CLINICAL EFFICACY OF PROPOFOL INDUCED ISOFLURANE ANAESTHESIA IN GERIATRIC DOGS PREMEDICATED WITH DIAZEPAM AND BUTORPHANOL

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THESIS

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DECLARATION

I hereby declare that the thesis entitled **"Clinical efficacy of propofol induced isoflurane anaesthesia in geriatric dogs premedicated with diazepam and butorphanol"** is a bonafide record of research done by me during the course of research and that the thesis has not previously formed the basis for the award of any degree, diploma, fellowship or other similar title, of any other University or Society.

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CERTIFICATE

Certified that the thesis entitled **"Clinical efficacy of propofol induced isoflurane anaesthesia in geriatric dogs premedicated with diazepam and butorphanol"** is a record of research work done independently by **Manasa M. R. (18-MVM-66)** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to her.

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We, the undersigned members of the advisory committee of **Manasa M. R. (18-MVM-66),** a candidate for the degree of Master of Veterinary Science in Veterinary Surgery and Radiology**,** agree that this thesis entitled **"Clinical efficacy of propofol induced isoflurane anaesthesia in geriatric dogs premedicated with diazepam and butorphanol"** may be submitted by **Manasa M. R. (18-MVM-66)** in partial fulfilment of the requirement for the degree.

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MANASA. M. R.

INTRODUCTION

1. INTRODUCTION

The word ‘anaesthesia’ is derived from Greek word ‘anaisthaesia’, meaning insensibility, which is used to describe the loss of sensation to any part or to the entire body. The drugs used for anaesthesia supress the activity of nervous tissue regionally, locally or within the central nervous system.

Now a days, veterinary anaesthesia started evolving as a science with incorporation of novel technologies and progress in pharmaceutical disciplines, in order to obtain the triad of anaesthesia i.e., analgesia, unconsciousness and muscle relaxation with safe methods without causing any complications. However anaesthesia in a compromised and aged patient is risky to the animal and challenging to the veterinary anaesthesiologists. On the other hand the need for general anaesthesia is rapidly increasing in the geriatric companion animals, not only for surgery but also for diagnostic and therapeutic purposes, as the longevity and concern of the people for older animals are increasing.

Geriatric patients are defined as those individuals that have completed 75 to 80 per cent of their expected life span (Baetge and Matthews, 2012). It is utterly necessary to evaluate the geriatric patient before anaesthesia, as the age decreases the functional reserve capacity of vital organs which increases the risk of ongoing diseases. Hence the drugs used in these animals must be titrated to their dose and administered according to the prevailing health status of the animal.

In the present day, canine anaesthesia largely adopts multimodal balanced anaesthesia by combining various groups of drugs at minimal doses, which may reduce side effects of each drug used. Acceptable combinations include cocktail of analgesics, sedatives, muscle relaxants and general anaesthetic drugs.

Butorphanol is a synthetic morphine derived opioid with μ antagonist and k agonist action, with good antitussive, analgesic and sedative actions. Premedication with butorphanol produced analgesia and mild sedation with minimum respiratory

distress in dogs (Gross *et al*., 2002). This makes butorphanol a better choice in geriatric anaesthesia.

Diazepam belongs to benzodiazepine group of drugs, which provides better sedation and hypnotic effects in animals. This drug also has muscle relaxant, anticonvulsant and anterograde amnesia properties with least affections on cardiopulmonary function. Since diazepam lacks analgesic effect, it can be very well combined with opioids to produce excellent analgesia with a decrease in the total amount of anaesthetic doses.

Since both butorphanol and diazepam have minimum effects on cardiopulmonary system, they can be used for deep sedation in weak, aged and sick animals.

Propofol is a short acting, versatile, intravenous, induction anaesthetic agent, which activated GABA (gamma-aminobutyric acid) and inhibits NMDA (N-methyl-D-aspartate) receptors, there by suppressing the central nervous system. Propofol can also provide smooth, rapid and adequate induction of anaesthesia in dogs (Dar *et al.,* 2019).

Isoflurane is a halogenated organic compound, which is a structural isomer of enflurane. It is commonly used in veterinary practice for mask induction and maintenance of anaesthesia. Haemodynamic stability and minimum cardiopulmonary effects are the attributes of isoflurane. It was reported that use of isoflurane would not impair liver and kidney functions (Sen and Kilic, 2018). Hence isoflurane can be safely used in compromised animals, with little adverse effect on hepatic and renal systems.

In the present study, butorphanol and diazepam were used for premedication, propofol for induction and isoflurane for maintenance of surgical plane of anaesthesia in geriatric dogs. The study was undertaken with the objective of evaluating efficacy of propofol-isoflurane anaesthesia with diazepam-butorphanol premedication for surgical procedures in geriatric dogs.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

The need for general anaesthesia increased rapidly in geriatric dogs, for surgery and for diagnostic and therapeutic purposes. The pharmacokinetics and pharmacodynamics of anaesthetic drugs got altered as age advanced (Dowling, 2005).

Geriatric patients were defined as those individuals, that had completed 75-80 per cent of their expected life span. The chances of morbidity and mortality in these individuals increased because of age related concurrent diseases and physiological changes occurring in various organ systems which led to a decline in organ function or reserve (Baetge and Matthews, 2012).

General anaesthesia altered the physiological limits of clinical observations (Haskins *et al.*, 2015) and monitoring was essential in geriatric patients throughout the anaesthetic period to avoid complications like hypoxia, apnoea or hypothermia (Sen and Kilic, 2018).

2.1. PHYSIOLOGICAL CHANGES ASSOCIATED WITH AGING

The anaesthetic risk of geriatric patients increased than in others which necessitated preanaesthetic screening of elderly patients (Joubert, 2007). Because of reduced functional reserve capacity of various organ systems, animal lost its ability of adaptation and homeostasis, which led to decreased response to external stress (Grubb *et al*., 2015).

2.1.1. Cardiovascular system

According to Dowling (2005), chronotropic and ionotropic effect of alfa adrenergic drugs decreased as the age advanced. These elderly patients had an increase in the output of sympathetic nervous system resulting in redistribution of blood flow, which altered the drug deposition and its action. Concurrently, there was disturbance in sodium and water retention in geriatric dogs and cats having underlying cardiac disease.

Baetge and Matthews (2012) opined that auto-regulation of blood flow got reduced in elderly patients due to the thickening of elastic fibres, increased collagen content in the heart wall and calcification of vascular wall. These changes resulted in the reduced filling, efficiency and cardiac output.

According to Dixon and Keates (2013) myocardial fibrosis, myxomatous valvular degeneration and ventricular hypertrophy of heart, were the major anatomical changes with ageing in dogs. Cardiac output and pumping ability of heart reduced with myocardial fibre atrophy and heart rate reduced when pacemaker cells were affected. Hence arrhythmia causing drugs like alfa 2 adrenergic agonists, thiopentone, and high doses of ketamine must be avoided.

2.1.2. Respiratory system

Carpenter *et al*. (2005) reported that, the drugs having mild respiratory depressant action, in geriatric patients led to significant hypoxia and hypercarbia, due to the decreased functional reserve capacity of lung in those patients.

Hughes (2008) mentioned that elasticity of the lungs decreased as age advanced, which led to reduced functional residual capacity of lung. Thus he opined that older patients were better maintained in positive pressure ventilation, since incidences of hypercapnia was more in them.

The changes in pulmonary system along with ageing were reduction in the efficiency of gas exchange, ventilatory volume and reduction in the diaphragmatic and intercostal muscle mass, which resulted in decline of vital capacity and total lung capacity, which led thorax to become more rigid (Grubb *et al*., 2015).

2.1.3.Central nervous system

Most of the aged dogs suffered from cognitive dysfunction, vision and hearing abnormalities. Hence aged animals got excited and confused in the hospital environment (Landsberg and Araujo, 2005).

The action of anaesthetic drugs got enhanced and minimum alveolar concentration of inhalant agents got reduced with ageing. Hence the linear usage of other drugs like local anaesthetics, barbiturates, opioids etc., along with main anaesthetic agents was avoided in anaesthetic protocols of geriatric patients (Carpenter *et al.*, 2005).

According to Dixon and Keates (2013) the process of ageing caused neuronal degeneration which resulted in reduction of cerebral mass. Concurrently cerebral perfusion, oxygen consumption and neurotransmitters like dopamine, noradrenaline also got depleted.

2.1.4. Renal system

Burkholder (2000) opined that 15-20 per cent of geriatric dogs and cats suffered from renal insufficiency due to decreased renal blood flow and glomerular filtration rate. The capacity of kidney reduced to concentrate urine and resulted in polyuria.

Baetge and Matthews (2012) stated that maintenance of rennin angiotensin system and sodium- water balance was difficult in older patients. Hence aged individuals had less capacity to tolerate acid-base imbalance, hypovolemia, haemorrhage and electrolyte imbalance.

Dixon and Keates (2013) suggested that, drugs like ketamine which get excreted through kidney should be used with caution in elderly patient due to their longer half-life.

2.1.5. Hepatic system

Dowling (2005) opined that hepatic blood flow got reduced with age during perioperative period and resulted in long-lasting plasma clearance of the drugs like lidocaine, morphine and acepromazine.

Hughes (2008) mentioned that hepatic metabolism of drugs depended on

blood flow and enzymatic activity in the liver. In elderly patients, though there was reduction in hepatic mass, enzyme activity remained constant with the reduction in functional microzomal enzymes. In elderly patients, liver functions like clotting, glucose regulation and detoxification were disturbed which made the patient unfit for complicated surgeries.

Thoracic epidural anaesthesia reduced the hepatic blood flow in human patients and hence hepatic hypo perfusion was considered as the major risk factor for liver injury in perioperative period (Trepenaitis *et al*., 2010).

2.1.6. Body composition

According to Shafer (2000) the change in the body composition of geriatric patient was increased body fat, which caused total volume of distribution to increase and thus duration of action of the drug got increased. The authors concluded that it was impossible to detect the dose by considering unknown volume of distribution of drug.

Changes with ageing in body composition were increased body fat, decreased skeletal muscle mass and intracellular water. Thus when intravenous drugs were administered, initial concentration of the drug in plasma increased and the total dose of the drug decreased in geriatric patients (Grubb *et al*., 2015).

2.2. BUTORPHANOL

Papich (2000) opined that opioids which acted centrally, produced relevant analgesia and sedation and also inhibited postoperative pain. Compared to NSAID's, opioids had more efficacy with wide margin of safety and minimum complications like gastrointestinal ulcerations and renal toxicity.

Administration of medetomidine with either butorphanol or buprenorphine intravenously produced high quality sedation with early onset and reduced the dose of anaesthetic drugs used during surgical procedures in dogs (Rauser and Lexmaulova, 2002).

Butorphanol combined with midazolam and acepromazine, resulted in good to excellent sedation in dogs and made induction smooth with reduced the dose of propofol for induction (Sano *et al.,* 2003).

Kuo and Keegan (2004) reported that medetomidine - hydromorphone and medetomidine - butorphanol combination of preanaesthetics had better quality of sedation, analgesia and muscle relaxation in canines when compared with administration of medetomidine alone.

Dexmedetomidine combined with butorphanol or diazepam provided sufficient sedation with better muscle relaxation during heavy manipulation of limbs for radiographic procedures in canines for the diagnosis of hip dysplasia. The same results when compared with effects of buprenorphine was less rewarding (Leppanen *et al*., 2006).

According to Fayyaz *et al*. (2009) premedication of dogs with opioid agonists reduced the doses of anaesthetic drugs used for induction and also enhanced the stability of hemodynamic parameters.

Butorphanol, acepromazine and glycopyrrolate combination (BAG) provided better analgesic, sedative and antisialogauge effects and acted as a safe premedicant combination to general anaesthesia in dogs (Kavechiya, 2010).

Butorphanol and medetomidine combination reduced the induction dose of alfaxalone when compared with administration of individual drugs alone in canines (Maddern *et al*., 2010).

Clarke *et al.* (2014) stated that ‘butorphanol’ was a synthetic morphine derived opioid with μ antagonist and k agonist action, with good antitussive, analgesic and sedative action. Opioids when combined with sedatives like $\alpha 2$ adrenoceptor agonists, benzodiazepines, phenothiazines or butyrophenones induced deep sedation and reduced the dosage of intravenous and inhalant anaesthetic agents.

Vijay *et al*. (2018) reported that preanaesthesia with combination of glycopyrrolate, dexmedetomidine and butorphanol in adult and geriatric dogs, showed better sedation with muscle relaxation, lowered the dose of propofol during induction and the concentration of isoflurane for maintenance, when compared with combination of glycopyrrolate, dexmedetomidine and fentanyl premedication.

2.2.1. Cardiopulmonary effects of butorphanol

Gross *et al*. (2002) opined that premedication with butorphanol had mild sedation and minimum respiratory distress effects, thus could be used during laryngeal examination in dogs with mild degree of distress in respiration. The patients premedicated with butorphanol at the dose rate of 0.5 mg per kg body weight and glycopyrrolate at the dose rate of 0.01 mg per kg body weight and anaesthetised with thiopental or propofol (IV up to effect), were scored better in visualisation of the larynx, compared with diazepam-ketamine anaesthesia.

The combination of medetomidine and butorphanol, when administered intramuscularly for captive wild wolves (*Canis rufus*), produced mild cardiovascular changes without much adverse effects (Larsen *et al*., 2002).

Mutoh *et al.* (2002) reported that preanaesthesia with acepromazine-butorphanol and midazolam-butorphanol combinations in dogs resulted in minimum cardiopulmonary variations except for mild hypotension with former combination.

Kuo and Kegan (2004) stated that medetomidine alone, medetomidine-hydromorphone, and medetomidine-butorphanol administration in dogs showed cardiovascular changes like decreased heart rate, cardiac output and increased central venous pressure after five minutes of administration. The mean values of systolic, diastolic and mean arterial pressure were less in medetomidine-hydromorphone treatment compared to medetomidine and medetomidine-butorphanol administration. It was concluded that addition of opioids like hydromorphone and butorphanol had no adverse effects on cardiovascular function,

compared with effects of administrating medetomidine alone. Also opined that these opioids had additive action with medetomidine and provided sufficient analgesia and sedation in dogs.

Fabio *et al*. (2007) compared the effects of preanaesthetic combinations medetomidine – butorphanol with midazolam – butorphanol in canines and concluded that later combination was better to be used in geriatric and sick animals because of mild cardiopulmonary effects of both drugs.

According to Dar *et al*. (2019) butorphanol and diazepam when used as preanaesthetics in geriatric dogs with either propofol or etomidate as an induction agent, had no major adverse effects on cardiopulmonary function.

2.2.2 Haematobiochemical effects of butorphanol

According to Ko *et al*. (2000) there were significantly high $PaCO_2$ and low pH and PaO_2 levels, when dogs were administered with medetomidine - butorphanol or medetomidine - ketamine combinations than when medetomidine was administered alone.

Papich (2000) reported that most of the opioids were metabolized in liver with first pass effect, thus renal disorders and hepatic insufficiency conditions had little effect on opioid pharmacokinetics. But when there was a decreased hepatic blood flow, due to the administration of anaesthetics or beta-blockers resulted in hepatic cirrhosis or shunts and clearance of the opioids was decreased.

There was an increase in the lymphocytes and neutrophils count when glucocorticoids were administered due to stimulation at adrenocortical region during opioid based general anaesthesia in humans (Brand *et al.,* 2003).

Intravenous administration of preanaesthetic combinations like medetomidine- hydromorphone at the dose rate of 20 μg and 0.1 mg per kg body weight respectively and medetomidine-butorphanol at the dose rate of 20 μg and 0.2 mg per kg body weight respectively in canine patients, increased the pCO_2 and

decreased the pO2 and pH values and led to respiratory depression. However this effect was not observed on administration of medetomidine at the dose rate of 20 µg per kg body weight alone (Kuo and Keegan, 2004).

2.3. DIAZEPAM

Hellyer *et al*. (2001) stated that addition of diazepam and opioids in balanced anaesthesthetic regimen reduced the inhalant anaesthetic requirement in dogs. Fentanyl serum concentration was higher when there was administration of diazepam at the dose rate of 0.5 mg per kg body weight IV than on flumazenil treatment. Serum concentration of diazepam and desmethyle diazepam had no significant changes compared to oxazepam. Diazepam increased the anaesthetic effect of isoflurane- fentanyl and decreased the minimum alveolar concentration (MAC) of isoflurane- fentanyl in the study.

Anesthesia induced by propofol- atracurium at the dose rate of 8 mg and 0.3 mg per kg body weight IV respectively, resulted in increased intra ocular pressure, which was blunted using diazepam at the dose rate of 0.25 mg per kg body weight IV (Hofmeister *et al*., 2006).

Leppanen *et al*. (2006) reported that butorphanol or diazepam when combined with dexmedetomidine provided sufficient sedation with better muscle relaxation during heavy manipulation of limbs for radiographic procedures in canines for the diagnosis of hip dysplasia.

Hazra *et al*. (2008) reported that diazepam, xylazine and ketamine combination anaesthesia was successfully used in dogs for phacoemulsification surgical technique along with retro bulbar block. This combination provided definitive eye position, with appropriate intra ocular pressure, stable physiological parameters and sufficient depth of anaesthesia.

Diazepam lacked analgesic effect, hence it was combined with opioids for preanaesthesia in dogs, which produced excellent analgesia and decreased the total

amount of anaesthetic drugs used (Psatha *et al*., 2011).

Gonzalez *et al*. (2013) ascertained that recumbency was observed within 10 minutes after sedating piglets with alfaxalone at the dose rate of 5 mg per kg body weight IM. But there was better quality of sedation and less twitching after addition of diazepam at the dose rate of 0.5 mg per kg body weight IM.

Diazepam at the dose rate of 0.2-0.5 mg per kg body weight IV did not had any dose sparing effect on propofol induction in canines. As benzodiazepines had shorter half-life, a hangover effect of these drugs was likely not possible. However administration of these drugs prolonged the recovery in some patients (Robinson and Weir, 2013).

Clarke *et al.* (2014) stated that benzodiazepine group of drugs provided better sedation and hypnotic effects along with muscle relaxation, anticonvulsant and anterograde amnesia in animals.

Rankin (2015) used diazepam in many species either before induction or in combination with ketamine, which altered the excitatory effects of central nervous system, produced by cyclohexamines. It also produced applicable preinduction sedation when used with other drugs like opioids or alfa 2-adrenergic agonists.

2.3.1. Cardiopulmonary effects of diazepam

Ko *et al*. (2006) ascertained that IV administration of diazepam or minimum dose (microdose) of medetomidine reduced the dose of propofol during induction period, sufficient to perform endotracheal intubation. However medetomidine had longer anaesthetic effect, compared to diazepam.

