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A Comparison of the Effects of Propofol and Thiopental on Intraocular Pressure in Dogs

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Abstract: This study was designed to compare the effects of propofol and thiopental on Intraocular Pressure (IOP) in dogs. In the study, twenty healthy dogs were used as material. Nonpremedicated cases were divided into two groups of 10 dogs each. Group I dogs were induced with 7 mg kg^{-1} of propofol, group II dogs induced with 20 mg kg^{-1} of thiopental prepared as 2.5% solution. IOP was measured before and 5 min after induction of anesthesia. Both anesthetics decreased IOP significantly ($p<0.001$) and falling ratios were similar between the two groups. Heart and respiratory rate, rectal temperature were recorded before and 10 min after induction of anesthesia. While the heart rate increased during anesthesia in group II dogs, there were no significant differences at other measured clinical parameters in both groups. In group I, recovery vas comfortable. However, recovery was violent and noisy in 5 dogs of group II. As a result both drugs decreased IOP at similar ratios. However, with regard to few side effects, it was concluded that the use of propofol might be more suitable in ophtalmic operations.

Key words: Propofol, thiopental, intraocular pressure, dog, anesthesia, temperature

INTRODUCTION

For the eye to function normally, it is required that the outer surface of the organ is tight and smooth. This tightness is maintained by Intraocular Pressure (IOP). IOP ranges between 10-25 mmHg in domestic animals and is formed by the balance between the production and draining of the aqueous humor (HA).

The HA, which is secreted by the ciliary body (corpus ciliare) into the posterior chamber, escapes through the pupil into the anterior chamber and drains out of the eye via the trabecular meshwork in the iridocorneal angle (angulus iridocornealis) into the scleral venous plexus to join the systemic circulation (Seymour and Gleed, 1999; Batista *et al*., 2000; Ofri *et al*., 2002).

IOP varies with a multitude of factors including the use of sedatives, myorelaxants and intravenous and inhalation anaesthetics, the performance of surgical interventions such as laryngoscopy, endotracheal intubation and extubation, surgical stimulations and hypoxia and hypercapnia that may develop under anaesthesia (Alexander *et al*., 1998; Batista *et al*., 2000; Cunningham and Barry, 1986; Presbitero *et al*., 1980). The use of anaesthetics, which increase IOP during surgery on eyes with ganglion cell loss as in the case of glaucoma may lead to complications including the prolapse of the iris at the site of trabeculectomy, destruction of the anterior chamber and expulsive choroidal haemorrhage during the operation. More importantly, the use of such anaesthetics may increase the loss of reserve ganglion cells. Particularly, in cases of glaucoma with severe visual field loss, ganglion cells, already greatly reduced in number are affected adversely by increase in IOP even if for a short term and this, in turn, may result in blindness.

Similarly in penetrating open-eye injuries, increase in IOP due to the particular anaesthetics used may lead to the prolapse of intraocular tissues such as the iris and vitreous body at the site of incision, resulting in the failure of the operation.

Furthermore, increase in IOP is not desired in non-ophthalmic surgery, either for the patient may be suffering from undiagnosed latent glaucoma that may increase the IOP during the operation and result in the damage of the optic nerve depending on the duration of general anaesthesia.

Therefore, to maintain ocular health, it is suggested that general anaesthetics that do not increase IOP and even reasonably reduce it be used in non-ophthalmic and ophthalmic surgery (Bozlan *et al*., 1998; Seymour and Gleed, 1999; Cantor *et al*., 2000; Schafer *et al*., 2002). Thiopental was introduced into veterinary practice in 1987 and over the next 60 years came to be the most widely

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used induction agent. It is a thiobarbiturate derivative, which is used as a general anaesthetic in animals. In dogs, it is used commonly either alone as an anaesthetic or for induction before inhalation anaesthesia. On the other hand, propofol is a non-barbiturate intravenous anaesthetic with the shortest elimination half life, which enables rapid reanimation by means of rapid induction of anaesthesia (Hilbery, 1992; Duke, 1995; Hall *et al*., 2001).

Like thiopental, propofol is a rapidly acting agent producing anesthesia of short duration. The attraction for using propofol is the rapid and excitement free awakening (Hall *et al*., 2001). The present study was aimed at the comparison of the effects of propofol and thiopental on intraocular pressure in dogs.

