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Ultrasound imaging of blood flow changes following spinal cord injury

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Traumatic spinal cord injury (tSCI) causes an almost complete loss of blood flow in the injury center as well as hypo perfusion of adjacent tissue (penumbra), resulting in secondary cell death over-time. The disruption of blood vessels and subsequent haemorrhage and edema after tSCI leads to an increase in intraspinal pressure (ISP) and a growing zone of ischemia and secondary injury in tissue adjacent to the primary contusion. A biomarker to identify ischemic changes in spinal cord tissue could help guide and assess neuro-protective treatment strategies for tSCI and potentially other situations. Intraoperative ultrasound imaging of the spinal cord enables the leveraging of the most recent advances. Using these advances, we have recently developed ultrafast contrast-enhanced ultrasound (CEUS) Doppler imaging of blood flow, which enables the segmentation and investigation of micro vascular flow (<30 mm/sec) not previously possible. Ultrafast plane wave acquisitions (>30,000 frames/second) and Doppler processing with microbubbles enables segmentation of blood flow in the entire vascular tree by velocity, providing access to the distribution of velocities at each level of flow. This combination of ultrafast imaging and nonlinear pulsing sequences enables for the first time the investigation of microvascular hemodynamics. This approach has been used to investigate hemodynamic changes in a rodent contusion tSCI model, where it was found the extent of hypoperfused spinal cord tissue correlates significantly to injury severity and functional outcome. Motivated by these observations, we seek to develop an early ultrasound-based non-invasive real-time biomarker of microvascular hemodynamics for tSCI and other applications.

Recent publications:

Matthew Bruce, Dane De Wees, Jonah Harmon, Lindsay Cates, Zin Z. Khaing, Christoph P. Hofstetter, Blood Flow Changes Associated with Spinal Cord Injury Assessed by Non-linear Doppler Contrast-Enhanced Ultrasound, Ultrasound in Medicine & Biology, Volume 48, Issue 8, 2022, ISSN 0301-5629 https://doi.org/10.1016/j.ultrasmedbio.2022.03.004.

Biography

Matthew F. Bruce received his Ph.D. degree in bioengineering from the University of Washington, Seattle, WA, USA. He previously worked for Philips Medical Systems, Bothell, WA, USA, and Supersonic Imagine, Aix-en-Provence, France. He is currently with the Applied Physics Laboratory, University of Washington. His interests include clinical and pre-clinical ultrasound imaging of tissue and blood flow.

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