ETORPHINE-ISOFLURANE-O_2 ANESTHESIA FOR OVARIOHYSTERECTOMY IN AN INDIAN RHINOCEROS (*Rhinoceros unicornis*)

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Abstract

Most previous reports of anesthesia in the rhinoceros describe the use of injectable agents for capture and translocation or for short clinical procedures. One recent case report documents the use of etorphine followed by guaifenesin, thiopental and isoflurane to provide surgical anesthesia for abdominal exploration through a flank incision in a white rhinoceros.[1] That animal was euthanatized while under anesthesia, therefore, the nature of recovery could not be determined.

This report describes anesthesia for ventral midline celiotomy, ovariectomy, and partial hysterectomy in a 22-yr-old 1955 kg female Indian rhinoceros (*Rhinoceros unicornis*) with a diagnosis of multiple leiomyomas involving the vagina and uterus.

Etorphine, 2.4 mg, was injected into the muscles on the medial aspect of the hind limb, using a rifle and plastic projectile syringe (Vario System, Telinject, Inc., Saugus, CA 91350 USA). After a brief period of mild hypermetria and ataxia the rhinoceros stood quietly. It was approached 8 min after darting, whereupon it walked into a corner of the paddock and head-pressed. Respiration rate at that time was 12 BPM and pulse rate, taken from the tail, was 76 BPM. Web slings, 9 ft long × 4 in wide (Mill Valley Splicing Co., Inc., Belchertown, MA 01007 USA) were then placed, one around its abdomen and one around its thorax and in front of one shoulder, after which it laid down. Respiration rate had decreased to 4 BPM, but it increased again when it was pulled out of the corner using the slings and a 16,400 lb capacity fork lift (Caterpillar, Inc., Peoria, IL 61629 USA). Leg movement occurred during positioning and the rhinoceros was given 0.2 mg etorphine i.v. An infusion of 12 g guaifenesin with 0.45 g thiopental was given i.v. through an 18-ga 2 in catheter placed in an auricular vein to eliminate chewing motions, and to relax its jaw for intubation. A 35-mm i.d. cuffed silicone tube (Bivona, Inc., Gary, IN 46406 USA) was introduced over an adult equine nasogastric tube which had been placed manually through the glottis into the trachea. Swallowing was present during intubation, but the rhinoceros did not cough. Additional guaifenesin, 22 g, and thiopental, 0.75 g, were given over the next 10 min while the rhinoceros was further positioned and anesthesia equipment was brought into the paddock. Two 9 French 15-cm wire guided catheters (Cook Veterinary Products, Bloomington, IN 47404 USA) were placed in the left (dependent) cephalic vein. The location of the vein was clearly visible, but a surgical cut-down was

necessary to penetrate the thick skin overlying the vessel. A 16-ga 24 in catheter (Intracath, Becton Dickinson Vascular Access, Sandy, UT 80470 USA) was later placed in the opposite cephalic vein. Intravenous fluids (Ringer's lactate solution) were given through large animal i.v. administration sets (Stat IV-1000 large animal, International Win, LTD., Kennett Square, PA USA 19348). A total volume of 80 L was administered.

A 22-ga 1 in catheter was placed in a right external auricular artery for measurement of arterial pressure (MAP) and blood gases.

At the time of initiation of isoflurane-O_2 anesthesia, (55 min. after induction with etorphine) heart rate was 60 BPM, respiratory rate was 8 BPM, and mean arterial pressure (MAP) was 76 mm Hg. Isoflurane-O_2 was given using a large animal circuit (Narkovet E, North American Drager, Telford, PA 18969 USA) with a 30 L rebreathing bag. Initial delivered isoflurane concentration was 5% in an O_2 flow of 15 LPM. After approximately 10 min, those settings were reduced to 2-3% and 10 LPM where they remained for approximately 1.5 hr. End tidal (ET) CO_2 was monitored using a sidestream capnometer (Normocap 200, Datex Medical Instrumentation, Inc., Tewksbury, MA 01876 USA).

Electrocardiogram (base-apex lead configuration), direct arterial pressure, nasal temperature and relative O_2 saturation (SpO_2) were monitored continuously using a portable monitor (Propaq 106, Protocol Systems, Beaverton, OR 97005 USA). For SpO_2 monitoring, a reflectance transducer, (RS-10, Nellcor, Inc., Hayward, CA 94545 USA) was placed on the gingiva or between the endotracheal tube and hard palate. During placement of the i.v. lines, instrumentation, initial surgical scrub, and stabilization of the anesthetic level a structure was erected to hold a tarpaulin over the anesthetized rhinoceros, and a 14 in wide × 8 ft long × 6 in deep trench was dug in the paddock parallel to its back. Using the fork lift to pull leg ropes, the rhinoceros was rolled into dorsal recumbency, with its midline in the trench, approximately 1.33 hr after etorphine induction. Mattresses and hay were placed alongside the trench to further secure its position. The arterial catheter had been dislodged during positioning, and a second 22-ga 1 in catheter was placed in an artery on the inside surface of the pinna. Mean arterial pressure was found to have decreased to 56 mm Hg, and a dobutamine (Dobutrex, Abbott Laboratories, North Chicago, IL 60664 USA) infusion was begun at a rate of 1.0 μg/kg/min. Within 5 min, heart rate increased to 80 BPM with only a modest increase in MAP to 62 mm Hg, and a phenylephrine infusion (phenylephrine HCl, USP, Elkins-Sinn, Inc., Cherry Hill, NJ 08003 USA) was added at a rate of 0.03 to 0.06 μg/kg/min. The phenylephrine, combined with dobutamine, 0.125-0.25 μg/kg/min, increased mean arterial pressure to 90 mm Hg with a heart rate of 65-70 BPM.

