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Multi-contrast MRI assessment of Abdominal Aortic Aneurysm (AAA) composition

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Introduction
Rupture risk analysis of abdominal aortic aneurysms requires knowledge of the composition of the AAA vessel wall which is preferably acquired non-invasively. Multi-contrast MRI is a successful method to classify calcium, fibrous tissue and lipid rich tissue in the carotid vessel wall. It is based on combining T1, T2 [1] and diffusion weighted images [2]. In this research the ability of multi-contrast MRI to determine the composition of the AAA vessel wall is studied.

Figure 1: Abdominal Aortic Aneurysm (a) and tissue used for histology and MR (b). The available AAA tissue was divided in two. One half provided the histological coupon, the other was used for MR and CT imaging (c).

Materials & Methods
AAA tissue was obtained from patients treated with conventional repair surgery. To determine its composition histological samples and μCT and multi-contrast MR images of the same specimen were used (Figure 1). Histology is used as a golden standard for tissue classification, but since it is decaferized in the staining process CT is needed for validation of calcified regions in the tissue.

The T1, T2 and diffusion weighted gray values were mapped to the red, green and blue channel respectively to give a color representation of the MR data.

MR imaging was performed with a 3T scanner with a Varian imaging console. The T1, T2 and diffusion weighted images and a μCT scan were made at the position depicted in figure 1c. K-means clustering is used for image analysis (figure 4).

Figure 2: Color representation of the MR data

Figure 3: The μCT image with tissue contour indicated in red (a) and the histological image where yellow is collagen, red is fibrin or muscle, blue is mucin and black is elastin (b)

Results
The calcified region in the μCT-image agrees with the signal void expected at the calcified region in the MR images. The regions that can be distinguished by color in the RGB representation of the MR data are classified as different clusters. The fibrin and collagen areas are distinguished in the clustered image. The densely packed area and the loosely packed area of muscle cells appear different in MR (yellow, orange, figure 4, clustered image).

Figure 4: Flowchart of k-means clustering algorithm. MR data is converted to a 3D feature space and k-means clustering is applied resulting in an image in which each pixel is assigned to one of 6 clusters.

Discussion
The differences between areas in the color representative of the MR data show that multi contrast MRI can be used for classification of the tissue. The clustering algorithm results are satisfying, but only tested for one sample. Reproducibility needs to be shown. The clustered images show good agreement with histology, so multi-contrast MR is a promising tool in characterisation of AAA tissue.

References: