Monitoring Microvascular Blood Flow During Hemorrhage and Resuscitation

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Introduction

Microvascular blood flow is critical to survival. Organismal survival depends on tissue survival which depends on cell survival. Cell survival depends on delivery of O2 and nutrients to cells. Delivery to cells depends on microvascular blood flow (arterioles, capillaries, venules). Clinically, macrovascular cardiovascular indicators are monitored (blood pressure, heart rate, cardiac output). Microvascular blood flow is not.

Technology now exists allowing real time microvascular blood flow imaging without dye or radioactive labeling. Microvascular blood flow is often not indicated by macrovascular variables.

We are investigating the use of orthogonal polarization spectral imaging (OPSI) based microvascular blood flow monitoring in a hemorrhage and resuscitation study. We recorded imagery from a non-invasively accessible site (sublingual surface) and an invasively accessible site (jejunal mucosa). If real time microvascular blood flow can be reliably imaged, this technology may eventually become clinically useful.

Methods

8 anesthetized (bispectral infusion, cecal vein), ventilated (end-tidal PCO2 30-35 mmHg for arterial PCO2 35-40 mmHg at baseline), instrumented, purpose bred hound dogs subjected to pressure titrated severe hemorrhage, low-pressure stabilization, and resuscitation protocol.

Results

Mean Arterial Pressure (MAP), Heart Rate (HR), Cardiac Output (CO), & Carotid Flow (CF) in each group (macrovascular cardiovascular indicators).

Motion and focus issues were prevalent. Microvascular flow and/or vessel density was decreased by hemorrhage, generally most difficult to clearly assess during low-pressure stabilization, and increased during resuscitation.

Discussion

- Microvascular blood flow responses can be monitored.
- Motion and focus issues can be prevalent.
- Motion and focus issues dramatically increase the amount of prep time required before any retrospective video analysis can be carried out.
- Sublingual microvascular flow assessment looks like it will be feasible at all time points from which a video segment without motion and focus issues can be obtained.
- Even putting aside motion and focus issues, jejunal villi microvascular flow assessment looks like it is going to be quite difficult when there is no hemorrhage. This is because sufficient red cell density exists in the villus vessels at early time points that the vessels appear as solid dark structures, making it quite difficult to determine if the contained red cell mass is flowing or not.
- Both sublingual and jejunal villi microvascular vessel density, however, appear likely to be assessable at all time points.

References


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