Blood flow assessment in cerebral arteries with 4D flow magnetic resonance imaging
An automatic atlas-based approach

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Akademisk avhandling

som med vederbörligt tillstånd av Rektor vid Umeå universitet för avläggande av teknologidoktorsexamen framläggs till offentligt försvar i Betula, Norrlands Universitetssjukhus fredagen den 25 maj, kl. 13:00.
Avhandlingen kommer att försvaras på svenska.

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The labeling accuracy on group level was between 96% and 87% for all studies, and close to 100% for ICA and BA. Short arteries (PCoA) and arteries with large individual anatomical variation (VA) were the most challenging. Blood flow measurements at automatically identified locations were highly correlated ($r=0.99$) with manually positioned measurements, and difference in mean flow was negligible. Both global and local thresholding out-performed k-means clustering, since the threshold value could be optimized to produce a mean difference of zero compared to reference. The local thresholding had the best concordance with the reference method ($p=0.009$, F-test) and was the only method that did not have a significant correlation between flow difference and flow rate. In summary, with a local threshold of 20%, ICC was 0.97 and the flow rate difference was $-0.04 \pm 15.1\text{ ml/min}$, n=308.

**Conclusion:** This thesis work demonstrated that atlas-based labeling was suitable for identification of cerebral arteries, enabling automated processing and flow assessment in 4D flow MRI. Furthermore, the proposed flow rate quantification algorithm reduced some of the most important shortcomings associated with previous methods. This new platform for automatic 4D flow MRI data analysis fills a gap needed for efficient in vivo investigations of arterial blood flow distribution to the entire vascular tree of the brain, and should have important applications to practical use in neurological diseases.