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Effects of anesthetics on resistive index of the medial long posterior ciliary artery and ophthalmic artery using color doppler imaging

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Abstract : Color Doppler imaging (CDI) was carried out to evaluate the anesthetics effect on ophthalmic circulation using CDI-derived resistive index (RI) values. CDI was preformed on 24 dogs, and RI values were calculated for the medial long posterior ciliary artery (mLPCA) and ophthalmic artery (OA) before and after administration of anesthetics. After administration of benoxinate or acepromazine, a significant change of the mLPCA RI was not found. But, a significant decrease of the RI following ketamine ($p < 0.001$) or xylazine ($p < 0.01$) administration could be observed as compared with the self-control. Mean RI value of OA also showed this same trend. Intraocular pressure was significantly decrease following benoxinate ($p < 0.01$), acepromazine ($p < 0.01$), and xylazine ($p < 0.001$) administration within normal range. The results suggest that some anesthetics influence on ophthalmic vascular resistance. Therefore, chemical restraint was carefully used in clinical application of CDI-derived RI measurement. Particularly, benoxinate and acepromazine is useful chemical restraint without a change of the ophthalmic vascular resistance.

Key words : color Doppler imaging, resistive index, ophthalmic vasculature, anesthetics, dogs

Introduction

Ultrasonography has been routinely used for differentiation and measurement of intraocular and orbital tumors [6,16,21], detection of retinal detachments in eyes with opaque media [8], axial-length measurements for microphthalmia [7,19,20], abnormalities in lens position [17], cataract [2], vitreal debris [8], vitreal hemorrhage [8], vitreal membrane formation [5], intraocular foreign body [3], and evaluation of traumatic injuries to the globe and orbit [14]. Additionally, in human medicine, ultrasonography is applied to detect and diagnose optic nerve lesion such as optic nerve sheath meningiomas and inflammatory fluid collection in the nerve sheath [15]. Two characteristics of ultrasound that have made it popular are its safety, and lack of pain or discomfort for the patient.

In humans, numerous orbital and ocular vessels have been mapped and their blood velocity parameters and waveforms characterized using color Doppler imaging (CDI) [4,10,11,15,24]. A few veterinary report has evaluated CDI of the canine ophthalmic vasculature [9,13].

Gelatt *et al* [9] reported evaluation of ophthalmic vessels using color Doppler imaging in normal sedated dogs and glaucomatous dogs. This investigation performed measurement under light sedation (butorphanol tartrate and acepromazine sulfate), lidocaine eye blocks, and corneal topical anesthesia (tetracaine HCl).

In human ophthalmology, no sedation or chemical restraints needs to ultrasonographic examination for patient cooperation. But, either sedation or general anesthesia is necessary for Doppler imaging as there can be no ocular movements in veterinary medicine. Any investi- gations of anesthetics effect were not conducted on normal canine ophthalmic vasculature during Doppler examination.

This study was performed to assess the effect on anesthetics in ophthalmic circulation and to figure out which anesthetic agent was available to examine ophthalmic

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ultrasonography without ophthalmic vascular resistance change.

Materials and Methods

Animals

Twenty four clinically healthy dogs (24 left eyes) were examined in this study. Dogs ranged in age from 1 to 5 years and body weight from 2.0 to 6.1 kg. Three breeds were represented: Maltese (4 female and 8 male), Yorkshire Terrier (2 female and 6 male), and Mixed breed (2 female and 2 male). Dog were determined to be clinically normal on the basis of results of physical examination, CBC, serum biochemical analyses, and ophthalmic examination. The ophthalmic examination consisted of slit-lamp biomicroscopy, direct ophthalmoscopy, and tonometry. Intraocular pressure was recorded under 30 mmHg in all dogs, and abnormalities were not detected in the anterior segment or fundus. There was no evidence of signs of orbital diseases or neuro-ophthalmologic diseases in any dog.

Color Doppler imaging technique

CDI was performed, using an ultrasonography (400 pro; GE, USA) with a 7 MHz electronic sector probe. Doppler settings (pulse repetition frequency, 6,000 Hz; gain setting, medium; wall filtering, 100 Hz; color Doppler flow setting, low to medium) were kept constant. The eyes and orbits were imaged with the dog lightly restrained in a sitting position. Dogs remained sitting throughout the trial.

