RESEARCH ARTICLE

Electrocardiographic Evaluation of Xylazine-Etomidate-Isoflurane and Dexmedetomidine-Ketamine-Isoflurane Anaesthesia under Guaifenesin Premedication for Various Surgeries in Cattle

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Abstract

The clinical study on electrocardiographic evaluation of two modalities of general anaesthesia was conducted in 12 clinical cases of cattle of either sex. The animals were randomly divided into two groups, consisting of 6 animals in each group. The cattle in both groups were premedicated with an intravenous injection of 50 mg/kg guaifenesin. The cattle in group-I were sedated with inj. xylazine (0.1 mg/kg I/V) and induced with inj. etomidate (0.5 mg/kg I/V). The cattle in group-II were sedated with inj. dexmedetomidine (2.5 µg/kg I/V) and induced with inj. ketamine (3 mg/kg I/V). Cattle from both groups were maintained under isoflurane anaesthesia. The morphological abnormalities were not detected in electrocardiography in cattle of any of the groups, except for changes in the amplitude and duration of the P wave, QRS complex, T wave, PR interval, and QT interval.

Key words: Cattle, Electrocardiography, Etomidate, Isoflurane, QRX complex.

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Introduction

The current state of large animal surgery favours performing major surgical procedures under general anaesthesia. Surgeons face various anaesthetic challenges that vary with individual animals. The patient may range from a newborn calf to an adult animal in terms of body weight and temperament, which may affect the selection of anaesthetic technique used for the induction of general anaesthesia. Some aspects of general anaesthesia, like regurgitation, bloat and nerve paralysis are more dangerous to the cattle; however, these risks associated with anaesthesia are reduced by knowledge and vigilance (Abrahamsen, 2008). In recent times, many surgical procedures have been carried out under general anaesthesia by intravenous anaesthesia as well as inhalation anaesthesia. Parenteral general anaesthetics have proven to be beneficial in terms of pain reduction during surgical interventions, as well as convenience for both the patient and the surgeon (Ley *et al.,* 1990). In terms of safety and early recovery, inhalant anaesthetic maintenance in cattle is thought to be superior to injectable techniques (Cantalapiedra *et al.*, 2000).

Etomidate is an ultra-short-acting hypnotic agent that is known for its cardiovascular stability (Saini *et al.*, 2020). It has no cardiovascular depression (Hall *et al.,* 2014) and at induction dose rates, it produces very minimal blood pressure changes and heart rate changes (Forman and Warner, 2011). Ketamine is a non-competitive antagonist of the *N*-methyl-D-aspartate (NMDA) receptor (Pai and Heining, 2007). It causes cardiovascular system stimulation (Sinner and Graf, 2008) and increases heart rate (Tweed *et al.*, 1972). Xylazine and dexmedetomidine are alpha-2 agonists that produce sedation, analgesia, bradycardia, and hypotension (Sandhu and Rampal, 2006). Due to the paucity of comprehensive work regarding the electrocardiographic changes with xylazine-etomidate and dexmedetomidine-ketamine induction boluses under isoflurane maintenance anaesthesia

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in guaifenesin premedicated cattle, the present clinical study was undertaken.

Materials and Method

The clinical study was conducted on 12 clinical cases of cattle presented to the Department of Veterinary Surgery and Radiology, Veterinary College, Bidar (Karnataka, India) for surgical treatments. They were randomly divided into two groups of six animals each. The cattle were fasted for 24 to 48 h and deprived of water for 12 to 18 h prior to anaesthesia. The clinical status of each animal was assessed by recording heart rate, respiratory rate, rectal temperature and haemato-biochemical examinations prior to anaesthesia. Pre-operative fluid therapy was given to all the animals as per requirement. All the cattle in groups I and II were premedicated with an intravenous injection of 50 mg/kg of 5% guaifenesin. After 5 min, inj. xylazine hydrochloride at 0.10 mg/kg and dexmedetomidine at 2.50 µg/kg to group-I and II animals, respectively, were administered by intravenous route. Ten min later, cattle in groups I and II were induced with inj. etomidate at 0.50 mg/kg and inj. ketamine hydrochloride at 3 mg/kg, respectively, intravenously. Isoflurane (1.50-2.50%) was used for the maintenance of the surgical plane of anaesthesia as per the requirements of cattle in each group for intramedullary interlocking nailing for the repair of humerus and tibial fractures (7 cases), herniorrhaphy of diaphragmatic and ventral hernias (1 case each), tarsorrhaphy for deep digital tendon rupture (1 case), and scrotal ablation (2 cases).

