Study for the discrepancy of arterial blood pressure in accordance with method, age, body part of measurement during general anesthesia using sevoflurane

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Background: Many pieces of previous research on measuring blood pressure (BP) using different methods focused on the disparity in the results. However, none of them dealt with the disparity caused by the difference in age and inhalation anesthetics. We attempted to find the variance in accordance with age, body part, and measuring methods (invasive vs noninvasive) and also studied how sevoflurane influences BP as the operation progresses.

Methods: In sixty patients, we measured the arterial BP in the upper and lower limbs by noninvasive methods before inducing anesthesia. After induction, we used sevoflurane to maintain anesthesia, and injected catheters into the radial artery and dorsalis pedis artery to measure arterial pressure at every ten minute by both invasive and noninvasive methods.

Results: The patients who were 40 or older showed significantly higher values in the systolic BP than the patients younger than 40. The values of systolic and diastolic BP measured by a noninvasive oscillometric method were meaningfully higher than those measured by an invasive method. As the operations progressed, the lower limbs showed higher systolic pressure than the upper limbs regardless of measuring methods, whereas the opposite is true for diastolic pressure.

Conclusions: The values in the arterial BP were measured high by noninvasive method. Systolic BP were estimated significantly high in the older patients and in the lower leg. Due to the effect of sevoflurane, the diastolic BP in the lower limbs becomes lower than that of upper limbs regardless of measuring methods, as the operation progresses.

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Key Words: Blood pressure, Dorsalis pedis artery, Radial artery, Sevoflurane.
Introduction

Under general anesthesia, hemodynamometry (blood pressure monitoring) is an essential element for monitoring patients. However, the arterial pressure value can vary depending on many factors, such as the measurement method, measuring location, posture, length and diameter of catheter, type of monitor, patient status, and drug dosage [1,2]. Arterial pressure is measured with invasive or non-invasive methods under anesthesia, but in most cases, these 2 methods produce different values due to diverse variables [3]. Comparison of arterial blood pressure by direct or indirect sphygmomanometry has been a topic of study for decades; nevertheless, a conclusion cannot be reached as the targets of measurement of the 2 methods are essentially different [4,5]. In clinical cases, whether both methods of sphygmomanometry are used at the same time or just one, it is important for anesthesiologists, who need to manage patients, to trust the outcome. Thus, it is important for them to consider and have knowledge of patterns of differences between measurement methods, even if they cannot make these comparisons themselves.

Differences in blood pressure according to the location where the measurement is taken are as follows: systolic pressure increases as the measuring location is moved toward the periphery of the body away from the heart; diastolic pressure does not differ. There is also a deformity in the arterial pressure waveform due to peripheral vascular resistance and reflection; this is severe in elderly patients [3,6]. However, not enough reviews have been performed to reach a conclusion on how trustworthy values measured from the lower limbs of elderly patients or of those who suffer from high blood pressure, even though differences in these values compared with non-invasive measurements can influence the addition of a vasopressor or anesthetic. Sevoflurane is a commonly used inhalation anesthetic that decreases autonomic reflection and heart rate variations and lowers systemic vascular resistance [7,8].

Many reports on hemodynamic changes of sevoflurane after induction of anesthesia have been published; yet, there have been no comparative studies of hemodynamometry as the operation progresses. This study aimed to determine how differences in age, measuring location, measurement method, and use of sevoflurane influence blood pressure as an operation progresses by invasively measuring the radial artery and dorsalis pedis artery while simultaneously measuring the blood pressure of the upper and lower limbs using a non-invasive method.

Materials and Methods

This study was approved by the Institutional Review Board and informed consent was obtained from the patients. Sixty patients (35 male and 25 female) aged 20–78 years who were about to undergo operations for facial fracture between January 2009 and December 2009, and who were rated as level 1 or 2 according to the American Society of Anesthesiologists classification, were enrolled. Obese patients with a body mass index (BMI) > 35, and those who suffered from high blood pressure, cardiovascular diseases, or diabetes were excluded.

For premedication, all patients received intramuscular (IM) midazolam 3 mg and glycopyrrolate 0.2 mg half an hour before anesthesia induction. After transferring patients to the operating room, they were attached to standard monitors, such as an electrocardiogram, SpO2 monitor, and a sphygmodynamometer. The patients were given 10 minutes to stabilize before non-invasive arterial pressure from the humerus of both arms and both the lower legs was measured and recorded via 2 monitors (Hewlett Packard-6M1046, 140 Herrenberger strasse, Böblingen, Germany). After a propofol injection, the patients were administered IV 1% lidocaine 4 ml to reduce pain followed by propofol 2 mg/kg to induce unconsciousness. Rocuronium 0.6 mg/kg was then injected to facilitate endotracheal intubation, and vital signs were observed. Patients were kept under anesthesia with sevoflurane at a rate between 1.8 and 2.2 vol%.

After anesthesia induction, to make measurement easier, the upper and lower limbs on the same side as the anesthesiologists were selected for convenience so they could continue to measure arterial pressure by catheterizing a 22 G catheter in the radial artery at the wrist and the dorsalis pedis artery at the instep. Blood pressure cuffs for the upper (humerus) and lower limbs (ankle) were used to simultaneously measure arterial pressure non-invasively. After all preparations, and once hemodynamic changes stabilized, both upper and lower limbs were measured and recorded with invasive and non-invasive methods (T0). Blood pressure was measured 4 times in total (T10, T20, T30, T40), whenever the patient was stabilized in terms of hemodynamics; patients were not touched and the operating table was not moved so as to minimize errors caused by movement or differences in reference point.

Student’s t-test and analysis of variance (ANOVA) were used to compare patients’ systolic and diastolic blood pressure based on gender, age group, and BMI. Since comparisons of blood pressure using invasive and non-invasive methods, and the arterial pressure of the upper and lower limbs, were taken from 1 patient, the results were not independent. Thus, a repeated measures ANOVA was used. We used SPSS (version 14.0 Korea) for all statistical analyses. Every variation is indicated as ± standard deviation. P values < 0.05 were considered statistically significant.

Results

Mean age of patients was 42.5 (range, 20–78 years).