Brain Tissue Oxygen Tension and Its Response to Physiological Manipulations is Dependent on Distance from Injury Site in a Swine Model of Traumatic Brain Injury

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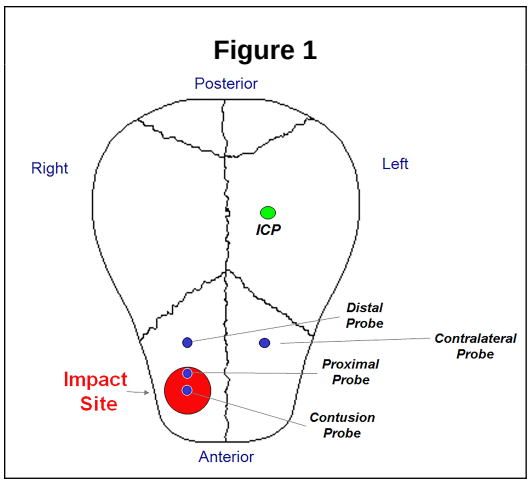
Introduction

The optimal site for placement of tissue oxygen probes following traumatic brain injury (TBI) remains unresolved. We studied brain tissue oxygen tension (PbtO2) at the sites of contusion, proximal and distal to contusion, and in the contralateral hemisphere to determine the effect of probe location on PbtO2 and to assess the effects of physiological interventions on PbtO2 at these different sites.

Figure 1



Methods

A controlled cortical impact (CCI) device was used to generate a focal lesion in the right frontal lobe in 12 anaesthetized swine. PbtO2 was measured using Licox brain tissue oxygen probes placed at the site of contusion, in peri-contusional tissue (proximal probe), in the right parietal region (distal probe), and in the contralateral hemisphere. PbtO2 was measured during normoxia, hyperoxia, hypoventilation, and hyperventilation.

Figure 2

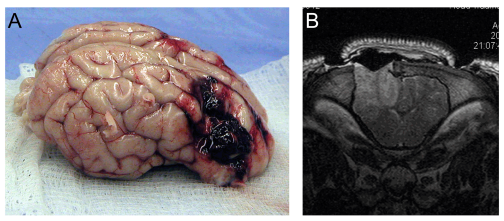


Figure 4

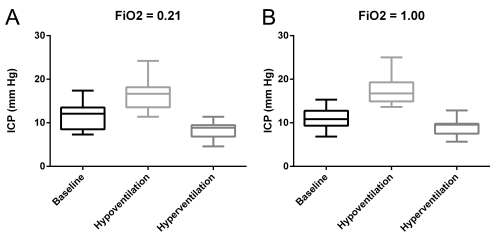
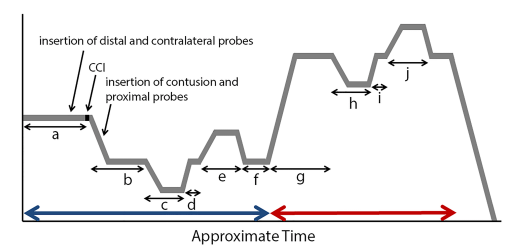


Figure 3



Results

Physiological interventions led to expected changes, including a large increase in PaO2 with hyperoxia, increased ICP with hypoventilation, and decreased ICP with hyperventilation. Importantly, at both normoxia and hyperoxia PbtO2 decreased substantially with proximity to the focal injury (contusion and proximal probes), and this difference was maintained at different levels of FiO2 and PaCO2. In the distal and contralateral probes, hypoventilation and hyperventilation were associated with expected raised and decreased PbtO2 values, respectively. However, in the contusion and proximal probes these effects were diminished, consistent with loss of cerebrovascular CO2 reactivity at and near the injury site. Similarly, hyperoxia led to the expected rise in PbtO2 only in the distal and contralateral probes, with little or no effect in the proximal and contusion probes, respectively.

Figure 5

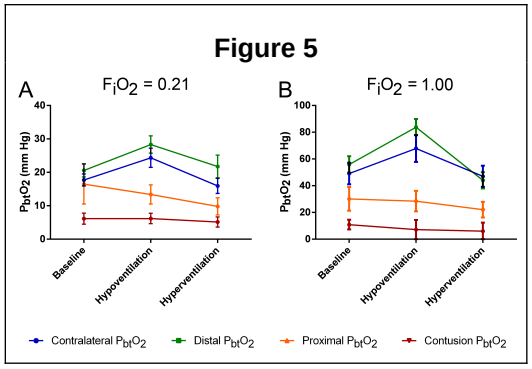
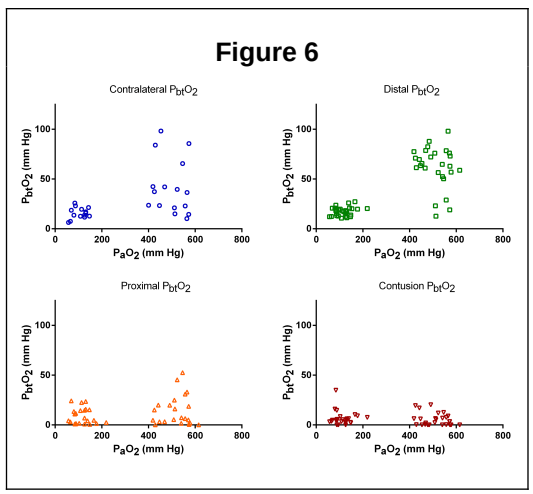


Figure 6



Conclusions

PbtO2 measurements are strongly influenced by the distance from the site of focal injury. Physiological alterations, including hyperoxia, hyperventilation, and hypoventilation substantially affect PbtO2 values distal to the site of injury, but have little effect in and around the site of contusion.