Noninvasive Continuous Imaging of Reduced Cerebral Perfusion with a Novel Diffuse Optical Tomography System: A Carotid Artery Occlusion Study in Pig

Chandran V. Seshagiri, Tanmayi Oruganti, and Bertan Hallacoglu

Introduction

Diffuse optical tomography (DOT) systems have demonstrated the ability to *non-invasively* measure changes in oxy- and deoxy- hemoglobin concentrations in brain tissue. Cephalogics has introduced a novel, compact DOT system that may help clinicians monitor changes in brain perfusion and oxygenation following injuries such as ischemic stroke, vasospasm, or traumatic brain injury. In this study, we tested the ability of the DOT device to track changes following irreversible occlusion of the internal carotid arteries (ICAs) of a pig.

Methods

A 41kg Yorkshire pig was anesthetized (isoflurane) and prepared for surgery. The pig was placed in a supine position; Cephalogics DOT sensor array was positioned under the pig's cranium; the array was secured using an elastic bandage wrap. Catheters were inserted into the femoral artery and advanced into both left and right ICAs just proximal to the retia mirabilia.

Following a 15-minute baseline DOT recording, surgical glue was injected into both ICAs occluding the primary blood supply to the brain. DOT recording continued for 30 minutes following the occlusion, which was confirmed angiographically.

DOT optical data were recorded to a laptop and images of the change in StO_2 were reconstructed every 1 minute. We compared mean ($\pm$SD) StO_2 across the entire imaged field (StO_2-A) with the mean ($\pm$SD) StO_2 in a regional area (StO_2-R) associated with the pig's brain.

Results

Comparing StO_2 estimates pre- and post-occlusion, StO_2-A showed a modest decrease while StO_2-R decreased more significantly ($-3\% \pm 7\%$ vs. $-15\% \pm 2\%$).

Conclusions

Despite the thickness of the pig's skull we captured a significant drop in StO_2 following complete, irreversible occlusion of both ICAs. Due to the small size of the pig brain, the imaging field of the DOT sensor array includes both cerebral and non-cerebral tissue. The DOT images show a larger drop in StO_2 in regions likely to reflect cerebral tissue.