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Arterial wall and plaque layer identification in volumetric MR images to assist non-invasive plaque vulnerability assessment

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Quantitative analysis of volumetric arterial MR images may facilitate non-invasive identification of plaque vulnerability. Automated arterial wall and plaque border detection methods must be developed and validated to realize this potential.

We report a method for automated identification of lumen-intima, intima-media, and media-adventitia borders in high-resolution MR images. A shape model of the vascular cross-section and an intensity model of local border appearance are derived from manually-traced examples of desired borders via machine learning. The three globally optimal wall-layer borders are automatically identified using a graph searching approach.

The method was trained in 18 and applied to 30 separate cross-sectional T2-weighted MR images of excised diseased human iliac arteries imaged at 1.5T, in-plane resolution 0.3 mm, 1 mm thick slices. Vessel wall borders from fully automated computer analysis with no manual corrections were compared to those manually defined by an expert observer. Average signed border positioning errors of the lumen-intima, intima-media, and media-adventitia borders were small: –0.03±0.13 mm, 0.01±0.16 mm, and 0.12±0.13 mm, respectively. Root-mean-square border positioning errors were 0.37±0.08 mm, 0.51±0.09 mm, and 0.51±0.13 mm, respectively. Figure shows an example of observer-defined (left) and computer-determined borders (right). Our results demonstrate that arterial wall and plaque borders can be automatically derived with high accuracy from in vitro volumetric MR images, a pre-requisite for image-based assessment of plaque vulnerability.