Dramatic change in cerebral oximetry during liver transplantation

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ABSTRACT

We report dramatic changes in bilateral cerebral tissue oxygenation in a patient undergoing an orthotopic liver transplant coincident with clamping and subsequent restoration of flow through the inferior vena cava. Although hemodynamic stability was maintained with low-dose vasopressor support, cardiac output was decreased, suggesting preload dependence of the measured cerebral oxygenation. Further investigation is warranted in patients with end-stage liver disease and interruption of venous return.

KEYWORDS Cerebral oximetry; cerebral tissue oxygenation; end-stage liver disease; liver transplantation

CASE REPORT

A 58-year-old woman presented for orthotopic liver transplant for nonalcoholic steatohepatitis with hepatocellular carcinoma. Comorbidities included obesity (body mass index 39 kg/m²), hypertension, hyperlipidemia, type 2 diabetes mellitus, diastolic ventricular dysfunction with thrombocytopenia, and deranged coagulation parameters.

Cerebral oximetry (FORE-SIGHT, CasMed, Branford, CT) was used in anticipation of hemodynamic perturbations during the procedure. Initial hemodynamic parameters were stable with a derived cardiac index (CI) of 3.6 to 4.1 L/min/m² and stroke volume variation (SVV) of 7% measured by an arterial catheter (FloTrac, Edwards Lifesciences Corp., Irvine, CA). Bilateral regional cerebral saturation (rSO₂) was 80% to 90%, slightly higher than readings anticipated given the vasodilatory state associated with end-stage liver disease.

A low-dose norepinephrine infusion (0.05 mcg/kg/min) was initiated prior to total occlusion of the inferior vena cava (IVC) at the start of the anhepatic phase. Despite preservation of the blood pressure, as expected, CI decreased (1.7 L/min/m²) and SVV increased (11%) with incremental improvements during the 49-minute clamping (CI 2.9 L/min/m², SVV 7% to 10%). We were surprised to find a *dramatic reduction* in bilateral cerebral oxygenation (<60% with >32% decline) coincident with IVC cross-clamping that did not respond to fluid or hemodynamic manipulations with a stable hematocrit (Figure 1). There were no changes in arterial oxygenation; rSO₂ only returned to baseline after restoration of IVC blood

flow, and in the absence of other changes, we conclude that the decrease in CI led to the changes in cerebral oxygenation.

The immediate perioperative and postoperative course was uneventful without evidence of neurological compromise.

DISCUSSION

Near-infrared measurement of cerebral tissue oxygen saturation uses transillumination at light wavelengths that are absorbed by hemoglobin (730 and 810 nm) incorporating signals from both venous weighted and arterial blood.¹ Data from cardiovascular procedures suggest that an absolute rSO₂ <50% to 60% or >20% to 25% decline from baseline is cause for concern and intervention.² A recent report summarizes small, nonhomogenous studies of near-infrared spectroscopy for frontal lobe oxygenation during liver transplantation, identifying impaired cerebral autoregulation, cerebral deoxygenation during the anhepatic phase, and cerebral hyperoxygenation with graft reperfusion.³

This current article confirms the dramatic effect of surgical interruption of IVC blood return on cerebral deoxygenation because both the absolute value and relative change exceeded commonly used thresholds in cardiac surgical patients.² Of significance, standard maneuvers to preserve hematocrit, oxygenation, and systemic perfusion did not reverse the cerebral deoxygenation, as has been demonstrated in high-risk cardiac surgical patients,⁴ and we did not observe cerebral hyperoxygenation upon reperfusion.

Our finding differs from several prior reports. One study prior to anesthetic induction in patients scheduled for liver transplantation suggested that elevated bilirubin levels may be related to decreased rSO₂ values,⁵ which contrasts with our

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Figure 1. Dramatic decrease in bilateral hemispheric cerebral oxygenation with application of inferior vena cava clamp and restoration after clamp release at reperfusion.

elevated baseline readings. In another preliminary study, rSO_2 was low (49% to 55%) throughout the procedure and was not different between the dissection, anhepatic, and reperfusion phases of liver transplantation,⁶ also in contrast to our finding.

This case report of a dramatic decrease in rSO_2 suggests that findings in patients with end-stage liver disease and clinical implications remain inconsistent. Until further prospective data are available, monitoring of cerebral oxygenation in this critically ill cohort may be useful to alert anesthesiologists to dramatic or unanticipated changes and to consider optimization of parameters described for the cardiac surgical population.

1. Murkin JM, Arango M. Near-infrared spectroscopy as an index of brain and tissue oxygenation. *Br J Anaesth*. 2009;103:i3–i13. doi:10.1093/bja/aep299.

2. Ghosh A, Elwell C, Smith M. Cerebral near-infrared spectroscopy in adults: a work in progress. *Anesth Analg*. 2012;115:1373–1383. doi:10.1213/ANE.0b013e31826dd6a6.
3. Sorensen H, Grocott HP, Secher NH. Near infrared spectroscopy for frontal lobe oxygenation during non-vascular abdominal surgery. *Clin Physiol Funct Imaging*. 2016;36:427–435. doi:10.1111/cpf.12244.
4. Deschamps A, Hall R, Grocott H, et al. Cerebral oximetry monitoring to maintain normal cerebral oxygen saturation during high-risk cardiac surgery: a randomized controlled feasibility trial. *Anesthesiology*. 2016;124:826–836. doi:10.1097/ALN.0000000000001029.
5. Song JG, Jeong SM, Shin WJ, et al. Laboratory variables associated with low near-infrared cerebral oxygen saturation in icteric patients before liver transplantation surgery. *Anesth Analg*. 2011;112:1347–1352. doi:10.1213/ANE.0b013e318214b2b0.
6. Zheng Y, Villamayor AJ, Merritt W, et al. Continuous cerebral blood flow autoregulation monitoring in patients undergoing liver transplantation. *Neurocrit Care*. 2012;17:77–84. doi:10.1007/s12028-012-9721-1.