



Original Contribution

Cerebral oxygenation in the beach chair position before and during general anesthesia in patients with and without cardiovascular risk factors[☆]



Yukiko Mori MD (Staff Anesthesiologist)^a,
Masana Yamada MD, PhD (Staff Anesthesiologist)^b,
Takahiko Akahori MD (Staff Anesthesiologist)^a,
Noboru Hatakeyama MD, PhD (Professor)^c, Mitsuaki Yamazaki MD, PhD (Professor)^d,
Yoshihiro Fujiwara MD, PhD (Professor)^c, Hiroyuki Kinoshita MD, PhD (Professor)^{c,*}

^aDepartment of Anesthesiology, Aichi Medical University School of Medicine, 1-1 Yazako Karimata, Nagakute 480-1195, Japan

^bDepartment of Anesthesiology, Toyama University School of Medicine, 2630 Sugitani, Toyama 930-0194, Japan

^cDepartment of Anesthesiology, Aichi Medical University School of Medicine, 1-1 Yazako Karimata, Nagakute 480-1195, Japan

^dDepartment of Anesthesiology, Toyama University School of Medicine, 2630 Sugitani, Toyama 930-0194, Japan

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Abstract

Study Objectives To evaluate changes in cerebral tissue oxygen index (TOI) values under the beach chair position before and during general anesthesia in surgical patients with or without cardiovascular risk factors.

Design: Prospective study.

Setting: Operating room in the university hospital.

Patients: Ninety-one patients undergoing surgery, including healthy patients (n = 28), patients with 1 cardiovascular risk factor (n = 33), and those with more than 1 risk factor (n = 30).

Interventions and Measurements: Cerebral TOI the day before and during general anesthesia was evaluated using a near-infrared spectroscopy NIRO-200 (Hamamatsu Photonics, Hamamatsu, Japan) for each patient. The initial TOI measurement in the supine position after a 10-minute rest or 10 minute after the endotracheal intubation was followed by measurements in 30° and subsequent 60° upright position for 5 minutes. Phenylephrine 0.1 mg and/or ephedrine 4 mg was administered intravenously to maintain mean blood pressure above 60 mm Hg accordingly.

Main Results: The beach chair position decreased mean arterial blood pressure and heart rate under general anesthesia, although patients with more than 1 cardiovascular risk factor needed significantly more phenylephrine doses to maintain mean blood pressure above 60 mm Hg. Values of TOI were within the normal range of about 70% before and during anesthesia in all groups.

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* Corresponding author at: Department of Anesthesiology, Aichi Medical University, School of Medicine, 1-1 Yazako Karimata, Nagakute 480-1195, Japan. Tel.: +81 561 62 3311; fax: +81 561 63 6621.

E-mail address: hkinoshi@aichi-med-u.ac.jp (H. Kinoshita).

Conclusions: The beach chair position under general anesthesia did not alter cerebral oxygenation in patients with or without cardiovascular risk factors showing normal preoperative cerebral TOI values when the mean blood pressure was maintained above 60 mm Hg. The careful management using the cerebral oxygenation monitoring appears to maintain cerebral perfusion in the beach chair position during general anesthesia.

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1. Introduction

The beach chair position reportedly provides good surgical condition for surgeons in arthroscopic shoulder surgery [1]. However, a possible decrease in cerebral oxygenation related to this position has been suggested by many previous reports, although exact mechanisms of the catastrophic complication remain to be determined [2–4].

Near-infrared spectroscopy is one of the methodologies for noninvasive and continuous evaluation of cerebral oxygenation, which reflects the balance between cerebral metabolic supply and demand [5]. Near-infrared spectroscopy demonstrates similar accuracy regarding the detection of cerebral ischemia to transcranial Doppler sonography or stump pressure measurements [6]. More importantly, the cerebral tissue oxygen index (TOI) is probably most reliable in parameters derived from cerebral near-infrared spectroscopy because the tissue hemoglobin concentration, skull thickness, and the area of the cerebrospinal fluid layer do not affect TOI values [7]. Our previous study demonstrated that the beach chair position under general anesthesia did not alter cerebral TOI values in patients showing normal preoperative TOI values, whereas this preliminary study did not determine differences of cerebral TOI values between patients with and without cardiovascular risk factors [8]. The combination of cardiovascular risk factors is likely to aggravate the cerebrovascular disease outcome because previous studies demonstrated that each cardiovascular risk factor including hypertension and diabetes mellitus independently contributes to the prevalence of intracranial atherosclerosis and/or brain infarction [9,10].

Therefore, the current study was designed to evaluate changes in cerebral TOI values under the beach chair position before and during general anesthesia in surgical patients with or without cardiovascular risk factors and to examine whether maintenance of mean blood pressure above 60 mm Hg affords appropriate cerebral TOI values under the beach chair position in the population.

2. Materials and methods

After institutional approval, informed consent was obtained from patients undergoing shoulder surgery. Ninety-one patients undergoing shoulder surgery were assigned to the patients without any cardiovascular risk factor (healthy group, $n = 28$), patients with 1 cardiovascular

risk factor (risk factor 1 group, $n = 33$), and those with more than 1 risk factor (risk factor 2 group, $n = 30$). Cardiovascular risk factors in this study contained cardiac diseases including angina pectoris and valvular disease, diabetes mellitus, hypertension, hypercholesterolemia, and smoking. Patients with the history of syncope and/or redness or rash on their forehead were excluded from this study.

2.1. Near-infrared spectroscopy measurement

Cerebral TOI (%) was evaluated using NIRO-200 (Hamamatsu Photonics, Hamamatsu, Japan) with 3 wavelengths of near-infrared light (775, 810, and 850 nm), and the sensor contains a laser diode and 2 detectors placed at 3.7 and 4.3 cm from the source of emitting light [8]. The oximeter probes were put on the bilateral forehead with the caudal border 1 cm above the eyelash for the measurement of the left and right TOI, respectively [8].

2.2. Protocol of measurements

During the measurements, noninvasive blood pressure in the upper limb at the heart level in 1-minute intervals and continuous heart rate by the electrocardiogram in addition to pulse oximetry was monitored [8]. Support stockings were placed on enrolled patients' lower extremities. Twenty-four hours before the induction of general anesthesia, the initial cerebral TOI measurement after 10-minute rest in the supine position was followed by measurements in 30° and subsequent 60° head-up tilt positions for 5 minutes [8]. Hemodynamic changes in response to the 90° head-up tilt under general anesthesia with volatile anesthetics were reportedly stable beyond 5 minutes after the positioning [11,12]. Therefore, the current study determined cerebral TOI as well as cardiovascular parameters 5 minutes after the 30° and subsequent 60° head-up tilt positions. The current study defined abnormal TOI as below 60% at any point [13], but no patient who enrolled in this study showed preoperative abnormal cerebral TOI values.

On the day of surgery, patients were allowed to take clear fluids freely until 6 hours before the induction of anesthesia. After arrival in the operating room, acetate Ringer's solution was administered at a rate of $10 \text{ mL kg}^{-1} \text{ h}^{-1}$ throughout the study period. After application of monitors and preoxygenation, anesthesia was induced with propofol 1.5 mg/kg intravenously (IV), followed by vecuronium 0.1 mg/kg IV. After bag-mask ventilation with a facemask using 3%

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