Scientific Works. Series C. Veterinary Medicine. Vol. LXIX (1), 2023
ISSN 2065-1295; ISSN 2343-9394 (CD-ROM); ISSN 2067-3663 (Online); ISSN-L 2065-1295

# PARTIAL INTRAVENOUS ANESTHESIA WITH ISOFLURANE AND ALFAXALONE FOR AN ADULT SHEEP UNDERGOING SOFT TISSUE SURGERY

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***Abstract***

*A 6-year-old Tsurcana male sheep was anesthetized in hospital conditions for a soft tissue surgery- bilateral orchidectomy. After intramuscular premedication with midazolam (0.2 mg/kg), butorphanol (0.1 mg/kg), and ketamine (5 mg/kg), anesthesia was induced intravenously with alfaxalone (1.6 mg/kg IV). The subject was intubated with an 8.5 mm endotracheal tube and anesthesia was maintained with isoflurane (1.5-2.5 vol % in $O_2$) and 3 boluses of alfaxalone (1.0 mg/kg) delivered intravenously every 10 minutes. The total surgical time was 40 minutes and the whole inhalation anesthesia time was 78 minutes, including the preparation of the subject at the beginning and after the surgical procedure. The mean arterial blood pressure was maintained at 80 mmHg throughout anesthesia, the average end-tidal $CO_2$ at 51 mm Hg, the mean oxygen saturation of haemoglobin was 99.5%, the mean heart rate was 130 beats per minute, respectively 31 respirations per minute. In conclusion, this anesthetic protocol may be clinically applicable for a male sheep undergoing invasive soft surgery, especially if there is a particular case involving a risk patient.*

***Key words****: alfaxalone, isoflurane, sheep, surgery.*

## INTRODUCTION

In veterinary practice, especially for small animals, soft tissue surgeries are usually performed in hospital conditions under closely monitored inhalation anesthesia. While sheep (*Ovis aries)* are widely used as large animal models (Costea et al., 2022), transferring this technique to farm animals such as sheep, requires adapted techniques and protocols.

Isoflurane anesthesia in small ruminants provides a shorter and safer recovery with a decreased impact over the cardiovascular and respiratory functions (Chowdhury, 2020). Balanced anesthetic techniques can include for sheep premedication the use of a benzodiazepine, an opioid and ketamine for their potent sedative and analgesic effects. In one of our previous studies (Costea et al., 2022), the premedication protocol used (midazolam, butorphanol, ketamine) provided a good sedation and analgesia, enabling painful surgical procedures, reducing the stress of the patients and assuring a smooth recovery.

Alfaxalone is a synthetic neuroactive steroid that acts non-reversible on the gamma aminobutyric acid receptors in the central nervous system. It may be utilized from sedation to maintenance and produces dose-dependent unconsciousness and muscle relaxation with minimal effect on cardiovascular variables (Andaluz et al., 2012).

## MATERIALS AND METHODS

An adult male, Tsurcana sheep (6-year-old), weighing 50 kg (Figure 1) was premedicated intramuscularly (IM) with 0.2 mg/kg midazolam (Midazolam®, Aguettant 5 mg/ml), 0.1 mg/kg butorphanol (Butormidor®, Richter Pharma AG 10 mg/ml) and 0.5 mg/kg ketamine (Ketamine® Richter Pharma AG Richter Pharma AG, 100 mg/ml). The subject was induced using the IV route, 10 minutes later, with 1.6 mg/kg alfaxalone (Alfaxan®, Orion Pharma 10 mg/ml) administered slow, over approximately 1.5 minutes. Alfaxan® is a non-irritant product composed of ethanol (150

mg/ml), chlorocresol (1.0 mg/ml) and benzethonium chloride (0.2 mg/ml).