Electrocardiographic observations were recorded before induction (0 min) and 10 min after sedation and after induction at 10th, 30th, 60th, and 120th min of general anaesthesia. Zero minute was taken as the control value and each interval was compared with it. An electrocardiogram machine with a standard base-apex bipolar lead was used to record the electrocardiogram. It was recorded at 25 mm/sec paper speed. The electrocardiogram was analysed for P wave amplitude and duration, PR interval, QRS complex amplitude, QT interval, T wave amplitude and ST segment morphology.

The resulting data were statistically analyzed by using ANOVA and DNMRT test as per Snedecor and Cochran (1994).

Results and Discussion

The details of all the electrocardiographic parameters recorded in the present clinical study are given in Table 1.

P wave amplitude (milli Volts)

There was a significant decrease in P wave amplitude at 10 and 30 min (Fig 1) after induction in group-I cattle, and there was a significant decrease in P wave amplitude at all the intervals (Fig 2) in group-II cattle. This might be due to a decrease in the heart rate, where lower the heart rate, smaller the amplitude of the P wave (Avdosko *et al*., 2010), and decrease in cardiac contractility caused by ketamine (Sandhu and Rampal, 2006).

P wave duration (seconds)

There were no significant variations in P wave duration at any of the intervals within the groups, and there was no significant difference between the groups at all the intervals.

PR interval (seconds)

In group I cattle, there was a non-significant increase in PR interval at all the intervals, and in group II cattle, non-significant prolongation of PR interval was observed at 10 min after sedation and at 30, 60, and 120 min (Fig 2) after induction. Gurukar (2016) reported prolonged PR intervals in cattle who compared xylazine and dexmedetomidine with ketamine induction and isoflurane as maintenance agents. Lin *et al.* (2008) reported an increased PR interval in dogs with dexmedetomidine sedation. There was a significant decrease in PR interval at 10 min (Fig 2) after ketamine bolus injection in group-II. This might be due to a ketamine-induced increase in heart rate (Stepien *et al*., 1995) and it might also be due to an increase in the conductivity between the SA node and the AV node (Tilley, 1985). Similar results have been reported by Bayan *et al.* (2021) in dogs.

QRS complex amplitude (milli Volts)

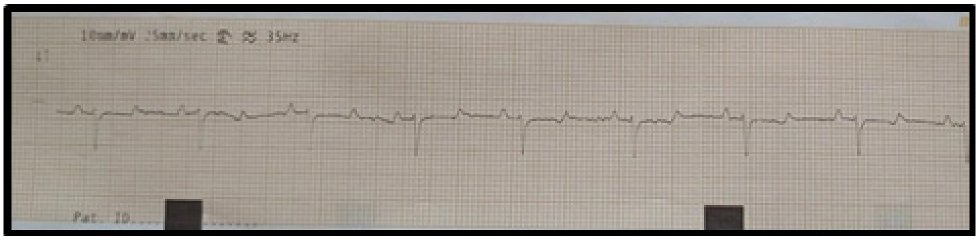
There was a significant decrease in QRS complex amplitude at all the intervals in both group I (Fig 1) and II (Fig 2) cattle. The decrease in QRS complex amplitude was slightly greater in group-II. The variations in QRS amplitude might be related to heart rate changes, as QRS complex and heart rate were indirectly related (Bayan *et al.,* 2021) and decreased cardiac contractility by ketamine (Sandhu and Rampal, 2006). Gurukar (2016) observed a slight decrease in QRS amplitude in cattle. Bayan *et al.* (2021) reported a non-significant decrease in QRS amplitude in dogs with glycopyrrolate-dexmedetomidine-ketamine-isoflurane anaesthesia.