Intravenous administration of anaesthetics ketamine and diazepam in an eight year old mixed breed dog premedicated with glycopyrrolate at the dose rate of 0.01 mg per kg body weight IM, acepromazine at the dose rate of 0.03 mg per kg body weight IM and hydromorphone at the dose rate of 0.1 mg per kg body weight IM, which was subjected for colonoscopy developed pulmonary oedema

due to hypotensive action of ketamine (Boutureira *et al*., 2007).

Braun *et al*. (2007) reported that there was no significant changes in the mean values of blood pressure and heart rate in dogs with premedication of either diazepam at the dose rate of 0.25 mg per kg body weight IV or lidocaine at the dose rate of 2 mg per kg body weight intravenously.

Cardiopulmonary effects of different drugs used for induction of anaesthesia were evaluated by Fayyaz *et al*. (2009) and reported that administration of a combination of ketamine-diazepam at the dose rate of 1.25 mg and 0.0625 mg per kg body weight IV respectively or propofol-diazepam at the dose rate of 2 mg and 0.2 mg per kg body weight IV respectively in hypovolemic dogs had fewer hemodynamic depression, when compared to isoflurane alone. When propofol-diazepam combination was used for induction of anaesthesia, it resulted in the reduction of total dose of propofol and maintained the mean arterial pressure within normal range. However the combination increased $PaCO_2$ value, when compared with isoflurane or ketamine-diazepam combination due to increased depth of anaesthesia.

Premedication with methadone hydrochloride at the dose rate of 0.2 mg per kg body weight IM and induction with alfaxalone and fentanyl-diazepam-propofol combination in dogs with moderate to severe systemic diseases, resulted in smooth induction with less cardiopulmonary adverse effects during post induction and maintenance of anaesthesia (Psatha *et al*., 2011).

Khurana *et al*. (2014) compared the effects of two balanced anaesthetic protocols in dogs and concluded that there was no preoperative or intra-operative arrhythmia in both diazepam-butorphanol-propofol-halothane and acepromazine-butorphanol-propofol-halothane anaesthesia groups.

2.3.2. Haematobiochemical effects of diazepam

Suresha *et al*. (2012) compared the haemato-biochemical effects of two

anaesthetic combinations in canines and reported a significant decrease in total erythrocyte count, volume of packed red cells and haemoglobin in both triflupromazine hydrochloride-propofol and diazepam-propofol groups. However total leukocyte count and differential leukocyte count showed no significant changes except for neutrophilia and lymphopenia in diazepam-propofol group and triflupromazine hydrochloride-propofol group respectively. Biochemical parameters showed increased level of blood glucose in both groups. But total plasma protein, alanine amino transferase, alkaline phosphatase and creatinine value remained within the normal ranges.

When the effects of two balanced anaesthetic protocols such as diazepam-butorphanol-propofol-halothane and acepromazine-butorphanol-propofol-halothane anaesthesia groups were compared in dogs, there was significant decrease in volume of packed red cells and total erythrocyte count in the groups administered with diazepam while the other group showed only fall in volume of packed red cells. However the biochemical parameters were within normal range in both groups (Khurana *et al*., 2014).

2.4. PROPOFOL

Kojima *et al*. (2002) opined that the dose of propofol for induction of anaesthesia was reduced when preanaesthetic combination acepromazine-butorphanol and midazolam-butorphanol were used.

Propofol produced smooth induction and recovery in dogs and cats. No cardiopulmonary adverse reactions were observed except for induction apnoea in 30 per cent of cats under study (Matthews *et al*., 2004).

Propofol was a shortacting, versatile, intravenous, anaesthesia induction agent, which activated GABA (gamma-aminobutyric acid) and inhibited NMDA (N-methyl- D-aspartate) receptors and suppressed the central nervous system (Kotani *et al*., 2008).

Fayyaz *et al*. (2009) reported that induction of anaesthesia using propofol-diazepam combination provided smooth and calm induction with deep plane of anaesthesia during maintenance in hypovolemic dogs, when compared to ketamine-diazepam and isoflurane administration for induction of anaesthesia in hypovolemic dogs.

Keates and Whittem (2012) compared the occurrence of induction apnoea with alfaxalone and propofol with intravenous dose escalation method and concluded that propofol had more chances of producing induction apnoea than alfaxalone in dogs during induction of anaesthesia.

Robinson and Weir (2013) reported that administration of midazolam at the dose rate of 0.4 mg per kg body weight IV after administration of propofol at the dose rate of 1 mg per kg body weight IV decreased the dose of propofol during induction of anaesthesia.

Taboada and Murison (2010) compared the effects of propofol and alfaxalone for induction of anaesthesia in cats and concluded that both the drugs had smooth induction and better quality recovery without incidence of post induction apnoea in any of the animals.

2.4.1. Cardiopulmonary effects of propofol

Lerche *et al*. (2000) reported that propofol-ketamine combination had better maintenance of cardiopulmonary parameters than propofol alone, when used for induction of anaesthesia in dogs.

Constant infusion rate of propofol at the dose rate of 0.2-0.4 mg per kg body weight IV in dogs produced dose dependant respiratory depression. Heart rate and mean arterial pressure were within normal range throughout anaesthetic period (Aguiar *et al.,* 2001).

Akkerdas *et al*. (2001) noticed that a combination of propofol-midazolam at the dose rate of 1-2 mg IV and 1.5 mg per kg body weight IM respectively should

be considered at last in cats, since this combination resulted increased depressant effects of general anaesthetics like isoflurane on cardiovascular system.

Bester and Stegmann (2001) opined that induction with propofol led to induction apnoea in dogs. Thus alternatives of dose and techniques for administration of this drug was a must.

Sams *et al*. (2008) compared effects of propofol and etomidates in dogs for induction of anaesthesia. Arterial blood pressure was better maintained in etomidate compared to propofol. However recovery period had adverse reactions in case of etomidate with rougher recovery with worsen ataxia scores, compared to propofol.

When propofol-diazepam combination was used as induction agent in dogs, dose of propofol was reduced, thus better maintenance of mean arterial pressure was attained, when compared with isoflurane or ketamine-diazepam combination as induction agents (Fayyaz *et al*., 2009).

Cardiopulmonary effects of propofol and alfaxalone were similar in dogs premedicated with acepromazine and morphine. However both of them had tendency to produce hypoventilation as a major adverse effect when used as total intravenous anaesthesia and ventilatory support was a must (Suarez *et al*., 2012).

Amenguel *et al.* (2013) evaluated the anaesthetic induction of propofol and alfaxalone and reported that there was decrease in the heart rate, systolic, diastolic and mean blood pressure after five minutes of induction with both the drugs. However the changes observed were not significant in their variation.

Sen and Kilic (2018) noticed dose dependent respiratory depression of anaesthetic agents like alfaxalone, sevoflurane, isoflurane and propofol when used in geriatric dogs for maintenance of surgical plane of anaesthesia.

2.4.2 Haematobiochmical effects of propofol

Fayyaz *et al*. (2009) compared the effects of different anaesthetic

combinations for induction of anaesthesia in dogs and reported that propofol-diazepam combination had increased PaCO2, because of increased depth of anaesthesia when compared with isoflurane or ketamine-diazepam combination.

Mcnally *et al*. (2009) opined that pre-oxygenation in dogs helped to increase $PaCO_2$ and pH and increased the time of de-saturation. Thus three minutes of preoxygenation can be recommended in dogs expecting airway difficulties, premedicated with acepromazine-morphine and anaesthesia induced with propofol.

Induction with ketamine or propofol caused a decrease in the levels of haemoglobin, volume of packed red cells and total erythrocyte count due to the haemodilution caused by the sequestering of RBC's in to the spleen (Sankar *et al*., 2011).

Amenguel *et al.* (2013) assessed the anaesthetic induction of propofol and alfaxalone and reported that there was non-significant increase in the end tidal carbon dioxide partial pressure and stable SpO2 levels after five minutes of induction with both the drugs.

Premedication with dexmedetomidine and induction with propofol (0.15 ± 0.03 mg/kg/min) or ketamine (0.54 mg/kg/min) as total intravenous anaesthesia produced good surgical plane of anaesthesia in goats suffering from uroithiasis. However haemodynamic stability was better with ketamine and propofol showed good muscle relaxation with better sedation (Kumar *et al*., 2014).

Taboada and Murison (2010) reported that end tidal carbon dioxide partial pressure was increased up to fifteen minutes after induction with propofol and during maintenance with isoflurane in felines. Later the values returned back to normal values after recovery.

Maeda *et al.* (2018) evaluated the glucose tolerance test in canines with constant rate infusion of propofol and concluded that there was hyperglycemia in peri- operative period due to the release of hormones like epinephrine and cortisol.

2.5 ISOFLURANE

Dose of isoflurane during maintenance was reduced by using midazolam as a pre anaesthetic and also reduced the dose of propofol for induction of anaesthesia (Bester and Stegmann, 2001).

The effects of isoflurane, halothane and sevoflurane anaesthesia on hepatocellular damage and hepatic function were investigated in canines by Topal *et al.* (2003) and concluded that halothane was inferior than sevoflurane and isoflurane in terms of liver functions during period of post-operation.

Lopez *et al.* (2009) reported that desflurane had faster recovery than isoflurane and sevoflurane in dogs. However all these maintenance agents had good recovery scores in canines.

Yamashita *et al.* (2009) evaluated the effect of age of canine patients on minimum alveolar concentration (MAC) of inhalant anaesthetic agent sevoflurane and concluded that there was a profound decrease in the MAC value of sevoflurane with the increase in age, due to the increased anaesthetic potency with ageing. Hence careful titration of inhalant anaesthetics with vigilant monitoring was a must in aged dogs.

Pawar *et al*. (2011) opined that administration of hydrocortisone ten minutes prior to weaning from nitrous oxide-isoflurane-remifentanil anaesthesia reduced the incidences of shivering postoperatively in human patients.

Isoflurane a halogenated organic compound and a structural isomer of enflurane, was commonly used in veterinary field for mask induction and maintainance of anaesthesia (Grimm *et al.*, 2015).

Sen and Kilic (2018) mentioned that alfaxalone-sevoflurae group had longer recovery period than other groups like propofol-isoflurane, propofol-sevoflurane, and alfaxalone-isoflurane. Overall observations reported shorter recovery periods to isoflurane than sevoflurane.

2.5.1 Cardiopulmonary effects of isoflurane

Ettinger (2000) reported that ECG changes during general anaesthesia was either elevation or depression in ST segment and changes in morphology of the T-wave was due to myocardial hypoxia in dogs.

Kuusela *et al.* (2001) reported that propofol-isoflurane anaesthesia had less respiratory depression and smooth-rapid recoveries than when propofol alone was used for maintenance of anaesthesia in dogs.

Nagasaki *et al.* (2001) reported that there was an increase in the heart rate and decrease in the systolic blood pressure in human patients during isoflurane and sevoflurane anaesthesia.

Inhalant anaesthetic agents like isoflurane, sevoflurane, enflurane, halothane and desflurane increased the heart rate in canines by decreasing the cardiac sympathetic vagal tone (Picker *et al*., 2001).

Polis *et al*. (2001) opined that inhalant anaesthetic agents like isoflurane, halothane and sevoflurane caused increase in heart rate and decreased respiration rate, systolic, diastolic and mean arterial blood pressure during maintenance of anaesthesia in mongrel dogs.

Sevoflurane (3.45 ± 0.22) had higher anaesthetic index than isoflurane (2.61 ± 0.14) in dogs. However both sevoflurane and isoflurane showed dose related cardiovascular and pulmonary depression in dogs when used for maintenance of anaesthesia (Galloway *et al*., 2004).

Enouri *et al*. (2008) reported that there was a decrease in the body temperature, respiration rate and volume of packed red cells after induction with propofol and during maintenance with isoflurane in dogs.

Uilenreef *et al*. (2008) opined that there was decrease in the heart rate, systolic, diastolic and mean arterial pressure during maintenance of anaesthesia

with isoflurane along with constant rate infusion of dexmedetomidine in canines

Fayyaz *et al*. (2009) opined that injectable anaesthetic combinations like ketamine-diazepam or propofol-diazepam provided rapid induction and also higher arterial blood pressure immediately after induction when compared with inhalant anaesthetic agent isoflurane. Cardiopulmonary changes associated with isoflurane was similar in both hypovolemic and normovolemic dogs. However patient's induced with isoflurane were at high risk of hypotension compared to ketamine-diazepam or propofol-diazepam combinations for induction of anaesthesia.

Chohan *et al*. (2013) reported that inhalant anaesthetic agents had systemic vasodilatory effects and increased cerebral blood flow and decreased blood pressure in dogs.

Caines *et al*. (2014) compared the effects of propofol and isoflurane for maintenance of anaesthesia in canines, undergoing magnetic resonance imaging with intracranial disease and reported that propofol had better cardiovascular stability and quick and smooth recovery compared to isoflurane.

2.4.2. Haematobiochemical effects of isoflurane

Kuusela *et al*. (2001) opined that arterial blood pH and bicarbonate concentrations were decreased after five minutes of induction with propofol and isoflurane commencement for maintenance of anaesthesia in adult Beagles and later attained the baseline values after recovery.

Conzen *et al*. (2002) reported that low flow sevoflurane and isoflurane used in renal insufficiency human patients did not result in significant changes in blood urea nitrogen, creatinine, creatinine clearance, urine protein and glucose.

Neto *et al*. (2007) stated that haemodynamic stability was better in isoflurane than for sevoflurane or halothane in dogs with acute blood loss.

Ramankutty (2008) reported that there was decrease in haemoglobin

concentration, volume of packed red cells, total leukocyte count, creatinine, total protein and sodium concentration in compromised and healthy dogs during maintenance of anaesthesia with isoflurane.

Enouri *et al*. (2008) reported that there was increase in total protein, PaO_2, $PaCO_2$ and decrease in the arterial pH after induction with propofol and during maintenance with isoflurane in dogs.

Uilenreef *et al*. (2008) opined that there was elevation in arterial blood $PaCO_2$, PaO_2 and bicarbonate concentration and depletion in pH values during maintenance of anaesthesia with isoflurane along with constant rate infusion of dexmedetomidine in canines.

Conti-patara *et al*. (2009) reported that isoflurane usage in geriatric patients developed arrhythmia and maintained better haemodynamic stability. Geriatric patients had tendency to develop hypocarbia and hypoventilation, hence ECG monitoring and assisted controlled ventilation was used to prevent them.

Gunderson *et al*. (2013) mentioned that there was elevated pCO_2 level during isoflurane anaesthesia in clinically normal dogs due to suppression of the respiratory centre and resulted in respiratory acidosis.

Tomihari *et al.* (2015) reported that both propofol and isoflurane, when used as anaesthetic maintenance agent decreased the heart rate, total erythrocyte count, total protein, total leukocyte count and lymphocyte count after two hours of commencement in healthy dogs.

Zlateva and Marinov (2015) reported that there was decrease in the total erythrocyte count, haemoglobin concentration, total leukocyte count, granulocyte, lymphocyte and monocyte count during isoflurane anaesthesia in cats.

Seisdedos *et al.* (2019) reported that there was limited increase in the sodium, potassium, calcium and chloride ion concentrations with propofol-isoflurane anaesthesia in healthy dogs.

Use of isoflurane or sevoflurane, did not impair the liver and kidney functions. Serum urea concentration at different levels of anaesthetic period for alfaxalone-isoflurane group was evaluated. The values were significantly higher compared to other groups, whereas alanine aminotransferase was less in alfaxalone-sevoflurane group in geriatric animals (Sen and Kilic, 2018).

MATERIALS AND METHODS

3. MATERIALS AND METHODS

3.1. SELECTION OF ANIMALS

The study was conducted in six geriatric dogs of either sex of different breeds presented for various surgical procedures to the Veterinary Hospitals of Kerala Veterinary and Animal Sciences University at Mannuthy and Kokkalai.

3.1.1 Signalment and anamnesis

The details on breed, sex, age, body weight, history, past and immediate present treatment, health status, disease conditions and previous surgery performed, if any were recorded.

3.2. PREANAESTHETIC EVALUATION

All the animals under study were subjected for thorough pre-anaesthetic evaluation before posting for surgery. A thorough clinical examination, blood smear and wet film examination were carried out. Blood was collected for the evaluation of haematological and serum biochemical parameters. Electrocardiography, thoracic radiography and blood pressure measurement were carried out for all the animals under study to evaluate the functional status of all vital organs.

3.3. PREPARATION OF ANIMALS

Food was withheld for about 12 hours and water for six hours before administration of the anaesthesia in all the cases. All the animals were prepared for the relevant surgical procedures.

3.4. ANAESTHETIC PROTOCOL

3.4.1 Preanaesthetic medication

Butorphanol[1] at the dose rate of 0.2mg per kg body weight and diazepam[2] at the dose rate of 0.25mg per kg body weight (Plate 1) were administered

intravenously as pre- anaesthetic medication at one minute interval. After ten minutes of premedication, pre-oxygenation was carried out for three minutes with help of a mask (Plate 3).

3.4.2. Induction of anaesthesia

After pre-oxygenation, propofol[3] (1% w/v) emulsion (Plate 1) was administered as slow intravenous bolus injection, to effect general anaesthesia by observing the reduction in respiration rate, pedal and palpebral reflexes along with the deviation of eyeball towards ventromedial angle . Soon after induction animals were intubated with appropriate sized endotracheal tube to maintain airway patency (Plate 2 and 3).

3.4.3. Maintenance of anaesthesia

Anaesthesia was maintained with isoflurane[4] (Plate 1), in oxygen at the rate of 100 mL / kg body weight / min, in all the animals using Bain's circuit system incorporated with isoflurane vapourizer (Plate 2 and 3).

3.4.4. Monitoring

All the animals were monitored from the administration of the anaesthetics till recovery from anaesthesia. Vital parameters like body temperature, respiration rate, pulse rate and SpO_2 level were monitored using a multipara monitor connected to the patient (Plate 2).

The parameters like rectal temperature, pulse rate, respiration rate, heart rate, capillary refill time and colour of visible mucous membrane were recorded

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1. Inj. Butorphanol – Butodol-1 1mg/mL, Neon Laboratories Ltd., Mumbai, India.
2. Inj. Diazepam – Calmpose 5mg/mL, Sun Pharma Laboratories Ltd., Assam, India.
3. Inj. Propofol – Propofol (1% w/v), Neon Laboratories Ltd., Mumbai, India.
4. Isoflurane – Isoflurane USP 250 ml, Raman & Well Pvt. Ltd., Bombay, India.

every five minutes after administration of anaesthesia up to recovery from surgical plane of anaesthesia.

The blood sample for haematological, plasma/serum biochemical studies and blood gas analysis, was collected and blood pressure and electrocardiographic examination was done before premedication, ten minutes after commencement of isoflurane administration and after recovery from general anaesthesia.

