COMBINED ANESTHESIA TECHNIQUE WITH ISOFLURANE AND LUMBOSACRAL EPIDURAL BUPIVACAINE IN AN ANTELOPE SPECIES (IMPALA (AEPYCEROS MELAMPUS))

Gecombineerde anesthesie met isofluraan en lumbosacraal epiduraal bupivacaïnetoediening bij een antilopespecies (Impala (Aepyceros melampus))

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SUMMARY

An impala (Aepyceros melampus) premedicated with a combination of xylazine, carprofen, methadone and atropine was anesthetized with isoflurane in oxygen for tibial fracture repair in combination with a lumbosacral epidural injection of bupivacaine for additional analgesia and muscle relaxation during surgery. The cardiopulmonary parameters remained within normal ranges, except for an initial hyperventilation. Recovery after 3 hours of anesthesia following administration of atipamezole was fast and uneventful. Subcutaneous administration of carprofen during a period of 5 days assured adequate postoperative analgesia.

SAMENVATTING

Na premedicatie met een combinatie van xylazine, carprofen, methadone en atropine werd een impala (Aepyceros melampus) onder algemene verdoving gebracht met isofluraan en zuurstof voor chirurgische correctie van een tibiafractuur. Bijkomende intra-operatieve analgesie en spierrelaxatie werden bekomen door het uitvoeren van een lumbosacrale epidurale injectie met bupivacaïne. Op een initiële hyperventilatie na bleven alle cardiopulmonaire parameters binnen de normale grenzen. Het ontwaken na 3 uur anesthesie voorafgegaan door de toediening van atipamezole verliep snel en probleemloos. Toereikende postoperatieve analgesie gebeurde met subcutane injecties van carprofen gedurende 5 dagen.

INTRODUCTION

The physical and chemical restraining of wild ruminants is a challenge for the veterinarian. Antelopes have explosive physical power and are often self-destructive while being handled (Sedgwick, 1999). A different approach to immobilization must be made between free-ranging wild animals and those living in captivity. Normally, intramuscular anesthetics are used for the immobilization and capture of these animals. The capture of free-ranging wild ruminants can be done by remote delivery of a dart (blow pipes, CO_2 rifles, etc.) loaded with an immobilizing drug (Caulkett, 2002). Darting should be limited to larger animals. As a rule, animals less than 12-15 kg of BWT should not be immobilized by remote drug delivery, since they are easily injured or killed by the dart impact (Nielsen, 1996). Field immobilization involves the administration of animal anesthesia under the most difficult circumstances without the benefit of any pre-anesthetic evaluation and preparation. On the other hand, for wild ruminants living in captivity, physical capture with subsequent administration of immobilizing drugs or sedatives to facilitate non-traumatic, safe handling may be the optimum method. After the intramuscular administration of a sedative, a limited pre-anesthetic evaluation can be done. In these animals, longer anesthetic procedures can be carried

out using a combined anesthesia technique involving sedatives, opioids and volatile anesthetics in combination with additional analgesic techniques.

Special consideration for pre-anesthetic preparation includes fasting. Ruminants have a multi-compartmental stomach with a large rumen that does not empty completely (Riebold, 1996). Small ruminants should be fasted for 12 hours and deprived of water for 8 to 12 hours (Riebold, 2002). Endotracheal intubation of ruminants is recommended since regurgitation and aspiration of rumen contents are possible. Although airway control by intubation does not prevent regurgitation, aspiration can still be minimized. Therefore, airway control shortly after induction is an important aspect of ruminant anesthesia, since it prevents `fatal aspiration pneumonia. Another complication associated with recumbency and anesthesia is ruminal tympany. As tympany develops, elevated pressure is placed on the diaphragm, decreasing functional residual capacity and impeding ventilation (Masewe *et al.*, 1979). Therapy involves the passage of a stomach tube to decompress the rumen. Ruminants salivate copiously while under anesthesia; this excess salivation can be partially counteracted by anticholinergic agents (Riebold, 2002). Capture myopathy can develop during or following the anesthesia of wild ruminants. Therefore, stress prior to anesthesia in combination with prolonged induction times should be kept to a minimum level, and oxygen should be supplemented during anesthesia (Caulkett, 2002; Citino *et al.*, 2002).

