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Research paper

Effect of blood pressure elevation on cerebral oxygen desaturation in the beach chair position

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ABSTRACT

Objective: The beach chair position (BCP) during shoulder arthroscopy is a known risk factor for cerebral ischemia. We retrospectively investigated whether maintaining the arterial blood pressure (ABP) prevented the decrease in the regional cerebral tissue oxygen saturation (rSO_2).

Methods: We analyzed 20 consecutive patients who underwent elective shoulder surgery in the BCP under general anesthesia. The bilateral rSO_2 was monitored continuously throughout the procedure with the help of near-infrared spectroscopy (INVOS 5100 Cerebral Oximeter, Somanetics Corporation, Troy, MI, USA). Anesthesiologists maintained patient blood pressure while they were in the BCP, which was measured using an ABP transducer placed at the level of the external auditory meatus. We compared rSO_2 measured in the supine position and in the BCP.

Results: Measurement of cortex level mean ABP (mABP) values in the BCP were >50 mmHg and over 60% higher than those noted for the supine position in most patients. Although all bilateral rSO_2 values in the BCP were significantly lower than those in the supine position, the reductions was <20%. Further, 35% (7 of 20) patients that were part of the study experienced cerebral desaturation events at any given point during the procedure. None of the patients experienced clinical postoperative neurological complications.

Conclusions: Although cortex level mABP in the BCP was >50 mmHg, a decrease was recorded in the rSO_2 values. This rSO_2 decrease was proportional to the reduction in the cortex level mABP induced by a postural change to the BCP. Therefore, despite appropriate blood pressure management, shoulder surgery in the BCP might involve certain risks for patients with cerebrovascular diseases.

1. Introduction

The beach chair position (BCP) is commonly used during arthroscopic shoulder surgery.[1] The BCP facilitates the approach to the shoulder joint and improves the arthroscopic visualization.[1] However, this position increases the risk of neurologic complications such as vision loss, spinal cord injury, cerebral infarction, and death.[2,3] It has been reported that a change from the supine position to the BCP under general anesthesia causes a significant decrease in the cardiac output and the mean arterial blood pressure (mABP).[4] Pohl and Cullen reported a case of brain death and three of severe cerebral dysfunction after arthroscopic shoulder surgery in the BCP under general anesthesia.[2] Near-infrared spectroscopy (NIRS) is typically used in the measurement of regional cerebral tissue oxygen saturation (rSO_2).[5] A previous report indicates that despite similar intraoperative hemodynamics, patients having undergone surgery in the BCP are at a higher risk of cerebral desaturation events (CDEs) than patients in the lateral decubitus position.[6] According to the report, blood pressure in BCP patients is overestimated when compared with the actual blood pressure at the level of the brain because it was measured at the brachial artery in both groups. In order to prevent cerebral hypoperfusion and CDEs, previous reports recommend that the blood pressure level measured by a cuff at the upper extremity be maintained at over 80% of its preoperative value. This is because the rSO_2 value depends on cerebral blood flow and oxygen transport.[2,6] The ABP transducer should be placed at the level of the external auditory meatus and not at the level of the heart upon insertion of an invasive percutaneous arterial catheter. Further, anesthesiologists should maintain blood pressure based on the values obtained from

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this level, which reflects the cerebral cortex blood pressure.[2] Our hospital typically aims to maintain the cortex level mABP at above 60 mmHg. The purpose of this study is to investigate whether our targeted mABP would decrease the occurrence of CDEs during the BCP.

2. Methods

The retrospective study protocol was approved by the Institutional Review Board of The Gifu University Hospital. We examined 20 consecutive patients aged 21–82 years who underwent elective shoulder surgery in the BCP under general anesthesia at the Gifu University Hospital, between January 2011 and December 2012. Anesthesia was induced with thiopental or propofol and remifentanil. The administration of rocuronium produced a neuromuscular blockade. The effect of anesthesia was maintained with sevoflurane and remifentanil titrated to bispectral index values between 40 and 60. All patients received orotracheal intubation with an endotracheal tube and mechanical ventilation. The ventilator settings were maintained at 35–45 mmHg $PaCO_2$ and the inhalation oxygen concentration was maintained at 50%. Bilateral forehead rSO_2 was monitored continuously for the length of the surgery using NIRS (INVOS 5100 Cerebral Oximeter, Somanetics Corporation, Troy, MI, USA). A percutaneous arterial catheter was inserted into the non-operative radial artery after anesthesia induction. Patients were positioned in the BCP and the ABP transducer was placed at the level of the external auditory meatus. The target cortex level mABP was set at above 60 mmHg. Both values of the rSO_2 and cortical mABP were extracted at the following time points: (a) the first value was measured in the supine position just before the posture change (baseline indicated as “Pre” in Figure); (b) subsequent measurements were taken after switching to the BCP at 5 min intervals for 90 min; (c) the final measurement was after the return to the supine position at the end of the surgery (indicated as “Supine” in Figure). When the blood pressure decreased, ephedrine, phenylephrine, or fluid infusion was used to maintain mABP. The total amounts of ephedrine or phenylephrine administered during 90 min of the surgery after the posture change to the BCP are shown in Table 1. Based upon a previous report,[7] CDEs are defined as when the rSO_2 values decreased $\geq$20% of the baseline value or when the absolute rSO_2 values were <50%.

