Digital Breast Tomosynthesis

Comparison of different methods to calculate patient doses

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Outlook

• Introduction
• Materials & Methods
  – Method Dance et al
  – Method Sechopoulos et al
• Results
  – Comparison of different methods to calculate average glandular dose (AGD)
  – Comparison with dose indicated on the system
  – Comparison of 2D and 3D AGD values
• Conclusion
Introduction

- New development in the field of breast imaging
- Pseudo 3D technique with reduced structured noise from overlaying tissues
- Examination of dose delivered to patient
- Comparison of different methods to calculate average glandular dose
Materials & Methods

- 2 DBT systems
  - Siemens Inspiration (100 cases)
  - Hologic Selenia Dimensions (18 cases)

- 3 AGD calculation methods
  - Dance based on individual breast glandularity
  - Dance based on patient age
  - Sechopoulos (also based on glandularity)

- Input for calculations from DICOM header
- Tube output and HVL from half yearly QC test
- Glandularity information provided by radiologists
- Distance chest – nipple from measurements
Method Dance

\[ AGD = K g c s \sum t(\alpha), \]

- extension of 2D formula
- K, air kerma for single projection
- g, c and s-factor of 2D calculations
- t(\alpha), tomofactor for projection angle \( \alpha \)
- different c-factors for age and glandularity

**Method Dance**

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**Method Sechopoulos**

\[ AGD = X_{CR} D_gN_0 \sum_{\alpha=\alpha_{MIN}}^{\alpha_{MAX}} RGD(\alpha), \]

- \( X_{CR} \), the exposure of a single projection measured in the reference point
- \( D_gN_0 \), the normalized glandular dose for zero degree projection angle
- \( RGD(\alpha) \), the relative dose coefficient for projection angle \( \alpha \) (for CC and MLO)
- \( \delta \), chest wall to nipple distance

\[ RGD_{CC} = a + b\alpha + c\delta + d\alpha^2 + e\delta^2 + f\alpha\delta + g\alpha^3 + h\delta^3 + i\alpha\delta^2 + j\alpha^2\delta, \]

\[ RGD_{MLO} = \frac{a + c\alpha + e\delta + g\alpha^2 + i\alpha\delta + k\alpha\delta}{1 + b\alpha + d\delta + f\alpha^2 + h\delta^2 + j\alpha^2}. \]

Results

1. Comparison between the different methods
2. Comparison with dose indicated on the system
3. Comparison of 2D and 3D AGD values
1. Comparison of different methods

Siemens Inspiration

<table>
<thead>
<tr>
<th>Breast thickness (mm)</th>
<th>Dance-age (mGy)</th>
<th>Dance-glandularity (mGy)</th>
<th>Sechopoulos (mGy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>45 mm</td>
<td>1.79</td>
<td>1.88</td>
<td>1.75</td>
</tr>
<tr>
<td>min</td>
<td>0.64</td>
<td>0.69</td>
<td>0.35</td>
</tr>
<tr>
<td>max</td>
<td>4.98</td>
<td>4.67</td>
<td>3.87</td>
</tr>
</tbody>
</table>

- Calculated AGD - age
- Calculated AGD - Sechopoulos
- 2D Acceptable level

Introduction

Materials & Methods

Results

- Different methods
- Indicated AGD
- 2D vs 3D

Conclusion
1. Comparison of different methods

**Siemens Inspiration**

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**Hologic Selenia Dimensions**

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</thead>
<tbody>
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<td>45 mm</td>
<td>1.35</td>
<td>1.47</td>
<td>1.35</td>
</tr>
<tr>
<td>min</td>
<td>0.81</td>
<td>0.99</td>
<td>0.82</td>
</tr>
<tr>
<td>max</td>
<td>4.30</td>
<td>4.66</td>
<td>3.60</td>
</tr>
</tbody>
</table>
### Results

#### Siemens Inspiration

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<thead>
<tr>
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<th>System 1</th>
<th>System 2</th>
</tr>
</thead>
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<tr>
<td>Mean ratio</td>
<td>1.23</td>
<td>1.15</td>
</tr>
<tr>
<td></td>
<td>1.27</td>
<td>1.13</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>0.244</td>
<td>0.014</td>
</tr>
<tr>
<td></td>
<td>0.293</td>
<td>0.088</td>
</tr>
<tr>
<td>Maximum deviation</td>
<td>0.976</td>
<td>0.053</td>
</tr>
<tr>
<td></td>
<td>0.937</td>
<td>0.253</td>
</tr>
</tbody>
</table>

- 23% difference when all views are compared
- 15% difference if only CC views are considered, STD 0.014

#### Hologic Selenia Dimensions

- 13% for all views
- 10% for CC view

Small differences between 2 methods
- different breast models used in the simulation
- heel effect
2. Comparison with dose indicated on the system

**Dance:**

- Best correlation for calculations based on patient age
- Confirmation of Siemens: their calculation is based on this method

**Sechopoulo**
3. Comparison of 2D and 3D AGD values

Performed on Siemens DBT system
- 100 patients for 3D
- 1000 patients for 2D
- data collection in same period of time

Doses in 1 view DBT = 2 * doses in 1 view 2D digital mammography

~ factor 2
Conclusion

- Different methods to calculate 3D AGD
- Small differences between 2 methods
  - Differences in breast model
  - Heel effect
- Good agreement with system AGD
- Doses in 1 view DBT are almost double of doses in 1 view FFDM
Acknowledgement

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