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Research Article

EVALUATION OF ATROPINE-XYLAZINE-PROPOFOL-HALOTHANE ANAESTHESIA IN BUFFALOES UNDERGOING DIAPHRAGMATIC HERNIORRHAPHY

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ABSTRACT

A combination of atropine-xylazine-propofol-halothane was evaluated in five buffaloes undergoing diaphragmatic herniorrhaphy. Xylazine (0.04 mg/kg, IM) was used as a preanaesthetic agent after 15 min of atropine (0.04 mg/kg, IM) administration. Anaesthesia was induced with 1% propofol given intravenously '*till effect*' and was maintained with halothane with 100% oxygen. Overall higher score was obtained for premedication and induction while lower score for maintenance, sedation, analgesia and muscle relaxation. There was a non-significant change in rectal temperature and heart rate during the entire period of experiment. Rapid and shallow respirations were observed during anaesthesia with a significant increase in respiratory rate at recovery. There was a significant decrease in haemoglobin, packed cell volume, total erythrocytes count, total platelet count and platelet concentration after 15 min of halothane administration. A non-significant hyperglycemia was observed during anaesthesia till recovery. There was a significant increase in triglycerides at 5 min of propofol administration, while a significant decrease in alanine aminotransferase, total plasma proteins, albumin and potassium levels at 15 min of halothane administration was observed. In conclusion, atropine-xylazine-propofol-halothane anaesthesia can be used in buffaloes undergoing diaphragmatic herniorrhaphy with no major alterations in body vital functions but supplementation of specific analgesics is needed during surgical manipulations.

Key words: Buffalo, diaphragmatic herniorrhaphy, halothane, propofol

Inhalation anaesthetics are unique drugs due to their administration and elimination from the body chiefly via the lungs which favors predictable and rapid adjustment of anaesthetic depth (Steffey and Mama, 2007). This is even more important during anaesthesia in clinical cases of buffaloes suffering from diaphragmatic hernia. Halothane, introduced in veterinary anaesthesia in 1956, has been used widely in veterinary practice but the literature is scarce on use of halothane in buffaloes undergoing diaphragmatic herniorrhaphy (Singh *et al*., 2013). Propofol, an alkyl phenol derivative, was found to be a safe induction agent in buffalo calves (Kumar *et al.,* 2011; Ratnesh *et al.,* 2014) and worked well as an induction agent with halothane (Kumar *et al*., 2014). Atropine-xylazine premedication before propofol was found to be safe in buffalo calves (Potliya, 2012). The present study was undertaken to evaluate the atropine-xylazine-propofol-halothane anaesthesia in buffaloes undergoing diaphragmatic herniorrhaphy.

MATERIALS AND METHODS

The study was undertaken on five clinical cases of buffaloes suffering from diaphramatic hernia (DH) presented to the Teaching Veterinary Clinical Complex, LUVAS, Hisar. For each case; brief history regarding pregnancy or parturition, lactation, milk yield, duration of illness, tympany, consistency of faeces and rumination were recorded. DH was diagnosed using radiography and then confirmed by rumenotomy. The ruminal contents were evacuated completely and animals were kept off-feed and water after laparo-rumenotomy. Diaphragmatic herniorrhaphy was performed under general anaesthesia, on next day of rumenotomy. Each animal was weighed before performing diaphragmatic herniorrhaphy for calculating the proper dose of drugs to be used for general anaesthesia. Pre-anaesthetic medication included administration of atropine (0.04 mg/kg, IM) and xylazine (0.04 mg/kg, IM) was administered 15 min later after atropine. Animals were placed in lateral recumbency for induction of anaesthesia. Propofol was used as induction agent given intravenously '*till effect'*. After induction, intubation was performed with cuffed endotracheal tube and connected to large animal anaesthetic machine. For maintenance of anaesthesia; halothane, through agent specific vaporizer placed out of circuit, was used in 100% oxygen through a semi-closed rebreathing system. Animals were placed in dorsal recumbency for surgery. A post-xiphoid abdominal approach for repair of DH was followed. Concentration of inhalation was regulated to maintain adequate depth of anaesthesia after monitoring animal's response to prevent surgical stimulation and body reflexes. Inhalation of halothane was discontinued at the completion of surgery. All the animals were administered

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normal saline solution intravenously throughout the period of surgery. Post operatively, strepto-penicillin, meloxicam and multivitamins were administered in recommended doses.

