



Research in

**AGRICULTURE, LIVESTOCK and FISHERIES**

ISSN : P-2409-0603, E-2409-9325

An Open Access and Peer-Reviewed International Journal

Article Code: 0268/2020/RALF

Res. Agric. Livest. Fish.

Article Type: Research Article

Vol. 7, No. 1, April 2020: 97-105.

## **PULSE OXIMETRY AND CLINICAL CHANGES DURING ELECTROSURGERY IN DOGS ANAESTHETIZED WITH XYLAZINE-THIOPENTONE AND XYLAZINE-KETAMINE COMBINATIONS**

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### **ARTICLE INFO**

### **ABSTRACT**

**Received**  
27 March, 2020

**Revised**  
14 April, 2020

**Accepted**  
16 April, 2020

**Online**  
30 April, 2020

**Key words:**  
*Oximetry*  
*Electrosurgery*  
*Xylazine-Thiopentone*  
*Xylazine-Ketamine*  
*Dogs*

This study was performed to explore the pulse oximetric evaluation of cardio-respiratory systems along with the determination of body temperature in dogs anaesthetized with xylazine-thiopentone (X-T) and xylazine-ketamine (X-K) combinations during electrosurgery. Six apparently healthy dogs weighed 20 to 25 kg undergoing electrosurgery (bipolar), were divided into two groups: group A (X-T) and group B (X-K). In group A (n=3), dogs were anaesthetized with xylazine @ 1.1 mg/kg body weight (BW) as intramuscular (IM) and thiopentone @ 20 mg/kg BW as intravenous (IV) injections, and in group B (n=3), dogs were anaesthetized with xylazine @ 1.1mg/kg BW IM and ketamine @ 5.5 mg/kg BW IM after premedication with atropine sulphate @ 0.05 mg/kg BW IM. Bipolar electrosurgery for gastrotomy or castration was performed in the dogs. Pulse oximetric monitoring and the evaluation of clinical changes: heart rate, respiratory rate and peripheral blood oxygen saturation (SpO<sub>2</sub>) were done along with the determination of body temperature before the induction of anaesthesia (control) and thereafter on 10, 20, 30, 40 and 50 minutes post-induction in both groups during electrosurgery. Temperature, heart rate and respiratory rate were altered significantly ( $P<0.05$ ) during the experimental period in both groups as compared to the control values. SpO<sub>2</sub> was decreased significantly ( $P<0.05$ ) throughout the experiment and returned to the level of initial control value after complete recovery in both groups. These findings revealed that during electrosurgery in dogs the anaesthetic combinations of X-T and X-K exert certain clinical changes in the vital signs (body temperature, heart rate, respiratory rate) and SpO<sub>2</sub> which should be carefully considered to take necessary steps for perioperative patient's safety and recovery.

**To cite this article:** Munif MR, MM Alam and MR Alam, 2020. Pulse oximetry and clinical changes during electrosurgery in dogs anaesthetized with Xylazine-Thiopentone and Xylazine-Ketamine combinations. Res. Agric. Livest. Fish. 7(1): 97-105.



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## INTRODUCTION

Pulse oximetry is a common method of monitoring the saturation of haemoglobin with oxygen non-invasively in human and animals (Matthews *et al.*, 2003) to find out the possible cardio-respiratory complications allowing for immediate assessment and management of hypoxic state in patients (Michale and Anne, 2012) perioperatively. Hypoxaemia or deficient oxygenation in the blood (Ali *et al.*, 2007) may be encountered as one of the most dangerous complications during general anaesthesia (GA) and the recovery period. Most anaesthetics in dogs and cats are induced using intravenous techniques (Brodbelt *et al.*, 2006) for performing various surgical approaches. GA is frequently performed for various surgical interventions in dogs including major and minor surgical affections (Cima *et al.*, 2016) such as fracture, tumor, spaying, castration, gastrotomy, enterotomy, cystotomy etc. More than fifty percent of anaesthesia-related deaths occur after anaesthesia, and around half of these deaths happen within three hours of the end of the anaesthesia (Brodbelt *et al.*, 2006). Therefore, continuous patient monitoring during anaesthesia and recovery period is necessary to save lives.

