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Dexmedetomidine-butorphanol premedication, ketamine-diazepam induction and isoflurane maintenance anaesthesia for surgical management of acute abdomen in dogs

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Abstract
Twelve dogs of different age and sex presented with clinical signs of acute abdomen like abdominal pain, distension, cessation of defecation and urination, oliguria, dystocia etc. were selected for the study. All the animals were premedicated with dexmedetomidine and butorphanol intravenously. The anaesthesia was induced with ketamine-diazepam intravenously and maintained with isoflurane using variable vaporizer setting. The heart rate, respiratory rate, temperature, SPO2, EtCO2, tidal volume, minute volume, systolic blood pressure, diastolic blood pressure and mean arterial pressure were monitored through out the anaesthetic period. The qualities of anaesthesia like time for intubation, Fresh gas flow, average vaporizer setting, time for extubation, time for head raising, time for sternal recumbency and time for unassisted standing were recorded. Haematology and serum biochemical analysis were done peri-operatively, intra-operatively and post-operatively. The heart rate was initially decreased after premedication and after induction, but because of the positive ionotropic properties of ketamine the heart rate was well maintained during the anaesthetic maintenance period. The respiratory rate and body temperature was decreased significantly after premedication to throughout the period of anaesthesia. The SpO2, EtCO2, tidal Volume and minute volume were maintained well during the anaesthetic period. There was no significant change in haematological and serum biochemical parameters during different stages of anaesthesia. The anaesthetic protocol employed in the present study proved to be safe for dogs with acute abdomen as there was no anaesthetic complications.

Keywords: Acute abdomen, dexmedetomidine, butorphanol, ketamine-diazepam and isoflurane

Introduction
One of the major obstacles confronting a veterinary anaesthetist is providing anaesthesia for a patient with an acute abdomen. Acute surgical disorders of the abdomen in dogs typically manifest with instability, significant physiological disturbances and variable medication response. Furthermore, smooth anaesthetic recovery depends on preoperative stabilisation and postoperative supportive care. There could be a number of intraoperative issues that need specific treatment. According to Thurmon *et al*. (1996) [1], patients with acute abdominal disorders that warrant for surgery frequently have haematological, biochemical, electrolyte and acid-base abnormalities. To guarantee proper anaesthetic management, the authors emphasised how crucial it is to understand the physiological significance of these aberrations in the context of anaesthesia. A key issue for a veterinary anaesthetist, according to Erik (2003), is giving anaesthesia to patients with acute abdominal disorders. According to the author, these patients frequently displayed unstable circumstances, severe physiological anomalies and inconsistent responses to various treatments. The three anaesthetic goals for patients with acute abdominal problems, according to the author, are to relieve pain, relax muscles, and prevent necrosis while providing appropriate tissue oxygen flow (DO2). In order to determine the effectiveness of balanced anaesthesia in the surgical therapy of acute abdominal problems, the current study used dexmedetomidine-butorphanol as premedicants, ketamine-diazepam for induction and isoflurane inhalant anaesthesia for maintenance.

Materials and Methods

The study was conducted in twelve clinical cases of dogs with the history of acute abdomens like caesarean section, pyometra, obstructive urolithiasis, gastrointestinal tract obstruction and strangulated hernia. The demographic distribution of the twelve cases were presented in the table 1. All animals included in the study underwent thorough clinical examinations. Preanesthetic screening was conducted using specialized diagnostic techniques, such as radiography, ultrasonography, electrocardiography, or echocardiography, along with haematology and serum biochemical analysis. Due to the urgent nature of acute abdominal disorders, food and water restriction before surgery could not be implemented. The hairs around the surgical area was cleanly shaved and surgical area was prepared aseptically.

Table 1: Demographic distribution of selected cases

Animal No.	Breed	Age in years	Sex	Surgical condition
1.	Daschund	6	Female	Emergency C Section
2.	Spitz	7.5	Female	Open Cervix Pyometra
3.	Non-Descript	10	Male	Strangulated Inguinal Hernia
4.	Pug	2	Female	C Section Single Pup Syndrome
5.	Pug	6	Female	Closed Pyometra
6.	Labrador	2	Male	Cystic Calculi
7.	Non-Descript	10	Male	Perineal Hernia
8.	Spitz	7	Male	Strangulated Inguinal Hernia
9.	Non-Descript	9	Female	Closed Pyometra
10.	Dobermann	4.5	Male	Perineal Hernia
11.	Non-Descript	0.7	Male	Intussusception
12.	Non-Descript	5	Female	Closed Pyometra

