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NOTE

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Immobilization of captive plains zebras (*Equus quagga*) with a combination of etorphine hydrochloride, acepromazine, and xylazine hydrochloride

Tithipong PLANGSANGMAS[1)], Hathaipat RATTANATHANYA[1)], Wanlaya TIPKANTHA[2)], Saowaphang SANANNU[2)], Umaporn MAIKAEW[3)], Jessada THAEONOEN[3)], Bencharong SANGKHARAK[4)], Pornpiroon CHINSON[5)], Watcharin HIN-ON[6)], Nathavut KANATIYANONT[6)], Boripat SIRIAROONRAT [7)], Nantarika CHANSUE [8)] and Parntep RATANAKORN[1)]*

[1)]Faculty of Veterinary Medicine and Applied Zoology, HRH Princess Chulabhorn College of Medical Science, Chulabhorn Royal Academy, Lak Si, Bangkok 10210, Thailand
[2)]Bureau of conservation and Research, The Zoological Park Organization of Thailand, Bang Sue, Bangkok 10800, Thailand
[3)]Khao Kheow Open Zoo, The Zoological Park Organization of Thailand, 235 Moo 7, Bang Phra, Si Racha, Chonburi 20110, Thailand
[4)]Department of National Parks, Wildlife and Plant Conservation, Chatuchak, Bangkok 10900, Thailand
[5)]Bureau of Disease Control and Veterinary Services, Department of Livestock Development, Ratchatewi, Bangkok 10400, Thailand
[6)]Zoo and Wildlife Veterinarians Association of Thailand, Muang, Nonthaburi 11000, Thailand
[7)]Faculty of Environment and Resource Studies, Mahidol University, Phutthamonthon, Nakhon Pathom 73170, Thailand
[8)]Faculty of Veterinary Science, Chulalongkorn University, Patumwan, Bangkok, 10330, Thailand

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ABSTRACT. The plains zebra (*Equus quagga*) is a zebra species commonly kept in zoos around the world. However, they are not tame like their domestic relatives and are difficult to immobilize. We immobilized 30 captive plains zebra with a combination of etorphine hydrochloride (2–4 mg), acepromazine (8 mg), and xylazine hydrochloride (30 or 50 mg) to perform physical examination and blood sample collection for disease diagnostics. Physiological parameters including heart rate, respiratory rate, body temperature, and hemoglobin oxygen saturation were recorded. All zebras exhibited satisfactory anesthesia and fully recovered without re-narcotization. The results suggest that etorphine hydrochloride-acepromazine-xylazine hydrochloride combination for plains zebra immobilization is a safe and sufficient regimen for short procedures such as wellness examinations and sample collection.

KEY WORDS: anesthesia, etorphine, immobilization, plains zebra, remote drug delivery system

Zebras are non-domestic equids commonly kept in captivity for different purposes. Zoos keep zebras for ex-situ conservation, education, and for their aesthetic characteristics in display. Despite the similar anatomical and physiological characteristics to its domesticated relatives, zebras have different behavior and temperament. Adults become aggressive and have unpredictable responses to humans which could cause harm humans and to themselves [27]. Therefore, management of zebras in a captive condition is a challenging task that requires knowledge and experience. Zebras, similar to other animals, benefit from routine health exams by a veterinarian. In order to complete a thorough examination, physical examination and diagnostic tests are essential. As prey animals, flight or fight response is expected and physical restraint for veterinary procedures is not recommended. Stress induced capture myopathy can occur as well as fatal head or neck injuries from chasing and restraint [6]. Successful chemical restraint for sedation and immobilization has been reported for non-domestic equids [2, 3, 5, 9, 12, 13, 18, 19, 21–23, 25, 28]. If performed cautiously, chemical restraint is considered safe for both animals and staff involved.

