Indian J Anim Health (2024), 63(1): 111-115
DOI: https://doi.org/10.36062/ijah.2024.09423

Research Article

Cardiopulmonary effects of dexmedetomidine-butorphanol premedication, propofol-diazepam induction and isoflurane maintenance anaesthesia for surgical management of acute abdomen in dogs

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Abstract

In the study, twelve dogs of various ages and sexes were selected with the clinical signs of acute abdomen disorders such as abdominal pain, distension, cessation of defecation and urination, oliguria and dystocia. Dexmedetomidine and butorphanol were administered intravenously as premedicant and propofol-diazepam as intravenous induction agents. Isoflurane with a variable vaporizer setting was employed for anaesthesia maintenance. Throughout the anaesthesia period, parameters including heart rate, respiratory rate, temperature, SPO2, EtCO2, tidal volume, minute volume, systolic and diastolic blood pressure and mean arterial pressure were continuously monitored. After premedication and during the 30th and 45th minutes of anaesthesia, the heart rate decreased. The respiratory rate was significantly reduced after induction and remained low throughout the anaesthesia period. However, SpO2, EtCO2, tidal volume, and minute volume were maintained well within acceptable levels during anaesthesia. In this study, there were no anaesthetic complications or mortality, indicating the safety of the anaesthetic protocol in dogs with acute abdomen. Hence, it is concluded that special attention should be given to dogs with pre-existing cardiopulmonary abnormalities due to the potential cardiopulmonary depressant effect of the employed anaesthetic protocol.

Keywords: Acute abdomen, Butorphanol, Dexmedetomidine, Isoflurane and propofol-diazepam

Highlights

- The research was carried out to tailor a balanced anaesthetic protocol for dogs suffering from acute abdominal disorders. Dogs with acute abdomen often presented with cardiopulmonary and electrolyte abnormalities along with compromised liver and kidney functions. Anaesthesia for dogs with acute abdominal disorder is challenging.
- Usage of dexmedetomidine is still in a primitive stage in veterinary anaesthesia, and even though it has a potent cardiovascular depression effect, dexmedetomidine is safer when compared to xylazine, even in pregnant animals and animals that do not fast before surgery.
- A combination of alpha 2 agonists and opioids provided a synergistic effect and increased the depth of sedation in dogs, thereby reducing the dose of dexmedetomidine and ketamine and also having isoflurane sparing effect.
- Ketamine hydrochloride, a dissociative anaesthetic, has a cardiovascular stabilization property, and it is suitable for patients with cardiovascular instability is highly suitable for patients with acute abdominal disorder.
- The results of the present study indicated that the combination of dexmedetomidine and butorphanol as preanaesthetic, propofol and diazepam as induction agent and isoflurane maintenance had a significant effect on the cardiopulmonary system in dogs with acute abdominal disorders.

INTRODUCTION

One of the major obstacles that confronted veterinary anaesthetists was providing anaesthesia for patients with acute abdomen. Acute surgical disorders of the abdomen in dogs typically manifested with instability, significant cardiovascular and pulmonary disturbances and varied responses to medications. There were several intraoperative issues that required

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specific treatment. According to Thurmon *et al.* (1996), patients with acute abdominal disorders that warranted surgery often had cardiopulmonary, haematological, biochemical, electrolyte and acid-base abnormalities. Understanding the physiological significance of these aberrations in the context of anaesthesia was crucial to ensuring proper anaesthetic management, as emphasized by the authors. According to Hofmeister (2003), a key issue for veterinary anaesthetists was administering anaesthesia to patients with acute abdominal disorders. According to the author, these patients frequently displayed unstable conditions, severe cardiopulmonary anomalies and inconsistent responses to various treatments. To determine the cardiopulmonary effects of balanced anaesthesia in the surgical therapy of acute abdominal problems, the current study used dexmedetomidine and butorphanol as premedicants, propofol and diazepam as induction agents and isoflurane as maintenance for anaesthesia.

