Determination of an optimal dose of medetomidine-ketamine-buprenorphine for anaesthesia in the Cape ground squirrel (*Xerus inauris*)

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ABSTRACT

The optimal dose of medetomidine-ketamine-buprenorphine was determined in 25 Cape ground squirrels (*Xerus inauris*) undergoing surgical implantation of a temperature logger into the abdominal cavity. At the end of anaesthesia, the squirrels were given atipamezole intramuscularly to reverse the effects of medetomidine. The mean dose of medetomidine was 67.6 ± 9.2 μg/kg, ketamine 13.6 ± 1.9 mg/kg and buprenorphine 0.5 ± 0.06 μg/kg. Induction time was 3.1 ± 1.4 min. This produced surgical anaesthesia for 21± 4.2 min. Atipamezole 232 ± 92 μg/kg produced a rapid recovery. Squirrels were sternally recumbent in 3.5 ± 2.2 min.

Keywords: anaesthesia, atipamezole, buprenorphine, Cape ground squirrel, ketamine,, medetomidine, *Xerus inauris.*

Joubert K E, Serfontein T, Scantlebury M, Manjerovic M B, Bateman P W, Bennett N C, Waterman J M **Determination of an optimal dose of medetomidine-ketamine-buprenorphine for anaesthesia in the Cape ground squirrel (*Xerus inauris*)**. *Journal of the South African Veterinary Association* (2011) 82(2): 94–96 (En.). Pharmacology, Department of Paraclinical Studies, Faculty of Veterinary Science, University of Pretoria, Private Bag X04, Onderstepoort, 0110 South Africa.

INTRODUCTION

The Cape ground squirrel (*Xerus inauris*) inhabits hot and arid areas of southern Africa. Ground squirrels have been suggested to use both behavioural and physiological means to adapt to the extremes of temperature they encounter. For example, they may use their tail as a parasol to reduce solar radiation[1] or retreat to cool burrows as a thermal refuge during the day[6] in order to regulate body temperature (T_b). The present study utilised 2 populations of squirrels, 1 from an open plain with little or no shade and a 2nd population from a location surrounded by shady thorn trees. The reason for anaesthetising the squirrels was to implant miniature temperature loggers (iButtons® DS1922L ± 0.0625 °C; Thermochron, Dallas Semiconductors, Maxim Integrated Products, Inc., Sunnyvale, CA) into the abdomen of the squirrels to monitor T_b and relate this to environmental and behavioural data. The anaesthetic requirements for this project were a rapid induction, sufficient anaesthetic duration to complete implantation of the loggers and a rapid recovery before being returned to their colonies. The surgery and anaesthesia were performed in the field where minimal equipment was available.

Ketamine has been used for the immobilisation of the Cape ground squirrel[18]. High doses of ketamine (40–50 mg/kg) were required for complete immobilisation of the squirrels[18]. No recovery times were recorded[18]. In Richardson's ground squirrel (*Spermophilus richardsonii*), ketamine at 86 mg/kg, droperidol (2.6 mg/kg) and fentanyl (52 μg/kg), and pentobarbitone (50 mg/kg) failed to produce surgical anaesthesia[15]. Xylazine (10 mg/kg) and ketamine (85 mg/kg) administered either subcutaneously or intramuscularly produced surgical anaesthesia in Richardson's ground squirrel[15]. Medetomidine-ketamine anaesthesia has been successfully used for the induction of anaesthesia in dogs[7,8,11,12,14,16,20], cats[17], mice[5], horses[2] and wildlife (impala and badgers)[3,13]. Medetomidine-ketamine has been shown to produce a rapid induction, provide adequate analgesia for surgery and a rapid recovery when reversed with atipamezole. On this basis medetomidine-ketamine was selected for anaesthesia. Antagonism of medetomidine generally results in reversal of the analgesic effects. For this reason, buprenorphine was administered for post-operative analgesia.

