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CASE REPORT
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Balanced Anesthesia with Paravertebral Brachial Plexus Block in Maned Sloth (*Bradypus torquatus*)

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ABSTRACT

***Background*:** Maned sloths are docile mammals endemic to the Brazilian Atlantic Forest, threatened with extinction due to the degradation of their habitat. Injury involving limbs is common when animals enter the urban environment. However, information regarding anesthesia in sloths is still scarce. This case is intended to report the anesthetic management of a maned three-toed sloth adult female undergoing amputation of the forelimb.

***Case*:** A female maned three-toed sloth weighing 4.2 kg with a history of burns to the thoracic forearm caused by electric shock was admitted by the University Veterinary Hospital. Ketamine (6 mg/kg - IM) and midazolam (0.2 mg/kg - IM) were administered as premedication, and after 10 min, tramadol (2 mg/kg - IV) was used. After detecting good general condition, the animal was referred to the surgical center for forearm amputation. Anesthetic induction was performed using isoflurane 2.5% (FiO2 = 1.0) via a mask, followed by intubation and maintenance using the same drug (1.5% initial concentration). Next, the vertebrae C7 to C10 and T1 to T2 were identified, corresponding to the 7th, 8th, 9th, and 10th cervical medullary segments and the 1st and 2nd thoracic medullary segments, corresponding to the respective related spinal nerves, which give rise to the brachial plexus in the species. The vertebral foramen was accessed using a hypodermic needle inserted cranially and caudally to the transverse processes of C7, C8, C9, and C10 at a distance of 1 cm, laterally to the right of the animal's dorsal midline at a 45º angle to the vertebral column. The 1st rib palpated dorsally allowed T1 and T2 to be located, and the needle was inserted according to the delimitations already described. The brachial plexus was blocked with 0.5 mL of lidocaine solution (1.5%) into each intervertebral foramen. After 10 min, the animal underwent thoracic limb amputation. Heart rate (HR), respiratory rate (*f*), end-tidal carbon dioxide ($EtCO_2$), peripheral oxyhemoglobin saturation (SpO2), end-tidal isoflurane (EtISO) and rectal temperature (RT) were registered using a multiparametric monitor. The parameters recorded throughout the 50-min interval of the surgical procedure remained within the regular pattern of species. EtISO registered were 1.03 ± 0.19 mmHg. No movements were observed responding to pain stimuli, and the animal exhibited smooth recovery in 28 min.

***Discussion*:** Although limb trauma is a frequently reported condition, this study is a pioneer in the approach of using paravertebral brachial plexus block as part of the anesthetic protocol in sloths. Initially, a ketamine-midazolam combination was used to immobilize the animal for handling and preoperative clinical assessments. This combination of dissociative anesthetics with muscle relaxants has been widely used in anteaters and sloths, with physiological stability and smooth recovery reported. As thoracic limb amputation is a painful procedure, tramadol was used as an analgesic. Isoflurane was used for anesthesia maintenance, as reported in other studies with sloths. Brachial block using cervicothoracic access to the nerve roots that give rise to the brachial plexus was considered easy to perform. Lidocaine with vasoconstrictor was chosen based on the duration of the surgical procedure. Maintaining the sloth in a mild anesthetic plane associated with low isoflurane intraoperative requirement demonstrated the analgesic effectiveness of the locoregional block. The proposed anesthetic protocol was effective and safe, evidenced by stable physiological variables, no pain-related movements during surgery, and gentle animal awakening.

Keywords: xenarthra anesthesia, ketamine, isoflurane, locoregional anesthesia.

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INTRODUÇÃO

The sloth (*Bradypus torquatus*), endemic to the Atlantic Forest of eastern Brazil, is a species classified as vulnerable by the Red Book of Endangered Brazilian Fauna, due to its small geographical range and the devastated nature of its habitat [2,9,13,17]. In search of food, the sloth enters urban centers exposing itself to multiple dangers. High-voltage wires, used for transportation, are one of the main causes of accidents, causing violent shocks, burns, amputations and even death [14-16]. When injured, extensive surgical procedures are usually necessary and anesthesia represents a notable challenge, due to the scarcity of information and the metabolic particularities of the species [8,12]. Local anesthesia techniques are usually associated with general anesthesia protocols, to add safety and comfort to the patient [3]. The paravertebral brachial plexus block is used to desensitize the structures that make up the thoracic limb [10]. Reports of anesthetic procedures in sloths, especially with balanced techniques involving nerve blocks, are scarce and, when successful, contribute to the conservation of the species. This study aims to report the anesthetic management of a sloth that underwent amputation of its right thoracic limb due to severe tissue damage caused by electric shock.