Acute pain can occur following elective surgical procedures and trauma. This pain can be prevented or alleviated by a range of analgesic agents and techniques (opioids, non-steroidal anti-inflammatory drugs (NSAID's), local anesthetic agents, etc.) (Dobromylskyi *et al.*, 2000). Epidural injections can be used to provide anesthesia of the hind limbs. Local anesthetics can be used at dosages that will give total sensory and motor loss to the affected area, thus leading to intra-operative muscle relaxation (Dobromylskyi *et al.*, 2000).

For all these reasons, a combined anesthetic protocol including (1) premedication with an alpha$_2$-agonist, an opioid and a non-steroidal anti-inflammatory drug, (2) induction and maintenance with isoflurane in oxygen, and (3) additional analgesia and myorelaxation with epidurally administered bupivacain was used in this antelope presented for tibial fracture repair.

CASE REPORT

History

A 1-year-old female antelope (Aepyceros melampus/ Impala), weighing 16 kg was presented with acute lameness of the right hind limb. The animal was living in captivity and was not used to being handled. Radiological examination of the physically restrained, nonsedated animal (darkened area, quiet environment) revealed a distal tibial fracture in the growth plate. Except for the fractured limb, the animal seemed in good physical condition. The animal was scheduled for surgery. It was decided to use an internal fixation with a small intramedullary pin in combination with a tension band for fracture repair. An additional external fixation technique for immobilization of the hind leg was added.

Anesthetic technique

The animal was fasted and deprived of water for 12 hours before surgery, during which time it was housed in a small box. Premedication was done with a combination of 0.2 mg/kg of xylazine (Xyl-M 2% , VMD, Arendonk, Belgium), 0.1 mg/kg of methadone (Mephenon , Denolin, Brussels, Belgium) and 0.02 mg/kg of atropine (Atropini sulphas , Sterop Laboratories, Brussels, Belgium) given intramuscularly. Carprofen (Rimadyl , Pfizer Animal Health, Louvain-la-Neuve, Belgium) was given intravenously at a dosage of 4 mg/kg. Anesthesia was induced by mask with 3% isoflurane (Forene , Abbott laboratories, Queenborough, Kent, England); flow rates of 4 L/min of oxygen and 4 L/min of nitrous oxide were given during induction. Before intubation, the larynx was visualized by a laryngoscope and sprayed with a 10% lidocaine solution (Xylocaine 10% Spray, Astra Pharmaceuticals, Brussels, Belgium) to desensitize the larynx. Following tracheal intubation using a stylet (endotracheal tube 5.5 mm ID, Rüsch, Germany), anesthesia was maintained with isoflurane in 1 L/min of oxygen using a circle anesthetic system (Spiromat 656, Dräger, Lübeck, Germany) and a precision out-of-circuit vaporizer (quick lock system) (Vapor 19,3 , Dräger, Lübeck, Germany). The vaporizer setting was 1.0 vol% during maintenance of anesthesia. The respiration was spontaneous over the entire anesthetic period. An 18 gauge IV catheter (Vygon, Ecouen, France) was placed in the right jugular vein. Ringer lactate (Hartmann, Baxter, Lessen, Belgium) was infused at 10 ml/kg/h during anesthesia. Approxima-

tely 480 mL of ringer lactate was given over a period of 3 hours. Before surgery an epidural injection with 3 ml of bupivacain (Marcaine 0.5% , Astra Pharmaceuticals, Brussels, Belgium) at the lumbosacral space was given. The area was clipped and aseptically prepared for injection. The epidural injection was performed to provide sufficient analgesia of the hind limbs. A 22 G epidural needle (Yale Spinal, Becton-Dickinson, 0.7 x 90 mm) was used.