We used SPSS 11.0.1 (SPSS Japan, Tokyo, Japan) for the statistical analysis of the data. Each rSO_2 value was compared to the control (Pre) using the paired Student's t-test. Data are expressed as the mean ± standard deviation. P-values < 0.05 were considered statistically significant.

3. Results

No subjects were excluded from this study. Table 1 outlines patient characteristics. The non-invasive mABP was recorded as 91.2 ± 10.8 mmHg in the supine position before anesthesia induction. The mABP immediately prior to the posture change was noted as 73.5 ± 12.5 mmHg (Pre). Post patient positioning in the BCP, the mABP was recorded as 66.8 ± 17.7 mmHg (1 min), 66.9 ± 21.2 mmHg (5 min), 62.2 ± 11.8 mmHg (10 min) and 61.2 ± 9.6 mmHg (90 min). The mABP was found to be 78.7 ± 11.1 mmHg (Supine in Fig. 1A) upon return to the supine position. Regardless of the method used for mABP elevation, all values of cerebral level mABP in the BCP were lower than those noted for the supine position (Pre). Although the target mABP in the BCP was over 60 mmHg, cerebral level mABP recorded for 98.5% of the time points was over 60% of its value in the supine position and was above 50 mmHg in 96.5% of the time points.

Immediately prior to the posture change, the right rSO_2 was recorded as 68.1 ± 10.5% (Pre). Upon positioning in the BCP, the right rSO_2 was measured as 63.7 ± 10.3% (1 min), 62.4 ± 11.1% (5 min), 62.5 ± 11.6% (10 min) and 65.0 ± 8.0% (90 min). Upon return to the supine position, the right rSO_2 reading was recorded as 68.2 ± 7.7% (Supine) (Fig. 1B, open circles). Similarly, the left rSO_2

Table 1
Frequency of cerebral desaturation events and the amount of ephedrine or phenylephrine administration in 90 min in the beach chair position.

Patient number	Age	Sex	PS	Ephedrine (mg)	Phenylephrine (mg)	Frequency of CDEs		Comorbidity (and prescribed drugs)
						Right	Left	
1	62	M	1	27.5	0	0	0	(loxoprofen, teprenone)
2	43	F	1	27.5	0	0	0	
3	53	M	1	5	0	0	0	
4	66	M	2	15	1.65	6	7	HT, LC, gout (glycyrrhizin, UDCA, allopurinol, amlodipine, lornoxicam, lansoprazole)
5	53	M	2	35	2.05	14	3	DM (hydroxyzine, rosuvastatin, sitagliptin, oxatomide, zolpidem)
6	69	F	1	15	0.85	1	0	(alfacalcidol)
7	56	M	1	15	0.96	0	1	
8	72	M	1	20	1.00	0	0	
9	54	F	1	10	1.02	2	2	
10	67	M	2	17.5	0.35	3	2	VSA (amlodipine, diltiazem)
11	51	F	1	15	0.77	0	0	Glaucoma, Meniere's disease
12	21	M	1	5	1.32	0	0	
13	63	M	2	30	0.80	7	9	VSA (diltiazem, rosuvastatin)
14	59	M	1	25	0.59	0	0	
15	32	M	2	7.5	0	0	0	Asthma
16	64	M	2	8.5	0.51	0	0	DM (metformin)
17	74	M	2	7.5	0.48	0	0	Fatty liver (zolpidem, sulpiride, etizolam, lansoprazole, olmesartan, allopurinol, tamsulosin)
18	66	M	2	20	0.23	0	0	HT, COPD (amlodipine, aldioxa, triazolam, etizolam)
19	82	F	1	15	0.71	0	0	(sodium citrate 1 iron, methylcobalamin)
20	61	F	2	5	0.48	0	0	VSA (diltiazem, pravastatin)

Patient characteristics. The doses of ephedrine or phenylephrine administered after the posture change to the BCP during 90 min. Frequency of the CDEs; the number of CDEs among 19 time points after posture change during 90 min.
CDEs: cerebral desaturation events, COPD: chronic obstructive pulmonary disease, DM: diabetes mellitus, F: female, HT: hypertension, LC: liver cirrhosis, M: male, PS: American Society of Anesthesiologists physical status classification, UDCA: ursodeoxycholic acid, and VSA: vasospastic angina pectoris.

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