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CASE REPORT

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Cardiopulmonary cerebral resuscitation in an african pygmy hedgehog (*Atelerix albiventris*): a case report

Ressuscitação cerebral cardiopulmonar em um ouriço-pigmeu africano (*Atelerix albiventris*): relato de caso

Gabriel Pereira Tavares[1], Brenda de Oliveira Graces[1], Eduarda da Fontoura Moura[1], Ísis Moukaddem de Souza[1], Raquel Martina Rodrigues Castillo[1], Isabella Michels Carvalho[3], Rochelle Gorczak[1]*

ABSTRACT: Exotic species are increasingly becoming a focus in veterinary medicine, necessitating proper handling by skilled professionals. Although the importance of staying updated on current practices is widely acknowledged, bibliographic references on such topics are often scarce. The African pygmy hedgehog (*Atelerix albiventris*), which has a life expectancy of 4–6 yr in captivity and an average weight of approximately 700 g, presents unique challenges to anesthetists due to its small size and high metabolic rate. This case report describes the successful management of cardiopulmonary cerebral resuscitation (CPCR) in a 6-year-old male African pygmy hedgehog weighing 430 g. The animal underwent a lumpectomy procedure. Physiological parameters remained stable during the first 10 min of the surgery; however, bradycardia, bradypnea, and hypothermia were subsequently observed. Isoflurane flow was reduced, but this was followed by the loss of electrocardiogram signals, pulse oximetry readings, and ocular reflexes, indicating cardiorespiratory arrest. The CPCR protocol was promptly initiated. Successful stabilization of physiological parameters in this case was achieved through careful management of the CPCR protocol, supported by knowledge of the species' anatomy and physiology, effective anesthesia monitoring, and the rapid diagnosis of the arrest. This case highlights the importance of species-specific expertise in the successful management of critical incidents in exotic animals.

Keywords: anesthesia monitoring; cardiorespiratory arrest management; exotic animal medicine.

RESUMO: Espécies exóticas estão se tornando cada vez mais um foco na medicina veterinária, necessitando de manejo adequado por profissionais qualificados. Embora a importância de se manter atualizado sobre as práticas atuais seja amplamente reconhecida, referências bibliográficas sobre esses tópicos são frequentemente escassas. O ouriço-pigmeu-africano (*Atelerix albiventris*), que tem uma expectativa de vida de 4 a 6 anos em cativeiro e um peso médio de aproximadamente 700 g, apresenta desafios únicos para anestesistas devido ao seu pequeno tamanho e alta taxa metabólica. Este relato de caso descreve o manejo bem-sucedido da ressuscitação cerebral cardiopulmonar (RCCP) em um ouriço-pigmeu-africano macho de 6 anos de idade, pesando 430 g. O animal foi submetido a um procedimento de lumpectomia. Os parâmetros fisiológicos permaneceram estáveis durante os primeiros 10 minutos da cirurgia; no entanto, bradicardia, bradipneia e hipotermia foram observadas posteriormente. O fluxo de isoflurano foi reduzido, mas isso foi seguido pela perda dos sinais do eletrocardiograma, das leituras da oximetria de pulso e dos reflexos oculares, indicando parada cardiorrespiratória. O protocolo de RCCP foi prontamente iniciado. A estabilização bem-sucedida dos parâmetros fisiológicos neste caso foi alcançada por meio do manejo cuidadoso do protocolo de RCCP, apoiado pelo conhecimento da anatomia e fisiologia da espécie, monitoramento anestésico eficaz e diagnóstico rápido da parada. Este caso destaca a importância do conhecimento sobre a espécie e no manejo bem-sucedido de incidentes críticos em animais exóticos.

Palavras-chave: monitoramento anestésico; reanimação cardiorrespiratória; medicina de animais exóticos.

INTRODUCTION

The Brazilian territory is known worldwide as the large diversity of species, and because of this number is becoming more common into the veterinary routine the service of wild animals (Bexton, 2017). Is part of the routine the service of exotic species, mostly as the ones as considered already pets. In Brazil the wild species are 26,4% of the service (Abrase, 2012). The African pygmy hedgehog, is a little mammal is originally of the African continent and, is found all over the world (Hedley, 2011).