All the twelve animals were premedicated with dexmedetomidine at the dose rate of 2 µg/ kg i.v. and butorphanol at the dose rate of 0.1 mg/kg i.v. Anaesthesia was induced with inj. Ketamine hydrochloride at the dose rate of 5 mg/kg i.v. and diazepam at the dose rate of 0.5 mg/kg i.v. after 5 minutes. Or endotracheal intubation was performed using Murphy type cuffed endotracheal tubes. The animal was connected to the Boyle's apparatus through rebreathing circle system and initially a fresh gas flow of 3L was given for 3 minutes to remove the nitrogen from the breathing circuit. After 3 minutes, the fresh gas flow was reduced to 20 ml/kg body weight with minimum flow rate of 500 ml per minute, to favour optimal function of vaporiser. The anaesthesia was maintained using isoflurane with variable vaporiser setting based on animal response to surgical stimuli.

The physiological parameter like heart rate, respiratory rate, oesophageal temperature (table 2) and cardiopulmonary parameters including SPO2, EtCO2 and NIBP were monitored throughout the surgery using Schillers Q5 multipara meter monitor (Table 3). The respiratory parameters like tidal volume and minute volume were recorded using Birds Ventilometer throughout the surgery (Table 3). Anaesthetic parameters like time for intubation in minutes, fresh gas flow in minutes, vaporiser setting, time for extubation calculated from closure of vaporizer setting to 0, time for head raising in minutes, time for sternal recumbency in minutes and time for unassisted standing in minutes were recorded (Table 4). The haematological and serum biochemical parameters were analysed before, during and after anaesthesia (Table 5). Anaesthetic complication during this study, if any were recorded.

Table 2: Mean±SE of Heart rate, Respiratory rate and temperature during different stages of anaesthesia

	Pre Operative	After Premedication	After induction	15 minutes	30 minutes	45 minutes	60 minutes	75 minutes	90 minutes	After Recovery
Heart rate	114.17±8.73^{ab}	82.67±6.47^{ab}	101.58±5.62	109.00±6.56	99.25±5.14	91.67±4.46	85.75±4.82	104.83±8.38	105.75±8.12	112.25±8.39^{b}
Respiratory rate	52.75±6.70^{a}	26.17±2.46^{a}	8.33±1.17^{ab}	18.50±3.49^{ab}	14.42±2.47^{ab}	17.00±4.03^{ab}	16.50±3.26^{ab}	20.83±4.87^{ab}	26.75±4.80^{a}	44.17±5.82^{bp}
Temperature	39.05±0.27^{a}	38.84±0.24^{b}	38.13±0.37^{c}	37.86±0.31^{d}	37.21±0.30^{a}	36.56±0.45^{ab}	36.09±0.60^{a} bc	36.13±0.69^{a} bc	35.33±0.98^{abc} de	37.70±0.19^{ep}

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±0.42	98±0.46	98±0.53	98±0.94	98±0.65	99±0.45	99±0.40
$ETCO_2$	37±2.71	28±3.51	27±2.51	25±0.79	22±1.45	24±3.42	22±6.50
Tidal volume	104±10.63	91±10.62	96±13.21	105±10.08	116±33.21	91±13.75	97±23.50
Minute volume	0.6±0.06	1.3±0.14	1.1±0.06	1.1±0.14	1.3±0.26	1.5±0.07	2.1±0.35
Systolic BP	122.08±5.82	133.82±6.81^{a}	129.18±6.40^{b}	95.50±7.65^{ab}	105.71±7.73	105.20±5.82	89.50±3.50
Diastolic BP	73.33±5.00	92.82±7.10^{a}	86.55±5.36^{b}	58.70±7.64^{ab}	63.29±6.45^{a}	58.60±5.23^{a}	49.25±4.75^{ab}
Map	93.42±5.34	103.08±7.31^{a}	102.82±5.63^{b}	73.60±7.80^{ab}	75.57±4.36	75.67±5.65	61.50±4.50^{ab}

Table 4: Mean±SE of Fresh gas flow, Average Vaporizer setting, time for intubation, extubation, head raising, sternal recumbency and unassisted standing

