

Virtual Short Axis: A Novel Method for Computing Left Atrial Volumes from Two and Four Chamber MRI

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Target Audience: Cardiologists, cardiovascular physiologists, radiologists, engineers and scientists with research interests in cardiovascular MRI.

Purpose: Accurate quantification of left atrial (LA) volumes throughout the cardiac cycle is important to assess atrio-ventricular coupling. Furthermore, left atrial volumes reflect left ventricular loading conditions. Although the area-length (AL) method¹, which is based on the areas and lengths of the atrium in the four chamber and two chamber views, is frequently used to compute LA volumes, it is based on geometric assumptions and does not take into account unique left atrial remodeling that can occur based on patient characteristics and underlying disease state. The serial short-axis (SSA) method is more accurate, but requires that an additional 6-8 short-axis cine slices be acquired. In this abstract, we present and validate a new method for computing LA volumes from standard four and two chamber views called the virtual short axis (VSA) method. The VSA method computes short-axis LA contours based on the LA contours in four and two chamber views and sums the volumes from these “virtual” short-axis slices to compute a total LA volume.

Methods: 9 normal volunteers between the ages of 19 and 52 underwent cardiac MRI. Slices were taken in the 4-chamber view, 2-chamber view, and 6-8 short-axis views along the LA from the LA apex to ~1.5 cm distal to the mitral annulus. MRI was performed on a Siemens Verio 3T MRI scanner. A retrospectively-gated breath-hold balanced SSFP sequence was used with the following parameters: FOV:360-400mm, 256x128 matrix, 8mm slice thickness, 40° flip angle, TR/TE of 5.4/1.4ms. Contours were manually drawn at end-diastole and end-systole on 2 and 4 chamber views and in all short-axis LA slices and propagated to remaining timeframes using the dual-contour propagation method of Feng, et al.² LA volume-time curves (VTCs) were computed in each study from these contours using three methods: area-length method (AL), serial short-axis method (SSA) and VSA. SSA was considered to be the gold standard.

To validate the VSA method, we tested the hypothesis that the VSA VTCs are closer to the SSA VTCs than the AL VTCs. This was done in two steps. First, volume differences at each time point were computed for the VSA and AL methods versus SSA, VSA-SSA and AL-SSA, and compared them using mixed modeling with compound symmetry covariance structure applied to the differences. Second, we compared the absolute differences |VSA-SSA| and |AL-SSA| using mixed modeling with compound symmetry covariance structure applied to the differences.

Results/Discussion: Figure 1 shows VTCs averaged over the nine volunteers for each of the three methods. Qualitatively, all three VTCs have similar shapes. Table 1 shows the least squares estimates of the mean differences between VTCs computed by the AL and VSA methods relative to SSA. Both the AL and VSA methods were not significantly different from SSA. Table 2 shows the least-squares estimate of difference between the absolute differences |VSA-SSA| and |AL-SSA|. |AL-SSA| was found to be significantly higher than |VSA-SSA|.

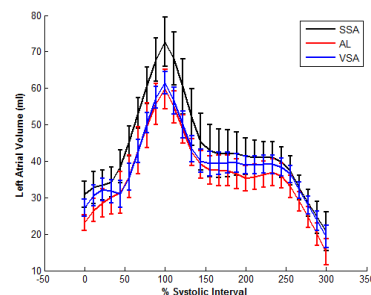


Figure 1: Comparison of VTCs averaged over nine normal human volunteers computed using serial short-axis (SSA), area-length method (AL) and virtual short axis (VSA).

Table 1: Least-squares estimates of the mean difference in ml between VTCs computed using VSA and AL compared to SSA

	Estimate	Standard Error	DF	t Value	Pr > t	Alpha	Lower	Upper
AL-SSA	-5.7	3.8	24	-1.52	0.14	0.05	-13.5	2.1
VSA-SSA	-6.2	3.8	24	-1.66	0.11	0.05	-14.0	1.5

Table 2: Least square estimate of the mean difference in ml between |AL-SSA| and |VSA-SSA| VTCs

	Estimate	Std Error	DF	t Value	Pr > t	Adjustment	Adj P	Alpha	Lower	Upper	Adj Lower	Adj Upper
AL-SSA - VSA-SSA	6.8	0.83	8	8.12	<.0001	Tukey-Kramer	<.0001	0.05	4.8	8.7	4.8	8.7

Conclusion: The virtual short-axis method is an effective method for quantifying LA volumes and yields volumes from standard four and two chamber views that are closer to serial short axis volumes than the area-length method.

References:

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