The study was divided into five divisions: Clinical observations, behavioural observations, physiological study, haematological study and blood biochemical study. In clinical observations; a fixed criterion was followed for evaluation of quality of anaesthesia. Scoring was done to assign numerical values; starting from 1 to 4 (1-poor, 2-fair, 3-good, 4-excellent) for premedication quality, induction quality, maintenance quality and recovery quality. Qualitative and subjective effects (sedation, analgesia, muscle relaxation) of drugs were judged by observing physical response of the medicated animal to surgical stimulation during diaphragmatic herniorrhaphy. Numerical values starting from 0 to 3 (0-no effect, 1-mild effect, 2-moderate effect, 3-deep effect) was used for sedation, analgesia and muscle relaxation during maintenance of anaesthesia.

In behavioural observations, animals were observed to record the behavioral changes, namely: muzzle dryness, weak time (time elapsed from administration of drug to onset of ataxia), down time (time elapsed from administration of drug to onset of sternal or lateral recumbency) and body reflexes (i.e. drooping of eyelids, loss of palpebral reflex, loss of corneal reflex, rotation of eyeball, loss of tongue reflex, loss of jaw tone and loss of swallowing reflex). Recovery from effect of drugs was taken to have occurred by extubation time (time elapsed from discontinuation of inhalation anaesthetic to removal of endotracheal tube), regaining of head rightening reflex, return to sternal recumbency, standing time with ataxia, browsing time (time elapsed from discontinuation of inhalation anaesthetic to occasional nibbling of grass) and complete recovery without ataxia.

In physiological study, recording of rectal temperature along with ambient temperature, heart rate and respiratory rate was done before performing rumenotomy and on the next day before drug administration, at 15 min after administration of atropine, at 15 min after administration of xylazine, at 5 min of propofol administration, and then at 15 and 30 min after halothane infusion, at recovery and at 24 h after recovery.

For haematological and biochemical studies; blood samples were collected before undertaking rumenotomy and on next day before drug administration, at 5 min after induction of anaesthesia with propofol, and then at 15 and 30 min after halothane infusion, at recovery and at 24 h of recovery. For haematological parameters, blood samples were collected in vials containing EDTA and then estimated using an automatic analyser MS4.

Blood samples for analysis of biochemical parameters were collected in two sets of test tubes. One set of test tube containing 3.8% sodium fluoride (10 mg/ml of blood) for determining glucose and other set containing heparin (10 units/ml) for estimation of triglycerides, cholesterol, lactate dehydrogenase (LDH), alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), gammaglutamyl transferase (GGT), direct bilirubin, urea nitrogen, creatinine, total proteins, albumin, sodium, potassium, chloride and calcium. Biochemical parameters were analysed with EM 200™ (Erba Mannheim, Germany) analyzer using commercially available Transasia XL system pack kits. Sodium, potassium, chloride and calcium were analysed by an automatic electrolye analyser Easylyte™. The data was statisticaly analysed by one-way-analysis of variance and Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

All five DH-affected animals were in compromised body status having illness ranging from 12 days to 45 days (27.4±5.55 days) with inappetance, decreased rumination, history of tympany, black hard and scanty faeces and decreased milk yield. The animals had a mean body weight of 336.00±16.76 kg.

