SPATIOTEMPORAL PROPAGATION OF CEREBRAL HEMODYNAMICS DURING AND AFTER RESUSCITATION FROM CARDIAC ARREST

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Cardiac arrest (CA) affects over 500,000 people in the United States. Although resuscitation efforts have improved, poor neurological outcome is the leading cause of morbidity in CA survivors, and only 8.3% of out-of-hospital CA survivors have good neurological recovery. Therefore, a detailed understanding of the brain before, during, and after CA and resuscitation is critical. We have previously shown, in a preclinical model of asphyxial CA, that measurement of cerebral blood flow (CBF) is essential to better understand what happens to the brain during CA and resuscitation. We have shown that CBF data can be used to predict the time when brain electrical activity resumes. Moreover, we have described CBF characteristics after resuscitation, including the hyperemic peak and stabilized hypoperfusion. Overall, our previous work focused on the study of the temporal evolution of CBF dynamics. To provide a more complete picture of CBF dynamics associated with CA and resuscitation, we postulate that both the temporal and spatial evolution of CBF dynamics must be understood. To investigate spatiotemporal dynamics, we used laser speckle imaging (LSI) to image rats (n = 6) that underwent either 5- or 7-min asphyxial CA, followed by cardiopulmonary resuscitation (CPR) until return of spontaneous circulation (ROSC). During induction of global cerebral ischemia through CA, we have observed two periods during which a decrease in CBF propagates in space in a cranial window over the right hemisphere. The first period of time is during CA and the second is after the hyperemic peak, before stabilized hypoperfusion occurs post-ROSC. Figure 1 shows a representative rat blood flow maps of the spatial propagation during CA (top row) and after ROSC (bottom row). For each row, the leftmost image shows CBF at t = 0min, and each subsequent image to the right is the time after the initial image. The arrows on the images represent the propagation direction in which CBF decreases. In this example, during CA, the propagation direction is down and to the left (posterior-medial anatomically), while after ROSC it is down and to the right (posterior-laterally, anatomically).

We postulate that study of spatiotemporal dynamics in a global cerebral ischemia model may lead to important insight into our understanding of cerebral function during and after resuscitation from CA, which may provide clinicians with knowledge that can lead to improvements in neurological outcome. Furthermore, future experiments that can elucidate the mechanism behind the spatiotemporal propagation may provide insights into cerebral injury following CA.

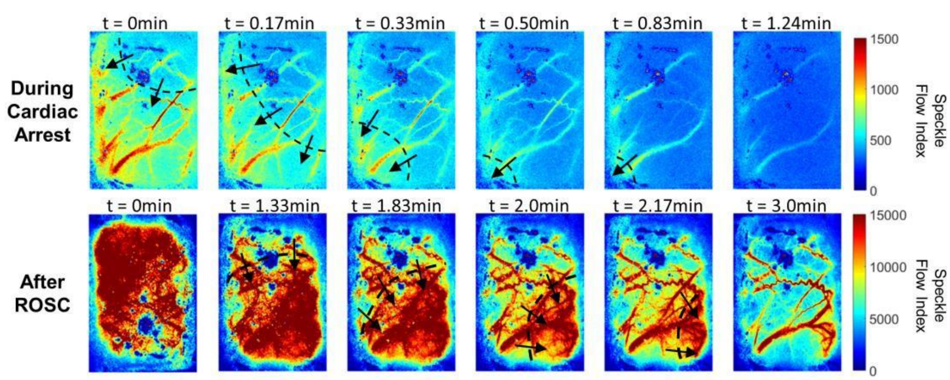

Figure 1 – Visualization of spatiotemporal propagation during CA (top row) and after ROSC (bottom row) in a representative rat. During CA decrease in CBF propagates down and to the left, while after CA the decrease in CBF propagates down and to the right.