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Effects of intravenous lignocaine on anaesthetic parameters in cattle under dexmedetomidine-butorphanol-ketamine-midazolam-isofluraneanaesthesia

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Abstract

The present study was conducted for clinical evaluation of a multimodal anaesthetic protocol using butorphanol-dexmedetomidine-midazolam-ketamine-isoflurane and lignocaine continuous rate infusion (CRI) in six cross-bred female cattle. Preanaesthetics used were butorphanol and dexmedetomidine which were administered intravenously at dose rates of 0.05 mg/kg and 1 µg/kg body weight, respectively. Ketamine and midazolam were intravenously administered at dose rates of 4.0 and 0.2 mg/kg body weight respectively, to induce anaesthesia. Isoflurane was used to maintain anaesthesia after endotracheal intubation, at a concentration of 1.05 ± 0.97 per cent concentration in 100 per cent oxygen using a large animal anaesthesia machine. Simultaneously, intravenous lignocaine was administered at a bolus dose of 2 mg/kg body weight followed by a CRI of 3 mg/kg body weight/hour using a volumetric infusion pump. Isoflurane sparing effect of intravenous lignocaine reduced the required concentration of isoflurane for maintenance. The third plane of surgical anaesthesia was maintained and various surgical procedures were done. Recovery was smooth. Other than the mild regurgitation of ruminal fluid in an animal, no anaesthetic complications were noticed.

Key words: *Cattle, lignocaine, isoflurane sparing*

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Anaesthesia is one among the greatest discoveries in medical science there has ever been documented to reduce pain and suffering. To overcome the distress caused by pain during surgical procedures, the animal should be in the state of general anaesthesia. Previous approaches for general anaesthesia in cattle involved a lot of risk, mainly due to the overdose, when one or two drugs were used in the anaesthetic regimen. Balanced general anaesthesia involves combination of different agents to create the anaesthetic state. This approach uses less of each drug than if the drugs were administered alone (Hendrickx *et al.,* 2008). Further, balanced anaesthesia approach increases the likelihood of a drug's desired effects and to reduce its side effects.

Lignocaine, an amino amide local anaesthetic, when given intravenously creates analgesia by its direct action on spinal transmission, attenuation of spontaneous post injury activity in Aδ and C fibers and blockade of ectopic discharges in neurones involved in nociception. Intravenous infusion of lidocaine has been used widely as part of combination anaesthetic techniques to complement general anaesthesia in domestic animals. Maintenance of anaesthesia with inhalant anaesthetics in ruminants is considered to be superior to injectable techniques (Praveen *et al.,* 2021). Several studies have revealed that lidocaine infusion significantly reduced the mean alveolar concentration (MAC) of inhalation agents in a variety of species including horses, dogs, goats, cats and cattle.

In the present study, clinical efficacy of lignocaine continuous rate infusion with combination of midazolam - ketamine - isoflurane anaesthesia in cattle premedicated with butorphanol and dexmedetomidine is evaluated in adult cattle for various surgical procedures.

Materials and methods

Six adult cattle which were presented to University Veterinary Hospital, Mannuthy for various surgical procedures were subjected to detailed physical and clinical examination, and health status of the animals were assessed. Physiological parameters like rate of respiration, heart rate and rectal temperature were recorded before anaesthesia. All animals were fasted for 24 hours and water was withheld for 12 hours prior to anaesthesia. The animals received a combination of dexmedetomidine and butorphanol at dose rates of 1 µg/kg and 0.05 mg/kg body weight intravenously as premedication. The time taken by the animals from administration of preanaesthetics to exhibition of salivation, drooped eyelids, lowered head and incoordinated gait was recorded as the time taken for sedation. Quality of sedation was graded according to Bodh *et al.* (2015).

After sedation, the animals were casted and restrained on lateral recumbency on the operation table and general anaesthesia was induced by administration of ketamine and midazolam at 4 mg/kg and 0.2 mg/kg body weight intravenously respectively. Time taken for induction of general anaesthesia was calculated as the time from administration of induction agents and the endotracheal intubation. Quality of induction was graded according to Bodh *et al.* (2015).

