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Haematophysiological assessment in dogs with propofol anaesthesia during orthopaedic surgery

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Abstract

Anaesthesia in orthopaedic surgery is a critical point in the surgical procedure. A total of 24 dogs aged between 1 and 5 years with long bone fractures were selected for the study. A locking compression plating was done in all the dogs. Buprenorphine 0.02 mg/kg body weight was administered subcutaneously, followed by xylazine hydrochloride, 1 mg/kg body weight, intramuscularly after 10 minutes. Later, general anaesthesia was induced with an intravenous injection of propofol at 4 mg/kg. After achieving lateral recumbency, midazolam at 0.1 mg/kg was administered intravenously. Maintenance of anaesthesia was performed with additional propofol as needed. There was a non-significant decrease in heart rate and a substantial decrease in respiratory rate and rectal temperature during maintenance of anaesthesia. A significant reduction in the oxygen saturation and mean arterial blood pressure was reported during surgery. Intraoperative significant decrease in Hb, PCV, and TEC was seen. DLC at various intervals showed a significant increase in neutrophil count intraoperatively, followed by a reduction in count. The anaesthesia was well tolerated, and an uneventful recovery was observed in all dogs, with sufficient muscle relaxation during surgery.

Keywords: Anaesthesia in orthopaedic surgery, locking compression plating, mean arterial blood pressure, propofol, buprenorphine

Introduction

Due to an increase in the number of automobile accidents involving stray and owned pets, many veterinarians observe fractures and other orthopaedic abnormalities in dogs daily. Orthopaedic surgeries are excruciating procedures. Animal anaesthesia is critical during various surgical procedures in canines. Many orthopaedic patients reported are geriatric, traumatised, and have often experienced extensive blood loss. To stabilise such a patient, a multimodal drug combination must be used. To achieve balance, anaesthetic combinations are used. Opiates can be used in orthopaedic surgery because they have potent analgesic properties and an anaesthetic-sparing effect. They also decrease gastrointestinal motility in dogs and cause bradycardia. An alpha-2 agonist, xylazine, has muscle-relaxant properties, but it is hypotensive, which may be fatal for the compromised patient. Midazolam can be an effective central acting muscle relaxant. Propofol is a non-barbiturate anaesthetic with a short half-life and can effectively work as a controlled anaesthetic. Low postoperative nausea, short duration, and rapid recovery are advantageous in dog anaesthesia. There are limited reports on cardiopulmonary assessment of propofol during orthopaedic surgery. So, the study was undertaken to evaluate propofol during maintenance of anaesthesia in dogs during orthopaedic surgery.

Material and Method

Adult dogs aged 1-5 years with a history of long- bone fractures of the tibia and femur were selected for the study. Dogs with neurological issues, in addition to the fracture, were excluded. A presurgical orthopaedic evaluation was conducted. The animals were kept off feed for 8 to 12 hours before surgery. Water was withheld for 4 hours before surgery. A

preoperative antibiotic injection of Cefotaxime at 10 mg/kg was administered intramuscularly 30 minutes before surgery. All animals were premedicated with buprenorphine 0.02 mg/kg body weight subcutaneously, followed by xylazine hydrochloride 1 mg/kg body weight intramuscularly after 10 minutes. General anaesthesia was induced with an intravenous injection of propofol at 4 mg/kg. After achieving lateral recumbency, midazolam at 0.1 mg/kg was administered intravenously. Maintenance of anaesthesia was performed with additional propofol as needed. During maintenance of anaesthesia in all dogs, physiological parameters such as heart rate (Beats/Min), rectal temperature (°F), and respiratory rate (Breaths/min) were recorded before surgery, after sedation, after induction of anaesthesia, at 10-minute intervals during surgery, and after complete recovery from anaesthesia. Parameters such as mean blood pressure (mmHg) and SpO₂ (%) were measured 10 minutes after induction of anaesthesia and at 10-minute intervals during maintenance of anaesthesia. About 2-3 ml of venous blood was collected in an EDTA vial from either the cephalic or saphenous vein to measure haematological parameters. Haematological parameters such as haemoglobin (g/dL), packed cell volume (%), total erythrocyte count ($\times 10^6/\mu\text{L}$), total leucocyte count ($10^3/\mu\text{L}$), platelet count ($\times 10^3/\mu\text{L}$), and differential leucocyte count (%) were recorded before, during surgery, after complete recovery from anaesthesia, and on the 3rd and 7th days postoperatively. Biochemical parameters were measured by collecting 4-5 ml of venous blood from either the cephalic or the saphenous vein in a clot activator vacutainer. The blood was then centrifuged at 3000 rpm for 10 minutes, and the serum was separated for analysis. The biochemical parameters were recorded before, during surgery, after complete recovery from anaesthesia, and on the 3rd and 7th days. The estimations were performed using a semi-automatic biochemistry analyser (ERBA CHEM 7 model, TransAsia Biomedicals, India). Standard diagnostic kits were used to estimate the biochemical parameters such as serum alkaline phosphatase (IU/L), serum calcium (mg/dL), and serum phosphorus (mg/dL) before surgery, and then 15, 30, and 45 days after surgery.