3.4.5. Surgical management

Surgery was carried out in all the animals as per the standard protocols under aseptic conditions. Administration of amoxicillin[1] at the dose rate of 10 mg per kg body weight IV and meloxicam[2] at the dose rate of 0.2 mg per kg body weight IM were carried out before the surgery to all the animals. Postoperatively, animals were maintained with antibiotic and anti-inflammatory drugs orally for five consecutive days.

3.5 ANAESTHETIC PARAMETERS

3.5.1. Quality of sedation

It was rated as poor (+), moderate (++), good (+++) or excellent (++++), depending on whether dog is recumbent, can be aroused or not, willing to stand or walk and resistance to being moved or manipulated.

3.5.2. Time for induction of anaesthesia

Induction time was calculated as the time interval between the beginning of administration of propofol and the time when the animal induced for general anaesthesia.

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1. Inj. Amoxicillin – Amoxirum-Forte 300mg, Virbac Animal Health India Pvt. Ltd. Mumbai, India.
2. Inj. Meloxicam – Melonex 5mg/mL, Intas Pharmaceuticals Ltd. Ahmedabad, India.

Induction of anaesthesia was assessed by observing the reduction in respiration rate, pedal and palpebral reflexes with the mild deviation of eyeball towards ventromedial angle. After induction, the jaw tone was assessed for relaxation and intubation was performed using appropriate sized cuffed endotracheal tube.

3.5.3. Volume of propofol used

It indicated the total volume of propofol (1% w/v) emulsion used in mL for the induction of anaesthesia.

3.5.4. Degree of muscle relaxation

It was rated as poor (+), moderate (++), good (+++) or excellent (++++), depending on resistance in opening jaws manually and by assessment of relaxation of muscles during surgical procedure.

3.5.5. Per cent of isoflurane for maintenance of anaesthesia

It indicated the minimum and maximum per cent of isoflurane setting used in the vapouriser during maintenance of surgical plane of anaesthesia.

3.5.6. Flow rate of oxygen

It indicated the oxygen flow rate in mL, per minute setting used during maintenance of surgical plane of anaesthesia.

3.5.7. Duration of isoflurane maintenance

It was calculated from the time of start of isoflurane administration after induction of anaesthesia to the time of disconnecting the isoflurane in the anaesthetic circuit.

3.5.8. Duration of surgical plane of anaesthesia

Duration of anaesthesia was calculated as the time interval between the endotracheal intubation and extubation. When dogs regained palpebral reflex and respiration became normal, it was removed and duration of the surgical plane of anaesthesia was noted.

3.5.9. Recovery time

Recovery time was calculated as the time interval between disconnecting of isoflurane and the time when the animal regained its palpebral and pedal reflexes completely, with regular respiration rate and able to responded to vocal stimuli by trying to sit at least in sternal recumbency

3.6. PHYSIOLOGICAL PARAMETERS

Rectal temperature (^{0}C), pulse rate (per minute), respiration rate (per minute), capillary refill time (sec) and colour of visible mucous membrane were recorded before administration of anaesthesia and at five minutes interval during anaesthetic period, and recovery.

3.7. HAEMATOLOGICAL PARAMETERS

The blood samples for haematological studies were collected before premedication, ten minutes after commencement of isoflurane administration and after recovery from general anaesthesia. Venous blood samples were collected for the estimation of total erythrocyte count (10^6/µL), total leucocyte count (10^3/µL), haemoglobin concentration (g/dL) and volume of packed red cells (%), differential leukocyte counts (%), platelet count (10^3/µL) using Mythic 18 vet-blood analyser (Plate 4).

3.8. PLASMA/SERUM BIOCHEMICAL PARAMETERS

The blood samples for plasma/serum biochemistry were collected before premedication, ten minutes after commencement of isoflurane administration and

after recovery from general anaesthesia. Samples were estimated for the alanine aminotransferase (IU/L), aspartate aminotransferase (IU/L), blood urea nitrogen (mg/dL), creatinine (mg/dL), random blood sugar (mg/dL) and total plasma protein (g/dL), using Master Hospitex Diagnostic-Serum Biochemistry Analyser (Plate 4).

3.9. BLOOD GAS ANALYSIS

Venous blood samples were collected in heparin containing vials for the blood gas analysis before premedication, ten minutes after commencement of isoflurane administration and after recovery from general anaesthesia using Epoc-Blood gas analyser.

3.10. BLOOD PRESSURE

Blood pressure measurement was carried out before premedication, ten minutes after isoflurane administration and after recovery from surgical plane of anaesthesia using Elko-digital sphygmomanometer (Plate 4) with cuff positioned in forelimb antibrachi in all the animals.

3.11. ELECTROCARDIOGRAM (ECG)

Electrocardiogram (ECG) was recorded before premedication, ten minutes after commencement of isoflurane administration and after recovery from general anaesthesia using ECG machine.

The animals were positioned on right lateral recumbency, on an appropriate table, with limbs perpendicularly positioned to the trunk. Electrodes were attached to forelimbs and hind limbs. Speed used for all recordings was 25mm/s, with calibration of voltage of 1 centimetre for each millivolt (1mV = 1cm).

The ECGs were recorded in the bipolar lead II (L II) and the evaluated parameters were heart rate, cardiac rhythm, duration (milliseconds-ms) and amplitude (millivolts-mV) of the P wave, duration (ms) of the PR, QT interval and QRS complex, amplitude (mV) of the R wave, polarity characteristics of the T

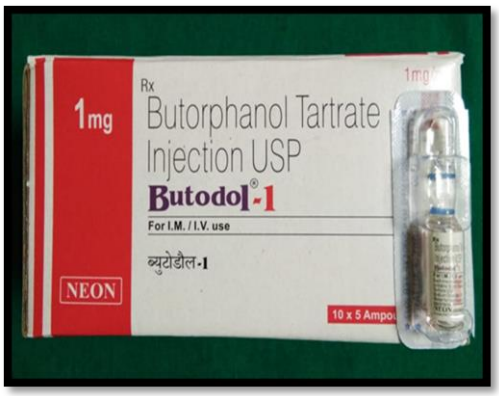
wave, presence or absence of uneven ST segment were analysed using BPL-Cardiart 6108T ECG machine (Plate 4).

3.12. POST ANAESTHETIC COMPLICATIONS

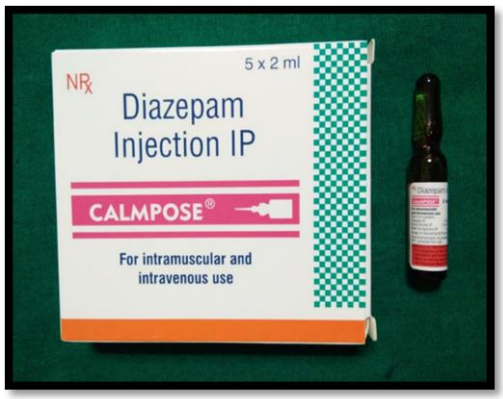
All the dogs were monitored during post anaesthetic period to assess the efficacy of the anaesthetic regimen. Post-operative complications were recorded if any in all the animals.

3.13. STATISTICAL ANALYSIS

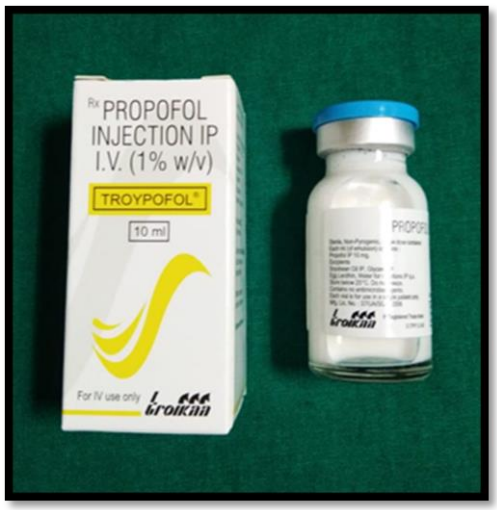
The data were analysed using SPSS version 24.0. The test adopted was repeated measures of ANOVA. The level of significance was fixed at 5% ($p<0.05$).



A. Butorphanol



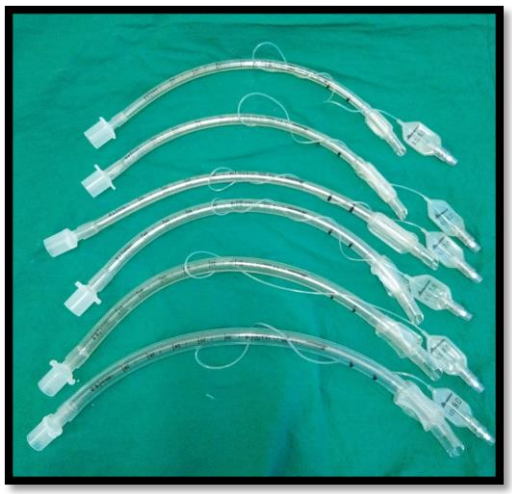
B. Diazepam



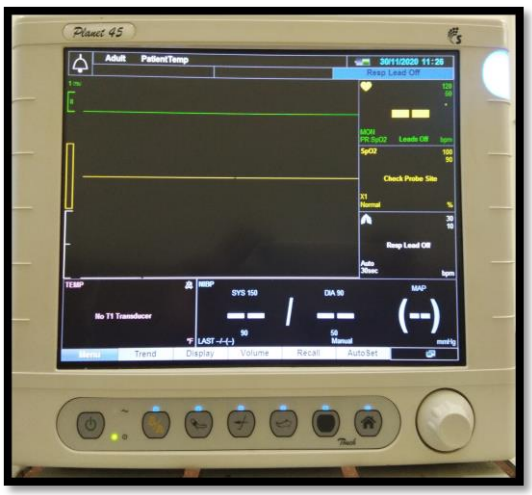
C. Propofol

D. Isoflurane

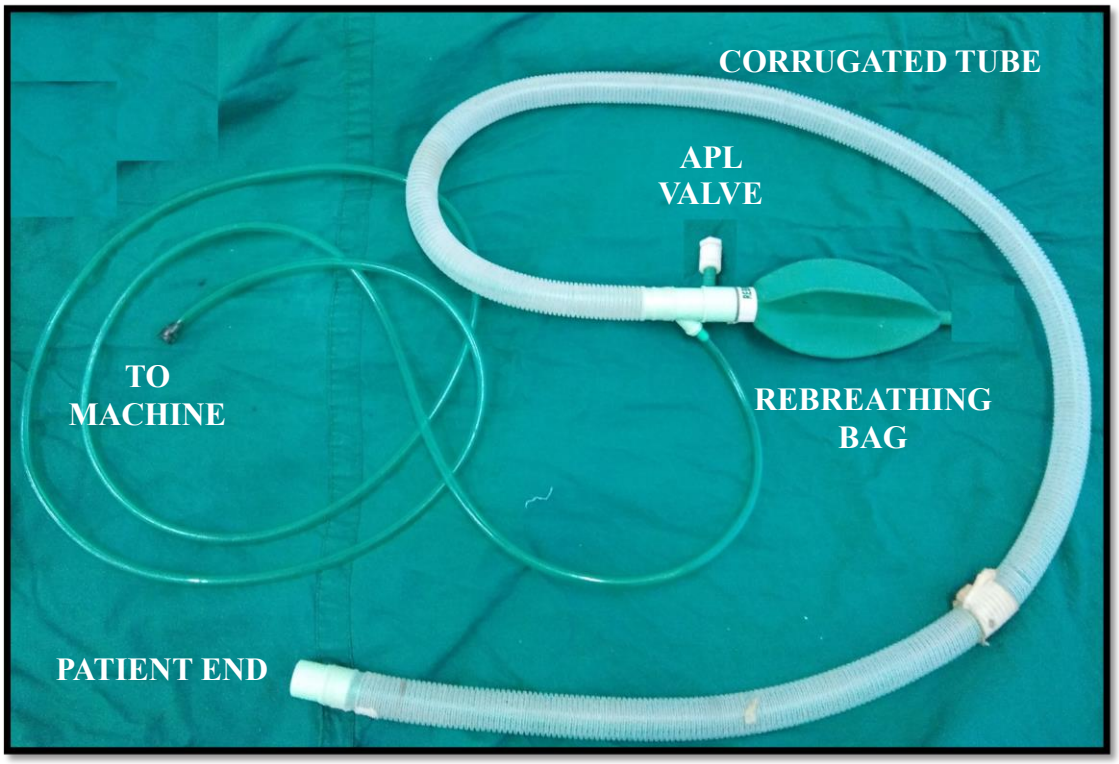
Plate 1. Anaesthetic drugs used in the study



A. Endotracheal tubes



B. Multipara monitor



C. Bain's circuit system

Plate 2. Instruments used during anaesthesia

A. Preoxygenation

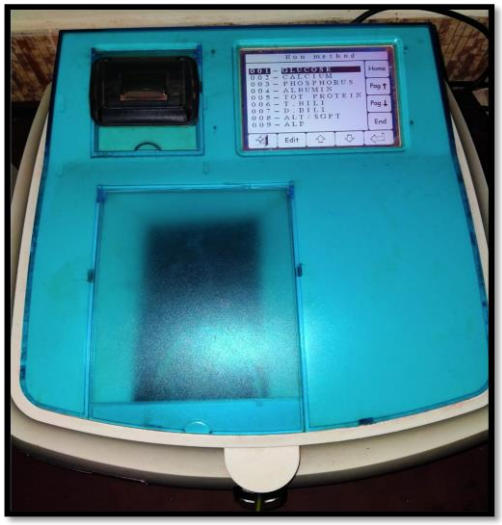
B. Endotracheal intubation

C. Propofol induction

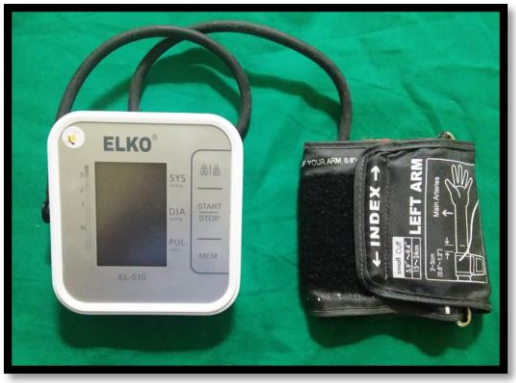
D. Isoflurane vapourizer

Plate 3. Preoxygenation, induction and maintenance of anaesthesia

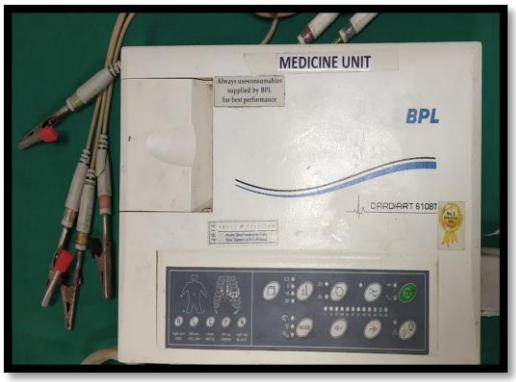
A. Haematology analyser



B. Serum biochemical analyser



C. Digital sphygmomanometer



D. ECG machine

Plate 4. Instruments used in the study

RESULTS

4. RESULTS

Six different breeds of geriatric dogs which were subjected to various surgical procedures were included in the study. Animals were numbered serially from G1 to G6. All the dogs were subjected for thorough pre-anaesthetic evaluation before subjecting for anaesthesia to know the underlying clinical pathology of the patients.

Preanaesthesia was carried out in all the animals under study by administering butorphanol at the dose rate of 0.2 mg per kg body weight and diazepam at the dose rate of 0.25 mg per kg body weight, intravenously with one minute gap between the administrations. After ten minutes, pre-oxygenation was carried out for three minutes with pure oxygen with the help of a mask. Propofol (1% w/v) was administered slowly as a bolus, intravenously to effect induction of anaesthesia. Maintenance of surgical plane of anaesthesia was carried out with isoflurane in oxygen at the flow rate of 100 mL / kg body weight / min by using Bain's circuit system incorporated with isoflurane vapourizer.

All the parameters under observations were recorded before premedication, ten minutes after commencement of isoflurane administration and after recovery from surgical plane of general anaesthesia. The data recorded were analysed using SPSS version 24.0 (Repeated Measures of ANOVA). The level of significance was fixed at 5% ($p<0.05$). The analyzed observations are presented in Table 1 to 8.

4.1. SELECTION OF ANIMALS

Six geriatric dogs of various breeds aged between ten to nineteen years of either sex, which were subjected to various surgical procedures including both soft tissue and orthopaedic procedures were included in the study. Animals were numbered serially from G1 to G6.

4.1.1. Signalment and anamnesis (Table 1)

There were six geriatric dogs with mean a age of 13.33 ± 1.33 years and mean body weight of 15.8 ± 2.40 kg. Out of six dogs G1 was Pomeranian, G2 and G5 were Dachshund, G3 and G4 were Non Descriptive and G6 was Labrador Retriever. Animals G1, G2 and G6 were female and others were male. The surgeries performed were surgical treatment for hematoma auris in G1, excision of mammary tumour in G2 and G6, external skeletal fixation in G3 and G4 and resection of papilloma in G5.

4.2. PRE-ANAESTHETIC EVALUATION

Pre-anaesthetic evaluation of all animals revealed clinical pathologies like microfilariasis in G3 and G4 with anaemia, leucocytosis in animal G6 and thrombocytopaenia in animal G3. Thoracic radiography revealed pulmonary milliary nodular metastasis in G2 and G6. ECG in G1 and G5 revealed myocardial hypoxia and G6 was suggestive of valvular insufficiency, which was confirmed as mitral valvular insufficiency through echocardiography. Blood smear, blood pressure and serum parameters were within the normal range in all six geriatric dogs.

Thoracic radiography of animals revealed right atrial enlargement in animal G1. Splenomegaly, hepatomegaly, right ventricular enlargement with bronchial pattern in pulmonary area in animal G2. Bronchial pattern was evident in caudal and apical lung lobes in animal G3. Animal G4 showed thoracic spondylosis with beaking and bridging between the intervertebral spaces and osteolytic changes in coastal arches. There were pathologies like vascular pattern in pulmonary areas with slight left atrial enlargement in animal G5. Animal G6 radiography revealed vascular pattern in lung parenchyma (Plate 5, 6 and 7).

4.3. PREPARATION OF ANIMALS

Food was withheld for about 12 hours and water for six hours before administration of the anaesthesia in all the cases. All the animals were prepared for the relevant surgical procedures as per standard protocols.

4.4. ANAESTHETIC PROTOCOL

Preanaesthesia was carried out in all the animals under study by administering butorphanol at the dose rate of 0.2 mg per kg body weight and diazepam at the dose rate of 0.25 mg per kg body weight, intravenously at one minute interval in between. After ten minutes, pre-oxygenation was carried out for three minutes with pure oxygen with the help of a mask.