MATERIALS AND METHODS

Twenty-five squirrels from the SA Lombard Nature Reserve (3660 ha, 18 km northwest of Bloemhof, South Africa, 27°35'S, 25°23'E) were captured in Tomahawk wire-mesh traps (15 × 15 × 50 cm) as previously described[9,18]. Thirteen males and 12 females were captured. Their mean weight was 625.2 ± 70.2 g (males 632.2 ± 84.9 g, females 618.8 ± 52.7 g). Females and resident males were trapped for implantation of temperature loggers. Five migratory males were caught. These males were anaesthetised for the placement of radio-collars (1), body measurements (1) and collection of semen (3) and their data were excluded from analysis. An initial dose of medetomidine (Domitor, Pfizer Animal Health) of 0.03 mℓ (50 μg/kg) and ketamine (Anaket V, Centaur Laboratories, Isando) of 0.075 (15 mg/kg) was chosen. If anaesthesia was unsuccessful the doses of medetomidine and ketamine were increased by 0.01 mℓ and 0.025 mℓ, respectively until appropriate anaesthetic levels were achieved. The medetomidine and ketamine were administered in the same insulin syringe (1 mℓ BD U-100 Insulin Syringe, Manta Medical, Bryanston). Buprenorphine (Temgesic, Schering Plough, Isando) was administered at a standard dose of 0.1 mℓ per squirrel in a separate insulin syringe. All injections were given intramuscularly into the lumbar epaxial muscles. Following induction of anaesthesia, the abdomen was shaved and prepared for surgery following standard aseptic techniques. During preparation potassium clavulanate and amoxicillin trihydrate (Synulox RTU, Pfizer Animal Health) (20 mg/kg) was administered subcutaneously. An incision approximately 15 mm in length was made in the ventral midline between the xiphoid and the umbilical scar. The temperature logger was then

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Table 1: **Data collected from the squirrels include weight, sex, doses of drugs administered and times.** N/R indicates the data were not recorded.

Squirrel no.	Weight (g)	Sex	Medetomidine (µg/kg)	Ketamine (mg/kg)	Buprenorphine (µg/kg)	Induction time (min)	Anaesthetic time (min)	Surgery time (min)	Atipamezole (µg/kg)	Recovery time (min)	Procedure	Comments
2	580	Female	68.97	17.24	51.72	5	16	N/R	344.83	11	Celiotomy	Discordant recovery
3	660	Female	60.61	12.12	45.45	5	14	8	303.03	4	Celiotomy	
4	600	Male	66.67	13.33	50.00	2	16	9	333.33	3	Celiotomy	
5	620	Female	64.52	12.90	48.39	3	22	11	322.58	2	Celiotomy	
6	700	Male	85.71	14.29	42.86	4	23	10	428.57	4	Celiotomy	
8	600	Female	66.67	13.33	50.00	2.5	16	10	333.33	3	Celiotomy	
9	605	Female	66.12	13.22	49.59	4	22	8	330.58	3	Celiotomy	
10	620	Female	64.52	12.90	48.39	2	23	10	161.29	1	Celiotomy	
11	650	Female	61.54	12.31	46.15	6	19	10	153.85	3	Celiotomy	
14	560	Female	71.43	14.29	53.57	2	23	11	178.57	5	Celiotomy	
16	515	Female	77.67	15.53	58.25	2	25	8	194.17	5	Celiotomy	
17	660	Male	60.61	12.12	45.45	1	21	12	151.52	1	Celiotomy	
18	450	Male	88.89	17.78	66.67	5	21	10	222.22	5	Celiotomy	
19	680	Male	58.82	11.76	44.12	3	20	N/R	147.06	3	Celiotomy & collar	
20	640	Male	62.50	12.50	46.88	2	30	10	156.25	1	Celiotomy	
21	710	Female	56.34	11.27	42.25	2	25	8	140.85	3	Celiotomy	
23	500	Male	80.00	16.00	60.00	3	28	6	200.00	2	Celiotomy	
24	675	Female	59.26	11.85	44.44	2	18	7	148.15	4	Celiotomy	
25	630	Female	63.49	12.70	47.62	4	19	13	158.73	3	Celiotomy	
Mean	613.42		67.60	13.55	49.57	3.13	21.11	9.47	232.05	3.47		
S.D.	68.90		9.21	1.86	6.29	1.39	4.20	1.81	91.75	2.22		
Median	620		64.52	12.9	48.39	3.00	21.00	10.00	194.17	3.00		
Squirrels excluded from the study												
1	570	Male	52.63	13.16	52.63			15	263.16	5	Celiotomy	Not completely anaesthetised
12	725	Male	82.76	11.03	0.00	1	30	n/a	206.90	5	Ejaculation	
22	635	Male	62.99	9.45	0.00	5	15	n/a	157.48	5	Collar	
15	750	Male	80.00	13.33	0.00	2	25	n/a	200.00	5	Measurements	
7	635	Male	62.99	9.45	0.00	1.2	40	n/a	314.96	N/R	Ejaculation	
13	660	Male	60.61	9.09	0.00	2	35	n/a	151.52	7	Ejaculation	

inserted into the abdomen. The linea alba was closed with 4/0 Nylon (Ethicon, Johnson & Johnson, Midrand) and the subcutaneous tissue and skin with 4/0 PDS (Ethicon, Johnson & Johnson) in a standard fashion. The squirrels' heart rate and respiration were monitored using a multiparameter physiological monitor (Dash 4000, GE Electronics, Midrand) following standard anaesthetic procedures for patient safety. The data are not presented. The anaesthesia was reversed with a volume of atipamezole (Antisedan, Pfizer Animal Health) equal to the total volume of medetomidine administered for immobilisation. Squirrels used for semen collection, measurement and radio transmitter placement did not receive buprenorphine.