Result and Discussion

Cardiopulmonary parameters were measured before anaesthesia induction and at regular intervals during maintenance of anaesthesia. Heart rate was recorded, and the summary data for different time intervals are presented in Table 1. The presurgery mean $\pm$ SE heart rate was 96.79 ± 2.69 beats per minute, which gradually decreased to 89.25 ± 2.77 beats per minute over 60 minutes. The heart rate returned to 97.04 ± 2.37 beats per minute after complete recovery. There was no significant difference in the dogs' heart rates within the group. A substantial decrease in the mean $\pm$ SE heart rate was observed during surgery, remaining within the normal physiological range. Similar findings were reported by Anandamay *et al.* (2016) [1] and Ravasio *et al.* (2025) [2] after the use of propofol for induction and maintenance of anaesthesia during surgery. Bayan *et al.* (2025) [3] found that cardiac parameters were within the normal range during maintenance of anaesthesia with propofol in dogs. Similarly, Cattai *et al.* (2018) [4] found that heart rate and cardiac output remained constant during propofol anaesthesia in dogs due to a compensatory chronotropic response. However, Silva *et al.* (2011) [5] reported that heart rate exhibited substantial variability between animals during maintenance of anaesthesia.

Table 1: Mean $\pm$ Standard Error (SE) of heart rate, respiratory rate, and temperature at different time intervals

Time interval	Heart rate	Respiratory rate	Temperature
Before surgery	96.79 $\pm$ 2.69	16.33 $\pm$ 0.25 ^a	101.32 $\pm$ 0.12 ^a
10 Min	93.67 $\pm$ 2.69	14.63 $\pm$ 0.39 ^{ab}	100.95 $\pm$ 0.10 ^{ab}
20 Min	93.04 $\pm$ 3.06	14.25 $\pm$ 0.52 ^{ab}	100.47 $\pm$ 0.10 ^{bc}
30 Min	91.33 $\pm$ 3.09	13.21 $\pm$ 0.61 ^{ab}	100.20 $\pm$ 0.13 ^{cd}
40 Min	90.50 $\pm$ 2.81	12.96 $\pm$ 0.70 ^b	99.82 $\pm$ 0.13 ^{de}
50 Min	89.83 $\pm$ 2.68	12.71 $\pm$ 0.54 ^b	99.78 $\pm$ 0.10 ^{de}
60 Min	89.25 $\pm$ 2.77	12.54 $\pm$ 0.52 ^b	99.64 $\pm$ 0.15 ^{de}
70 Min	89.21 $\pm$ 2.61	12.79 $\pm$ 0.50 ^b	99.63 $\pm$ 0.12 ^e
80 Min	89.92 $\pm$ 2.57	12.83 $\pm$ 0.31 ^b	99.67 $\pm$ 0.13 ^{de}
90 Min	88.81 $\pm$ 2.08	12.67 $\pm$ 0.31 ^b	99.91 $\pm$ 0.16 ^{cde}
After Surgery	97.04 $\pm$ 2.37	16.83 $\pm$ 0.29 ^a	101.04 $\pm$ 0.11 ^a

Different superscripts a and b between columns indicate significant differences at the 5% ($p < 0.05$) and 1% ($p < 0.01$) significance levels