The Hedghog is a member of the family Erinaceidae and order Erinaceomorpha, they have nocturnal habits and the body is dorsal covered by thorns used to protect them from predators, measuring in media 0,5 to 1 cm of length (Heatley, 2009). These animals weight between 250 to 700 grams, the male are commonly more heavy then the female, the life expectancy in captivity can be 4 to 6 years, and are reports that these patients that survived until 10 years old (Meredith & Redrobe, 2002; Doss & Carpenter, 2017).

The performance of anesthetic procedures in such small species with rapid metabolism tends to become quite a challenge for the anesthetist. This is because effective doses are usually smaller, requiring the use of different dilutions than usual. Moreover, the fast metabolism of these animals can lead to unpredictable situations, such as rapid

[1] Medicina Veterinária- Centro Universitário Ritter dos Reis (UniRitter), Porto Alegre/RS, Brasil.

*Corresponding author: r.gorczak@yahoo.com.br

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superficialization or deepening of the anesthetic plane (Longley, 2008).

In anesthetic procedures, care for the patient's physiological systems (cardiovascular, respiratory, and metabolic) before, during, and after the procedure is crucial. Several studies report that this particular species is highly prone to presenting cardiomyopathies and acute failures in its physiological functions, often leading to the sudden death of these patients (Cracknell, 2008). It is almost impossible to find bibliographic references regarding cardio-pulmonary-cerebral resuscitation (CPCR) in exotic species. There are no described techniques, evidence, or reports on specific resuscitation protocols for the species in question.

Therefore, this article presents a protocol for brain-cardio-pulmonary resuscitation in the African Pygmy Hedgehog (*Atelerix albiventris*). The objective, besides providing the report, is to contribute to the academic community with a resuscitation protocol performed in Hedgehogs.

CASE REPORT

A male African Pygmy Hedgehog (*Atelerix albiventris*), 6 years old, weighing 430 grams, was attended to. The patient presented with a circumscribed nodule measuring 1.4 cm in diameter located on the chest, near the left axillary region, which required excision.

Due to the patient's temperament and handling difficulty, preoperative exams and physical evaluation were not possible, carrying out assessment via observation. The animal was admitted on the day of surgery without prior fasting. For the surgery, the animal underwent three minutes of oxygen therapy in a chamber, and then received isoflurane to effect through the universal vaporizer (Figure 1). Approximately two minutes later, the patient entered a superficial anesthetic plane, allowing manipulation. Therefore, full physical assessment was performed, temperature parameters, heart rate, and placement of monitors for electrocardiography were measured, with the patient maintained under isoflurane on the oxygen therapy mask.

Figure 1 – Pygmy Hedgehog (*Atelerix albiventris*) underwent oxygen therapy and isoflurine inhalator agent in chamber.

Source: personal arquive, 2023.

A 24-gauge catheter was inserted into the left cephalic vein for venous access, for emergency purposes. After being placed on the table with heated pads for the procedure, the patient was positioned in sternal recumbency. The animal's mouth was opened with the aid of gauze, exposing the larynx and glottis, thus a splash of lidocaine 0.01 ml diluted 1:2 in NaCl was administered intratracheally, avoiding laryngospasm, followed by immediate intubation using a 2.0 mm uncuffed endotracheal tube (Figure 2), connected to a Baraka dual T circuit for maintenance of inhalation anesthesia. With the patient placed in dorsal recumbency, 0.1 ml of lidocaine diluted in NaCl to a final volume of 1 ml was applied for the surgical site block.

Figure 2 – Pygmy Hedgehoh (*Atelerix albiventris*) with venous acess, intubated and being monitored.

Source: personal arquive, 2023.

