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LONG-DURATION ANESTHESIA IN ARABIAN ORYX (*ORYX LEUCORYX*) USING A MEDETOMIDINE–ETORPHINE COMBINATION

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Abstract: To investigate the potential use of long-duration anesthesia for airlifted translocations of Arabian oryx (*Oryx leucoryx*), six animals were anesthetized for a mean of 259 min (SD = 76.9 min), using a combination of etorphine and medetomidine given i.m. at mean dosages of 68 μg/kg (SD = 29 μg/kg) and 5.00 μg/kg (SD = 0.27 μg/kg), respectively. Clinical variables (rectal temperature, heart and respiratory rates) and behavioral responses (reactions to a pain solicitation, movements of animals) were recorded every 15 min to assess the state of anesthesia. Body temperature decreased slightly at the beginning of anesthesia and remained constant in all but one animal with hypothermia and another with hyperthermia. Respiratory rate increased from a mean value of 20 breaths/min (SD = 5 breaths/min) 30 min following darting (T = 30 min) to a mean value of 40 breaths/min (SD = 12 breaths/min) at T = 90 min. Respiratory rate decreased to a mean value of 20 breaths/min (SD = 15 breaths/min) at T = 120 min and then remained constant in all but one male, which displayed persistant polypnea. Heart rate remained roughly constant. All the clinical variables remained in normal physiological ranges. Hematologic analysis showed a significant ($P < 0.001$) decrease of hematocrit and red blood cells counts from 41.00% (SD = 3.00%) and 7.86×10^6 cells/ml (SD = 0.93×10^6 cells/ml) at T = 30 min to 34.30% (SD = 2.70%) and 4.70×10^6 cells/ml (SD = 0.90×10^6 cells/ml) at T = 140 min, respectively. No major problems occurred during the anesthesia, but the difficulty of performing close monitoring of clinical parameters after 3 hr of anesthesia could jeopardize the safety of anesthesia for longer than 5 hr.

Key words: Arabian oryx, *Oryx leucoryx,* anesthesia, etorphine, medetomidine, translocation.

INTRODUCTION

The National Wildlife Research Center (NWRC) in Taif (21°15′N, 40°41′E), Saudi Arabia, has maintained an intensive captive breeding program of Arabian oryx (*Oryx leucoryx*) for reintroduction into the wild since 1986.[1]

Oryx intended for release operations are bred at the center in social groups. Contact with humans is minimized; thus, these animals remain very shy and are easily stressed. The oryx are translocated to protected areas at 1 yr of age.

The first translocation occurred in 1991, from NWRC to Mahazat as-Sayd reserve (21°59′ to 22°31′N, 40°27′ to 42°12′E), 200 km northeast of Taif. A combination of etorphine (M99, 4.9 mg/ml, C-Vet, Minster House, Bury St. Edmunds, Suffolk, U.K.) at 0.050 mg/kg (SD = 0.004 mg/kg) and xylazine (Rompun, 50 mg/ml, Bayer, Puteaux, France) at 0.20 mg/kg (SD = 0.05 mg/kg) or a combination of etorphine at the same dose and azaperone (200 mg/ml, Centaur Labs, Johannesbourg, South Africa) at 1.5 mg/kg (SD = 0.3 mg/kg) was used to immobilize young oryx. Anesthetized animals were placed in transport crates, anesthesia was reversed with diprenorphine (M5050, 6 mg/ml, C-Vet), and animals were tranquilized for transportation with 20 mg of haloperidol (10 mg/ml, Centaur Labs), 10 mg i.v. and 10 mg i.m.[16] Seventeen animals were translocated following this protocol. Five of them developed a capture myopathy syndrome within 1 wk of translocation and died.[16]

Subsequent translocations were performed with oryx anesthetized throughout the entire trip, for a mean duration of 150 min (SD = 13 min). Twenty oryx were administered an i.m. combination of either 0.050 ± 0.006 ($\bar{x}$ ± SD) mg/kg etorphine and 0.20 ± 0.06 mg/kg xylazine or 0.050

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Table 1. Total dose, induction, and recovery times for six Arabian oryx (*Oryx leucoryx*) immobilized with a combination of etorphine and medetomidine.