MATERIALS AND METHODS

The study was conducted on twelve clinical cases of dogs that had a history of acute abdomen, including caesarean section, pyometra, obstructive urolithiasis, gastrointestinal tract obstruction and strangulated hernia. The demographic distribution of these twelve cases is presented in Table 1. All animals included in the study had undergone thorough clinical examinations. Specialized diagnostic techniques like radiography, ultrasonography, electrocardiography or echocardiography, along with haematology and serum biochemical analysis, were used for preanesthetic screening. Due to the urgent nature of acute abdominal disorders, it had not been possible to implement food and water restrictions before surgery. The hairs around the surgical area were cleanly shaved and the surgical area was prepared aseptically using 7.5% w/v povidone-iodine surgical scrub solution (Betadine®, Win-Medicare Private Limited, New Delhi, India), 2.5% v/v chlorhexidine gluconate solution, and 70% v/v ethyl alcohol solution (Bactorub Pink®, Raman and Weil Private Limited, Mumbai, India).

In the study, all twelve animals were premedicated with dexmedetomidine at a dose rate of 2 µg/kg body weight i.v. followed by butorphanol at a dose rate of 0.2 mg/kg body weight i.v. After the animals were sedated, anaesthesia was induced by inj. propofol at a dose rate of 4 mg/kg body weight i.v. to effect slowly over 30 seconds, followed by diazepam at a dose rate of 0.5 mg/kg body weight i.v. after 5 minutes. Oroendotracheal intubation was performed using Murphy-type cuffed endotracheal tubes. All the animals were connected to Boyle's apparatus through a rebreathing circle system, and initially, a fresh gas flow of 3 L was given for 3 minutes to eliminate nitrogen from the breathing circuit. After 3 minutes, the fresh gas flow was reduced to 20 mL/kg body weight, with a minimum flow rate of 500 mL per minute to optimize the function of the vaporizer. The anaesthesia was maintained using isoflurane with a variable vaporizer setting ranging from 0.5 to 3 per cent, adjusted based on each animal's response to surgical stimuli.

The physiological parameters like heart rate, respiratory rate, oesophageal temperature (Table 2) and cardiopulmonary parameters, including SPO_2, $EtCO_2$

Table 1. Demographic distribution of selected cases

Animal No.	Breed	Age in years	Sex	Surgical condition
1	Golden Retriever	2	Female	Emergency c section
2	Rajapalayam	2	Female	Emergency c section
3	Chippiparai	5	Female	Emergency c section
4	Pug	8	Female	Open pyometra
5	Pug	9	Male	Uretherotomy
6	Non-descript	5	Male	Cystotomy
7	Pug	6	Female	Open pyometra
8	Non-descript	4.5	Female	Closed pyometra
9	Pit Bull	10	Male	Cystotomy and urethrotomy
10	Daschund	6	Female	Emergency c section
11	German Sephard	0.5	Male	Linear foreign body
12	Kanni	0.2	Male	Intussusception

Table 2. Mean±SE of heart rate and respiratory rate during different stages of anaesthesia

	Preoperative	After premedication	After induction	15 minutes	30 minutes	45 minutes	60 minutes	75 minutes	90 minutes	After recovery
Heart rate	125.08[a] ±6.88	90.75[b] ±8.48	99.17 ±5.97	97.33 ±6.04	94.25[b] ±5.47	90.50[b] ±6.70	95.63 ±5.94	89.67 ±6.10	85.50 ±14.50	114.92 ±6.49
Respiratory rate	50.08[ac] ±6.89	33.75 ±4.31	16.00[b] ±2.44	12.92[b] ±1.94	24.09[bc] ±9.33	11.33[b] ±1.70	13.13[b] ±3.32	14.67[bc] ±2.45	15.50 ±4.50	38.33[c] ±5.27

Row-wise group means with different superscripts (abc) differ significantly ($p<0.05$)

Table 3. Mean±SE of SPO_2, $ETCO_2$, tidal volume, minute volume, systolic blood pressure, diastolic blood pressure and mean arterial pressure during different stages of anaesthesia

