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Evaluation of ketamine-guaifenesin and sevoflurane for maintenance of anaesthesia in buffaloes undergoing diaphragmatic herniorrhaphy

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Abstract
Diaphragmatic herniorrhaphy was conducted in twelve buffaloes for evaluation of ketamine-guaifenesin and sevoflurane for maintenance of anaesthesia. In all animals laparo- rumenotomy was carried out 24 hours prior to diaphragmatic herniorrhaphy. Sedation was achieved with Inj. Midazolam @ 0.10 mg/kg IV. Induction of anesthesia was carried out in all the animals with the double drip solution (guaifenesin 50 mg/ml and ketamine 2.00 mg/mL) @1.50 mL/kg b.wt. Maintenance of anaesthesia in group I was carried out with same solution @2.50 ml/kg/hr and sevoflurane 2% in oxygen in group II animals. Quality of induction, onset of analgesia, muscle relaxation, palpebral reflexes, corneal reflexes, position of eyeball, duration of anaesthesia and recovery time were recorded. Smoother and faster recovery was seen in group II, whereas, smooth and prolonged recovery was seen in group I animals. Uneventful recovery was seen in all animals.

Keywords: diaphragmatic herniorraphy in buffaloes, ketamine-guaifenesin anesthesia, ruminant double drip anesthesia, inhalant anesthesia in buffaloes, sevoflurane anesthesia, diaphragmatic hernia in buffaloes

Introduction
Now a day, general anesthesia is more frequently employed in bovine for both the diagnostic and surgical procedures, which are usually more complex and for longer duration procedures (Reibold, 2007) [10]. Sedation is prerequisite for most of the surgical interventions, in order to perform surgery with maximum precision and efficiency. Midazolam has both analgesic and muscle relaxant effect (Richter, 1981) [11] with minimum adverse effect on cardiovascular system (Jones *et al.*, 1979) [4].
Currently, Maintenance of anesthesia is done either by injectable or inhalant anesthetics. Ketamine is employed in bolus or together with xylazine and guaifenesin in 5% dextrose as triple drip to take care of anesthesia (Kerr *et al.*, 2007) [5], double drip (Ketamine and Guaifenesin) method with induction dose at 1.5 mL/kg b.wt and maintenance dose at 2 mL/kg/hr used in buffaloes (Kherkar, 2019) [6] and triple drip (Xylazine, Ketamine and Guaifenesin) method (Dhawale *et al.*, 2018) [2]. Guaifenesin is a centrally acting skeletal muscle relaxant that can also be used to induce recumbency in cattle. Currently inhalant anesthetic are widely used in large animal anaesthesia. Sevoflurane is poly fluorinated methyl isopropyl ether, which is clear, colorless volatile liquid at 27 °C temperature, non-inflammable and non-explosive in mixture of air or oxygen.
Diaphragmatic hernia is chronic wasting disorder observed in adult dairy buffaloes that are either in their late gestation or have recently calved wherein passage of abdominal viscera into the thorax through an opening within the diaphragm at the musculotendinous junction. Treatment of diaphragmatic hernia was done initially with exploratory laparo-rumenotomy followed by repair of diaphragmatic defect carried out under general anesthesia using controlled ventilation (Saini *et al.*, 2007) [12]. Hence, this study was conducted to evaluate ketamine- guaifenesin and sevoflurane for maintenance of anesthesia during diaphragmatic herniorrhaphy in buffaloes.

Materials and Methods
The present clinical study was carried out in the Department of Veterinary Surgery and Radiology, College of Veterinary and Animal Sciences, Udgir. Twelve clinical cases of bovine suspected for diaphragmatic hernia diagnosed on the basis of history, clinical symptoms and radiography were included in this study. All the animals were randomly divided into two groups consisting of six animals in each group.

Further, all the animals were kept off feed for 24-48 hours and water was withheld for 12-24 hours prior to anesthesia and surgery.

All animals underwent left flank explorative laparo-rumenotomy in a standing position under paravertebral regional anaesthesia and evacuated contents of the rumen, the ruminal floor and reticulum were investigated with the hand to locate foreign bodies, size and shape of diaphragmatic hernial ring.