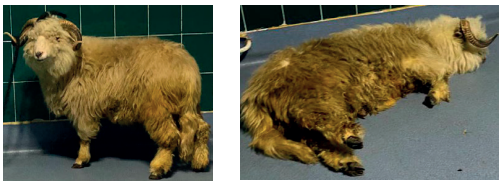

Figure 1. Tsurcana sheep before premedication and 7 minutes after premedication

For intubation 10 mg lidocaine (Xilina®, Zentiva, 10 mg/ml) was topically administrated onto the arytenoid cartilages and endotracheal intubation was performed with the sheep positioned in sternal recumbency, on a padded surgical table using an 8.5 mm diameter cuffed endotracheal tube. The endotracheal intubation was followed by the placement of an oro-ruminal rubber tube.

The subject was maintained using isoflurane (Vetflurane®, Virbac, 1000 mg/g) in 100% oxygen, delivered connected to a rebreathing anesthesia circuit. The protocol included the possibility of using the controlled mechanical ventilation anesthesia machine (AEON 7200®) set to deliver a peak inspiratory pressure (PIP) of 10 cm $H_2O$ and an inspiratory time of one second.

Physiological variables were continuously monitored: pulse oximetry, capnography, electrocardiography, oscillometer and Doppler arterial blood pressure and nasopharyngeal temperature via a vital sign monitor adapted for veterinary medicine (COMEN C80-V®).

Ringer Lactate solution was provided via an infusion pump set at 5 mL/kg/hr.

The subject also received 10 mg/kg Amoxiciline (Amoxicilina FP 20%®, Pasteur) and 1 mg/kg meloxicam (Meloxidyl®, Ceva 5 mg/ml), subcutaneous at the end of the surgery.

For this subject withholding food and water was performed for 12 hours before the procedure.

## RESULTS AND DISCUSSIONS

The main challenge of this case was represented by the choice of an anesthetic protocol, which would allow the management of a surgical intervention on soft tissues, for a farm animal raised as a companion animal and operated in hospital conditions, with maximum reduction of the anesthetic risk.

Lower doses of drugs should be administered when combinations protocols are used or high-risk animals are involved, preferable to use inhalational anesthetics only for maintenance of anesthesia and injectable anesthetic drugs for the premedication and induction (Galatos, 2011).

Preanesthetic evaluation was performed in low stress conditions with minimum contention. The subject was assigned to ASA 2 risk group classification adapted for veterinary subjects (Costea et al., 2022): a healthy patient, with no organic disease. Inhalational anesthesia, with the subject intubated with a cuffed endotracheal tube, should be considered for risk animals or prolonged and complicated surgical procedures, giving the advantages of avoiding aspiration of ruminal contents and saliva in the same time with an efficient ventilation and oxygenation.

We did not decide to use a locoregional anesthesia technique, as we wanted to evaluate the effectiveness of the protocol used for anesthesia and pain management, independent of any locoregional anesthesia technique.

The choice of alfaxalone as an induction agent allowed easy intubation in sternal recumbency, with the patient relaxed, without producing any significant respiratory and cardiovascular effects, the patient remaining stable. The use of alfaxalone for a premedicated (sedated) sheep, as an induction agent to be followed by inhalant anesthesia and completed with alfaxalone boluses, was decided since the literature offered similar protocols for unsedated sheep or protocols in which alfaxalone was used in different combinations with alpha 2 agonists (Riebold, 2015).

Intubation was done quickly, under direct visual control, 10 minutes after premedication and pre-oxygenation trough flow by with 100% $O_2$, with the subject adequately in sternal recumbency, with the head and neck aligned, fully extended, using a long laryngoscope blade.

Since the rumen cannot be emptied completely after withholding food and water, we maintained the subject during surgery in right lateral recumbency, head lowered in order to minimize the aspiration the risk to allow drainage of fluids (Figure 2). The subject's

position was changed after induction and left for the entire maintenance in right lateral recumbency.