The time from injection of medetomidine-ketamine and buprenorphine until loss of response to a paw pinch (induction time), the duration of anaesthesia (induction to recovery), the duration of surgery, the time from induction to the injection of atipamezole (anaesthetic time) and the time to return of the righting reflex following the administration of atipamezole (recovery time) were recorded. Any adverse anaesthetic or surgical events were recorded.

Descriptive statistics were used to describe the data collected. Data were normally distributed. A *t*-test was used to examine differences between males and females with respect to the following variables: weight, induction time, duration of surgery, recovery time, anaesthetic time and doses of drugs administered per kg. Statistical significance was set at $P < 0.05$. This study was approved by the Animal Use and Care Committee of the Universities of Central Florida and Pretoria and complied with their guidelines for animal research (UCF IACUC #07-43W).

RESULTS

The male and female groups were not statistically different with respect to weight, induction time, duration of surgery, recovery time, anaesthetic time and doses of drugs administered per kg and their data were analysed together. Data for all 25 squirrels are presented in Table 1. The reason for excluding some data is that buprenorphine was not administered, no surgery was performed and the duration of anaesthesia was variable. Temperature loggers were implanted into 20 squirrels (8 males, 12 females). The 1st squirrel was excluded from analysis as the dose of drugs administered was insufficient to complete the surgery. The doses of medetomidine and ketamine were increased after this squirrel. This left 19

squirrels (7 males, 12 females) in which the procedure was successfully completed with the initial doses administered. The mean dose of medetomidine was 67.6 ± 9.2 μg/kg, ketamine 13.6 ± 1.9 mg/kg and buprenorphine 0.5 ± 0.06 μg/kg. Squirrel no. 2 had a rough recovery characterised by excitement and the dose of ketamine was reduced for the following squirrels by 5 mg/kg. The remaining 18 squirrels were successfully managed with the combination described and had satisfactory recoveries.

DISCUSSION

This study showed that a combination of medetomidine, ketamine and buprenorphine provided rapid surgical anaesthesia that was rapidly reversed at the end of the procedure with atipamezole. Ketamine alone does not completely immobilise Cape ground squirrels at doses between 10 and 25 mg/kg while doses of 40–50 mg/kg are required for complete immobilisation[18]. In the Richardson's ground squirrel, 86 mg/kg of ketamine alone did not produce surgical anaesthesia[15]. The combination of xylazine and ketamine did produce surgical anaesthesia of 20–30 min duration[15]. This duration of anaesthesia would be sufficient to allow for the implantation of temperature loggers[15]. Medetomidine was chosen over xylazine due to greater potency, more specific affinity for alpha$_2$ receptors and its safety when used in wild animals in combination with ketamine[4,10,19].

The induction time for xylazine-ketamine was 1.3 min[15] compared with the 3.1 min in our study. The longer duration for induction observed in the present study is most probably due to the lower dose of ketamine used, 86 mg/kg[15] compared with 13.6 mg/kg. The squirrels could be handled within a minute of administration of the immobilising drugs intramuscularly (loss of righting reflex) but would be responsive to pain stimuli. The present study's induction time was to the point of not responding to painful stimuli (paw pinch reflex). Handling of the immobilised squirrels was possible before the end of the induction time. In the present study squirrels were only handled once they were anaesthetised.

Recovery times (3.5 min) observed in the present study were faster than those reported for xylazine-ketamine (16–19 min)[15]. This is most probably the result of administration of an antagonist at the end of the procedure. With the exception of squirrel number 2, all recoveries were smooth and uneventful. It was thought that the rough recovery in squirrel number 2 could have been due to the residual effects of ketamine after the reversal of the medetomidine.

The combination of medetomidine, ketamine and buprenorphine produced satisfactory anaesthesia for 20 min and recovery from anaesthesia was rapid following the administration of atipamezole in Cape ground squirrels. This combination produced an adequate depth of anaesthesia for surgery.

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