

## Chemical immobilisation of the wild Patagonian otter (*Lontra provocax*) and the North American mink (*Neovison vison*)

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**ABSTRACT.** The Patagonian otter (*Lontra provocax*) is an endangered species endemic to southern Chile and Argentina. Most of its distribution range has recently been occupied by the American mink (*Neovison vison*). As part of a long-term study on the impact of mink in Patagonia, we assessed five reversible anaesthetic combination protocols in different doses on wild *L. provocax* and *N. vison*, and described the occurrence of any adverse effects. We assessed 16 anaesthetic procedures with a combination of ketamine-medetomidine (KET-MED;  $6.0 \pm 2.8$ - $0.05 \pm 0.01$  mg/kg IM, respectively) or ketamine-dexmedetomidine (KET-DEX;  $4.1 \pm 0.9$ - $0.02 \pm 0.004$  mg/kg IM) in *L. provocax* and 23 anaesthetic procedures with KET-MED ( $13.3 \pm 4$ - $0.1 \pm 0.04$  mg/kg IM), KET-DEX ( $4.8 \pm 0.3$ - $0.024 \pm 0.001$  mg/kg IM) in a low dose of ketamine (LDK) or KET-DEX ( $10.2 \pm 0.9$ - $0.025 \pm 0.002$  mg/kg IM) in a high dose of ketamine (HDK) in *N. vison*. Reversal was accomplished using atipamezole at 5 times the dose of MED or 10 times the dose of DEX. All anaesthetic combinations produced complete immobilisation and rapid anaesthetic induction, except for two otters anaesthetised with KET-MED which exhibited a longer time to initial effect. Hypothermia was commonly observed at the end of the anaesthetic procedures. Due to the hypoxemia presented in four otters at the beginning of anaesthesia, it is recommended to use additional oxygen when possible.

**Key words:** Anaesthesia, atipamezole, mustelid, reversal.

### INTRODUCTION

The Patagonian otter (*Lontra provocax*) is an endangered species native to Southern Chile and Argentina (Larivière 1999) and the American mink (*Neovison vison*) an invasive species in Chile since the 1960s (Medina 1997). Recently undertaken research involving the capture of these two species has required anaesthesia (Soto-Azat *et al* 2006).

Ketamine (KET) combined with medetomidine (MED) followed by antagonism with atipamezole (ATI) is a well-documented safe and efficient anaesthetic protocol to be used in carnivores (Jalanka and Roeken 1990), including mustelids, and recommended especially under field conditions (Spelman *et al* 1994, Spelman 1999). However, bradycardia, hypotension, hypoxemia and hypothermia have been described as major adverse effects (Spelman 1999, Fernandez-Moran *et al* 2001, Soto-Azat *et al* 2006). This study aimed to evaluate five anaesthetic combination protocols based on different doses of 3 drugs on wild *L. provocax* and *N. vison*, using KET-MED and KET-DEX, both antagonised with ATI, and to describe the main adverse effects observed.

### MATERIAL AND METHODS

A total of 14 *L. provocax* and 23 *N. vison* were captured in southern Chile between 2004 and 2013 (permit granted by Subsecretaria de Pesca N°2286 and 448). Otters were

captured with soft-catch leghold traps, and minks with box traps. After estimating the weight of each animal, they were physically restrained and injected with the anaesthetic combination administered by hand with a 1 ml syringe and a 23G needle (Soto-Azat *et al* 2006). Anaesthetic protocols were divided into five groups: 1) four otters anaesthetised with a combination of KET-MED at a dose of  $6.0 \pm 2.8$ - $0.05 \pm 0.01$  mg/kg IM (two otters were anaesthetised twice; capture and subsequent radiotransmitter implantation), 2) 10 otters anaesthetised with a combination of KET-DEX at a dose of  $4.1 \pm 0.9$ - $0.02 \pm 0.004$  mg/kg IM, 3) 10 minks anaesthetised with a combination of KET-MED at a dose of  $13.3 \pm 4$ - $0.1 \pm 0.04$  mg/kg IM, 4) six minks anaesthetised with a combination of KET-DEX at a dose of  $4.8 \pm 0.3$ - $0.024 \pm 0.001$  mg/kg IM (low dose of ketamine: LDK), and 5) seven minks anaesthetised with a combination of KET-DEX at a dose of  $10.2 \pm 0.9$ - $0.025 \pm 0.002$  mg/kg IM (high dose of ketamine: HDK). Reversal was accomplished using ATI at five times the dose of MED or 10 times the dose of DEX, respectively. Details of anaesthetised individuals are provided in tables 1 and 2.