The mean $\pm$ SE respiratory rate in the dogs before surgery was 16.33 ± 0.25 breaths per minute. A decrease to 12.54 ± 0.52 was observed over a 60-minute interval, which was significant. These values were within the normal physiological range for dogs. Significant respiratory depression was observed in a dog maintained under propofol anaesthesia. Pakgohar and Mehrannia (2024) [6] opined that a sufficient sample size enables meaningful comparisons between animals in a clinical study. No significant decrease in respiratory rate was observed from 30 minutes until the animal's recovery. Muir III and Gadawski (1998) [7], Anandamay *et al.* (2016) [1], and Bayan (2024) [3] reported similar findings. Rectal temperature was recorded at various intervals (Table 1). Before surgery, rectal temperature was 101.32 ± 0.12 °F. There was a significant decrease in temperature within each group during maintenance of anaesthesia. Similar findings were reported by Njoku (2015) [8], Yadav *et al.* (2015) [9], Chandrakala (2015) [10], Anandamay *et al.* (2016) [1], Bolaji Alabi *et al.* (2018) [11], and Zalavadiya *et al.* (2024) [12] during maintenance of propofol anaesthesia. Borncamp *et al.* (2015) [13] observed an immediate decrease in rectal temperature following propofol induction.

Reduced metabolic rate, peripheral vasodilation, depression of the thermoregulatory center, and increased heat dissipation lower rectal temperature in dogs. This observation was noted by Paddleford and Harvey (1999) [14] and Saghiv and Sagiv (2020) [15]. Non-invasive mean arterial blood pressure was measured by placing a cuff on the antebrachium between the elbow and carpal, 10 minutes after induction of anaesthesia. The mean $\pm$ SE values of arterial blood pressure were recorded and summarised in the table. 2. There was a substantial decrease in blood pressure in the group from 30 to 90 minutes during surgery. This variation is within the normal range. Similar observations were noted by Silva *et al.* (2011) [5] and Nakaigawa *et al.* (1995) [16]. However, Sarotti *et al.* (2024) [17] reported a decrease in MAP in dogs after induction of anaesthesia with propofol. This is due to the direct effect of propofol on the dog's heart. Additionally, propofol may attenuate arterial baroreflex function by affecting sympathetic nervous activity centrally and/or peripherally, which could lead to a decrease in MAP in dogs during maintenance anaesthesia with propofol (Cattai *et al.*, 2018) [4].

Table 2: Mean $\pm$ SE mean arterial blood pressure at different time intervals

Time	MAP	SpO ₂
10 Min	89.96 $\pm$ 1.21 ^a	98.42 $\pm$ 0.38 ^a
20 Min	88.21 $\pm$ 1.14 ^{ab}	98.17 $\pm$ 0.41 ^{ab}
30 Min	86.04 $\pm$ 1.53 ^{ab}	97.54 $\pm$ 0.41 ^{abc}
40 Min	84.25 $\pm$ 1.45 ^b	96.08 $\pm$ 0.47 ^{bcd}
50 Min	84.92 $\pm$ 1.20 ^{ab}	95.29 $\pm$ 0.63 ^d
60 Min	85.04 $\pm$ 1.12 ^{ab}	96.00 $\pm$ 0.38 ^{cd}
70 Min	85.33 $\pm$ 1.04 ^{ab}	96.25 $\pm$ 0.52 ^{bcd}
80 Min	86.57 $\pm$ 0.96 ^{ab}	96.43 $\pm$ 0.57 ^{abcde}
90 Min	87.32 $\pm$ 0.90 ^{ab}	97.14 $\pm$ 0.51 ^{abcde}

Different superscripts a and b between columns indicate significant differences at the 5% ($p < 0.05$) and 1% ($p < 0.01$) significance levels

Oxygen saturation of blood was recorded by placing a probe on an unpigmented area of the dog's tongue, and the readings were displayed on the multipara. SpO₂ was recorded after 10 minutes of induction of anaesthesia and then at every 10-minute interval during maintenance of anaesthesia. There was a significant difference in SpO₂ during anaesthesia maintenance at 50- to 90-minute intervals. Similar findings were reported by Bufalari *et al.* (1997) [18], Mohamadina *et al.* (2008) [19], and Bolaji Alabi *et al.* (2018) [11] while using propofol as an anaesthetic during maintenance of anaesthesia in dogs. A decrease in oxygen saturation within the group is due to reduced oxygen perfusion at the cellular level, driven by decreased heart and respiratory rates. This is also due to blunting the hypoxic ventilatory response, which decreases tidal volume, minute volume, and respiratory rate (Sahinovic *et al.* 2018, Marangoni *et al.* 2023) [20, 21].

To measure haematological parameters, venous blood was collected in an EDTA vial from the cephalic vein. The mean $\pm$ SE haemoglobin values at different time intervals are summarised in Table 3.

