J. Vet. Sci. (2002), 3(3), 203-205

JOURNAL OF
Veterinary
Science

Influence of Isoflurane Anesthesia on Pulsatility Index and Peak Systolic Velocity of Basilar Artery in Dogs by Doppler Ultrasonography

Ki-Chang Lee, Min-Cheol Choi* and Jung-Hee Yoon

College of Veterinary Medicine, Seoul National University Seoul 151-742, Korea

Received July 25, 2002 / Accepted September 2, 2002

Abstract

This study was performed to examine the influence of isoflurane anesthesia on the pulsatility index (PI) and the peak systolic velocity (PSV) of the blood flow in the basilar artery of dogs by duplex Doppler ultrasonography. Twelve healthy dogs were used to measure the PI and the PSV under the conscious state and isoflurane anesthesia. The pulsatility index (PI) and the peak systolic velocity (PSV) in the basilar artery were measured five times with random intervals. The blood pressure was measured. The PI and PSV values in dogs under isoflurane anesthesia were 1.37 ± 0.32 and 72 ± 19 cm/sec, whereas those in the conscious dogs were 1.37 ± 0.13 and 81 ± 16 cm/sec, respectively. The indirect mean arterial systolic and diastolic pressures under isoflurane anesthesia were 107 and 51 mmHg, whereas those in the conscious dogs were 133 and 74 mmHg. Though the isoflurane is generally known to induce hypotension, there were no significant differences in the PI and PSV between the isoflurane-anesthetized and the conscious dogs. In conclusion, the isoflurane anesthesia did not influence the PI and PSV in the basilar artery of dogs.

Key words: Dog, Doppler ultrasonography, isoflurane, peak systolic velocity, pulsatility index

Introduction

It has been reported that the pulsatility index (PI) and the peak systolic velocity in the basilar artery measured to examine brain damage can be used for the prediction and the diagnosis of brain damage in the dog by Doppler ultrasonography [4]. Concerning the isoflurane anesthesia, it has been known that the arterial pressure and vascular resistance, which is reflected in the PI, were decreased in dogs [9, 11]. In order to examine the abnormal velocity and pulsatility index in the basilar, knowledge of baseline values are of important. However, only a few studies were performed to establish the normal major blood flow profile in dogs by Doppler ultrasonography [12, 13]. Besides, the normal range and anesthetic influence on the peak systolic velocity and the pulsatility index in the basilar artery have not even been established.

The aim of this study is to examine how the isoflurane anesthesia influences on the pulsatility index and the peak systolic velocity of the blood flow in the basilar artery of the dogs by Doppler ultrasonography.

Materials and Methods

Experiment Animals

Twelve healthy one-year-old beagle dogs, weighing 6.4~10 kg, were used without sex discrimination. All of the dogs were considered to be normal following physical and hemodiagnostic (complete blood count) examinations and a *Dirofilaria immitis* immunodiagnostic test (Snap; IDEXX Laboratories Co., USA).

Doppler Ultrasound

Doppler ultrasonography was performed using a Toshiba 260A with a 3.5 MHz sector transducer (5.66-25.00 kHz pulse repetition frequencies, 100 Hz wall filter). Doppler waveforms were recorded at gains in which noises first became apparent and at pulse repetition frequencies that were sufficient to prevent aliasing.

Basilar Artery (BA)

Dogs were placed in right lateral recumbency. The basilar artery was examined through the foramen magnum acoustic window. Following an initial B-mode examination, color flow Doppler was performed to identify the vessels of interest. Once identified, pulsed wave Doppler was initiated and the waveform analysis was performed after freezing the image. The Doppler angle was maintained between 30-40 degrees. Measurements such as PSV, mean velocity and end diastolic velocity (EDV) were made on a representative spectral

* Corresponding author:
Department of Radiology, College of Veterinary Medicine, Seoul National University San 56-1 Shillim-dong, Kwanak-gu, Seoul 151-742, Korea
Tel: +82-2-880-8692, Fax: +82-2-880-8662,
E-mail: mcchoi@snu.ac.kr

waveform (Fig. 1). The waveform analyses were performed 5 times at random intervals. The PI value was calculated by the equation, PI = (PSV - EDV)/ mean velocity.