Anesthetic monitoring

Monitoring included a calibrated (Quick Cal Calibration Gas, Datex-Ohmeda Corp., Helsinki, Finland) multi-anesthetic gas analyzer (Capnomac Ultima , Datex Engstrom Instrumentation Corp., Helsinki, Finland) for determination of the following parameters: inspiratory and end tidal anesthetic agent concentration (FiAA % and ETAA %), inspiratory oxygen fraction (FiO$_2$), end tidal CO$_2$ concentration (ET CO$_2$ %) and respiratory rate (RR). Gas samples were taken at the Y-part (Straight Adapter®, Datex-Engstrom Instrumentarium Corp., Helsinki, Finland) with a rate of 200 mL/min and were returned to the anesthetic circuit. Tidal volume (TV) was monitored with a respirometer (Volumeter , Dräger, Lübeck, Germany). Heart rate (HR) and peripheral hemoglobin saturation (SpO$_2$%) were monitored continuously using a pulse oximeter (N-20PA Portable Pulse Oximeter , Nellcor Puritan Bennett Inc., Pleasanton, CA, U.S.A.) with the probe placed on the tongue. Heart rate and sinus rhythm were monitored by electrocardiogram (ECG) (78352A, Hewlett Packard, Brussels, Belgium). Corneal and eyelid reflexes were evaluated every 15 minutes during anesthesia.

Anesthetic findings

The measured physiologic variables were within acceptable ranges throughout the 3 hours of anesthesia, except for an initial higher RR (range: 100 to 160 breaths per minute) during the first 30 minutes of anesthesia preceding surgical intervention. This hyperventilation was accompanied by lower ET CO$_2$ values (range: 1.5 to 4%). In the following anesthetic period, RR and ET CO$_2$ % stabilized between 56 and 62 breaths/minute and 4.6 and 5.2%, respectively. The initial hyperventilation was characterized by low tidal volumes; later, the tidal volume varied between 70 and 90 ml. HR varied between 62 and 78 beats/minute (88 beats/minute pre-operatively). SpO$_2$% remained between 97 and 100%. Cardiac arrhythmias were not

observed. Fifteen minutes after mask induction, the difference between the FiAA % (1.2%) and the ETAA % (1.0 - 1.1%) was stable until the vaporizer was switched off. The eyelid reflex was negative and the corneal reflex positive, being accompanied by ventrally rotated eyeballs during maintenance of anesthesia.

Recovery

Recovery from anesthesia was rapid, complete and uneventful. Atipamezole (Antisedan , Pfizer Animal Health, Louvain-la-Neuve, Belgium) was administered intravenously at a dosage of 6.25 µg/kg. Post-operative analgesia was provided by the epidural injection of bupivacain and by carprofen being given pre-operatively and repeated every 24 hours for 5 days at a dosage of 4 mg/kg subcutaneously. Antibiotics (sodium-ceftiofur 1 mg/kg IM, Excenel®, Pharmacia & Upjohn, Puurs, Belgium) were administered for a period of 5 days to prevent wound infection. The antelope was placed on and covered with a heating pad during surgery, except for the end of the anesthetic period during the radiological control. In spite of these measures, the rectal temperature at the onset of recovery was 35.6°C. An IR heating source was placed at approximately 70 cm above the antelope and its temperature returned to normal after 5 hours. Because of the fracture and external transfixation, the animal was placed in a small box (length: 150 cm, height: 120 cm and width: 90 cm) to limit its movements. To prevent decubital wounds, the recovery box was stuffed with straw.

DISCUSSION

Artiodactyla, like all wild animals, are a challenge to restrain without causing injuries both to handler and animal. It must be emphasized that these animals can barely tolerate manual restraint and that handling is a very stressful situation for them. Therefore chemical immobilization is often inevitable for painful procedures. Anesthesia with profound analgesia and adequate muscle relaxation is absolutely mandatory for surgical procedures. The choice of the anesthetic technique depends on the kind of surgical intervention. In our case, inhalation anesthesia following premedication and in combination with epidural analgesia was chosen.

Food and water was withheld 12 hours before surgery. Fasting and water deprivation should decrease the likelihood of tympany and regurgitation by decreasing the volume of fermentable ingesta. Additionally, pulmo-