Different drug combinations were used for zebra sedation and immobilization. Butorphanol and detomidine were used

*Correspondence to: Ratanakorn, P.: parntep.rat@cra.ac.th

as a combination for standing sedation in Grevy's zebra (*Equus grevyi*) [2, 5] and Burchell's zebra (*Equus burcellii*) [5]. If immobilization is desired, etorphine is considered the primary drug of choice combined with azaperone or different alpha-2 adrenergic agonists (e.g. medetomidine, detomidine, or xylazine) for zebra immobilization [3, 6, 10, 13, 19, 23, 26]. Etorphine is an ultra-potent opioid used for wildlife immobilization since the 1970's [11]. Derived from thebaine, it is 500 times more potent than morphine [7]. Advantages of etorphine are the rapid induction which is beneficial for easily excited animals such as zebras, analgesic effects, and has specific antagonists (naltrexone and diphrenorphine) that allow complete reversal resulting in a reduced recovery period. However, pronounced respiratory depression is commonly seen from immobilization with etorphine, along with common opioid side effects such as poor muscle relaxation, excitement, bradycardia and tachycardia, and re-narcotization [20]. These adverse effects can be reduced by combining synergistic agents as cocktails for a good immobilization.

We chemically immobilized 30 plains zebras (*Equus quagga*) with a combination of median dose 3 (2–4) mg etorphine hydrochloride (Captivon®, Wildlife pharmaceuticals (Pty) Ltd., Mpumalanga, South Africa), 8 mg acepromazine (Combistress, Kela Laboratoria, Hoogstraten, Belgium), 30 (n=21) or 50 (n=9) mg xylazine hydrochloride (Ilium Xylazil-100, Troy Laboratories Pty Limited, New South Wales, Australia). The drugs were mixed in a single dart and administered (intramuscularly) via a remote drug delivery system (Dan-Inject® rifle, Dan-Inject APS, Børkop, Denmark). The zebras were kept captive in public and private zoos from different regions of Thailand. The purpose for immobilization was for general health examination and collection of blood samples as a part of an outbreak investigation of African horse sickness (AHS) in Thailand [8, 15, 24]. Target animals were sub-adult and adult zebras of both sexes. Weight was estimated based on the age range and body condition [4, 6]. All animals were fasted 6–8 hr prior to immobilization. All immobilization events took place during 06:00–11:00 hr to prevent hyperthermia. When the animal is recumbent, we make sure that the airway is clear at all times, then the darts are carefully removed with safety equipment consisting of safety goggles, examination gloves and pliers for manual manipulation of penetrated darts. Dart wounds were cleaned with normal saline and disinfectants. The area of penetration was sprayed with visually identifiable color paint and blindfolds were used to prevent visual stimulation during the anesthesia. The animals were transported by a large net to the recovery area to perform required procedures. The animal is placed in a lateral recumbency (LR) position on a flat surface with the neck straight and supported by hay. Physiological parameters were recorded immediately when the zebras achieved recumbency and every 5 min until the antidote was administered. Heart rates were measured by auscultation, respiratory rates (RR) were counted from chest excursions, body temperatures were recorded by inserting a thermometer in the rectum, and hemoglobin oxygen saturation (S_pO_2) was assessed by a handheld pulse oximeter with the sensors attached to the tongue (VE-H100B, Edan Instruments Inc., Shenzhen, China). Supplemental oxygen was provided via nasal insufflations at 4 l/min when S_pO_2 dropped lower than 90%. Yohimbine (n=9; Reverzine®, Parnell Laboratories (AUST) Pty Ltd., New South Wales, Australia) with an equivalent dose of xylazine or atipamezole with a dose of 0.15–0.25 mg/mg xylazine (n=21; Atipam®, Eurovet Animal Health, Noord-Brabant, Netherlands), and Naltrexone (Trexonil®, Wildlife Pharmaceuticals (Pty) Ltd., Mpumalanga, South Africa) with a dose of 30 mg/mg etorphine were injected intramuscularly as antagonists when all procedures were finished. Animals were continuously monitored until full recovery and released back into its pen. For safety measures, an ambulance with at least two emergency medical technicians were notified of ultra-potent narcotic drug usage and were present with emergency drugs and the human opioid antagonist drug naloxone during all immobilization events to respond as quickly as possible to accident exposures according to Kreeger and Arnemo [11].