Parameters	Values
FGF	58.25±6.73
Vaporizer setting	1.36±0.14
Time for intubation	3.92±0.08
Time for extubation	18.08±1.38
Time for head raising	34.00±2.41
Time for sternal recumbency	61.50±3.69
Time for unassisted standing	112.92±10.05

Table 5: Mean±SE of haematology and serum biochemical analysis during different stages of anaesthesia

Parameter	Before Premedication	During maintenance	After Recovery
Haemoglobin (g/dL)	11.08±0.96	9.84±1.09	9.14±1.32
Packed cell volume (percent)	32.30±2.72	28.80±3.69	26.05±4.23
Total erythrocyte count (x10^6/µL)	5.49±0.40	4.86±0.49	4.60±0.68
Total leucocyte count (x10^3/µL)	31525.00±7719.64	26483.33±8171.79	27948.33±8993.87
Serum urea nitrogen (mg/dL)	70.81±12.77	81.59±26.67	77.48±22.44
Serum creatinine (mg/dL)	1.29±0.13	2.15±0.56	1.71±0.42
Serum ALT (U/L)	28.58±3.59	39.64±3.26	36.25±4.12
Serum ALP (U/L)	186.08±50.60	190.83±60.26	191.50±60.56
Serum glucose (mg/dL)	73.92±11.79	112.42±15.17	123.67±15.50
Serum total protein (g/dL)	5.76±0.38	5.57±0.32	6.14±0.34
Serum Albumin (g/dL)	2.28±0.16	2.22±0.17	2.41±0.11
Serum Globulin (g/dL)	3.47±0.32	3.35±0.36	3.73±0.26
Sodium	172.75±9.49	173.11±6.80	172.22±8.05
Potassium	3.41±0.46	2.73±0.32	2.37±0.26
Chloride	108.83±2.34	110.81±1.80	113.33±2.06

Results and Discussion

In the present study twelve clinical cases of dogs, out of which six were female and six were male with age ranging from 7 months to 10 years were selected randomly with the signs of acute abdomen. The following parameter were recorded and presented.

Heart rate (Beats per minute)

The heart rate of all the animals decreased significantly (p<0.05) after premedication and thereafter it increased gradually and reached to near normal after recovery from anaesthesia. The decrease in heart rate after premedication was caused by cardiovascular depression effect of dexmedetomidine and this was due to activation of postsynaptic α_2 adrenoceptors by dexmedetomidine in the central nervous system (CNS) resulted in the inhibition of sympathetic activity, thereby potentially reducing both blood pressure and heart rate. This finding concurred with the findings of Clarke KW (2014) [2] and Smith *et al*. (2017) [6]. The gradual increase in heart rate after induction of anaesthesia with ketamine might be due to stimulation of sympathetic nervous system. Similar findings were noticed by Fayyaz *et al.*, (2009) [7], Mair *et al.*, (2009) [8] Dugdale (2010) [3] and Jiang *et al.*, (2011) [9]. According to Fayyaz *et al.* (2009) [7], administration of ketamine resulted in an increase in heart rate, cardiac output and blood pressure, hence ketamine alone or in combination with other medications was often considered a reasonable choice for veterinary patients with hypovolemia and certain forms of cardiopulmonary instability.

Respiratory rate (Breaths/minute)

Respiratory rate in all the animals were reduced significantly (p<0.01) after premedication and induction of anaesthesia. Thereafter, the respiratory rate increases gradually and back to near normal after recovery from anaesthesia. The reduction in respiratory rate after premedication was due to the respiratory depression effect of dexmedetomidine and butorphanol. The alpha-2 agonist and the opioid, both of this have recorded depression of respiratory rate in animals as stated by Murphy and Hug (1982) [10] and Belleville *et al.*, (1992) [11]. Paul *et al.* (2019) [12] stated that the decrease in respiratory rate after ketamine induction might be due to the respiratory depressant effects of ketamine. The gradual increase in the respiratory rate during isoflurane anaesthesia was also observed by Flaherty (2009) [4, 8], who expressed that isoflurane led to a dose-dependent depression of respiration in the absence of surgical stimulation and however, under surgical conditions respiratory stimulation occurred which might have mitigated the side effects.

