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REMOTE CHEMICAL IMMOBILIZATION AND ANESTHESIA FOR ORCHIDECTOMY IN A PLAINS ZEBRA (*Equus quagga*)

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Abstract

This case study evaluates the remote chemical immobilization protocol for a reproductive surgical procedure of a free-ranging male Plains Zebra (Equus Quagga), 11 years old, 400 kg body weight. The zebra was darted twice in the gluteal muscles (first from a distance of 30 meters, succeeded after 25 minutes by the second dart, from 15 meters), as the first dart was not fully discharged. Each syringe contained a 5 ml total volume of the combination: 1000 mg Ketamine, 50 mg Medetomidine, 10 mg Butorphanol, and 5 mg Midazolam. The induction time calculated from the last dart until the animal gained lateral recumbency was 8 minutes. A bilateral locoregional intratesticular block was performed using a total dose of 2mg/kg Lidocaine. The maintenance phase lasted 54 minutes ensuring optimal anesthesia and analgesia, necessary for the procedure. Atipamezole 0,15mg/kg was used for antagonization, intravenously and was effective in 1 minute. The patient was classified with a final recovery score of 1 and assisted into a standing position, presenting stable coordination and reduced ataxia. During anesthesia clinical monitoring was continuous, without any complications recorded.

Key words*: zebra, chemical, immobilization, Ketamine, Medetomidine.*

INTRODUCTION

The plains zebras that roam throughout much of sub-Saharan Africa's savannah are known for their unique physical traits. Zebras are specialized grazers and require regular access to water and grass (Landman & Kerley, 2001).

This study aims to evaluate the remote chemical immobilization, monitorization, and recovery protocol for a free-ranging male Plains Zebra (*Equus quagga*), from Africa. Immobilization of feral free-roaming animals can be complicated and many immobilization methods have been described over the years.

Butorphanol-Azaperone-Medetomidine (BAM) immobilization is the most commonly used in zebras (Stemmet et al., 2018), as an adaptation from horses (Balko et al., 2022), and as an alternative to Etorphine-Azaperone (EA) (Stemmet, 2018). The main change in physiological parameters with the EA protocol is related to oxygen metabolization, as severe hypoxia or hypoxemia may occur, as well as a prolonged recovery time (Stemmet, 2018).

Another alternative to EA, also described in zebras, is the Ketamine-Butoprhanol-Medetomidine (KBM) method (Stemmet et al., 2019). The KBM method may reduce the severe hypoxemia produced by EA and balance the severity of hypoxemia, as well as the mean time of ataxia and recovery (Stemmet et al., 2019). Even if the recovery time was longer with KBM, immobilization was done effectively in boma-habituated zebras (Stemmet et al., 2019).

Pre-immobilization evaluation can be a visual assessment of each animal's behavior. As a part of evolutionary factors associated with long-term hunting by humans, a reaction in behavior was studied, comparing the occurrence or non-occurrence of habituation in feral horses *(Equus caballus ferus)* and Plains Zebras *(Equus quagga)*, with the help of Flight Initiation Distances (FID), which was analyzed for 87 equids and resulted in a bigger value in zebras, which suggests that approaching free-roaming zebras may be more difficult than approaching free-roaming horses (Brubaker & Coss, 2015).

Chasing equids can also affect muscle cells, and capture myopathy can occur in free-roaming zebras (Paterson, 2014) that are darted, with clinical signs such as cardiac dysfunction and dyspnea (Breed et al., 2019).

Reproduction control in a free-ranging equid population (King et al., 2022), indicates that no difference in body condition or mortality was found after the orchiectomy, and geldings continued to exhibit the same behaviors as before the orchiectomy, even maintaining similar levels of aggression and still protecting the harem from which they come from.

MATERIALS AND METHODS

The authors propose an alternative combination for the KBM method in immobilizing free-roaming feral zebras, adding the benzodiazepine Midazolam. For remote chemical immobilization, a combination of Ketamine (Ketamine dry powder 2 g, Kyron Laboratories, Johannesburg, South Africa), diluted with Medetomidine (Medetomidine 20 mg/ml, 20 ml vial Kyron Laboratories, Johannesburg, South Africa), Butorphanol (DOLOREX® 10 mg/ml, Merck Animal Health, Germany) and Midazolam (Midazolam 5 mg/ml, 2 ml vial, PFIZER INC., NY) was utilized and referred to as the KBMM method. The substances were delivered with a compressed air tranquilizer dart-gun Pneu-Dart® X-Caliber using a single disposable 5 ml Pneu-Dart® Remote Delivery Device (RDD) Type U. The formula used for calculating the combination (available for two RDDs) was Ketamine dry powder 2000 mg mixed with 100 mg Medetomidine, 20 mg Butorphanol, and 10 mg Midazolam. One RDD was filled with 1000 mg Ketamine + 50 mg Medetomidine + 10 mg Butorphanol + 5 mg Midazolam.

The dental formula was visually evaluated and, after induction, based on the eruption and replacement of incisor and molar teeth (Smuts, G. L., 1974), age was determined. As hypsodont mammals, with a sharper dental crown and different enamel proportion, initial wear of the tooth crown and abrasion and attrition were evaluated (Winkler D. E., & Kaiser T. M., 2015). Also, differences between free-roaming and captive equids were taken into consideration, as less abrasion-dominated tooth wear is usually encountered more in captive equids rather than their free-ranging conspecifics (L. A. Taylor, 2014).

Body weight was documented based on the average weight of male zebras and muscle mass by visual estimation (Bray & Edwards, 1999). Body condition score (BCS) was assigned using a BCS chart adapted to a numerical scoring system for captive (zoo) equids, including zebras (Bray & Edwards, 1999).