Anaesthetic variables were recorded, including time to initial effect, recumbency time, loss of pedal reflex and reversal time. To evaluate the anaesthetic depth, we examined animals for sonorous stimulus response, jaw relaxation, interdigital toe pinch and level of alertness. The degree of muscular relaxation was characterised as “adequate” or “inadequate”. Physiological parameters monitored were rectal temperature measured with a digital thermometer, cardiac rate measured with a stethoscope, respiratory rate, capillary refill time and arterial haemoglobin oxygen saturation (SPO<sub>2</sub>) measured with a pulse oximeter, however, in the combination of KET-DEX with LDK in minks it was not possible to measure SPO<sub>2</sub>. All parameters were monitored at 5 min intervals for 30 min, following Soto-Azat *et al* (2006).

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**Table 1.** Summary of chemical immobilisation in wild otters (9 females and 5 males) anaesthetised intramuscularly with ketamine-medetomidine or ketamine-dexmedetomidine and reversed with atipamezole.

| Parameters with KET-MED      | n  | Mean  | SD    | Range      |
|------------------------------|----|-------|-------|------------|
| Weight (kg)                  | 4  | 11.5  | 2.04  | 10-14.5    |
| Ketamine dose (mg/kg)        | 6  | 6.0   | 2.8   | 3.4-10.0   |
| Medetomidine dose (mg/kg)    | 6  | 0.05  | 0.01  | 0.03-0.06  |
| Initial effect (min)         | 6  | 4.9   | 4.3   | 1.2-10     |
| Recumbency (min)             | 6  | 5.7   | 3.08  | 2.4-10     |
| Reversal times (min)         | 6  | 18    | 12.5  | 5-37       |
| Body temperature             | 6  | 37.3  | 0.7   | 35.8-40    |
| Heart rate                   | 6  | 86.1  | 9.1   | 73-93.2    |
| Respiratory rate             | 6  | 22.3  | 3.3   | 17.5-25.6  |
| SpO <sub>2</sub>             | 3  | 86    | 7.21  | 80-94      |
| Parameters with KET-DEX      | n  | Mean  | SD    | Range      |
| Weight (kg)                  | 10 | 6.3   | 2.12  | 3-8.74     |
| Ketamine dose (mg/kg)        | 10 | 4.1   | 0.9   | 2.9-5.7    |
| Dexmedetomidine dose (mg/kg) | 10 | 0.02  | 0.004 | 0.01-0.03  |
| Initial effect (min)         | 10 | 2.8   | 1.3   | 1.4-5.5    |
| Recumbency (min)             | 10 | 5.9   | 3.4   | 2.4-13     |
| Reversal times (min)         | 10 | 65.4  | 58.4  | 8-180      |
| Body temperature             | 10 | 37.1  | 0.7   | 32.2-39.1  |
| Heart rate                   | 10 | 107.3 | 22    | 84-161     |
| Respiratory rate             | 10 | 38    | 16    | 23.3-52.66 |
| SpO <sub>2</sub>             | 3  | 84.2  | 4.3   | 70-96      |

## RESULTS AND DISCUSSION

The anaesthetic induction was rapid and smooth for all individuals, except for two otters anaesthetised with KET-MED which exhibited a longer time to initial effect (10 min), however, this was shorter than the time reported by Bauquier *et al* (2010). The average time to initial effect for otters was 4.9 and 2.8 min for KET-MED and KET-DEX, respectively. The recumbency time was similar for both combinations. The average time to initial effect for minks was 1.7, 2.2 and 1.3 min for KET-MED, LDK KET-DEX and HDK KET-DEX, respectively. The recumbency time for minks was 6.2 min with LDK KET-DEX (table 2). The anaesthetic recovery following ATI administration was smooth and calm, as previously reported in other species of otters (Fernandez-Moran *et al* 2001, Soto-Azat *et al* 2006). The average time to total recovery in otters was 18.0 and 65.4 min for KET-MED and KET-DEX, respectively. In three otters anaesthetised with KET-DEX recovery lasted longer than 1 hour. The recovery in minks was evaluated only with the combination KET-DEX. Average total recovery time was 22.1 and 28.0 min with

LDK and HDK, respectively (these animals were released for home range studies). The other minks were euthanised following legal recommendations.

