Noninvasive Noncontact Speckle Contrast Diffuse Correlation Tomography of Cerebral Blood Flow in Rats

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Abstracts will be considered for both poster and platform presentations

Disease biomarkers

Cerebral blood flow (CBF) is tightly coupled with neural activities and instantly regulated to meet brain metabolic demands. Technologies capable of noninvasively imaging CBF in both animals and humans are critically needed for translational studies of cerebral diseases, which are often associated with regional cerebral ischemia and hypoxia. In contrast to large imaging modalities such as CT, MRI and PET, optical instruments are fast, continuous, inexpensive, and portable. The goal of this study is to adapt and optimize a novel, noninvasive, noncontact, near-infrared speckle contrast diffuse correlation tomography (scDCT) technique developed in our laboratory for continuous and longitudinal imaging of CBF variations in rats. The noncontact scDCT probe was setup above the heads of adult Sprague-Dawley rats for continuous imaging of CBF distributions. The performance of the optimized scDCT system was tested for continuous 3D imaging of CBF variations in rats during CO2 inhalations (increasing CBF) and during ipsilateral and bilateral transient ligations of carotid arteries (reducing CBF). We observed significant CBF increases (1.20 ± 0.07, n = 9, assigning the baseline as “1”) during CO2 inhalations (10%CO2/90%O2) and significant CBF decreases [0.37 ± 0.10 (ipsilateral), 0.31 ± 0.12 (bilateral), n = 8] during transient ligations. The capability of scDCT for longitudinal monitoring was tested in a rat undergoing ipsilateral main common cerebral artery occlusion (MCAO) over a long period of 14 days. Significant CBF decreases were observed during MCAO [0.28 ± 0.05 (ipsilateral), 0.63 ± 0.04 (contralateral)]. CBF was then gradually recovered towards its baseline over the recovery period of two weeks after stroke. In addition, we found that the 3D imaging significantly reduced the partial volume effect from the top layer tissues (scalp and skull). To the best of our knowledge, we report the first noncontact 3D tomographic system that enables continuous and longitudinal 3D imaging of CBF distributions in rat’s brain through the intact scalp and skull. Furthermore, the scDCT allows for probing depths up to ~10 mm, which is sufficient for transcranial brain measurements in mice, rats, and human neonates, who have relatively thinner skulls. Thus, ultimately we expect to provide a unique cerebral monitoring tool for both basic neuroscience research in numerous academic/industrial laboratories and translational clinical applications in Neonatal Intensive Care Units.