Clinical Observations: Mean scores for quality of anaesthesia are shown in Table 1. Overall score for premedication and induction was above good while score for maintenance, sedation, analgesia and muscle relaxation was below fair. Low scores during maintenance may be due to minimal neuromuscular blocking effect and no analgesic action of halothane (Hall *et al.*, 2001). Also, halothane may decrease the response threshold to noxious stimuli and contribute a heightened awareness to noxious stimuli (Steffey and Mama, 2007). Recovery score was

Table 1

Mean scores depicting quality of anaesthesia during atropine-xylazine-propofol-halothane in buffaloes undergoing diaphragmatic herniorrhaphy

Parameters	Premedication (1-4)*	Induction (1-4)	Maintenance (1-4)	Recovery (1-4)	Sedation (0-3)	Analgesia (0-3)	Muscle relax (0-3)
Score	3.2±0.49	3.2±0.37	1.8±0.37	2.4±0.51	1.8±0.37	1.4±0.4	1.4±0.4

*Values in parentheses indicate range of scores for each parameter

above fair. Recovery from halothane anaesthesia has been reported to be rapid and free from excitement although unrelieved pain can give rise to restlessness during recovery (Hall *et al*., 2001). In an experimental study on buffalo calves (Malik *et al*., 2011), low scores were obtained for sedation and analgesia during midazolam-butorphanol-thiopentone-halothane anaesthesia. Higher anaesthetic scores were obtained in dogs undergoing various surgical procedures during atropine-xylazine-propofol-halothane anaesthesia (Singh *et al*., 2012).

Behavioural Changes: The effects of administration of atropine-xylazine-propofol-halothane combination on behavioural parameters are shown in Table 2. After atropine administration; muzzle and nostrils became dry in all the animals which may be due to very selective effect of atropine for muscarinic receptors, as salivary secretion mediated through M_3-receptors are most sensitive to muscarinic blockade (Lemke, 2007). A decrease in spontaneous activity with ataxia was seen in all the animals after xylazine administration. The sedative and anxiolytic action of xylazine might be due to activation of supraspinal autoreceptors or postsynaptic receptors located in locus ceruleus (LC) neurons in pons of lower brain stem (Lemke, 2007). Similar observation was reported in buffalo calves after administration of atropine and xylazine by Khan *et al*. (2007) and Potliya (2012). All the animals were restrained in lateral recumbency after xylazine administration and propofol was administered intravenously '*till effect*'. Mean dose of propofol administered was 1.56±0.04 mg/kg. Drooping of eyelids occurred soon after intravenous administration of propofol. Rapid onset of action is caused by rapid uptake of propofol into the central nervous system (Zoran *et al.,* 1993). Propofol induces depression by enhancing the effect of the inhibitory neurotransmitter GABA and decreasing the brains metabolic activity (Concas *et al.,* 1991). Palpebral and corneal reflexes were lost after propofol administration with ventral rotation of eyeball. Sluggish or abolished corneal reflex had been reported after induction of propofol anaesthesia in calves (Genccelep *et al.,* 2005). Genccelep *et al*. (2005) in cow calves recorded downward rotation of the eyeball during surgical anaesthesia with propofol. Intubation was performed after loss of tongue reflex, swallowing reflex and relaxation of jaw. After single bolus injection, propofol has been reported to induce a rapid and smooth induction followed by a short period of unconsciousness (Morgan and Legge, 1989). Similar observations were reported in buffalo calves during propofol anaesthesia alone (Kumar *et al*., 2011; Ratnesh *et al*., 2014) or with atropine-xylazine-propofol anaesthesia.

Halothane was administered for 55.40±5.10 min with vaporizer setting starting at 2.62±0.6% and maintained on 2.00±0.64% through semi-closed re-breathing circuit system. Vapour concentrations from 2 to 4% in the inspired air have been reported to produce smooth and rapid induction of anaesthesia in all species of domestic animal (Hall *et al*., 2001).

