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Reversible Immobilization of Free-ranging African Lions (*Panthera leo*) with Medetomidine-tiletamine-zolazepam and Atipamezole

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ABSTRACT: A combination of medetomidine-tiletamine-zolazepam was used to conduct six immobilizations of free-ranging lions (*Panthera leo*) in Waza National Park, Cameroon, during 1999 and 2000. Drugs were administered by dart injection at 0.07±0.01 (mean±SD) mg/kg of medetomidine and 1.8±0.5 mg/kg of tiletamine-zolazepam. Chemical immobilization was characterized by smooth inductions (14.1±6 min), satisfactory analgesia, and muscle relaxation. One animal was treated for bradypnea. No major alterations of physiologic parameters (heart and respiratory rates, rectal temperature) were seen during immobilization in the other lions. Relative arterial oxygen saturation was measured in two animals and revealed mild hypoxemia. The animals received atipamezole at 0.3±0.1 mg/kg intramuscularly for reversal of anesthesia. Recoveries were uneventful. All animals were radiocollared, and no mortalities occurred during an 18-mo follow-up period. Use of medetomidine-tiletamine-zolazepam for anesthesia and reversal of anesthesia with atipamezole appear to be useful for reversible immobilization of free-ranging lions.

Key words: Anesthesia, atipamezole, immobilization, lion, medetomidine, *Panthera leo*, tiletamine, zolazepam.

Ideally, drugs used for the capture of free-ranging animals should rapidly induce reliable and reversible immobilization. Various drugs and drug combinations have been used for immobilization of free-ranging lions (*Panthera leo*), including phencyclidine (Melton et al., 1987), ketamine-xylazine (Herbst et al., 1985; Stander and Morkel, 1991), tiletamine-zolazepam (King et al., 1977; Stander and Morkel, 1991), and medetomidine-ketamine (Quandt, 1992; Bengis and Keet, 2000). In large felids, tiletamine-zolazepam has been the drug combination of choice for immobilization (Kreeger et al., 2002). This combination has a wide safety margin and few cardiopulmonary or thermoregulatory side effects, but as a result of the long elimination half-life of tiletamine and the lack of an antagonist, recoveries are often prolonged. In combination with medetomidine, however, the effective dose of tiletamine-zolazepam can be reduced by as much as 75% in several species (Cattet et al., 1999; Caulkett et al., 1999; Kreeger et al., 2002) and the recovery time thereby significantly shortened by antagonizing the effects of medetomidine with atipamezole. Here, we present data from the successful use of medetomidine-tiletamine-zolazepam and atipamezole for reversible immobilization of free-ranging lions.

Six immobilizations were carried out on five lions in Waza National Park, Cameroon (10°50′–11°40′N, 14°20′–15°00′E) during the dry seasons of 1999 and 2000 as part of a current study on behavioral ecology. These included two males (lions 1 and 2; age, 6–12 yr; estimated body weight, 150–180 kg) and three females (lions 3, 4, and 6; age, 5–7 yr; estimated body weight, 90–150 kg). Lion 2 was immobilized a second time as lion 5. Animals were immobilized with a mixture of medetomidine (10 mg/ml; Zalopine®, Orion Pharma Animal Health, Turku, Finland) and tiletamine-zolazepam (500 mg dry substance; Zolétil®, Virbac SA, Carros, France). Standard doses of from 8 mg to 10 mg of medetomidine and

from 200 mg to 250 mg of tiletamine-zolazepam were administrated to males, and doses of from 5 mg to 10 mg of medetomidine and from 125 mg to 250 mg of tiletamine-zolazepam were given to females. The drugs were administered into the muscles of the hind limb using a CO_2-powered dart gun (Dan-Inject® ApS, Børkop, Denmark) and 1.5 ml plastic air-pressurized darts with 2×30-mm collared needles (Dan-Inject®). Lions were darted during daylight hours from a car at a range of from 12 m to 20 m (Yardage Pro® 500, Bushnell Corporation, Overland Park, Kansas, USA). Lengths of procedures were recorded from the time of darting until full recovery.