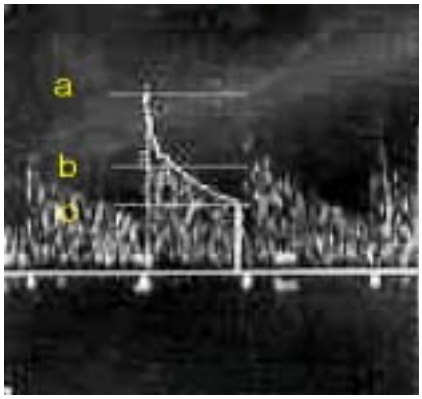

Fig. 1. Pulsatility index (PI) measurement at basilar artery. Drawing of calipers from the peak (a) to the end diastolic spectrum(c) to measure the PI of the blood flow in the basilar artery is shown.
a: peak systolic velocity, b: mean velocity, c: end diastolic velocity

Inhalation Anesthesia

Twelve beagle dogs were anesthetized with isoflurane. Before performing experiments, feed was withheld for 12 hours. For the inhalation anesthesia, a semi-open circle anesthetic system (Anesthesia Apparatus FO-20S, Acoma Medical Industry Co., Tokyo, Japan), with Tec-type vaporizer for isoflurane (Acoma Vaporizer 1 MK- Ⅲ, Acoma Medical Industry Co., Tokyo, Japan), out of circle, was used for the whole period of experiment. Induction was produced by 4% isoflurane (Aerane®, Choongwae medical Co. Ltd., Seoul, Korea) in oxygen via facemask without any preanesthetics. After induction of anesthesia, endotracheal tube was inserted and the dog was placed in the right lateral recumbency. Lactated Ringer s solution was administered intravenously at a rate of 5 ㎖/㎏/h. Body temperature was maintained at approximately 38 ±0.5℃ with a water pad and blanket. Two percent of isoflurane in oxygen was delivered via endotracheal tube for at least 60 minutes.Determination of baseline MAC was initiated at 1.5% isoflurane and was duplicated following the method of Eger *et al.* (1980). Respiratory gases were monitored continuously using a gas analysis module (M-CaiOV, Datex-Ohmeda, Helsinki, Finland) connected to an anesthetic patient monitoring system (S-3, Datex-Ohmeda, Helsinki, Finland).

Blood Pressure

Blood pressure was measured by an indirect (i.e., oscillometric) blood pressure monitor [10]. Dogs were placed in right lateral recumbency. Limb circumference over the left dorsal pedal artery was measured, and a cuff width of approximately 40% to 60% of the limb circumference was chosen. Three readings were taken at 5-minute intervals. Systolic and diastolic blood pressures were recorded. One of the authors (Lee) took all the measurements to obtain all values in an identical fashion.

Data Analysis

Statistical evaluation was performed using the SPSS statistical computer program. A one-way ANOVA (*post-hoc* scheffe) was applied to data analyses.

Results

Pulsatility Index and Peak Systolic Velocity of Blood Flow in Basilar Artery

The mean PI and PSV values under isoflurane anesthesia (1.5 %) were 1.37 0.32 (mean SD) and 72 19 (mean SD) ㎝/sec and those in the conscious dogs were 1.370.13 and 8116 ㎝/sec, respectively (Fig. 2). The Doppler angle had the range of 30~40°. There are no significant differences of PI and PSV values between isoflurane-anesthetized and the conscious dogs.

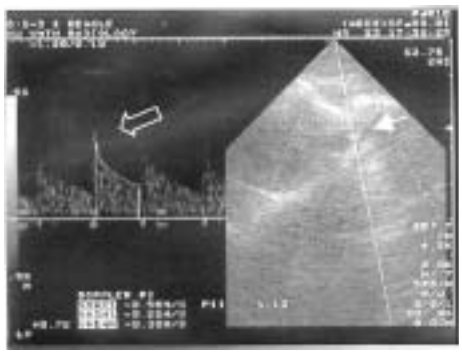

Fig. 2. Duplex Doppler image of the basilar artery
A spectral waveform for velocity measurement in basilar artery (empty arrow) is shown on the left in figure 2. Real time image and sample gate (arrow) are on right side of the each image. The basilar artery showed typical parabolic velocity profile and low resistance flow pattern.

Blood Pressure

Mean values of blood pressure under isoflurane anesthesia were 107 ± 15 (mean ± SD) mmHg in systole and 51 ± 12 (mean ± SD) mmHg in diastole, respectively. In conscious dogs, the values were 137 ± 13 (mean ± SD) mmHg in systole and 78 ± 15 (mean ± SD) mmHg in diastole. The systolic and diastolic blood pressures decreased significantly in isoflurane group ($p<0.05$) compared to the normal value.

Discussion

It has been generally known that isoflurane anesthesia induced hypotension and decreased vascular resistance [5, 7, 9, 11]. This study showed the significantly decreased blood pressures in the isoflurane-anesthetized dogs, which are

accordant with the results of the other reports.

Evans *et al.* and Blohme *et al.* reported that the PI is one of the indicators of peripheral resistance [1, 3]. Theoretically, it is known that the PI value is inversely proportional to the vascular resistance. That is to say, when the vascular resistance is decreased, the PI value is increased, and vice versa. The PI of the basilar artery under isoflurane anesthesia was expected to increase, but it showed the negligible difference in anesthetized dogs when compared to normal value. Though there are some controversies concerning the PI in intra- and/or extra-cranial arteries, it is important to know the normal value in the basilar artery for examining the cerebral blood flow indirectly. In this study, the mean PI and peak velocity in the basilar artery were 1.37 $\pm$0.13 and 72 $\pm$ 19 cm/sec, respectively. And these values under anesthesia were not significantly different from those of the normal values.