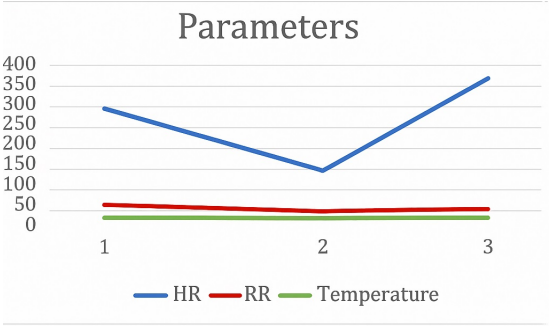
The Doppler transducer was attached to the thoracic region for monitoring heart rate, a pulse oximeter was positioned on the right front limb, and electrocardiogram electrodes were placed in their usual positions. Additionally, a heated thermal bag was applied, and temperature was monitored using a rectal thermometer.

Parameters remained stable, with an average heart rate (HR) 245 bpm, respiratory rate (RR) 30 mpm and temperature 36ºC, until 10 minutes into the procedure when a drastic bradycardia, bradypnea, and hypothermia of 33°C were noted. Consequently, the vaporization of isoflurane was reduced. Subsequently, loss of electrocardiographic and pulse oximetry traces was observed, along with the absence of audible heart sounds confirmed by Doppler. Assessment of the patient's ocular reflexes revealed complete absence and centralization, leading to the diagnosis of cardiopulmonary arrest. The cardiopulmonary cerebral resuscitation (CPCR) protocol was initiated.

With the animal in right lateral recumbency, cardiac massage was initiated using the one-handed technique, utilizing the thumb and index finger. This technique involves positioning the patient in right lateral recumbency, with the index finger providing support for the right side of the patient while the thumb is placed immediately above the heart, performing rhythmic movements aiming to approximate the physiological HR of the species, between 250 to 300 bpm. This was followed by manual ventilation every 3 seconds. After approximately 1.5 minutes, adrenaline (0.1 mg/kg diluted in a 2:1 ratio, with 2 parts saline solution to 1 part drug) was administered via

endotracheal route. Less than a minute after administration, the presence of electrocardiogram trace was observed, with the patient presenting a HR of approximately 360 bpm (graphic 1).

Graphic 1 – Monitoring of evaluation parameters at momenta after induction (1), ten minutes after induction (2), and after CPCR (3) of the African Pygmy Hedgehog (*Atelerix albiventris*).



After resuscitation, the nodulectomy procedure was resumed, during the procedure, the animal did not show excessive blood loss. The surgical procedure lasted 15 minutes and anesthetic 40 minutes, respectively. The animal remained on assisted ventilation for about 20 minutes and then returned to spontaneous ventilation. Approximately one hour after the emergency procedure, the patient was awake and was extubated, but displayed mild motor incoordination and low response to external stimuli.

The patient remained in an incubator with controlled temperature, undergoing monitoring of glucose levels, physiological functions, and feeding. The animal received analgesia with tramadol (0.2 mg/kg), non-steroidal anti-inflammatory meloxicam (0.08 mg/kg), both subcutaneously, and antibiotic therapy with amoxicillin (15 mg/kg, orally). After 24 hours, the patient was stable, with parameters within normal range and alert, and was discharged from the hospital (figure 3). After histological evaluation, the tumor was diagnosed as cutaneous squamous cell carcinoma.

Figure 3 – Anesthesia recovery from Pygmy Hedgehog (*Atelerix albiventris*).

Source: personal arquive, 2023.

DISCUSSION

African Pygmy Hedgehogs (*Atelerix albiventris*) are small animals that, when raised in captivity, which means., in breeding facilities with constant human contact, exhibit docile temperaments. However, when they feel threatened, they assume a curled-up posture, projecting their dorsal spines outward, making handling for routine assessment difficult and often necessitating anesthesia for proper physical evaluation. Therefore, paying attention to species specific details when anesthetizing becomes crucial. These patients are highly sensitive to stress, so, consideration should always be given to the environment where these animals will be kept prior to surgery. A quiet place with good air circulation and controlled temperature helps keep the animal calmer, facilitating handling (Cracknell, 2008). For this reason, the animal was not evaluated prior to the procedure.