Animal no.	Sex	Weight (kg)	Etorphine dose (mg/kg)		Medetomidine dose (mg/kg)	Diprenorphine dose (mg/kg)	T1[a] (sec)	T2[b] (sec)	T3[c] (min)	T4[d] (min)	T5[e] (sec)
			Initial	Total							
41	M	100.6	0.050	0.089	0.0050	0.179	173	530	20	270	100
11	M	95.5	0.030	0.030	0.0050	0.063	185	450	20	120	270
19	M	90.9	0.055	0.099	0.0055	0.132	120	300	30	330	50
18	M	105.4	0.047	0.047	0.0047	0.095	120	308	30	250	180
2	M	102.5	0.049	0.049	0.0050	0.098	208	465	16	330	87
40	F	105.0	0.048	0.095	0.0048	0.190	240	2,520	45	255	66
Mean		99.9	0.040	0.068	0.0050	0.126	174.3	762.1	26.8	259.1	125.55
SD		5.7	0.008	0.029	0.00027	0.050	47.8	865.9	10.6	76.9	83.97
Maximum		105.4	0.055	0.099	0.0055	0.190	240	2,520	45	330	2,701
Minimum		90.9	0.030	0.030	0.0047	0.063	120	300	16	120	50

[a] Time to first signs of sedation.
[b] Time to final recumbency.
[c] Time to handling.
[d] Duration of anesthesia.
[e] Time to standing following the injection of reversal agents.

± 0.006 mg/kg etorphine and 5.0 ± 0.7 μg/kg medetomidine (Domitor, 10 mg/ml, Farmos, Turku, Finland). No deaths occurred during these translocations.

Translocations of oryx in Saudi Arabia, which are planned for the near future, will likely have to be performed over greater distances and would thus require anesthesia over longer periods of time. Roan antelopes (*Hippotragus equinus equinus*) have been successfully immobilized with etorphine for 3–5 hr for translocation.[8]

The purpose of the present study was to determine how long Arabian oryx could be safely kept anesthetized with an etorphine–medetomidine combination in preparation for future translocations to new protected areas.

MATERIAL AND METHODS

Animals

Between 13 January 1993 and 21 March 1993, six adult Arabian oryx were anesthetized for different periods of time ranging from 120 to 330 min. Five captive males, kept alone in a 0.5-ha enclosure, were anesthetized via dart at the NWRC, and a wild female was darted in the Mahazat as-Sayd reserve. All animals were clinically healthy and in good physical condition when darted. Air temperature ranged from 10°C to 22°C during all anesthesia. After handling, oryx were weighed on a platform scale (561SG, GIM, Beaupraut, France) with a precision of 0.1 kg (Table 1).

Animals kept at the NWRC received no food for 48 hr prior to anesthesia. Daily food intake was recorded by weight for each captive animal 2 wk before and 1 mo after darting to study potential long-term side effects of anesthesia on food consumption. Behavior of all darted animals was checked five times each day during the week following darting.

General procedure

A combination of 0.040 mg/kg (SD = 0.008 mg/kg) of etorphine and 5.00 μg/kg (SD = 0.27 μg/kg) of medetomidine was administered i.m. in the hindquarters of each oryx. Anesthetic mixtures were delivered in 3-ml syringes, fitted with unbarbed needles, using a dart gun (GUT 50, Telinject, Römerberg, Germany) from a distance of 10–30 m.

Times to first signs of sedation (charac-

terized by a low ear position, loss of equilibrium, and steady gait) (T 1), to final recumbency (T 2), to handling (T 3), to administration of antagonist agents (T 4), and to stand-up (T 5) were recorded with a stopwatch (Table 1).

After handling, animals were placed in a sternal position and blindfolded. All tested animals were administered an i.m. combination of 2 g oxytetracycline (T.L.A., 0.2 g/ml, Pfizer, Orsay, France), 240 mg methylprednisolone (Solumedrol, 60 mg/ml, Upjohn, Paris, France), 2.5 mg selenium (Biodyl, Rhone Merieux, Lyon, France), 0.4 g vitamin E (Séléphérol, Vetoquinol, Lure, France), and 10 ml of a multivitamin mixture (Astevitam, Vetoquinol).

Indications for field evaluation of anesthesia effectiveness were checked every 15 min. These indications included heart and respiratory rates, rectal temperature (°C), palpebral reflex, mucous membrane color, capillary-refill time, and muscle relaxation. Reactions to external disturbances such as noise and pain, salivation, accidental regurgitation, ruminal distension, and potential side-effects of anesthesia were also recorded.

To follow red blood cell (RBC) counts and hematocrit (Hct) changes during anesthetic procedures, blood samples were obtained every 20 min by venipuncture from the jugular vein, using 10 ml ethylenediaminetetraacetic acid (EDTA) vacutainers (Venoject, Terumo, Japan). Blood samples were kept at 4–6°C until processed. Red blood cell counts were performed, within 6 hr of sampling using a Malassez counting chamber.[9] Hematocrit evaluation was carried out with heparinized microhematocrit tubes (Hawksley and Sons, Lancing, England) centrifuged for 10 min at 4,000 rpm.

