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Clinical Report

Anesthesia in a giant armadillo (*Priodontes maximus*) for femoral fracture fixation

Matias Bassinello Stocco[1], Lianna Ghisi Gomes[1]*, Thais Oliveira Morgado[1], Sandra Helena Ramiro Corrêa[2], Luciana Dambrósio Guimarães[2], Roberto Lopes de Souza[2]

[1] Graduate Program in Veterinary Sciences, Faculty of Veterinary Medicine, Federal University of Mato Grosso, Cuiabá, Brazil.
[2] Faculty of Veterinary Medicine, Federal University of Mato Grosso, Cuiabá, Brazil.

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A B S T R A C T

An adult female armadillo (Priodontes maximus) weighing 32.4 kg was admitted to the Veterinary Hospital of the Federal University of Mato Grosso (HOVET-UFMT) - Campus Cuiabá. Results of clinical and complementary examinations revealed a complete oblique fracture of the middle third of the femur. As a pre-anesthetic regimen, a combination of ketamine (10 mg/kg) and midazolam (0.2 mg/kg) was administered, and analgesic support with morphine (0.5 mg/kg) and dipyrone (25 mg/kg) was provided. This was followed by induction of anesthesia through a facial mask and its maintenance with sevoflurane diluted in 100% oxygen by means of a calibrated vaporizer. The anesthetic system used was suitable for the weight of the animal; the animal breathed spontaneously. During the procedure, the animal had stable cardiovascular and respiratory parameters, and had a fast and satisfactory recovery.

INTRODUCTION

Priodontes maximus is the largest armadillo species, weighing up to 60 kg and measuring 1 m in length (CARTER; SUPERINA; JUNIOR, 2016). Despite being widely distributed in the national territory, it is vulnerable due to hunting and deforestation. It is also besides being a little-studied mammal due to the difficulty of its observation in its natural habitat (PORFIRIO et al., 2012).

In view of the number of incidents that occur with wild animals, the difficulty encountered by professionals in obtaining data regarding anesthesia, and the absence of descriptions of anesthetic procedures in armadillo in the literature, we were motivated to report a case of general inhalation anesthesia in an animal of this species undergoing fixation of a complete oblique fracture of the middle third of the femur.

CASE REPORT

The State Environmental Department (SEMA) of the Municipality of Tangará da Serra - Mato Grosso (MT) referred a female, adult armadillo weighing 32.4 kg with suspected trampling to the Veterinary Hospital of the Federal University of Mato Grosso (HOVET-UFMT) - Campus Cuiabá. Normal nutritional status was observed during the clinical examination. The animal was in the lateral position and apathetic, and it was estimated to have moderate dehydration. It had a capillary refill time (CRT) of 3 seconds, pale mucosa, normothermia, heart rate (HR) of 128 beats per minute (bpm), and respiratory rate (RR) of 32 moments per minute (mpm). In addition, excoriations of the skin and increase in the volume of the left pelvic limb were observed. The radiographic examination of the left pelvic limb was performed in the dorso-ventral, cranio-caudal and mid-lateral positions, and a complete oblique fracture was found in the middle third of the femur. The following

* Corresponding author: liannaghisi@gmail.com

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tests were also done: complete blood count and biochemical profile (urea, creatinine, albumin, alanine aminotransferase [ALT], and alkaline phosphatase [ALP]).

The results of investigations were as follows: erythrocytes count, 1.7 X 10^6/mm^3, hemoglobin level, 5.3 g/dL; hematocrit, 18.0%; mean corpuscular volume (MCV), 83.7 μ^3; mean corpuscular hemoglobin concentration (MCHC), 35.6 g/dL; fibrinogen level 800 mg/dL; leukocytes count, 15.5 x 10^3/mm^3; neutrophils count, 11.6 x 10^3/mm^3; eosinophils count, 0.3 x 10^3/mm^3; basophils count, 0.2 x 10^3/mm^3; lymphocytes count 3.3 x 10^3/mm^3; monocytes count, 0.2 x 10^3/mm^3; platelets count, 192 x 10^3/mm^3; total plasma proteins (TPP) level, 6.8 g/dL; urea, 193 mg/dL; creatinine, 3.3 mg/dL; albumin 1.5 g/dL; ALT, 135 IU/L; and ALP, 63 IU/L. After the diagnosis, the animal was hospitalized for stabilization before the anesthetic-surgical procedure.