Surgery began 2.2 hr after etorphine induction. The rhinoceros did not show any clinical signs of arousal in response to surgical stimulation, but arterial blood pressure increased dramatically during traction on the ovaries, and MAP varied between 70 and 150 mm Hg during the surgical procedure. Dobutamine and phenylephrine were discontinued and not used again until ovariectomy and partial hysterectomy were completed, and closure of the abdominal incision was begun, at which time MAP decreased to 65 mm Hg.

Although spontaneous respiratory rate was 8 BPM and SpO_2 readings had remained above 95%, ET CO_2 had risen to 74 mm Hg 15 min after the rhinoceros had been placed in dorsal recumbency. An arterial blood gas determination at that time indicated that $PaCO_2$ was 99 mm Hg. Arterial PO_2 was only 84 mm Hg (Table 1) despite the presumed inspired O_2 concentration of > 90%. Controlled intermittent positive pressure ventilation (CV) was initiated using a Bird Mark 9 respirator (Bird Products, Palm Springs, CA 92262 USA) driven by O_2 at a cylinder outlet pressure of 65 PSI, and a 30L reservoir bag in a 38-L "barrel". Respiratory rate was controlled at 9-10 BPM and plateau airway pressure, measured at the endotracheal tube was ~25 cm H_2O. An arterial blood gas determination 45 min after initiation of CV indicated that PaO_2 had risen slightly to 97 mm Hg, and $PaCO_2$ had decreased to 55 mm Hg. Forty-five minutes later, PaO_2 had decreased again, and an attempt was made to provide positive end expiratory pressure (PEEP) at ~10 cm H_2O. Arterial O_2 tension decreased further to 60 mm Hg during PEEP, and it was discontinued (Table 1). Tidal volume was increased by increasing plateau airway pressure to ~34 cm H_2O, and PaO_2 increased to 72-74 mm Hg.

After the first 1.5 hr of inhalation anesthesia, O_2 flow to the breathing circuit was lowered to 3 LPM. This flow was maintained for the remaining 4.5 hr and appeared to be equal to metabolic O_2 requirements for the rhinoceros. The soda lime was changed once during the procedure, because inspired CO_2 rose above 0 mm Hg. Ventilation was continued during the soda lime change using a 160 LPM demand valve (LSP model 063-050, Allied Health, St. Louis, MO 63110 USA) and it was possible to keep $ETCO_2$ at 45 mm Hg using this device.

Ambient temperature was measured at 24°C at the midpoint of the anesthetic period, and the rhino's nasal temperature remained at 35.3°C during the last 4 hr of anesthesia.

Isoflurane delivery was discontinued at the beginning of abdominal closure, 5.25 hr after etorphine induction. Blood pressure increased gradually over the next 1.5 hr, but no signs of arousal from anesthesia were noted. Surgery was completed 6.5 hr after etorphine induction. The rhinoceros was put in lateral recumbency and naltrexone HCl (INADA 6277, Wildlife Pharmaceuticals, Fort Collins, CO 80524 USA) 240 mg i.v. and 240 mg i.m. were given 7 hr after the initial etorphine injection. The endotracheal tube was pulled as it rolled to a sternal position, and the rhinoceros stood 1.5 min after naltrexone administration. The rhinoceros stood quietly, and seemed aware of auditory, but not visual stimuli for approximately 10 min. At 15 min, it could apparently see and was walking with some ataxia, and at 17 min it was trotting and charged a member of the staff, running him out of the paddock. Other than mild ataxia it appeared to have no gait abnormalities.

Although the rhinoceros recovered well initially, unfortunately, it died approximately 32 hr later as a result of hemorrhage from the left ovarian pedicle. The rapid recovery from 7 hr etorphine-isoflurane anesthesia demonstrates that this technique can be used to safely anesthetize adult rhinoceros in dorsal recumbency for long periods of time, provided that cardiovascular and respiratory monitoring and support are available.

LITERATURE CITED

1. Cornick-Seahorn, J.L., S.K. Mikota, D.O. Schaeffer, G.S. Ranglack, and S.B. Boatright. 1995. Isoflurane anesthesia in a rhinoceros. J. Am. Vet. Med. Assoc. 206:508-511.

Table 1. Arterial blood gas determinations.

Anesthesia Time	1^H 40'	2^H 30'	3^H 15'	4^H 07'	5^H 04'	5^H 45'
pH	7.17	7.35	7.36	7.42	7.42	7.41
$PaCO_2$ mmHg	99	55	56	48	48	49
PaO_2 mmHg	84	97	88	60	72	74
BE mEq/L	+3.1	+3.5	+5.0	+6.3	+6	+6
SaO_2% (Calc)	92	97	96	91	94	95
SpO_2%	96	97	96	93	96	95
Respiration	spontaneous	CV[a]	CV	CV-PEEP[b]	CV	CV

[a]Controlled intermittent positive pressure ventilation
[b]Positive end expiratory pressure