Length of anesthesia was modulated according to individual clinical evaluation of animals. Additional doses of etorphine were administered to three oryx that required strong manual restraint and were able to stand 2–4 hr following the initial darting.

Diprenorphine at double the total dose of etorphine and atipamezole (Antisedan, 5 mg/ml, Farmos) at five times the total dose of medetomidine[5] were mixed in the same syringe, and two thirds of the mixture was given i.v. and one third was given i.m. to antagonize etorphine and medetomidine, respectively (Table 1).

Two animals died at 4 and 14 days, respectively, after anesthesia. Postmortem examinations were performed at the center.

Data from serial recordings (rectal temperature, heart rate, respiratory rate, RBC count, Hct) were analyzed with a statistical graphics program (Systat version 5.0, SAS Institute, Evanston, Illinois 60204, USA), and means were compared with the Wilcoxon signed ranks test and the Friedman two-way analysis of variance for the entire set of dependent data.

RESULTS

Anesthesia

Immobilization data are presented in Table 1. The period of induction was uneventful and very quiet, with gradual onset of ataxia followed by sternal recumbency in 410 ± 57 sec in five males. Final recumbency time was delayed (2,520 sec) in the wild female darted in Mahazat because of high excitation and a long run during the induction period. Handling took place 10 min after final recumbency in all cases.

Mean duration of total anesthesia for the six animals was 259.1 min (SD = 76.9 min; range, 120–330 min). The first injection of 0.040 (±0.008) mg/kg etorphine combined with 5.00 (±0.27) μg/kg medetomidine induced a state of adequate anesthesia for 120 (±30) min. During this period, myorelaxation and sedation were adequate; narcosis was deep, corneal reflex was present, and no arousal, defensive reactions after rough handling or pinching, or muscular tension of legs and neck were observed. Grinding of molar teeth and groaning was observed in all animals 15–40 min following darting and remained present during all immobilization stages.

The first injection induced recumbency

for a mean period of 230 min in five oryx (oryx 11, whose anesthesia was reversed 120 min after darting, is not included here). Approximately 3 hr after darting, three of five animals were able to stand up or required strong manual restraint. These oryx received supplementary injections of etorphine i.m. of 2–4 mg/animal (Table 1). Quality of renarcosis was poor, and effects of these additional injections were of short duration. Oryx 19 was given two additional injections of 2 mg etorphine i.m. 160 min and 270 min after initial darting. Anesthesia was reversed 60 min after the third injection of etorphine while the animal was attempting to stand. Total duration of anesthesia for this animal was 330 min. The wild female received 3 mg etorphine 210 min after initial darting, and anesthesia was reversed 40 min after this second injection when this animal began to display voluntary movements. Oryx 41 received 4 mg etorphine 210 min after initial darting; adequate narcosis lasted for 120 min. Oryx 2 did not receive a supplementary injection of etorphine; the first administration induced adequate anesthesia for 180 min, and this animal remained manually restrainable for 330 min, at which time anesthesia was reversed. Anesthesia was reversed in two animals while they were in a deep stage of narcosis induced by the first administration of drug: anesthesia was reversed in oryx 11 120 min after darting because of inhalation of ruminal fluid and was reversed in oryx 18 250 min after darting because of a significant decrease in body temperature.

Body temperature

Rectal temperature varied significantly throughout immobilization (Friedman test). After a decrease from 38.9 ± 0.6°C to 37.9 ± 1.2°C in the first 120 min, mean temperature remained stable (38–38.5°C) until the end of the procedure, but standard deviation increased from 1.8°C to 2.4°C during the same period. The only exception was oryx 18, whose body temperature continuously and regularly decreased, despite a safety cover placed over its body. Anesthesia was reversed in this animal when its body temperature reached 34°C, 250 min after initial darting, while its state of narcosis was still adequate.

Respiratory and heart rates

In the present study, the Wilcoxon signed ranks test showed a significant increase ($P < 0.01$) in the respiratory rate (RR) between 30 min (20 ± 5 breaths/min) and 90 min (40 ± 12 breaths/min) and a significant decrease ($P < 0.01$) between 90 min and 120 min (20 ± 15 breaths/min). Respiratory rates were slow with deep thoracic movements until the end of immobilization for all but oryx 41, which displayed a substantial increase in RR ($\bar{x}$ = 100 breaths/min) from 180 to 330 min.