After induction of anaesthesia, trachea was intubated with large animal endotracheal tube of appropriate size by digital palpation of the epiglottis. The endotracheal tube was connected to the Mallard 2800C (AB Medical Technologies, California, USA) large animal inhalation anaesthesia machine and general anaesthesia was maintained with isoflurane in 100 per cent oxygen through a semi-closed circuit. Simultaneously, the animals were given a bolus dose of 2mg/kg body weight lignocaine intravenously, followed by a CRI of lignocaine at a dose rate of 3mg/kg body weight/h using volumetric infusion pump. The vapouriser setting was adjusted during anaesthesia to maintain uniform surgical plane of anaesthesia, observing the reflexes. Muscle relaxation was assessed and graded according Bodh *et al.* (2015).

Position of eye ball, pin prick reflex at coronary band, pedal and palpebral reflexes were assessed after induction and at every 15 minute interval during the maintenance. Stopping of CRI of lignocaine and weaning from isoflurane anaesthesia were done upon completion of surgical procedure. The time duration between ceasing of isoflurane to spontaneous attainment of standing position was noted as recovery time. Recovery time was divided as: time for first voluntary movement, time for assuming sternal recumbency and time for standing up. Quality of recovery was assessed according to Bodh *et al.* (2015). The percentage of isoflurane vapour used for maintenance of anaesthesia was recorded. The quantity of isoflurane liquid utilised for maintenance of anaesthesia was calculated as mentioned below employing Avogadro's principle as described by Kumar *et al.* (2013).

Isoflurane vapour delivered (mL) =
Vapouriser setting (%) x Fresh gas flow (FGF) (Litres/min) x Duration (min) x 10

The total isoflurane vapour delivered (mL) for the total duration of anaesthesia was calculated by summing up the isoflurane vapour delivered for each of the FGF and vapouriser setting employed (Praveen, 2021).

Isoflurane liquid utilised =
Total isoflurane vapour delivered (mL) / 201.5

Results and discussion

The study was conducted on six female cattle above one year age with mean age of 4.75± 0.96 years and mean body weight of 333.00 ± 46.32 kg. Surgeries conducted under the current protocol included herniorrhaphies, external skeletal fixation, tumour resection, extirpation of eyeball and enucleation of eye.

Sedation

The mean time taken for sedation was 7.67 ± 1.08 min which was shorter when compared to that observed by Praveen (2021) in cattle, when xylazine was used instead of dexmedetomidine along with butorphanol. The comparatively faster sedation may be due to the tenfold more selective α_2 receptor agonism of dexmedetomidine when compared to xylazine (Lemke, 2007). Salivation, lowered head, drooping of eyelids, bellowing and incoordinated gait with reduced alertness were the signs of sedation encountered in the present study which were consistent with the observations of Praveen (2021) and Sindhu (2021). The quality of sedation was moderate (Bodh *et al.,* 2015) in all the animals, except for animal number I, which showed mild sedation (Bodh *et al.,* 2015). Similar results were observed by Balage and Aher (2018) using the same combination in cattle. The lower doses of butorphanol and dexmedetomidine used in the current study could be the reason for the moderate levels of sedation, even with their synergistic sedative and analgesic effects (Khattri *et al*., 2013).

Induction of anaesthesia

The mean time taken for induction was 5.83 ± 1.11 min. The signs associated with induction were ventral rotation of eyeball, loss of swallowing reflex, absence of jaw muscle tone, absence of pedal, palpebral and pin prick reflex. All animals achieved excellent quality (Bodh *et al.,* 2015) induction. Similar observations were reported by Kaur and Singh (2004) in buffaloes and Praveen (2021) in cattle using a similar combination of drugs.

Excellent quality of muscle relaxation (Bodh *et al.,* 2015) was observed in all the animals. Similar result was also reported by Kumar *et al*. (2014) in buffaloes and Praveen (2021) in cattle by using the same combination. The muscle relaxation observed in the present study after induction could be due to the effects of midazolam (Doherty and Valverde, 2006) and dexmedetomidine (Khattri *et al*., 2013). Pin prick, pedal and palpebral reflexes were abolished completely within two minutes of induction and remained absent throughout the maintenance, which indicated excellent analgesia in all the animals, which could be due to the combined analgesic effect produced by butorphanol (Doherty and Valverde, 2006), ketamine (Zanos *et al*., 2018) and by intravenous lignocaine through its direct action on spinal transmission, attenuation of spontaneous postinjury activity in Aδ and C fibers and blockade of ectopic discharges in neurones for nociception(Lamont, 2006).