Recovery was manifested by regain of alar reflex and regain of corneal and palpebral reflex with opening of eyelids after discontinuation of halothane infusion. Extubation was performed when animal started chewing endotracheal tube after regain of tongue reflex and swallowing reflex. All the animals returned to sternal recumbency (at 22.60±3.36 min) after regain of muscle tone and regain of head righting reflex. All animals stood (at 28.20±4.03 min) with some assistance and starts walking with ataxia. Recovery from inhalation anaesthesia results from elimination of anaesthetic from CNS which is influenced by both the solubility of anaesthetic in blood and duration of anaesthesia (Steffey and Mama, 2007). Malik *et al*. (2011) reported median sternal recumbency time and standing time of 16±6.83 min and 18.50±9.43 min, respectively after medetomidine-butorphanol-thiopentone-halothane anaesthesia and 46.5±23.86 min and

Table 2
Effect of administration of atropine-xylazine-propofol-halothane combination on different behavioural characteristics in buffaloes undergoing diaphragmatic herniorrhaphy

Parameters	Mean±SE (Min)
Muzzle dryness°	14.60±2.62
Weak time°°	12.40±1.03
Down time°°	22.20±2.24
Drooping of eyelids*	2.40±0.51
Loss of palpebral reflex*	2.40±0.24
Loss of corneal reflex*	3.20±0.58
Rotation of eye ball*	3.80±0.37
Relaxation of jaw muscle*	3.20±0.58
Loss of tongue reflex*	3.20±0.66
Loss of swallowing reflex*	3.20±0.66
Intubation*	5.20±0.58
Regain of alar reflex regain†	3.20±0.73
Regain of palpebral reflex†	4.40±1.50
Regain of corneal reflex†	4.60±1.54
Eyes open†	6.20±1.39
Regain of tongue reflex†	10.40±2.58
Regain of swallowing reflex†	11.20±2.33
Extubation†	13.40±2.04
Regaining of muscle tone†	14.40±2.06
Regaining of head righting reflex†	17.40±2.16
Return to sternal recumbency†	22.60±3.36
Standing with ataxia†	28.20±4.03
Browsing time†	38.60±8.54
Complete recovery†	59.00±10.08

°after administration of atropine; °°after administration of xylazine; *after administration of propofol; †after discontinuation of alothane

Table 3
Effects of atropine-xylazine-propofol-halothane anaesthesia on clinical parameters in buffaloes undergoing diaphragmatic herniorrhaphy

Parameters (Units)	Before rumen-otomy	Effect of anesesthetic combination in animals undergoing diaphragmatic herniorrhaphy							
		Before drug adminis-tration	At 15 min of atropine administration	At 15 min of xylazine administration	At 5 min of propofol administration	At 15 min of halothane anaesthesia	At 30 min of halothane anaesthesia	At recovery	At 24 h of recovery
Ambient temperature (^{0}C)	29.20^{a}±1.69	27.80^{a}±1.59	28.00^{a}±1.58	28.40^{a}±1.36	28.40^{a}±1.36	28.40^{a}±1.36	28.40^{a}±1.36	28.80^{a}±1.39	27.80^{a}±1.59
Rectal temperature (^{0}C)	37.60^{a}±0.36	36.76^{a}±0.34	36.80^{a}±0.30	37.00^{a}±0.27	37.04^{a}±0.30	37.08^{a}±0.34	37.08^{a}±0.34	37.00^{a}±0.38	37.56^{a}±0.19
Heart rate (beats /min)	56.00^{a}±3.30	50.60^{a}±3.25	54.60^{a}±4.43	49.60^{a}±4.93	50.80^{a}±2.87	54.80^{a}±3.20	56.20^{a}±2.94	55.00^{a}±2.57	56.00^{a}±2.39
Respiratory rate (breaths/min)	12.80^{ab}±1.32	10.80^{b}±0.97	11.40^{ab}±0.87	11.20^{b}±0.86	12.80^{ab}±1.83	13.20^{ab}±1.50	14.00^{ab}±1.18	14.60^{a}±0.60	12.40^{ab}±0.51

Means with different superscripts vary significantly ($p<0.05$)

70.00±39.82 min, respectively after midazolam-butorphanol-thiopentone-halothane anaesthesia in buffalo calves. Standing time of 16.50±1.63 min was reported in dogs recovering from atropine-xylazine-propofol-halothane anaesthesia in clinical cases (Singh *et al*., 2012).

