenges at KWH**

- Lesions only be seen in 3D DBT but not be identified in 2D stereotactic targeting, x, y, z co-ordinates of the target could not be determined.
- No 3D Tomo-guided biopsy facility in KWH, even not accessible in other HA hospitals.
- It is also not common and quite expensive in private sector. (Price range: $15,000 - $23,000)
- As an alternative, patients could then be only put for short term interval mammogram. It is not desirable and may induce great anxiety to patients.
Meeting the challenges

- What can we do to release patient’s worrisome??
- How can we tackle such technical challenges??
- Can it be substituted for the stereotactic targeting?
- Only based on our existing resources.
- Back to basic of the Stereotactic examination.
- Any additive information from 3D DBT images?
- **Challenge**: Any clinical support from Radiologists??
Criteria need to be considered

- Target location
  - X,Y co-ordinates

- Target depth
  - Z co-ordinate

- Increase biopsy yield
  - Minimize sampling error
Back to Basic of the stereotactic examination:

Target can be identified at scout film

x, y, z coordinates of target lesion could not be determined
Back to Basic of the stereotactic examination:

Can a simple grid be used for substitution?

x, y, z coordinates of target lesion could not be determined
Our journey in designing new grid technique:

- Designing a home-made grid for lesion localization

Breast phantom is used to simulate as in real situation

Scout image of phantom taken
Our journey in designing new grid technique:

- Designing a home-made grid for lesion localization

A radio-opaque grid paper (1 cm x 1 cm square size) placed on top of the biopsy paddle window

Second image of breast phantom with radio-opaque grid
Our journey in designing new grid technique:

- Designing a home-made grid for lesion localization

A transparent plastic sheet placed on top of monitor to prepare the grid sheet

A transparent home-made grid pattern sheet is made (with magnification factor included)
Our journey in designing new grid technique:

Target location
X,Y co-ordinates
Our journey in designing new grid technique:

- Find the x, y coordinates of the target by grid technique

Estimate the target location from the mammogram

Scout image taken to locate the target
Our journey in designing new grid technique:

- Find the x, y coordinates of the target by grid technique

Target lesion located

A transparent home-made grid pattern placed on top of the monitor
Our journey in designing new grid technique:

- Find the x, y coordinates of the target by grid technique

A radio-opaque grid worksheet placed on top of the biopsy paddle window

Corresponding square identified
Our journey in designing new grid technique:

- Find the x, y coordinates of the target by grid technique

A radio-opaque marker stick on top of the corresponding square
Our journey in designing new grid technique:

- Find the x, y coordinates of the target by grid technique

Corresponding square identified

Second image showing the radio-opaque marker superimposed on the lesion
Our journey in designing new grid technique:

- Find the x, y coordinates of the target by grid technique

Second image showing the radio-opaque marker superimposed on the lesion

Entry point (x, y coordinates) obtained

Skin marked accordingly
Our journey in designing new grid technique:

- Target location
  - X,Y co-ordinates
- Target depth
  - Z co-ordinate
- Increase biopsy yield
  - Minimize sampling error
Our journey in designing new grid technique:

- Find the z coordinate (depth) of the target for biopsy
- Additive depth information can be obtained from 3D images
- **Slap image** = Image layer with lesion best seen on
- **Slap number (S)** = distance in (mm) above the breast platform
  - Image layer of 1 mm interval
Our journey in designing new grid technique:

- Find the z coordinate (depth) of the target from 3D images

Images courtesy of TWGHs
Our journey in designing new grid technique:

- **Slap number** = distance in (mm) above breast platform
- **z co-ordinate (depth) of the target can be obtained**

Images courtesy of TWGHs
Our journey in designing new grid technique:

- Target location (X,Y co-ordinates)
- Target depth (Z co-ordinate)
- Increase biopsy yield
  Minimize sampling error
**Increasing biopsy yield and minimize sampling error:**

- Incorporation of larger gauge needles to acquire more tissue samples in breast biopsy has decreased the probability of false-negative finding and sampling error.\(^7\)

- All examinations under this biopsy technique method are performed with the Vacuum Assisted Biopsy device (VAB) so as to increase the biopsy yield.

- Specimens are collected with a 10G (VAB) hand piece of 20mm in full biopsy tissue volume or 10mm in half according to the location of lesion. At least 12 specimens are rewarded in two biopsy round to minimize the sampling error.

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Our journey in designing new grid technique:

We are ready!

- Target location
- $X,Y$ co-ordinates
- Target depth
  - $Z$ co-ordinate
- Increase biopsy yield
- Minimize sampling error
An innovative 2D Mammographic biopsy technique has been introduced at KWH since May 2016, with the endorsement of the Department Head of Radiology.

- 7 cases have been successfully performed with proven pathological results.
- Procedures of examination, risk and limitation have been explained and discussed with patients.
- Informed consent for examinations also obtained.
Initial results at KWH

- 7 patients with age range: 43-63, mean age 50.4
- Results: 3 DCIS, 2 Radial Scar, 1 LCIS and 1 fibrosis respectively
- All pathology results are carefully correlated with mammographic findings during the weekly multi-disciplinary meetings

Table 2. Result of seven women presented as architectural distortion in DBT with the breast biopsy examination under 2D grid technique at KWH
Conclusions

- This Innovative 2D Mammographic biopsy technique definitely helps in filling up the service gap in the absence of 3D biopsy facility.
- It can tackle our technical challenges based on the limited resources.
- At least it can help to reduce patients’ anxiety if short term follow up mammogram remains as the only choice otherwise.
- *Enhancing our job satisfaction & professional recognition.*


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Thank YOU