The diaphragmatic herniorrhaphy was done the next day to laparo-rumenotomy. In both groups, animals were sedated with Inj. Midazolam1 @ of 0.10 mg/kg body weight intravenously. After fifteen minutes of Midazolam, induction was done by rapid administration of calculated dose of ruminant double drip (Dextrose 5% consisted of guaifenesin 50 mg/mL and ketamine 2 mg/mL) @ 1.50 mL/kg body weight intravenously. Induction of anaesthesia was assessed based on signs and symptoms of eye ball position, reflexes etc. The animals were restrained in supine position over the operation table. The required dose for induction of anaesthesia was calculated in mL/kg for each group and dose utilized for induction was measured.

Maintenance of anesthesia

In group I six animals were maintained using ruminant double drip of Guaifenesin + Ketamine @ 2.50 mL/kg/h intravenously. The flow rate was monitored based on the depth of anesthesia and pain reflexes.

In group II six animals after induction in sternal recumbency intubated with endotracheal tube (18 mm). The Mallard large animal anesthetic machine2 was used to maintain anesthesia with sevoflurane3. Initially sevoflurane was given with higher concentration at 7% until downward rotation of the eyeball was observed and later on sevoflurane concentration was reduced to 2%. The vaporizer setting was altered during anesthesia as and when required to maintain a uniform surgical plane of anesthesia and clinical values on multi-para monitor. After completion of the surgery, Y-piece was disconnected from endotracheal tube after the reappearance of the swallowing reflex.

Anesthetic parameters

The anesthetic parameters like onset of sedation, quality of induction, induction time, analgesia, muscle relaxation, corneal reflex, palpebral reflex and position of eyeball was recorded before induction, during maintenance at 15, 30 and 45 min interval. Maintenance dose of anesthetics, duration of anaesthesia, recovery time and quality of recovery were noted for the evaluation of anaesthesia in group I and II animals.

Results and Discussion

All the animals were ranged between 5-11 years of age, weighing approximately 268-450 kg and were diagnosed for diaphragmatic hernia by radiographic examination and were continued by explorative rumenotomy. Diaphragmatic herniorrhaphy was performed 24 hours after explorative laparo-rumenotomy in all animals.

Mean sedation time was 2.91±0.20 and 3.03±0.23 min in group I and II, respectively. After IV administration of midazolam (n=12), the animals started showing ataxia (99.16%), forward movement (66.66%) and downward movement of eye ball (41.66%) and sternal recumbency (50%). However, one animal in group II, acquired sternal recumbency immediately after injection. Venugopal *et al.*, (2018) [14] observed better result with guaifenesin as an adjunct to xylazine-ketamine induction rather than addition of midazolam in cattle. The mean induction time was 5.91±0.35 and 5.83± 0.52 min in group I and II, respectively. There was no significant difference in induction time between group I and group II. Quality of induction of anesthesia was overall excellent (50%) to good (50%) in both the groups. All animals after induction of anaesthesia were restrained in sternal recumbency for endotracheal intubation wherein the left hand was passed in the oral cavity carrying and safeguarding the cuffed tip of the endotracheal tube. Thangadurai *et al.*, (2016) [13] reported quite early induction in 1.64±0.09 min in cattle when they carried out premedication with diazepam and induction with guaifenesin (50 mg/kg b.wt. IV) and ketamine hydrochloride (4 mg/kg b.wt. IV).

Dhawale *et al.*, (2018) [2] used double drip and triple drip for induction of anesthesia to undertake surgical procedures for urogenital affections in cattle and observed induction as per calculated dose. Further, Kherkar *et al.*, (2019) [7] also used double drip of 25 g guaifenesin and 500 mg of ketamine in 500 mL of 5% dextrose for induction in buffaloes @ 1.50 mL/kg b.wt. and observed no significance difference between the calculated dose and actual dose required to induce anesthesia.