Coupling gel was applied to the closed upper lid and the scan was performed. Horizontal and transverse scans were taken through the eye and orbit. In transverse scan, the transducer was positioned dorsal of the zygomatic arch. B-mode and CDI were performed initially to identify vessels of interest for subsequent spectral Doppler analysis. Spectral Doppler analysis of the medial long posterior ciliary artery (mLPCA) was performed in their ocular portion (closely at optic nerve head) whereas the ophthalmic artery (OA) was routinely sampled at retrobulbar region as it acompany with venous plexus.

Once a particular vessel was localized, interrogated using the Doppler gate to obtain a spectral waveform and thus quantitative information. The resistive index (RI) was determined by: RI = (PSV-EDV)/PSV where PSV was the peak systolic velocity, and EDV was end diastolic velocity.

The RI was calculated for each vessel as an average value obtained from three similar-appearing Doppler waveforms to reduce the effects of physiologic variation.

Anesthetics

Prior to anesthetics experiment, CDI was performed to obtain RI values of conscious status for a self-control. Acepromazine maleate was given in 0.03 mg/kg doses IV, ketamine hydrochloride in 10 mg/kg IV, xylazine hydrochloride in 2 mg/kg IM. Benoxinate hydrochloride was locally applied in 5 drops for 2 minutes. RI measurment was performed followed by anesthtics application after 20 minutes later. All dogs (24 left eyes) were used to experiment for each anesthetics. Withdrawal periods between each anesthetics were over 14 days.

Intraocular pressure measurements

Tonopen-XL®(Mentor Ltd, USA) was used to measure intraocular pressure. The mean of three intraocular pressure data was calculated. Each measurement was perform before and after administered anesthetics.

Statistical analysis

Statistical analysis was performed using the SPSS statistical computer program. According to property of sample, repeated ANOVA and paired sample t-test were applied to data analysis. For all tests, P values < 0.05 were considered significant.

Results

After administration of benoxinate or acepromazine, a significant change of the RI values was not found. But, a significant decrease of mLPCA-RI and OA-RI following ketamine ($p < 0.001$) administration could be observed as compared with self control. A case of xylazine, mLPCA-RI ($p < 0.01$) and OA-RI ($p < 0.05$) was significantly decreased also (Table 1). Paired sample *t*-test showed that there were significant decrease in intraocular pressure following benoxinate ($p < 0.01$), acepromazine ($p < 0.01$), and xylazine ($p < 0.001$) administration (Fig. 1), though, within a normal range.

Discussion

External pressure from the ultrasound transducer may

Table 1. CDI-derived RI values(mean ± SD) of mLPCA and OA after administration anesthetics

	Conscious status	Benoxinate	Xylazine	Ketamine	Acepromazine
mLPCA	0.686 ± 0.079	0.696 ± 0.070	0.597 ± 0.103*	0.562 ± 0.079*	0.701 ± 0.064
OA	0.802 ± 0.030	0.801 ± 0.035	0.752 ± 0.046*	0.678 ± 0.055*	0.810 ± 0.047

* : Comparisons significant are indicated by asterisk against conscious status, $p < 0.05$

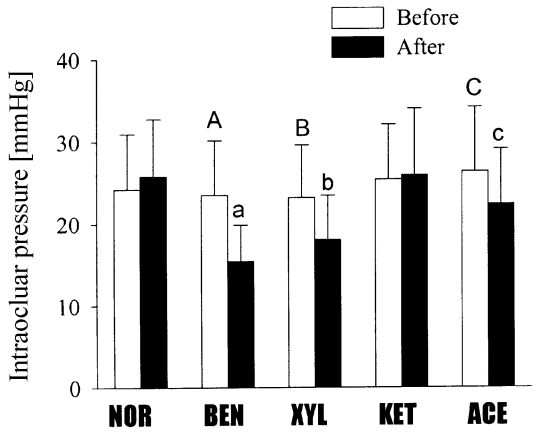

Fig. 1. Intraocular pressure measurements before and after administration anesthetics. (Comparisons significant at the following level are indicated by A:a, B:b, C:c, $p < 0.01$).

