RESEARCH ARTICLE

Propofol/Etomidate Induced and Isoflurane Maintained Anaesthesia in Dogs

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Abstract

Twenty-four clinical cases of dogs presented for surgical interventions requiring general anaesthesia were randomly divided into four groups (n=6) irrespective of age, breed, sex, body weight and surgical procedure. The animals of group I and II were first premedicated with atropine sulphate @ 0.02 mg/kg BW and butorphanol @ 0.2 mg/kg BW intramuscularly; whereas, atropine sulphate @ 0.02 mg/kg BW and buprenorphine @ 0.02 mg/kg BW was administered intramuscularly in animals of group III and IV, followed by diazepam @ 0.5 mg/kg BW intravenously in all the dogs. Induction of anaesthesia was achieved by intravenous administration of 1% propofol in group I and III and 0.2 % etomidate in group II and IV till effect. Dose sparing effect of pre-anaesthetic drugs, anaesthetic duration, *viz.,* duration of surgery, duration of maintenance of anaesthesia, total duration of anaesthesia, recovery time and quality parameters, *viz.,* quality of sedation, induction, maintenance anaesthesia and recovery were recorded. There was significant reduction in the induction dose of etomidate as well as recovery time as compared to propofol with both the pre-anaesthetic agents. The induction dose of propofol was also significantly reduced particularly with butorphanol than with buprenorphine. Duration of surgery, duration of maintenance of anaesthesia and total duration of anaesthesia were apparently lower in group IV than other three groups, but the duration of surgery only differed significantly due to variety of surgical procedures. Quality of sedation, induction, maintenance anaesthesia and recovery were found good to excellent in all the groups.

Keywords: Anaesthesia, Dog, Etomidate, Isoflurane, Propofol.

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Introduction

Choosing a safe anaesthetic protocol is an integral part of surgical intervention, and balanced anaesthetic technique is the administration of combination of two or more anaesthetic drugs, which provides smooth rapid induction, adequate hypnosis, proper analgesia, uncomplicated recovery with minimal suppression of vital organ functions and adverse effects of the individual drugs (Thurmon and Short, 2007). Propofol is the most widely used short acting intravenous induction and maintenance anaesthetic agent in dogs which produces smooth and rapid induction and recovery (Ogawa *et al.*, 2006); whereas, etomidate is the least commonly used short acting non-barbiturate, carboxylated imidazole derivative with rapid onset of induction with rapid recovery and has stable cardiopulmonary function. Butorphanol is potent opioid pre-anaesthetic agent that produces mild to moderate analgesia and sedation along with minimum cardiovascular and respiratory depression in dogs (Carpenter *et al.,* 2005), while buprenorphine is a potent semisynthetic lipophilic opioid analgesic with partial agonist and antagonist properties and provides post-operative analgesia for 6-8 h (Watanabe *et al.,* 2018). Diazepam is a water insoluble benzodiazepine used as sedative, anxiolytic, muscle relaxant, hypnotic and anticonvulsant that was used in combination with opioid analgesics to reduce the anxiety and enhance the sedative effect in pre- and post-operative periods (Hellyer *et al.,* 2001).

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The present research work was carried out with objectives to evaluate sedative and dose sparing effect of atropine sulphate-butorphanol/buprenorphine and diazepam as preanaesthetic agents; quality of propofol and etomidate as induction anaesthesia and the efficiency and quality of isoflurane as maintenance agent in dogs.

Materials and Methods

Twenty-four clinical cases of dogs presented for surgical interventions requiring general anaesthesia were randomly divided into four groups (n=6) irrespective of age, breed,