Muscle relaxation was classified as adequate for both anaesthetic protocols and both species. Capillary refill time in all cases fell within normal ranges (1-3 seconds).

For the KET-MED combination, the rectal temperature average was 37.3 and 37.4 °C in otters and minks, respectively. Temperature continuously decreased in all studied individuals. Further, four animals showed moderate hypothermia (34-36 °C) at the end of the anaesthetic procedure. Rectal temperature also decreased in all individuals anaesthetised with the KET-DEX combination. The most affected were minks with HDK, decreasing to 35.3 °C average (figure 1). Rectal temperature average in otters under KET-DEX was 37.1 °C. In minks with LDK the average was 36.7 °C and in minks with HDK it was 35.4 °C (figure 1). Anaesthetic related hypothermia usually occurs due to depression of the hypothalamic thermoregulatory centre, and as core body heat redistributes to the skin surface through anaesthetic-induced vasodilation (Matsukawa *et al* 1995, Taguchi and Kurz 2005). Although we tried

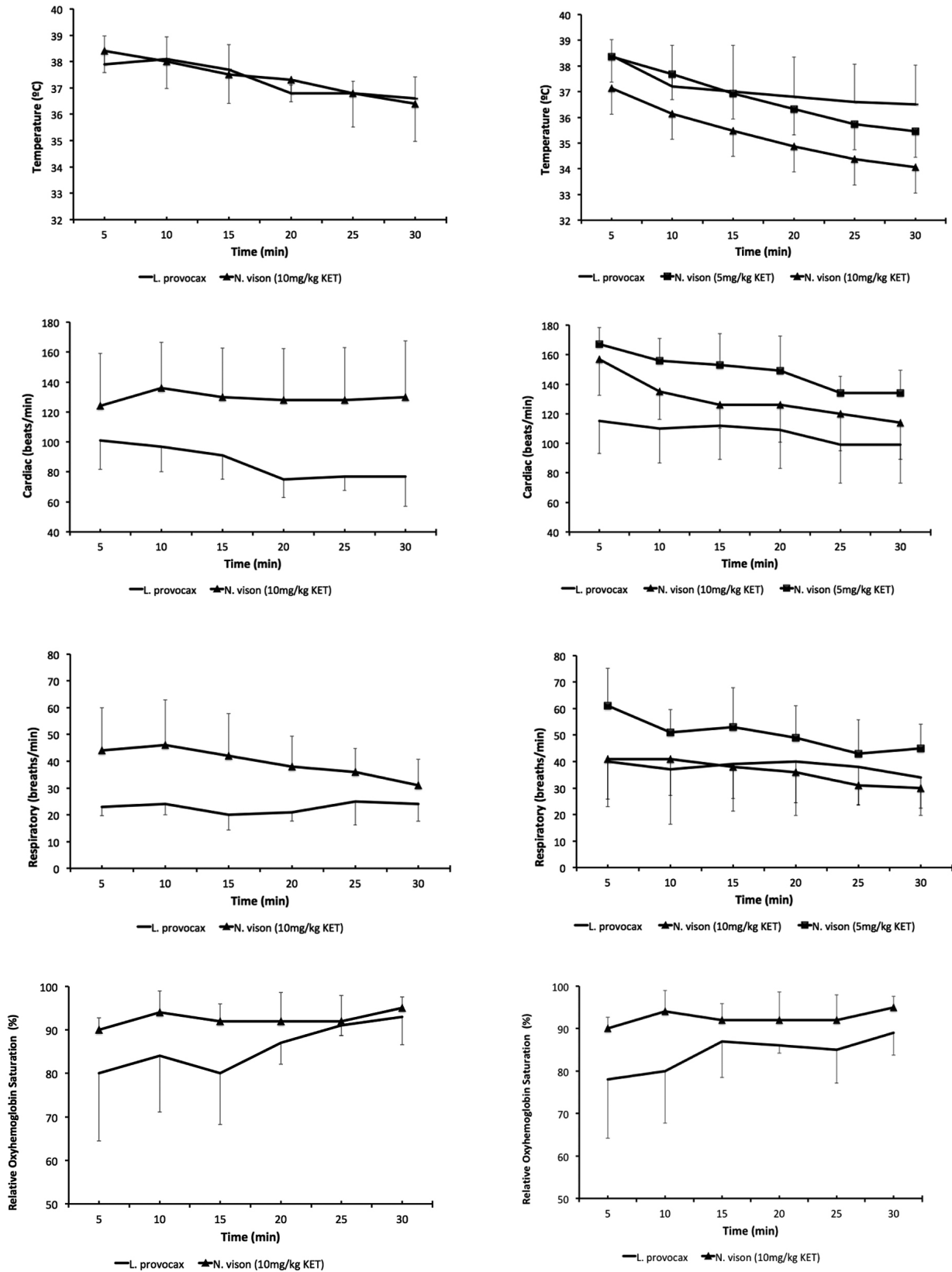
**Table 2.** Summary of chemical immobilisation in minks (10 females and 13 males) anaesthetised intramuscularly with ketamine-medetomidine or ketamine-dexmedetomidine and reversed with atipamezole.