Changes in heart rate were not significant through the anesthesia period, but the range of observed values was wide. The mean oscillated between 45 and 65 beats/min (SD = 15 beats/min).

Hematologic values

Plasma remained uncolored in all animals during immobilization. Hematocrit and RBC counts varied significantly ($P < 0.001$) through time; Hct decreased until 100 min after darting (34.8 ± 3.4%), increased until 160 min (37.0 ± 0.3%), and then remained unchanged. RBC counts decreased until 60 min (5.00 ± 2.70 × 10^6 cells/ml) and then increased until 230 min (6.40 ± 0.30 × 10^6 cells/ml). All the values remained within the physiological range for this species.[15]

Reversal

Diprenorphine, at twice the dosage of etorphine, and atipamezole, at five times the dosage of medetomidine, reversed all immobilizations. Recovery was smooth and uneventful in all cases. Animals stood up at the first attempt 126 ± 84 sec after injection of reversal agents.

Oryx remained slightly sedated and quiet for 2 days following anesthesia. They were

often seen recumbent and seeking shade, and they did not interact with conspecifics. They ate no food the day after anesthesia. Dry alfalfa hay intake level reached the previous daily mean value of 2,000 ± 300 g/animal 4–7 days following anesthesia in all individuals.

Postmortem examinations

Two animals died after anesthesia. Oryx 11 regurgitated shortly after darting, before handling took place, and ruminal fluid entered the trachea and bronchi. When auscultation revealed obstruction sounds in the lungs 120 min after darting, anesthesia in this animal was reversed. Broad-spectrum antibiotic treatment was undertaken, but this animal died 5 days after anesthesia. Postmortem findings revealed an acute inhalation pneumonia, and anaerobic bacteria (*Clostridium* spp.) were isolated from its trachea and lungs. The wild female (oryx 40) was brought back to the NWRC from Mahazat and died 2 wk after translocation. Postmortem examination revealed an acute enterotoxemia. Histopathologic findings showed muscular rhabdomyolysis of the gastrocnemius muscle.

DISCUSSION

Etorphine is a highly potent narcotic analgesic derived from thebaine and is extensively used in the immobilization and capture of wild animals.[6] Its use often induces a depression of the respiratory and cough centers, a lowering of the body temperature, and an inhibition of gastrointestinal motility.[2] Etorphine can also lead to elevated body temperature due to muscle rigidity and an increase in muscle metabolism.[2] A period of excitation resulting from inhibition of alpha-2 adrenergic receptors may occur during the induction stage.[13] This excitation phase is well marked in members of the family Hippotraginae, particularly Arabian oryx.[12]

Medetomidine is a selective and specific alpha-2 adrenoreceptor agonist that inhibits sympathetic tone.[10] This drug induces good myorelaxation and minor physiologic changes such as slight hypothermia, bradycardia, and bradypnea in Arabian oryx.[5] Alpha-2 adrenoreceptor agonists, when used in association with etorphine, inhibit the excitation stage and produce adequate myorelaxation and immobilization.[6] In this experiment, the combination of medetomidine and etorphine elicited smooth and rapid induction of immobilization in all but the wild female darted in Mahazat.

Physiologic responses in Arabian oryx anesthetized with etorphine–medetomidine were similar to those in previous studies of etorphine–xylazine anesthesia in this species[18] and in the scimitar-horned oryx (*Oryx dammah*).[11] In these previous studies, anesthesia of about 1 hr induced hypothermia, various changes in respiratory rate, and no significant changes in heart rate. During long-duration anesthesia of roan antelopes, a strong correlation between rectal temperature and RR was found, both of which significantly decreased throughout anesthesia.[8] Hypothermia, but no alteration of heart rate, was recorded during 150-min etorphine–acepromazine–xylazine immobilization of six adult male scimitar-horned oryx.[13] In the present study, a decrease in body temperature was recorded during the first 2 hr of anesthesia in all animals. In three animals, rectal temperature stabilized afterwards and remained within the normal physiologic range. Hypothermia associated with an alteration of heart rate and RR through time was observed in one animal and hyperthermia was noticed in another. Tachypnea was usually recorded during the first 90 min of anesthesia, but afterwards RR remained relatively constant and within the normal physiologic range. The animal that displayed hyperthermia was placed in the shade but showed a persistant polypnea and high heart rate (from 180 to 330 min). Polypnea, associated with tachycardia, might be related to hyperthermia in this animal.[18] Effects of an etorphine–medetomidine combination on the cardiorespiratory and thermoregulation systems do not appear to

jeopardize success and safety of 5-hr anesthesia in Arabian oryx.