In veterinary surgery, the reasonable use of an electrosurgical unit may provide a bloodless surgical field and reduce the operation time (Parker, 1998; Papazoglou *et al.*, 2001) significantly. During GA, atropine sulphate is most commonly used in premedication to minimize or prevent the vagal effects, bradycardia caused by administration of alpha-2 agonists (Ko *et al.*, 2001) and reduce potential muscles spasm, gastrointestinal motility and secretion, salivation during anesthesia (Liga and Edite, 2011). Xylazine, an alpha-2 agonist is used in animal experiments (Nesgash *et al.*, 2016) as premedicant which inhibits the release of catecholamines and dopamine resulting in analgesic and sedative effects, and hinders nerve conduction in the central nervous system leading to relaxation of striated muscles. Ketamine, a dissociative anaesthetic, can produce a profound analgesia (White *et al.*, 1980) which increases heart rate and mean arterial pressure, stimulates cardiovascular functions. When used alone, it can induce undesired effects such as muscular hypertonicity, myoclonus and convulsions (Nesgash *et al.*, 2016). To minimize these side effects, ketamine is administered in combination with other drugs: benzodiazepines and alpha-2 agonists such as xylazine (Dzikiti *et al.*, 2008; Ozkan *et al.*, 2010). Ultra-short acting barbiturate e.g. thiopentone sodium, is the first thiobarbiturate to gain popularity as an anaesthetic agent for animals (Hall *et al.*, 2000). This is an intravenous anaesthetic drug and used in dogs (Shaaban *et al.*, 2018) during various surgical procedures where it decreases the depth of respiration more than the rate, and apnea may occur with rapid administration or with high doses (Schuszler *et al.*, 2008).

Considering these effects, the changes in the vital signs (body temperature, heart rate, respiratory rate) and peripheral blood oxygen saturation should be monitored with great importance during GA and recovery period to ensure emergency and critical care of the patients. Therefore, this study was performed to evaluate the clinical changes during electrosurgery in dogs anaesthetized with Xylazine-Thiopentone and Xylazine-Ketamine combinations.

## MATERIALS AND METHODS

This experiment was carried out from June to November, 2018 at the Veterinary Teaching Hospital (VTH) of Bangladesh Agricultural University (BAU), Mymensingh-2202.

### Experimental Animals

Six apparently healthy and adult street dogs with good physical condition were chosen for this experiment. The body weight of these animals ranged from 20 to 25 kg. They were kept in the squeeze cage at the VTH, BAU before and after the experiment, and adequate feed and water were supplied. The dogs were kept off feed and water about 12 hours before the experiment.

## Experimental design

### Agents used for the experiment

Atropine Sulphate (Atrovet, Techno Drugs Limited, Narsingdi, Bangladesh) 10 ml vial, each ml contains 1 mg Atropine Sulphate; Xylazine Hydrochloride (Xyla<sup>®</sup>, Interchemie werken "De Adelaar" B.V., The Netherlands) 50 ml vial, each ml contains 20 mg of Xylazine Hydrochloride; Ketamine Hydrochloride (Ketalar<sup>®</sup>, Popular Pharmaceuticals, Tongi, Bangladesh) 10 ml vial, each ml contains 50 mg Ketamine Hydrochloride; Thiopentone Sodium (TPS IV<sup>®</sup> Injection, Popular Pharmaceuticals Ltd. Tongi, Bangladesh) 500 mg vial along with 1 ampoule of 10 ml distilled water, after proper mixing each ml contains 50 mg Thiopentone Sodium.

### Devices used for the experiment

Patient monitor device (Oxysmart-M<sup>®</sup>, Oxycon Co., Ltd, China); Bipolar electrosurgical unit (Mediton<sup>®</sup> MT-400, Class I, Type CF, Distributor Progettazione Produzioni Elettroniche, 40013 Castel Maggiore [BO] Italy via C. Bonozzi); Clinical thermometer; Stethoscope.