CASE

An adult female sloth weighing 4.2 kg, collected from the urban area by veterinarians from the Wild Animal Screening Center (CETAS) in Salvador, Bahia, Brazil, was treated at the Veterinary University Hospital of the School of Veterinary Medicine and Zootechny of the Federal University of Bahia (UFBA). The preoperative physical assessment showed the animal to be active, and in good general condition, with a heart rate (HR) of 136 bpm and a respiratory rate (*f*) of 34 bpm.

The animal was pre-medicated with ketamine[1] [6 mg/kg - IM] and midazolam[1] [0.2 mg/kg - IM]. After 10 min, the cephalic vein was cannulated, and the animal was treated with tramadol hydrochloride[2] [2 mg/kg, IV]. Subsequently, the sloth received fluid therapy with Ringer's lactate solution[3] [10 mL/kg/h] and underwent trichotomy of the cervicothoracic region. After 30 min of premedication and immediately after the 1st spontaneous movement, the animal was induced into anesthesia using isofluorane[1] [2.5%] in oxygen delivered by sealed nasal mask. Once loss of mandibular tone was detected, intubation was carried out using an orotracheal tube with a 2.5 cuff, and isoflurane anesthesia was maintained at an initial concentration of 1.5% (FiO2 = 1.0), in a circuit without gas recirculation. The animal was placed in the left lateral decubitus position under an active thermal mattress and the room temperature was maintained at 25°C.

Next, after antisepsis of the cervicothoracic region with Iodopovidone solution[4], the vertebrae C7 to C10 and T1 to T2 were identified by palpation, corresponding to the 7th, 8th, 9th and 10th cervical medullary segments and the 1st and 2nd thoracic medullary segments, which correspond to the respective related spinal nerves, which give rise to the brachial plexus in the species [4]. The intervertebral foramen was accessed using a 25 x 7 mm hypodermic needle[5] inserted cranially and caudally to the transverse processes of C7, C8, C9 and C10 at a distance of one centimeter, laterally to the animal's dorsal midline, at a 45º angle to the vertebral column. The first dorsally palpated rib allowed T1 and T2 to be located, and the needle was inserted according to the delimitations already described. The paravertebral brachial plexus block was performed with 0.5 mL of 1.5% lidocaine [2.2 mL of 2% lidocaine diluted in 0.9% NaCl to a final volume of 3.0 mL] in each intervertebral foramen (Figure 1).

After 10 min, the surgical procedure to amputate the right thoracic limb began. Throughout the procedure, adjustments were made to the concentration of isoflurane provided to ensure a mild anesthetic plan characterized by satisfactory muscle relaxation, absence of movement associated with painful stimuli, and the presence of an interdigital reflex in the contralateral

Figure 1. Paravertebral brachial plexus block in a sloth (*Bradypus torquatus*) based on anatomical references.

Figure 2. Sloth (*Bradypus torquatus*) recovering after amputation of the right thoracic limb.

thoracic limb. The procedure took 50 min, and there were no trans operative complications. The means and standard deviations of cardiorespiratory parameters recorded with a multiparameter monitor[6] at 5-min intervals during surgery were: HR (79.6 ± 4.76 bpm); *f* (7.22 ± 2.43 bpm); rectal temperature (RT; 33.9 ± 0.25°C), peripheral oxyhemoglobin saturation (SpO2; 92 ± 0.87%), end-tidal carbon dioxide concentration (EtCO2; 42.3 ± 2.8 mmHg), and end-tidal isofluorane concentration (EtISO;1.03 ± 0.19 mmHg). The sloth recovered from anesthesia without signs of pain or agitation (Figure 2). The time required for the animal to stand up was 28 min. The animal was then sent for follow-up and postoperative care.

DISCUSSION

To the best of the authors' efforts, we found no data in the literature on the approach, technique, safety, or efficacy of paravertebral brachial plexus block in sloths. As such, this report is a pioneer in these aspects, as well as adding important information in the field of anesthesia in xenarthran mammals.

Regarding the choice of drugs, we initially opted to use a ketamine-midazolam combination to immobilize the animal for handling and preoperative clinical assessments. Dissociative anesthetics associated with muscle relaxants are widely used in anteaters and sloths promoting physiological stability and smooth recovery reported [8,12,18]. In sloths, the recommended doses of ketamine and midazolam vary between 2 and 20 mg/kg and 0.22 and 0.42 mg/kg, respectively [5]. In fact, the doses used allowed the animal to be immobilized and manipulated, with the effect lasting approximately 30 min until spontaneous movement began, ruling out adverse events.

Since thoracic limb amputation is an intensely painful procedure, it was decided to use tramadol as an analgesic. In a recent report, the use of tramadol, at the same dose, was considered safe as part of the clinical and surgical approach protocol for a golden sloth (*Choloepus didactylus*) that was also a victim of electric shock [1]. After 30 min of dissociative administration, the animal was induced into anesthesia with isoflurane. Isoflurane or other inhalant anesthetics are commonly used with a mask to induce and maintain anesthesia in captive sloths with reference concentrations between 2.0 and 3.5% in animals of the same order [5,11].