Parameters	After induction	15 minutes	30 minutes	45 minutes	60 minutes	75 minutes	90 minutes
SPO_2	98±0.51	98±0.51	98±0.30	98±0.67	99±0.46	99±0.56	99±0.00
$ETCO_2$	43±3.45	42±3.81	43±3.80	44±4.59	46±5.29	48±6.55	50±0.50
Tidal volume	134±20.53	158±31.94	195±41.02	171±37.67	190±43.33	176±29.44	114±4.00
Minute volume	2.5±0.71	2.2±0.55	2.5±0.41	1.4±3.49	2.7±0.94	2.3±0.51	1.9±0.70
Systolic BP	117.83±5.45	91.08±9.61	92.91±6.32	90.55±6.45	100.50±5.36	99.17±5.74	105.50±0.50
Diastolic BP	67.08±6.12	58.33±4.26	53.82±4.75	51.64±4.83	59.13±3.62	63.33±5.26	65.50±1.50
MAP	84.56±9.36	70.25±7.46	65.91±5.32	64.27±4.81	73.71±7.45	71.67±5.69	76.83±2.50

Row-wise group means with different superscripts (abc) differ significantly ($p<0.05$)

and NIBP, were monitored throughout the surgery using a Schillers Q5 multiparameter monitor (Table 3). The respiratory parameters like tidal volume and minute volume were recorded using a Birds Ventilometer throughout the surgery (Table 3). Anaesthetic complications during this study, if any, were recorded.

RESULTS

In the present study, twelve clinical cases of dogs were selected randomly with the signs of acute abdomen, out of which seven were females and five were males of age ranging from 2 months to 9 years. The following parameters were recorded and presented.

Heart rate (Beats per minute): The heart rate of all the animals decreased significantly ($p<0.01$) after premedication and then decreased significantly ($p<0.05$) at 30th and 45th minute of anaesthesia when compared to pre-operative values, thereafter heart rate decreased non significantly and reached to near normal after recovery.

Respiratory rate (Breaths/minute): Respiratory rates in all the animals were reduced significantly ($P<0.01$) after induction throughout the anaesthetic period up to 75th minutes of anaesthesia, and the respiratory rate gradually increased from 90th minutes and returned to nearly normal after recovery. There was a high significant ($p<0.01$) increase in respiratory rate after the recovery period when compared to after induction of anaesthesia.

SPO2 and ETCO2 (per cent): The saturation of peripheral oxygen (percent) and end tidal carbon dioxide concentration (per cent) were maintained within the normal range throughout the anaesthetic maintenance, and there was no significant difference in SPO2 and ETCO2 values during different periods of anaesthesia.

Tidal volume (mL/min) and minute volume (L/min): There was no significant difference in the values of tidal volume (mL/min) and minute volume (L/min) during different periods of anaesthetic maintenance and were maintained within the normal range throughout the surgical period.

Non-invasive blood pressure (systolic, diastolic and mean arterial pressure in mmHg): There was no significant change in systolic, diastolic, and mean arterial pressure during different time intervals of anaesthesia after induction. However, there was a non-significant decrease in the systolic, diastolic and mean arterial pressure after induction of anaesthesia up to the 60th minute of anaesthesia; thereafter, the blood pressure gradually increased.

DISCUSSION

Heart rate (Beats per minute): The decrease in heart rate after premedication was caused by the cardiovascular depression effect of dexmedetomidine, and this was due to activation of postsynaptic $\alpha 2$ adrenoceptors by dexmedetomidine in the central nervous system (CNS) which resulted in the inhibition of sympathetic activity and also due to reflex bradycardia that happens due to peripheral vasoconstriction, thereby potentially reducing both blood pressure and heart rate. This finding concurred with the findings of Clarke *et al*. (2014) and Smith *et al.* (2017). The significant decrease in the heart rate at 30th and 45th minute of anaesthesia was due to cardiovascular depressant effect of propofol. This concurs with the findings of Hofmeister *et al.* (2006), Fayyaz *et al*. (2009) and Sager and Norkus (2018). The authors explained that propofol acted by blocking calcium channels and cautioned that high doses of propofol could adversely affect cardiac contractility and systemic vascular resistance, ultimately leading to a reduction in cardiovascular function and reduction in blood pressure. Glowaski and Wetmore (1999) found that propofol caused minimal cardiovascular depression, particularly when it was administered slowly until the desired state of relaxation was achieved.

