*FULL ARTICLE*

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# Anesthetic protocol using propofol and isoflurane in spectacled bear (*Tremarctos ornatus*)

## *Protocolo anestésico com propofol e isoflurano em urso-de-óculos (*Tremarctos ornatus*)*

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**ABSTRACT**

The management of wild animals generally requires chemical containment with the use of sedatives, tranquilizers, general anesthetics or dissociative drugs. The spectacled bear (*Tremarctos ornatus*) is the only member of the family Ursidae characteristic of South America. There are few reports on the main anesthetic protocols used in this specie. The aim of the present study was to report the use of propofol and isoflurane in a captive spectacled bear, after sedation with tiletamine-zolazepam. A male bear approximately 15 years old and 264 lb (scale weight) underwent anesthesia for treatment of a recurrent ulcerated wound on the neck. A combination of tiletamine and zolazepam injected intramuscularly was initially used. Due to the need to prolong the anesthetic time, the decision was made to administer propofol 1% (4.0 mg/kg/IV), which proved satisfactory regarding the inhibition of eyelid and laryngotracheal reflexes, thereby facilitating tracheal intubation. The subsequent use of isoflurane provided adequate maintenance of anesthesia, with vital signs within the normal range for the species, but there was hyperthermia. Based on the present findings, the use of tiletamine/zolazepam, propofol and isoflurane proved satisfactory and the doses employed were safe for the spectacled bear (*Tremarctos ornatus*). Inhalation anesthesia was essential to prolonging the time and maintaining safety throughout the procedure.

**Keywords:** Bear. General anesthesia. Inhalation anesthesia. Zoo.

**RESUMO**

O manejo de animais silvestres geralmente requer contenção química com uso de sedativos, tranquilizantes, anestésicos gerais ou drogas dissociativas. O urso-de-óculos (*Tremarctos ornatus*) é o único membro da família Ursidae característico da América do Sul. Há poucos relatos sobre os principais protocolos anestésicos utilizados nessa espécie. O objetivo do presente estudo foi relatar o uso de propofol e isoflurano, após sedação com tiletamina-zolazepam, em um urso-de-óculos cativo. Um urso macho de aproximadamente 15 anos e 120 kg (peso da balança) foi submetido à anestesia para tratamento de uma ferida ulcerada recorrente no pescoço. Foi inicialmente utilizada uma combinação de tiletamina e zolazepam injetados por via intramuscular. Devido à necessidade de prolongar o tempo anestésico, optou-se por administrar propofol 1% (4,0 mg/kg/IV), que se mostrou satisfatório quanto à inibição dos reflexos palpebrais e laringotraqueais, facilitando a intubação traqueal. O uso subsequente de isoflurano proporcionou manutenção adequada da anestesia, com sinais vitais dentro da normalidade para a espécie. Com base nos presentes achados, o uso de tiletamina/zolazepam, propofol e isoflurano mostrou-se satisfatório e as doses empregadas foram seguras para o urso-de-óculos (*Tremarctos ornatus*). A anestesia inalatória foi essencial para prolongar o tempo e manter a segurança durante todo o procedimento.

**Palavras-chave:** Urso. Anestesia geral. Anestesia inalatória. Zoológico.

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## Introduction

The management of wild animals often requires the use of sedatives, tranquilizers, general anesthetics or dissociative drugs (Bush et al., 1980; Fahlman et al., 2010; Laricchiuta et al., 2008; Radandt, 2009) prior to clinical exams, surgery, medical treatment and movement between enclosures (Caulkett & Cattet, 2002). The aim of anesthetic procedures is to provide greater security for both the animal and handlers. Concern for the welfare of wild animals in captivity is a standard routine at zoos (Caulkett & Cattet, 2002; Radandt, 2009).

The spectacled bear (*Tremarctos ornatus*) is the only member of the family Ursidae in South America, where it inhabits mountainous regions of western Venezuela, Colombia, Ecuador, Peru and Bolivia (Kattan et al., 2004; von Hohendorff & Giacomini, 2006). This animal lives approximately 25 years old and reaches approximately 80 cm in height. Females weigh between 60 and 62 kg (133 and 136 lb) and males weigh between 140 and 175 kg (309 and 386 lb) (von Hohendorff & Giacomini, 2006). This species is threatened due to poaching and habitat loss throughout its area of distribution. It is currently categorized as vulnerable on the IUCN Red List (International Union for Conservation of Nature and Natural Resources, 2017) (Kattan et al., 2004; Sánchez-Mercado et al., 2008).