During the maintenance of anesthesia, the depth of anesthesia and vital signs were carefully monitored and the anesthetic depth was adjusted in order to maintain an adequate level for the surgical procedure. Starting from these considerations, during the 40 minutes of surgical procedure, 3 consecutives boluses of alphaxalone (1 mg/kg, IV) were administrated intravenously (IV) every 10 minutes in order to maintain the surgical plan of anesthesia.

Figure 2. Subjected during maintenance phase

Heart rate rhythm (HR) was stable and maintained between 101 and 135 bpm, with a mean of 130 bpm. The same trend was respected for the respiratory frequency, respectively a mean of 31 rpm (30-33 rpm), with the subject breathing with spontaneous autonomy during the entire anesthesia. As a matter of fact, the controlled mechanical ventilation protocol was not used for this case. As a result, the recovery was extremely quick and the subject was well oxygenated during the entire length of anesthesia ($SpO_2$ values registered 98-100%).

The average end-tidal $CO_2$ ($EtCO_2$) level remained high during the maintenance phase, with a mean value of 51 mm Hg, while we targeted $ETCO_2$ value between 30-45 mmHg (Chandrasekharan et al., 2016). The higher values where corelated with the sequences of lower repiratory frequency, after alphaxalone bolus administration (1 mg/kg, IV).

MAP measured oscillometrical was maintained above 80 mmHg throughout anesthesia, but that measuring method required many attempts to measure it, since the cuffed where difficult to position. From this point of view, we recommend the introduction in sheep anesthesia monitoring techniques of higher sensitivity techniques, respectively the invasive arterial blood measuring.

The evolution of body temperature was monitored during the entire anesthesia, from premedication to induction, with no major impact on its trend, since the subject remained normothermic during the procedure. In this sense, we used two methods in comparison, respectively monitoring with the help of an esophageal temperature probe respectively with an electronic thermometer, from the level of the nasal cavity. We did not register significant differences between the two measurement methods. The technique used at the level of the nasal cavity, however, being easier, in the context in which the subject had an endotracheal and esophageal tube, can be recommended.

The total surgical duration was 40 min and the total inhalation anesthesia time was 78 min, including the preparation of the subject between premedication and induction and the post-surgery cleaning procedures.

Respiration was assisted until adequate gaging reflexes developed, 10 min after the end of gas anesthesia and then after another 2 minutes, the endotracheal tube was safely removed.

The patient was able to adopt the quadrupedal position 8 minutes after extubation (Figure 3), with complete control over posture and walking, 17 minutes after extubation.

Figure 3. Patient in quadrupedal position, 8 minutes after extubation

## CONCLUSIONS

The anesthesia of farm and production animals must be regarded with the same seriousness as that of companion animals. When a sheep is not raised for production, but as a companion animal, the challenge of ensuring a safe protocol is extremely important.

For the presented case, we used a protocol based exclusively on a partial intravenous anesthesia technique, thus ensuring the anesthesia and analgesia necessary to perform the bilateral orchidectomy, without other additional locoregional anesthesia techniques.

The clinical monitoring of the depth of anesthesia, vital signs, as well as the surgical comfort were maintained within the specific physiological limits, so that there were no syncopes during the anesthesia that would determine the change of the initial anesthetic plan or the stabilization of the patient.

Maintaining anesthesia using isoflurane and repeated boluses of alfaxalone was an optimal solution for the patient, assuring stability and an awakening, respectively a quick recovery, without complications.

The use of alfaxalone as a unique agent for induction and, respectively as a maintenance agent along with isoflurane, was an optimal choice for this patient, as it allowed easy intubation, as well as maintaining the patient in stable and safe conditions.

The monitoring of the patient during the anesthesia was possible without any complications, the only difficulties being represented by the positioning of the cuff for measuring the non-invasive pressure, so we recommend the use of the invasive technique if this is available.

The awakening phase was a stage managed very easily, as the patient returned from anesthesia gradually, stably, without showing any adjacent complications, subsequently his evolution was perfect.

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