Table 3: Mean $\pm$ SE haematological parameters during different durations in three groups

Duration	Hb	PCV	TEC	TLC	PLT
Pre Op	11.98 $\pm$ 0.29 ^a	36.38 $\pm$ 0.98 ^a	5.37 $\pm$ 0.24 ^{ab}	7.42 $\pm$ 0.29 ^{ab}	2.78 $\pm$ 0.10 ^b
Intra OP	11.17 $\pm$ 0.28 ^a	32.68 $\pm$ 0.90 ^b	4.84 $\pm$ 0.23 ^a	6.68 $\pm$ 0.25 ^a	2.40 $\pm$ 0.07 ^a
Post OP	13.19 $\pm$ 0.27 ^b	41.04 $\pm$ 1.0 ^c	6.11 $\pm$ 0.25 ^b	8.12 $\pm$ 0.34 ^b	3.00 $\pm$ 0.10 ^b
Day 3	13.22 $\pm$ 0.22 ^b	40.44 $\pm$ 0.87 ^c	5.99 $\pm$ 0.24 ^b	8.03 $\pm$ 0.32 ^b	3.00 $\pm$ 0.09 ^b
Day 7	13.70 $\pm$ 0.13 ^b	40.58 $\pm$ 0.61 ^c	5.99 $\pm$ 0.25 ^b	7.99 $\pm$ 0.31 ^b	2.95 $\pm$ 0.08 ^b
Day 15	13.54 $\pm$ 0.13 ^b	41.54 $\pm$ 0.82 ^c	6.16 $\pm$ 0.19 ^b	8.13 $\pm$ 0.32 ^b	3.14 $\pm$ 0.10 ^b

Different superscripts a and b between columns indicate significant differences at the 5% ($p < 0.05$) and 1% ($p < 0.01$) significance levels

The mean $\pm$ SE values of haemoglobin fluctuate significantly within the animals at different time intervals. A significant decrease in haemoglobin was observed during the surgery across all groups. This may be due to blood loss during the surgery on dogs. These findings align with those of Cost *et al.* (2013) [22], Pusp *et al.* (2023) [23], whereas Morey *et al.* (2006) [24] found no significant changes in haemoglobin during different time intervals in dogs. Bruno *et al.* (2015) [25] suggested that the decrease in haemoglobin observed in humans due to hypercoagulability during orthopedic surgery was not seen in dogs during orthopedic procedures. Therefore, the reduction in haemoglobin is likely due to blood loss during surgery, RBC sequestration, or hemodilution in the dog. There was a significant decrease in haemoglobin within the groups during the surgical procedure on the animal. Similar findings were reported by Cost *et al.* (2013) [22],

Rajhans (2013) [26], Patil *et al.* (2017) [27], Chaurasia *et al.* (2019) [28], and Pusp *et al.* (2023) [23]. At the same time, Morey *et al.* (2006) [24] found no significant changes in packed cell volume during different time intervals in dogs. There was significant ($p > 0.05$) variation within the animals in total erythrocyte counts of dog. A significant gradual increase after surgery was recorded in all groups. These values fluctuated within the normal physiological ranges, attributed to the normal functioning of the reticuloendothelial system. Similar findings were recorded by Tembhurne *et al.* (2010) [29], Erfourth *et al.* (2012) [30], Lee *et al.* (2012) [31], Rajhans (2013) [26], Patil *et al.* (2017) [27], Chaurasia *et al.* (2019) [28] and Sabiza *et al.* (2021) [32].

The summarised data are presented in Table 3. The mean $\pm$ Standard Error (SE) of total leucocyte count in $N \times 10^3/\mu L$ for all dogs was measured on day 0, during the intraoperative period, and at different postoperative intervals. A non-significant decrease in total leucocyte count followed by gradual increase was observed in all animals. The maximum leukocyte count was recorded before surgery, then gradually decreased and returned to normal on day 15. The high preoperative total leucocyte count was attributed to initial inflammation induced by stress and pain. As the inflammatory response subsided, a gradual decline in the total leucocyte count was observed. Similar findings were reported by Sastry (1998), indicating that post-fracture leukocytosis could be linked to the release of corticosteroids triggered by trauma, pain, and stress as part of the body's defense mechanism against stress. Rajhans (2013) [26], Patil *et al.* (2017) [27], Chaurasia *et al.* (2019) [28], Preethi (2020) [34], and Choudhary (2024) [33] also reported similar findings. The values remained within the normal physiological range ($6-17 \times 10^3/\mu L$) throughout the study period, as stated by Aiello S.E. and Mays A. (1998) [35].