Propofol (1% w/v) was administered slowly as a bolus, intravenously to effect induction of anaesthesia. Induction of anaesthesia was assessed by observing the reduction in respiration rate, pedal and palpebral reflexes with the mild deviation of eyeball towards ventromedial angle. Soon after induction, animals were intubated with appropriate sized endotracheal tube to maintain airway patency. Maintenance of surgical plane of anaesthesia was carried out with isoflurane in oxygen at the flow rate of 100 mL / kg body weight / min by using Bain's circuit system incorporated with isoflurane vapourizer.

4.5. ANAESTHETIC PARAMETERS (Table 2)

4.5.1. Quality of sedation

The quality of sedation after ten minutes of intravenous administration of preanaesthetics butorphanol and diazepam was graded to be moderate to excellent in all animals under study.

4.5.2. Time of induction of general anaesthesia

The mean induction time after propofol administration with premedication of butorphanol and diazepam intravenously was 1.33 ± 0.24 mL.

4.5.3. Volume of propofol used

The mean volume of propofol used for induction of anaesthesia in six geriatric dogs was 3.5 ± 0.32 mL. The overall mean dose of propofol used for induction was 2.25 ± 0.12 mg / kg body weight.

4.5.4. Degree of muscle relaxation

Degree of muscle relaxation in all six geriatric animals was graded to be excellent.

4.5.5. Per cent of isoflurane for maintenance of anaesthesia

The mean per cent of isoflurane for maintenance of anaesthesia used in six geriatric dogs was 1.78 ± 0.15 to 2.38 ± 0.11.

4.5.6. Flow rate of oxygen

The mean flow rate of oxygen was 1600 ± 3.0 mL per minute, maintained throughout anaesthetic period. The flow rate used was 100 mL per / body weight / minute in all the animals.

4.5.7. Duration of isoflurane maintenance

The mean duration of isoflurane maintenance for six geriatric dogs for various surgical procedures was 74.17 ± 14.57 minutes.

4.5.8. Duration of surgical plane of anaesthesia

The mean duration of surgical plane of anaesthesia was 92.5 ± 16.82 minutes in all six geriatric dogs.

4.5.9. Time for recovery

The mean time for recovery after disconnecting isoflurane in all six geriatric dogs was found to be 17.17 ± 1.01 minutes.

4.6. PHYSIOLOGICAL PARAMETERS (Table 3)

4.6.1. Rectal temperature

Rectal temperature (°C) was found to be 38.86 ± 0.18, 37.56 ± 0.13 and 37.80 ± 0.16 before premedication, during anaesthesia (ten minutes after commencement of isoflurane) and after recovery from surgical plane of general anaesthesia respectively. There was a significant decrease in the rectal temperature during isoflurane anaesthesia, which was followed by a non-significant increase after recovery from surgical plane of general anaesthesia. The values observed were within in the normal physiological limits.

4.6.2. Pulse rate

Pulse rate (per minute) was 117.5 ± 7.0, 123.67 ± 5.35 and 114.33 ± 6.01 before premedication, ten minutes after commencement of isoflurane administration and after recovery from general anaesthesia respectively. Pulse rate increased after ten minutes of isoflurane administration which became normal after recovery from surgical plane of general anaesthesia. But the changes observed were not significant and were within in the normal physiological limits.

4.6.3. Respiration rate

The mean value of respiration rate (per minute) in all six animals was 35.17 ± 1.52, 16 ± 1.03 and 25.67 ± 1.31 before premedication, ten minutes after commencement of isoflurane administration and after recovery from general anaesthesia respectively. There was a significant decrease in the respiration rate at ten minutes after commencement of isoflurane administration followed by a significant increase in the mean value after recovery from surgical plane of general anaesthesia.

4.6.4. Capillary refill time

Before premedication mean value of capillary refill time was 1.67 ± 0.21. The value remained same as 1.67 ± 0.21 even at ten minutes after commencement of isoflurane administration and after recovery from general anaesthesia. There was no significant changes in the mean values of capillary refill time at any stage of observation.

4.6.5. Colour of visible mucous membrane

Colour of conjunctival mucous membrane was pale roseate in all six animals in all the stages of anaesthesia throughout the period of observation.

4.7. HAEMATOLOGICAL PARAMETERS (Table 4)

4.7.1. Total Erythrocyte Count

The mean value of total erythrocyte count (10^6/µL) was found to be 4.62 ± 0.2 before premedication. The count reduced to 3.47 ± 0.22 at ten minutes after isoflurane administration and then increased to 4.59 ± 0.36 after recovering from general anaesthesia. The reduction during isoflurane commencement was not significant however there was a significant increase in the mean value after recovery from surgical plane of anaesthesia.

4.7.2. Total Leucocyte Count

The mean total leucocyte count (10^3/µL) was 14.92 ± 2.04, 10.07 ± 1.84 and 12.97 ± 2.07 before premedication, after ten minutes of isoflurane administration and after recovery from general anaesthesia respectively. There was a significant decrease in the mean value after ten minutes of isoflurane commencement, followed by a non-significant increase after recovery from surgical plane of general anaesthesia.

4.7.3. Lymphocytes

The mean lymphocytes (%) was 22.5 ± 2.63 before premedication. It was 26.93 ± 5.69 at ten minutes after commencement of isoflurane administration and 24.57 ± 3.27 after recovering from general anaesthesia. The changes observed were not significant.

4.7.4. Monocytes

The mean monocytes (%) was 6.27 ± 0.4, 7.53 ± 0.42 and 6.92 ± 0.57 before premedication, during isoflurane anaesthesia and after recovery from general anaesthesia respectively. There was significant increase in the mean value after ten minutes of isoflurane commencement, followed by a non-significant decrease after recovery from surgical plane of general anaesthesia.

4.7.5. Granulocytes

The mean value of granulocytes (%) was found to be 71.23 ± 2.84, 65.62 ± 5.95 and 69.52 ± 3.38 before premedication, ten minutes after commencement of isoflurane administration and after recovery from general anaesthesia respectively. There was no significant changes in the values during the observation period.

4.7.6. Haemoglobin

Haemoglobin (g/dL) mean value was 9.83 ± 1.20 before premedication. However it reduced to 7.78 ± 0.91 after ten minutes of isoflurane administration and then raised to 9.57 ± 1.3 after recovery from general anaesthesia. The reduction in the haemoglobin value was not significant after ten minutes of isoflurane administration and there was non-significant increase after recovery from surgical plane of general anaesthesia.

4.7.7. Volume of packed red cells

Volume of packed red cells (%) mean value was 36 ± 3.82 and 25.17 ± 3.38 before premedication and during isoflurane anaesthesia. The value became 31.4 ±

4.75 after recovering from general anaesthesia. The mean value of volume of packed red cells reduced at ten minutes after isoflurane commencement and returned back after recovery from surgical plane of general anaesthesia. However the changes observed were not significant.

4.7.8. Platelet count

The mean platelet count (10^3/µL) was 255.5 ± 50.49 and 249.83 ± 62.57 before premedication and ten minutes after isoflurane administration. After recovery from general anaesthesia the value became 217.67 ± 42.55. There was no significant changes in the mean values under observation.

4.8. PLASMA/SERUM BIOCHEMICAL PARAMETERS (Table 5)

4.8.1. Alanine aminotransferase

Alanine aminotransferase (IU/L) level was 46.26 ± 10.9 before premedication and the level decreased to 39.43 ± 7.76 and 33.42 ± 6.88 at ten minutes after isoflurane commencement and after recovery from anaesthesia. There was no significant changes in the values during the observation period.

4.8.2. Aspartate aminotransferase

Aspartate aminotransferase (IU/L) level was 32.28 ± 6.07 before premedication and the level decreased to 26.3 ± 2.15 at ten minutes after isoflurane commencement and the level got elevated to 32.29 ± 4.0 after recovery from general anaesthesia. However the changes in the values vary non-significantly.

4.8.3. Blood urea nitrogen

Blood urea nitrogen (mg/dL) level was 13.59 ± 3.34, 9.07 ± 1.17 and 8.1 ± 1.34 before premedication, during isoflurane anaesthesia and after recovery from general anaesthesia respectively. Though the values decreased during the observation period, it was not significant.

4.8.4. Creatinine

Creatinine (mg/dL) level was found to be get altered after ten minutes of commencement of isoflurane as 1.01 ± 0.03, when compared to the level before premedication 1.11 ± 0.15. Later the level became 1.01 ± 0.04 after recovering from surgical plane of general anaesthesia. However the changes observed were not significant.

4.8.5. Random blood sugar

The mean random blood sugar (mg/dL) value was 75.01 ± 14.13, 87.88 ± 12.21 and 93.8 ± 8.41 before premedication, ten minutes after commencement of isoflurane administration and after recovery from general anaesthesia respectively. The mean values under observation showed no significance, though there was a reduction in the value after ten minutes of isoflurane administration and increased after recovering from surgical plane of general anaesthesia.

4.8.6. Total plasma protein

The mean total plasma protein (g/dL) value was 8.32 ± 0.54, 7.96 ± 1.01 and 7.52 ± 0.96 before premedication, ten minutes after commencement of isoflurane administration and after recovery from general anaesthesia respectively. The changes observed during the observation period were not significant.

4.9. BLOOD GAS ANALYSIS (Table 6)

4.9.1. Blood gases

4.9.1.1. Blood pH

Blood pH was 7.47 ± 0.05, 7.37 ± 0.11 and 7.40 ± 0.08 before premedication, ten minutes after commencement of isoflurane administration and after recovery from general anaesthesia respectively. There was non-significant decrease in the value at ten minutes after commencement of isoflurane and which increased after recovery from surgical plane of anaesthesia.

4.9.1.2. Partial pressure of carbon dioxide (pCO_2)

Partial pressure of carbon dioxide (mmHg) was found to be 21.12 ± 1.80 before premedication, which increased to 32.53 ± 3.02 at ten minutes after isoflurane commencement. After recovery from general anaesthesia it was found to be 28.98 ± 3.63. There was significant increase in the value at ten minutes after commencement of isoflurane and the decrease in the value after recovery from surgical plane of anaesthesia was non-significant.

4.9.1.3. Partial pressure of oxygen (pO_2)

Partial pressure of oxygen (mmHg) was 168.73 ± 14.51 before premedication and the level raised to 181.07 ± 18.47 ten minutes after isoflurane administration. Later it became 159.74 ± 25.73 after recovering from general anaesthesia. The changes observed were not significant.

4.9.2. Blood chemicals (Table 6)

4.9.2.1. Sodium ion (Na^+)

Sodium ion (m*M*/L) mean level was 146.33 ± 0.96, 148.5 ± 0.99 and 148.83 ± 1.05 before premedication, ten minutes after commencement of isoflurane administration and after recovery from general anaesthesia respectively. There was a significant increase in the mean value at ten minutes after commencement of isoflurane and after recovery from general anaesthesia when compared to the baseline values, however the change was not significant at ten minutes after isoflurane commencement and after recovery from surgical plane of anaesthesia.

4.9.2.2. Potassium ion (K^+)

Potassium ion (m*M*/L) mean level was 4.18 ± 0.17, 4.25 ± 0.31 and 4.62 ± 0.19 before premedication, ten minutes after commencement of isoflurane administration and after recovery from general anaesthesia respectively. The changes in the values showed no significance.

4.9.2.3. Calcium ion (Ca^{2+})

Calcium ion (m*M*/L) mean level was 1.16 ± 0.03, 1.21 ± 0.02 and 1.19 ± 0.03 before premedication, ten minutes after commencement of isoflurane administration and after recovery from general anaesthesia respectively. The chances observed in the values were not significant to each other.

4.9.2.4. Chloride ion (Cl^-)

Chloride ion (m*M*/L) mean level was 116.67 ± 0.67, 117.33 ± 0.17 and 119.33 ± 1.38 before premedication, ten minutes after commencement of isoflurane administration and after recovery from general anaesthesia respectively. There was a non-significant increase in the value after at ten minutes of commencement of isoflurane anaesthesia, while the increase was significant after recovery from general anaesthesia.

4.9.2.5. Bicarbonate ion (HCO_3^-)

Bicarbonate ion (m*M*/L) level was 15.4 ± 0.98, 18.33 ± 0.95 and 17.22 ± 1.42 before premedication, ten minutes after commencement of isoflurane administration and after recovery from general anaesthesia respectively, however the changes observed were not significant to each other.

4.10. BLOOD PRESSURE (Table 7)

Systolic blood pressure (mmHg) was 149.16 ± 23.85 before premedication. It was 120.83 ± 12.53 and 127.83 ± 13.14 after ten minutes of isoflurane administration and after recovery from general anaesthesia respectively. There was a non-significant decrease in the systolic blood pressure at ten minutes after commencement of isoflurane administration which non-significantly increased after recovery from surgical plane of general anaesthesia.

Diastolic blood pressure (mmHg) was 97.5 ± 15.87, 63.83 ± 4.60 and 79.33 ± 11.36 before premedication, during isoflurane anaesthesia and after recovery

from general anaesthesia respectively. The changes observed were not significant though there was decrease in the mean diastolic pressure after ten minutes of isoflurane administration and an increase after recovery from surgical plane of general anaesthesia.

Mean arterial pressure (mmHg) was 114.67 ± 18.29, 82.83 ± 6.5 and 95 ± 11.88 before premedication, at ten minutes after commencement of isoflurane administration and after recovery from general anaesthesia respectively. Though there was a variation in values, the changes were not significant.

4.11. ELECTROCARDIOGRAM (ECG) (Table 8)

Heart rate (bpm) observed in ECG was 117.67 ± 7.22, 123.33 ± 5.21 and 114.33 ± 5.74 before premedication, ten minutes after commencement of isoflurane administration and after recovery from general anaesthesia respectively. However the changes observed were not significant to each other.

P wave duration (s) was 0.037 ± 0.002, 0.043 ± 0.002 and 0.047 ± 0.004 before premedication, ten minutes after commencement of isoflurane administration and after recovery from general anaesthesia respectively. The chances observed in the values were not significant to each other.

P wave amplitude (mV) was 0.153 ± 0.035, 0.182 ± 0.038 and 0.215 ± 0.047 before premedication, ten minutes after commencement of isoflurane administration and after recovery from general anaesthesia respectively. The changes in the values showed no significance.

R wave amplitude (mV) was 1.233 ± 0.222, 1.192 ± 0.236 and 1.308 ± 0.291 before premedication, ten minutes after commencement of isoflurane administration and after recovery from general anaesthesia respectively. The changes observed during the observation period were not significant.

QRS wave duration (s) was 0.042 ± 0.002, 0.04 ± 0.00 and 0.043 ± 0.004 before premedication, ten minutes after commencement of isoflurane

administration and after recovery from general anaesthesia respectively. However the changes observed were not significant to each other.

T wave duration (s) was 0.047 ± 0.003, 0.061 ± 0.007 and 0.039± 0.006 before premedication, ten minutes after commencement of isoflurane administration and after recovery from general anaesthesia respectively. The chances observed in the values were not significant to each other.

T wave amplitude (mV) was 0.205 ± 0.035, 0.230 ± 0.032 and 0.163 ± 0.056 before premedication, ten minutes after commencement of isoflurane administration and after recovery from general anaesthesia respectively. However the changes observed were not significant to each other.

PR interval (s) was 0.110 ± 0.012, 0.113 ± 0.011 and 0.117 ± 0.01 before premedication, ten minutes after commencement of isoflurane administration and after recovery from general anaesthesia respectively. The changes in the values showed no significance.

QT interval (s) was 0.21 ± 0.01, 0.24 ± 0.018 and 0.21 ± 0.01 before premedication, ten minutes after commencement of isoflurane administration and after recovery from general anaesthesia respectively. The changes observed during the observation period were not significant.

The overall electrocardiogram changes observed after ten minutes of isoflurane administration were increased P wave amplitude and duration, increased R wave amplitude and T wave amplitude and duration, increased P-R interval and Q-T interval.

The overall changes observed after recovery from surgical plane of general anaesthesia were increased P wave amplitude and duration, increased R wave amplitude and P-R interval and decreased T wave amplitude and duration and Q-T interval (Plate 8, 9 and 10).

All the changes observed in electrocardiography were not significant in their variation.

4.12. POST ANAESTHETIC COMPLICATIONS

Recovery was rapid and smooth in all animals, except for one dog G4 where mild degree of shivering was noticed.

