Anaesthesia of gemsbok (*Oryx gazella*) with a combination of A3080, medetomidine and ketamine

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ABSTRACT

An effective anaesthesia protocol was developed for adult free-ranging gemsbok *(Oryx gazella)* using a combination of A3080, medetomidine and ketamine. A short induction time; good muscle relaxation, adequate oxygenation and stable heart rate and respiration rate characterised this anaesthetic regime. Equal doses of A3080 and medetomidine (22–45 µg/kg) plus 200 mg of ketamine were administered to each animal. The anaesthesia was rapidly and completely reversed by intramuscular naltrexone at a dose of $\bar{X}$ = 0.9 ± 0.2 mg/kg and atipamezole at a dose $\bar{X}$ ± 90 ± 20 µg/kg. No mortality or morbidity occurred with this protocol.

Key words: A3080, anaesthesia, atipamezole, gemsbok, ketamine, medetomidine, naltrexone, *Oryx gazella,* oxygen saturation.

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INTRODUCTION

The gemsbok is a popular and economically important species on game farms and is a flagship animal in certain South African National Parks. Their preferred habitat is open grasslands, but they can also be found in open woodlands. Gemsbok are considered to be nervous and highly aggressive and less tractable than roan or sable antelope. They resist handling when semi-immobilised and their strength and long sharp horns make them very dangerous unless properly anaesthetised[2,10]. Safe and reliable anaesthesia of gemsbok has been difficult with currently available anaesthetics. Most anaesthetic protocols use either etorphine (3–7 mg) or fentanyl (50–60 mg) combined with tranquillisers such as azaperone (60–100 mg) or xylazine (15–50 mg)[2,3]. The induction time with this combination can be prolonged, up to 12 min. Following darting, and before becoming recumbent, they may develop a forced pacing gait or running behaviour, characteristic of reaction to an opioid in many ungulates. In this state, gemsbok may run for long distances (up to several kilometres) with the possible development of hyperthermia and/or capture myopathy. Stubborn animals or semi-immobilised gemsbok often exhibit muscle rigidity, vocalisation, and chewing movements, and fight against manipulation[3,9,11], and these cases require additional anaesthetic supplementation to enable safe handling[2].

Previous studies using the synthesised fentanyl derivative (A3080) have shown that it is a rapid-acting opioid with a shorter duration of action than carfentanil or etorphine and it is reported to be slightly less potent than carfentanil[14,15]. A3080 has been demonstrated to shorten induction time compared to carfentanil in cervids by 26–65%[8]. A study using A3080 alone in impala showed a general relationship between dosage and induction times[7]. The anaesthesia produced when A3080 is used alone in some species is characterised by extensive muscle rigidity, the hallmark of opioid anaesthesia in most large ungulates[15], which makes manipulation difficult and often dangerous to personnel. The animal in this state is also very difficult to intubate if oxygen supplementation is required. Narcotic antagonists such as naltrexone (NAL) provide rapid and complete reversal of A3080 with no reports of re-narcotisation[7,8,14,15].

A pilot study was conducted as part of a capture operation in May 1998 using a combination of A3080 (A3080, Wildlife Pharmaceuticals) and ketamine (KET) (Ketamine 200 , Wildlife Pharmaceuticals) in the Karoo National Park, South Africa. In this operation, which lasted 4 h, 14 adult male and female gemsbok were darted from a helicopter, immobilised and loaded into trucks for transportation. The dosage of A3080 was either 4 mg (n = 5), 5 mg (n = 8) or 6 mg (1 large male) plus a standard dose of 200 mg of KET per animal. All animals showed initial signs in less than 2 min and were sternally recumbent within 2–4 min after running about 500 m. Marked muscle rigidity, struggling, vocalising and chewing movements were noted. Intravenous KET (100–200 mg/animal) had to be administered to partially relax animals so that they could be safely handled before being transported and loaded into the waiting truck. These gemsbok had increased respiration rates (50–70 breaths/min). No other physiological data were collected during this capture operation. Intramuscular NAL (Trexonil®, Wildlife Pharmaceuticals) (80–120 mg/animal) reversed the effects of the A3080 anaesthesia within 10 min. The period of ataxia following anaesthesia reversal was shortest in those animals that received 120 mg of NAL. There was no residual sedation that could have been attributed to the KET. The safety and success of this operation prompted a more complete physiological study on the use of A3080 in this species.