The experiment was performed with two anaesthetic combinations in two groups (group A and group B). Each group consisted of three experimental animals. Atropine Sulphate and Xylazine Hydrochloride (HCl) were administered as intramuscular (IM) injections to each animal for premedication before anaesthetic induction.

**Group A (n=3):** Xylazine-Thiopentone combination was used to anaesthetize the dogs of this group. Xylazine HCl @ 1.1 mg/kg BW was injected IM five minutes after administration of Atropine Sulphate @ 0.05 mg/kg BW IM. Ten minutes followed by the injection of Xylazine HCl, Thiopentone Sodium @ 20 mg/kg BW was administered as a slow intravenous (IV) injection. The anaesthesia was maintained using half dose of the induction anesthetic agent (Thiopentone Sodium) when needed.

**Group B (n=3):** Xylazine-Ketamine combination was used to anaesthetize the dogs of this group. Xylazine HCl @ 1.1 mg/kg BW was injected IM five minutes after administration of Atropine Sulphate @ 0.05 mg/kg BW IM. Ten minutes followed by the injection of Xylazine HCl, Ketamine HCl @ 5.5 mg/kg BW IM was administered. The anaesthesia was maintained using half dose of the induction anesthetic agent (Ketamine HCl) when needed.

## Experimental procedures

### Restraining and anaesthesia

Before performing general anaesthesia (GA) for electrosurgery, each dog was physically restrained in the squeeze cage, and sufficient premedication with the administration of atropine sulphate and xylazine HCl was performed. Then the induction agents for GA were injected. In the dogs of group A, the IV anesthetic agent (Thiopentone Sodium) was administered into the radial vein of each animal using 5 ml disposable sterile plastic syringe and needle, whereas for group B, the IM anesthetic agent (Ketamine HCl) was administered into the gluteal muscles of the hind limb of each animal. After anaesthesia, the animal was brought out from the squeeze cage and placed on the operating table in lateral recumbency.

### Electrosurgery

Castration or gastrotomy was performed using bipolar electrosurgical unit in the experimental dogs anaesthetized with both the anaesthetic combinations. For electrosurgery, routine pre-operative procedures were followed, and thereafter the patient return electrode was placed under the body of the animal in lateral recumbency. Then the electrosurgical unit was switched on and the active bipolar electrode was used to perform surgery with necessary cutting and coagulation. Finally the operations were completed with routine procedures, and sufficient post-operative care and management were ensured.

### Clinical examinations

Before the administration of induction anaesthetic agents; body temperature, heart rate, respiratory rate and peripheral blood oxygen saturation (SpO<sub>2</sub>) of the dogs were recorded as pre-anesthetized control values for both group A and group B. The parameters were recorded at 10, 20, 30, 40 and 50 minutes after induction of anaesthesia during electrosurgery, and again after complete recovery from the anaesthesia (about six hours from induction) in both groups. Respiratory rate (breath/minute) and heart rate (beat/minute) were recorded

with the help of stethoscope. Pulse oximetric evaluation was performed by monitoring the SpO<sub>2</sub> (%) from the Patient monitor device, and body temperature (°C) was determined manually with the thermometer.

### Statistical analysis

The data obtained in this investigation were calculated and represented as 'mean ± standard error' for all the clinical changes occurred during the experiment in both groups, and Paired t-tests were performed for data analysis using IBM SPSS Statistics, Version 20.  $P < 0.05$  was considered as statistically significant for all the tests.