MATERIALS AND METHODS

In total 20 clinically healthy dogs, 17 of which were female and 3 male, weighing 9-30 kg, constituted the material of the study. The animals were allocated randomly to two groups, each comprising of 10 dogs. The dogs included in the first group were administered an injectable emulsion of propofol (Propofol 1% Fresenius, Fresenius Kabi, Deutschland GmbH) at a dose of 7 mg kg^{-1} by intravenous route, whilst the dogs included in the second group were administered 2.5% thiopental (Pental Sodyum 1 g, İ.E. Ulagay İlac San. Türk A.S.) at a dose of 20 mg kg^{-1} by intravenous route. The first one-third of the thiopental dose was administered rapidly, whilst the remaining two-thirds of the dose was administered slowly.

The period until the disappearance of the palpebral reflex was recorded as the period of the induction of anaesthesia and the period until reanimation was recorded as the anaesthesia period. Heart rate, respiratory rate and body temperature were recorded prior to the trial and 10 min after the induction of anaesthesia for all cases, which were not premedicated.

One minute after both eyes of the animals were administered a topical anaesthetic eye drop; the IOP was measured using a Schiotz tonometer. The 5.5 g weight of the identation tonometer was used and the equivalent of the value read was calculated in mmHg using the Friedenwald calibration table and was recorded as the pre-anaesthesia measurement. The measurement was repeated 5 min after the induction of anaesthesia with thiopental and propofol and the results were recorded as measurements during anaesthesia. Each IOP measurement was replicated three times and the mean of the equivalents calculated according to the calibration table was recorded as the IOP of the eye. Statistical analyses were performed using a Macintosh computer and the StatView™ package by the t-test.

RESULTS AND DISCUSSION

In the present study, it was determined that anaesthesia was induced in both groups within a very short period of approximately 30-40 sec after the injection of propofol and thiopental.

The mean IOP values of both groups for the periods prior to anaesthesia and during anaesthesia are given in Table 1. Mean heart rates, respiratory rates and body temperatures are presented in Table 2. As can be seen in Table 1, IOP decreased significantly during anaesthesia, when compared to the period prior to anaesthesia in both groups ($p<0.001$). Furthermore, the mean of the IOP values measured in the right and left eyes of the animals decreased from 16.32±0.51 mmHg in the period prior to anaesthesia to 10.12±0.29 mmHg in the period during anaesthesia in Group I and from 15.22±0.65 to 9.92±0.57 mmHg in the same periods in Group II. The rate of decrease in IOP was 37.9% in Group I and 34.8% in Group II.

As Table 2 shows, the heart rate increased significantly in Group II during anaesthesia ($p<0.01$). However, no statistical difference was determined for any of the clinical parameters in Group I or for respiratory rates and body temperatures in Group II between the periods prior to anaesthesia and during anaesthesia.

In the group that received propofol, anaesthetic post-induction apnea developed in one of the dogs at the beginning of anaesthesia. However, it was observed that the animal was calm and comfortable during reanimation. In the group that received thiopental, anaesthetic post-induction apnea developed in 4 animals, whilst excitation occurred in 5 animals during recovery period.

In animals undergoing ophthalmic surgery, the method of anaesthesia applied serves two main objectives. These are the prevention of a possible increase in IOP and as targeted in all kinds of surgery, the stabilization of cardiopulmonary functions. Prolonged elevated levels of IOP during ophthalmic surgery may cause corneal opacity and damage to the pupil. For this reason, during ophthalmic surgery performed under general anaesthesia, it is required that IOP is maintained at normal levels or levels below normal values (Donlon,

Table 1: Intraocular pressure changes in the groups (mmHg)

Groups	Pre-anesthetic period	During anesthesia	p-value
Propofol			
Right eye	16.54±0.56	10.37±0.38	***
Left eye	16.09±0.87	9.86±0.44	***
Total	16.32±0.51	10.12±0.29	***
Thiopental			
Right eye	14.67±0.88	10.35±0.91	***
Left eye	15.77±0.97	9.48±0.70	***
Total	15.22±0.65	9.92±0.57	***

