Anatomic measurement accuracy: CT parameters and 3D rendering effects

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INTRODUCTION

• Measurements from 3D-CT rendering are used in research and clinical management (treatment planning, patient monitoring, oncology, and diagnostic aid/efficiency)

• Measurement accuracy has been documented for *linear measurements*, but not *volume* or *surface area*

• How do image acquisition parameters affect measurements?
Purpose:

- Confirm **linear measurement** accuracy
- Investigate accuracy of **volume** and **surface area**
- Assess effect of 3D-CT image resolution on measurements
- Evaluate effect of 3D-CT rendering techniques on measurements
METHODS

Scanned:

- 3 human mandibles
- a phantom object
Independent Variables:

CT Scanner Parameters:
1. Reconstruction Algorithm (Boneplus, Soft, Standard)
2. Slice Thickness (1.25mm, 2.5mm)
3. FOV (16x16cm, 18x18cm, 29.9x29.9cm)

3D Rendering Techniques: (Next Slide)
3D Rendering Techniques:

1. **Volume Render**

   → Restricting Density →

**Surface-Shaded Display:**

2. Automatically Segmented &
3. Manually Defined
• **Linear Measurements** (8 linear, 2 angular) were based on landmarks common to published literature

![Linear Measurements Diagram]

• **Volume** & **Regional Surface Area** Measurements

![Volume and Surface Area Measurements Diagram]

• **Measurements:** *Computer models vs. Anatomic Truth*
RESULTS:

1. Linear

2. Volume

3. Surface Area
RESULTS: Linear Measurements

Mandible 1: Two-Dimensional Distance Measurements
RESULTS: Linear Measurements

- Linear measurements from 3D-CT are accurate.
- Linear accuracy is **not** sensitive to the CT scanning parameters or rendering techniques.

### Linear Measurements Table

<table>
<thead>
<tr>
<th>Object</th>
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<th>Reconstruction Alg.</th>
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* Denotes a group of "acceptable" measurements satisfying ARE ≤ 0.05
RESULTS: Volume Measurements

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• Only 1.25mm Slice Thickness for the Mandibles produced accurate group of volumes
• HOWEVER, all but one of the phantom object parameters produced accurate volumes
• Therefore, we looked further into the effect of slice thickness
## RESULTS: Volume Measurements

### Mandible Volumes Separated by Slice Thickness

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1. Models from 1.25mm original data = (7/9) groups within 0.05 ARE and remaining two approach threshold.

2. Models of 2.5mm slice thickness = NO groups achieve 0.05 ARE.
RESULTS: Volume Measurements

(*) = group not statistically different from anatomic truth

Increase slice thickness = groups of measurements stray farther from anatomic truth
To Summarize:

- Volume measurement accuracy is optimal from **thin slices** (1.25mm)

- Volume measurements from thin slices are **not sensitive** to CT scanning parameters or 3D rendering techniques

*THIN (1.25mm) vs. THICK (2.5mm)*
Surface Area Measurements
Separated by Rendering Mode Algorithm

Surface Area Measurements

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Surface area measurements are not accurate.
• All measurements were 25-45% inflated.

Volume Render = Slice Summation

Surface ROI = Stair-Stepping
CONCLUSIONS

1. **Linear Measurements**: *ACCURATE*
   - NOT sensitive to scanning parameters or rendering techniques

2. **Volume**: *THIN slices MOST ACCURATE*
   - NOT sensitive to scanning parameters or rendering techniques

3. **Surface Area**: *NOT ACCURATE*
   - Inflated Measurements
Potential applications:

- Characterization and grading of bone fractures
- 3D-CT alongside 2D images helps increase rate of successful diagnoses

✓ Vocal Tract Development Lab subject scans can be used for researching:
  - Speech production
  - Biological basis of development
  - Developmental Disorders

Orthopedic treatment and Surgical implants
References:


QUESTIONS?

Process of Volume Render Segmentation:

Acknowledgements

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