Are MRI Measurements of Common Carotid Mean Wall Thickness Consistent with B-mode US Measurement of Intima-Media Thickness?

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Introduction

Intima-media thickness (IMT) of the common carotid artery has been shown to correlate with extent of systemic atherosclerosis, myocardial infarction and stroke [1]. Due to the inherently small nature of the subject matter, B-mode ultrasound (US) is currently the only imaging modality with sufficient resolution to identify and measure IMT. However, with the advent of high-resolution MRI, the *in vivo* carotid artery wall and associated plaque are being accurately visualized and quantified [2]. Since both modalities cover a similar segment of the common carotid artery, the possibility of obtaining both local and systemic atherosclerotic disease status using a single imaging modality must be considered. The goal of this work is to determine if the resolution afforded by cross-sectional, black-blood, T1W high-resolution MRI in measuring the common carotid artery mean wall thickness is comparable to measuring common carotid artery IMT by B-mode US.

Methods

32 carotid arteries were selected from patients with 16-79% stenosis by duplex US recruited into the 2-year ORION [3] trial with rosuvastatin (4552IL/0044). All patients underwent examination by high-resolution MRI and B-mode US separated by no more than 4 weeks. The 1.5T MRI examination included acquisition of black-blood, T1-weighted axial images. Acquisition parameters were: TR/TE = 800/9.3 ms, echo train length (ETL) = 8, matrix size = 256x256, slice thickness 2mm, and zero-filled interpolation to 512x512 pixels. 17 arteries were acquired with a field of view (FOV) = 13 cm yielding a pixel size of 0.253 x 0.253 mm, and 15 arteries were acquired with a FOV = 16 cm yielding a pixel size of 0.312 x 0.312 mm. At a distance 0.8-1.4 cm proximal to the bifurcation, the lumen and outer wall boundaries of the common carotid artery were automatically detected (Fig. 1) in a minimum of 2 adjacent slices via a novel technique that utilized a combined active shape model and genetic algorithm to initialize a B-spline snake. The average thickness between these boundaries was computed and declared as mean wall thickness.

B-mode US images were centered 10 mm proximal to the bifurcation and were acquired by an experienced vascular ultrasonographer following a standardized clinical trial imaging protocol. In 3 separate longitudinal planes (anterior, posterior, lateral), IMT was measured along the common carotid artery far-wall over a 10 mm length using an automated program provided by Q-Lab (Philips Medical Systems). The average value across all 3 planes was declared the IMT.

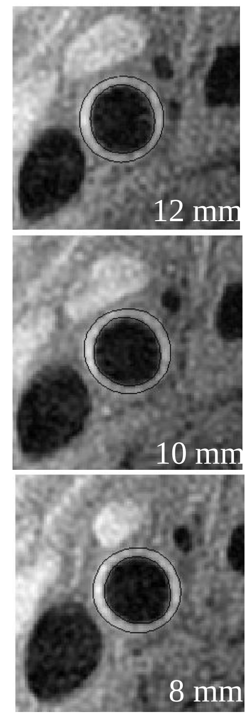


Figure 1

Results

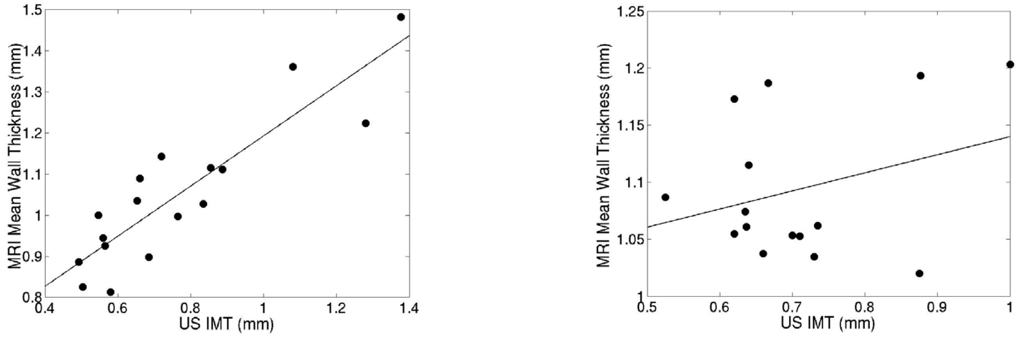
Automated mean wall thickness by MRI was highly correlated with B-mode US IMT (r = 0.89) when FOV = 13 cm was utilized (Fig 2a). When FOV = 16 cm was implemented (Fig 2b), correlation was low (r = 0.31) and mean wall thickness was never less than 1 mm. Mean wall thickness by MRI was larger at all values compared to IMT by B-mode US, which may be due to the inclusion of the adventitia in the MRI measurement.

Conclusion

Amongst individuals with 16 -79% carotid stenosis, MRI measurements of the common carotid artery using a pixel size of 0.253 x 0.253 mm was highly correlated with ultrasound measurement of IMT. Although a FOV = 16 cm provides a greater signal-to-noise ratio (SNR), the subsequent resolution appears insufficient for detection of the subtle difference in wall thickness. Although further evaluation is needed to determine the exact relationship between MRI and US and to assess their comparative reproducibility, automated mean wall thickness by MRI may serve as an alternative to IMT by B-mode US. In patients with black blood, T1W, carotid MRI with pixel size of 0.253 x 0.253 mm, it may be possible to obtain both local and systemic atherosclerotic information. Furthermore, with the improved SNR and resolution available in 3T we may be able to achieve even better results in the future.

References

1. O'Leary et al. *NEJM*. 340:14-22, 1999.
2. Toussaint et al, *Circulation*, 94:932-38, 1996.
3. Chu et al, *Stroke*. 35:2444-48, 2004



(a) (b)

Figure 2. a) FOV = 13 cm, b) FOV = 16 cm