Table 1. Observations on age, sex, breed, bodyweight and surgery performed

Animal number	Age (years)	Sex	Breed	Body weight (Kg)	Surgery performed
G1	11	Female	Pomeranian	8.3	Hematoma auris
G2	12	Female	Dachshund	17	Mammary tumour resection
G3	10	Male	Non Descriptive	14	External skeletal fixation
G4	19	Male	Non Descriptive	16.5	External skeletal fixation
G5	15	Male	Dachshund	13	Resection of papilloma
G6	13	Female	Labrador Retriever	26	Mammary tumour resection

Table 2. Observations on anaesthetic parameters (Mean ± SE)

n = 6

Parameters	Results
Quality of sedation	Moderate to Excellent
Time for induction of general anaesthesia (min)	1.33 ± 0.24
Volume of propofol used (mL)	3.5 ± 0.32
Degree of muscle relaxation	Excellent
Per cent of isoflurane for maintenance of anaesthesia	1.78 ± 0.15 to 2.38 ± 0.11
Flow rate of oxygen (mL/min)	1,600 ± 3.0
Duration of isoflurane maintenance (min)	74.17 ± 14.57
Duration of anaesthesia (min)	92.5 ± 16.82
Time for recovery (min)	17.17 ± 1.01

Table 3. Observations on physiological parameters (Mean ± SE)

n = 6

Parameters	Before premedication	Ten minutes after commencement of isoflurane administration	After recovery from general anaesthesia
Rectal temperature (ºC)	38.86 ± 0.18	37.56 ± 0.13*	37.80 ± 0.16
Pulse (per minute)	117.5 ± 7.0	123.67 ± 5.35	114.33 ± 6.01
Respiration rate (per minute)	35.17 ± 1.52	16 ± 1.03*	25.67 ± 1.31*
Capillary refilling time (seconds)	1.67 ± 0.21	1.67 ± 0.21	1.67 ± 0.21
Colour of visible mucous membrane	Pale roseate	Pale roseate	Pale roseate

Means with '' as superscript within a row differ significantly at 5% level*

Table 4. Observations on haematological parameters (Mean ± SE)

n = 6

Parameters	Before premedication	Ten minutes after commencement of isoflurane administration	After recovery from general anaesthesia.
Total erythrocyte count (10^6/µL)	4.62 ± 0.2	3.47 ± 0.22	4.59 ± 0.36*
Total leucocyte count (10^3/µL)	14.92 ± 2.04	10.07 ± 1.84*	12.97 ± 2.07
Lymphocyte (%)	22.5 ± 2.63	26.93 ± 5.69	24.57 ± 3.27
Monocytes (%)	6.27 ± 0.4	7.53 ± 0.42*	6.92 ± 0.57
Granulocytes (%)	71.23 ± 2.84	65.62 ± 5.95	69.52 ± 3.38
Haemoglobin (g/dL)	9.83 ± 1.20	7.78 ± 0.91	9.57 ± 1.3
Volume of packed red cells (%)	26.27 ± 3.17	20.52 ± 1.78	23.77 ± 3.27
Platelet count (10^3/µL)	255.5 ± 50.49	249.83 ± 62.57	217.67 ± 42.55

Means with '' as superscript within a row differ significantly at 5% level*

Table 5. Observations on plasma/serum biochemistry (Mean ± SE)

n = 6

Parameters	Before premedication	Ten minutes after commencement of isoflurane administration	After recovery from general anaesthesia.
Alanine aminotransferase (IU/L)	46.26 ± 10.9	39.43 ± 7.76	33.42 ± 6.88
Aspartate aminotransferase (IU/L)	32.28 ± 6.07	26.3 ± 2.15	32.29 ± 4.0
Blood Urea Nitrogen (mg/dL)	13.59 ± 3.34	9.07 ± 1.17	8.1 ± 1.34
Creatinine (mg/dL)	1.11 ± 0.15	1.01 ± 0.03	1.01 ± 0.04
Random blood sugar (mg/dL)	75.01 ± 14.13	87.88 ± 12.21	93.8 ± 8.41
Total plasma protein (g/dL)	8.32 ± 0.54	7.96 ± 1.01	7.52 ± 0.96

Means with '' as superscript within a row differ significantly at 5% level*

Table 6. Observations on blood gas analysis (Mean ± SE)

n = 6

Parameters	Before premedication	Ten minutes after commencement of isoflurane administration	After recovery from general anaesthesia.
Blood pH	7.47 ± 0.05	7.37 ± 0.11	7.40 ± 0.08
pCO_2 (mmHg)	21.12 ± 1.80	32.53 ± 3.02*	28.98 ± 3.63
pO_2 (mmHg)	168.73 ± 14.51	181.07 ± 18.47	159.74 ± 25.73
Na^+(m*M*/L)	146.33 ± 0.96	148.5 ± 0.99*	148.83 ± 1.05
K^+ (m*M*/L)	4.18 ± 0.17	4.25 ± 0.31	4.62 ± 0.19
Ca^{++} (m*M*/L)	1.16 ± 0.03	1.21 ± 0.02	1.19 ± 0.03
Cl^- (m*M*/L)	116.67 ± 0.67	117.33 ± 0.17	119.33 ± 1.38*
HCO_3^- (m*M*/L)	15.4 ± 0.98	18.33 ± 0.95	17.22 ± 1.42

Means with '' as superscript within a row differ significantly at 5% level*

Table 7. Observations on blood pressure (Mean ± SE)

n = 6

Parameters	Before premedication	Ten minutes after commencement of isoflurane administration	After recovery from general anaesthesia
Systolic blood pressure (mmHg)	149.16 ± 23.85	120.83 ± 12.53	127.83 ± 13.14
Diastolic blood pressure (mmHg)	97.5 ± 15.87	63.83 ± 4.60	79.33 ± 11.36
Mean arterial pressure (mmHg)	114.67 ± 18.29	82.83 ± 6.5	95 ± 11.88

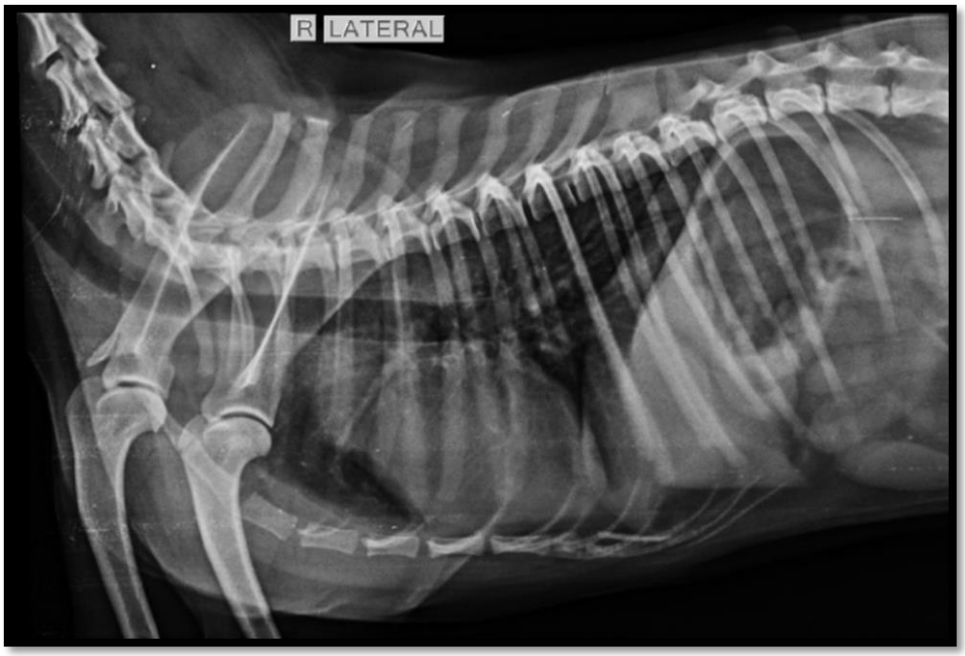
Means with '' as superscript within a row differ significantly at 5% level*

Table 8. Observations on electrocardiography (Mean ± SE)

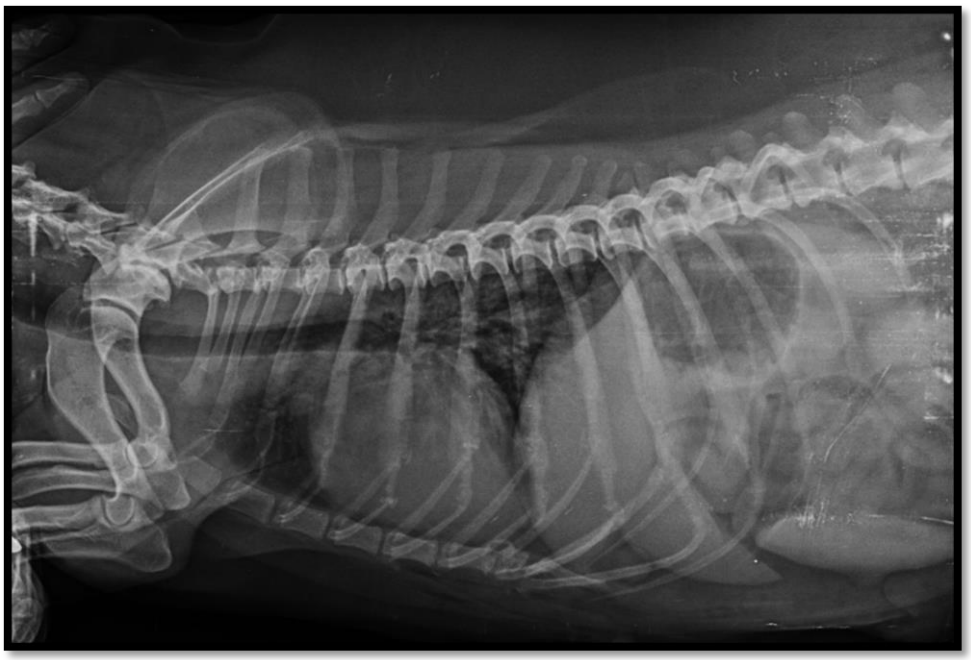
n = 6

Parameters	Before premedication	Ten minutes after commencement of isoflurane administration	After recovery from general anaesthesia.
Heart rate (bpm)	117.67 ± 7.22	123.33 ± 5.21	114.33 ± 5.74
P wave duration (s)	0.037 ± 0.002	0.043 ± 0.002	0.047 ± 0.004
P wave amplitude (mV)	0.153 ± 0.035	0.182 ± 0.038	0.215 ± 0.047
R wave amplitude (mV)	1.233 ± 0.222	1.192 ± 0.236	1.308 ± 0.291
QRS wave duration (s)	0.042 ± 0.002	0.04 ± 0.00	0.043 ± 0.004
T wave duration (s)	0.047 ± 0.003	0.061 ± 0.007	0.039 ± 0.006
T wave amplitude (mV)	0.205 ± 0.035	0.230 ± 0.032	0.163 ± 0.056
PR interval (s)	0.110 ± 0.012	0.113 ± 0.011	0.117 ± 0.01
QT interval (s)	0.21 ± 0.01	0.24 ± 0.018	0.21 ± 0.01

