3D Modeling of Thin and Thick-section CT: A Comparative Analysis

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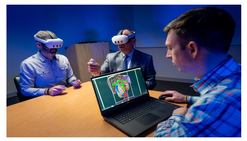
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Background

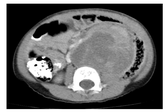
- Within surgical oncology, CT-based virtual 3D modeling can be applied to:

Surgical Planning



Family Education

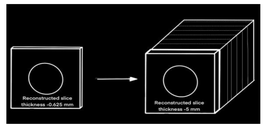






- CT images are initially acquired in thin-sections but they are often reconstructed into thick-sections for clinical use

Thin vs. Thick CT



Thin section images	Thick section images
• **More accurate** • Not always availability	• **Less accurate** • Available everywhere

- The routine use of thick-section CT imaging presents an opportunity to make 3D modeling more accessible, provided its limitations and capabilities are well understood.

Objectives

- Investigate the feasibility of 3D modeling from standard thick section reconstructed CT images
- Identify the anatomic information lost when using standard images for 3D modeling compared to thin-section data

Methods

Segmentation and Model Creation





Thick model

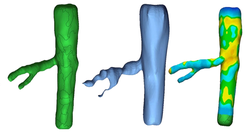
Thin model

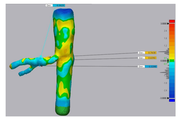
Slicer 5.6.2 App

- To minimize bias from prior anatomical knowledge, models were first created from thick-section CT images, as thin-section scans were expected to reveal more detailed anatomical information.

Deviation Analysis

Geomagic Control X



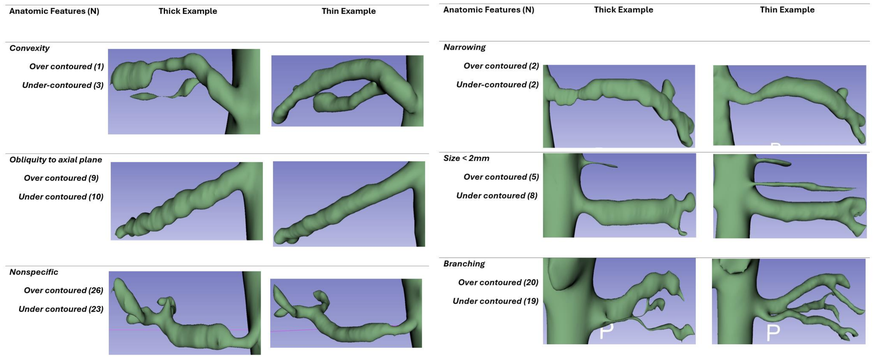


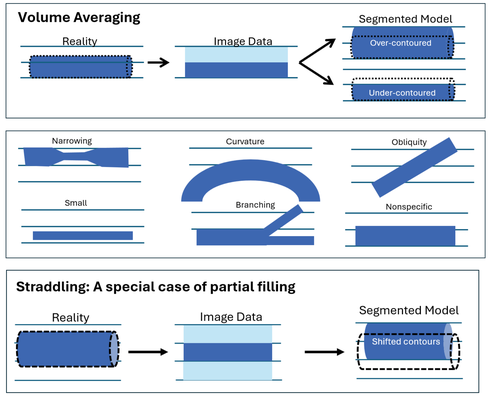
The maximum deviations of the thick models relative to the thin models were recorded, with positive deviations indicating over-contouring and negative deviations indicating under-contouring. The anatomical locations of each deviation were also documented and described.

Results

- Models from main renal arteries and veins were done utilizing thin and thick section images, resulting in 80 models (40 comparisons)
- Seven accessory renal arteries were identified on thin-section images, and five on thick sections
- Two accessory veins were modeled on thin- section images, one on thick
- The mean maximum deviation for arteries was 1.02 mm (over contoured) and 0.9 mm (under contoured)
- The mean maximum deviation for veins was 1.2 (over contoured) and 1.1 (under contoured)
- To assess the potential contributors to modeling inaccuracies, the anatomical feature corresponding to each maximum deviation was identified. Features observed included narrowing, size less than 2 mm, convexity, branching, obliquity to the axial plane, and non-specific findings.

Results: Anatomic Features & Discussion





Modeling from thick-section CTs resulted in both over- and under-contouring, with deviations around 1 mm — often minor, but occasionally significant. Importantly, **small accessory vessels** were sometimes only visualized in thin-section images, highlighting a key limitation of thick-section models. Volume averaging emerged as the primary cause of discrepancies. In thicker voxels, mixed tissue attenuation leads to blurred boundaries, causing either inclusion of non-target tissue (over-contouring) or exclusion of target structures (under-contouring). This effect is especially relevant for small or branching anatomy.

Conclusion

- Volume averaging is a major determinant for model discrepancies
- Segmentation of small vascular structures with thick-section CT image data may lead to inaccuracy in 3D models
- Guidelines are needed to promote awareness and increase consistency of 3D modeling workflows across institutions

Acknowledgments


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Chris Goode, HMBA




James Marmion

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