Physiological Study: The effects of administration of atropine-xylazine-propofol-halothane combination on physiological parameters are shown in Table 3. No significant change in rectal temperature and heart rate was observed during the entire period of experiment. Tachycardia was reported during propofol-halothane anaesthesia along with a significant decrease in rectal temperature at 45 and 90 min of halothane administration as compared to base value in buffalo calves (Kumar *et al.*, 2014). Higher rectal temperature and heart rate have been observed after atropine-xylazine-propofol anaesthesia in buffalo calves (Potliya, 2012). A significant increase in respiratory rate was observed at recovery (14.60±0.60 breaths/min) as compared to before drug administration (10.80±0.97 breaths/min). Also the rate of respiration was rapid with shallow depth during anaesthesia. This may be due to hypercapnia during halothane infusion or may be due to surgical stimulation in response to pain reflex. Inhalation anaesthetic generally depresses respiratory system functions but noxious stimulation may cause sufficient central nervous stimulation to lessen the ventilatory depression of the inhalation anaesthetic (Steffey and Mama, 2007). Rapid and shallow respiration is a

Table 4
Effects of atropine-xylazine-propofol-halothane anaesthesia on haematological parameters in buffaloes undergoing diaphragmatic herniorrhaphy

Parameters (Units)	Before rumeno-tomy	Effect of anesesthetic combination in animals undergoing diaphragmatic herniorrhaphy					
		Before drug adminis-tration	At 5 min of propofol administration	At 15 min of halothane	At 30 min of halothane	At recovery	At 24 h of recovery
Haemoglobin (g/dl)	9.88^{ab}±0.89	11.80^{a}±1.35	9.86^{ab}±0.87	8.14^{b}±1.38	10.52^{ab}±1.65	10.18^{ab}±1.04	11.10^{ab}±0.96
PCV (%)	37.16^{ab}±2.78	44.52^{a}±4.46	36.82^{ab}±2.99	30.58^{b}±4.81	38.94^{ab}±6.19	37.54^{ab}±3.79	40.72^{ab}±2.75
TEC (x10^6/mm^3)	6.95^{ab}±0.76	8.20^{a}±0.93	6.83^{ab}±0.66	5.66^{b}±0.89	7.21^{ab}±1.14	6.94^{ab}±0.75	7.70^{ab}±0.78
MCV (fl)	54.86^{a}±3.36	55.20^{a}±2.85	54.84^{a}±3.25	54.50^{a}±3.12	54.70^{a}±3.21	54.70^{a}±3.13	54.18^{a}±3.20
MCH (pg)	14.42^{a}±0.73	14.38^{a}±0.44	14.60^{a}±0.9	14.38^{a}±0.98	14.66^{a}±0.64	14.82^{a}±0.82	14.60^{a}±0.65
MCHC (%)	26.46^{a}±0.5	26.26^{a}±0.66	26.70^{a}±0.55	26.40^{a}±0.4	26.98^{a}±0.45	27.20^{a}±0.25	27.06^{a}±0.6
RDW (%)	14.36^{a}±0.56	13.92^{a}±0.5	13.82^{a}±0.67	14.06^{a}±0.53	14.12^{a}±0.62	13.82^{a}±0.51	13.62^{a}±0.64
TLC (x10^3/mm^3)	13.95^{a}±1.06	15.92^{a}±1.06	11.92^{a}±2.16	12.75^{a}±2.48	12.61^{a}±1.43	13.35^{a}±2.30	16.72^{a}±3.8
N (%)	54.84^{b}±2.64	71.22^{a}±3.52	69.90^{a}±3.71	65.14^{ab}±4.41	63.30^{ab}±5.85	59.86^{ab}±6.14	72.08^{a}±3.65
L (%)	42.56^{a}±2.59	26.82^{b}±3.65	27.86^{b}±3.71	31.56^{b}±4.02	30.26^{b}±3.73	33.04^{ab}±4.37	24.88^{b}±3.54
M (%)	1.26^{ab}±0.11	1.18^{ab}±0.08	1.20^{ab}±0.05	1.42^{a}±0.20	1.04^{b}±0.12	1.06^{ab}±0.14	1.20^{ab}±0.12
E (%)	0.68^{a}±0.19	0.42^{a}±0.09	0.38^{a}±0.08	1.34^{a}±0.95	4.96^{a}±3.47	5.44^{a}±3.93	0.84^{a}±0.35
B (%)	0.66^{a}±0.12	0.36^{a}±0.15	0.66^{a}±0.11	0.54^{a}±0.16	0.44^{a}±0.12	0.44^{a}±0.14	0.60^{a}±0.10
Total platelets count (x10^3/mm^3)	356.00^{ab}±99.09	478.80^{a}±126.67	277.00^{ab}±63.22	290.40^{ab}±71.09	277.40^{ab}±42.15	223.00^{b}±26.6	484.40^{a}±111.08
MPV (fl)	7.62^{a}±0.06	7.26^{a}±0.21	7.42^{a}±0.16	7.48^{a}±0.15	7.38^{a}±0.17	7.58^{a}±0.24	7.34^{a}±0.22
Pct (%)	0.27^{ab}±0.08	0.34^{a}±0.08	0.20^{ab}±0.04	0.21^{ab}±0.05	0.20^{ab}±0.03	0.16^{b}±0.02	0.36^{a}±0.08
PDW (%)	7.58^{a}±0.31	7.38^{a}±0.32	7.40^{a}±0.3	7.34^{a}±0.43	7.68^{a}±0.46	6.98^{a}±0.22	7.44^{a}±0.22