After complete immobilization was evident, with no signs of spontaneous movement, the lions were shaded and kept in lateral recumbency. Ophthalmic ointment (Aureomycine Specia® 1%, Rhône-Poulenc-Rorer, Paris, France) and a blindfold were applied. Each lion was clinically examined. Heart rate was determined by stethoscopic chest auscultation in lions 1 through 4 and by pulse oximetry in lions 5 and 6 (Nellcor® N-20P, Nellcor Inc., Pleasanton, California, USA) with the sensor (VetSat®, Nellcor) attached to the tongue. Respiratory rate was determined by observing thoracic movements. Rectal temperature was measured with a digital thermometer (Cooper, Melun, France). Assessment of the depth of immobilization was based on signs of spontaneous movement; muscle relaxation was determined subjectively on the basis of lack of muscle tone in limbs. Because of the high ambient temperatures (up to 46 C), the animals were frequently sprayed with water.

Lions were radiocollared with VHF transmitters (Telonics®, Arizona, USA). Blood and tissue samples were collected for genetic, biochemical, and serologic analyses. Dart wounds were treated, and prophylactic, long-acting antibiotics were administered intramuscularly (Oxytétracycline® 10%, Vetoquinol SA, Lure, France). Each lion was weighed using a portable scale and sling for calculation of actual drug doses per kilogram of body mass. At the end of the procedure, atipamezole (5 mg/ml; Antisedan®, Orion Pharma Animal Health) was administered intramuscularly in the thigh at the following atipamezole : medetomidine (mg : mg) dose ratios: lion 1, 3.3; lions 2 and 3, 2.5; lion 4, 2.1; lion 5, 5.0; and lion 6, 5.8. Animals were observed until full recovery was evident (i.e., no residual drug effects and coordinated walking).

The first four immobilized lions were in good health. Lion 5 was immobilized for inspection of a wound on the right front leg, and lion 6 was immobilized for health assessment because of poor body condition. The body mass was 120±33 (80–165) kg (mean±SD [range]). Calculated drug doses were 0.07±0.01 (0.05–0.10) mg/kg of medetomidine and 1.8 ±0.5 (1.3–2.7) mg/kg of tiletamine-zolazepam. Three lions required additional drugs, which were injected intramuscularly during the immobilization: Lion 1 received 1.20 mg of medetomidine and 62.5 mg of tiletamine-zolazepam, lion 4 received 0.85 mg of medetomidine and 20.5 mg of tiletamine-zolazepam because of suboptimal placement of the dart, and lion 6 received 0.90 mg of medetomidine and 23.0 mg of tiletamine-zolazepam because of a prolonged procedure. Atipamezole was administered at the dose of 0.3±0.1 (0.1–0.5) mg/kg.

Flight distances after darting were less than 290 m. Induction time (i.e., time from darting until recumbency) was 14.1±6.0 (6.6–22.2) min. Because of dense vegetation, lion 1 was found 18.8 min after darting (recorded as induction time). For lion 3, the induction time could not be recorded precisely but was less than 8.0 min. The signs of the drug effect generally occurred in the following order: tail down, ataxia, sitting down, and then recumbency.

Inductions were smooth, and all lions became completely immobilized. Analgesia (assessed by pinching of the skin) and muscle relaxation were adequate and

allowed minor surgical procedures, such as treatment of a superficial bullet wound for lion 5. Handling time (i.e., time from darting to administration of atipamezole) was 53.8±18.4 (34.0–55.5) min, and time from administration of atipamezole until the animal was standing was 134.7±133.1 (14.6–338.8) min. Signs of recovery started with palpebral movements; movement of ears, head, limbs; and finally, attempts to sit and stand. Recoveries were smooth, and no signs of overalertness, muscle rigidity, incoordination, or vomiting were observed. Time from standing until the animal was able to walk in a coordinated manner was 88.7±79.0 (13.0–206.2) min.

Physiologic data were collected at 5-min intervals. Heart rates recorded at 5, 20, and 30 min after approaching the immobilized animal were 57±13 (35–68), 56±18 (33–72), and 54±16 (31–68) beats/min, respectively, and respiratory rates were 18±2 (16–20), 16±3 (12–20), and 18±2 (16–20) breaths/min, respectively. Rectal temperature was 38.1±1.5 (35.8–39.8) C, 38.4±1.4 (36.3–40.2) C, and 38.0±1.4 (35.7–39.3) C at 5, 20, and 30 min, respectively. Capillary refill times were less than 2 sec, and mucous membrane color was normal. Side effects were observed in lion 3, which had a respiratory rate as low as 9 breaths/min at 25 min after darting; this individual was treated with 5 mg of epinephrine intramuscularly (1.0 mg/ml; Adrenaline®, Nycomed Pharma AS, Oslo, Norway). Relative arterial oxygen saturations for lions 5 and 6 were, respectively, 94% and 96% after 5 min, 87% and 92% after 20 min, and 89% and 91% after 30 min. Lions were radiotracked, and on the day following immobilization, all were observed to have resumed normal activities. All animals survived for at least 18 mo (Bauer, 2003).