Oesophageal temperature (°C)

The oesophageal temperature recorded in °C by multiparameter monitor was found to decrease gradually after premedication, after induction and through out the surgical period. The temperature was subnormal after recovery but return to below baseline values when compared to surgical period. Similar findings were recorded by Hareesh *et al.* (2018) [13] and Perk *et al.* (2002) [14] and the authors opined that the decrease in temperature might be due to the depression of the thermoregulatory centre by anaesthetic drugs.

SpO2 and $ETCO_2$ (percent)

The saturation of peripheral oxygen (percent) and end tidal carbon dioxide concentration (percent) were maintained within the normal range through out the anaesthetic maintenance and there was no significant difference in SpO2 and $ETCO_2$ values during different periods of anaesthesia. This might be 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)
There was no significance difference in the values of tidal volume (ml/min) and minute volume (l/min) during different period of anaesthetic maintenance and were maintained with in the normal range through out the surgical period. This might be due to supplementary oxygen provided during anaesthetic maintenance and respiratory stabilization provided by isoflurane used in this anaesthetic protocol.

Non-invasive Blood Pressure (Systolic, Diastolic and Mean Arterial Pressure in mmHg)
There was significant decrease (p<0.05) in systolic, diastolic and mean arterial pressure after premedication and followed by significant (p<0.05) increase in systolic, diastolic and mean arterial pressure. There was significant and gradual decrease in systolic, diastolic and mean arterial pressure were observed during 15th, 30th, 45th and 90th minutes of anaesthesia. The initial decrease in blood pressure after premedication was due to cardiovascular depressant effect of dexmedetomidine and this finding concurred with the findings of Clarke KW (2014) [2] and Smith *et al.,* (2017) [6]. The significant increase in blood pressure after ketamine induction was due to positive ionotropic effects of ketamine as mentioned by Fayyaz *et al.,* (2009) [7]. The reduction in blood pressure after 15th minute of anaesthesia to till the end of surgery was due to vasodilation effect produced by the isoflurane maintenance anaesthesia. Clarke *et al.,* (2014) [2] mentioned that isoflurane demonstrated a significant, dose-dependent decrease in arterial blood pressure and systemic vascular resistance at doses close to the minimum alveolar concentration (MAC), while exhibiting minimal myocardial depression.

Anaesthetic parameters
The mean Fresh gas flow employed in this study was 58.25±6.73, which was sufficient to maintain tissue oxygenation through out the surgery and this was indicated by maintenance of saturation of peripheral oxygen above 98 percent throughout the anaesthetic maintenance period. The average vaporizer setting for maintenance of anaesthesia was 1.36±0.14, which ranges from 3 percent to 0.5 percent depends upon the animal response to surgical stimuli as monitored through vital sign monitors and reflexes.
The time for intubation was 3.92±0.08 minutes and ease of intubation was good without any resistance or cough during intubation. The time for extubation of endotracheal tube was 18.08±1.38 and the endotracheal tube was extubated after the animals exhibited swallowing and coughing reflexes. The time for head raising, sternal recumbency and unassisted standing were 34.00±2.41 minutes, 61.50±3.69 minutes and 112.92±10.05 minutes, respectively.
There was no evidence of anaesthetic complications recorded in any of the animal during the anaesthetic maintenance.

Haematology and Serum Biochemical Analysis
There was no significant difference in haematological values like haemoglobin, PCV, total erythrocyte count and total leukocyte count. There was no significant difference in serum biochemical values like BUN, Creatinine, Total Protein, albumin, globulin, Serum glucose, ALP, ALT, Sodium, Potassium and Chloride during preoperative, intraoperative and post operative period.

Conclusion
The heart rate was initially decreased after premedication and after induction, but because of the positive ionotropic properties of ketamine the heart rate was well maintained during the anaesthetic period. The respiratory rate and body temperature was decreased significantly after premedication to throughout the period of anaesthesia and this is because of general depression of respiratory centre and thermoregulatory centre in the brain because of anaesthetic agents used in this study. The decreased in blood pressure after premedication to entire anaesthetic period was due to potent cardiovascular depression effect of dexmedetomidine and vasodilatory effect of isoflurane. The SpO2, EtCO2, tidal Volume and minute volume were maintained within the normal range during the anaesthetic period. There was no significant change in haematological and serum biochemical parameters during different stages of anaesthesia and this shows that the employed anaesthetic protocol is haemodynamically stable. There was no anaesthetic complication recorded during the entire anaesthetic period which indicates that the anaesthetic protocol employed in this study is safe for patients with acute abdomen.

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