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Decreased Cerebral Tissue Oxygen Saturation during Aortic Surgery Increases Risk of Post-Operative Complications

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Introduction: Currently only limited information exists exploring the relationship between brain oxygenation levels during aortic surgery and post-operative outcomes (1). The FORE-SIGHT® (CAS Medical Systems, Branford CT USA) cerebral oximeter measures absolute cerebral tissue oxygen saturation (SctO₂) values. We hypothesized that a relationship exists between decreased intraoperative SctO₂ values and post-operative complications following aortic surgery.

Methods: With IRB approval and informed consent, patients undergoing elective thoracic aortic surgery with deep hypothermic circulatory arrest (DHCA) were monitored intraoperatively using the FORE-SIGHT. Two sensors were placed on the subject's forehead bilaterally with SctO₂ values recorded every 2 seconds starting after induction of anesthesia until the end of surgery. SctO₂ minutes and the area above the curve (AAC) spent beneath the absolute threshold limits of 50, 55, 58, 60, & 65% were computed for both left & right sensors. Complications were categorized as "major" (death, stroke, depressed LV function, respiratory failure, sepsis, delirium, renal failure, GI complications, or severe volume overload) and "minor" (atrial fibrillation, minor volume overload, phlebitis, or none). Post-operative complications, Extubation time, ICU length of stay, and Hospital length of stay (HLOS) data were collected and compared to SctO₂ data and DHCA time.

Results: Demographics: 30 subjects; Gender 22M/8F; Race 25W/1AA/3HS/1IN; Post-induction SctO₂ was 70.6% (SD 5.1). SctO₂<60% (minutes & AUC), SctO₂<58% (minutes), and DHCA minutes were significantly associated with Extubation time and ICU LOS ($p<0.05$ two-tailed, Spearman). Major complications significantly correlated ($p<0.05$ two-tailed, Spearman) to Extubation time (median: 3 days vs 1 day for subjects with major complication) and HLOS (median: 13 days vs 7.5 days). Logistic regression odds ratio analysis showed that for every increment of 30 minutes below a SctO₂ threshold, the risk for major complications increased 2.1 times for SctO₂<60% and 3.7 times for SctO₂<55% (Table 1). Similar results were found for AAC of SctO₂ thresholds with 50 minute-% increments. Also for every 5 minutes of DHCA, the risk of major complications increased 1.6 times.

Discussion: Despite the low number of subjects enrolled in this study, decreased SctO₂ values and prolonged DHCA times were found to be associated with major complications, prolonged extubation times, and ICU/Hospital LOS. This study suggests that prolonged intraoperative periods of time with SctO₂<60% correlate significantly with an increased risk of having major complications and an increased LOS.

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1) Reich et al, Eur J Cardiothorac Surg. 2004 Mar;25(3):401-6.

Table 1 Brain hemisphere with lower SctO2	Minor or No Complication (n=14)	Major Complication (n=16)	Odds ratio unit	Odds ratio* (95% CI)	p-value of odds ratio*
	Median (IQR)	Median (IQR)			
SctO2 < 60% (minutes)	2.3 (0- 25.4)	59.3 (3.9-128.5)	30 minutes	2.11 (1.18, 5.16)	<0.01
SctO2 < 58% (minutes)	1.6 (0 - 14.3)	34.9 (0.8 - 94.7)		2.58 (1.18, 8.32)	<0.01
SctO2 < 55% (minutes)	0.45 (0 - 9.5)	10.9 (0 - 54.8)		3.71 (1.04, 33.78)	0.03
SctO2 < 50% (minutes)	0 (0 - 0.21)	0 (0 - 13.7)		219.20 (1.03, >999)	0.04
SctO2 < 60% (AUC)	8.1 (0 - 115.1)	200.8 (5.4- 648.8)	50 minutes- %	1.61 (1.05, 3.00)	0.01
SctO2 < 58% (AUC)	4.1 (0 - 72.1)	101.7 (1.7- 420.6)		2.01 (1.04, 5.81)	0.02
SctO2 < 55% (AUC)	0.55 (0 - 18.8)	15.9 (0 - 195.2)		3.22 (1.01, 36.60)	0.04
SctO2 < 50% (AUC)	0 (0 - 0.57)	0 (0 - 41.9)		>999 (0, >999)	0.02
DHCA duration (minutes)	21.0 (18.8 - 23.8)	26.5 (20.0 - 33.75)	5 minutes	1.92 (1.05, 4.13)	0.03