The animal was fasted for 12 hours and allowed water intake for 3 hours. After the routine pre-anesthetic physical examination and evaluation of the laboratory tests, it was classified as ASA III according to the American Society of Anesthesiology (ASA) classification. The preanesthetic medication (MPA) consisted of a combination of ketamine (Quetamina Injetável Vetnil® 10 g/100 mL, Vetnil - Indústria e Comércio de Produtos Veterinários Ltda., SP, Brazil) (10 mg/kg) and midazolam (Midazolam 15mg/3mL, União Química – Farmacêutica Nacional S/A, SP, Brazil) (0.2 mg/kg) and analgesic support with morphine (Dimorf® 10 mg/mL, Cristália – Produtos Químicos e Farmacêuticos Ltda., SP, Brazil) (0.5 mg/kg) and dipyrone (Algivet® 0.5 g/mL, Vetnil – Indústria e Comércio de Produtos Veterinários Ltda., SP, Brazil) (25 mg/kg). All drugs were administered intramuscularly (IM).

After waiting for 20 minutes, trichotomy of the surgical field was performed, and subcutaneous administration of fluid therapy with Ringer's lactate (Ringer com Lactato 500 ml, Equiplex, GO, Brazil) (20 mL/kg/h) (FALZONE et al., 2013) was inititated. Enrofloxacin (Zelotril® 10%, Agener União – Saúde Animal, SP, Brazil) (10 mg/kg) and cephalothin (Kefalomax® 200 mg/mL, BioQuimico, RJ, Brasil) (20 mg/kg) were administered as IM antibiotics prophylaxis. Anesthesia was induced through a face mask with 5 vol% sevoflurane (Sevoflurano 1 mg/ml, Sevocris, Cristália – Produtos Químicos Farmacêuticos Ltda., SP, Brazil), followed by maintenance with an average volume of 2.3 vol%. The needed anesthetic depth (plane II of the 3rd stage of general anesthesia) was maintained based on the evaluation of the clinical parameters proposed by Guedel (NATALINI, 2007). Sevoflurane diluted in 100% oxygen was administered through a calibrated vaporizer (Calibrated Vaporizer, HB Hospitalar, São Paulo, Brazil) and an anesthetic system with oxygen flow rate at 40 mL/kg/min. The animal maintained spontaneous breathing. Throughout the procedure, the animal was kept in the right lateral position under a thermal mattress to maintain body temperature.

Cardiorespiratory variables were monitored with the aid of a multiparameter monitor (Patient Monitor, Model: PM 9000 Express, Shenzhen Mindray Bio-Medical Electronics CO., Ltd, Shenzhen, China) and recorded every 10 minutes. The first recording (M0) was done immediately after the induction of anesthesia, and the subsequent recordings (M10, M20, M30, M40, M50, M60, M70, M80, M90, M100, and M110) were made every 10 minutes after the preceding recording throughout the anesthetic-surgical procedure. A capnography sensor was attached at the end of the facial mask to measure expired CO_2 concentration ($EtCO_2$) and RR. The pulse oximetry sensor was positioned in the ear to measure hemoglobin oxygen saturation ($SatO_2$). The digital clinical thermometer was used to measure the body temperature (T °C) by the rectal route. Electrodes were used for the monitoring of the HR in the DII derivation (Table 1). The procedure lasted 110 minutes (Figure 1), and approximately 20 minutes after the end of the anesthesia, the patient began to recover in a gradual, quiet, and excitement-free manner, starting with the head and limb movements. Total recovery occurred at 1 hour and 40 minutes after the end of the anesthesia.

Table 1 – Values of cardiorespiratory variables observed: heart rate (HR), respiratory rate (RR), body temperature (T°C), hemoglobin oxygen saturation ($SatO_2$) and carbon dioxide partial pressure ($ETCO_2$) observed in the anesthetized armadillo (*Priodontes maximus*) undergoing osteosynthesis of a complete oblique fracture of the middle third of the femur under sevoflurane anesthesia.

	M0	M10	M20	M30	M40	M50	M60	M70	M80	M90	M100	M110
HR (bpm)	95	98	95	95	100	92	95	95	95	100	95	95
RR (mpm)	45	25	20	20	20	20	30	30	25	25	35	35
T (ºC)	35,2	34,3	34,0	34,9	35,2	35,1	35,1	35,0	34,7	35,0	35,0	35,0
$SatO_2$(%)	99	100	99	99	99	99	99	100	100	99	99	99
$EtCO_2$	38	35	38	40	45	45	40	38	44	35	35	35

M0: moment evaluated immediately after induction; and M10, M20, M30, M40, M50, M60, M70, M80, M90, m100 and M110: moments evaluated in the trans-anesthetic with a 10 minute interval between each evaluation until the end of the surgical procedure.

Figure 1 – The anesthetized armadillo (*Priodontes maximus*) after surgery to fix the complete oblique fracture of the middle third of the femur.