sex, body weight and surgical procedure. All the dogs were fasted for 12 h and water withheld for 6 h prior to anaesthesia. The animals of group I and II were first premedicated with atropine sulphate (Inj. Atroplus, Atropine sulphate 0.6 mg/mL, Instant Pharmaceuticals, Amritsar) @ 0.02 mg/kg BW and butorphanol (Inj. Butrum-2, Butorphanol tartrate 2 mg/mL, Aristo Pharmaceuticals Pvt. Ltd., MP) @ 0.2 mg/kg BW intramuscularly; whereas, atropine sulphate @ 0.02 mg/kg BW and buprenorphine (Inj. Buprerays, Buprenorphine 0.3 mg/mL, Parcotic Healthcare Pvt. Ltd., Gujarat) @ 0.02 mg/kg BW was administered intramuscularly in animals of group III and IV. After fifteen minutes, diazepam (Inj. Diazrays-10, Diazepam 5 mg/mL, Anhil Parenterals Pvt. Ltd., Gujarat) @ 0.5 mg/kg BW was administered intravenously in all the dogs and then induction of anaesthesia was achieved by intravenous administration of 1% propofol (Inj. Dipventin, Propofol injection 10 mg/mL, Naprod Life Sciences Pvt. Ltd., Thane) in group I and III, and 0.2 % etomidate (Inj. Troymidate, Etomidate 2 mg/mL, Troika Pharmaceuticals Ltd., Uttarakhand) in group II and IV till effect, and the endotracheal intubation was performed in all the animals. Subsequently, the anaesthesia was maintained by isoflurane with 100% oxygen through small animal inhalation anaesthesia machine (Landmark USA-2100, Vetland Medical Sales & Services, Kentucky, USA) in all the animals.

The induction doses of 1% propofol in group I and III and 0.2% etomidate in group II and IV were calculated in milligrams per kilogram body weight. The time interval in min from the start of isoflurane administration to cessation of isoflurane administration was recorded as duration of maintenance anaesthesia. Time elapsed in min from starting of skin incision till the last skin suture taken was considered as duration of surgery. The time interval in min from the disappearance to reappearance of pedal reflex was recorded as the total duration of anaesthesia. The time interval in min from discontinuation of isoflurane administration to reappearance of the pedal reflex was considered as recovery time.

Quality of sedation and quality of induction anaesthesia was graded on scale of 1 to 4 score as suggested by Singh *et al.* (2012) and Dinesh *et al.* (2019). Quality of maintenance anaesthesia was assessed by evaluation of palpebral reflex, pedal reflex, jaw tone and eye ball position. All the reflexes were evaluated before administration of any anaesthetic drugs, prior to induction, immediately after induction and thereafter at every 10 min up to 50 min of observation period. The data generated was analyzed statistically.

Results and Discussion

The mean values of induction dose of propofol were 2.55±0.42 mg/kg and 3.44±0.25 mg/kg in group I and III; whereas, the mean values of induction dose of etomidate were 1.34±0.13 mg/kg and 1.30±0.15 mg/kg in group II and IV, respectively (Table 1). Significant difference in the induction dose of propofol was noticed in between the groups, but not of etomidate. The mean values of induction dose of propofol in both the groups and with butorphanol as preanesthetic in particular, were reduced as compared to the recommended dose of 4 to 6 mg/kg. Thurmon and Short (2007) stated that opioid alone or in combination with diazepam produced potent dose sparing effect in dogs which might be due to synergic effect of benzodiazepine and opioid agent. Similar findings were recorded by various scientists (Ko *et al.,* 2006; Dar *et al.,* 2019; Suthar, 2016; Tyagi *et al.,* 2020; Chaudhary, 2021) after premedication with diazepam or midazolam with or without butorphanol on dose of propofol in dogs. As observed in the present study, the reduction in the dose of propofol to 3.3±1.1 mg/kg (Shih *et al.,* 2008) and 3.3±1.8 mg/kg (Ko *et al.,* 2011 and Slingsby *et al.,* 2011) after buprenorphine premedication has also been reported in dogs.

A reduction in the induction dose of etomidate upto 1.34±0.13 mg/kg and 1.30±0.15 mg/kg, in group II and IV, respectively, was observed in the present study as compared to the recommended dose of 1.5 to 3.0 mg/kg in dogs (Branson, 2007). Perk *et al.* (2002), Sams *et al.* (2008), Dar *et al.* (2019), Chaudhary (2021) and Sastry *et al.* (2021) also reported reduction in induction dose of etomidate after benzodiazepine with or without opioid premedication in dogs.

