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ANESTHESIA AND USE OF A SLING SYSTEM TO FACILITATE TRANSVAGINAL LAPAROSCOPY IN A BLACK RHINOCEROS (*DICEROS BICORNIS MINOR*)

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Abstract: Transvaginal laparoscopy to allow assessment of ovarian pathology and to attempt retrieval of oocytes was facilitated in a captive, female black rhinoceros (*Diceros bicornis minor*) through the use of a sling on two separate occasions. Following induction of anesthesia with an opioid-based combination, the rhinoceros was intubated and maintained on isoflurane in oxygen. The use of the sling and volume controlled inhalation anesthesia allowed for maintenance of appropriate anatomic positioning, analgesia, and insufflation of the abdominal cavity for laparoscopy during both procedures.

Key words: Anesthesia, *Diceros bicornis*, laparoscopy, rhinoceros, sling.

BRIEF COMMUNICATION

Abdominal laparoscopic surgical techniques in megavertebrates rarely have been employed, and only one report exists in the current literature.[6] Abdominal laparoscopy in rhinoceros species is complicated by their large size, the need for appropriately sized and specifically designed equipment, and limitations associated with attempting laparoscopy in a recumbent position.[9] Abdominal laparoscopy for reproductive procedures such as the transvaginal laparoscopic approach described here is facilitated by maintenance of the anatomic relationship of the pelvic and abdominal viscera found in the standing position.[7] Although standing sedation is routinely achievable in rhinoceros species, movement of the animal and positional changes can occur.[6,7] This brief communication describes the use of a specially designed sling and inhalation anesthesia to facilitate transvaginal laparoscopy in a captive, adult, southern black rhinoceros (*Diceros bicornis minor*).

A wild-caught black rhinoceros, age greater than 30 yr old and weighing approximately 1,000 kg, was anesthetized on two separate occasions to further characterize ovarian and paraovarian pathology previously identified by ultrasonography and to attempt retrieval of oocytes after pharmacologic ovarian stimulation.

In preparation for the anesthetic events, a sling and frame (Fig. 1) was constructed to facilitate positioning of the animal at an appropriate height to allow manipulation of laparoscopic equipment via a transvaginal approach. The sling bed, constructed from vinyl truck tarpaulin, measured 90 by 150 cm and was supported by four nylon straps, each 5 cm in width, oriented perpendicular to the body of the rhinoceros and two straps, positioned in the midline of the sling bed, oriented parallel to the animal's body. Each strap had a breaking stress of 2,000 kg. Those straps positioned parallel to the rhinoceros were designed to pass between the fore- and hindlimbs of the animal and were adjustable through the use of a ratchet. Each strap was attached to an eye ring on the supporting frame by a bow shackle with a 3,250-kg load limit. The rectangular supporting frame was constructed of square steel tubing with a 65-mm outer diameter and a wall thickness of 4.5 mm. The dimensions of the frame were 122 by 230 cm, and two supporting crossbars reinforced the frame. The frame was suspended from a front-end loader by four chains with self locking hooks, each with a 2,000-kg lifting capacity.

Food and water were withheld from the animal for 36 and 12 hr, respectively, before both anesthetic events. Anesthesia was induced with etorphine (Etorphine, Vericore Ltd., Dundee, Scotland DD23XR, U.K.; 3.5 mg i.m.), azaperone (Stresnil, Boehringer Ingelheim Pty. Ltd., North Ryde, New South Wales 2113, Australia; 80 mg i.m.), and hyaluronidase (Hyaluronidase, Kyron Laboratories Pty. Ltd., Benrose 2011, South Africa; 5,000 IU i.m.) delivered by projectile syringe (Dan-inject ApS, BK-7080 Børkop, Denmark) on both occasions. After attainment of standing sedation, the rhinoceros was blindfolded, a 20-ga catheter was