QT interval (seconds)

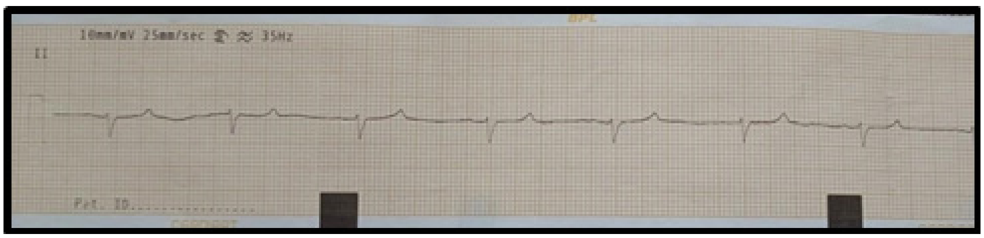
There was a significant prolongation of the QT interval in group-I cattle at 60 and 120 min (Fig 1) after induction. In group-II cattle, there was a non-significant prolongation of the QT interval at all the intervals (Fig 2). However, these variations were within the normal physiological limit. The prolongation of the QT interval might be due to a decrease in heart rate, as heart rate and QT interval are inversely proportional to each other (Bayan *et al.,* 2021). Gurukar (2016) observed a non-significant increase in the QT interval in cattle and compared xylazine and dexmedetomidine with ketamine induction and isoflurane as maintenance agents. Liu *et al.* (2018) reported prolongation of the QT interval in dogs with etomidate anaesthesia. Lin *et al.* (2008) reported an increased QT interval in dogs with dexmedetomidine sedation.

T wave amplitude (milli Volts)

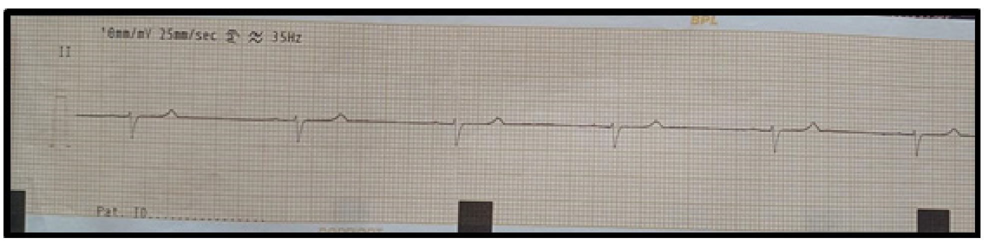
There was a non-significant increase in T-wave amplitude in cattle from both groups (Fig 1 and 2). Variations in T-wave amplitude were within the normal physiological limit. Similar findings have been reported by Bayan *et al.* (2021) in dogs, Gurukar (2016) in cattle with dexmedetomidine, and Liu *et al.* (2018) in dog with etomidate anaesthesia.



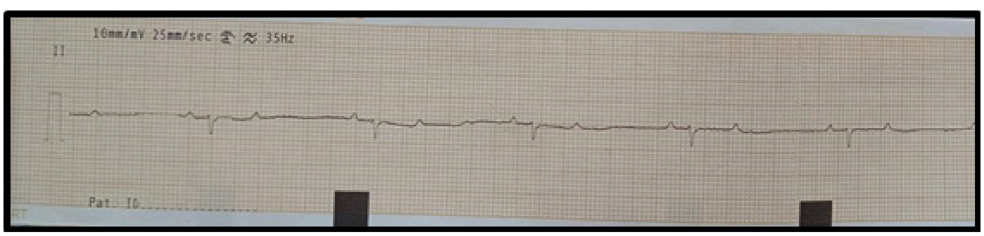
A. ECG showing normal wave morphology with normal sinus rhythm at 0 minute