In this case, fasting was not requested because it is not recommended for these animals before anesthesia due to their rapid metabolism, which predisposes them to postoperative hypoglycemia. This was particularly crucial in avoiding post-CPCR hypoglycemia, as a concurrent hypoglycemic episode could decrease the survival chances of the patient (Raymond & White, 1999; Doss & Garcia, 2022). Postoperative gastrointestinal motility care is also essential, as various medications can cause gastrointestinal motility disturbances, such as opioids. These were avoided in this case due to the risk of intoxication and gastrointestinal motility reduction, especially in a post-CPCR patient with reduced blood flow to the gastrointestinal tissue.

Injectable anesthetics can also be administered; however, it is worth noting that the patient's total recovery period is generally prolonged with injectable anesthesia. The drugs commonly used for this type of anesthesia include ketamine combined with diazepam and xylazine, as well as the use of tiletamine and zolazepam, among other protocols. However, in this second protocol, there are reports of prolonged recovery and excessive patient agitation (Cracknell, 2008). In this case, although injectable anesthesia is commonly used in routine practice, it was not an option to minimize depression in the animal, yet, despite that, asystole was identified.

Like most mammals, anesthesia induction can be performed either via inhalation or injectable routes. Volatile agents such as isoflurane and sevoflurane are ideal for anesthesia induction and anesthetic maintenance (Cracknell, 2008). These drugs present significant differences in their pharmacological properties. The first provides rapid induction, recovery of most of the exhaled gases, enhances muscle relaxants and has a lower hepatotoxic tendency. The second is completely eliminated from the lungs and has rapid induction and recovery, it is mainly metabolized by the liver, thus causing less damage to the kidneys (Steffey *et al.*, 2017; Oliva & Dos Santos, 2019).

Isoflurane depresses ventilation in high concentrations, improves airway resistance in dogs, while sevoflurane does not irritate the airways, depressing respiration in a dose-dependent manner and slightly increases PaCO2. On the cardiovascular side, isoflurane maintains better cardiac performance and does not sensitize the myocardium to catecholamines, while sevoflurane reduces blood pressure (Udelsmann *et al.*, 2006; Steffey *et al.*, 2017; Oliva & Dos Santos, 2019). A study carried out with rats showed that sevoflurane was superior to isoflurane, presenting

greater tolerability than isoflurane and also suggested that both do not present significant hepatotoxicity (Ruxanda *et al*., 2016).

The choice of isoflurane was due to its advantages in cardiovascular stability, less biotransformation and better maintenance of cardiac output, in addition to being the agent available at the location performed. They are highly recommended for short-duration procedures that do not cause significant pain to the patient. This type of anesthesia is easily achievable, requiring only inhalation anesthesia equipment, a mask, and a chamber for patient induction (Cracknell, 2008). In this case, induction was successfully performed in a box after oxygen therapy.

Volatile agents are the drugs of choice for the anesthetic maintenance of these species. Small endotracheal tubes (1.0 to 1.5mm), intravenous catheters, feeding tubes, or masks can be used for greater intraoperative safety (Ivey & Carpenter, 2004; Huckins *et al*., 2021). For increased perioperative safety, the animal was intubated and maintained on oxygenation throughout the procedure.

Cardiorespiratory arrest is a critical condition that occurs when the heart stops beating and breathing stops. There are several causes that can trigger this condition, including the patient's age, heart disease, anaphylaxis, trauma, strokes, chronic conditions, in addition to the use of medications (Nolan *et al.*, 2020), the cardiorespiratory arrest of this animal was probably due to the size and depth of the anesthesia used, associated with the age condition.

Transanesthetic monitoring in these patients is a significant challenge due to their small size. Therefore, monitoring with Doppler assistance for heart rate, as well as the use of electrocardiography and pulse oximetry, can be employed without major difficulties, similar to any other species. During the reported species' CPCR, efforts were made to maintain the heart rate within the physiological range for the species, between 250 to 300 bpm (Cracknell, 2008).

