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Simultaneous Imaging of Cortical Partial Oxygen Pressure and Anatomic Structures Using a Transparent Optical Sensor Foil

Jan Warnat[1], Gregor Liebsch[2], Eva-Maria Stoerr[1], Alexander Brawanski[1], and Chris Woertgen[1]
[1]Department of Neurosurgery, University of Regensburg, Germany
[2]Biocam, Regensburg, Germany

Abstract:

Background/Purpose: Reliable information of cerebral oxygenation is – besides the monitoring of the intracranial pressure – of eminent interest when treating patients with brain injuries. In this study, we introduce a new, fast, and sensitive method capable of determining the cortical partial pressure on the surface of the cortex using a special sensor foil.
Methods: The introduced method exploits the O_2-dependent phosphorescence of a thin sensor foil, which is excited by a short light-emitting diode flash. The optical signal is registered by a charge-coupled device camera and analyzed with PC-based software. The adequacy of this method was tested in 10 animals. The sensor device was placed directly over the cortex after craniotomy and removal of the dura. Arterial oxygen pressure was systematically varied by modifying the ventilation gas mixture. A total of 225 measurements were performed within 4 regions of interest.
Results: Obtained results were sufficient in each case. The pO_2 over the cortex correlated well with arterial pO_2. Measurements over arteries showed a correlation coefficient of 0.72 ($P < 0.001$), over veins 0.58 ($P < 0.001$), and in a larger region of interest containing vessels and cortical tissue 0.59 ($P < 0.001$). The frequency of the measurements was 7 Hz with a single measurement covering an area of 30 x 30 µm.
Conclusion: For the first time, nearly online pO_2 maps of a brain cortex can be generated, allowing simultaneously also separate measurements over distinct anatomic structures yielding a good spatial resolution.

Key-words: brain, oxygenation, $p_{ti}O_2$, partial pressure, time-resolved luminescence imaging