Means with '' as superscript within a row differ significantly at 5% level*

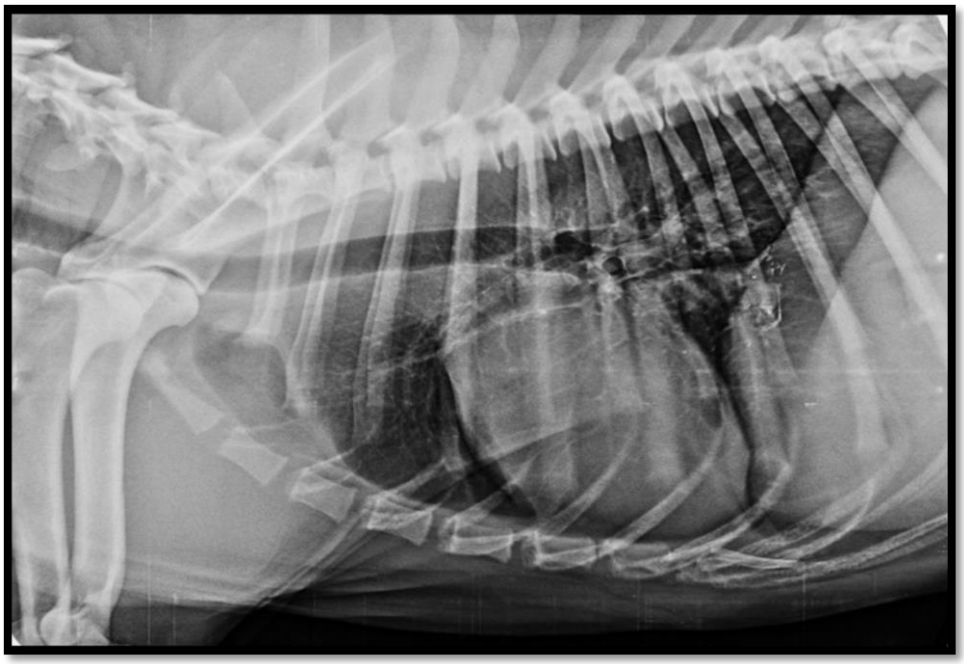


Thoracic radiography of animal G1

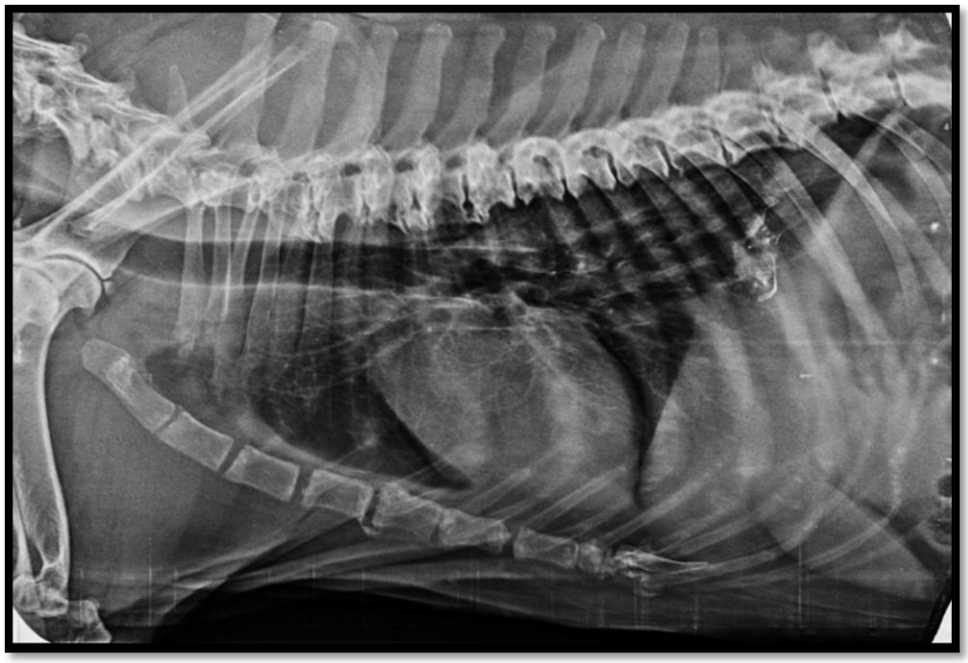


Thoracic radiography of animal G2

Plate 5. Thoracic radiography of animals G1 and G2

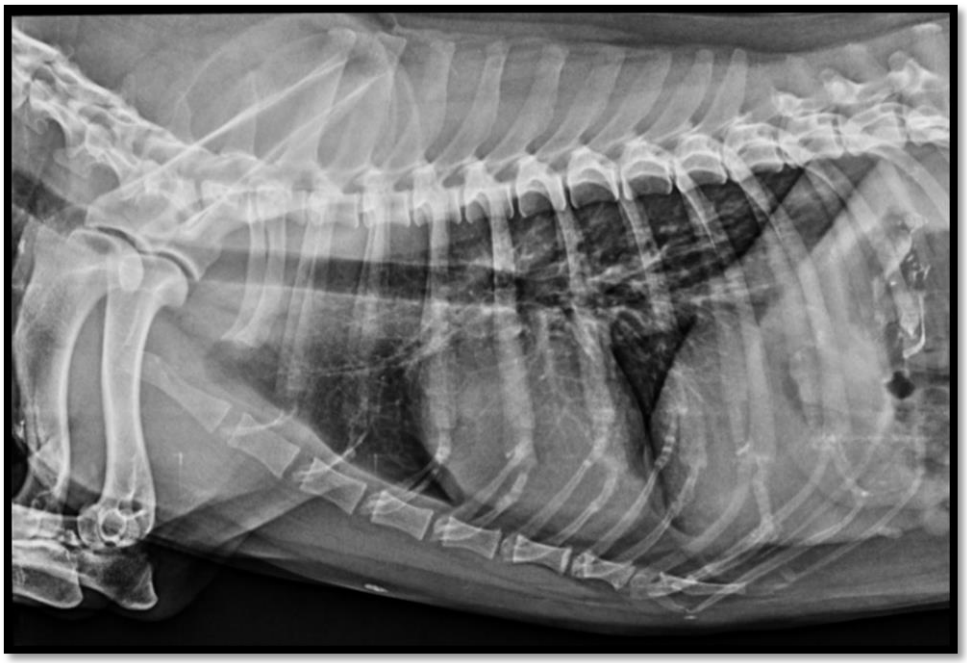


Thoracic radiography of animal G3

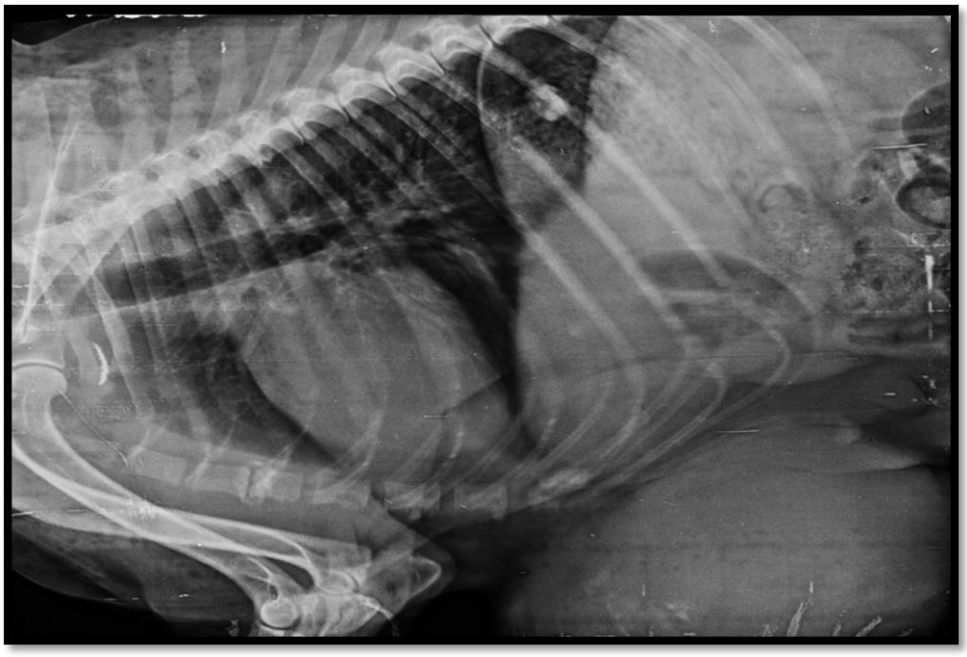


Thoracic radiography of animal G4

Plate 6. Thoracic radiography of animals G3 and G4

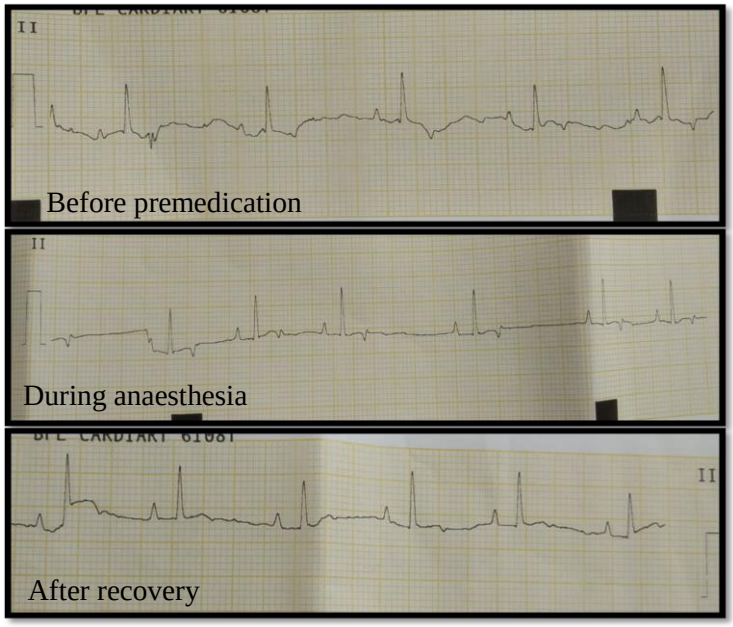


Thoracic radiography of animal G5

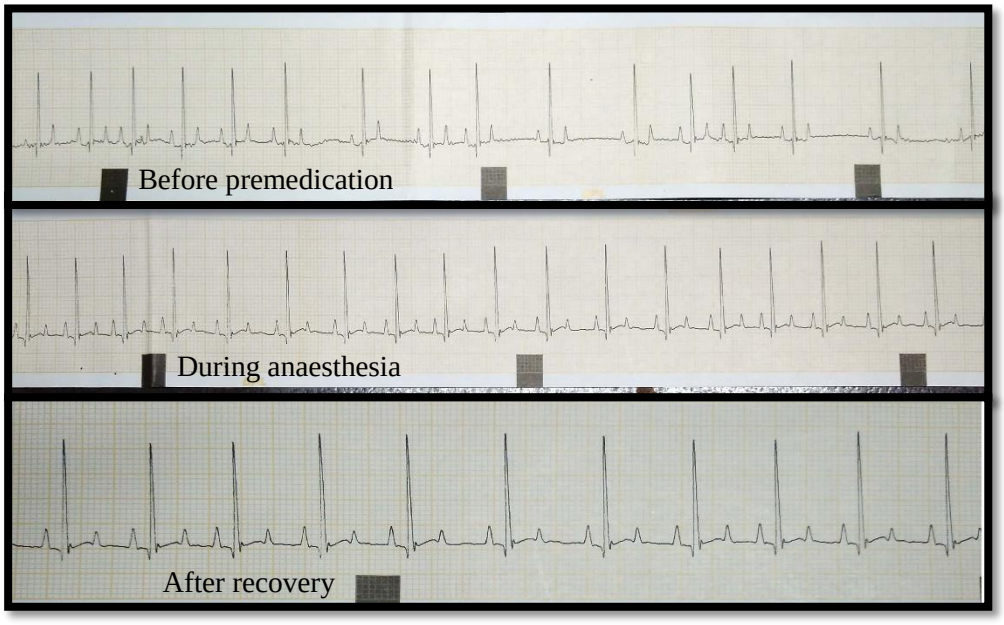


Thoracic radiography of animal G6

Plate 7. Thoracic radiography of animals G5 and G6

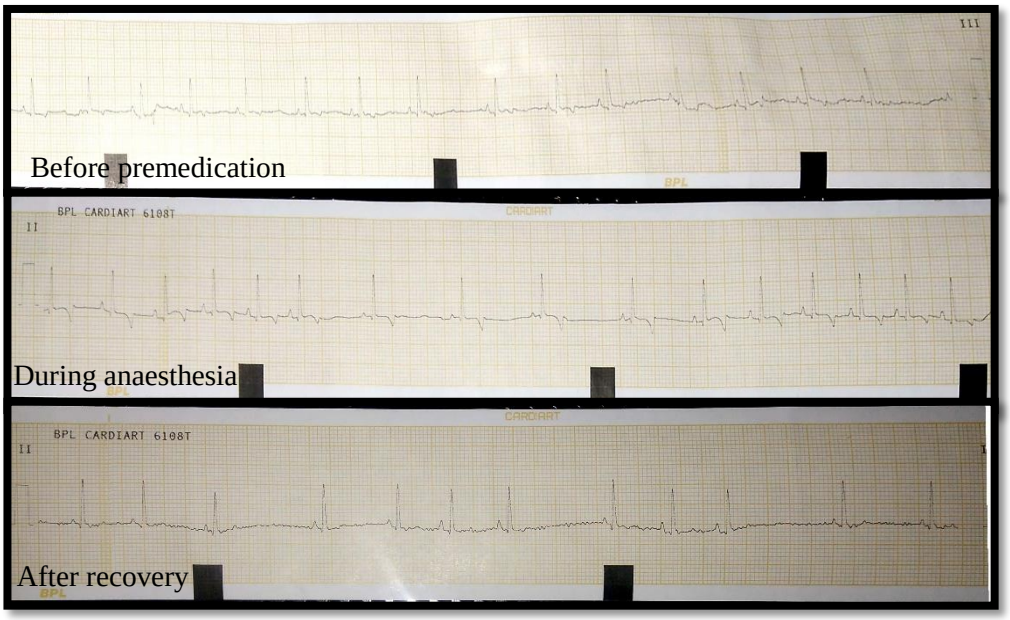


ECG of animal G1

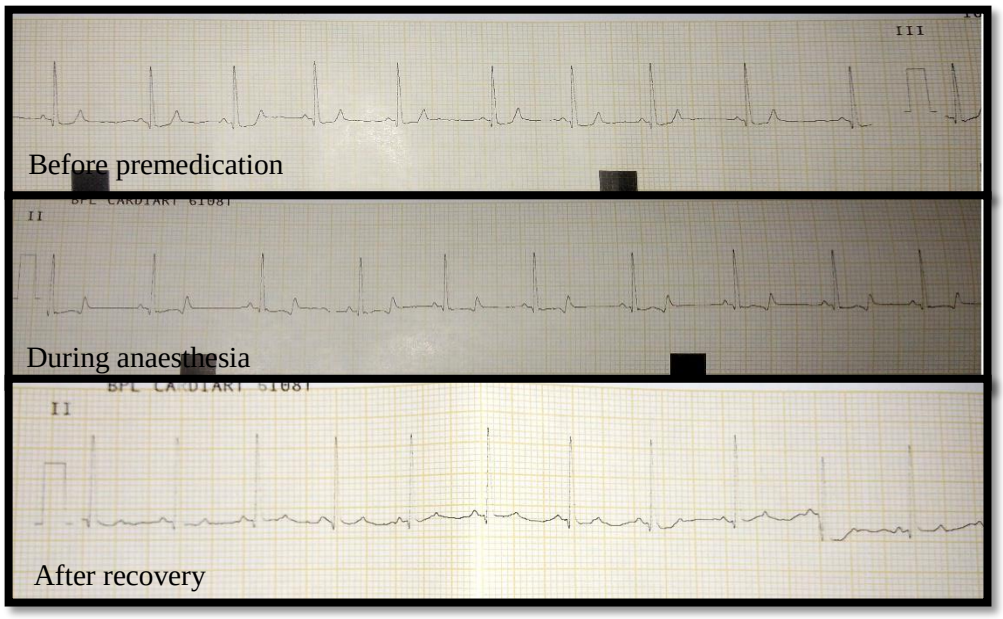


ECG of animal G2

Plate 8. Electrocardiography of animals G1 and G2

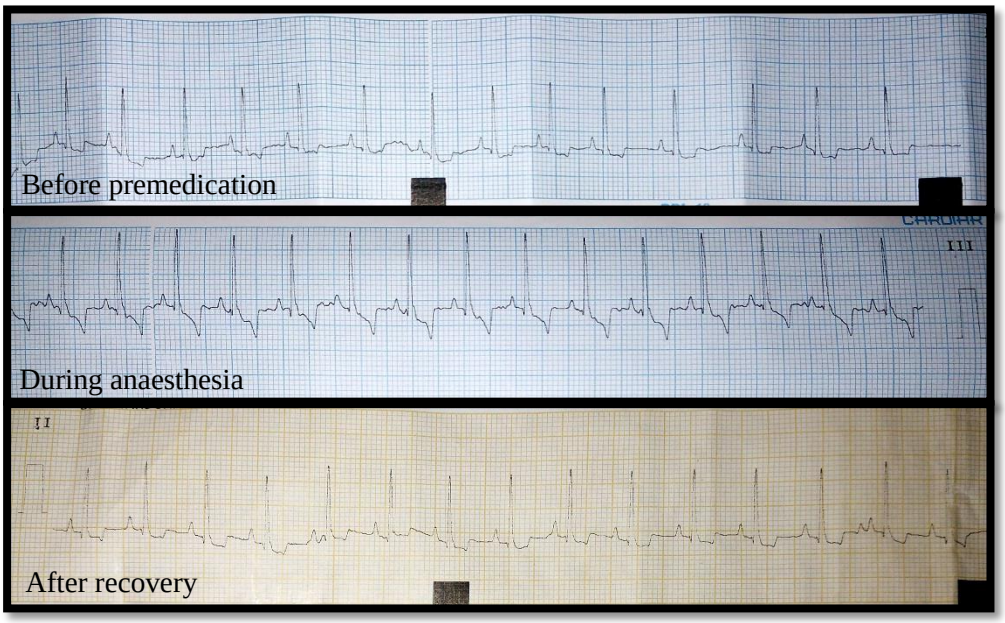


ECG of animal G3

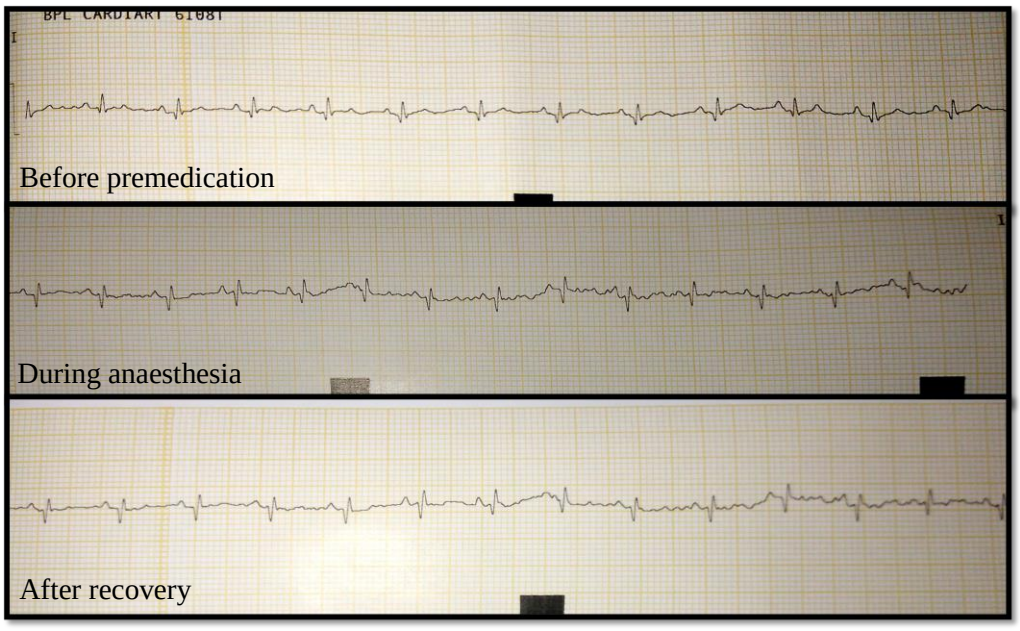


ECG of animal G4

Plate 9. Electrocardiography of animals G3 and G4



ECG of animal G5



ECG of animal G6

Plate 10. Electrocardiography of animals G5 and G6

DISCUSSION

5. DISCUSSION

The anaesthetic study was conducted in six geriatric dogs of either sex of different breeds with age ranging from ten to nineteen years, presented to the University Veterinary Hospitals, at Mannuthy and Kokkalai, Kerala Veterinary and Animal Sciences University Thrissur, Kerala. Animals were numbered serially from G1 to G6.

All the animals were subjected for thorough pre-anaesthetic evaluation. Wet film, blood smear examination, hemato-biochemical and serum analysis, electrocardiography, thoracic radiography and blood pressure measurement were carried out to know the underlying clinical disease conditions.

All the animals were administered with butorphanolat the dose rate of 0.2 mg per kg body weight and diazepam at the dose rate of 0.25 mg per kg body weight intravenously as premedication with one minute gap between the administrations. After ten minutes, pre-oxygenation was carried out for three minutes with pure oxygen with the help of a mask. Propofol (1% w/v) was administered slowly as a bolus, intravenously to effect induction of anaesthesia. Maintenance of surgical plane of anaesthesia was carried out by isoflurane in oxygen at the rate of 100 mL per kg body weight per minute by Bain's circuit system using isoflurane vapourizer.

Maintenance of surgical plane of anaesthesia was carried out by continuous monitoring of vital parameters, clinical observations, haematological and biochemical parameters, electrocardiography blood gas analysis and blood pressure.

5.1. SELECTION OF ANIMALS

5.1.1 Signalment and anamnesis

The mean age and breeds of the dogs included in the study were in accordance with the study conducted by Joubert (2007) for pre-anaesthetic screening of geriatric canine patients where the mean age was 10.99 ± 2.44 years

and mixed breed, Dachshund were presented in more per cent compare to other breeds.

5.2. PREANAESTHETIC EVALUATION

Pre-anaesthetic evaluation of animals revealed clinical pathologies like microfilariasis with anaemia in two animals, leucocytosis and thrombocytopaenia in one animal each. Thoracic radiography revealed pulmonary milliary nodular metastasis in two animals. Electrocardiography in two animals, revealed myocardial hypoxia and in one animal suggestive of valvular insufficiency, which was confirmed as mitral valvular insufficiency through echocardiography. Blood smear, blood pressure and serum parameters were within the normal range in all six geriatric dogs. Thoracic radiography of all animals revealed both cardiac, mediastinal and pulmonary changes.

Similar results were obtained by Joubert (2007) after pre-anaesthetic screening of geriatric dogs subjected for various surgeries, where cardiac diseases, respiratory disease conditions and infectious diseases were found. According to Burkholder (2000), Baetge and Matthews (2012) and Grubb *et al.* (2015) thorough pre-anaesthetic examination of geriatric animals must be carried out before subjecting for general anaesthesia.

5.3. PREPARATION OF ANIMALS

Food was withheld for about 12 hours and water for six hours before administration of the anaesthesia in all the cases. Similar kind of preanaesthetic preparation was followed by Yamashita *et al.* (2009) in dogs to study the effect of age on MAC value of sevoflurane.

5.4. ANAESTHETIC PROTOCOL

Preanaesthesia with diazepam and butorphanol, induction with propofol and maintenance of anaesthesia with isoflurane was carried out in all dogs under study.

Similar anaesthetic protocol was used by Dar *et al*. (2019) in geriatric dogs for different surgical procedures.

5.5. ANAESTHETIC PARAMETERS

5.5.1. Quality of sedation

Diazepam and butorphanol combination gave moderate to excellent level of sedation in the animals under study. Similar observations were reported by Fabio *et al*. (2007), when midazolam and butorphanol were used as pre anaesthetics in English bull dogs. Vijay *et al*. (2018) observed better quality sedation with butorphanol in geriatric dogs and when alfa 2 adrenergic agonists like dexmedetomidine and medetomidine were used along with either diazepam or butorphanol, the muscle relaxation was better along with sedation (Ko *et al*., 2000; Papich, 2000; Larsen *et al*., 2002; Leppanen *et al*., 2006 and Rankin**,** 2015). However alfa 2 adrenergic agonists were not used in the present study because of more adverse effects on cardiopulmonary system (Carpenter *et al*., 2005; Landsberg and Araujo, 2005 and Dixon and Keates, 2013).

Butorphanol when used as a pre anaesthetic, reduced the dose of propofol (Sano *et al*., 2003 and Vijay *et al*., 2018) and isoflurane (Mutoh *et al*., 2002 and Vijay *et al*., 2018). Diazepam also reduced the dose of propofol for induction, when used for premedication (Ko *et al*., 2006 and Psatha *et al*., 2011) and isoflurane for maintenance (Hellyer *et al*., 2001) in dogs. Since butorphanol and diazepam had minimum effects on cardiopulmonary system, they were safely used for deep sedation in weak, aged and sick animals (Rauser and Lexmaulova, 2002; Boutureira *et al*., 2007 and Fabio *et al*., 2007). Butorphanol has less respiratory depressant effect (Gross *et al*., 2002), thus gave better and mild sedation in compromised and aged patients.

5.5.2. Time for induction of general anaesthesia

Time for induction of general anaesthesia using propofol as a bolus injection, slow intravenously was 1.33 ± 0.24 minutes in the present study. Propofol provided smooth, adequate and fast induction of anaesthesia in geriatric dogs included in the study. Similar kind of fast and smooth induction was obtained with propofol in animals without any complications (Sams *et al*., 2008; Suarez *et al*., 2012; Taboada and Murison, 2010; Sen and Kilic, 2018 and Dar *et al*., 2019).

Duration for induction with propofol in dogs was 1.11 ± 0.25 minutes in the study conducted by Ramankutty (2008) which was in accordance with the present study. A short period of induction apnoea was noticed during propofol induction in animals (Ramankutty, 2008; Keates and Whittem, 2012 and Amenguel *et al.,* 2013). However in the present study, no animal showed this adverse effect, which might be due to the slow administration of drug and dose required for induction was less (Matthews *et al*., 2004; Sams *et al*., 2008 and Keates and Whittem, 2012).

5.5.3. Volume of propofol used

The mean volume and the dose of propofol used for induction of anaesthesia in geriatric dogs was lower in the present study when compared to previous reports. This might be because of the use of butorphanol and diazepam as premedication agents which might have helped to calm the patients by producing neurolept-analgesia (Dar *et al*., 2019). Hughes (2008) also made similar observation that in geriatric animals the dose of propofol required for induction was less when diazepam was used as premedicant.

In addition, benzodiazepines were reported to have ‘dose sparing effect’ on propofol used for induction (Bester and Stegmann, 2001; Ko *et al*., 2006 and Sams *et al*., 2008). Use of premedicants like butorphanol also reduced the dose of drugs used for induction by providing good sedation (Bester and Stegmann, 2001; Sano *et al*., 2003; Maddern *et al*., 2010 and Vijay *et al*., 2018). They also reduced the dose of drugs used for maintenance (Bester and Stegmann, 2001; Mutoh *et al*., 2002

and Vijay *et al*., 2018). Thus in the present study induction dose of propofol was reduced as reported in the study conducted by Dar *et al*. (2019) where butorphanol and diazepam were used as premedicants.

Induction apnoea followed by propofol administration was reported in many studies (Fabio *et al*., 2007; Keates and Whittem, 2012 and Amenguel *et al.,* 2013) and the review of literature revealed that the dose of the drug and anaesthetic techniques must be altered accordingly (Bester and Stegmann, 2001; Kojima *et al*., 2002 and Dowling *et al.,* 2005). However apnoea was not seen in any of the geriatric dogs in the present study, which might be due to less dose of propofol required for induction and the slow administration of drug (Keates and Whittem, 2012).

5.5.4. Degree of muscle relaxation

The anaesthetic protocol showed excellent muscle relaxation in all geriatric animals that underwent both soft tissue and orthopaedic surgical procedures. Probably it may be due to the use of muscle relaxant diazepam as pre anaesthetic (Suresha *et al*., 2012; Gonzalez *et al*., 2013 and Robinson and Weir, 2013) and isoflurane for maintenance of surgical plane of anaesthesia. Moreover, propofol would have acted as a good muscle relaxant (Vijay *et al*., 2018) and might have added for these results.

Similar kind of excellent muscle relaxation was noticed in goats after induction with diazepam and propofol (Kumar *et al*., 2014) and with propofol induced - isoflurane anaesthesia in adult and geriatric dogs (Vijay *et al*., 2018).