| Parameters with KET-MED       | n  | Mean  | SD    | Range       |
|-------------------------------|----|-------|-------|-------------|
| Weight (kg)                   | 10 | 0.740 | 0.2   | 0.4-1.1     |
| Ketamine dose (mg/kg)         | 10 | 13.3  | 4     | 9.1-20      |
| Medetomidine dose (mg/kg)     | 10 | 0.1   | 0.04  | 0.09-0.2    |
| Initial effect (min)          | 10 | 1.7   | 0.8   | 1-3.3       |
| Recumbency (min)              | 8  | 3.3   | 2.1   | 1.3-7.4     |
| Reversal times (min)          | –  | –     | –     | –           |
| Body temperature              | 10 | 37.4  | 0.7   | 34.1-39.7   |
| Heart rate                    | 10 | 130   | 4     | 80-196      |
| Respiratory rate              | 10 | 39.5  | 6     | 24-83       |
| SpO <sub>2</sub>              | 9  | 93    | 1.2   | 80-100      |
| Parameters with KET-DEX (LDK) | n  | Mean  | SD    | Range       |
| Weight (kg)                   | 6  | 0.560 | 0.2   | 0.375-1     |
| Ketamine dose (mg/kg)         | 6  | 4.8   | 0.3   | 4.2-5       |
| Dexmedetomidine dose (mg/kg)  | 6  | 0.024 | 0.001 | 0.021-0.025 |
| Initial effect (min)          | 6  | 2.21  | 1.1   | 1-4         |
| Recumbency (min)              | 6  | 6.2   | 4.6   | 2-13.3      |
| Reversal times (min)          | 6  | 22.1  | 20    | 2.3-60      |
| Body temperature              | 6  | 36.7  | 1.13  | 32.5-40.4   |
| Heart rate                    | 6  | 149   | 13    | 120-196     |
| Respiratory rate              | 6  | 50    | 6.2   | 32-80       |
| SpO <sub>2</sub>              | –  | –     | –     | –           |
| Parameters with KET-DEX (HDK) | n  | Mean  | SD    | Range       |
| Weight (kg)                   | 7  | 0.635 | 0.2   | 0.380-1     |
| Ketamine dose (mg/kg)         | 7  | 10.2  | 0.9   | 8.5-11      |
| Dexmedetomidine dose (mg/kg)  | 7  | 0.025 | 0.002 | 0.021-0.028 |
| Initial effect (min)          | 7  | 1.32  | 0.47  | 1-2         |
| Recumbency (min)              | 7  | 2.85  | 0.69  | 2-4         |
| Reversal times (min)          | 7  | 28    | 24.2  | 1.5-60      |
| Body temperature              | 7  | 35.4  | 1.2   | 32-39       |
| Heart rate                    | 7  | 130   | 15    | 72-196      |
| Respiratory rate              | 7  | 36    | 4.7   | 60-20       |
| SpO <sub>2</sub>              | 1  | 91    | 0.9   | 90-92       |

to prevent hypothermia by using hot water bottles, the temperature decreased under desirable levels in most cases. Fournier-Chambrillon *et al* (2003) described a decrease in temperature as the major adverse effect using KET-MED, but placing the animals on a warmed table was an effective way to correct this problem. This situation occurred in both species in our study. Quick reversal with ATI seems to be a key factor to control this adverse effect. However, the ideal would be to increase the temperature to normal

ranges and then reverse it, but our field conditions with no access to electricity prevented this scenario.

