Contrast MRA segmentation to predict surgical outcome after AVF creation

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Clinical problem
An arteriovenous fistula (AVF) is a surgical connection between an artery and vein utilized in hemodialysis. The AVF is typically constructed in the lower or upper arm. In 30% AVF creation is hampered by flow related complications [1]. The required arm inflow for hemodialysis is between 500 and 1500 ml/min. We promote predictive medicine, by developing a patient-specific 1D modeling framework based on MRI images, that simulates the hemodynamic effect of surgical AVF creation.

Pilot results

For 6 patients the framework confirms the surgeon, for 2 patients decision making might improve.

1) MRI protocol
Eight patients were scanned with a two-station 1.5T Contrast Enhanced MRA. Flow was measured in the aorta and in three arm arteries.

2) Patient-specific data extraction

Image Segmentation
The vessel centerline and contour were automatically extracted (Figure 1), after manual specification of the segmentation starting point. Vessel area was determined perpendicular to the local centerline, by a Full-Width at Half Maximum algorithm [2].

3) Boundary conditions
The measured MR flows were used to specify aortic input and to calibrate the outflow through peripheral vasculature.

4) Virtual surgery
Using an interactive interface, the artery is connected to a vein, hereby creating an AVF.

5) One-dimensional model
Pressures and flows are simulated, using the 1D wave propagation model as described in [3].

6) Interactive visualization
Results of several configurations can be explored by the vascular surgeon.


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