Descriptive statistics were calculated and displayed in Table 1 to summarize the immobilization event. The combination induced a quick time to LR within 3.83 ± 1.56 min and provided reliable recumbences without attempts to stand throughout the LR time (10.37 ± 2.40 min) of the immobilization. Recoveries from anesthesia were smooth, on average 2.5 ± 1.01 min after reversal. Zebras were considered fully recovered when they were able to walk in a calm and coordinated manner with no displays of head dropping [11, 22]. All zebras had unremarkable full recoveries and returned to normal behavior (Fig. 1). Table 2 shows the parameters recorded during immobilization. The average heart rates, RR, body temperature, and saturated oxygen recorded were 86.61 ± 27.93 beats/min, 16.91 ± 4.28 breaths/min, 38.31 ± 0.93°C and 95.26 ± 6.2% S_pO_2 respectively. The mean ambient temperature recorded during each session was 27.13 ± 1.43°C. Some zebras (n=6) presented signs of hypertonicity of the pelvic limbs and tail but were in accepted levels of anesthesia [14]. Re-narcotization did not occur and all zebras were reported with normal behavior and no losses were recorded one week post-immobilization.

Immobilization of captive zebras with a combination of etorphine hydrochloride, acepromazine, and xylazine hydrochloride provide a rapid induction and stable anesthesia for short procedures such as general health exams and blood collection. Even though hypertonicity of the pelvic limbs and tail movement was seen during immobilization in 6 animals, the depth of anesthesia was decent enough to perform our procedures with caution. Our study coincides with Sahu *et al*. [19] which uses the same combination of immobilizing drugs on a non-weight bearing individual zebra. Parameters recorded were all in normal ranges when compared to domestic horses [16] except for RR which were considered high on both studies. We speculate that pre-immobilization excitement is the causes of the increase. When compared to combinations with detomidine instead of xylazine, we found that for short durations, both combinations can be used depending on the availability of the drug and the anesthetic history of the animals of different situations [1, 17].

Apart from the drugs, dosage, and natural factors such as ambient temperature and health status of animals, the teamwork of the personal is vital for a successful immobilization. Safety measures should be included in the immobilization plan and trained individuals for the use of ultra-potent narcotic drugs is essential. We encourage veterinarians involved in zoological medicine to receive specific training and comply with local drug legislations in order to become familiar with these drugs and able to manage different drug combinations according to the situation.

Table 1. Summary data of 30 plains zebras remotely immobilized with a combination of etorphine hydrochloride (HCL), acepromazine, and xylazine hydrochloride (HCL) detailing animal characteristics, drug dose, and anesthetic time effects

Animal	Sex	Estimated Body Weight (kg)	Etorphine HCL (mg)	Acepromazine (mg)	Xylazine HCL (mg)	Atipamezole or Yohimbine† (mg)	Naltrexone (mg)	Time to LR (min)	LR time (min)	Recovery time (min)
1	M	150	2.5	8	30	7.5	75	1	8	2
2	M	150	2.5	8	30	5.0	75	3	9	1
3	F	150	2.5	8	30	5.0	75	4	13	2
4	F	150	2.5	8	30	5.0	100	5	9	2
5	M	180	3.0	8	30	7.5	60	8	14	2
6	F	180	3.0	8	30	5.0	100	2	7	2
7	M	200	3.0	8	30	7.5	100	3	9	3
8	M	200	3.0	8	30	5.0	100	3	10	2
9	F	200	3.3	8	30	5.0	100	3	7	2
10	M	200	3.3	8	30	5.0	100	4	8	1
11	M	200	3.3	8	30	5.0	100	4	10	5
12	M	200	3.3	8	30	5.0	100	3	9	3
13	M	250	3.2	8	30	5.0	100	2	11	2
14	M	250	3.2	8	30	5.0	100	4	11	4
15	F	250	3.3	8	30	7.5	100	3	9	3
16	F	250	3.3	8	30	5.0	100	4	8	4
17	F	250	3.3	8	30	5.0	100	3	8	1
18	F	300	3.3	8	50	7.5	100	4	11	2
19	F	350	4.0	8	50	7.5	120	4	9	3
20	F	350	4.0	8	50	7.5	120	4	10	2
21	F	350	4.0	8	50	7.5	120	3	9	2
22	F	150	2.0	8	30	30†	60	8	15	2
23	F	150	2.0	8	30	30†	60	3	9	4
24	F	180	3.0	8	30	30†	100	7	14	4
25	M	180	3.0	8	30	30†	60	4	13	2
26	F	200	3.0	8	50	50†	100	5	15	3
27	M	200	3.0	8	50	50†	100	4	10	3
28	F	200	3.0	8	50	50†	100	3	9	3
29	F	200	3.0	8	50	50†	100	4	14	3
30	F	250	3.0	8	50	50†	100	3	13	1
Mean ± SD		215.67 ± 59.23	3.06 ± 0.48	8 ± 0.0	36 ± 9.32	5.95 ± 1.24 40.67 ± 11.14†	94.17 ± 17.07	3.83 ± 1.56	10.37 ± 2.40	2.5 ± 1.01