A bilateral locoregional intratesticular block was performed using a total dose of 2 mg/kg Lidocaine.

The stallion received the following treatment postoperatively: antibiotic as an injectable aqueous suspension of procaine penicillin and benzathine penicillin, intramuscularly (Duplocillin® LA) 20 mL/animal, injectable NSAID - Ketoprofen, intravenously (Ketofen®), 10 mL/animal and a tetanus toxoid intramuscular shot (Zoetis Inc.).

To assess the efficacy of the immobilization, physiological parameters such as respiratory rate (RR), heart rate (HR), oxygen saturation (SpO2), and rectal body temperature (RT) were monitored. Respiratory rate was determined by visual observation of chest movements and counted in breaths/minute. Heart rate was recorded in beats/minute with a 3M™ Littmann® Classic III™ Monitoring Stethoscope. Temperature was clinically taken transrectally, with a digital veterinary thermometer (Kerbl). Peripheral oxygen hemoglobin saturation (SpO2) and heart rate (HR) were measured using a reflectance pulse oximeter probe (Nonin) attached to the tongue. All monitoring parameters were assessed continuously by the same person and recorded every 10 minutes from lateral recumbency until standing position, throughout the immobilization period.

Atipamezole 0.15 mg/kg (Antisedan® 5 mg/ml, Orion Corporation Animal Health, Turku, Finland) was used for antagonization, via the intravenous route.

The quality of induction was evaluated with an equine recovery chart where behavior during lateral recumbency, transition to sternal recumbency, description of sternal recumbency, transition to standing position, balance and coordination while standing, remarks, an overall impression were assessed and led to a final score (Table 1). The time between each transition was documented, with notes on balance and coordination in rapport with the level of ataxia. The final score consisted of the number of

attempts to standing position, level of ataxia, and excitation.

Table 1. Recovery final scores, from 1 to 6

Final score 1	One attempt, little to no ataxia
Final score 2	Two or more attempts, ataxia
Final score 3	More attempts, quiet recovery
Final score 4	More attempts, moderate recovery
Final score 5	More attempts, excitation
Final score 6	Very bad recovery, high risk of injury

RESULTS AND DISCUSSIONS

The dental evaluation resulted in an age estimation of 11 years. The weight was estimated at 400 kg. BCS was assigned a 6/9 score (moderately fleshy) with a thicker neck and ribs not discernable (Bray R. E. & Edwards M. S., 1999). The first syringe dart (RDD) was administered remotely and intramuscularly in the rump on the left side, from 30 meters distance. The suspicion that it was not fully discharged is based on the author's experience with remote chemical immobilization, the rapid detachment of the RDD from the rump on impact, and the delayed onset of action.

The stallion was clinically assessed from a distance. The first signs of anesthesia occurred 6 minutes after darting. The first signs of anesthesia (Figure 1) were recorded when clinical signs of ataxia and stilted gait occurred (Costea R., 2021).

Fig. 1. Stallion in standing position, after the second dart, showing the first signs of anesthesia and waiting for induction

The waiting time after the first dart was 25 minutes, signifying 19 minutes after the first signs of anesthesia. The second RDD was darted in the right gluteal muscles from the closest approachable distance of 15 meters.

The time from drug administration (after the second dart) to recumbency was referred to as the induction time and lasted for 8 minutes.

The stallion was approached and the head was covered, then manually helped to achieve lateral recumbency. A bilateral locoregional intratesticular block was performed after induction with a total dose of 2 mg/kg Lidocaine and a wait time of 10 minutes was allocated before surgery. The surgery lasted 8 minutes and the scrotal closed castration was elected as a surgical technique.

Physiological parameters were recorded every 10 minutes after induction until antagonization with the following mean ($\bar{X}$) and standard deviation (SD): HR ($\bar{X}$ = 41 bpm; 3.46), RR ($\bar{X}$ = 35.83 bpm; 5.67), Sat. O2 ($\bar{X}$ = 93.16%; 2.31), RT ($\bar{X}$ = 37.55 Celsius; 0.15) and CRT ($\bar{X}$ = 1 seconds; 0) (Table 2).

Table 2. Physiological parameters recorded during the maintenance phase (heart rate in beats/minute, respiratory rate in respirations/minute, oxygen saturation in %, rectal temperature in Celsius, and capillary refill time in seconds)

HR	48	40	40	39	40	39
RR	34	30	30	36	42	43
Sat. O_2	97	94	91	92	91	94
RT	37.7	37.7	37.6	37,5	37.5	37.3
CRT	1	1	1	1	1	1

The patient was classified with a final recovery score of 1/6 (see Table 1) and assisted into a standing position, manually helped during reversal to a sternal position with their front limbs extended for a smooth recovery.

A total immobilization time was defined as the interval between the induction and antagonization or the time the stallion remained recumbent (54 minutes in total). Atipamezole 0.15 mg/kg was effective in 1 minute after intravenous administration. The period from the administration of an antagonist to the standing position was well-monitored, as equine recovery complications can occur in this phase.

The zebra presented stable coordination and reduced ataxia in standing position.

The gelding was visually monitored for a week after the surgery and did not show any signs of pain or discomfort.

CONCLUSIONS

The KBMM method proved to be suitable for the castration of a male Plains zebra, with lateral recumbency and in-field conditions, achieving optimal anesthesia and recovery.
The stallion was darted twice to achieve induction suggesting that further research should be done on a group of zebras. The authors recommend a higher concentration of Butorphanol (similar to the KBM method) in the dart.
The maintenance phase lasted 54 minutes and optimal anesthesia and analgesia proved to be just necessary for the procedure.
Hypoxia occurred but it was mild. Oxygen therapy remains a recommendation for zebra anesthesia.
The gelding did not show any signs of capture myopathy after recovery.
No perioperative complications were recorded.

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