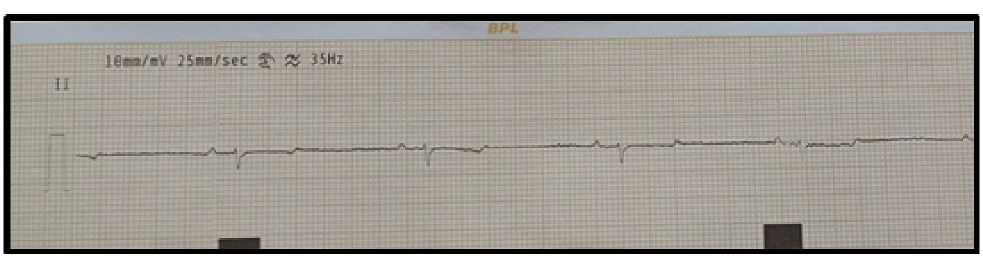
B. ECG showing normal sinus rhythm, slightly decreased P and QRS complex amplitude with decreased heart rate at 10 min after sedation with inj. xylazine



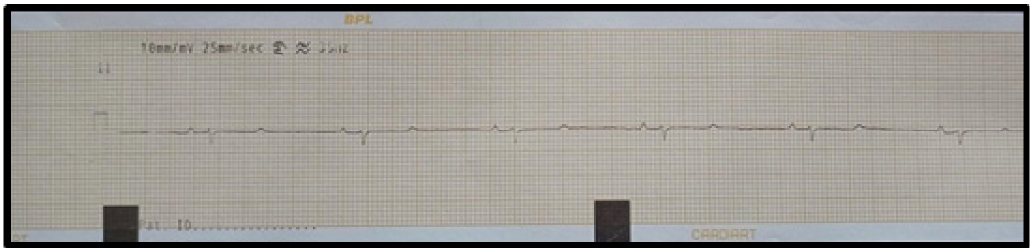
C. ECG showing normal rhythm with slightly decreased QRS complex amplitude and heart rate at 10 min after induction



D. ECG showing normal rhythm with decreased QRS complex amplitude and heart rate with slightly prolonged PR and QT interval at 30 min after induction

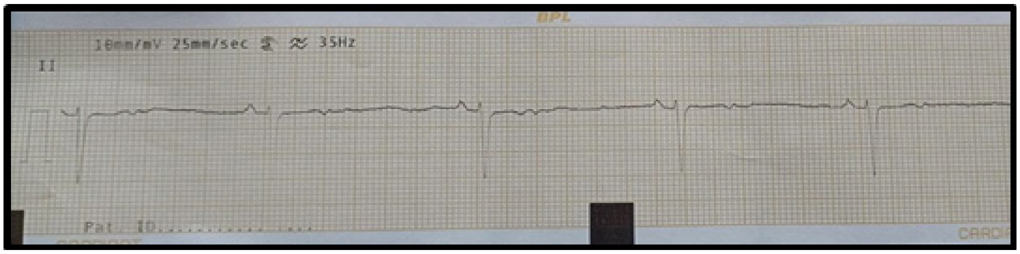


E. ECG showing normal rhythm with decreased T wave, QRS complex amplitude, heart rate and slightly increased PR and QT interval at 60 min after induction

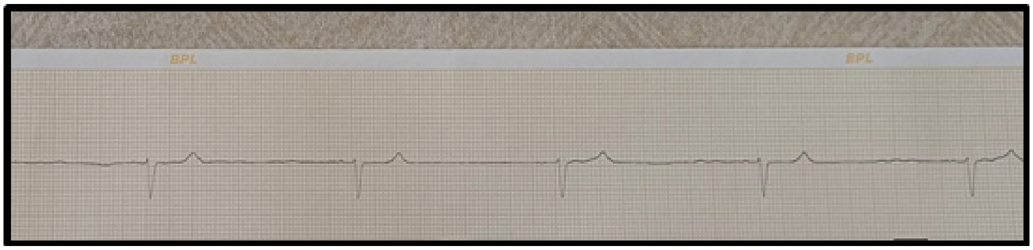


F. ECG showing normal sinus rhythm with decreased QRS complex amplitude, T wave amplitude, heart rate with normal wave morphology at 120 min after induction