Respiratory rate (Breaths/minute): The reduction in respiratory rate after induction of anaesthesia with propofol was due to the respiratory depression effect of propofol as found by Besancon *et al.* (1998), Muir and Gadawski (1998) and Sager and Norkus (2018).

Muir and Gadawski (1998) suggested that respiratory depression and apnea could be expected as potential adverse effects after the intravenous administration of propofol, especially when given rapidly to dogs. The authors further mentioned that propofol administration was often accompanied by a notable reduction in systemic arterial pressure, respiratory depression and instances of apnea.

SPO2 and ETCO2 (per cent): The saturation of peripheral oxygen (per cent) and end tidal carbon dioxide concentration (per cent) were maintained within the normal range because the anaesthetic protocol employed in the present study did not affect the normal ventilatory effect and due to supplementary oxygen provided during anaesthetic maintenance and respiratory stabilization provided by isoflurane used in this anaesthetic protocol.

Tidal volume (mL/min) and minute volume (L/min): The tidal volume and minute volume were maintained in normal range without any significant difference, and this was because the anaesthetic protocol employed in this study did not affect the ventilatory mechanism of the animals and respiratory stabilization provided by isoflurane used in this anaesthetic protocol.

Non-invasive blood pressure (systolic, diastolic and mean arterial pressure in mmHg): The non-significant decrease in the blood pressure after induction of anaesthesia with propofol was due to the cardiovascular depression effect of propofol. A similar effect was observed by Hofmeister *et al.* (2006) and Sager and Norkus (2018). The authors explained that propofol acted by blocking calcium channels and cautioned that high doses of propofol could adversely affect cardiac contractility and systemic vascular resistance, ultimately leading to a reduction in cardiovascular function and reduction in blood pressure.

In the present study, the heart rate decreased initially due to the reflex bradycardia and cardiovascular depressant effects of dexmedetomidine, which was used as a premedication agent and propofol, which was used as an induction agent. Additionally, the respiratory rate significantly decreased after the induction of anaesthesia with propofol because of the potent respiratory depressant effect of propofol in conjunction with other respiratory depressant drugs like butorphanol and dexmedetomidine. Consequently, the propofol induction led to severe cardiopulmonary depression in all the animals involved in the study. However, despite the significant reduction in heart rate, respiratory rate and a non-significant decrease in blood pressure, the saturation of peripheral oxygen, end-tidal carbon dioxide, tidal volume and minute volume remained within the normal range. In the present study, there was no evidence of any other complications, such as vomiting, tremors, myoclonus, or excitement in any of the animals. Hence, the results of the present study indicated that the combination of dexmedetomidine and butorphanol as preanesthetic, propofol and diazepam as induction agent and isoflurane maintenance had a significant effect on the cardiopulmonary system in dogs with acute abdominal disorders.

Conflict of interest: Authors have no conflict of interest in this study.

Author's contribution: VD: Involved in investigation, data generation, and preparing original draft; KS, DS: Engaged in conceptualization, data curation, supervision and final editing; SS, SV: Involved in statistical analyses, methodology and editing.

Data availability statement: All the data presented in the paper will be available with the corresponding author and may be provided on reasonable request.

ACKNOWLEDGMENT

The author acknowledges the Deans of Veterinary College and Research Institute, Tirunelveli, Orathanadu and Namakkal, Tamil Nadu Veterinary and Animal Sciences University (TANUVAS) for granting necessary permission to carry out the research in the clinical cases presented to the respective Veterinary Clinical Complex.

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Received- 10.09.2023, Accepted- 20.02.2024, Published- 06.04.2024 (Online), 01.06.2024 (Print)
Section Editor: Prof. S. K. Nandi, Associate Editor