Isoflurane was used as maintenance anaesthesia in all the four groups of dogs in the present study and the mean±SE values of duration of maintenance anaesthesia were 62.0±3.57, 59.67±4.23, 65.5±4.30 and 51.67±0.84 min in groups I, II, III and IV, respectively (Table 2). The corresponding values of duration of surgery were 57.00±4.16, 55.00±4.37, 61.33±4.22 and 45.50±1.26 min and total duration of anaesthesia 70.67±3.55, 66.50±4.22, 74.50±4.29 and 58.50±0.89 min in groups I, II, III and IV. Although the values of all three parameters were quite lower in group IV than other three groups, the differences in the mean values of only the

Table 1: Mean ± SE values of induction dose of propofol and etomidate in dogs

Groups (n=6)	Preanaesthetic agents			Induction agents	Induction dose (mg/kg BW)	*P* value
I	Atropine sulphate IM	Butorphanol IM	Diazepam IV	1% Propofol IV	2.55 ± 0.42^{b}	0.001
II				0.2% Etomidate IV	1.34 ± 0.13^{c}	
III		Buprenorphine IM		1% Propofol IV	3.44 ± 0.25^{a}	
IV				0.2% Etomidate IV	1.30 ± 0.15^{c}	

Means bearing different superscripts differ highly significantly between the groups (p≤ 0.01)

Table 2: Mean ± SE values of anaesthetic duration parameters in dogs

Groups (n=6)	Duration of maintenance anaesthesia (min)	Duration of surgery (min)	Total duration of anaesthesia (min)	Recovery time (min)
I	62.00 ± 3.57	57.00 ± 4.16^{ab}	70.67 ± 3.55	5.83 ± 0.31^{a}
II	59.67 ± 4.23	55.00 ± 4.37^{ab}	66.50 ± 4.22	3.67 ± 0.33^{b}
III	65.50 ± 4.30	61.33 ± 4.22^{a}	74.50 ± 4.29	5.83 ± 0.48^{a}
IV	51.67 ± 0.84	45.50 ± 1.26^{b}	58.50 ± 0.89	3.33 ± 0.21^{b}
p - value	0.07	0.05*	0.10	0.0001***

Means bearing different superscripts within the column differ significantly at p≤ 0.05 and P<0.001.

Table 3: Mean ± SE score values of anaesthetic quality parameters in dogs

Groups (n=6)	Quality of sedation	Quality of induction	Quality of recovery
I	3.50 ± 0.34	4.00 ± 0.00	4.00 ± 0.00
II	3.83 ± 0.17	3.83 ± 0.17	4.00 ± 0.00
III	3.50 ± 0.34	4.00 ± 0.00	3.83 ± 0.07
IV	3.83 ± 0.17	3.83 ± 0.17	4.00 ± 0.00
p - value	0.67	0.58	0.51

duration of surgery were significant (Table 2). However, the variation in the different duration of anaesthesia parameters was directly related to the varying surgical procedures included in the present study.

The mean (±SE) values of recovery time were 5.83±0.31, 3.67±0.33, 5.83±0.48 and 3.33±0.21 min in groups I, II, III and IV, respectively. Non-significant difference in the recovery time was noticed in between group I and III (propofol) and in between group II and IV (etomidate) groups; however the recovery time of the dogs of etomidate groups II and IV was significantly (p<0.001) lower than the dogs of propofol groups I and III (Table 2). Chaudhary (2021) recorded comparable recovery time in dogs induced with propofol and etomidate (5.00±1.10 and 3.33±0.33 min., respectively) followed by isoflurane maintenance anaesthesia. Sen and Kilic (2018) also reported 6.00±2.00 min of recovery time in dogs; whereas, Reed *et al.* (2019) reported 9.70±3.40 min extubation time in isoflurane maintained and propofol induced dogs. Similarly, Suthar (2016) reported 12.67±1.58 min of recovery time in propofol induced and isoflurane-maintained dogs with premedication of atropine-butorphanol-diazepam. However, Sastry *et al.* (2021) reported only 1.78±0.26 min' recovery time in the dogs induced with etomidate anaesthesia and maintained with isoflurane. The rapid post-anaesthetic recovery in all groups was attributed to low blood-gas solubility coefficient (1.94) of isoflurane used (Steffey, 2001).