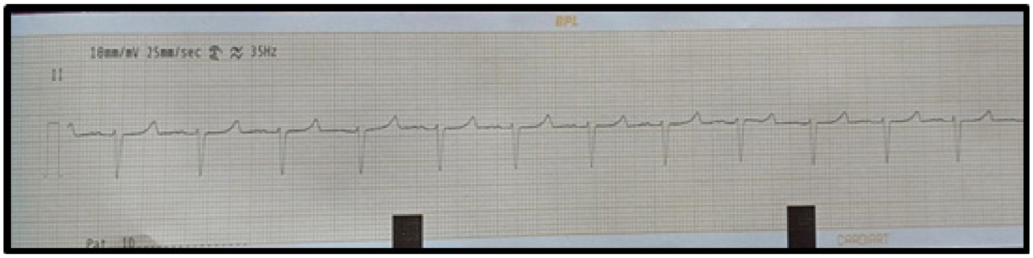
Fig. 1: Electrocardiography at various time intervals (A, B, C, D, E and F) in cattle (Group-I) (Case-3)



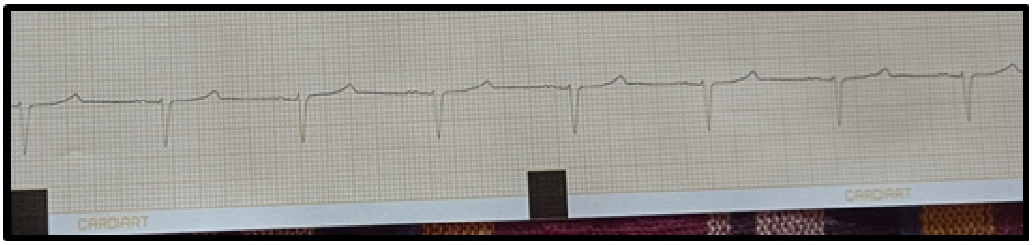
A. ECG showing normal sinus rhythm with normal wave morphology at 0 minute



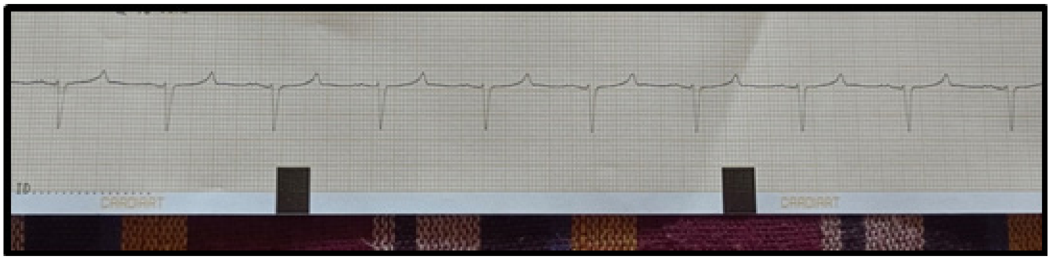
B. ECG showing normal sinus rhythm with decreased P wave and QRS complex amplitude and increased RR interval with decreased heart rate



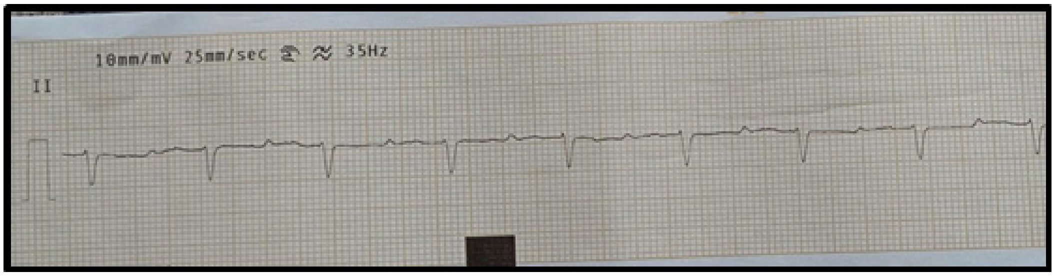
C. ECG showing normal sinus rhythm with decreased P wave amplitude, QRS complex amplitude and RR interval with increased heart rate at 10 min after induction



D. ECG showing normal sinus rhythm with slightly decreased heart rate with decreased QRS complex and P wave amplitude at 30 min after induction



