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Isoflurane Sparing Effect of Continuous Rate Infusion of Lignocaine as An Adjunct to General Anaesthesia during Right Flank Laparotomy in Cattle

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ABSTRACT

Background: Large ruminants are considered as high risk anaesthesia patient for abdominal surgery because of their heavy weight, the late-term gravidity and the expected long duration of anaesthesia. In order to augment cardiopulmonary function, we aimed at decreasing the requirement of inhalant agents for surgery. Several studies have revealed that lignocaine infusion significantly reduces the minimum alveolar concentration (MAC) of inhalation agents in a variety of species. Thus the present study is focused on assessing the adjunct property of intravenous lignocaine CRI in multimodal general anaesthetic protocol employed for intestinal surgery in cattle.

Methods: The study was carried out in 12 clinical cases of cattle which were randomly categorized into two equally groups. All the animals were premedicated with dexmedetomidine and butorphanol tartrate at the dose rate of 0.5 µg per kg and 0.02 mg per kg body weight *i.v.* respectively. After five minutes of premedication, induction of anaesthesia was achieved with double drip solution containing ketamine hydrochloride 2 mg and guaifenesin 50 mg per mL respectively, administered *i.v.* "to effect". Anaesthesia was maintained with isoflurane in all the animals. In group II animals ten minutes prior to skin incision, slow intravenous lignocaine bolus at the dose rate of 2 mg per kg and continuous rate infusion at the dose rate of 50 µg per kg per min was delivered through volumetric infusion pump.

Result: The Isoflurane liquid utilised for maintenance decreased significantly in group II than group I, which signifies that the inclusion of lignocaine in the anaesthetic protocol has 14.95 per cent isoflurane sparing effect.

Key words: Cattle, Continuous rate, Intravenous, Isoflurane, Lignocaine.

INTRODUCTION

Lignocaine is an amide group of local anaesthetic commonly employed for surgical procedures in large animals by local infiltration and nerve blocks. Intravenous administration of lignocaine has been used for regional anaesthesia and arrhythmia since the decade of 1960. Lately, its mechanism of action has been studied in more details in humans, emphasizing its multimodal aspect, which is the main objective of this research. Several studies have revealed that lignocaine infusion significantly reduces the minimum alveolar concentration (MAC) of inhalation agents in a variety of species including horses (Doherty and Frazier, 1998), dogs (Valverde *et al*., 2005) and goats (Doherty *et al*., 2007). However, there are no reports assessing the probable effects of intravenous lidocaine in anaesthetized adult cattle.

The plasma concentrations of lignocaine and its active metabolite, mono ethyl glycine xylidide, have different pharmacokinetic profiles when administered in the animal anesthetized with isoflurane and in the awaken animal. The volume of central compartment, clearance and elimination half-life of lidocaine are smaller in anesthetized animal than awaken animal, resulting in higher plasma concentrations of lidocaine in the anesthetized animal (Thomasy *et al*, 2005). Lidocaine toxicity is more likely to manifest when its plasma concentration reaches 5 µg per mL. Doses between 1 and 2 mg per kg administered as bolus followed by continuous infusion of 25 to 50 µg per kg per min reaches the plasma concentrations of 2 µg per mL are considered nontoxic.

The mechanism of intravenous lignocaine induced reduction in MAC of Isoflurane has not been elucidated. Several possibilities exists; The anaesthetic agents suppress central nervous system sodium channels in a voltage-dependent manner (Rehberg, 1996). Similarly, action of lignocaine on both peripheral and central nervous systems involves blockade of Na+ channels (Oliveira de, 2010). Hence both inhalant anaesthetics and lidocaine acts on voltage-gated Na+ channels in the central nervous system

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and thus their effects during general anesthesia could be additive.

MATERIALS AND METHODS

The study was conducted in 12 clinical cases of cattle presented for right flank laparotomy under general anaesthesia at large animal surgery outpatient unit of Veterinary Clinical Complex, Veterinary College and Research Institute, Tamil Nadu Veterinary and Animal Sciences University, Namakkal. The animals were randomly divided into two groups *viz*., group I and group II comprising of six animals each.

The age in months and body weight in kilograms of the selected animals were recorded. In all the animals the feed and water were withheld for 24 and 12 hours, respectively before induction of anaesthesia. Marginal auricular ear vein was cannulated under local infiltration analgesia employing 18 G intravenous cannula and secured *in situ* using a 1.5 inch diameter polyvinyl chloride splint and Micropore™ surgical tape to facilitate administration of drugs and fluids.