***: $p<0.001$

Table 2: Clinical parameters in the groups

	Propofol			Thiopental		
Parameters	Pre-anesthetic period	During anesthesia	p-value	Pre-anesthetic period	During anesthesia	p-value
Heart rate (min^{-1})	97.1±4.450	95.9±5.310	(-)	97.9±5.890	112.2±9.17	**
Resp. rate (min^{-1})	28.8±1.210	27.6±1.410	(-)	23.6±0.990	24.2±1.34	(-)
Body temperature (°C)	38.37±0.23	38.12±0.29	(-)	38.31±0.25	38.02±0.27	(-)

(-) : Insignificant; **:p<0.01;

1994; Bozlan *et al*., 1998; Seymour and Gleed, 1999; Batista *et al*., 2000; Schafer *et al*., 2002). In cases where dogs are premedicated, it is suggested that propofol be used at a dose of 4 mg kg^{-1}, whilst in cases where dogs are not premedicated, the dose is suggested to be increased to 7 mg kg^{-1}. Similarly, when premedicated, it is suggested that dogs be administered thiopental at a dose of 8-10 mg kg^{-1}, whilst when not premedicated, the administration dose may be increased to 20-25 mg kg^{-1}.

In the present study, in order to ensure the objective evaluation of the effects of both drugs on IOP, the animals were not premedicated and the anaesthetics were administered at the doses suggested for non-premedicated cases.

In the present study, it was observed that in both groups, IOP values decreased significantly during anaesthesia compared to the period prior to anaesthesia. Decrease in IOP during general anaesthesia is explained by various mechanisms. Some suggest (Presbitero *et al*., 1980) that since IOP is regulated by the hypothalamus, the inhibition of the hypothalamus during general anaesthesia results in the decrease of IOP, while some other suggest that decrease in IOP may be related to decrease of the HA (Murphy, 1985; Artru, 1993; Batista *et al*., 2000). It is also reported that the diencephalon is a region which has significant influence on IOP and that any pharmacological agent that affects the diencephalon may significantly reduce IOP (Miller, 1981; Schafer *et al*., 2002). Therefore, general anaesthetics such as propofol and thiopental, which affect the diencephalon are reported to facilitate the external flow of the HA, to relax the extraocular muscles and thereby to reduce IOP (Miller, 1981; Batista *et al*., 2000).

In the present study, following the intravenous injection of both anaesthetics, temporary anaesthetic post-induction apnea developed in 4 animals in the thiopental group and in one animal in the propofol group. After external heart massage was performed, respiration turned to normal in all of these animals. The development of anaesthetic post-induction apnea following injection is due to the depression of the central nervous system caused by the initial high plasma concentration. While reanimation occurred without any problem in the dogs that were administered propofol in the group which received thiopental, 5 of the animals exhibited reanimation associated with excitation. In fact, it is reported that in cases, where barbiturate derivatives are used alone as anaesthetics, reanimation will be associated with excitation (Hall *et al*., 2001).

Some researchers (Hilbery, 1992; Tramer *et al*., 1997) have pointed out to the risk of bradycardia during propofol anaesthesia and for this reason, they have suggested that the heart rate is required to be maintained throughout surgery. On the other hand, Labreck *et al*. (1998) has indicated that propofol anaesthesia does not have any significant effect on heart functions and that the risk of respiratory depression arises only with increase in the dose of the anaesthetic. Similarly, in a previous study (Quandt *et al*., 1998), it was determined that propofol did not cause any difference in the cardiovascular parameters of healthy dogs.

In agreement with these reports in the present study, no statistically significant difference was determined between the periods prior to anaesthesia and during anaesthesia for heart rate or respiratory rate in the group, which received propofol. However, in the group, which received thiopental, it was determined that the heart rate measured after anaesthesia was greater than the value measured prior to anaesthesia. As a matter of fact, it is reported that in dogs, thiopental may cause increased heart rate and decreased arterial blood pressure and cardiac yield (Goldberg *et al*., 1968; Nagel *et al*., 1979; Turner and Ilkiw, 1990; Miller, 1981; Quandt *et al*., 1998).

CONCLUSION

In this study, although it was determined that both propofol and thiopental reduced IOP markedly, the rates of decrease caused by the two anaesthetics did not differ significantly. However, due to the more limited adverse effects associated with its use, it was concluded that propofol be preferred for ophthalmic surgery.

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