Novel 3D Modeling and Measurement of the Left Atrial Appendage to Facilitate Watchman™ Device Implantation

Jason Nadeau BS¹, Ernesto Salcedo PhD¹, Adam Hansgen BS², John Carroll MD⁴, S. James Chen PhD²

¹Modern Human Anatomy Program, University of Colorado Anschutz Medical Campus, Aurora, CO, USA
²3D Imaging Lab, Division of Cardiology, School of Medicine, University of Colorado Anschutz Medical Campus, Aurora, CO, USA

Background
- Atrial fibrillation (AF) is one of the most common cardiac arrhythmias.
- AF increases stroke risk nearly fivefold due to clotting of pooled atrial blood.
- Blood clots tend to form in the left atrial appendage (LAA) in AF patients (Figure 1A).
- LAA closure with the Watchman™ Device (WM) is a new method to prevent stroke (Figure 1B).
- LAA size, morphology, and relative position vary widely across patients.
- WM size is assessed by 2D planimetrics on 2D transesophageal echocardiography (TEE) or cardiac computed tomography angiography (CCTA) (Figure 1C,D).
- True 3D LAA measurements based on non-uniform rational b-spline (NURBS) surface models derived from CCTA are now possible (Figure 1E).

Hypothesis: True 3D Measurements of LAA Anatomy from NURBS Models Yield Reciprocal and Accurate Results for Clinical Use

Methods
- Thirteen AF patients with CCTA received WM LAA closure; twelve were implanted successfully.
- NURBS surface models of the LAA and interatrial septum were generated from CCTA (Figures 2-3).
- 3D LAA measurements were made from NURBS surfaces via length and principal analysis of a 3D ostial contour, and distances between area centroids and the LAA lobe (Figure 4).
- 2D LAA measurements were acquired from perioperative TEE reports and saved in 3D.
- WM size was predicted from 2D and 3D ostial diameters for comparison to implanted WM size.
- WM compression and eccentricity index were calculated for comparison to ostium in 2D and 3D.

Results
- 3D maximum ostial diameter was significantly larger and 3D neck depth significantly smaller than corresponding 2D measurements (Figure 5).
- Predicted WM sizes from 2D minimum and 2D mean ostial diameters were significantly smaller than implanted WM by nearly one and two sizes, respectively. All 3D predicted WM sizes were significantly larger than 2D predictions by at least one size (Table 1).
- Implanted WM devices were compressed 6.8% beyond the maximum compression. The LAA ostium was significantly more elliptical than the implanted WM device in 2D and 3D.

Conclusions & Future Directions
- 3D measurement of the LAA offers a new way to evaluate LAA anatomy. Better awareness of unique LAA anatomy will allow for more personalized planning of LAA closure devices and procedures.
- Future work will involve an automated detection of landing zone for the WM device and delivery catheter.

References & Acknowledgements

Table 1. Predicted Watchman™ device sizes from 3D and 2D ostial diameters. Mean±SD. n=11. Diam = diameter; Max = maximum; Min = minimum; Os = ostium; WM = Watchman™.

<table>
<thead>
<tr>
<th>Method</th>
<th>Implant WM Size (mm)</th>
<th>Predicted WM Size from Mean Os Diam (mm)</th>
<th>Predicted WM Size from Max Os Diam (mm)</th>
<th>Predicted WM Size from Min Os Diam (mm)</th>
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<tr>
<td>3D</td>
<td>30.13±4.7</td>
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<td>2D</td>
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<td>35.9±4.2</td>
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