Axillary brachial plexus block for digit amputation in a common sloth (*Bradypus variegatus*) was described with the aid of a neurostimulator and vascular Doppler, using the axillary artery as a reference, to achieve desensitization distal to the scapulohumeral joint [6]. On that occasion, the authors used a combination of lidocaine 2% (4 mg/kg) and bupivacaine 0.5% (1 mg/kg) and reported 5 h of motor blockade. However, in the report in question, there was a need for a higher level of blockade involving the scapular region. To this end, the decision was made to use only lidocaine with vasoconstrictor (9 mg/kg), given that the duration of the surgical procedure was estimated at a maximum of 60 min. Cervicothoracic access to the nerve roots that give rise to the brachial plexus, following the anatomical description [4], was considered easy to perform.

During the surgical procedure, the animal was kept under light anesthesia, with preservation of the interdigital reflex in the left thoracic limb under anesthesia with isofluorane at an average expired concentration of 1.03 ± 0.19 mmHg. Since the literature states that concentrations above 2.0% are adequate for maintaining a surgical anesthesia plan in xenarthrans [5,11], the animal was continuously monitored in order to detect a sympathetic response or any type of motor response related to the pain stimulus that would justify analgesic supplementation.

In this context, parametric recordings within the normal ranges expected for the species revealed cardiorespiratory stability [5]. In anesthetized sloths, HR between 48 and 108 bpm and *f* of 8.6 ± 5.3 bpm were reported in awake sloths kept at an ambient temperature of 26°C [7]. Under anesthesia with ketamine and medetomidine, averages between 62.1 and 68.7 bpm and between 7.7 and 9.3 bpm were found for HR and *f*, respectively, in common sloths (*Bradypus variegatus*) [8]. The mean SpO2 and EtCO2 recorded allow the exclusion of hypoxemic episodes or intraoperative respiratory depression. In 2 collared sloths under dissociative anesthesia, initial oxygen saturation was generally in the upper 80%, and gradually increased to the mid 90% during anesthesia [18]. Data on sloths in captivity at the Smithsonian National Zoological Park show relatively stable oxygen saturation levels, generally in the low 90% during anesthesia [5]. In general, information on the ventilatory parameters of sloths are limited. In two-toed Hoffmann's sloths (*Choloepus hoffmanni*) and three-toed brown-throated sloths (*Bradypus variegatus*) immobilized with dexmedetomidine and ketamine, the mean partial pressures of carbon dioxide were 44.5 ± 5.1 mmHg and 50.6 ± 10.2 mmHg, respectively. However, it is not possible to draw general conclusions about overall ventilation from this study, as it was not possible to obtain reliable arterial blood samples, which more accurately and completely assess respiratory function, for blood gas analysis [12].

Based on the above, this report provides innovative information on anesthesia in sloths, especially for victimized animals that require a surgical procedure on the thoracic limb. Paravertebral brachial plexus block as part of multimodal anesthesia allowed the sloth to be kept in a light anesthetic plane and ensured physiological stability, with no signs of pain. The animal's brief and smooth post-operative recovery confirms the safety and effectiveness of the proposed protocol.

MANUFACTURERS

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Declaration of interest. The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

REFERENCES

1 **Almeida D.D.V.C., Albuquerque Lopes C.T., Magalhães-Matos P.C., Pereira Jr. J.J., Imbeloni A.A. & Domingues S.F.S. 2022.** Electrocution in a Sloth (*Choloepus didactylus*) - Clinical and Surgical Approach. *Acta Scientiae Veterinariae*. 50(1): 830. DOI: 10.22456/1679-9216.122849.

2 **Chiarello A., Santos P. Moraes-Barros N. & Miranda F. 2022.** *Bradypus torquatus*. The IUCN Red List of Threatened Species 2022: e.T3036A210442361. Available in: [https://dx.doi.org/10.2305/IUCN.UK.2022-2.RLTS.T3036A210442361.en.]

3 **Chinnadurai S.K., Strahl-Heldreth D., Fiorello C.V. & Harms C.A. 2016.** Best-practice guidelines for field-based surgery and anesthesia of free-ranging wildlife. I. Anesthesia and analgesia. *Journal of Wildlife Diseases*. 52(2): S14--S27. DOI: 10.7589/52.2S.S14.

4 **Cruz G.A., Adami M. & Oliveira V.L. 2013.** Características anatômicas do plexo braquial de bicho-preguiça-de-coleira (*Bradypus torquatus* Illiger, 1811). *Biotemas*. 26(3): 195-201. DOI: 10.5007/2175-7925.2013v26n3p195.