For the KET-MED combination, cardiac rate in otters was below expected when compared to the previously reported heart rates (100-180 beats/min) for *L. canadensis* under inhalation anaesthesia with isoflurane (Spelman *et al* 1993). Some individuals had mild bradycardia with stable heartbeat, other individuals had a mild tendency to decrease cardiac rate, with an average of 86 beats/min.



**Figure 1.** Means and SD (standard deviation) for rectal temperature, cardiac rate, respiratory rate and relative oxyhaemoglobin saturation at 5 min intervals for otters (*L. provocax*) and minks (*N. vison*) anesthetised with Ketamine-medetomidine (first column) and with Ketamine-dexmedetomidine (second column), the latter combination in two different doses of Ketamine in the case of minks. Single line: *L. provocax*; line with square: *N. vison* 5mg/kg KET; line with triangle: *N. vison* 10mg/kg KET.

Heart rate in minks averaged 130 beats/min and there was a pattern of maintenance of cardiac activity with a small range of variation. However, four minks had some cardiac frequencies below the expected range. With the KET-DEX protocol only one otter had values of cardiac rate below 100 beats/min, with an average of 107 beats/min in otters, 149 beats/min in minks with LDK and 130 beats/min in minks with HDK. The cardiac rate was generally stable for all animals under both anaesthetic protocols, with a slight tendency to decrease, however, animals under KET-DEX had values closer to the expected, according to previously reported values (figure 1).

Respiratory rate for the KET-MED combination averaged 22 breaths/min in otters, within the expected normal range. Minks had a mean of 39 breaths/min and seven individuals presented pronounced tachypnea at the beginning of the procedure. With the KET-DEX combination, three otters and seven minks had pronounced tachypnea at the beginning of anaesthesia: the otters presented 64-68 breaths/min, and the minks had 44-60 breaths/min. In both species, respiratory rate stabilised in the second or third monitoring period, which subsequently decreased to normal values in all cases (figure 1). Respiratory rate under both protocols showed to be fairly stable, starting with tachypnea in some cases but tending to decrease to normal parameters. Respiratory rate may be higher using KET-DEX than KET-MED, possibly due to fewer adverse effects of DEX on the respiratory system.

The average values for SpO<sub>2</sub> were above 80%. Two otters under KET-MED and two otters under KET-DEX anaesthesia showed lower SpO<sub>2</sub> values at the beginning of the anaesthetic procedure, possibly due to artefact movements and imprecise measurements during the monitor's adjustment on the tongue. Nevertheless, it is recommended to supplement oxygen if SpO<sub>2</sub> drops below 90% when possible (figure 1).

Several adverse effects have been described using KET alone, especially hyperthermia, rigidity and convulsion (Reuther and Brandes 1984). Alternatively, a protocol with butorphanol/midazolam/medetomidine works well in seals and sea lions (Spelman 2004). In this study, the five anaesthetic combinations with KET-MED and KET-DEX lead to a rapid induction and complete immobilisation with the advantage of being reversed with ATI. However, at low doses of KET, anaesthesia was not as deep as desirable at the beginning and at the end of the procedure. Doses <5 mg/kg of KET may not induce reliable immobilisation. Arnemo *et al* (1994) recommended doses of KET between 6.5 and 11.8 mg/kg, especially for painful procedures. Anaesthesia depth scores demonstrated that these two anaesthetic combinations can be used for short procedures, but supplementary anaesthesia is necessary for more complex procedures such as surgeries. Both anaesthetic combinations worked well. In the KET-MED combination, we used 2mg/kg more KET than Bauquier *et al* (2010), because they used a low level of anaesthesia and in two cases they had to administer additional doses of

ketamine. Taking all results together, we recommend the use of 8.0 mg/kg of KET and 0.025 mg/kg of DEX IM in otters, and 10 mg/kg of KET and 0.025 mg/kg of DEX IM in minks for field anaesthesia of short procedures (<30min) with reversal by ATI 0.5 mg/kg IM.

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