E. ECG showing normal sinus rhythm with slightly decreased heart rate with decreased P wave and QRS complex amplitude and increased PR interval and QT interval at 60 min after induction



F. ECG showing normal sinus rhythm with decreased P wave, T wave and QRS complex amplitude with increased P wave duration, PR interval and QT interval

Fig. 2: Electrocardiography at various time intervals (A, B, C, D, E and F) in cattle (Group-II) (Case-4)

Table 1: Mean±SE values of electrocardiographic parameters in Group-I and II cattle

Parameters	Grp	Time intervals (min)					
		0 min	**10 min sed**	**10 min ind**	**30 min ind**	**60 min ind**	**120 min ind**
P wave amplitude (milli Volts)	I	0.15±0.02^{BC}	0.11±0.02^{AB}	0.10±0.01^{A}	0.08±0.01^{A}	0.11±0.02^{B}	0.11±0.02^{AB}
	II	0.17±0.02^{C}	0.09±0.008^{A}	0.09±0.008^{A}	0.09±0.008^{A}	0.09±0.008^{A}	0.09±0.008^{A}
P wave duration (seconds)	I	0.06±0.007^{AB}	0.07±0.006^{AB}	0.06±0.008^{AB}	0.06±0.007^{AB}	0.05±0.006^{A}	0.05±0.006^{A}
	II	0.06±0.006^{AB}	0.08±0.006^{B}	0.07±0.004^{B}	0.07±0.004^{AB}	0.07±0.006^{AB}	0.06±0.007^{B}
PR interval (seconds)	I	0.16±0.01^{AB}	0.16±0.008^{AB}	0.16±0.008^{AB}	0.17±0.009^{ABC}	0.17±0.009^{ABC}	0.17±0.009^{ABC}
	II	0.19±0.01^{BC}	0.20±0.01^{C}	0.15±0.01^{A}	0.19±0.008^{ABC}	0.19±0.008^{ABC}	0.19±0.008^{ABC}
QRS complex amplitude (milli Volts)	I	1.20±0.15^{CD}	0.90±0.09^{AB}	0.92±0.09^{AB}	0.78±0.07^{AB}	0.74±0.06^{AB}	0.75±0.06^{AB}
	II	1.38±0.11^{D}	0.82±0.01^{AB}	1.00±0.05^{BC}	0.82±0.03^{AB}	0.75±0.07^{AB}	0.72±0.04^{A}
QT interval (seconds)	I	0.39±0.03^{A}	0.40±0.01^{AB}	0.45±0.02^{ABC}	0.43±0.01^{ABC}	0.46±0.06^{BC}	0.47±0.01^{C}
	II	0.39±0.02^{A}	0.44±0.02^{ABC}	0.40±0.02^{ABC}	0.45±0.02^{ABC}	0.45±0.02^{ABC}	0.45±0.02^{ABC}
T wave amplitude (milli Volts)	I	0.45±0.08^{A}	0.48±0.07^{A}	0.52±0.06^{A}	0.52±0.06^{A}	0.53±0.04^{A}	0.48±0.04^{A}
	II	0.37±0.06^{A}	0.43±0.06^{A}	0.46±0.07^{A}	0.48±0.07^{A}	0.45±0.04^{A}	0.41±0.05^{A}

Mean-SE bearing different superscripts within the row differ significantly at $p<0.05$

ST segment

There was no change in the morphology of the ST segment in cattle from any of the groups.

Conclusions

It is important to formulate an anaesthetic combination carefully in both compromised patients and normal healthy patients. Induction agents like etomidate and ketamine used in this study compensated for the cardiac side effects of xylazine and dexmedetomidine, respectively. Isoflurane used as a maintenance agent in both groups had a very minor effect on the heart. In this clinical study, there were no morphological ECG abnormalities detected in cattle of both groups; however, there were variations in the amplitude and duration of electrocardiographic waves, and those variations were minimal in group-I cattle as compared to group-II cattle; however, those variations did not indicate any anaesthetic emergency. Both protocols can be used in cattle for soft tissue surgeries and orthopaedic surgeries; however, etomidate can be used as an induction agent in thoracic surgeries with a minimum effect on the heart.