5.5.5. Per cent of isoflurane for maintenance of anaesthesia

The mean per cent of isoflurane used for maintenance of anaesthesia in the present study was 1.78 ± 0.15 to 2.38 ± 0.11. According to Yamashita *et al.* (2009) and Vijay *et al*. (2018) geriatric patients required lower MAC value of inhalant anaesthetics and required less concentration of inhalant anaesthetics for maintenance.

Another reason for the reduction in the dose of anaesthetic agents used for induction and maintenance could be inclusion of pre-anaesthetics like opioids, sedatives and tranquilizers in the anaesthetic regimen (Bester and Stegmann, 2001; Kojima *et al*., 2002 and Caines *et al*., 2014).

5.5.6. Flow rate of oxygen

The mean flow rate of oxygen was 1600 ± 3.0 mL per minute which was maintained throughout anaesthetic period. The flow rate used was 100 mL per kg body weight per minute in all the animals. This flow rate was found to be satisfactory in geriatric patients under the study. Similar flow rate was used by Tomihari *et al.* (2015) for isoflurane anaesthesia in healthy dogs.

5.5.7. Duration of isoflurane maintenance

The mean duration of isoflurane maintenance was 74.17 ± 14.57 minutes. The animals which underwent soft tissue surgeries were maintained with isoflurane for maximum up to 75 minutes, whereas two animals which underwent orthopaedic surgeries were maintained maximum up to 130 minutes.

5.5.8. Duration of surgical plane of anaesthesia

The mean duration of surgical plane of anaesthesia was 92.5 ± 16.82 minutes. Conzen *et al.* (2002) reported the maintenance of surgical plane of anaesthesia for up to 200 minutes in animals with inhalant anaesthesia.

5.5.9. Time for recovery

The mean time for recovery after disconnecting isoflurane in all six geriatric dogs was found to be 17.17 ± 1.01 minutes. Geriatric patients receiving isoflurane for maintenance of anaesthesia had early recovery than those who received sevoflurane and the mean recovery time with propofol induction and isoflurane maintenance was 6.0 ± 2.0 minutes as reported by Sen and Kilic (2018). Propofol – isoflurane used in dogs showed faster and smooth recovery (Sams *et al*., 2008;

Lopez *et al.*, 2009; Kavechiya, 2010; Vijay *et al*., 2018 and Dar *et al*., 2019) than when propofol was used for maintenance alone (Kuusela *et al*., 2001).

5.6. PHYSIOLOGICAL PARAMETERS

5.6.1. Rectal temperature

Rectal temperature decreased throughout the anaesthetic period significantly in all animals which returned to normal during recovery period. Similar kind of significant decrease in body temperature was noticed in the study of Taboada and Murison (2010), Sen and Kilic (2018) and Vijay *et al*. (2018), where propofol and isoflurane combination was used for maintenance of surgical plane of anaesthesia which returned to normal values after recovery (Kavechiya, 2010).

The reduction in the body temperature throughout anaesthesia period could be due to the decreased muscular activity and body metabolic rate. Along with this there was depression in the thermoregulatory centre with peripheral vasodilation which further reduced the body temperature during perioperative period (Kavechiya, 2010).

5.6.2. Pulse rate

The pulse rate increased non-significantly at ten minutes after isoflurane commencement and returned back to baseline values after recovery from surgical plane of general anaesthesia. According to Picker *et al*. (2001) and Sen and Kilic (2018), heart rate increased along with the concentration of the anaesthetic agents like isoflurane, sevoflurane, enflurane, halothane and desflurane in canine patients.

Heart rate increased after induction with propofol in dogs (Lerche *et al*., 2000; Aguiar *et al*., 2001 and Kojima *et al*., 2002) and during isoflurane anaesthesia in goats (Kumar *et al*., 2014) and in dogs (Thomihari *et al.*, 2014) with dexmedetomidine as constant infusion (Uilenreef *et al*., 2008). There was mild increase in the heart rate in isoflurane anaesthesia in human patients (Nagasaki *et al*., 2001).

The increase in heart rate with inhalant anaesthesia could be attributed to decrease in cardiac vagal activity in dogs (Picker *et al*., 2001). Other reason could be positive chronotropic property of propofol which might have led to the stimulation of sympathetic nervous system and cardio excitatory centre of brain (Grimm *et al.*, 2015). Whereas Polis *et al*. (2001) opined that decreased arterial blood pressure would have activated baroreceptor-reflex, which might have led to increase in the heart rate.

5.6.3. Respiration rate

Mean respiration rate was found significantly decreased at ten minutes after isoflurane commencement than before premedication and returned back to baseline values after recovery, where the increase in the respiration rate was significant at recovery from surgical plane of anaesthesia. Similar kind of results, where respiration rate got decreased after premedication and induction of anaesthesia were observed by Kuo and Keegan (2004), Kavechiya (2010), Kumar *et al*. (2014) and Vijay *et al*. (2018). There was also significant reduction in the respiration rate in dogs treated with propofol induction - isoflurane maintanace at 15^{th} minute in the study conducted by Sen and Kilic (2018).

Decrease in respiration rate could be due to depression of higher respiratory centres with anaesthetic drugs (Kuo and Keegan, 2004 and Clarke *et al.*, 2014) and also isoflurane is considered as a potent respiratory depressant than other volatile gaseous anaesthetics (Galloway *et al*., 2004 and Vijay *et al*., 2018).

5.6.4. Capillary refill time

The mean capillary refill time in the buccal mucosa remained constant throughout the observation period. The result was in agreement with the observation made by Haskins (2015) where the time was more than two seconds in cases of vasoconstriction otherwise between one to two seconds during perioperative period in dogs.

5.6.5. Colour of visible mucous membrane

Colour of visible mucous membrane remained pale roseate in all animals throughout anaesthesia. Similar observation was made by Haskins (2015) where the colour of visible mucous membrane was used to know the vasomotor tone in animals under general anaesthesia.

5.7. HAEMATOLOGICAL PARAMETERS

5.7.1. Total erythrocyte count

Total erythrocyte count decreased non-significantly after ten minutes of isoflurane administration and raised significantly back to normal after recovery from anaesthesia. Similarly total erythrocyte count mean values were found decreased non-significantly after premedication, induction and during maintenance in horses (Sankar *et al*., 2011) and in geriatric dogs (Kavechiya, 2010). However after recovery from anaesthesia, the values tend to attain base line values in geriatric dogs (Sen and Kilic, 2018).

The reason for decreased total erythrocyte count might be the pooling of red blood cells in the spleen because of stimulated adrenocortical area and interstitial fluid migrating in to circulating compartment (Sankar *et al*., 2011).

5.7.2. Total leucocyte count

The mean total leucocyte count decreased significantly at ten minutes after isoflurane commencement and the value increased non-significantly back to near normal after recovering from surgical plane of general anaesthesia. Similar observation was made by Sen and Kilic (2018) that the mean values of total leukocyte count decreased during the anaesthetic period and after recovery the value tended to attain baseline values.

Similar kind of decrease in the total leucocyte count was noticed with propofol and isoflurane anaesthesia in dogs (Ramankutty, 2008; Kavechiya, 2010

and Tomihari *et al.,* 2015) and with isoflurane anaesthesia in cats (Zlateva and Marinov, 2015). Isoflurane was more immunosuppressive compared to propofol and thus might have resulted in the decreased leucocyte count due to changes in the anti-inflammatory cytokines during trans-anaesthetic period (Tomihari *et al.,* 2015).

5.7.3. Lymphocyte

The mean lymphocyte per cent increased non-significanty at ten minutes after isofurane commencement which decreased after recovery from surgical plane of anaesthesia. Simiar kind of nonsignificant changes in the lymphocyte and neutrophil count during anaesthetic period was observed in dogs during propofol-isofurane anaesthesia (Kavechiya, 2010).

The reason could be stimulation of lymphocytes and neutrophils by glucocorticoids due to stimulation at adrenocortical region during general anaesthesia (Brand *et al.,* 2003).

5.7.4. Monocytes

There was significant increase in the mean value of monocytes after ten minutes of isoflurane commencement and there was a non-significant decrease after recovery from surgical plane of general anaesthesia. Similar results were obtained with propofol and isoflurane anaesthesia in compromised and healthy dogs (Ramankutty, 2008).

5.7.5. Granulocytes

The mean granulocytes per cent decreased non-significantly at ten minutes after isofurane commencement and raised back after recovery from surgical plane of anaesthesia. Similar results were obtained in cats with isoflurane anaesthesia by Zlateva and Marinov (2015).

5.7.6. Haemoglobin

There was reduction in the haemoglobin value after ten minutes of isoflurane administration when compare to the value before premedication. The values returned to baseline values after recovery from anaesthesia. However the variation during the observation period was not significant. Similarly haemoglobin mean values were found decreasing after premedication, induction and during maintenance of anaesthesia in horses (Sankar *et al*., 2011) and a non-significant decrease in haemoglobin value was reported in geriatric dogs (Sen and Kilic, 2018) where minimum value was recorded at 30^{th} minute of propofol-isoflurane anaesthesia (Kavechiya, 2010). The values attained the baseline level after recovery from anaesthesia (Sen and Kilic, 2018).

According to Sankar *et al*. (2011) the reason for the decrease in haemoglobin concentration could be due to pooling of erythrocytes in to the spleen. The decreased total erythrocyte count might have attributed to the decrease in the haemoglobin level during general anaesthesia (Kavechiya, 2010).

5.7.7. Volume of packed red cells

The mean value of volume of packed red cells decreased non-significantly after ten minutes of isoflurane administration and returned back without significance to baseline values after recovery from anaesthesia.

Similarly volume of packed red cells mean values were found decreased after premedication and induction in dogs (Sams *et al*., 2008) and also during maintenance in horses (Sankar *et al*., 2011). There was non-significant decrease in the volume of packed red cells value in propofol-isoflurane anaesthesia in geriatric dogs (Kavechiya, 2010) and after recovery, the value tend to attain baseline values (Sen and Kilic, 2018).

The mean values of haematocrit were within the normal range before and after anaesthesia in geriatric dogs (Joubert, 2007). During general anaesthesia

interstitial fluid migrating in to circulating compartment (Sankar *et al*., 2011), may led to haemo-dilution which might have reduced the volume of packed red cells values.

5.7.8. Platelet count

There was non-significant reduction in the mean value of platelet count after ten minutes of isoflurane administration and after recovering from surgical plane of anaesthesia. Similar kind of results were observed with propofol isoflurane anaesthesia in the study conducted by Sen and Kilic (2018) in dogs.

5.8. PLASMA/SERUM BIOCHEMICAL PARAMETERS

5.8.1. Alanine aminotransferase

The mean values of alanine aminotransferase decreased non-significantly after ten minutes of isoflurane administration and during recovery from surgical plane of general anaesthesia in the animals. The results are in accordance with the observation made by Kavechiya (2010) and Sen and Kilic (2018) with propofol-isoflurane anaesthesia in adult and geriatric dogs.

The reason for this reduction could be reduced hepatic circulation with anaesthetic agents (Shafer, 2000; Topal *et al.,* 2003 and Trepenaitis *et al*., 2010).

5.8.2. Aspartate aminotransferase

The mean values of aspartate aminotransferase decreased non-significantly after ten minutes of isoflurane administration, however it reached back the baseline values at recovery period with a variation which was non-significant.

Similar kind of observations were recorded by Kavechiya (2010) and Sen and Kilic (2018) where propofol isoflurane anaesthesia was carried out as similar to present study. The reason for the reduction during anaesthetic period could be hepatic hypoperfusion with anaesthetic agents (Trepenaitis *et al*., 2010).

5.8.3. Blood Urea Nitrogen (BUN)

The BUN values decreased non-significantly at ten minutes after isoflurane administration and after recovery from general anaesthesia in the present study, which is in accordance with the results obtained by Sen and Kilic (2018) with propofol-isoflurane anaesthesia in geriatric dogs and in contrast to the results of Kavechiya (2010) who observed a non-significant increase in the BUN values with propofol-isoflurane anaesthesia in adult dogs.

Liver and kidney functions will not be altered by isoflurane anaesthesia (Sen and Kilic, 2018) and thus the values were within the normal range with mild alterations.

5.8.4. Creatinine

There was a non-significant decrease in the creatinine value after ten minutes of isoflurane administration which returned back to baseline values after recovery from surgical plane of general anaesthesia. This is similar to the observations made by Sen and Kilic (2018) that the mean values of creatinine decreased during the anaesthetic period and after recovery the value tend to attain baseline values. In the contrary, Kavechiya (2010) reported a non-significant increase in the creatinine level with propofol-isoflurane anaesthesia in adult dogs. There was no significant changes in the BUN and creatinine values compared to baseline values in patients with renal insufficiency with both sevoflurane and isoflurane (Conzen *et al*., 2002).

The creatinine values in the present study were within the normal range with mild alterations, since liver and kidney functions will not be altered by isoflurane anaesthesia (Sen and Kilic, 2018).

5.8.5. Random blood sugar

The mean value of random blood sugar increased non-significantly when observed at ten minutes after isoflurane commencement and after recovery from

general anaesthesia when compared with the base value. Similar gradual non-significant increase in the glucose level was noticed by Kavechiya (2010), where the value reached maximum level at 30th minute of propofol-isoflurane anaesthesia in adult dogs. Similar kind of increase in glucose level was observed by Ramankutty (2008) also with propofol anaesthesia in healthy and compromised dogs.

The effects of isoflurane on biochemical parameters was negligible without any adverse effects (Sen and Kilic, 2018), thus the values were within normal range. Stress hormones, such as epinephrine and cortisol and inflammatory mediators induced hyperglycaemia in perioperative period (Maeda *et al.,* 2018). Anaesthetic stress stimulated hypothalamus and pituitary which lead to secretion of ACTH there by releasing glucocorticoids leading to hyperglycaemia (Kavechiya, 2010).

5.8.6. Total plasma protein

Total plasma protein mean value decreased non-significantly after ten minutes of isoflurane maintenance and after recovery from general anaesthesia. This is in collaboration with the observations of Kavechiya (2010) and Tomihari *et al.* (2015) that there was non-significant decrease in the level of total plasma protein in propofol and isoflurane anaesthesia in adult dogs.

5.9. BLOOD GAS ANALYSIS

5.9.1. Blood gases

5.9.1.1. Blood pH

There was a non-significant fall in the blood pH in the present study after ten minutes of isoflurane administration and the value increased slightly towards normal after recovery from anaesthesia. A reduction in blood pH was also observed by Kuusela *et al*. (2001), Sams *et al*. (2008), Fayyaz *et al.* (2009) and Suarez *et al*. (2012) after propofol induction and in isoflurane anaesthesia (Kuusela *et al*., 2001 and Neto *et al*., 2007) and also in isoflurane with dexmedetomidine as constant rate infusion (Uilenreef *et al*., 2008).

5.9.1.2. Partial pressure of carbon dioxide (pCO_2)

There was significant increase in the value of pCO_2 at ten minutes after commencement of isoflurane administration and there was non-significant decrease in the value after recovery from surgical plane of anaesthesia. The value of pCO_2 increased after induction with propofol (Akkerdas *et al*., 2001; Sams *et al*., 2008; Mcnally *et al*., 2009 and Suarez *et al*., 2012), thiopental and ketamine-diazepam (Enouri *et al*., 2008), isoflurane anaesthesia (Neto *et al*., 2007) and also in isoflurane with dexmedetomidine as constant rate infusion (Uilenreef *et al*., 2008).

The reason for elevated pCO_2 might be due to retention of CO_2 during anaesthesia, since the drugs used will tend to supress the respiratory centre leading to respiratory acidosis condition (Gunderson *et al*., 2013).

5.9.1.3. Partial pressure of oxygen (pO_2)

The pO_2 value increased non-significantly after ten minutes of isofurane administration and reduced back to normal baseline values after recovery from general anaesthesia. Similar observation that pO_2 value increased after induction with propofol (Akkerdas *et al*., 2001 and Sams *et al*., 2008) and in isoflurane anaesthesia (Neto *et al*., 2007 and Suarez *et al*., 2012) and also in isoflurane with dexmedetomidine as constant rate infusion (Uilenreef *et al*., 2008) were reported, and the reason probably may be due to continuous supply of oxygen (Suarez *et al*., 2012). The process of preoxygenation before induction of anaesthesia might have also added for the results by increasing the time of desaturation of oxygen (Mcnally *et al*., 2009).

5.9.2. Blood chemicals

5.9.2.1. Sodium ion (Na^+)

There was a significant increase in the mean value at ten minutes after commencement of isoflurane and after recovery from general anaesthesia when compared with baseline values. Similar observation was reported by Seisdedos *et*

al. (2019) that Na^+ got decreased with propofol-isoflurane anaesthesia in healthy dogs.

5.9.2.2. Potassium ion (K^+)

Potassium ion level increased at ten minutes after commencement of isoflurane administration and after recovery from general anaesthesia without significance change. Similar observation was reported with propofol-isoflurane anaesthesia in healthy dogs (Seisdedos *et al*., 2019).

5.9.2.3. Calcium ion (Ca^{2+})

Calcium ion level increased and later returned to baseline values at ten minutes after commencement of isoflurane administration and after recovery from general anaesthesia respectively without much significance. The result obtained is in agreement with Seisdedos *et al*. (2019) where propofol-isoflurane anaesthesia was used in healthy dogs.

5.9.2.4. Chloride ion (Cl^-)

Chloride ion level increased non-significantly at ten minutes after commencement of isoflurane administration while increased significantly after recovery from general anaesthesia. Seisdedos *et al*. (2019) reported similar results with propofol-isoflurane anaesthesia in healthy dogs.

5.9.2.5. Bicarbonate ion (HCO_3^-)

The value increased non-significantly after ten minutes of isofurane administration and reduced back to normal baseline values after recovery from general anaesthesia. Similar observations were reported by Kuusela *et al*. (2001) and Sams *et al*. (2008) that HCO_3^- got decreased after induction with propofol and after ten min of induction. However the values decreased after premedication and during maintenance with halothane and isoflurane anaesthesia in dogs (Neto *et al*., 2007).

The mild changes in the blood electrolyte values could be secondary to change in the meatabolic rate modifications of organ systems during trans-anaesthetic period (Seisdedos *et al*., 2019).

5.10. BLOOD PRESSURE

The mean values of systolic, diastolic and mean arterial blood pressure were decreased non-significantly after ten minutes of administration of isoflurane and then increased non-significantly after recovery from surgical plane of general anaesthesia. These results are in accordance with the observations made by Lerche *et al*. (2000), Hofmeister *et al*. (2006), Braun *et al*. (2007), Hazra *et al*. (2008), Kotani *et al*. (2008) and Sams *et al*. (2008) where systolic, diastolic and mean arterial blood pressure were decreased after induction with propofol and during maintenance with isoflurane in dogs (Polis *et al*., 2001; Uilenreef *et al*., 2008 and Kavechiya, 2010). The same observations were also made in human patients during isoflurane anaesthesia (Nagasaki *et al*., 2001).