The emergency protocol was based on the RECOVER small animal protocol (2012), combining a set of measures adopted in cases of cardiopulmonary arrest, such as patient positioning for cardiac massage, chest compressions, and respiratory movements per minute (Cracknell, 2008; Fletcher *et al.*, 2012). As it concerns a different and relatively smaller animal than those presented in RECOVER, the techniques were adapted to the physiological issues of the reported species.

One significant challenge in anesthetic procedures is maintaining body temperature, which is crucial. The majority of anesthetic agents depress the system, causing hypothermia (Gorczak *et al.,* 2021). In these very small patients, temperature maintenance is challenging due to their high propensity for hypothermia owing to their size and low body mass, necessitating continuous warming (Lightfoot, 1999; Unno, 2016). Therefore, the patient in this case was kept warm throughout the procedure with a heated thermal bag to maintain the body temperature within the physiological range. In African Pygmy Hedgehogs, the ideal rectal temperature ranges from 35.4 to 37°C (Doss & Carpenter, 2017). In this case, the patient started the procedure at 36°C, with a drastic drop within minutes, requiring continuous warming.

Hypothermia can result from the use of anesthetic agents by reducing metabolism, as well as from the use of halogenated agents. Therefore, it is recommended to start supplemental warming during patient induction and anesthesia. Studies have shown that hypothermia can lead to intense immunosuppressant and negatively impact metabolism, and excessive hypothermia can lead to coma and death (Ivey & Carpenter, 2004; Johnson-Delaney, 2006). The animal in this case was under inhalation anesthesia with isoflurane, which was reduced during resuscitation.

Even with continuous warming provided by a heated thermal bag around the animal, the patient experienced a temperature drop, contributing to the cardiopulmonary arrest. Changes in the urinary system can directly affect the metabolism and excretion of drugs in these patients. In African Pygmy Hedgehogs, alterations such as nephritis, tubular necrosis, and glomerulo nephritis have been detected. Therefore, the anesthetist must be attentive to signs of changes in this system, such as polyuria, polydipsia, and dehydration, if preoperative evaluation of these patients is possible (Johnson-Delaney, 2006). None of these alterations were observed in the patient in this case after anesthesia.

Fluid rate is essential to consider in these patients because of their small size, there is a significant chance of volume overload. Therefore, careful administration of fluid therapy volume and medications is essential. Maintenance fluid volume should remain at a rate of 50 to 100ml/kg/day. This volume can be administered subcutaneously or intravenously as long as it is done slowly (Johnson-Delaney, 2006). For this case, fluid therapy was not performed due to the rapidity of the procedure and the risk of over hydration, which could lead to deleterious effects such as pulmonary edema.

Routes of drug administration can be challenging in this species. Having knowledge of anatomy and training in venous access is important to improve anesthetic work. Oral administration of drugs is often not possible because most medications are placed on food, making administration difficult in debilitated patients. Other possible drug administration routes are intramuscular or subcutaneous, administered in the flank region of the patient. In this case, the endotracheal route was chosen due to the small volume to be administered in the conventional dose of the medication. For endotracheal administration, a higher dose is required, associated with a greater drug dilution (Fletcher *et al.*, 2012; Doss & Garcia, 2022).

Another possible technique for anesthesia in these species is loco regional anesthesia, which, in this case, involved blocking around the surgical site to remove sensitivity around the surgery area, providing both anesthesia during the surgical procedure and postoperative analgesia maintenance. Subcutaneous lidocaine application around the excised nodule was used for this purpose (Longley, 2008; Doss & Carpenter, 2017; Doss & Garcia, 2022).

CONCLUSIONS

Medicine for unconventional pets remains a challenge in veterinary practice. Having physiological and anatomical knowledge about the species is essential for good surgical and anesthetic safety. Understanding techniques and drugs already used in other animals is the basis for the success of resuscitation procedures. In

the present report, it can be concluded that knowledge of CPCR maneuvers, combined with anesthetic monitoring and rapid identification of the patient's arrest condition, was crucial for the successful outcome of the case. Additionally, the lack of specific literature on emergency resuscitation protocols in exotic species, as well as a standardization of doses of specific emergency drugs for small species with rapid metabolism like the African Pygmy Hedgehog, is noteworthy.

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