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Original Contribution

Prone position results in enhanced pressor response to ephedrine compared with supine position during general anesthesia☆

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Abstract

Study Objective: To elucidate and compare the pressor response to ephedrine in the prone or supine position during general anesthesia (GA).

Design: Prospective cohort study.

Setting: Department of General Surgery or Spine Surgery, Zhongda Hospital, Southeast University, Nanjing, China.

Patients: Fifty-six patients who were scheduled to undergo elective surgery in the supine or prone position (n = 28 each) and using a generic GA protocol.

Interventions: During surgery, the patients received intravenous (IV) ephedrine when their systolic blood pressure (SBP) decreased to 90 to 110 mm Hg.

Measurements: Hemodynamic changes were measured at 1-minute intervals for 10 minutes and were compared with baseline.

Main Results: Forty-nine patients (23 in the prone position and 26 in the supine position) completed the study. There were no significant differences between the groups with regard to demographic characteristics, hemodynamic parameters, end-tidal concentration of sevoflurane, and dose of propofol and remifentanil (all $P > .05$). After the bolus injection of ephedrine, a significant increase in SBP was observed in both groups compared to baseline, but the duration and magnitude of the increase in SBP were longer and greater in the prone position than in the supine position. The magnitude of increase of the mean blood pressure was significantly greater in the prone position compared to the supine position at 2 to 7 minutes after ephedrine injection. Ephedrine could cause significant increase in diastolic blood pressure 2 minutes after IV injection, which could last until at least 9 minutes in the prone position group compared to only for 5 minutes in the supine position group (all $P < .05$).

Conclusion: Compared to the supine position, the prone position could augment the pressor response to IV ephedrine during GA. Further studies are recommended to identify its association with other confounding factors such as surgery type or duration, patient history of cardiovascular disease, or patient hydration status.

☆ Conflict of interest: The authors declare that they have no conflict of interest.

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1. Introduction

Hypotension is a frequent and common phenomenon during general anesthesia (GA) [1,2]. Intraoperative hypotension (IOH) has been reported to be independently associated with adverse perioperative outcomes and long-term mortality [3-6]. Immediate correction of IOH is of great importance for anesthetized patients because IOH might play a role in the development of postoperative ischemic stroke [3,6,7]. Fluctuation in intraoperative blood pressure (BP) is associated with 30-day mortality in patients undergoing aortocoronary bypass surgery [8]. Maintaining BP at a normal level, decreasing the fluctuation in intraoperative BP, and shortening the duration of IOH should decrease the incidence of complications related to inadequate major organ perfusion.

The prone position is used to facilitate surgical procedures to the spine and other neurosurgical procedures. However, the position is associated with a decrease in patient's stroke volume and cardiac index (CI) [9,10]. The decreased cardiac output and other factors including compression of patient's abdomen and thorax can pose a high risk of hypotension in this position. Among all the techniques adopted to correct IOH, vasopressors possess unique characteristics. Ephedrine is 1 of the most frequently used vasoconstrictors for treating IOH related to GA and epidural anesthesia [11,12].

Although some studies suggest that the prone position is accompanied with a higher sympathetic tone than the supine position in conscious subjects [13-15], and although some other studies support different opinions [16,17], there is still no study that compared the role of ephedrine on reversing IOH during GA in these 2 different surgical positions. Hence, a prospective clinical study was designed to elucidate the pressor response to ephedrine in these 2 different body positions during GA.

2. Materials and methods

2.1. Patients, study design, and ethical considerations

Patients (n = 56) who were hospitalized at the departments of general surgery or spine surgery of the Zhongda Hospital, Southeast University (Nanjing, China), and scheduled to undergo elective surgery under GA in the supine or prone position were enrolled in this prospective cohort study. Consecutive patients were enrolled until there were 28 patients in each group. The study protocol was reviewed and approved by the institutional review board of the Southeast University Zhongda Hospital (Nanjing, China). The study was registered at the Chinese Clinical Trial Center (ChiCTR; registration no. ChiCTR-RNRC-13003094; registered on March 7, 2013; principal investigator: Jiangyan Xia). The study was conducted between March and July 2013. Written informed consent was obtained preoperatively from each patient.

2.2. Inclusion and exclusion criteria

Patients who were between 20 and 64 years of age with an American Society of Anesthesiologists physical status classification of I or II were included in the study. Patients with a history of hypertension, cardiovascular disorders, sinus bradycardia, diabetes mellitus, body mass index >30 kg/m^2, or any motor or sensory neurodegenerative disease were excluded. No patient took any medications that might influence body's cardiovascular functions 24 hours preoperatively. Patients did not consume any solid food for 8 hours and liquids for at least 2 hours before entering the operating room.

2.3. Surgical procedure, patient groups, and GA

Surgeries in the supine position mainly included gastrectomy and enterectomy, whereas the procedures in the prone positions were mainly lumbar disc excision and vertebral fusion. Patients were assigned to 1 of the 2 groups according to the type of surgery they had to undergo: supine position (n = 28) or prone position (n = 28). A central venous catheter was inserted into the right internal jugular vein after GA induction and used for fluid supplementation and bolus injection of ephedrine. Lactated Ringer's solution was infused continuously at a rate of 10 mL/kg per hour during the study. The following parameters were monitored and recorded: noninvasive BP monitor, electrocardiogram, pulse oximetry, end-tidal carbon dioxide, body temperature, and urine output. Lead II of the electrocardiogram was continuously monitored throughout the study. Central venous pressure was not measured as part of the study protocol. The protocol for induction and maintenance of GA was identical between the 2 groups. GA was induced with fentanyl (4-5 μg/kg), followed by propofol (2-2.5 mg/kg intravenous [IV]), and endotracheal intubation was facilitated with cisatracurium (0.2 mg/kg IV). Depth of anesthesia (DOA) was maintained with end-tidal concentration of sevoflurane (1%-2.5%) plus propofol (4-6 mg/kg per hour), remifentanyl (5-10 μg/kg per hour), and cisatracurium 0.15 mg/kg per hour. Ventilation was controlled mechanically: tidal volume was set at 8 mL/kg and end-tidal carbon dioxide was kept at 30 to 40 mm Hg by adjusting the frequency of ventilation. Patients in the treatment group were placed in the prone position after endotracheal intubation.

2.4. Administration of ephedrine and measurement of hemodynamic changes

A single-dose bolus injection of ephedrine 0.1 mg/kg was administered to patients through the central venous catheter when their systolic BP (SBP) decreased to 90 to 110 mm Hg. Hemodynamic parameters were measured at 1-minute intervals for 10 minutes after the bolus injection of ephedrine. All BP measurements were performed using an automated BP apparatus during the operation. In all patients, no vasoconstrictors or vasodilators were used before the