The use of dissociative anesthesia with zolazepam and tiletamine (ZT) is described to the immobilization of different species of bears, such as *Helarctos malayanus*, *Ursus americanus*, *Ursus arctos*, *Ailuropoda melanoleuca*, *Tremarctos ornatus*, *Melursus ursinus* and *Ursus thibetanus* (Bush et al., 1980; Caulkett & Cattet, 2002; Cattet et al, 2003; Fahlman et al., 2010; Garofalo et al., 2021; Laricchiuta et al., 2008; McEntire et al., 2020). This type of pharmacologic association is currently regarded as standard anesthesia for bears capture (Fahlman et al., 2010; Radandt, 2009). However, it has a prolonged recovery period due to the absence of antagonist drugs (Radandt, 2009). Midazolam has been used in association with different anesthetic protocols, including tiletamine-zolazepam, in bears with the aim of decreasing or preventing seizure activity (McEntire et al., 2020).

Due to limited informations about anesthetic protocols in *Tremarctos ornatus*, studies have recently been carried out in order to establish and identify combinations that are safe and that promote less cardiorespiratory alterations during chemical restraints in this species (Laricchiuta, et al., 2008; von Hohendorff & Giacomini, 2006). The main classes of drugs used in the anesthetic induction of these animals are benzodiazepines, alpha2 adrenergic agonists and dissociative anesthetics. Volatile and dissociative anesthesia have been used to maintain anesthesia in several species of bears (Garofalo et al., 2021; Laricchiuta, et al., 2008; McEntire et al., 2020; von Hohendorff & Giacomini, 2006). In many cases, the use of dissociative drugs in bears leads to hypoxia, which may result in the damage and the death of cells of the nervous system, as well as ischemia, myocardial infarction and multiple organ failure. Therefore, oxygen supply is often necessary during chemical containment (Laricchiuta et al., 2008).

Propofol is a general intravenous anesthetic with different chemical characteristics, with similar effects to barbiturates, used to produce sedation, as well to induce and maintain anesthetic procedures in domestic animals. However, little has been reported about its use in procedures in different bear species.

In prolonged procedures, the use of inhalatory anesthetic such as isofluorane preceded by the use of opioids such as carfentanil and ZT has demonstrated good safety in induction and maintenance, especially in captive Kodiak brown bears (*Ursus arctos middendorffi*).

The aim of the study is to report the use of propofol and isoflorane for the induction and maintenance of anesthesia in a captive spectacled bear (*Tremarctos ornatus*).

## Materials and Methods

A captive male spectacled bear (*Tremarctos ornatus*) approximately 15 years old and 264 Ib (scale weight) belonging to the Arruda Câmara Zoological Park in the city of João Pessoa (state of Paraíba, Brazil; 07° 05' 00" S and 34° 50' 00" W) was underwent anesthesia for treatment of a recurrent ulcerated wound located ventrally in the cervical region, measuring approximately 10 cm in diameter and containing fly larvae. Upon initial inspection, the animal was thin and exhibited agitated behavior.

During anesthesia for the treatment of the skin wound, a dental evaluation and blood collection were also performed. Pre-anesthesia was initiated with a combination of zolazepam (50 mg/ml) and tiletamine (50 mg/ml) (zoletil 100, Virbac SA DEC.V. Mexico, Guadalajara, Mexico) at a dose of 2.0 mg/kg (0.91 mg/lb) of body weight intramuscularly (IM), administered with the aid of a blowgun (Figure 1). After 15 minutes, a supplementary dose was required (1.0 mg/kg IM) (0.453 mg/lb), followed by the administration of midazolam (5.0 mg/ml) (Teuto, Goiás, Brazil) at a dose of 0.1 mg/kg (0.05 mg/lb) IM. After administering the second dose of tiletamine-zolazepam, the animal began to show muscle tremors and increased respiratory rate. Venipuncture was subsequently performed for fluid therapy with 0.9% saline solution (HalexIstar, Goiás, Brazil) at a volume of 20 ml/kg/h. Analgesia was promoted using meloxicam 2% (Maxican-Ourofino Animal Health, Sao Paulo, Brazil) at a dose of 0.1 mg/kg (0.05 mg/lb) injected subcutaneously. As it was just a chemical containment for the lesion evaluation, cleaning and collection of materials for exams, the manipulation of the wound was considered a pain of mild to moderate intensity, therefore, only the use of meloxicam was enough for the patient's analgesia.

