

Advancements in DSC and BOLD Perfusion imaging

Acquisition, analysis and clinical application

Akademisk avhandling

Som för avläggande av medicine doktorsexamen vid Sahlgrenska akademien, Göteborgs universitet kommer att offentligen försvaras i Hörsal Arvid Carlsson, Academicum, Medicinargatan 3, torsdagen den 23 november, klockan 13.00

av

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Fakultetsopponent:

Docent Irene Klærke Mikkelsen

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Avhandlingen baseras på följande delarbeten

- I. **Effects of bolus injection duration on perfusion estimates in dynamic CT and dynamic susceptibility contrast MRI**
Jonathan Arvidsson, Göran Starck, Kerstin Lagerstrand, Doerthe Ziegelitz and Oscar Jalnefjord
Magnetic Resonance Materials in Physics, Biology and Medicine 2022 36:95-106
- II. **MRI diffusion and perfusion alterations in the mesencephalon and pons as markers of disease and symptom reversibility in idiopathic normal pressure hydrocephalus**
Simon Agerskov, **Jonathan Arvidsson**, Doerthe Ziegelitz, Kerstin Lagerstrand, Göran Starck, Isabella Björkman-Burtscher, Carsten Wikkelsö and Mats Tullberg
PLOS ONE 2020 15(10):1-13
- III. **Arterial occlusion duration affects the cuff-induced hyperemic response in skeletal muscle BOLD perfusion imaging as shown in young healthy subjects**
Jonathan Arvidsson, Stefanie Eriksson, Edvin Johansson and Kerstin Lagerstrand
Magnetic Resonance Materials in Physics, Biology and Medicine 2023
- IV. **Exploring the dynamics of ischemia and reactive hyperemia with skeletal muscle BOLD imaging in patients with peripheral artery disease, age matched controls and young healthy subjects**
Jonathan Arvidsson, Stefanie Eriksson, Oscar Jalnefjord, Edvin Johansson, Joakim Nordanstig and Kerstin Lagerstrand
Manuscript

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Abstract

This thesis is focused on perfusion MRI techniques and topics related to image acquisition, analysis and clinical applications. The first half of the thesis is focused on dynamic susceptibility contrast (DSC) MRI, a technique which is based on the contrast enhancements caused by an intravenously administered paramagnetic contrast agent. The second half of this thesis is focused on blood oxygen level dependent (BOLD) MRI, which leverages a signal effect caused by paramagnetic properties of venous blood. For application in peripheral muscle, this signal effect can be enhanced by restricting the blood flow of a feeding artery to the studied tissue. In papers I and III, it is shown that the duration of the contrast agent injection and the duration of the flow restriction, indeed affects the measures of perfusion produced with these techniques. The pathophysiology of normal pressure hydrocephalus (iNPH) is not completely understood, but symptoms point toward brain stem regions. In paper II, DSC-MRI and diffusion MRI was applied to patients with iNPH, pre and post shunt-surgery, showing the possible involvement of these regions in iNPH symptoms and disease reversibility.

In paper IV peripheral muscle BOLD was applied to patients with peripheral artery disease (PAD) and controls, in an exploratory study. Perfusion related measures derived from acquired BOLD curves were able to separate between PAD patients and controls, in accordance with previous studies. Further data exploration found a number of curve traits that could be indicative of potential disease phenotypes, and these have now been documented. As the technique continues to develop towards individual prognostication, these curve traits may be of value for establishing disease severity.

In conclusion, this work has made advancements of the common knowledge base within the field of perfusion imaging, spanning from the well-studied area of DSC-MRI to the comparatively new technique of peripheral muscle BOLD imaging and their application to clinically relevant patient cohorts.

Keywords: MRI, CBF, CBV, TTP, biophysical modelling, signal representation

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