5 **Deem S.L. & Fiorello C.V. 2002.** Capture and Immobilization of Free-Ranging Edentates (9-Dec-2002). Available in: <https://www.ivis.org/library/zoological-restraint-and-anesthesia/capture-and-immobilization-of-free-ranging--edentates>.

6 **Futema F. & Campos M.A.R. 2017.** Anestesia locorregional. In: Cubas Z.S., Silva J.C.R. & Catão-Dias J.L. (Eds). *Tratado de Animais Selvagens: Medicina Veterinária*. 2.ed. São Paulo: Roca, pp.1864-1883.

7 **Gilmore D.P., Costa C.P. & Duarte D.P. 2000.** An update on the physiology of two-and three-toed sloths. *Brazilian Journal of Medical and Biological Research.* 33: 129-146. DOI: 10.1590/S0100-879X2000000200001.

8 **Hanley C.S., Siudak-Campfield J., Paul-Murphy J., Vaughan C., Ramirez O., Keuler N.S. & Sladky K.K. 2008.** Immobilization of free-ranging hoffmann's two-toed and brown-throated three-toed sloths using ketamine and medetomidine: a comparasion of physiologic parameters. *Journal of Wildlife Diseases*. 44(4): 938-945. DOI: 10.7589/0090-3558-44.4.938.

9 **Hirsch A. & Chiarello A.G. 2012.** The endangered maned sloth *Bradypus torquatus* of the Brazilian Atlantic forest: a review and update of geographical distribution and habitat preferences. *Mammal Review*. 42(1): 35-54. DOI: 10.1111/j.1365-2907.2011.00188.x.

10 **Imani Rastabi H., Sehat Kashani S., Masoumi P., Yazdaninia S. & Ghazi Mirsaeed S. M. 2019.** Brachial plexus block as a part of balanced anesthesia in a jungle cat (*Felis chaus*) undergoing forelimb orthopedic surgery. *Comparative Clinical Pathology*. 28: 1855-1857. DOI: 10.1007/s00580-019-03048-0.

11 **Knight F., Connor C., Venkataramanan R. & Asher R. 2020.** Body temperatures, life history, and skeletal morphology in the nine-banded armadillo (*Dasypus novemcinctus*) (Accepted version). *Peer Community in Ecology*. 1: 1-18. DOI: 10.17863/CAM.50971

12 **Kinney M.E., Cole G.A., Vaughan C. & Sladky K.K. 2013.** Physiologic and serum biochemistry values in free-ranging hoffmann's two-toed (*Choloepus hoffmanni*) and brown-throated three-toed (*Bradypus variegatus*) sloths immobilized using dexmedetomidine and ketamine. *Journal of Zoo and Wildlife Medicine*. 44(3): 570-580. DOI: 10.1638/2012-0040R1.1

13 **Lara-Ruiz P., Chiarello A.G. & Santos F.R. 2008.** Extreme population divergence and conservation implications for the rare endangered Atlantic Forest sloth, *Bradypus torquatus* (Pilosa: Bradypodidae). *Biological Conservation.* 141(5): 1332-1342. DOI: /10.1016/j.biocon.2008.03.002

14 **Lima D.A., Lima W.C., Rodrigues M.C., Quessada A.M., Santos K.M., Moura C.R., Magalhães C.S. & Sousa J.M. 2012.** Trauma elétrico em preguiça de vida livre: relato de caso. *Revista Portuguesa de Ciências Veterinárias*. 583-584(111): 199-202.

15 **Miranda F.R., Garbino G. S., Machado F. A., Perini F. A., Santos F. R. & Casali D. M. 2023.** Taxonomic revision of maned sloths, subgenus *Bradypus* (Scaeopus), Pilosa, Bradypodidae, with revalidation of *Bradypus crinitus* Gray, 1850. *Journal of Mammalogy*. 104(1): 86-103. DOI: 10.1093/jmammal/gyac059.

16 **Moraes-Barros N., Silva S.M., Summa J.L., Summa M.E., Geraldi V.C., Belluci M., Klefasz A. & Morgante J.S. 2014.** Contribution of wildlife governmental centers to conservation and biological study of sloths *Bradypus variegatus*. *Natureza & Conservação*. 12(1): 79-85. DOI: doi.org/10.4322/natcon.2014.014.

17 **Tourinho L., Sinervo B., Caetano G.H.D.O., Giné G.A.F., Santos C.C., Cruz-Neto A.P. & Vale M.M. 2022.** Integrating climate, ecophysiology, and forest cover to estimate the vulnerability of sloths to climate change. *Journal of Mammalogy*. 103(4): 755-766. DOI: 10.1093/jmammal/gyac043.

18 **Vogel I., De Thoisy B. & Vié J.C. 1998.** Comparison of injectable anesthetic combinations in free-ranging two-toed sloths in French Guiana. *Journal of Wildlife Diseases*. 34(3): 555-566. DOI: 10.7589/0090-3558-34.3.555.