

Effects of Isoflurane and Enflurane on Ocular Parameters in Dogs

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SUMMARY

In this study, effects of isoflurane (group 1) and enflurane (group 2) on intraocular pressure (IOP) and papillary size (PS) was investigated in 28 stray dogs. IOP was measured prior to anesthesia (S(stage) 1), after xylazine premedication (S2), in the middle of anesthesia (S3), after atropine administration (S4) and after full anesthetic recovery (S5) and pupillary diameter (PD) at S3 and S4. Atropine was administrated to both group cases in S4. When rationed with S1 data, reductions in IOP in S2, 3 and 4 were noted as %13, 41 and 24 in group 1 and % 10, % 45 and %36 in group 2, respectively. The PS values increased almost % 50 in S4 in group 1 and % 30 in group 2 as compared to S3 parameters. The results show that both anesthetic agents reduces IOP almost by half compared to baseline value and also an increase in both IOP and PS after atropine application suggest the presence of a direct correlation between these two parameters.

Key Words

Isoflurane, Enflurane, Dog, Ocular Parameters

Köpeklerde Göz Parametreleri Üzerine İzofloran ve Enfloranın Etkileri

ÖZET

Çalışmada 28 sokak köpeğinde izofloran ve enfloranın göz içi basıncı (GİB) ve pupillar büyüklük (PB) üzerine olan etkileri araştırılmıştır. GİB anestezi öncesi (basamak (B1), ksilazin premedikasyonundan sonra (B2), anestezi sırasında (B3), atropine uygulamasından sonra (B4) ve anestezi tamamlanmışktan sonra (B5); PB ise B3 ve B4'te ölçüldü. B1'deki verilerle karşılaştırıldığında GİB'nin B2, 3 ve 4 ki düşüş oranları sırasıyla grup 1'de % 13, 41 ve 24; grup 2'de ise %10,45 ve 36 olarak belirlendi. B3'de ki parametrelerle karşılaştırıldığında PB oranı B4'te birinci grupta %50 ve ikinci grupta ise %30 oranında arttığı görüldü. Bulgulardan her iki anestetik ajanın GİB'ni anestezi öncesi duruma göre yaklaşık yarı yarıya azaldığı saptandı. Ayrıca atropin uygulamasından sonra GİB ile PB'te ki artış açısından her iki parametre arasında direkt bir ilişkinin olduğu kanısına varıldı.

Anahtar Kelimeler

Izofloran, Enfloran, Köpek, Göz Parametreleri

INTRODUCTION

There have been many suggestions on various anesthetic regimes based on the combinations of different preanesthetic and anesthetic agents (Presbitero et al., 1980; Artru, 1993; Sator et al., 1998; Artru and Momota, 1999; Jia et al., 2000; Atalan et al., 2002). The pharmacokinetic and pharmacologic characteristics of these agents, their anesthetic qualities and efficacies in various species and adverse effects on the lung, heart, liver, kidney, cardiovascular and respiratory systems have been widely investigated (Hall et al., 2001). However, the studies investigating the outcomes of the current anesthetics only on the animal eyes are few as well as new (Presbitero et al., 1980; Artru, 1993; Sator et al., 1998; Artru and Momota, 1999; Jia et al., 2000). Most of these studies have been performed on laboratory animal as a model to human eye studies rather than on clinical animal patients (Artru, 1993; Artru and Momota, 1999; Jia et al., 2000). This is particularly due to the slow development of veterinary ophthalmic surgery because of the requirement of fine and sophisticated instruments. Nevertheless, in the last decades, intraocular ophthalmic surgery in the veterinary field has made a great progress (Gelatt, 1991;

Gelatt, 2000). A poorly managed anesthetic can result in vision loss when the eye is opened during surgery. The interaction of ophthalmic drugs with anesthetic drugs must be considered. Moreover, anesthetics may have definite effects on the physiology of the eye, therefore, an understanding of these matters is essential for everyone who administers anesthesia for ophthalmic surgery. This is of utmost important if exacting conditions such as still, fixed eye, minimal bleeding, decreased oculocardiac reflexes, decreased intraocular pressure, smooth emergence without nausea, vomiting or retching and postoperative analgesia are required for safe ophthalmic surgery (Orkin and Cooperman, 1983).

