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SOCIETY FOR NEUROSCIENCE IN ANESTHESIOLOGY AND CRITICAL CARE

ARTICLE OF THE MONTH

Shoulder Surgery in the Beach Chair Position is Associated with Diminished Cerebral Autoregulation but No Differences in Postoperative Cognition or Brain Injury Biomarker Levels Compared with Supine Positioning: The Anesthesia Patient Safety Foundation Beach Chair Study

Laflam A, Joshi B, Brady K, Yenokyan G, Brown C, Everett A, Selnes O, McFarland E, Hogue CW. *Anesth Analg.* 2015 Jan;120(1):176-85. doi:10.1213/ANE.0000000000000455.

In this installment of the SNACC Article of the Month, we address the important patient safety issue of cerebral desaturation and the risk of neurologic injury associated with anesthesia and surgery in the “beach chair” position for shoulder surgery. The beach chair position allows better surgical visualization compared to lateral decubitus position but may be associated with catastrophic neurologic complications, including stroke, spinal cord ischemia, and transient visual loss. The mechanism of neurologic injury in the beach chair position is unknown, but anesthesiologists often debate the gravitational effects of head elevation on cerebral perfusion and consequently, the need to correct the blood pressure measured at the arm or the leg to estimate the perfusion pressure at the level of the brain. The Anesthesia Patient Safety Foundation (APSF) has funded investigation in this field, which led to the article by Laflam et al. To shed more light on this subject and this article, we have enlisted the expertise of Deepak Sharma, MD, DM, who is the Chief of Neuroanesthesiology & Perioperative Neurosciences at the University of Washington, Seattle, Washington and currently chairs the Education Committee of SNACC. We hope you will find this article, and Dr. Sharma’s commentary, enlightening and ask you to share your thoughts by signing on to the ***SNACC LinkedIn Feed***.

~John F. Bebawy, MD

Commentary

Deepak Sharma MBBS, MD, DM
Professor & Chief of Neuroanesthesiology and Perioperative Neurosciences
University of Washington, Seattle, Washington

Significant concerns have been raised in the recent years about the potential risk of the rare but devastating neurologic complications including stroke with shoulder surgery in the beach chair position. While the exact mechanism of neurological damage with surgery in upright position remains unclear, it is speculated that inadequate cerebral perfusion may be contributory. In order to avoid cerebral ischemia, clinicians often correct the

blood pressure measured at the arm or the leg to estimate the pressure at the level of the brain, but it is unclear if non-invasive blood pressure or estimated temporal mean arterial pressure are reliable for identifying a cerebral desaturation event in the beach chair position. Consequently, there is increasing interest in monitoring adequacy of cerebral perfusion intraoperatively.

In their prospective, observational study, Andrew Laflam et al. [*Anesth Analg.* 2015 Jan;120(1):176-85] hypothesized that the patients in the beach chair position have diminished cerebral autoregulation than those who undergo surgery in the lateral decubitus position. They also examined the relationship between patient positioning during surgery and postoperative cognition and serum brain injury biomarker levels. Briefly, the investigators monitored regional cerebral oxygenation (rSO_2) with Near Infra Red Spectroscopy (NIRS) in patients undergoing shoulder surgery in the beach chair (n=109) or lateral decubitus position (n=109) to calculate the variable cerebral oximetry index (COx) - a continuous, moving Pearson correlation coefficient between mean arterial pressure (MAP, measured by a continuous, non-invasive, finger plethysmographic monitor) and rSO_2. The COx approaches 0 when the MAP is within the range of cerebral autoregulation and the COx is higher when the MAP is below the lower limit of autoregulation. Values of COx obtained throughout surgery were averaged for each patient. The patients received routine institutional perioperative care that included combined regional (interscalene brachial plexus block) and general anesthesia. The patients undergoing surgery in the beach chair position were older and were more likely to have hypertension than those who underwent surgery in the horizontal position; the surgical procedures differed between the groups (more arthoplasties in beach chair versus more rotator cuff repairs in horizontal position); and patients in the beach chair position were more likely to receive phenylephrine, ephedrine, and/or metoprolol. The average blood pressure during surgery was higher but estimated blood pressure at the tragus was lower in the beach chair group. Despite these differences, after adjusting for age and history of hypertension, the investigators found the COx to be significantly higher (indicating diminished autoregulation) and rSO_2 significantly lower in the beach chair position compared to the lateral decubitus position.