In this study, medetomidine-tiletamine-zolazepam was a safe and effective immobilization combination for four of five free-ranging African lions. When used alone, the recommended doses of tiletamine-zolazepam are between 4 and 5 mg/kg for wild lions (McKenzie and Burroughs, 1993; Kreeger et al., 2002). When used in combination with medetomidine, the mean effective dose of tiletamine-zolazepam in the present study could be reduced to 1.8 mg/kg.

Induction times were similar or shorter than those reported for other drug combinations in lions. Depending on dose, xylazine-ketamine combinations allowed lions to be handled after 6 to 92 min (Herbst et al., 1985; Stander and Morkel, 1991), and medetomidine-ketamine combination allowed lions to be handled after 3.5 to 10 min (Quandt, 1992). Recovery was extended for the first three animals in our study (lions 1–3, 232.3±122.6 [98.3–338.8] min; lions 4–6, 37.0±25.3 [14.6–64.5] min). This probably resulted from higher doses of tiletamine-zolazepam (lions 1–3, 2.1±0.5 [1.7–2.7] mg/kg; lions 4–6, 1.6±0.4 [1.3–2.0] mg/kg) and lower doses of atipamezole (lions 1–3, 0.2±0.05 [0.2–0.3] mg/kg; lions 4–6, 0.3±0.2 [0.1–0.5] mg/kg). We believe that the dose of atipamezole should be at least 5.0 mg per milligram of medetomidine in lions given the drug combination used in this study. This is the dose ratio used by Quandt (1992) in lions immobilized with medetomidine-ketamine; however, additional immobilizations are needed to better define the appropriate dose of atipamezole for the drug combination used in the present study. Intramuscular injection of the antagonist seemed to be appropriate in our study, and no signs of resedation were observed. Quandt (1992) reported that lions immobilized with medetomidine-ketamine frequently recovered without showing any signs of arousal before getting up. Such spontaneous recoveries, which under field conditions can be extremely dangerous for people handling the animals, were not seen during the present study.

Physiologic parameters recorded in our study were similar to values reported in other studies (Quandt, 1992; Tomizawa, 1997), with the exception of the study by

King et al. (1977), in which lions immobilized with tiletamine-zolazepam had higher heart rates (88 [64–120] beats/min). Respiratory rates can be influenced by a variety of factors, including ambient temperature, body temperature, and drugs. In our study, respiratory rates dropped by as much as 60% to 85% during immobilization compared to reported reference ranges of between 40 and 120 breaths/min in conscious animals resting in the shade (King et al., 1977). In the present study, rectal temperatures remained stable during immobilization, which is contrary to lions immobilized with medetomidine-ketamine, in which body temperature decreased gradually by 0.9 C to 2.2 C in five individuals (Tomizawa et al., 1997). Mild, transitory hypoxemia was detected in the two animals monitored with pulse oximetry. Hypoxemia also occurred in cheetahs (*Acinonyx jubatus*; Deem et al., 1998) and polar bears (*Ursus maritimus*) (Cattet et al., 1999) anesthetized with medetomidine-tiletamine-zolazepam. Thus, access to supplemental oxygen is recommended.

Lion 3 received the highest dose of drugs in our study (10 mg of medetomidine and 250 mg of tiletamine-zolazepam; actual body weight, 90 kg) and was the only individual that showed serious side effects (bradycardia, bradypnea, and prolonged recovery). In polar bears, medetomidine-tiletamine-zolazepam can induce hypertension and subsequent major adverse effects in animals with a preexisting respiratory or cardiovascular disease (Cattet et al., 1999). Vomiting (a common side effect of medetomidine) or convulsions resulting from dissociative anesthetics (Quandt, 1992; Kreeger et al., 2002) did not occur in any of our lions.

In conclusion, medetomidine-tiletamine-zolazepam appears to be a useful combination for reversible immobilization of free-ranging African lions. Immobilization was complete and reliable. Analgesia was adequate for minor painful interventions, and recoveries appeared to be shortened by administration of atipamezole. The sample size of the present study is small, however, and further studies should be performed to characterize fully the efficacy and safety of this drug combination and the appropriate dose of antagonist in free-ranging lions.

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