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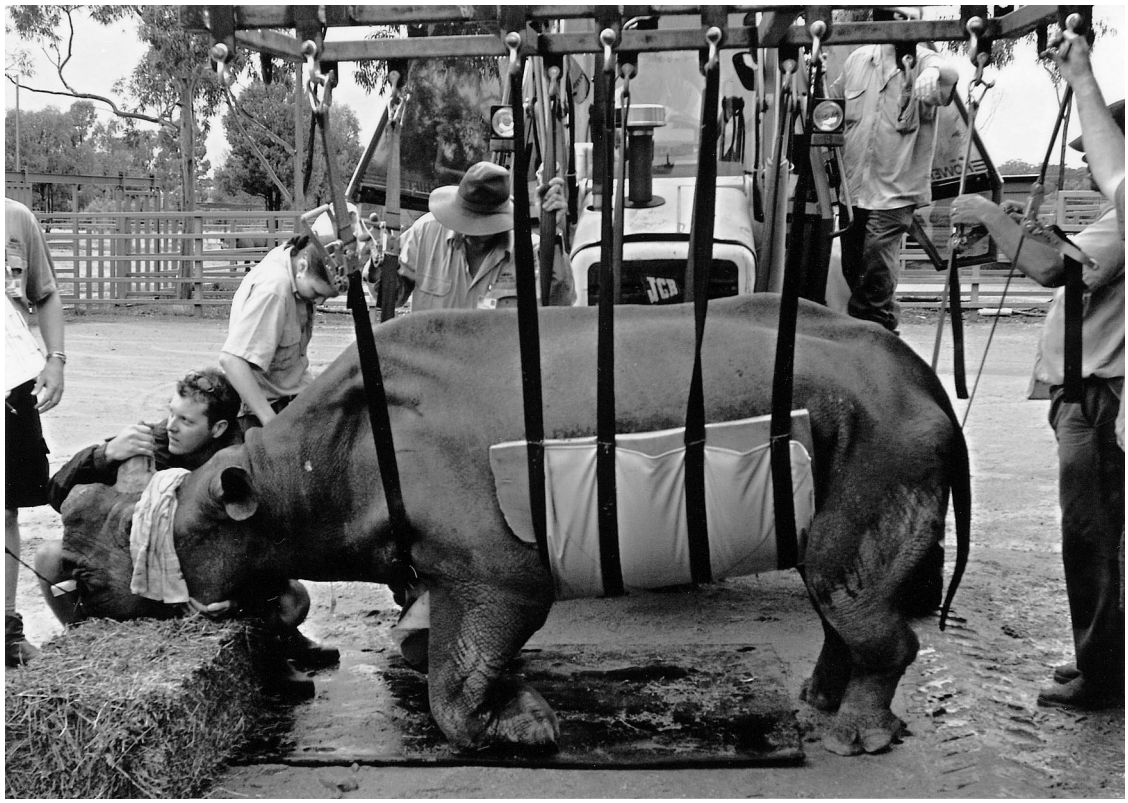

Figure 1. Female black rhinoceros after intubation and placement of a specially designed sling in preparation for transfer to the surgical site for transvaginal laparoscopy.

placed in an auricular vein of each pinna, and fluid support with compound sodium lactate (Hartmann's Solution, Baxter Healthcare Pty. Ltd., Old Toongabbie, New South Wales 2146, Australia; 4 L/hr) was initiated. The sling was positioned with a 5-cm-deep piece of foam rubber, conforming to the dimensions of the sling bed, ventral to the thorax and abdomen of the rhinoceros. The animal was then pulled into lateral recumbency onto a rubber mat and repositioned for intubation with a cuffed 26-mm endotracheal tube.

Subsequent to intubation in the first anesthetic event, the animal developed spontaneous ear and head movements and etorphine (1 mg i.m.) and ketamine (Parnell Ketamine Injection®, Parnell Laboratories Aust. Pty. Ltd., Alexandria, New South Wales 2015, Australia; 300 mg i.v.) were administered to deepen the plane of anesthesia. Approximately 2 min later, the rhinoceros became apneic, possibly because of the i.v. administration of ketamine, and spontaneous respiration occurred only intermittently until the conclusion of the procedure. Intermittent positive pressure ventilation (IPPV) with a large-animal rebreathing circuit (model VML, Matrix Medical Inc., Orchard Park, New York 14127, USA) equipped with a 30-L rebreathing bag was initiated and continued at four breaths per minute throughout the procedure. In the second anesthetic procedure, the rhinoceros required no supplemental injectable agents and breathed spontaneously throughout the procedure. Anesthesia was maintained in both instances with isoflurane (I.S.O. Inhalation Anaesthetic, Veterinary Companies of Australia Pty. Ltd., Artarmon, New South Wales 2064, Australia; 1.5–2% in oxygen at 10 L/min).

After intubation of the rhinoceros, the sling was attached to the rigid frame suspended from the bucket of a front-end loader. The rhinoceros was then suspended in the sling and repositioned over a platform constructed of hay bales. The rhinoceros was lowered toward the platform, and its head was supported by inflated tire inner tubes. Further hay bales were positioned beside the animal's thorax and abdomen to provide support and stabilization; however, the animal remained suspended in the sling throughout both procedures.