All the animals were premedicated with dexmedetomidine and butorphanol tartrate at the dose rate of 0.5 µg per kg and 0.02 mg per kg body weight i.v. respectively. After five minutes of premedication, induction of anaesthesia was achieved with double drip solution containing ketamine hydrochloride 2 mg and guaifenesin 50 mg per mL respectively, administered i.v. "to effect". Following induction oroendotracheal intubation was accomplished and the animal were connected to breathing tube of large animal anaesthetic machine (Mallard Medical INC, Model 2800C®, Redding CA 96002, USA) with built-in out of circle precision vapourizer (Forane®, Model 100, SurgiVet, USA). The oxygen flow rate was set at 10 litres per minute for the first 3 min to attain denitrogenation of the anaesthetic circle and also to increase the fraction of inspired-oxygen concentration. The fresh gas flow rate was then reduced to 3 to 5 litres based on the size of the animal. The changes made on the fresh gas flow rate and vapourizer setting to achieve uniform level of anaesthesia throughout the surgery was recorded periodically.

In group II animals ten minutes prior to skin incision, slow intravenous lignocaine bolus at the dose rate of 2 mg/kg and continuous rate infusion at the dose rate of 50 µg per kg per min was delivered through volumetric infusion pump (Infuser breeze, Medilogix Medical Technologies Private Limited, Chennai, India.) till the start of skin closure.

All the animals were monitored continuously during anaesthesia by instrumenting with base apex lead system of electrocardiography, a pulse oximeter (placed on the tongue), temperature probe, non-Invasive blood pressure cuff of Welch Allyn vital sign monitor®. The airway adapter of Bird spirometer® was connected between the endotracheal tube and the Y piece of the breathing tube and minute volume was monitored continuously. The quantity of isoflurane utilized for maintenance of anaesthesia was calculated using total fresh gas flow rate, duration and vapourizer setting employing Avogadro's principle and equated to 300 kg body weight for 1 h duration for statistical comparison. The data obtained were statistically compared employing one way ANOVA as described by Snedecor and Cochran (1994). The data collected were analysed using SPSS®10 software package.

RESULTS AND DISCUSSION

The mean (±SE) tidal volume in mL per kg body weight during isoflurane anaesthesia was 3.83±0.09 and 3.73±0.07 in group I and II, respectively. The mean (±SE) minute volume in mL per kg body weight during isoflurane anaesthesia was 82.51±7.60 and 75.75±3.53 in group I and II, respectively. There was no significant difference in tidal volume and minute volume during isoflurane anaesthesia recorded between the groups. The decrease in tidal volume within the group observed in the study could be attributed to the rapid shallow pattern of breathing noticed in ruminants during anaesthesia (Table 1). Similar observations were recorded by Senthilkumar (2013).

The mean (±SE) FGF rate in mL per kg per min was 4.72±0.37 and 4.69±0.33 in group I and II, respectively. Statistical comparison revealed no significant difference in FGF rate between two groups.

The mean vapourizer setting was 1.24±0.11 and 0.90±0.15 per cent in group I and II, respectively. Statistical comparison revealed vapourizer settings in group II were significantly lower ($p<0.05$) than group I.

The quantity of isoflurane utilized was calculated from the FGF rate, vapourizer setting and total duration of inhalational anaesthesia. The isoflurane liquid utilized was calculated for equated 300 kg body weight and one hour duration employing Avogadro's principle. The isoflurane liquid utilized were 14.93±0.86 and 12.49±0.73 mL in group I and II, respectively.

The isoflurane liquid utilized in group II was significantly lower ($p<0.05$) than group I. Thus the bolus and CRI dose of lignocaine given in all the animals of group II resulted in

Table 1: Mean (± SE) tidal volume and minute volume.

Group	Tidal volume (mL/kg)	Minute volume (mL/kg)
I	3.83±0.09	82.51±7.58
II	3.73±0.07	75.75±3.53

Table 2: Economics of isoflurane anaesthesia.

Group	Fresh gas flow rate (mL/kg/min)	Mean vapourizer setting	Isoflurane liquid utilized(mL) equated for 300 kg and 1 h
I	4.72±0.37	1.24^{p}±0.11	14.93^{p}±0.86
II	4.69±0.33	0.90^{q}±0.15	12.49^{q}±0.73

Column-wise group means with different superscript (pq) differ significantly ($p<0.05$).

reducing MAC of Isoflurane by 16.34 per cent in comparison with group I (Table 2).

SUMMARY AND CONCLUSION

The isoflurane liquid utilized in group II was significantly lower ($p<0.05$) than group I. Thus the infusion of lignocaine in all the animals of group II decreases the isoflurane utilization (MAC) by 16.34 per cent in comparison with group I. The isoflurane sparing effect of systemic lignocaine infusion is partially elucidated. The intravenous administration of lignocaine suppresses both peripheral and central nervous systems by blockade of Na+ channels as isoflurane act on voltage-gated Na+ channels in the central nervous system and thus their effects during general anesthesia could be additive. In addition lignocaine ensures pain relief on the spinal level which presupposes a reduction in MAC which is in accordance with Rehberg *et al.* (1996).

Conflict of interest

All authors declare that they have no conflict fo interest.

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