Estimation of Adipose Compartment Volumes in CT Images of a Mastectomy Specimen


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INTRODUCTION

Virtual clinical trials (VCTs) based upon the computer simulation of breast anatomy, imaging, and image analysis, represent a viable preclinical alternative to the conventional clinical trials. Realistic simulation urges for the measurements of breast anthropometrics from real clinical breast images [1].

PURPOSE

Anatomical measurements of the breast tissue size and distribution of adipose compartments from High Resolution CT slices of a mastectomy specimen.

CT ACQUISITION & RECONSTRUCTION

- A total mastectomy specimen was imaged on a whole body, multi-slice CT system (Siemens Sensation 64) using the following parameters:
  
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition Time</td>
<td>72.318 s</td>
</tr>
<tr>
<td>Body Part Examined</td>
<td>Chest</td>
</tr>
<tr>
<td>Slice Thickness</td>
<td>0.6 mm</td>
</tr>
<tr>
<td>Tube Potential</td>
<td>120 kVp</td>
</tr>
<tr>
<td>Tube Current</td>
<td>400 mAs</td>
</tr>
<tr>
<td>Exposure Time</td>
<td>1000 ms</td>
</tr>
<tr>
<td>Focal Spot Size</td>
<td>1.2 mm</td>
</tr>
<tr>
<td>Reconstruction Diameter</td>
<td>500 mm</td>
</tr>
<tr>
<td>Gantry/Tilt</td>
<td>0</td>
</tr>
<tr>
<td>ROI Size</td>
<td>(0.72x0.72) mm</td>
</tr>
<tr>
<td>Distance from Source to Detector</td>
<td>1040 mm</td>
</tr>
<tr>
<td>Distance from Patient</td>
<td>570 mm</td>
</tr>
<tr>
<td>Number of Reconstructed Slice</td>
<td>619 (each of 512x512 pixels)</td>
</tr>
</tbody>
</table>

MASTECTOMY SPECIMEN CT SLICES

- CT slices were imported in ITK-SNAP software [2].
- 306 slices were analyzed; remaining slices did contain no tissue or had poor quality.
- Curve-based contrast adjustment was performed and slices were viewed in sequence for better understanding of the compartments in consecutive slices.
- Each compartment spanned in multiple slices.
- There were some compartments, clearly distinguishable from neighbors.

ADIPOSE COMPARTMENT SEGMENTATION

- The compartments were identified and then segmented from each slice manually with the boundary marking.
- 205 most discernible compartments were segmented from 619 input slices.
- The segmented compartments spanned 4082 slices, approx. 20 on average.
- The average estimated volume was 0.91 cm³ ± 0.87.
- Selection bias and small path sample may have caused high variance in volume data.

RESULTS: TIME VS. VOLUME

- Average time spent for segmenting a compartment was 8.75 minutes.
- The estimated volume was correlated to the segmentation time (p < 0.001).
- Standard deviation of residuals tends to increase with volume indicating heteroscedasticity.

RESULTS: DISTRIBUTION OF VOLUME

- Distribution of volume was not normal; rather left-skewed.
- Kolmogorov-Smirnov test, Lilliefors test, Jarque-Bera test, and visual cdf comparison (between empirical and standard) rejected the hypothesis of the normality of volume data.

RESULTS: CONFIDENCE VS. VOLUME

- Per slice segmentation confidence level was assigned in the scale of 5 (1-5).
- The average confidence for 205 segmented compartments was 3.88.
- The confidence level was assigned based upon operator’s visibility rather than the size of a compartment.

RESULTS: CONFIDENCE VS. VOLUME

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REFERENCES


ACKNOWLEDGEMENT

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View of C1 slices in sagittal plane

Axial plane view of slices

Slice views in coronal plane

Segmentation marked slices in axial, sagittal and coronal planes

3-D visualizations of segmented compartments

Scatter plot of segmentation time Vs. volume

Histogram of estimated compartment volumes (cm³)

QQ plot of sample volume data and standard normal

Histogram of average confidence level (1-5)

Histogram of estimated compartment volumes (cm³)

Confidence level Vs. estimated volume

Volumes of the segmented adipose compartments (cm³)

Avg. confidence level of compartments (1-5)