Medetomidine (MED) (Medetomidine, Wildlife Pharmaceuticals) is an imidazole-based compound with potent selective and highly specific agonist activity at both pre- and post-synaptic alpha$_2$-adrenoreceptors[17,18]. It has an alpha$_2$-adrenergic binding affinity that is 10 times greater than the commonly-used sedative xylazine[6,17]. Medetomidine is a potent sedative and analgesic with anxiolytic properties and at high doses produces hypnotic or anaesthetic effects[6,15]. Medetomidine combined with KET has been demonstrated to be effective in a broad range of non-domestic ungulates[6]. Ketamine has a synergistic effect combined with MED in cervids[6,16] and has been observed to potentiate synthetic opiates in bovids[12,13]. MED has been used alone for short-duration anaesthesia in

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Table 1: **Summary of the doses of the anaesthetic and reversal drugs and their effects on gemsbok.**

Parameter	Mean ± SD	Range
Mass (kg)	198 ± 24	138–240
MED and A3080 (µg/kg)	29 ± 7	22–45
KET (mg/kg)	1.0 ± 0.1	0.8–1.5
Initial signs	1:31 ± 0:19[a]	0:50–2:06
Recumbency	3:18 ± 1:04	1:40–5:20
ATP(µg/kg)	90 ± 20	60–140
NAL (mg/kg)	0.9 ± 0.2	0.6–1.4
Standing (min)	5:25 ± 1:50	2:45–9:13

[a]min:sec.

Arabian oryx with good results[4]. When prolonged anaesthesia was desired (3 h) for relocation of Arabian oryx, MED was combined with etorphine[1]. Atipamezole (AP) (Antisedan, Orion Corp., Orion-Farmos) is a potent and selective alpha$_2$-adrenoreceptor that antagonises the effects of MED[6,18].

The objective of this study was to determine whether the rapid induction potential of A3080 could be combined with the potent selective alpha$_2$ -agonist effects of MED and the dual synergistic effect of KET to result in a predictable rapid balanced anaesthesia in free-ranging gemsbok. The hypothesis was that the protocol would ensure adequate muscle relaxation for safe handling for both animals and personnel under field conditions.

During anaesthesia the physiological parameters for cardiovascular and respiratory function should be maintained within an acceptable range. The chosen anaesthetics should be reversible to facilitate the immediate release of the animal back into its environment with no post-anaesthetic sedation or complications.

MATERIALS AND METHODS

The gemsbok in this study were free-ranging in the Vaalbos National Park, South Africa, during June 1999. The animals included both subadult and adult males and females. They were in good physical condition and their pelage was considered to be good for the season and available indigenous vegetation.

Anaesthetics used in this study were A3080 (10 mg/mℓ), MED (20 mg/mℓ) and KET (200 mg/mℓ) formulated as sterile injectable solutions in multidose vials. The drugs were delivered by a CO_2-powered remote injection device delivering a 3-mℓ plastic air-pressurised dart with a 40 mm collared needle (Dan-Inject SA) to insure a deep intra-muscular (i.m.) injection.

Group 1 consisted of 2 adult male gemsbok chased by helicopter into a boma before darting. The doses of A3080 given were (32 and 36 µg/kg) plus 200 mg KET per animal (1.1 and 1.4 mg/kg).

Group 2 consisted of 18 free-ranging gemsbok (8 males, 10 female) that received equal doses of A3080 and MED (22–45 µg/kg) plus 200 mg KET (0.8–1.0 mg/kg). The dose of A3080 and MED was adjusted according to a visual evaluation of the animal's mass and the success of previous anaesthetic procedures. The gemsbok were darted from a helicopter.

Initial data collected included time from dart delivery to first signs of drug effect and the time until the animal became recumbent. Physiological data collected once the animal could be handled included heart rate, respiration rate, oxygen saturation by pulse oximetry (Nellcor N-200, Nellcor Incorp.) and rectal temperature. The degree of muscle relaxation and response to ear and eye stimulation were subjectively evaluated. The physiological data were collected at 5 min intervals for 15 min. The gemsbok were weighed before reversal of the anaesthetics.

The anaesthetic effect A3080 and MED was reversed using i.m. injections of NAL and AP. The time interval to standing and the completeness of the reversal were recorded.

RESULTS

The 2 males in Group 1 that received A3080 and KET developed initial signs in less than 1:30 (min:sec) and were recumbent in less than 2:30. The quality of anaesthesia was considered to be poor, since the animals were struggling, responsive to noise, difficult to restrain and dangerous to handle. Limited physiological data were obtained on these animals and included respiration rates of 40–48/min, heart rates of 120 and 208/min, oxygen saturation of 80–83% and rectal temperatures of 41.9–42.1 °C. These gemsbok weighed 138 and 186 kg respectively. Owing to the poor response the procedure was aborted by giving i.m. NAL (1.0 mg/kg). The gemsbok were standing within 1:35 and rapidly returned to their normal state.