There was non-significant decrease in the platelet count within all groups, where a reduction in platelet count was noticed intraoperatively. These findings were consistent with those of Cost *et al.* (2013) [22] and Pusp *et al.* (2023) [23], whereas Morey *et al.* (2006) [24] found no significant changes in packed cell volume across different time intervals in dogs. Considering the differential leukocyte count was recorded and summarised in Table 4. The Mean $\pm$ SE value of neutrophil (%), eosinophil, basophil, monocyte was recorded at different time intervals and is summarised in Table 5.

Table 4: Neutrophil, eosinophil, basophil, monocyte count (%) at different time intervals

Duration	Neutrophil	Lymphocyte	Eosinophil	Monocyte
Pre Op	79.38 $\pm$ 0.67	19.67 $\pm$ 0.53	4.04 $\pm$ 0.26	3.67 $\pm$ 0.31
Intra OP	86.54 $\pm$ 0.67	17.38 $\pm$ 0.61	2.38 $\pm$ 0.24	2.21 $\pm$ 0.22
Post OP	72.46 $\pm$ 0.77	16.00 $\pm$ 0.36	3.54 $\pm$ 0.28	5.13 $\pm$ 0.29
Day 3	68.46 $\pm$ 0.72	19.83 $\pm$ 0.74	3.46 $\pm$ 0.33	5.08 $\pm$ 0.23
Day 7	64.21 $\pm$ 0.67	21.25 $\pm$ 0.55	3.71 $\pm$ 0.33	3.83 $\pm$ 0.23
Day 15	64.08 $\pm$ 0.52	18.58 $\pm$ 0.33	3.42 $\pm$ 0.30	3.04 $\pm$ 0.34

Different superscripts a and b between columns indicate significant differences at the 5% ($p < 0.05$) and 1% ($p < 0.01$) significance levels

A significant rise in the dog's neutrophil count was observed during surgery up to 86.54 $\pm$ 0.67%. Post-surgery, the neutrophil count drops significantly to normal levels by the 15th postoperative day, possibly reflecting a reduced inflammatory response. Manteca *et al.* (2023) [36] and Vaisanen *et al.* (2004) [37] reported an increase in neutrophil count during surgery, followed by a return to normal levels postoperatively, due to changes in stress and cortisol levels.

These findings were supported by Rajhans (2013) [26], Patil *et al.* (2017) [27], and Chaurasia *et al.* (2019) [28]. A non-significant decrease in lymphocyte count was noted intraoperatively, with the count returning to normal by day 15. These findings are consistent with the observations of Schalm *et al.* (1975) [38], Rajhans (2013) [26], Patil *et al.* (2017) [27], Chaurasia *et al.* (2019) [28], Preethi (2020) [34], and Choudhary (2024) [33]. The values stayed within the normal physiological range (12-30%) throughout the study, as noted by Aiello, S.E. and Mays, A. (1998) [35]. The gradual rise in lymphocyte count was due to a relative change in neutrophil levels, which, after an initial increase, returned to normal. This occurs because macrophages activate the production of immunoregulatory cytokines. These cytokines trigger the activation of the adrenal axis and boost glucocorticoid production. A non-significant decrease in the eosinophil count was observed with a minimum during surgery and a maximum on day 15. The values were within normal range during the study. Similar findings were reported by Tembhurne *et al.* (2010) [29], Patil *et al.* (2017) [27], Chaurasia *et al.* (2019) [28], Preethi (2020) [34], and Choudhary (2024) [33] regarding fracture healing following implantation and grafting in dogs. The monocyte count increased non significantly from the intraoperative period to 15 days post-surgery within all groups. These align with the findings of Rajhans (2013) [26], Patil *et al.* (2017) [27], Chaurasia *et al.* (2019) [28], and Choudhary (2024) [33]. The gradual rise in monocyte count was due to a relative change in neutrophil levels, which, after an initial increase, returned to normal.

Conclusion

The protocol of xylazine sedation followed by induction with propofol and midazolam, with maintenance using propofol, provides stable cardiopulmonary effects and consistent haematological changes in dogs during orthopaedic surgery.

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