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References

Abrahamsen, E.J. (2008). Ruminant field anaesthesia. *Veterinary Clinics of North America: Food Animal Practice., 24*(3), 429-441.

Avdosko, G, Birgele, E., & Mencendorfa, L. (2010). Changes in electrocardiogramm of Cocker spaniel and German shepherd dogs during anaesthesia. *Veterinary Medicine Zootechnics, 49,* 8-16.

Bayan, H., Sarma, K.K., Rao, G.D., Dutta, D.K D., & Phukan, A. (2021). Cardiopulmonary functions in dogs under propofol, ketamine and isofluraneanaesthesiapremedicated with glycopyrrolate, dexmedetomidine and butorphanol. *Indian Journal of Animal Research, 1,* 1-6.

Cantalapiedra, A.G, Villanueva, B., & Pereira, J.L. (2000).Anaesthetic potency of isoflurane in cattle: Determination of the minimum alveolar concentration. *Veterinary Anaesthesia and Analgesia*, *27*(1), 22-26.

Forman, S. A., & Warner, D.S. (2011). Clinical and molecular pharmacology of etomidate. *Journal of American Society of Anesthesiologists*, *114*(3), 695-707.

Hall, L.W., Clarke, K.W., & Trim C.M. (2014). *Veterinary Anaesthesia*, 11th Edn., W.B. Saunders, China, pp. 147-162.

Ley, S., Waterman, A., & Livingston, A. (1990). Variation in the analgesic effects of xylazine in different breeds of sheep. *Veterinary Record*, *126,* 508.

Lin, G.Y., Robben, J.H., Murrell, J.C., Aspegrén, J., McKusick, B.C., & Hellebrekers, L.J. (2008). Dexmedetomidine constant rate infusion for 24 hours during and after propofol or isoflurane anaesthesia in dogs. *Veterinary Anaesthesia and Analgesia*, *35*(2), 141-153.

Liu, C., Lin, T., & Zhou, Z. (2018). Dexmedetomidine combined with etomidate or emulsified isoflurane for induction reduced cardiopulmonary response in dogs. *PloS One*, *13* (12), 0208625.

Pai, A., & Heining, M. (2007). Ketamine. *Continuing Education in Anaesthesia, Critical Care and Pain*, *7*(2), 59-63.

Saini, R., Palecha, S., Tanwar, M., Bishnoi, P., Pooniya, R., & Palsania, S.K. (2020). Comparative efficacy of etomidate and propofol for anaesthesia in dogs. *Indian Journal of Veterinary Surgery, 41*(2), 92-97.

Sandhu, H., & Rampal, S. (2006). *Essentials of Veterinary Pharmacology and Therapeutics*, 2nd Edn., Kalyani Publishers, Delhi, India. pp. 218-219.

Sinner, B., & Graf, B.M. (2008). Ketamine. In: *Modern Anesthetics. Handbook of Experimental Pharmacology*. 2nd Edn., Edt. Schüttler, J. and Schwilden, H. Springer, Berlin, pp. 313-333.

Snedecor, G. W., & Cochran, W. G. (1994). *Statistical Methods*. 6th ed. Iowa State University Press, Ames, Iowa, USA.

Stepien, R.L., Bonagura, J.D., Bednarski, R.M., & Muir 3rd, W.W. (1995). Cardiorespiratory effects of acepromazine maleate and buprenorphine hydrochloride in clinically normal dogs. *American Journal of Veterinary Research*, *56*(1), 78-84.

Tilley, L.P. (1985). *Essentials of canine and feline electrocardiography: Interpretation and Treatment*. 2nd edn., Lea &Febiger. Philadelphia, London, pp. 337-484.

Tweed, W.A., Minuck, M., & Nymin, D. (1972). Circulatory response to ketamine anaesthesia. *Anesthesiology, 37*, 613.

Gurukar, Vinutha K. (2016). Evaluation of dexmedetomidine and xylazine sedation for ketamine-isoflurane general anaesthesia in cattle undergoing clinical surgeries. *Master Thesis.* Karnataka Veterinary Animal and Fisheries Sciences University, Bidar, India.