The Effect of Slice Thickness on Assessment of Atherosclerosis Geometry Measures

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Introduction:

Atherosclerotic disease of the extracranial carotid arteries confers a risk of thromboembolic stroke that is traditionally assessed by lumenal diameter stenosis. Non-invasive cross-sectional MR imaging provides the possibility to evaluate geometric and compositional morphology of this disease. It is therefore now possible to measure features of the plaque such as plaque volume or lumenal cross-sectional area. Most *in vivo* MR methods for assessing atheroma use black blood SE imaging with high in-plane resolution (<0.5mm) but relatively thick slices (> 2mm). This study was conducted to assess the extent to which this reduced resolution affects the assessment of plaque volume. Imaging of intact excised endarterectomy specimens was performed with standard clinical resolution and volume measures were compared to those obtained with ultra-high resolution studies.

Methods:

Six carotid endarderectomy specimens were excised en bloc, and imaged ex vivo in a 1.5T clinical MRI scanner, utilizing a small solenoid radio-frequency coil. High-resolution images were collected using the same sequences as are used in routine imaging of carotid disease *in* vivo, namely: black blood FSE with fat saturation with 0.5mmx0.5mm in-plane resolution and 2 mm slice thickness. T1, T2 and PD images were acquired of 24 slices covering the atheroma. In addition an ultra-high resolution 3D gradient-echo sequence (TR=40 ms, TE=11 ms, flip angle = 25°) image was acquired (0.2mmx0.2mmx0.2mm). For this acquisition, lower resolution images (2mm thick slices) were formed by averaging (Fig. 1). Wall volume and maximum wall area of the plaque were measured. Results were compared in order to study the effect of imaging resolution on wall volume and wall area measurements.

Results:

The assessment of plaque geometric features made using reduced resolution was in good agreement with that made using slices that were substantially thinner. The measured relative mean difference ((low res. minus high res.) ± SD) in wall volume was found to be 1.2% ± 4.4% (n=6). The bias was not statistically significant. At a 95% confidence level, the actual error is less than 1.2% +2 x 4.4% = 10.0%. The relative mean difference (low res. minus high res. ± SD) in maximal wall area was –3.7% ± 4.5% (n=6). This bias is again not statistically significant; at a 95% confidence level, the actual error was less than 3.7% + 2 x 4.5% = 12.7%.

Discussion and Conclusion:

Measurement of atherosclerotic plaque geometry using a slice thickness of 2mm or less, results in a small error in the estimation of wall volume, and a slightly larger error in the assessment of maximal wall area. This good agreement implies that plaque features are relatively smooth over distance of a few millimeters, and that current imaging methods will be able to detect changes in plaque volume that are greater than 10%.

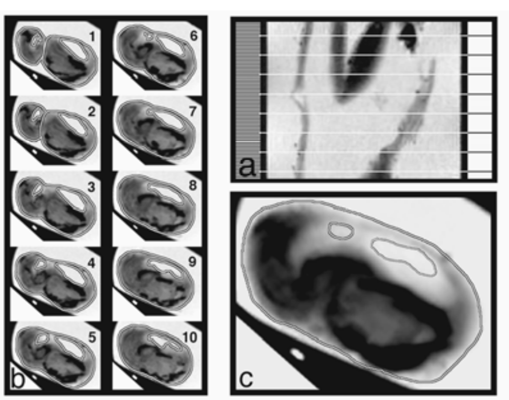

Figure 1. Illustration of slice averaging in bifurcation region. **a**: sagittal view of ex vivo specimen. Illustration of relative size of high and low resolution slices. Slice thickness indicated on the left side is 0.2 mm, on the right side 2 mm. **b**: Transverse view of ten high resolution slices **c**: low resolution transverse slice, formed by averaging over slices 1-10 in Fig. 1b.

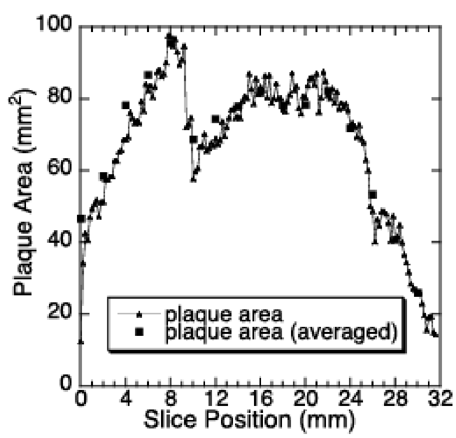

Figure 2. Comparison of high-resolution plaque area and average plaque area in an ex vivo specimen. Measured plaque area is plotted versus slice position.