*LR, lateral recumbency; SD, standard deviation. †Yohimbine dose.

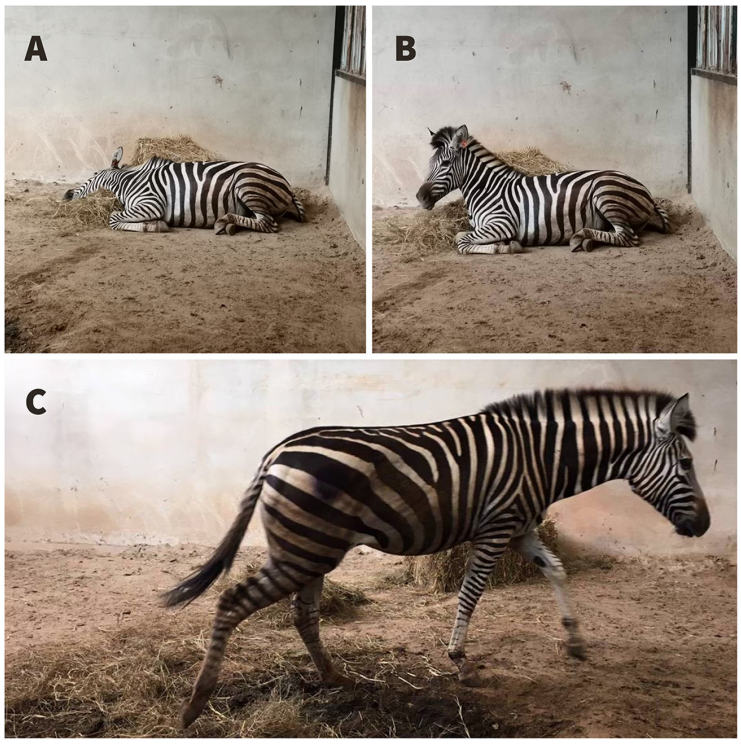

Fig. 1. Recovery of immobilized zebras after administration of antidotes. (**A**) The zebra is placed in a holding pen with hay to support its neck in a lateral recumbency position. (**B**) The zebra gains consciousness and advances to a sternal recumbency position. (**C**) The zebra has fully recovered with no signs of ataxia, head dropping, and over-excitement.

Table 2. Parameters measured during remote immobilization of 30 plains zebras with a combination of etorphine hydrochloride, acepromazine, and xylazine hydrochloride

Parameter	
Heart Rate (beats/min)	86.61 ± 27.93 (36–200)
Respiratory Rate (breaths/min)	16.91 ± 4.28 (10–30)
S_pO_2 (%)	95.26 ± 6.20 (76–100)
Body Temperature (°C)	38.31 ± 0.93 (36.06–39.78)
Ambient temperature (°C)	27.13 ± 1.43 (24–29)

Data are presented as mean ± standard deviation with the range in the parentheses.

CONFLICT OF INTEREST. The authors declare that there are no conflicts of interest.

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