In man, local anesthetics have become increasingly popular for a variety of intraocular procedures, particularly with the increasing popularity with the day case surgery in man. The main techniques used to administer local anesthesia are peribulbar and retrobulbar injections. However, the effect of these on IOP has received little attention in patients with glaucoma, in which transient severe increases in IOP may have the potential to cause further compromise of visual functions (O'Donoghue et al., 1994). Studies on the effect of local anesthetics on

the eye undergoing intraocular surgery recorded an increase in IOP between 2.9 – 6.2 mmHg depending on the volume of the drug injected after such an application. The increase in IOP is presumably secondary to rise in orbital pressure caused by large volume of the anesthetic injected (Jia et al., 2000). Therefore, O'Donoghue et al. (1994) pointed out that the changes in IOP in patients with glaucoma with an acute increase in IOP being succeeded by an acute decrease on entry into the anterior chamber may be hazardous. Large increase in IOP may be detrimental in patients, undergoing penetrating keratoplasty and glaucoma surgery (O'Donoghue et al., 1994; Sator et al., 1998). The increase is likely to be higher and more prolonged enough to compromise further optic nerve head function. Therefore, anesthesia in such patients must provide a soft eye suitable for ophthalmic surgery (Sator et al., 1998). Furthermore, low intraocular pressure and motionless eye are prerequisite to good operating conditions and successful intraocular surgical procedures (Benson et al., 1998). The control of IOP is often of primary important in intraocular surgical procedures. Anesthetics that influence IOP have a decisive role in providing desirable operation condition (Presbitero et al., 1980). These facts encouraged us to investigate alterations in some ocular parameters during during isoflurane and enflurane anesthesia.

MATERIALS and METHODS

This study was conducted on 18 male and 10 female native dogs aged between 1-5 years (median: 2.25) and weighed between 12-30 kg (median: 23 kg). All cases free from ocular problems, underwent various operations including ear trimming (n= 3), tail docking (n= 2), repairmen of dental defects (n= 12) and lumbal fusion operation (10), anterior cruciate ligament transection (No: 1). They were divided at random into two equal groups. After Xylazine hydrochloride (Rompun, Bayer) at 1.5 mg/ kg by i/m route premedication and Thiopental sodium (Pentothal sodium, Abbott) at 20 mg/kg i/v induction, groups 1 and 2 were anesthetized with % 1.9 and 1,5 MAC Isoflurane (Forane, Abbottand) and % 3.3 and 1,5 MAC Enflurane (Ethrane, Abbott), respectfully. All dogs also received

Atropine sulphate at 0.02 mg/ kg s/c (Atropine Sulfat, Drogosan) in the middle of the anesthesia, to investigate Atropine action on ocular parameters when combined with Isoflurane and Enflurane.

During anesthesia, intraocular pressure (IOP) and pupillary size (PS) of both eyes were measured. IOP measurement was performed with Schiotz tonometer (Riester, Germany) prior to anesthesia (S(stage) 1), after xylazine premedication (S2), in the middle of anesthesia (S3), after atropine administration (S4) and after full anesthetic recovery (S5). PS was measured with a caliper in the middle of anesthesia and after Atropine administration. The data obtained during these measurements were presented as mean and standard deviation and were analyzed with ANOVA and paired-sample t-test using SPSS computer program. The results were considered as significant at $P < 0.01$ and 0.05 with 95% confidence interval.

RESULTS

The statistical evaluation of the data obtained during IOP and PS measurements has been shown in Table 1. According to this, a non-significant ($p > 0.05$) difference IOP between groups at Ss 1, 2 and 3 whereas a highly significant difference ($p < 0.001$) between them at Ss 4 and 5 (Table 1) is present.

When consecutive stages were compared the differences were significant for both groups. In other words, IOP reduced significantly after premedication, this reduction continued in both groups up to S 3. After atropine premedication (S 4), an increase in IOP occurred in both groups, but its rate was lower group 2 in comparison with group 1. In the last stage (S 5), IOP approximates to its baseline level (awake stage, S1) in groups 1 whereas this rate remained lower in group 2 (Tables 1 and 2).