Sedation quality scores observed were good to excellent in all the animals, except in one dog each from group I and III, in which paradoxical excitement was observed after administration of diazepam; however, non-significant difference in the mean values of sedation quality was observed in between the groups (Table 3). Kojima *et al.* (2002) used butorphanol in dogs to improve the sedative effect of diazepam and midazolam; whereas, Ko *et al.* (2011) reported mild to moderate sedation after buprenorphine administration in dogs.

The mean score value of induction quality was 4.00±0.00 in group I and III (Propofol groups) and 3.83±0.17 in group II and IV (Etomidate group) with non-significant difference between all the groups. Successful smooth endotracheal intubation was also performed in all the animals of four groups after induction of anaesthesia, except in one dog each of group II and IV (Etomidate group), in which difficult endotracheal intubation was noticed due to interference of laryngeal movement and gagging reflex of animal (Table 3). Comparable little better induction quality with propofol than with etomidate was observed by Sams *et al.* (2008), Dar *et al.* (2019), Chaudhary (2021) and Sastry *et al.* (2021) in dogs. Similarly, Jones *et al.* (2021) reported gagging in 45% of dogs after etomidate induction following midazolam premedication, and Rodriguez *et al.* (2012) reported unsatisfactory quality of induction anaesthesia using etomidate in dogs due to myoclonic movements and salivation. On the contrary, Perk *et al.* (2002) reported abolished pharyngolaryngeal reflex and easy endotracheal intubation in etomidate induced dogs with premedication of diazepam and alfentanil.

Sano *et al.* (2003) and Jones *et al.* (2021) reported adverse signs like respiratory depression, induction apnea, muscle twitching, extensor rigidity, paddling, opisthotonous, bradycardia, hypotension, tachycardia, salivation, urination and vomition in propofol and etomidate induced dogs, however; no such adverse signs were noticed in the present study. The adverse signs could be reduced by prior administration of benzodiazepines and opioids (Suthar, 2016; Javdani *et al.,* 2020; Chaudhary, 2021), which produces smooth, rapid and good to excellent quality of induction anaesthesia as was observed in the present study.

Isoflurane was used as maintenance anaesthesia in all animals and quality of maintenance anaesthesia was evaluated by observing jaw tone, pedal reflex, palpebral reflex and eye ball position at different time intervals during maintenance period. The mean score values of jaw tone, palpebral reflex, pedal reflex and eyeball position were observed excellent (4.00±0.00) during entire maintenance anaesthetic period in all the animals of four groups indicating that isoflurane produced excellent quality of maintenance anaesthesia with sufficient depth, muscle relaxation and analgesia during surgery. Similarly, Basha and Ranganath (2012), Suthar (2016) and Chaudhary (2021) also reported excellent quality of maintenance anaesthesia with better control over anaesthetic depth using isoflurane in dogs.

Smooth and good to excellent recovery with mean score values of 4.00±0.00 were recorded in all animals of three groups, except in one dog of group III (3.83±0.07), which showed paddling during recovery period (Table 3). Similarly, Jadon *et al*. (2008), Suthar (2016) and Chaudhary (2021) reported smooth, rapid and excellent quality of recovery using isoflurane anaesthesia in dogs.

Conclusions

The dose sparing effect of pre-anaesthetic drugs butorphanol @ 0.2 mg/kg BW and buprenorphine @ 0.02 mg/kg BW, IM, and anaesthetic duration, *viz.,* duration of surgery, maintenance of anaesthesia, total duration of anaesthesia and quality parameters, *viz.,* quality of sedation, induction, maintenance anaesthesia and recovery time were studied with intravenous administration of 1% propofol in group I and III, and 0.2 % etomidate in group II and IV till effect and maintenance with isoflurane in dogs (n=6 each) undergoing various surgical procedures. The induction dose and recovery time were significantly reduced in etomidate groups as compared to propofol with both the pre anaesthetic agents. The quality of sedation, induction, maintenance anaesthesia and recovery were found good to excellent in all the groups.

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