Many controversies have been reported about isoflurane anesthetic influences on the cerebral blood flow and velocity. Jones *et al.* reported that isoflurane caused cerebral vasodilatation and an increase in cerebral perfusion in dogs [8]. Meanwhile, Thiel *et al.* reported isoflurane caused little change on the blood flow and the velocity in the middle cerebral artery of humans [14]. To the contrary, Holzer *et al.* and Newberg *et al.* stated that isoflurane decreased the cerebral blood flow in human [6,11].

Though intracranial cerebral blood flow velocity was not measured in this study, it could be deduced that isoflurane did not affect the PSV as well as the PI in the basilar artery when compared to those in the normal one. This means the blood flow of the extra cranial artery like basilar artery was not affected under isoflurane anesthesia.

Conclusively, the decreased blood pressure under isoflurane anesthesia did not influence on the PI and PSV in the basilar artery. Therefore isoflurane anesthesia can be used safely without any changes of blood flow.

References

1. **Blohme, L., Pagani, M., Parra-Hoyos, H., Olofsson, P., Takolander, R., and Swedenborg,** J. Changes in middle cerebral artery flow velocity and pulsatility index after carotid endarterectomy. Eur. J. Vasc. Surg. 1991, **5**, 659-663.
2. **Cheung, A.T., Levy, W.J., Weiss, S.J., Barclay, D.K., and Stecker, M.M.** Relationships between cerebral blood flow velocities and arterial pressures during intra-aortic counterpulsation. Cardiothorac Vasc Anesth. 1998, **12(1),** 51-57.
3. **Evans, D.H., Barrie, W.W., Asher, M.J., Bentley, S., and Bell, P.R.** The relationship between ultrasonic pulsatility index and proximal arterial stenosis in a canine model. Circ. Res. 1980, **46**, 470-475.
4. **Fukushima, U., Sasaki, S., Okano, S., Oyamada, T., Yoshikawa, T., Hagio, M., and Takase, K.** Non-invasive diagnosis of ischemic brain damage after cardiopulmonary resuscitation in dogs by using transcranial Doppler ultrasonography. Vet. Radiol. Ultrasound. 2000, **41(2),** 172-177.
5. **Hellyer, P., Muir, W.W. 3rd, Hubbell, J.A., and Sally, J.** Cardiorespiratory effects of the intravenous administration of tiletamine-zolazepam to dogs. Vet. Surg. 1989, **18(2),** 160-165.
6. **Holzer, A., Greher, M., Hetz, H., Standhardt, H., Donner, A., Heinzl, H., Zimpfer, M., and Illievich, U.M.** Influence of aortic blood flow velocity on changes of middle cerebral artery blood flow velocity during isoflurane and sevoflurane anesthesia. Eur. J. Anaesthesiol. 2001, **18(4),** 238-244.
7. **Hysing, E.S., Chelly, J.E., Doursout, M.F., and Merin, R.G.** Comparative effects of halothane, enflurane, and isoflurane at equihypotensive doses on cardiac performance and coronary and renal blood flows in chronically instrumented dogs. Anesthesiology. 1992, **76(6),** 979~984.
8. **Jones, R.S. and Snowdon, S.L.** Experimental investigation of the cardiovascular and respiratory effects of increasing concentrations of isoflurane in the dog. Res. Vet. Sci. 1986, **40(1),** 89-93.
9. **Klide, A.M.** Cardiopulmonary effects of enflurane and isoflurane in the dog. Am. J. Vet. Res. 1976, **37(2),** 127-131.
10. **Meurs, K.M., Miller M.W., Slater, M.R., and Glaze K.** Arterial Blood pressure measurement in a population of healthy geriatric dogs. Am. Anim Hosp Assoc. 2000, **36,** 497-500.
11. **Newberg, L.A., Milde, J.H., and Michenfelder, J.D.** Systemic and cerebral effects of isoflurane-induced hypotension in dogs. Anesthesiology. 1984, **60(6),** 541-546.
12. **Spaulding K.A.** A review of sonographic identification of abdominal blood vessels and juxtavascular organs. Vet. Radiol. Ultrasound. 1997, **38(1),** 4-23.
13. **Szatmari, V., Sotonyi, P., and Voros, K.** Normal duplex Doppler waveforms of major abdominal blood vessels in dogs: a review. Vet. Radiol. Ultrasound. 2001, **42(2),** 93-107.
14. **Thiel, A., Zickmann, B., Zimmermann, R., and Hempelmann, G.** Transcranial Doppler sonography: effects of halothane, enflurane and isoflurane on blood flow velocity in the middle cerebral artery. Br .J .Anaesth. 1992, **68(4),** 388-393.