During the statistical evaluation of PS data, it was found to have a highly significant difference between groups as well as stages within the groups (Table 1).

Table 1. Statistical evaluation of the data (Mean±SD) obtained during IOP and PS measurements in groups 1, 2 and 3. Ss: Stages of measurements conducted; Pvs: P values

Table 1. Grup 1, 2 ve 3'ün GİB ve PB ölçümleri sırasında elde edilen verilerin (Ortalama±SD) istatistiksel olarak değerlendirilmesi. Ss: Yapılan ölçümlerin basamakları; Pvs: P değerleri.

Ss	IOP (mmHg)			PS (mm)		
	Group 2	Group 3	Pvs	Group 2	Group 3	Pvs
1	§21.95±2.34	§21.23 ±2.84	>0.05	-	-	-
2	§19.05±2.51	§19.14±2.81	>0.05	-	-	-
3	§12.86±2.29	§11.63±3.95	>0.05	§3.54±1.45	§3.06±1.48	>0.05
4	§16.79±2.19*	§13.62±2.19*	<0.001	§5.32±1.10*	§3.9815±1.4*	<0.001
5	§21.38±2.29*	§18.70±3.17*	<0.001	-	-	-
Pvs	<0.001	<0.005		<0.001	<0.05	

*: Significant differences between groups, §: Significant differences between successive Ss.

Table 2. Rates (%) of decrease in IOP from S2 to S5 when rationed with S1 values

Table 2. S1 değerleriyle oranlandığında S2'den S5'e kadar GİB'da gözlenen düşüş oranları (%)

Groups	S2	S3	S4	S5
1	11.06	39.96	22.55	3.27
2	9.50	45.01	28.09	11.82

DISCUSSION

The result of the present study is consistent with those of others (Artru, 1993; Sator et al., 1998; Artru and Momota, 1999; Jia et al., 2000) in the content that volatile anesthetics facilitate the decrease of IOP. According to the current results, IOP reduction was higher in enflurane than isoflurane, but the difference between last two agents was not marked. This reduction was significant in both groups when the data in AS 1 and 3 were compared.

Some authors (Cunningham and Barry, 1986; Erickson-Lamy et al., 1982) have investigated the possible causes of IOP reduction during anesthesia. They all have concentrated on the influence of various anesthetic agents on the rate of aqueous humor formation and its outflow resistance facility, alterations in ocular blood circulation, tonus of the extraocular muscles. In this study, the possible effect of PS on IOP was investigated. An increase in papillary size means the peripheral contraction of the iris, which may indirectly narrow the iridocorneal angle, leading to an increase in humor aqueous outflow resistance. Additionally, with papillary dilatation the vascular perfusion of the iris is diminished resulting in increased IOP pressure (Ruthowski and Thompson, 1972). By taking account these parameters, an experimental design was set up to investigate any correlation between an alteration in PS and IOP. It was thought that atropine could be a good choice because of commonly used pre-anesthetic and also having the mydriatic characteristic. The result of this study has confirmed the presence of some relations between these two variables, because following atropine application the PS raised by 46 %, which was associated with an increases in IOP by 12 % (Table 1).

The influence of enflurane on IOP in human patients has been studies with the different rates of reduction, i.e. 21 % by Rattke and Waldman (1975), 40 % by Rubciman et al. (1978) and 60 % by Presbitero et al. (1980). This rate determined in the canine eye of this study was 45 %. As seen readily, all studies are in agreement in that enflurane drops IOP. However, there are distinct differences between the results of these studies about the percentage of the reduction. The cause of this difference could be correlated with the use of different pre-anesthetic and anesthetic induction agents, experimental design and species used in the studies.

As was in enflurane, the present study demonstrated that isoflurane reduce IOP about 40 %. A study of Sator et al. (1998) on the outcome of some anesthetic agents including isoflurane documented a sharp and significant reduction in IOP at the end of induction, which however stabilized throughout the anesthesia and returned to the base-line value soon after the emergency from the anesthesia. Jia et al. (2000) agree with the previous authors about the influence of isoflurane IOP, but they disagree with them with regard to the pattern of IOP reduction during the anesthesia, since they claimed that reduction in IOP continued slowly throughout anesthesia rather than becoming stabilized after sharp fall after induction.