## RESULTS

The effects of Xylazine-Thiopentone (X-T) and Xylazine-Ketamine (X-K) combinations on body temperature and heart rate of the dogs are presented in Figure-1 and Figure-2 respectively. In case of body temperature for group A with X-T anaesthesia, the mean control value was  $38.07 \pm 0.18^\circ\text{C}$ , which decreased to  $35.20 \pm 0.46$ ,  $33.83 \pm 0.69$ ,  $32.87 \pm 0.41$ ,  $33.63 \pm 0.38$ ,  $35.57 \pm 0.46$  and  $37.97 \pm 0.24^\circ\text{C}$  respectively at 10, 20, 30, 40, 50 minutes and after complete recovery from the anaesthesia (about 360 minutes from induction). Whereas, for group B with X-K anaesthesia, the mean control value was  $38.8 \pm 0.15^\circ\text{C}$ , which decreased to  $33.73 \pm 0.18$ ,  $32.07 \pm 0.30$ ,  $31.27 \pm 0.39$ ,  $33.00 \pm 0.29$ ,  $34.30 \pm 0.26$  and  $38.57 \pm 0.12^\circ\text{C}$  at 10, 20, 30, 40, 50 and 360 minutes respectively. In both groups, the decrement in body temperature continued significantly ( $P < 0.05$ ) up to 50 minutes of induction, and then it returned near to the level of control value after complete recovery. In case of heart rate for group A with X-T anaesthesia, the mean control value was  $69 \pm 0.58/\text{minute}$ , which altered to  $103.60 \pm 0.88$ ,  $97.00 \pm 0.58$ ,  $87.67 \pm 0.88$ ,  $75.67 \pm 0.88$ ,  $68.67 \pm 0.88$  and  $70.67 \pm 0.33/\text{minute}$  at 10, 20, 30, 40, 50 and 360 minutes respectively; where significant changes ( $P < 0.05$ ) were observed up to 40 minutes of induction. Similarly, for group B with X-K anaesthesia, the mean control value was  $69.33 \pm 0.67/\text{minute}$ , which altered to  $102.60 \pm 0.88$ ,  $96.33 \pm 0.88$ ,  $90.00 \pm 1.15$ ,  $87.33 \pm 1.45$ ,  $81.67 \pm 1.20$  and  $69.67 \pm 0.88/\text{minute}$  at 10, 20, 30, 40, 50 and 360 minutes respectively; where significant changes ( $P < 0.05$ ) were observed up to 50 minutes of induction. However, heart rate returned near to the level of control value after complete recovery from the anaesthesia in both groups.

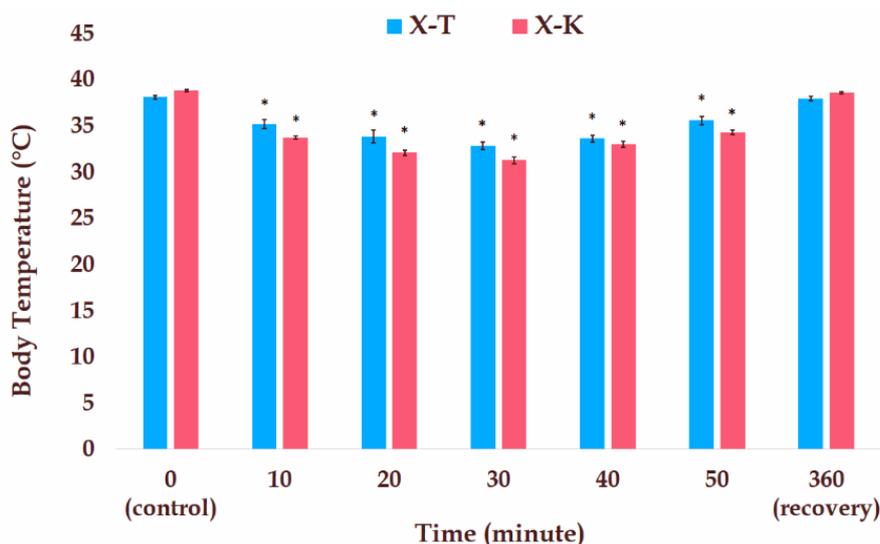
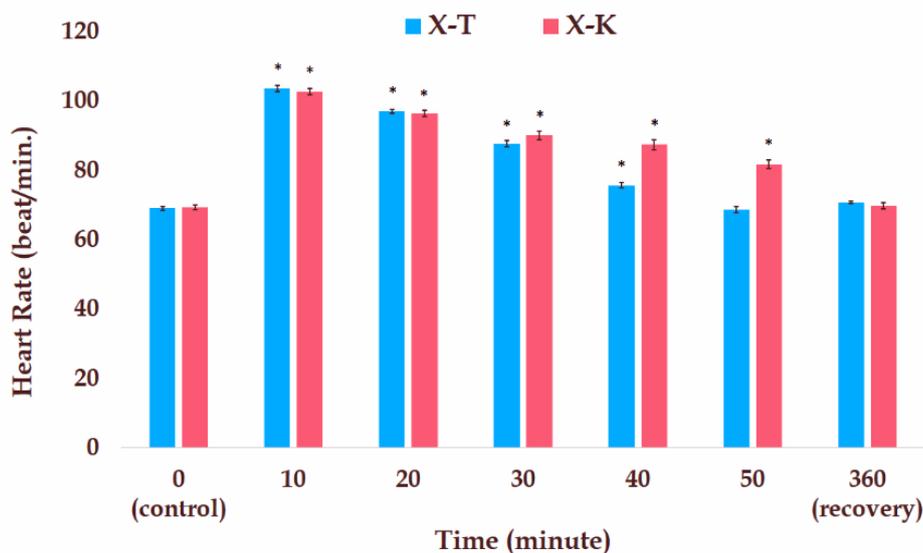