potentially result in an increase in intraocualr pressure during the examination [24]. Ocular perfusion and the vascular resistance of the uveal and retinal vasculature may be altered by intraocular pressure [9]. It is important during Doppler imaging to minimize this external pressure so as to reduce any potential effect on blood flow [24]. Previous study has shown that the retinal blood flow remained stable during moderate rose in intraocular pressure [12]. Riva *et al* [18] have shown that blood velocity in the retinal circulation was effectively autoregulated up to intraocular pressures of 42 mmHg using laser Doppler velocimetry. But, Yu *et al* [25] founded no evidence for active autoregulation of the choroidal circulation at intraocular pressure above 30 mmHg in the dog by local hydrogen clearance polarography. In this way the choroidal circulation differed from the retinal circulation. It would appear, therefore, that the small intraocular pressure rising produced during the ultrasound examination was unlikely to influence retinal circulation, but choroidal ciculation maybe affected. Further study will be required in this area of investigation. External pressure of eyeball was applied to OA-RI measurement. Therefore, excessive pressure by the probe on the eyelid may have the potential to raise intraocular pressure and alter intraocular hemodynamics. But mLPCA-RI measurement was minimized external pressure without direct contact of eyeball.

Sedatives and general anesthetics also have the potential to lower intraocular pressure as well as systemic blood pressure [9]. But, ketamine cause temporary increases in intraocular pressure, believed to be due to spasm of the extraocular muscles [22]. Although within normal range, intraocular pressure lowering effect was shown in all drugs under study except for ketamine. Acepromazine and benoxinate did not cause significant change on OA and mLPCA RI. We think, acepromazine and benoxinate may have less affection on the systemic vascular resistance for dosage and local effect, respectively. OA and mLPCA RI after administration of ketamine or xylazine were statistically significantly decreased. These results may be explained in the previous study [1,23]. Thompson *et al* [23] suggested that ketamine produces an increase in heart rate, cardiac output, and arterial pressure. Adamson *et al* [1] demonstrated that intramuscular injection of xylaxine did not increase vascular resistance as compared with intravenous injection. After ketamine administration, increased arterial pressure may increase ocular perfusion pressure and reduce ophthalmic vascular resistance. Instance to xylazine, relaxation of extraocular muscles may influence vascular resistance.

The results suggest that some anesthetics influence on ophthalmic vascular resistance. Therefore, chemical restraint was carefully used in clinical application of CDI-derived RI measurement. Particularly, benoxinate and acepromazine is useful chemical restraint without ophthalmic vascular resistance change.

Conclusions

This study was carried out to evaluate the effect of anesthetics on the ophthalmic circulation. The results were as follows.

In mLPCA, mean RI value of self-control was 0.69

± 0.08, those of after anesthetics administration were 0.70 ± 0.07, 0.70 ± 0.06, 0.56 ± 0.08, and 0.60 ± 0.10 in benoxinate, acepromazine, ketamine, and xylazine, with respectively. After administration of benoxinate or acepromazine, a significant change of the RI was not found. But, a significant decrease of the RI following ketamine or xylazine administration could be observed as compared with the self-control. Mean RI values of OA also showed this same trend.

There were significant decrease in intraocular pressure following benoxinate, acepromazine, and xylazine administration, although those data were normal range.

Therefore, we conclude that benoxinate and acepromazine is useful chemical restraint without ophthalmic vascular resistance change.