During clinical evaluation, the need to increase the procedure time was noted. The decision was made to use inhalation anesthesia. Based on the protective reflection and develop chewing of the animal, the propofol 1% (Propovan-Cristália, Sao Paulo, Brazil) was administered slowly (4.0 mg/kg/IV) (1.81 mg/lb), followed by tracheal intubation using a number 12 cuffed tube (Solidor, Well Lead Medical co., Ltd, China) as shown in Figure 2. Maintenance of anesthesia was performed by using a portable inhalation anesthesia machine (Incotec; Espirito Santo, Brazil) in a circuit with rebreathing using a flexible corrugated trachea with a diameter of 22 mm, using isoflurane in 100% of free oxygen at a flow rate of 50 mL/kg/min as reported by Garofalo et al. (2021) , during two hours, monitored with the support of AxiumVet© software program (IMFtec, Sao Paulo, Brazil), which was also used to measure heart rate (HR), electrocardiogram (ECG), respiratory rate (RR), pulse oximetry ($SpO_2$%) and temperature (To) (Figure 3).

The cervical wound was cleaned, blood sample was collected and evaluation of the oral cavity. The animal had a smooth recovery from anesthesia, not being subjected to other chemical containment protocols besides this one.

Figure 1 – Chemical restraint dart containing tiletamine/zolazepam in spectacled bear (*Tremarctos ornatos*).

Figure 2 – Maintenance of inhalation anesthesia by tracheal intubation in spectacle bear (*Tremarctos ornatos*).

Figure 3 – Electrodes for monitoring vital signs during inhalation anesthesia in spectacled bear (*Tremarctos ornatos*).

## Results and Discussion

The combined use of zolazepam and tiletamine (ZT) as an anesthetic agent for chemical restraint proved to be adequated and safe for the procedure in question (Caulkett & Arnemo, 2015). The supplementation of the dose was necessary due to either under-dosage (2.0 mg/kg) or the underestimation of body weight. The option to use a dosage lower than one cited by Bush et al. (1980) and von Hohendorff & Giacomini (2006) was based on the clinical status of the animal, its age and the fact that it has not been feeding for a several days. However, lower doses may be used when combined or not with other drugs (ex: alpha-2 adrenergic agonists) (Fahlman et al., 2010; Laricchiuta et al., 2008).

In the case reported here, only wound cleaning, evaluation of the oral cavity and collection of biological material were carried out. Therefore, the use of meloxicam and the combination of tiletamine-zolazepam was sufficient to promote analgesia.

The muscle tremors and tachypnea exhibited by the animal are commonly observed in bears anesthetized with ZT ( Caulkett & Arnemo, 2017; von hohendorff & Giacomini, 2006). The occurrence of tremors is reported even in bears anesthetized with other dissociative anesthetics such as ketamine (Cattet et al., 1997, 1999). The use of midazolam for remission of develop chewing and muscle tremors is due to its greater affinity for benzodiazepine receptors, its better sedative effect, its lesser irritating effect when administered intramuscularly and its minimal cardiorespiratory effects in comparison to diazepam (Lemke, 2007; Tranquilli et al., 2007). However, the latter one remains the drug of choice in such cases (von Hohendorff & Giacomini, 2006).

The use of the blowgun was effective, practical and safe for the administration of the anesthetic drugs. The choice of the most adequate technique for each species of bear is extremely important (Caulkett & Cattet, 2002; von Hohendorff & Giacomini, 2006). However, a pneumatic gun achieves the best results for chemical containment using dissociative anesthesia in free-living bears (Bush et al., 1980; Cattet et al., 2003; Caulkett & Cattet, 1997; Fahlman et al., 2010; Radandt, 2009; Stirlingt et al., 1989). Although, when it comes down to not compromise the trust between bears and their keepers, the option has been to make oral administration of honey associated with synthetic opioids such as carfentanil for anesthetic induction in the Kodiak brown bear (Mama et al., 2000).