Rapid decrease in RBC counts and Hct during the first hour of immobilization with etorphine has already been reported for many species of wild mammals.[4,7] The observed decreases were significant ($P < 0.001$) when compared with reported normal values.[15] Two theories can be used to explain these decreases. First, because the spleen acts as a reservoir of erythrocytes and its contraction is controlled by alpha-adrenergic receptors,[9] medetomidine (an alpha-2 adrenoreceptor agonist) and deep anesthesia (resulting from a suppression of adrenergic stimuli) can induce splenic relaxation and sequestration of red RBCs, which could be responsible for a decrease in the Hct.[9] Second, decreases in Hct and RBC count may be the result of hemodilution; entry of tissue fluid into the blood stream results from bradycardia and lower blood pressure induced by the state of anesthesia.[7] Both theories explain the observed changes in circulating RBCs during anesthesia in terms of stress reaction.[7] Further investigations should examine the changes of mean corpuscular volume that occur during immobilization. Lower values for Hct and RBC counts that occur after 100 min of anesthesia are perhaps equivalent to resting values.[7]

During the first 2 hr of anesthesia, clinical symptoms were similar in the six oryx. During this period, some head movements were recorded, but the state of myorelaxation and narcosis were adequate. Lack of muscle tension and pain reaction indicated that an adequate level of analgesia was achieved. Presence of positive pain reaction and the appearance of voluntary movements occurred 120–210 min following darting. This time period corresponded to stabilization of hematologic parameters and, according to the splenic relaxation theory, to the reactivation of alpha-2 adrenoreceptors.

Bloating and regurgitation were the main problems encountered after 120 min of anesthesia. Stimulation of opiate receptors induces an inhibition of esophageal and intestinal motility, resulting in passive regurgitation.[2] Emetic action of alpha-2 adrenoreceptors agonists has been reported in other species tranquilized with medetomidine.[10] Tracheal intubation should be performed during long-duration anesthesia in Arabian oryx.

The first injection of the etorphine–medetomidine combination induced a state of recumbency for a mean of 230 min in five oryx. This period of recumbency is longer than that previously reported (90–120 min) in other ungulates immobilized with an etorphine–acepromazine.[3,14] Effects of supplementary injections of etorphine did not last long and did not induce adequate narcosis. The efficacy of concurrent injections of supplemental drugs, such as tranquilizers or dissociative anesthetics, in association with etorphine for prolonging or reinducing adequate anesthesia needs more study.

Anesthesia reversal was uneventful. Oryx were able to stand on the first attempt at a mean of 126 sec after the injection of reversal agents. During the first 2 days following anesthesia, the animals were quiet and often recumbent and did not interact with conspecifics or try to escape when approached by keepers. Complete anorexia lasted for 2 days, and food intake reached the preanesthesia levels 4–7 days following anesthesia. Similar anorexia has already been observed in white-tailed deer (*Odoicolus virginianus*) tranquilized with xylazine[17] and is thought to be caused by reduced plasma insulin concentration resulting from the action of this alpha-2 adrenoreceptor agonist. In the present study, anorexia should also be considered a long-term side effect of long-duration anesthesia. Long-term side effects, such as anorexia, recumbency, and lethargy, did not exceed 12 hr when anesthesia was reversed 30–60 min following etorphine-induced immobilization. The duration of anesthesia side effects appears to be related to the duration of anesthesia itself.

Despite the deaths of two animals, the combination of etorphine and medetomidine administered i.m. appears to provide adequate immobilization for at least 3 hr in Arabian oryx. Additional injections of etorphine i.m. can prolong immobilization for an additional 2 hr. Over time, additional injections are less effective, and dosages must be increased to reinstate adequate anesthesia. Moreover, clinical parameters such as body temperature or respiratory rate may sometimes be impossible to maintain within the normal physiologic range after 3 hr of anesthesia. It is expected that anesthesia that lasts over 5 hr, performed with airlifted animals, may increase the difficulties of monitoring the clinical parameters, may increase the duration and consequences of the long-term side effects of such anesthesia, and may drastically increase the mortality rate. Translocation under deep anesthesia probably cannot be safely undertaken to translocate oryx over great distances.

Up to 10 hr are required to airlift oryx from Taif to Uruq Bani Ma'arid, Saudi Arabia, a new protected area situated at the edge of the Empty Quarter. A new procedure based on boma training and use of long-acting tranquilizers such as perphenazine enanthenate (Trilifan, Schering-Plough, Levallois, France) has recently been successfully used to translocate 18 oryx from the NWRC to Uruq Bani Ma'arid (unpubl. data).

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