Figure-1: Changes in body temperature (°C) during X-T and X-K anaesthesia

± = Standard Error, \* = Significant at 5% level of significance, X-T = Xylazine-Thiopentone, X-K = Xylazine-Ketamine



**Figure-2: Changes in heart rate (beat/min.) during X-T and X-K anaesthesia**

± = Standard Error, \* = Significant at 5% level of significance, X-T = Xylazine-Thiopentone, X-K = Xylazine-Ketamine

The effects of X-T and X-K combinations on respiratory rate and peripheral blood oxygen saturation (SpO<sub>2</sub>) of the dogs are presented in Figure-3 and Figure-4 respectively. In case of respiratory rate for group A with X-T anaesthesia, the mean control value was 23.67±0.88/minute, which changed to 21.67±0.88, 19.67±0.88, 18.33±0.33, 19.67±0.33, 22.00±0.58 and 24.00±0.58/minute at 10, 20, 30, 40, 50 and 360 minutes respectively; where significant changes ( $P<0.05$ ) were observed at 20, 30 and 50 minutes of induction. On the other hand, for group B with X-K anaesthesia, the mean control value was 23.00±0.58/minute, which changed to 27.00±0.58, 25.00±0.58, 22.00±0.58, 22.33±0.88, 23.67±0.67 and 25.00±0.58/minute at 10, 20, 30, 40, 50 and 360 minutes respectively; where significant change ( $P<0.05$ ) was only observed at 10 minutes of induction. In both groups, respiratory rate returned near to the level of control value after complete recovery from the anaesthesia. In case of SpO<sub>2</sub> for group A with X-T anaesthesia, the mean control value was 99.00±0.58%, which altered to 76.00±1.15, 75.33±0.67, 82.00±1.15, 87.33±1.20, 93.67±0.8 and 99.00±0.58% at 10, 20, 30, 40, 50 and 360 minutes respectively; where significant changes ( $P<0.05$ ) were observed up to 50 minutes of induction. On the contrary, for group B with X-K anaesthesia, the mean control value was 99.00±0.58%, which altered to 95.00±0.58, 95.00±0.58, 93.33±0.88, 96.00±0.58, 97.00±0.58 and 98.00±0.58% at 10, 20, 30, 40, 50 and 360 minutes respectively; where significant changes ( $P<0.05$ ) were observed up to 30 minutes of induction. However, in both groups, SpO<sub>2</sub> returned near to the level of control value after complete recovery from the anaesthesia.