Transrectal ultrasonography was performed to

Table 1. Physiologic parameters during inhalation anesthesia and the use of a sling with a southern black rhinoceros.[a]

Time Postinduction (min)	Procedure	HR (bpm)	RR (bpm)	SpO_2 (%)	$ETCO_2$ (mm Hg)[b]
20	1	60	12	82	
	2	66	12	95	43
40	1	68	4	89	
	2	55	6	88	48
60	1	67	4 (IPPV)	88	
	2	49	6	89	49
80	1	39	4 (IPPV)	92	
	2	45	5	95	52
100	1	35	4 (IPPV)	90	
	2	37	6	91	58
120	1	34	4 (IPPV)	92	
	2	36	8	96	56
	1	30	4 (IPPV)	95	
140	2	50	9	88	50

[a] HR, heart rate; RR, respiratory rate; SpO_2, oxygen saturation; $ETCO_2$, end tidal CO_2.
[b] $ETCO_2$ not monitored in the first procedure.

assess follicular development in response to the ovarian stimulation protocol. The perineum was cleaned and disinfected with 4% chlorhexidine gluconate (E-Z Scrub 747, Becton Dickinson Canada Inc., Mississauga, Ontario L5J 2M8, Canada), and the tail was wrapped in preparation for transvaginal laparoscopy. An incision was made in the dorsal vaginal wall, and a trochar was placed before insufflation of the abdomen with carbon dioxide to a pressure of 30 mm Hg and introduction of a specifically designed, 3-m-long, flexible endoscope (ESO Endoskopietechnik, 22880 Wedel, Germany) for laparoscopic examination. Two terramycin pessaries (Tetravet Foaming Pessaries, Pharm Tech Pty. Ltd., Hornsby, New South Wales 2077, Australia) were placed in the vagina at the conclusion of each procedure.

The laparoscopic procedures were concluded 140 and 145 min after the induction of anesthesia. Isoflurane was then discontinued. In the first anesthetic event, IPPV with 100% oxygen was continued at a reduced rate of two breaths per minute with a large-animal demand valve and an oxygen cylinder until spontaneous respirations resumed approximately 15 min after cessation of isoflurane. The rhinoceros was moved off the platform and repositioned in lateral recumbency, and the sling was removed. The rhinoceros was extubated, and the etorphine was antagonized with naltrexone hydrochloride (Naltrexone, Kyron Laboratories; 150 mg i.v.). The rhinoceros was ambulatory 8 min after naltrexone administration in the first anaesthetic event but remained moderately ataxic for a further 5 min. In the second anesthetic event, the animal was ambulatory within 4 min of naltrexone administration but exhibited no ataxia. Physiologic parameters, including pulse rate, respiratory rate, percent oxygen saturation, and end tidal CO_2, were measured during the anesthetic events (Table 1). The animal was placed on trimethoprim/sulfadimidine (Trimidine Powder, Parnell Laboratories Pty. Ltd.; 5 g/25 g p.o., b.i.d. for 5 days). No postoperative problems were experienced.

The use of a sling and intubation of the rhinoceros were instrumental to the success of the transvaginal laparoscopic approach. The use of a sling to attain and recover from lateral recumbency in an anesthetized Asian elephant has been described.[4] The rhinoceros, in this case, would not tolerate the sling before the induction of anesthesia, as described for the elephant, so the sling was applied after induction of standing sedation. In a previous report of abdominal laparoscopy in a white rhinoceros, standing sedation with a combination of butorphanol and azaperone produced adequate analgesia and restraint for the procedure.[7] Standing sedation was not deemed appropriate in this case because the oocyte retrieval attempt required the animal to be rigidly immobile.

Intubation of the animal and maintenance of anesthesia with isoflurane was deemed necessary because of the anticipated long duration of the procedure and to provide IPPV, if required, because the sling and abdominal insufflation were expected to increase abdominal pressure, consequently producing a degree of respiratory compromise. Intu-

bation and maintenance of anesthesia with inhalation agents has been described in a small number of rhinoceros.[1–3,5,8] Despite the use of a potent, opioid-based anesthesia protocol and the potential for respiratory compromise associated with pressure from the sling and abdominal insufflation, pulse oximetry values were comparable to those reported in a white rhinoceros undergoing standing sedation for abdominal laparoscopy.[6,7]

Specifically designed equipment and intubation of the rhinoceros to provide respiratory support and maintenance of anesthesia were necessary for appropriate positioning of the animal and to maintain a prolonged and controlled plane of analgesia and restraint. Despite the smaller size of the black rhinoceros compared with the white rhinoceros (*Ceratotherium simum*) and greater one-horned rhinoceros (*Rhinoceros unicornis*), this anesthetic approach could be modified and applied to the two larger species for similar procedures. The combination of a sling system and volume-controlled ventilation anesthesia provided an alternative approach to standing sedation for laparoscopic access to the reproductive tract in this female black rhinoceros.

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