Fig 1: Animal showing signs of ataxia with forward movement after midazolam administration

In group I animals, onset of analgesia at different body parts *viz.*, fetlock, abdomen, base of horn and ribs was 10.83±0.30, 10±0.44, 10.33±0.33 and 9.83±0.30 min. Whereas, in group II animals, the onset of analgesia fetlock, abdomen, base of horn and ribs was 14.16±0.74, 13.83±0.54, 14.16±0.30 and 14.66±0.33 min, respectively. Though no significant difference was noted in the time for onset of analgesia at different body parts within the group, onset of analgesia was significantly (P >1%) longer in group II. The longer onset of analgesia in group II could be due to the time required to intubate the animal, starting the vaporizer and allowing sevoflurane to act.

Pal *et al.*, (2016) [9] reported quite early onset of analgesia in buffaloes assessed by pin prick method at fetlock, abdomen, base of horn, base of tail and rib at 2.50±0.23, 2.17±0.17, 2.17±0.17, 2.17±0.17 and 2.17±0.17 min, respectively after acepromazine – ketamine anesthesia.

In group I four animals (66.66%) showed excellent muscle relaxation and two animals (33 33%) showed good muscle relaxation throughout the observation period, whereas, in group II animals showed excellent (50%) too good muscle (50%) relaxation. Branson *et al.*, (2001) [1] reported good to excellent quality of maintenance of anesthesia using sevoflurane in dogs.

The palpebral reflexes were diminished 10 min after sedation. Though the reflexes were intact, they were weak after induction and remained weak during the maintenance of anaesthesia with double drip in group I. Whereas, abolishment of the palpebral reflexes was noticed at almost all the intervals during sevoflurane administration in group II.

The corneal reflexes were intact throughout the observation period in group I, however, mild to moderate response was observed during maintenance of anesthesia, whereas, corneal reflexes were absent throughout maintenance of anesthesia with sevoflurane in group II.

Fig 2: Multi- parameters physiological monitor used to monitor physiological parameters during maintenance anesthesia and recovery.

Ventromedial position of the eyeball was noticed in most of the animals after sedation. Further, it was centrally placed during maintenance of anesthesia with guaifenesin-ketamine in group I and rotated downward during sevoflurane maintenance in group II.

Fig 3: Buffalo showing signs of head up during recovery in Ketamine-Guaifenesin (Group I)

Ninu *et al.*, (2015) [8] reported central position of eyeball after thiopentone and ketamine induction and Hikasa *et al.*, (1994) [3] noted ventral position of eyeball during sevoflurane maintenance. The calculated dose of double drip for maintenance of anesthesia in buffaloes of group I was 853.33±63.20 mL, whereas, the actual dose required was 733.33±88.191 mL. Further, in group II, initially sevoflurane vaporizer setting was kept at 7%, then gradually reduced to 2% by assessing depth of anesthesia as per surgeon's requirement to maintain the surgical plane of anesthesia and regulated at 2% throughout surgical procedure. The mean duration of anesthesia was 66.66±2.47 min and 62.50±2.81 min in Group I and II, respectively.