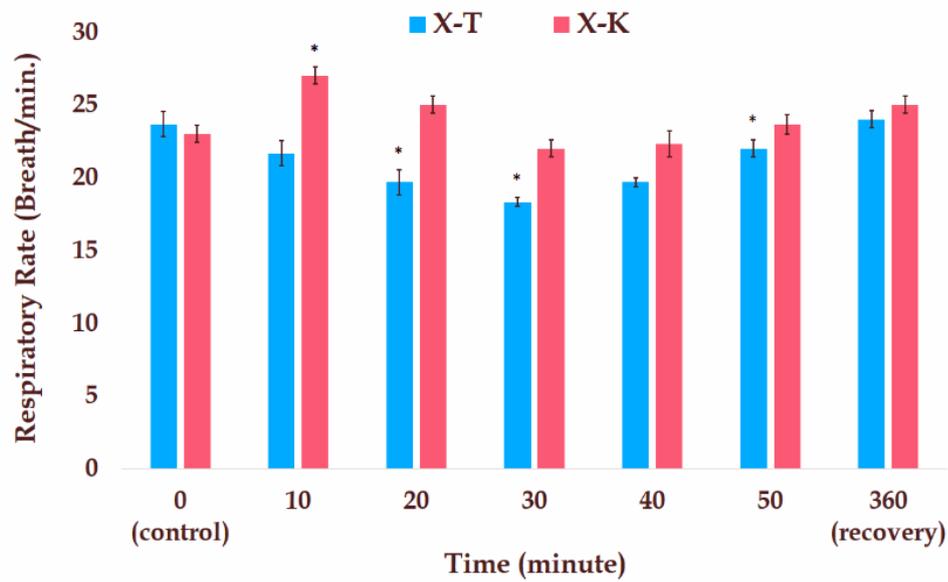


Figure-3: Changes in respiratory rate (breath/min.) during X-T and X-K anaesthesia

± = Standard Error, \* = Significant at 5% level of significance, X-T = Xylazine-Thiopentone, X-K = Xylazine-Ketamine

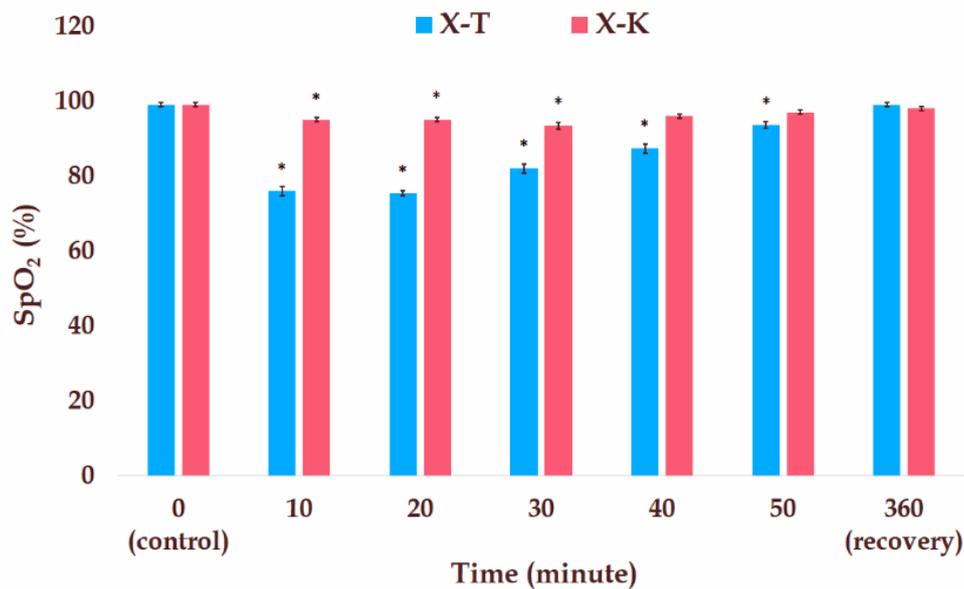


Figure-4: Changes in SpO<sub>2</sub> (%) during X-T and X-K anaesthesia

± = Standard Error, \* = Significant at 5% level of significance, X-T = Xylazine-Thiopentone, X-K = Xylazine-Ketamine

## DISCUSSION

In the present study, Pulse oximetric evaluation of cardio-respiratory systems and the investigation of clinical changes (body temperature, heart rate, respiratory rate and SpO<sub>2</sub>) in dogs were done, which are in agreement with previous reports (Erhardt *et al.*, 1990; Matthews *et al.*, 2003; Tavakoli and Rajabian, 2015). Electrosurgery (bipolar) was performed in the dogs under GA, as also reported by Guedes *et al.* (2017) and Meakin *et al.* (2017). GA in dogs was induced using X-T and X-K combinations, which is collateral with the investigations of Muhammad *et al.* (2009), Nesgash *et al.* (2016) and Gebremedhin *et al.* (2018).