The responses of the gemsbok in Group 2 that received the A3080, MED and KET combination are presented in Table 1, which indicates their body mass $\overline{X}$ = 198 ± 24 kg (mean ± SD). The time to initial signs was also rapid at $\overline{X}$ = 1:31 ± 0:19, with recumbency occurring at $\overline{X}$ = 3:18 ± 1:04 following a brief period of progressive and marked ataxia. Neither the onset nor time to recumbency were affected by increasing the dose of the A3080/MED combination. All animals went down in sternal recumbency in a controlled manner and maintained it if left alone for 5 min. During this remote observation period we monitored respiratory rate and depth to ensure that the animal was not apnoeic or hypoventilating. If an animal was approached too soon after recumbency it would often attempt to rise and then fall onto its side. The quality of the anaesthesia was considered to be fair to good based on the degree of muscle relaxation and ease of handling. When approached after going down, most animals would undergo a brief period of teeth grinding and vocalisation for up to 5 min. These responses ceased as the anaesthesia deepened over time. The improved quality of the anaesthesia was subjectively correlated with the administration of increasing doses of A3080/MED. Minimal salivation was noted.

The physiological data recorded over the 15 min monitoring period from gemsbok in Group 2 are summarised in Table 2. The oxygen saturation, respiration and heart rates remained constant

Table 2: **Physiological data over 15 minutes of monitoring for 18 gemsbok that received A3080, medetomidine and ketamine.**

Parameter	0 min	5 min	10 min	20 min
Respiration rate (min)	73 ± 31	72 ± 23	70 ± 21	73 ± 23
Heart rate (min)	79 ± 16	82 ± 15	71 ± 18	66 ± 15
O_2 saturation (%)	86 ± 6	82 ± 15	84 ± 13	85 ± 6
Rectal temperature (°C)	39.4 ± 1.0	39.6 ± 1.0	39.7 ± 1.0	39.7 ± 1.0

throughout the monitoring period. The rectal temperature was 39.4 ± 0.9 °C, and rose only slightly to 39.7 ± 0.9 °C at the end of the monitoring period.

The anaesthetic procedure was rated as good in 16 gemsbok. It was rated as fair in 2 animals because of an increase in muscle tone. All animals failed to respond to tactile stimulation of the eyes and ears suggesting that a level of anaesthesia was present.

The rates and characteristics of the recovery were comparable. Following i.m. injection of the antagonists (NAL and AP) the recovery time to standing averaged 5:19 ± 1:51. Recovery was rapid and smooth, with the animals first gaining control of their head in a sternal position, followed by a rapid rise to a standing position and then moving off within 30 sec with little to no noticeable ataxia.

DISCUSSION

Ketamine was administered at a constant total dose of 200 mg/animal. Ketamine has synergistic properties with MED[6], which we also noted in the pilot study in the Karoo in 1998 where KET supplements allowed safe manipulation of the gemsbok. Synergism with opioids has been reported to improve the quality of the anaesthesia and decrease the amount of opioid required in bovids[12,13]. No residual sedation was seen that could be attributed to the dosage of KET following the reversal of A3080 and MED.

The animals in Group 1 showed rapid onset of anaesthesia and short time to recumbency, but the quality of the anaesthesia was very poor owing to the extreme muscle rigidity and struggling. In Group 2 the rigidity induced by the opioid A3080 was effectively reduced by addition of MED to the combination. During induction the animals rapidly progressed through the trotting gait phase as the anaesthetic took effect. They ran only 300–500 m before becoming sternally recumbent. The MED addition had the net effect of maintaining a rapid onset leading to sternal recumbency combined with a relaxed and manageable animal.

The physiological parameters measured during this study were within acceptable ranges (Table 2). All animals exhibited an initial increased panting respiration, which was attributed to the effect of MED, as noted in some species such as markhor[5]. The O_2 saturations were marginally low but tidal volume and respiratory rate appeared adequate. The O_2 saturation recorded by pulse oximetry may have been artificially low owing to the peripheral vasoconstriction effect of MED[6]. The heart rate was also stable during monitoring. Our dose rates for MED and A3080 covered a 2-fold range, yet the induction times and the physiological parameters remained stable with similar averages and ranges. This stability of physiological parameters was also reported in impala with increasing dosages of A3080[7].

The antagonists NAL and AP were given i.m. in all animals and resulted in a controlled, rapid and complete reversal. When these drugs were given intravenously in other species the reversal was very rapid, with the animal having a tendency to stumble or crash into fixed objects immediately upon rising.

The safety of this protocol is demonstrated by acceptable physiological parameters seen over the wide effective dose range of A3080 and MED of 22–45 µg/kg. This is useful when the exact mass of the free-ranging animal may be difficult to estimate. Another characteristic of this anaesthesia was that the gemsbok in this study group did not experience the elevated temperature that can occur during opioid anaesthesia.

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