Means with different superscripts vary significantly ($p<0.05$); PCV=Packed cell volume; TEC=Total erythrocytic count; TLC=Total leucocyte count; MCV=Mean corpuscular volume; MCH=Mean corpuscular haemoglobin; MCHC=Mean corpuscular haemoglobin concentration; RDW=Red cell distribution width; MPV=Mean platelet volume; Pct=Plateletcrit; PDW=Platelet distribution width

characteristic feature of halothane anaesthesia (Gahlawat *et al*., 1986). Kumar *et al.* (2014) also reported a significant increase in respiratory rate at peak effect of propofol and at recovery from halothane in buffalo calves. Significant increase in respiratory rate has been reported during maintenance of anaesthesia with halothane after induction with thiopental sodium in healthy buffalo calves premedicated with medetomidine/midazolam-butorphanol (Malik *et al*., 2011). A decrease in respiratory rate from base value after atropine-xylazine-propofol administration has been reported in buffalo calves (Potliya, 2012).

Haematological Studies: The effects of administration of atropine-xylazine-propofol-halothane combination on haematological parameters are shown in Table 4. A significant decrease was observed in haemoglobin, packed cell volume, total erythrocytes count, total platelet count and platelet concentration at 15 min of halothane administration which may be due to sequestration of RBC's in the spleen or by shifts in body fluids associated with decrease in arterial pressure due to vasodilation and decreased cardiac output during anaesthesia. Similar results were obtained during halothane anaesthesia in sheep (Genccelep *et al*., 2004) and goats (Hikasa *et al*., 2002) while non-significant variations in haematological parameters were observed during atropine-xylazine-propofol (Potliya, 2012) and propofol-halothane (Kumar *et al*., 2014) anaesthesia in buffalo calves.