The results of this study demonstrate that isoflurane and enflurane are unable to decline IOP during anesthesia with a resultant of a quick set back to its baseline values after full recovery. Such a temporary IOP reduction could

possible be useful during intraocular surgery particularly in the case with high IOP pressure and face with optic nerve degeneration and vision loss as a result of chronic high IOP.

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KAYNAKLAR

- Artru AA, Momota Y (1999).** Trabecular Outflow Facility and Formation Rate of Aqueous Humor During Anesthesia with Sevoflurane-Nitrous Oxide or Sevoflurane-Remifentaniil in Rabbits. *Neurosurgical Anesth*, 88, 781-786.
- Artru AA (1993).** Trabecular Outflow Facility and Formation Rate of Aqueous Humor During Propofol, Nitrous Oxide, and Halothane Anesthesia in Rabbits. *Anesth Analg*, 77, 564-569.
- Atalan G, Demirkan İ, Güneş V, Cihan M, Çelebi F, Çitil M (2002).** Comparison of Xylazine+Ketamine HCL Anesthetic Agents with Eceporomazine + Butorphenol + Ketamine Combinations for Their Clinical and Cardiorespiratory Effects in Dogs. *Vet Cerrahi Derg*, 8(3-4), 35-40.
- Benson GJ, Manning JP, Hartsfield SM, Thurmon JC (1998).** Intraocular Tension of the Horse. Effects of Succinylcholine and Halothane Anesthesia. *Am J Vet Res*, 42(10), 1831-1832.
- Cunningham AJ, Barry P (1986).** Intraocular Pressure-Physiology and Implications For Anaesthetic Management. *Can Anaesth Soc J*, 33(2), 195-208.
- Erickson-Lamy KA, Kaufman PL, McDermott ML, France NK (1982).** Comparative Anesthetic Effects on Aqueous Humor Dynamics in the Cynomolgus Monkey. *Arch Ophthalmol*, 102, 1815-1819.
- Gelat KN (2000).** Essentials of Veterinary Ophthalmology. Philadelphia, Lippincott.
- Gelat KN (1991).** Veterinary Ophthalmology. (2nd Ed), Philadelphia, Lea & Fibiger.
- Hall LW, Clarke KW, Trim CM (2001).** Veterinary Anaesthesia. Saunders, London, pp 1-145.
- Jia L, Cepurna WO, Johnson EC, Morrison JC (2000).** Effect of General Anesthetics on IOP in Rats with Experimental Aqueous Outflow Obstruction. *IOVS*, 41(11), 3415-3419.
- O'Donoghue E, Batterbury M, Lavy T (1994).** Effect on Intraocular Pressure of Local Anesthesia in Eyes Undergoing Intraocular Surgery. *J Ophthalmol*, 78, 605-607.
- Orkin FK and Cooperman LH (1983).** Complications in Anesthesiology. Philadelphia, Lippincott, p 342
- Presbitero JV, Ruiz RS, Rigor BM, Drouilhet JH, Reilly EL (1980).** Intraocular Pressure During Enflorane and Neurolept Anesthesia in Adult Patients Undergoing Ophthalmic Surgery. *Anesth Analg*, 59(1), 50-54.
- Rathke N, Waldman J (1975).** The Influence of Enflurane Anesthesia on Intraocular Pressure in Youths. *Anesth Analg*, 54, 212-215.
- Rubciman JC, Bowen-Wright RM, Welsh NA et al. (1978).** Intraocular Pressure Change During Halothane and Enflurane Anesthesia. *B J Anaesth*, 50, 371-374.
- Ruthowski PC, Thompson HS (1972).** Mydriasis and Increased Intraocular Pressure. I. Pupillographic Study. *Arch Ophthalmol*, 87, 21.
- Sator S, Schabernig WC, Akramian J, Zulus E, Winkler M (1998).** Desflurane Maintains Intraocular Pressure at an Equivalent Level to Isoflorane and Propofol During Unstressed Non-Ophthalmic Surgery. *Br J Anaesth*, 80, 243-244.