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Original Contribution

Middle cerebral artery blood flow velocity during beach chair position for shoulder surgery under general anesthesia

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Abstract
Objectives: The goal of the present study was to examine changes of middle cerebral artery (V_{MCA}) blood flow velocity in patients scheduled for shoulder surgery in beach chair position.
Design: Prospective observational study.
Setting: Operating room, shoulder surgery.
Patients: Fifty-three consecutive patients scheduled for shoulder surgery in beach chair position.
Interventions: Transcranial Doppler performed after induction of general anesthesia (baseline), after beach chair positioning (BC1), during surgery 20 minutes (BC2), and after back to supine position before stopping anesthesia (supine).
Measurements: Mean arterial pressure (MAP), end-tidal CO_2, and volatile anesthetic concentration and V_{MCA} were recorded at baseline, BC1, BC2, and supine. Postoperative neurologic complications were searched.
Main Results: Beach chair position induced decrease in MAP (baseline: 73 ± 10 mm Hg vs lower MAP recorded: 61 ± 10 mm Hg; $P < .0001$) requiring vasopressors and fluid challenge in 44 patients (83%). There was a significant decrease in V_{MCA} after beach chair positioning (BC1: 33 ± 10 cm/s vs baseline: 39 ± 14 cm/s; $P = .001$). The V_{MCA} at baseline (39 ± 2 cm/s), BC2 (35 ± 14 cm/s), and supine (39 ± 14 cm/s) were not different. The minimal alveolar concentration of volatile anesthetics, end-tidal CO_2, SpO_2, and MAP were not different at baseline, BC1, BC2, and supine.
Conclusion: Beach chair position resulted in transient decrease in MAP requiring fluid challenge and vasopressors and a moderate decrease in V_{MCA}.

1. Introduction

Beach chair position offers several advantages for shoulder surgery, but it also carries hemodynamic challenge for the anesthesiologist and risks of neurologic complication

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for the patient [1,2]. Several case reports highlighted the risk of severe neurologic injuries occurring in otherwise healthy patients [3-5]. At the present time, the incidence of neurologic complications after shoulder surgery in the beach chair position remains unknown, and it is likely that these complications are significantly underreported.

In awake healthy volunteers, upright position increases systemic vascular resistance and systemic blood pressure through sympathetic nervous system activation [6]. However, hemodynamic control in the sitting position is challenging in anesthetized patients in whom baroreflex is altered. Furthermore, chronic antihypertensive treatments have been shown to increase the risk of severe hypotension [7]. Adverse neurologic events reported after shoulder surgery in beach chair position were mainly attributed to inadequate cerebral perfusion at least in part because of systemic hypotension and gravitational effect of positioning the head above the level of the heart. Thus, monitoring cerebral blood flow and metabolism may be of interest. However, neither measure of cerebral tissue oxygenation ($SctO_2$) using near-infrared spectroscopy nor jugular bulb venous oxygen saturation ($SvjO_2$) have proven clinical relevance in this setting [8,9].

Transcranial Doppler measures cerebral blood flow velocities from the middle cerebral artery (V_{MCA}) which carries 60% to 70% of the ipsilateral carotid artery blood flow. Only 1 study reported the measurement of V_{MCA} during beach chair position in 19 patients [10]. The goal of the present study was to examine the change in V_{MCA} at several predefined time during shoulder surgery in beach chair position.

2. Materials and methods

After approval of local ethic committee (Comité de protection des personnes Nord Ouest III), we conducted a prospective observational study including consecutive patients scheduled for shoulder surgery in beach chair position between September 1, 2008, and September 31, 2009. Because no change in care was planned, local ethics committee allowed for waived written informed consent. Nevertheless, oral informed consent was obtained from all consecutive patients aged older than 18 years included in the study.

Main demographic, medical history, and chronic treatments of the patients were obtained from medical records. Anesthesia was performed by a senior anesthesiologist, and data were recorded by the resident in anesthesiology. After intravenous line placement and monitoring including noninvasive blood pressure (measure repeated every 3 minutes during induction of anesthesia and every 5 minutes during surgery), continuous 5-lead electrocardiography, and peripheral O_2 saturation (SpO_2; IntelliVue MP70 Philips HealthCare, Amsterdam, The Netherlands), a single-shot interscalene block (15-20 mL ropivacaine at 0.33%) was performed. After preoxygenation, anesthesia was performed with propofol (2-2.5 mg/kg) and sufentanil (0.2 μg/kg). The trachea was intubated, and the lungs were mechanically ventilated (Fabius GS, Dräger, France) and respiratory rate adjusted to obtain an end-tidal CO_2 ($EtCO_2$) of 30 to 35 mm Hg. The inspired fraction of O_2 was set at 30%. Ventilation was then kept constant throughout the study. Sevoflurane or desflurane concentration was adjusted to achieve a bispectral index (BIS; Aspect Medical Systems, Newton, MA) between 40 and 50 throughout the anesthesia. End-tidal O_2 and $EtCO_2$ (IntelliVue MP70 Philips HealthCare), BIS, and volatile anesthetics were continuously measured throughout the anesthesia. Esophageal temperature was monitored, and normothermia was maintained with a forced warm air blanket (Bair Hugger 570; Arizant HealthCare, Eden Prairie, MN). Hypotension defined as a decrease in mean arterial pressure (MAP) more than 20% of the preinduction value was treated by intravenous vasopressor (ephedrine or phenylephrine), crystalloid, or colloid administration according to the anesthesiologist in charge of the patient.

A transcranial Doppler 2-MHz probe (Ez-Dop; Compumedics DWL, Singen, Germany) was placed over the temporal window (opposite side of surgery) and the MCA blood flow was identified. Then, the probe position was held through a specific head frame (Marc 600 Headframe; Spencer Technologies, Seattle, WA). The V_{MCA} before induction of anesthesia was not measured because the head frame used to hold the probe must be removed during preoxygenation and airway management. Once stable, the patient was carefully moved in the beach chair position with his head firmly maintained in the neutral position. The V_{MCA} could not be collected continuously because care of the patient during positioning and critical phase of anesthesia involved all health care professionals and because there was no automatic data storage. Consequently, we chose to recorded data at the following predefined time points: (1) anesthetized patient in supine position before beach chair positioning (baseline), (2) after beach chair positioning was secured (BC1), (3) during surgery (20-30 minutes after skin incision; BC2), (4) 3 to 5 minutes after back to supine position before stopping anesthesia (supine). At each heart rate, MAP (blood pressure cuff on the upper arm at heart level), $EtCO_2$, BIS, expired volatile anesthetic concentration, and V_{MCA} were collected by the resident in anesthesiology.

We noted the lowest MAP (data stored in the anesthesia monitor), vasopressors, and fluids administered during beach chair positioning.

At the end of the surgical procedure, the surgeon was ask to evaluate intraarticular visualization using a visual analog scale from 0 (very bad visualization) to 10 (excellent visualization). Early postoperative neurologic complications were recorded during hospital stay (delay in awakening, agitation, abnormalities of the neurological examination).