Source: author's collection.

DISCUSSION

According to the findings of the physical examination and the analysis of the laboratory results, we classified this animal in ASA III. This is because, according to Souza; Dalpino; Costa (1987) and Souza et al. (1987), the hematological and biochemical values were abnormal for a Xenarthra. When we associated these values with the evaluation of the general state of the patient, we determined it fitted in this ASA class. The difficulty of venous catheterization prior to the surgical procedure made it necessary to administer fluid therapy through the SC route. Although, according to Natalini (2007) and Falzone et al. (2013), this route is not indicated route for patients who undergo anesthetic-surgical procedures, this maneuver was indispensable for the procedure.

Different sedatives protocols are found in the literature for the chemical containment of several species of armadillos, as described by West et al. (2007), Miranda et al. (2010), Falzone et al. (2013), Souza et al. (2016) and Gasparotto et al. (2017). Drugs chosen for MPA are widely recommended for immobilization of wild animals, and doses of 10 mg/kg and 0.2 mg/kg for ketamine and midazolam, respectively, were adopted from a study by Miranda et al. (2010), which promote adequate chemical containment, allowing the manipulation of this animal without major interferences. However, there are already reports of using lower doses of these drugs in this species (WEST et al., 2007).

Falzone et al. (2013) performed the sedation of three armadillos (*Priodontes maximus*); they supplemented the containment with inhalation anesthesia with isoflurane, administered through a face mask, using a volume of 2.5% supplied according to the need of anesthetic depth, as was done in this case. However, the drug of choice for induction and maintenance of anesthesia is sevoflurane by extrapolating from the data obtained from domestic animals as there are no reports of the use of this drug in Xenarthras. This anesthetic agent was chosen because it has a very low blood-gas solubility coefficient, as described by Kazama; Ikeda (1988), promoting a faster recovery of the patient, as observed at the end of the procedure.

Gasparotto et al. (2017) observed that the total recovery time is an average of 2.5 ± 0.5 hours after dissociative anesthesia. Falzone et al. (2013) have already used reversal agents at the end of the anesthetic procedure in *Priodontes maximus*, observing a recovery within only 5 minutes after the administration of naltrexone (0.25 mg/kg) and yohimbine (0.125 mg/kg) intravenously. Despite the non-use of reversal drugs in this case, we observed the beginning of the anesthetic recovery in 20 minutes, and the total recovery time was approximately 1 hour and 40 minutes. It occurred in a fast, gradual, quiet, and excitation-free manner. We believe this happened due to the choice of the anesthetic protocol.

During the whole anesthetic procedure, the values of the analyzed variables remained close to the values known for xenarthras (FOURNIER-CHAMBRILLON et al., 2000;

WEST et al., 2007). This corroborates with the data obtained in the chemical containment of different species of armadillo by Fournier-Chambrillon et al. (2000), Falzone et al. (2013) and Gasparotto et al. (2017). They demonstrated that there was cardiorespiratory stability during the anesthetic-surgical procedure.

The T (°C) remained within the physiological limits recognized for the species, as reported by Gasparotto et al. (2017), despite that these animals are incomplete homeothermic (MACCARINI et al., 2015). During the anesthetic-surgical procedure, care was taken to maintain the optimum body temperature of this animal. There were no variations in this parameter, and consequently the maintenance of temperature did not negative influence the responses to surgical stimuli. In addition, it reduced the recovery time.

For the cardiovascular and respiratory variables, the data of RR, $EtCO_2$ and $SatO_2$ remained within the acceptable values for an anesthetic procedure, which suggests that there was no respiratory depression and hypoxemia. For the HR, we did not observe at any moment any change that we could identify as tachycardia or bradycardia; this was also observed by Fournier-Chambrillon et al. (2000). Owing to the difficulty of evaluation due to the lack of equipment to fit the anatomy of the species in question and the difficulty of arterial catheterization to evaluate the invasive pressure, the variables for systolic, diastolic and mean arterial pressures were not measured during the procedure.

It is important to say that there is difficulty in using regional anesthetic blocks due to the morphology of the animal and the necessity of its use due to the surgical and local fracture procedure. The use of balanced anesthesia protocols, as described by Tonner (2005), despite this, the observed values of the cardiovascular and respiratory variables suggest that the analgesic protocol was effective for the procedure.

CONCLUSIONS

Therefore, we conclude that there was stability of the cardiovascular and respiratory variables since there were no changes observed in the values analyzed during the anesthetic-surgical period. In addition, the recovery was of rapid onset, gradual, quiet, and free of excitation. We therefore suggest that this protocol can be used to promote adequate anesthesia and analgesia for surgical procedures in armadillos.

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