nary functional residual capacity may be better preserved in the fasted anesthetized ruminant (Tranquilli, 1986). After the antelope was manually restrained, premedication with xylazine, methadone and atropine was given intramuscularly. During this time, the environment was kept as quiet as possible and the animal was approached without excessive noise from movement or equipment. The use of alpha2-agonists such as xylazine for immobilization is described in artiodactyla (Pearce and Kock, 1989; Foster, 1999; Citino *et al.*, 2001; Grobler *et al.*, 2001; Citino *et al.*, 2002). Alpha2-adrenergic agonists are potent central nervous system depressants with sedative, muscle relaxant, and some analgesic properties (Nielsen, 1996). Given alone, xylazine does not produce reliable immobilization. Its effectiveness is decreased in excited or stressed animals (Caulkett, 2002). Xylazine may induce a recumbent sleep-like or anesthetic state. However, stimulation may cause rapid arousal with defense responses intact (Nielsen, 1996). Therefore, not only is methadone (a µ-agonist with a similar effect as morphine) given to provide analgesia, but opioids are often combined with a sedative such as xylazine to produce a deep sedation (Nolan, 2000). Atropine was mainly added to counteract the potential bradycardia induced by the combination of an opioid and an alpha2-agonist. Anticholinergic agents consistently fail to prevent salivary secretion unless used in high doses and repeated frequently, since ruminants have high levels of atropinase (Riebold, 1996 and 2002). Anticholinergics make salivary and bronchial secretions more viscous and difficult to clear from the trachea.

Induction of anesthesia was achieved by mask induction with isoflurane. Endotracheal intubation was done to prevent the inhalation of regurgitated ruminal content and to provide a secure airway. Maintenance of anesthesia could be achieved with only low doses of isoflurane in oxygen, because a lumbosacral epidural injection for additional analgesia was given before surgery. Puncture of the lumbosacral space for epidural administration is described in ruminants (Nelson *et al.*, 1979; Lewis *et al.*, 1999; Aithal *et al.*, 2001; Amarpal *et al.*, 2002). Bupivacaine was chosen to ensure good muscle relaxation and analgesia during surgery. Bupivacaine has a rather slow onset of motor block, but due to its high protein binding capacity, the duration of the block is long (3-6 hours) (Dobromylskyi *et al.*, 2000). The motor block of the hind limbs caused no problems in the early recovery period because the antelope was placed in a small box stuffed with straw. Moreover, it was not able to stand up the first 24 hours after surgery due to the external fixation of tibia and tarsus.

Cardiopulmonary parameters remained in normal ranges during anesthesia, except for a short period of hyperventilation immediately after the induction of anesthesia. This was probably caused by an inadequate level of anesthesia shortly after induction. Immediately after intubation, the surgical area was clipped and prepared for surgery. The epidural analgesia technique was not yet working, since bupivacaine has a slow onset of action. Neither bradycardia nor hypoventilation were observed during anesthesia. Thirty minutes after induction, the anesthesia level was stable, probably due to the multimodal anesthetic technique.

Sedation following the use of alpha2-agonists can be reversed with an alpha2-antagonist. A very small dose of atipamezole, a potent and selective alpha2-antagonist, was effective. Only low doses are required for reversal of the sedative effects of xylazine in ruminants (Thompson *et al.*, 1991; Ancrenaz, 1994). Recovery was fast and without excitation, despite the very low dosage of atipamezole. Low dosing was effective due to the weaning sedative effect of xylazine several hours after premedication. The endotracheal tube was left in place until the animal was able to assume sternal recumbency.

Post-operative analgesia for 5 days with carprofen was sufficient. Carprofen is a NSAID with little inhibitory effect on cyclo-oxygenase (COX) enzymes at therapeutic doses, yet with good anti-inflammatory activity (Delatour *et al.*, 1996). Due to carprofen's minimal effect on the COX cascade system, less toxic side-effects such as gastric ulceration, increased bleeding and decreased renal perfusion are encountered, and it is for this reason that carprofen has been licensed for preoperative use (Nolan, 2000). Besides its use as a pre-emptive analgesic agent, carprofen is also highly useful for controlling post-surgical orthopedic pain and its longer duration of action in ruminants makes it very useful in clinical practice. (Welsh *et al.*, 1992; Lees *et al.*, 1996; Dobromylskyi *et al.*, 2000). The animal was able to stand up the day after surgery.

CONCLUSION

Inhalation anesthesia with 1 vol% isoflurane in oxygen after premedication with xylazine, methadone, atropine and carprofen resulted in stable cardiopulmonary values throughout anesthesia. The multimodal anesthetic protocol was characterized by adequate

muscle relaxation and analgesia levels, probably due to the epidural administration of bupivacaine at the lumbosacral space. The reversal of sedation with atipamezole at the end of surgery resulted in rapid and complete recovery. Postoperative analgesia was provided with carprofen.

This combined anesthesia technique with isoflurane and bupivacaine administered epidurally seemed a good choice for elective surgery on antelopes living in captivity.

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