Blood Biochemical Studies: The effects of administration of atropine-xylazine-propofol-halothane combination on biochemical parameters are shown in Table 5. A non-significant hyperglycaemia was observed during anaesthesia till recovery. Hyperglycaemia may be due to propofol-induced systemic insulin resistance resulting in attenuated insulin-stimulated glucose uptake in muscle and impaired insulin-mediated inhibition of hepatic glucose output (Yasuda *et al.*, 2013). Halothane has also been reported to inhibit insulin secretion without alteration of glucose oxidation in rat pancreatic islets (Gingerich *et al*., 1980). A non-significant increase in plasma glucose was observed in buffalo calves during propofol anaesthesia (Kumar *et al*., 2011; Ratnesh *et al*., 2014) and during atropine-xylazine-propofol anaesthesia while significant hyperglycaemia was observed during propofol-halothane anaesthesia (Kumar *et al*., 2014).

A significant increase in triglycerides was observed in the present study at 5 min of propofol administration, which may be due to impaired lipid metabolism. Similar observation was made after induction of anaesthesia with propofol in rats (Ypsilantis *et al*., 2007) and sheep (Vishwakarma *et al*., 2013). There was a significant decrease in ALT, total proteins and albumin at 15 min of

Table 5

Effects of atropine-xylazine-propofol-halothane anaesthesia on blood biochemical parameters in buffaloes undergoing diaphragmatic herniorrhaphy

Parameters (Units)	Before rumeno-tomy	Effect in animals undergoing diaphragmatic herniorrhaphy					
		Before drug administration	At 5 min of propofol administration	At 15 min of halothane anaesthesia	At 30 min of halothane anaesthesia	At recovery	At 24 h of recovery
Glucose (mg/dL)	99.16^{a}±17.45	80.32^{a}±12.02	113.52^{a}±21.58	107.14^{a}±27.17	153.58^{a}±46.98	162.82^{a}±55.65	91.04^{a}±5.83
Triglycerides (mg/dL)	14.60^{ab}±3.17	12.60^{b}±2.25	21.60^{a}±2.44	14.80^{ab}±2.40	17.80^{ab}±2.75	17.40^{ab}±2.91	15.40^{ab}±2.66
Total cholesterol (mg/dL)	42.00^{a}±6.56	40.80^{a}±7.28	33.60^{a}±6.90	28.40^{a}±6.92	33.80^{a}±5.21	31.20^{a}±3.73	40.20^{a}±6.34
LDH (IU/L)	3724.20^{a}±1129.23	4217.00^{a}±1264.06	4076.60^{a}±1575.47	3857.40^{a}±1592.24	4223.20^{a}±1460.11	3800.20^{a}±1624.71	5237.00^{a}±1638.23
ALT (IU/L)	33.84^{ab}±3.01	53.50^{a}±7.81	37.98^{ab}±6.35	32.18^{b}±8.64	38.30^{ab}±6.67	39.62^{ab}±9.21	44.96^{ab}±6.89
AST (IU/L)	522.94^{a}±215.48	1070.50^{a}±328.25	944.76^{a}±300.15	901.24^{a}±357.81	1004.18^{a}±317.24	848.26^{a}±248.88	917.68^{a}±315.81
ALP (IU/L)	93.20^{a}±10.21	98.20^{a}±18.83	95.60^{a}±20.39	72.80^{a}±20.12	78.60^{a}±8.26	90.20^{a}±20.43	90.80^{a}±15.15
GGT (IU/L)	17.38^{a}±4.61	30.12^{a}±8.79	25.50^{a}±8.84	21.26^{a}±9.20	23.68^{a}±8.06	25.24^{a}±11.43	28.44^{a}±10.76
Bilirubin Direct (mg/dL)	0.43^{a}±0.19	0.65^{a}±0.18	0.50^{a}±0.13	0.49^{a}±0.16	0.44^{a}±0.14	0.64^{a}±0.27	0.43^{a}±0.12
Urea(mg/dL)	49.60^{a}±7.56	70.82^{a}±7.11	62.02^{a}±6.66	51.74^{a}±8.42	64.48^{a}±7.94	66.58^{a}±7.75	68.80^{a}±7.11
BUN (mg/dL)	23.17^{a}±3.53	33.09^{a}±3.32	28.98^{a}±3.11	24.17^{a}±3.94	30.13^{a}±3.71	31.10^{a}±3.62	32.14^{a}±3.32
Creatinine (mg/dL)	1.68^{a}±0.18	2.21^{a}±0.23	1.94^{a}±0.24	1.72^{a}±0.38	2.02^{a}±0.22	2.15^{a}±0.33	2.12^{a}±0.32
Total proteins (g/dL)	6.65^{a}±0.41	6.71^{a}±0.79	5.86^{ab}±0.59	4.44^{b}±1.01	5.48^{ab}±0.55	5.39^{ab}±0.60	6.53^{a}±0.71
Albumin (g/dL)	2.60^{ab}±0.29	2.84^{a}±0.37	2.26^{ab}±0.32	1.85^{b}±0.44	2.23^{ab}±0.37	2.14^{ab}±0.26	2.54^{ab}±0.32
Globulin (g/dL)	4.05^{a}±0.30	3.87^{ab}±0.53	3.59^{ab}±0.34	2.60^{b}±0.63	3.26^{ab}±0.18	3.25^{ab}±0.41	3.99^{a}±0.52
A:G ratio	0.66^{a}±0.09	0.77^{a}±0.13	0.63^{a}±0.07	1.22^{a}±0.55	0.67^{a}±0.08	0.68^{a}±0.09	0.66^{a}±0.09
Sodium (mmol/L)	138.34^{a}±2.19	138.86^{a}±2.49	141.14^{a}±1.61	141.52^{a}±2.75	141.16^{a}±2.25	140.60^{a}±2.45	143.26^{a}±1.44
Potassium (mmol/L)	3.58^{ab}±0.26	3.86^{a}±0.25	3.29^{ab}±0.32	2.93^{b}±0.58	3.58^{ab}±0.22	3.67^{ab}±0.22	3.61^{ab}±0.16
Chloride (mmol/L)	100.98^{b}±2.14	108.44^{ab}±3.47	107.44^{ab}±4.34	113.42^{a}±7.52	107.22^{ab}±2.51	109.02^{ab}±2.97	110.50^{ab}±3.49
Calcium (mmol/L)	0.71^{a}±0.14	0.85^{a}±0.13	0.91^{a}±0.13	0.77^{a}±0.17	0.81^{a}±0.12	0.77^{a}±0.15	0.79^{a}±0.1