The administration of propofol 1% as an agent for anesthetic induction in a spectacled bear (*Tremarctos ornatus*) in a dose of 4.0 mg/kg, proved to be satisfactory regarding to inhibition of eyelid and laryngotracheal reflexes, which are not abolished by using ZT, thereby, facilitating orotracheal intubation (Caulkett & Cattet, 2002). The general anesthetic propofol is not very much studied in this or other bear species. However McEntire et al. (2020) reported that in 146 anesthetic procedures performed in three species of bears including the spectacled bear, the maintenance of the anesthesia, in most cases, was completed with isoflurane e ketamine and in just three cases propofol was used, given as an intravenous bolus. Garofalo et al. (2021) used a dose of 2.0 mg/kg of propofol for anesthetic induction in a spectacled bear premedicated with tiletamine-zolazepam (3.8 mg/kg) and dexmedetomidine (6.4 µg/kg).

The use of isoflurane provided adequate maintenance of anesthesia (Mama et al., 2000), with vital signs in the normality range for the species during the two hours of the surgical procedure (mean HR = 112 beats per minute; RR = 18 breaths per minute; $SpO_2$ = 98%). In the study described by McEntire et al. (2020), the heart rate greater than 120 bpm was considered tachycardia; the heart rate less than 70 bpm was considered bradycardia; and hypoxemia when SpO2 less than 95%. Inhalation anesthesia with isoflurane is rarely reported or it is little used in bears, whereas halogenated compounds, such as halothane, has been reported after the use of ZT (Bush et al., 1980) and it is also indicated for dental procedures (von Hohendorff & Giacomini, 2006).

Heart rate and pulse pattern remained constant throughout the period in which the animal remained intubated, demonstrating sinus rhythm. Spectacled bears anesthetized with ZT generally exhibit heart rate and pulse pattern lower (Bush et al., 1980; Cattet et al., 2003; Laricchiuta et al., 2008) than the values founded in the present study. This difference is most likely due to the lower dose used for the initial chemical containment.

The average rate of $SpO_2$ was 98% throughout the two hours procedure and it was maintained by the delivery flow rate of 50 mL/kg/min of $O_2$. Pulse oximetry values, in particular, have been inconsistent in bears under different anesthetic protocols. Ideally, arterial catheterization and blood gas analysis would be the direct methods used to monitor blood pressure and oxygen saturation (McEntire et al., 2020). The supply of oxygen and accurate measurement of SpO2 in anesthesia using ZT in bears is extremely important, as these species can often present hyperthermia during anesthetic procedures, resulting in increased oxygen consumption and tissue hypoxia, in addition to the supply of oxygen protecting the brain against hyperthermic damage. Fahlman et al., 2010, have recommended O2 support through an intranasal tube to avoid tissue hypoxia promoted by the use of dissociative anesthetics, such as ZT, in bears, when they will not be submitted to orotracheal intubation.

The body temperature was maintained at 40.5 °C throughout the procedure. However, ice packs were used in the axillary and nape regions to maintain the body temperature in acceptable limits for the species (41°C) (von Hohendorff & Giacomini, 2006). This procedure was necessary, because bears are susceptible to hyperthermia due to the large amount of fat reserves in the subcutaneous layer, which makes body heat dissipation difficult (von Hohendorff & Giacomini, 2006).

## Conclusion

Based on our findings, the use of premedication with tiletamine/zolazepam and midazolam, followed by anesthetic induction with propofol and maintenance with isoflurane proved to be satisfactory and the doses managed were safe for the spectacled bear (*Tremarctos ornatus*). Inhalation anesthesia was essential to prolong the time and to keep the safety throughout the procedure. The importance of maintaining body temperature in these animals is emphasized, performing maneuvers to avoid hyperthermia.

## Conflict of Interest

The authors declare that there is no conflict of interest in this article.

## Ethics Statement

All ethical and bioethical principles, and animal welfare were followed according to current legislation (CEBEA/CFMV,2017) as well as procedure authorization by the zoo.

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