The decrease in body temperature of the dogs within both groups is in agreement with the findings of Kumar *et al.* (1990), Muhammad *et al.* (2009), Sindak *et al.* (2010) and Gebremedhin *et al.* (2018). The decrease in temperature might be due to the depression of the thermoregulatory center (Buggy and Crossley, 2000; Fox *et al.*, 2008) in the hypothalamus of the brain during anaesthesia in the dogs. In both groups, increased heart rate was found (group A: up to 40 minutes and group B: up to 50 minutes), which is consistent with the findings of Likiv *et al.* (1991), Muhammad *et al.* (2009) and Ullah *et al.* (2017). Thereafter, its gradual decrease towards the level of control value was observed up to complete recovery, as also observed by other researchers (Cruz, 1991; Gebremedhin *et al.*, 2018). Heart rate increased earlier in the experiment due to the voluntary and involuntary excitement stages of anaesthesia and the initial cardiovascular stimulatory effects of ketamine followed by abnormal heart rhythms (Tanaka *et al.*, 2005), and later decreased due to the depressant actions of xylazine (Knight, 1980; Taylor, 1990) and thiopentone (Hall *et al.*, 2000) on the heart. Decreased respiratory rate was found in the dogs with X-T combination during the experiment, and an initial increase (up to 20 minutes) was found with X-K combination and thereafter, it decreased (up to 40 minutes) and returned towards the level of control value after recovery. These findings are in agreement with the reports of Kumar *et al.* (1990) and Muhammad *et al.* (2009). The decrease in respiratory rate might be due to the depressant effects of xylazine (Taylor, 1990), thiopentone (Hall *et al.*, 2000) and ketamine (Tanaka *et al.*, 2005) on the respiratory centre of the dogs that counteracted with the respiratory stimulation.

This study showed decreased SpO<sub>2</sub> during the entire experimental period, and it returned towards the level of control value after complete recovery in both groups. Similar findings have been reported in various investigations (Matthews *et al.*, 2003; DuBois *et al.*, 2004; Ward *et al.*, 2006; Sankar *et al.*, 2011; Nusory, 2011). The decrease in SpO<sub>2</sub> might be due to the depression caused by the anaesthetic drugs on the ventilator function of the lungs. Low SpO<sub>2</sub> is indicative of reduced peripheral oxygenation and diminished tissue perfusion.

## CONCLUSIONS

Pulse oximetric evaluation in dogs can be a good indicator to monitor and detect the incidence of blood oxygenation, apnoea, hypoxaemia etc. to take necessary steps for saving life during GA through quick and easy assessment of cardio-respiratory complications. Thus, the safety of the anaesthesia can be evaluated smoothly for better recovery of the patients. X-T and X-K combinations assert some cardio-respiratory as well as clinical changes at certain levels influencing the functions of the vital organs (heart, lungs and brain) which should be carefully considered by the veterinarians for the proper management of patients undergoing GA.

## ACKNOWLEDGEMENTS

The authors express their gratitude to the Ministry of Science and Technology, Bangladesh as well as the authority of Veterinary Teaching Hospital (VTH), Bangladesh Agricultural University (BAU), Mymensingh-2202, for funding and carrying out the research work smoothly.

## AUTHORS' CONTRIBUTIONS

MRM: research implementation, data acquisition, data sorting and interpretation, statistical analysis, manuscript preparation; MMA: study concept, guidance of literature, revision of manuscript; \*MRA: study design, technical guidance and support, result interpretation, revision of manuscript.

## CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

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