Means with different superscripts vary significantly ($p<0.05$); LDH=Lactate dehydrogenase; ALT=Alanine aminotransferase; AST=Aspartate aminotransferase; ALP=Alkaline phosphatase; GGT=Gammaglutamyl transferase; BUN=Blood urea nitrogen

halothane anaesthesia. This may be due to shifts in body fluids associated with decrease in arterial pressure due to vasodilation and decreased cardiac output during anaesthesia. Continuous decline in total plasma proteins was reported during glycopyrrolate-propofol anaesthesia in sheep (Vishwakarma *et al*., 2013).

Non-significant variations were observed in plasma sodium, chloride and calcium while a significant decrease in potassium was observed at 15 min of halothane anaesthesia. A significant increase was observed in sodium and potassium during propofol-halothane anaesthesia in buffalo calves along with decreased plasma concentration of chloride at peak effect of propofol (Kumar *et al*., 2014) while Ratnesh *et al*. (2014) observed significant decrease in potassium at peak effect of propofol and a significant increase in chloride at recovery in buffalo calves. Singh *et al.* (2013) observed no significant variation in sodium level, elevated potassium level and non-significant decrease in chloride levels during halothane maintenance anaesthesia in buffaloes undergoing diaphragmatic herniorrhaphy.

The results of the study indicated that atropine-xylazine-propofol-halothane anaesthesia in buffaloes undergoing diaphragmatic herniorrhaphy produced transient alterations in haematological and biochemical changes but maintenance of anaesthesia with halothane was not smooth due to less analgesia with atropine-xylazine-propofol-halothane anaesthesia.

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