The reason might be due to the systemic vasodilatory effects of isoflurane (Chohan *et al*., 2013). The reason also could be because of negative inotropic effect of propofol which reduces the systemic vascular resistance resulting in hypotension in dogs (Lerche *et al*., 2000).

5.11. ELECTROCARDIOGRAPHY (ECG)

The overall electrocardiogram changes observed after ten minutes of isoflurane administration were increased P wave amplitude and duration, increased R wave amplitude and T wave amplitude and duration, increased P-R interval and Q-T interval.

The overall changes observed after recovery from surgical plane of general anaesthesia were increased P wave amplitude and duration, increased R wave amplitude and P-R interval and decreased T wave amplitude and duration and Q-T interval.

There was no arrhythmia throughout the perioperative period in any of the animals and sinus tachycardia was observed in all animals might be due to the use of isoflurane for maintenance, which had less cardiac depression (Conti-patara *et al*., 2009). These results were in agreement with the results obtained by Conti-patara *et al*. (2009) and Khurana *et al*. (2014), where isoflurane was used for maintenance of anaesthesia in dogs.

Other changes observed during trans-anaesthetic period were increased PR interval, elevation or depression of ST segment with the change in the T wave morphology. Similar findings are reported by Conti-patara *et al*. (2009) for isoflurane anaesthesia in dogs and Khurana *et al*. (2014) for propofol-halothane anaesthesia. The reasons for these changes might be myocardial hypoxia, hypercapnia, electrolytic abnormalities, and cardiac hypertrophy (Ettinger, 2000).

5.12. POST ANAESTHETIC COMPLICATIONS

Recovery was rapid and smooth in all animals, except for one dog where mild degree of shivering was noticed. This is in accordance with the observation made by Pawar *et al*. (2011) where shivering was noticed in human patients during recovery period from isoflurane anaesthesia.

SUMMARY

6. SUMMARY

The anaesthetic study was conducted in six geriatric dogs of either sex of different breeds with age ranging from ten to nineteen years, presented to the Veterinary Hospitals of Kerala Veterinary and Animal Sciences University at Mannuthy and Kokkalai, which were subjected to various surgical procedures including both soft tissue and orthopaedic procedures. Animals were numbered serially from G1 to G6.

Detailed history was collected and clinical examination was carried out to all dogs under study. On the day of presentation, preoperative evaluation of cardiovascular, respiratory, renal and hepatic systems were done and a detailed signalment and anamnesis of each case was collected. Clinical examination was carried out in all the dogs to assess the physical status of these animals before sedation.

Preanaesthesia was carried out in all the animals under study by administering butorphanol at the dose rate of 0.2 mg per kg body weight and diazepam at the dose rate of 0.25 mg per kg body weight, intravenously with one minute gap between the administrations. After ten minutes, pre-oxygenation was carried out for three minutes with pure oxygen with the help of mask. Propofol (1% w/v) was administered slowly as a bolus, intravenously for induction of anaesthesia. Maintenance of surgical plane of anaesthesia was carried out with isoflurane in oxygen at the rate of 100 mL per kg body weight per minute by using Bain's circuit system incorporated with isoflurane vapourizer.

All the vital parameters were monitored during pre-anaesthesia, maintenance and recovery period in all animals. The blood sample for haematological, plasma/serum biochemical studies and blood gas analysis, was collected and blood pressure and electrocardiographic examination was done before premedication, ten minutes after commencement of isoflurane administration and after recovery from general anaesthesia.

The animals were prepared for the relevant surgical procedures and surgery was performed as per standard protocols under strict aseptic conditions. Administration of amoxicillin at the dose rate of 10 mg per kg body weight IV and meloxicam at the dose rate of 0.2 mg per kg body weight IM was done in all animals before surgery. Postoperatively, animals were maintained with antibiotic and anti-inflammatory drugs orally for five consecutive days.

The mean age of dogs under study was 13.33 ± 1.33 years and mean body weight was 15.8 ± 2.40 kg. The quality of sedation after administration of butorphanol and diazepam was graded to be moderate to excellent and the mean induction time was 1.33 ± 0.24 min after propofol administration for induction of anaesthesia. The mean dose of propofol used in the study was 2.25 ± 0.12 mg per kg body weight, which was lower when compared to previous reports.

Degree of muscle relaxation was graded to be excellent in all animals. The mean per cent of isoflurane used for maintenance of anaesthesia was 1.78 ± 0.15 to 2.38 ± 0.11 with the mean flow rate of oxygen of 1600 ± 3.0 mL per minute.

The mean duration of isoflurane maintenance for different surgical procedures was 74.17 ± 14.57 minutes. The mean duration of surgical plane of anaesthesia was 92.5 ± 16.82 minutes. The mean time for recovery after disconnecting isoflurane was found to be 17.17 ± 1.01minutes.

The mean value of rectal temperature and respiration rate reduced significantly after ten minutes of isoflurane commencement and returned to baseline values without significance and with significance respectively.

The mean respiration rate showed non-significant increase after ten minutes of isoflurane commencement and returned to baseline values without significant change. The mean capillary refilling time remained constant and colour of conjunctival mucous membrane was pale roseate throughout the observation period.

Systolic, diastolic and mean arterial pressure decreased non-significantly at ten minutes after commencement of isoflurane administration and returned to baseline values after recovery from surgical plane of general anaesthesia.

The mean value of total erythrocyte count and the mean total leucocyte count decreased after ten minutes of isoflurane commencement non-significantly and significantly respectively and returned to baseline values after recovery from surgical plane of general anaesthesia significantly and non-significantly respectively.

The mean lymphocyte count increased non-significantly while mean monocytes per cent increased significantly after ten minutes of isoflurane commencement which returned to baseline values after recovery from surgical plane of general anaesthesia without significant change. The mean granulocytes per cent decreased after ten minutes of isoflurane commencement which returned to baseline values after recovery from surgical plane of general anaesthesia without any significant change.

The mean haemoglobin, volume of packed red cells, alanine aminotransferase, aspartate aminotransferase, blood urea nitrogen and creatinine decreased after ten minutes of isoflurane commencement and returned to baseline values after recovery from surgical plane of general anaesthesia without any significance.

The mean platelet count and the mean total plasma protein decreased after ten minutes of isoflurane commencement and after recovery from surgical plane of general anaesthesia without much significance.

Blood gas analysis and ECG remained steady at all the observation periods in all the animals without any complications.

Recovery was rapid and smooth in all animals, except for one dog where mild degree of shivering was noticed.

The following conclusions were drawn from the study,

1. Pre-anaesthetic evaluation of geriatric patients helped to know the underlying disease conditions and probable complications during perioperative period.
2. The quality of sedation, induction, maintenance and recovery from general anaesthesia were good without any complication.
3. The present anaesthetic protocol was found be safe in the geriatric animals with the variations in physiological, haematological and plasma/serum biochemical parameters within the normal acceptable range.
4. Electrocardiographic, blood pressure and blood gas parameters were within the regular standard range in all geriatric animals and thus the anaesthetic protocol had minimum adverse effects on cardio-pulmonary system.
5. The clinical efficacy of anaesthetic protocol was found be satisfactory in all animals under study.

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7. REFERENCES

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CLINICAL EFFICACY OF PROPOFOL INDUCED ISOFLURANE ANAESTHESIA IN GERIATRIC DOGS PREMEDICATED WITH DIAZEPAM AND BUTORPHANOL

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(18-MVM -066)

ABSTRACT

Submitted in partial fulfilment of the requirement for the degree of

MASTER OF VETERINARY SCIENCE

(Veterinary Surgery and Radiology)
2020

Faculty of Veterinary and Animal Sciences

Kerala Veterinary and Animal Sciences University

DEPARTMENT OF VETERINARY SURGERY AND RADIOLOGY

COLLEGE OF VETERINARY AND ANIMAL SCIENCES

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ABSTARCT

Six geriatric dogs of various breeds presented for different surgical procedures at the Veterinary Hospitals of Kerala Veterinary and Animal Sciences University, at Mannuthy and Kokkalai were selected for the study. The study was undertaken with the objective of evaluating efficacy of propofol induced, isoflurane manitained anaesthesia with diazepam-butorphanol premedication for surgical procedures in geriatric dogs. All the dogs were subjected for thorough clinical and pre-anaesthetic evaluation before subjecting for anaesthesia. Preanaesthesia was carried out in all animals by administering butorphanol @ 0.2 mg/kg (B.W.) and diazepam @ 0.25 mg /kg body weight (B.W.) intravenously at one minute interval. After ten minutes the patients were subjected to pre-oxygenation for three minutes using a mask. Propofol (1% w/v) was administered as a slow bolus intravenous injection to effect induction of general anaesthesia. Surgical plane of anaesthesia was maintained with isoflurane in oxygen using isoflurane vapourizer incorporated Bain's circuit system. The parameters like blood pressure, electrocardiographic examination, blood and anaesthetic parameters were monitored at all stages of anaesthesia. Haematological, plasma/serum biochemical studies and blood gas analysis were also conducted. The quality of sedation, induction, maintenance and recovery from general anaesthesia were good without any complication. Variations in physiological, haematological and plasma/serum biochemical parameters were within the normal acceptable range. Electrocardiographic parameters, blood pressure and blood gas parameters were within the regular standard range in all the dogs. The anaesthetic protocol was found be safe in the geriatric dogs.

ANNEXURES

Acad. Form No. 19

KERALA VETERINARY AND ANIMAL SCIENCES UNIVERSITY

Faculty of Veterinary and Animal Sciences

PROGRAMME OF RESEARCH WORK FOR THESIS FOR MASTERS DEGREE

1. Title of thesis:

Clinical efficacy of propofol induced isoflurane anaesthesia in geriatric dogs premedicated with diazepam and butorphanol

2 (a) Title of the departmental/ KVASU Research project of which this forms a part:

Nil

(b) Code No. if any, and order by which departmental/ KVASU research project is approved:

Not applicable

3 (a) Name of student:

Manasa M. R.

(b) Admission No.:

18- MVM- 66

(c) Name of the Discipline:

Veterinary Surgery and Radiology

4 (a) Name of Major Advisor (Guide):

Dr. S. Anoop

(b) Designation:

Associate Professor,
Department of Veterinary Surgery and Radiology, College of Veterinary and Animal Sciences, Mannuthy, Thrissur – 680 651.

5. Objective of the study:

Efficacy of propofol-isoflurane anaesthesia with diazepam-butorphanol premedication for surgical procedures in geriatric dogs

6. Practical / Scientific utility:

Geriatric patients are defined as those have completed 75-80 per cent of their anticipated life span. There will be increased anaesthetic morbidity and mortality in the geriatric patients because of the decline in organ function and age-related concurrent

diseases. Hence special protocols are required for smooth and safe anaesthesia in geriatric dogs.

Geriatric dogs presenting for anaesthesia usually have multiple organ system affections. Thus preanaesthetic assessment of all systems is highly warranted in these patients. Opioids and benzodiazepines have minimal cardiovascular and respiratory effects and are safe options for geriatric patients. Propofol is a short-acting, rapidly metabolized agent, characterized by virtual lack of any cumulative effects and results in rapid recovery. Isoflurane has relatively low blood solubility, fast onset of action and recovery with good muscle relaxation.

On scanning the available literature, reports on combination of these drugs for anaesthesia of geriatric patients are scanty. Hence, the present study is undertaken to evaluate clinical efficacy of propofol induced isoflurane anaesthesia in diazepam-butorphanol premedicated geriatric dogs.

7. Important publications on which study is based:

According to Reid *et al.* (1996) propofol at the dose rate of 5 mg per kg body weight was adequate for induction of anaesthesia in dogs over the age of eight year. In addition, the clearance of propofol by old dogs was slower and lower doses were sufficient for older dogs.

Carpenter *et al.* (2005) stated that appropriate preoperative screening, judicious dosing of anaesthetics, and careful monitoring and supportive care, the risk of anesthesia in geriatric animals could be greatly reduced.

Screening of geriatric patients was found important, as sub-clinical diseases could be present in nearly 30 per cent of these patients. Pre-anaesthetic screening had to be advocated as a valuable tool for improving anaesthetic safety and determining anaesthetic risk. (Joubert, 2007)

Hughes (2008) reported that pre-anaesthetic assessment and stabilisation could improve the outcome in geriatric anaesthesia. Benzodiazepines, which were otherwise poor sedatives with an opioid produced a good sedative effect in geriatric patients. Anti-cholinergic and α-2 agonist drugs which promote arrhythmias should be avoided in geriatric patients.

McNally *et al.* (2009) stated that in dogs, pre-oxygenation using 100 per cent oxygen delivered through a facemask for three minutes before induction of anaesthesia increased the time to desaturation.

Sooryadas *et al.* (2011) reported electrocardiogram changes during xylazine-propofol anaesthesia in dogs. The changes including tachycardia, bradycardia with second degree heart block, wandering pace maker, ventricular pre-excitation, atrial premature contraction, ST coving, biphasic T waves and peaked T waves were observed.

8. Outline of the technical programme

The study will be conducted in minimum of six geriatric dogs, irrespective of sex and breed presented for surgery to the University Veterinary Hospitals of Kerala Veterinary and Animal Sciences University at Mannuthy and Kokkalai. Detailed history will be collected and clinical examination will be carried out. Preoperative evaluation of cardiovascular, respiratory, renal and hepatic systems will be done (Hughes, 2008). Diazepam (0.25 mg per kg body weight) and butorphanol (0.2 mg per kg body weight) will be administered intravenously as pre- anaesthetic medication. Immediately following this, propofol (1% w/v) will be administered as slow intravenous injection to effect general anaesthesia. Pre-oxygenating the patient with 100 per cent oxygen will be carried out for three minutes simultaneously. It will be followed by maintenance with isoflurane with oxygen after endotracheal intubation, in all the animals.

After administration of premedication, degree of sedation will be observed. Anaesthetic depth will be assessed based on palpebral reflex, position of eye ball, mandibular muscle tone, pedal reflex for every 10 minutes after induction of general anaesthesia till recovery (Huskins, 2007). All the cases will be subjected to detailed clinical, haematological and serum biochemical parameters, blood gas, electrocardiogram and blood pressure evaluation before premedication, ten minutes after commencement of isoflurane administration and after recovery from general anaesthesia.

Data will be analysed statistically using SPSS version 24.0.

9. Main items of observation:

1. Detailed clinical examination
2. Physiological parameters
    a. Rectal temperature (ºC)
    b. Pulse (per minute)
    c. Respiration rate (per minute)
    d. Capillary refilling time (seconds)
    e. Colour of visible mucous membrane
3. Haematological parameters
    a. Total erythrocyte count (10^6/ µL)
    b. Total leucocyte count (10^3/µL)
    c. Differential leucocyte count (%)
    d. Haemoglobin (g/dL)
    e. Volume of packed red cells (%)
    f. Platelet count (10^3/ µL)
4. Serum biochemical findings
    a. Alanine aminotransferase (IU/L)
    b. Aspartate aminotransferase (IU/L)
    c. Blood Urea Nitrogen (mg/dL)
    d. Creatinine (mg/dL)
    e. Random blood sugar (mg/dL)
    f. Total plasma protein (g/dL)
5. Blood gases
6. Electrocardiogram

7. Blood pressure (mmHg)

8. Anaesthetic parameters

a. Time for induction of general anaesthesia
b. Volume of propofol used
c. Degree of muscle relaxation
d. Per cent of isoflurane for maintenance of anaesthesia
e. Flow rate of oxygen (mL/min)
f. Duration of isoflurane maintenance
g. Duration of anaesthesia
h. Time for recovery

9. Complications, if any

10. Facilities:

(a) Existing:

Facilities in the Department of Veterinary Surgery and Radiology and other departments in the College of Veterinary and Animal Sciences, Mannuthy and University Veterinary Hospitals at Mannuthy and Kokkalai will be utilized.

(b) Additional facilities required:

Anaesthetics and analytical kits

11. Duration of the study:

Four semesters

12. Financial estimate:

Anaesthetics :Rs 8000/-
Cost of diagnostic
and lab tests, contingencies,
documentation etc. :Rs 17000/-

Total : Rs 25000/-

Signature of student

Project co-ordination group to which proposal is to be placed:

Animal diseases - II

Signature of Major Advisor

Mannuthy,
Date:

Name and signature of the members of the Advisory Committee:

1. Dr. S. Anoop
   Associate Professor
2. Dr. K. D. John Martin
   Professor and Head
3. Dr. Soumya Ramankutty
   Assistant Professor
4. Dr. V. Beena
   Assistant Professor

APPENDIX –I

References:

Carpenter, R.E., Pettifer, G.R. and Tranquilli, W.J. 2005. Anesthesia for geriatric patients. *Vet. Clin. Small Anim. Pract.* **35**: 571-580.

Haskins, S.C. 2007. Monitoring Anesthetized Patients. In: Thurmon, J. C, Tranquilli, W. J, Grimm, K. A. (ed), *Lumb and Jones' Veterinary Anesthesia And Analgesia* (4th Ed.). Blackwell Publishing Ltd, UK, pp. 533-558.

Hughes, J.M.L. 2008. Anaesthesia for the geriatric dog and cat. *Ir. Vet. J.* **61**: 380-387.

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APPENDIX -II

Time frame of work:

Semester -I

1. Collection and review of literature
2. Planning and preparation for research work

Semester -II

1. Collection and review of literature
2. Conducting clinical trials in selected cases
3. Standardisation of anaesthetic protocol

Semester -III

1. Pre-anaesthetic screening of patient
2. Blood collection and evaluation

Semester -IV

1. Analysis of data collected
2. Preparation and submission of thesis

CERTIFICATE

Certified that the research project has been formulated observing the stipulations laid down under the Prevention of Cruelty to Animals Act (Amendment, 1998).

Place: Mannuthy **Dr. S. Anoop**

Date: (Major Advisor)

Curriculum vitae

1. Name of the candidate: Manasa M. R.

2. Date of birth: 03/07/1995

3. Place of birth: K. R. Nagar, Mysore, Karnataka

4. Marital status: Unmarried

5. Permanent address: D/o N. Ramaswamt Gowda, Ramakripa, Kuvempu badavane, K. R. Nagar (T), Mysuru, (D), Karnataka – 571604.

6. Major field of specialization: Veterinary Surgery and Radiology

7. Educational status: B.V.Sc. and AH

8. Professional experience: NIL

9. Publications made: Clinical efficacy of propofol induced isoflurane anaesthesia in geriatric dogs premedicated with diazepam and butorphanol. *Journal of Veterinary and Animal Sciences*

10. Membership of professional societies:
    1. Karnataka Veterinary Council
    2. KVAFSU Alumni
    3. Indian Veterinary Association Indian Society for Advancement of Canine Practice
    4. Indian Society for Veterinary Surgery