Maintenance of anaesthesia

The mean concentration (per cent) of isoflurane vapours used to maintain anaesthesia was 1.05 ± 0.97 per cent. The mean volume of vapours of isoflurane used (mL) was 2843.74 ± 1047.41 mL/h and the mean quantity of isoflurane liquid used was 14.02 ± 5.24 mL/h. Mean isoflurane per cent used at different time intervals are provided in Table 1.

Table 1. Mean concentration (per cent) of isoflurane used to maintain anaesthesia at different time intervals.

Time	Mean ± SE of isoflurane %
0th minute	1.28 ± 0.23
15th minute	1.33 ± 0.39
30th minute	0.93 ± 0.22
45th minute	1.03 ± 0.16
60th minute	0.90 ± 0.22
75th minute	0.85 ± 0.15

The mean concentration (per cent) of isoflurane vapours used for the present study was 54.34 per cent lower compared to that used by Yaygingul *et al.* (2017) and Praveen (2021) which was 2.30 per cent. It was concluded that this reduction in per cent of isoflurane vapours required to maintain the anaesthesia in the present study was due to the isoflurane sparing effect of lignocaine CRI. Findings by Doherty *et al.* (2007) in goats and Vesal *et al.* (2011) in calves also support this observation. Doherty and Seddighi (2010) stated that even though it is unclear how lignocaine lowers the MAC of isoflurane, it is not just due to its analgesic qualities, but also due to its action on other receptor types, including N-Methyl-D-aspartate (NMDA), Gamma-aminobutyric acid (GABA), acetylcholine, and glycine. Even with this isoflurane sparing effect of lignocaine CRI, two animals in which ophthalmic surgeries like eyeball enucleation and extirpation were done, the concentration of isoflurane required was comparatively high.

Recovery from anaesthesia

The mean time taken in the present study for appearance of first voluntary movement after weaning off isoflurane was 7.50 ± 1.82 min. This was slightly longer than the period observed by Praveen (2021) and shorter than the period observed by Vigneshwaran *et al.* (2020). The shorter mean time of first voluntary movement in comparison could be due to the less isoflurane used because of the sparing effect of lignocaine CRI.

The mean time taken for assuming sternal recumbency and standing up in the present study were 15.17 ± 5.16 min and 35.33 ± 17.04 min respectively. These were longer than the observations made by Praveen (2021) and shorter than those by Vigneshwaran *et al.*(2020). The longer mean duration required by the animals to stand up in the present study could be attributed to the combined effect of injectable anaesthetics administered, the direct action on spinal transmission by the intravenous lignocaine (Lamont, 2006) and also due to the prolonged time taken by one animal to stand up (120 min).

The quality of recovery was graded as excellent (Bodh *et al.,* 2015) in all the animals. Similar observation was made by Praveen (2021) in cattle maintained in isoflurane anaesthesia. Even though the recovery noticed in all animals were smooth and without any excitement and all the animals stood up unassisted, ataxia was noticed while walking for a short period of time, which warranted manual support for short period to avoid falling. Similar observation was noticed by Valverde *et al.* (2005) in horses maintained in isoflurane anaesthesia and lignocaine CRI.

Complications during anaesthesia

Regurgitation of ruminal contents in small amount was noticed in one animal during the maintenance of anaesthesia, even though the animals were fasted for 24 hours and water was withheld for 12 hours prior to the anesthesia. Similar observations were made by Praveen (2021). Lin and Walz (2014) opined that the large rumen that was usually full of liquid material does not empty completely even after 24 to 48 hours of fasting and regurgitation occurs during deep planes of anaesthesia when the oesophageal muscles and transluminal pressure gradients relax as a result of anaesthetic-induced muscle relaxation.

Conclusion

Maintenance of a lignocaine CRI along with the isoflurane maintenance in ketamine-midazolam induced dexmedetomidine-butorphanol premedicated cattle resulted in considerable reduction in the mean per cent of isoflurane required. The isoflurane sparing effect of lignocaine in the present study was observed to be minimum during the ophthalmic surgeries. The anaesthetic combination of present study provided excellent quality recovery which was smooth and excitement free.

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Conflict of interest

The authors declare that they have no conflict of interest.

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