Based on these data, it could be argued that under anesthesia in beach chair position, the blood pressure may actually need to be maintained higher than the horizontal position. However, more importantly, their results show that although none of the patients suffered a clinical stroke, irrespective of the position, a large number of patients (65% in lateral position and 75% in beach chair position) had intraoperative blood pressure below their respective lower limit of autoregulation at some point. Also of note is the finding that the average MAP at the lower limit of cerebral autoregulation was 65 mmHg and 70 mmHg in lateral and beach chair positions, respectively, questioning the generally accepted lower limits of autoregulation, which are somewhat lower. This finding is consistent with the author's prior studies in patients undergoing cardiac surgery where a wide range of MAP at the lower limit of autoregulation has been reported. Yet another important observation was that the lower limit of autoregulation under anesthesia was difficult to predict based on preoperative blood pressure measurements suggesting that empirically determining individual perioperative blood pressure targets may not guarantee maintenance of the blood pressure within the autoregulatory range. The study obviously provides new insight into the physiology of cerebral oxygenation in upright position, but at the same time, also suffers from some important limitations. First and most importantly, the authors provide no CO_2 data, which are critical to examine the impact of relative CO_2 values on the cerebral blood flow and rSO_2. In the absence of data demonstrating comparable CO_2 values in the two surgical positions, it is difficult to confidently ascertain that the sole factor impacting rSO_2 and hence, COx, was, in fact, the position. Further lacking are the data demonstrating comparable end-tidal anesthetic gas concentrations / MAC values between the two groups, which can effect cerebral blood flow in a dose dependent manner. Finally, it is unclear whether the more frequent use / higher doses of phenylephrine in the beach chair group contributed to the lower rSO_2.

Not withstanding the above limitations, the investigators examined cognitive outcomes and biomarkers of neurological injury. Since the incidence of clinical strokes is low and hence, difficult to study, they evaluated the patients at screening, on postoperative day seven to ten and one month after surgery with the National Institutes of Health Stroke Scale and with a battery of psychometric tests comprising tests of verbal learning and memory, visual memory, executive functions, psychomotor speed, attention control and fine motor dexterity. Cognitive scores were combined into a composite cognitive outcome based on Z-score. The biomarkers investigated were serum S100β, neuron-specific enolase, and glial fibrillary acidic protein, which were measured at baseline, after surgery, and on postoperative day one. Despite the fact that the study was not powered to examine the differences in cognitive outcomes or biomarkers; the investigators found no difference in Z-score seven-ten days or four-six weeks after surgery between the two surgical positions as well as no difference in serum biomarker levels between the two positions.

Previous studies have shown that the beach chair position is associated with approximately 10% decrease in rSO_2 in anesthetized patients, which is reversible after repositioning.[Closhen D, et al. J Neurosurg Anesthesiol. 2013 Oct;25(4):414-9] However, awake subjects do not experience a decrease in rSO_2 in the same position nor do anesthetized patients in supine position, indicating that the vasodilation by anesthetics in combination with the beach chair position contributes to the drop in rSO_2. Despite the fact that the transient intra-operative cerebral desaturation events have not been shown to be associated with either postoperative cognitive dysfunction or levels of biomarkers of neuronal injury, and the degree and duration of cerebral ischemia required to produce neurocognitive dysfunction in this patient population remains undefined; the results of Laflam et al. suggest the need for strict hemodynamic management with higher blood pressure in upright position.