Reference

1. **Adamson SL, Morrow RJ, Langille BL.** Site-dependent effects of increases in placental vascular resistance on the umbilical arterial velocity waveform in fetal sheep. Ultrasound Med Biol 1990, **16**, 19-27.
2. **Alexandra W, Wilkie DA, Myer CW.** Ultrasonographic abnormalities in the eyes of dogs with cataracts : 141cases (1986-1992). J Am Vet Med Assoc 1993, **203**, 838-841.
3. **Awschalom L, Meyers SM.** Ultrasonography of vitreal foreign bodies in eyes obtained at autopsy. Arch Ophthalmol 1982, **100**, 979-980.
4. **Baxter GM, Williamson TH.** Color Doppler imaging of the eye : Normal ranges, reproducibility, and observer variation. J Ultrasound Med 1995, **14**, 91-96.
5. **Boroffka SA, Verbruggen AJ, Boeve MH, Stades FC.** Ultrasonographic diagnosis of persistent hyperplastic tunica vasculosa lentis/persistent hyperplastic primary vitreous in two dogs. Vet Radiol Ultrasound 1998, **39**, 440-444.
6. **Coleman DJ, Lizzi FL.** Computerized ultrasonic tissue characterization of ocular tumors. Am J Ophthalmol 1983, **96**, 165-175.
7. **Cottrill NB, Banks WJ, Pechman RD.** Ultrasonographic and biometric evaluation of the eye and orbit of dogs. Am J Vet Res 1989, **50**, 898-903.
8. **Dziezyc J, Hager DA, Millichamp MJ.** Two-dimensional real-time ocular ultrasonography in the diagnosis of ocular lesions in dogs. J Am Anim Hosp Assoc 1987, **23**, 501-507.
9. **Gelatt KJ, Gelatt KN, Mackay E, Brooks DE, Newell SM.** Doppler imaging of the ophthalmic vasculature of the normal dog : Blood velocity measurements and reproducibility. Vet Ophthalmol 1999, **2**, 87-96.
10. **Giovagnorio F, Quaranta L, Bucci MG.** Color Doppler assessment of normal ocular blood flow. J Ultrasound Med 1993, **12**, 473-477.
11. **Greenfield DS, Heggerick PA, Hedges TR.** Color doppler imaging of normal orbital vasculature. Ophthalmology 1995, **102**, 1598-1605.
12. **Grunwald JE, Riva CE, Kozart DM.** Retinal circulation during a spontaneous rise of intraocular pressure. Br J Ophthalmol 1988, **72**, 754-758.
13. **Heechun Lee, Dongwoo Chang, Youngwon Lee, Kidong Eom, Hojung Choi, Kangmoon Seo, Mincheol Choi, Junghee Yoon**. Use of color Doppler imaging for determining the resistive index of the medial long posterior ciliary artery in clinically normal conscious dogs. Am J Vet Res 2002, **63**, 211-214.
14. **Homco LD, Ramires O.** Ultrasonographic diagnosis retrobulbar abscesses. Vet Radiol Ultrasound 1995, **36**, 240-242.
15. **Lieb WE, Cohen SM, Merton DA, Shields JA, Mitchell DG, Goldberg BB.** Color doppler imaging of the eye and orbit : Technique and normal vascular anatomy. Arch Ophthalmol 1991, **109**, 527-53.
16. **Miller WW, Cartee RE.** B-scan ultrasonography for the detection of space occupying ocular masses. J Am Vet Med Assoc 1985, **187**, 66-68.
17. **Paulsen ME, Lavach JD, Severin GA, Eichenbaum JD.** The effect of lens-induced uveitis on the success of extracapsular cataract extraction : A retrospective study of 65 lens removals in the dog. J Am Anim Hosp Assoc 1986, **22**, 49-56.
18. **Riva CE, Sinclair SH, Grunwald JE.** Autoregulation of retinal circulation in response to decrease of perfusion pressure. Invest Ophthalmol Vis Sci 1981, **21**, 34-38.
19. **Rubin LF, Koch SA.** Ocular dianostic ultrasonography. J Am Vet Med Assoc 1968, **153**, 1706-1717.
20. **Schiffer SP, Rantanen NW, Leary GA, Bryan GM.** Biometric study of the canine eye, using A-mode ultrasonography. Am J Vet Res 1982, **43**, 826-830.
21. **Schoster JV, Dubielzig RR, Sullivan L.** Choroidal melanoma in a dog. J Am Vet Med Assoc 1993, **203**, 89-91.
22. **Slatter, D.** Structure and function of the eye. *In* : Slatter, D. (ed) Fundamentals of Veterinary Ophthalmology. pp.

7-9, Saunders, Philadelphia, 1981.

23. **Thompson RS, Trudinger BJ, Cook CM.** Doppler ultrasound waveform indices; A/B ratio, pulsatility index and Pourcelot ratio. Br J Obstet Gynaecol 1988, **95**, 581-588.
24. **Williamson TH, Baxter GM, Dutton GN.** Colour doppler velocimetry of the arterial vasculature of the optic nerve head and orbit. Eye 1993, **7**, 74-79.
25. **Yu D, Alder VA, Cringle SJ, Brown MJ.** Choroidal blood flow measured in the dog eye in vivo and in vitro by local hydrogen clearance polarography : Validation of a technique and response to raised intraocular pressure. Exp Eye Res 1988, **46**, 289-303.