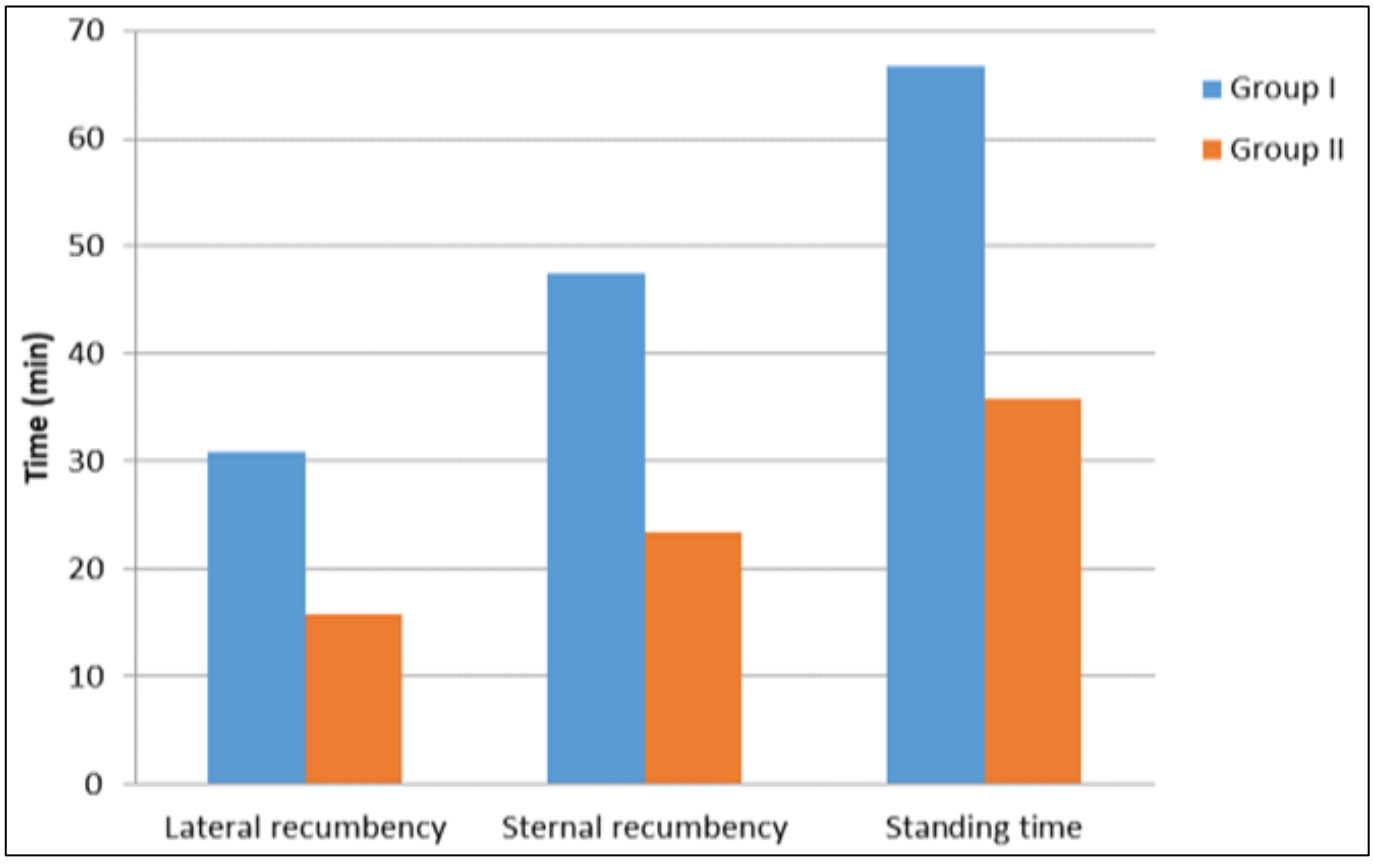

Fig 4: Mean of lateral recumbency with head up, sternal recumbency and standing time (min) for Group I and Group II animals

Recovery time in group I was 24.33±1.01 min where guaifenesin and ketamine were used for induction and maintenance of anesthesia, whereas, quite faster recovery (11.83±1.00 min) was noted in group II where induction was done with guaifenesin and ketamine and maintenance was done with sevoflurane.

Significant (P>1%) difference was noted between the recovery time of both the groups. The average time taken by animals of group I for lateral recumbency with head up, sternal recumbency and for standing was 30.83±1.53, 47.5±1.11 and 66.66±1.66 min, respectively, whereas, in Group II, the average time taken for lateral recumbency, sternal recumbency and standing was 15.83±1.53, 23.33±1.05 and 35.83±1.53 min, respectively (Fig 1).

Smooth and prolonged recovery in all the six buffaloes were noted in group I whereas, in group II, four buffaloes showed smoother and faster recovery and smoother and slightly prolonged recovery. Hikasa *et al.*, (1994) [3] reported time to regain swallowing reflex, head up motion, sternal recumbency and standing position was 3.90±1.90, 5.00±2.00, 11.30±1.90, and 16.30±3.40 min, respectively, in cattle.

Conclusions

Endotracheal intubation in bovines was carried out after sedation with midazolam @ 0.10 mg/kg and induction of anaesthesia with double drip (guaifenesin 50 mg/mL and ketamine 2.00 mg/mL in 500 mL D5% solution) @ 1.50 mL/kg body weight. Muscle relaxation was comparatively better in group I where maintenance was carried out with double drip (guaifenesin-ketamine) than in group II (sevoflurane). Sevoflurane maintenance showed comparatively faster recovery than double drip of anesthesia.

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