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RESEARCH PAPER

# Evaluation of the anaesthetic effects of combinations of ketamine, medetomidine, romifidine and butorphanol in European badgers (*Meles meles*)

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## Abstract

**Objective** To evaluate the effects of three anaesthetic combinations in adult European badgers (*Meles meles*).

**Study design** Prospective, randomized, blinded, experimental trial.

**Animals** Sixteen captive adult badgers.

**Methods** The badgers were each anaesthetized by intramuscular injection using the three techniques assigned in random order: romifidine 0.18 mg $kg^{-1}$, ketamine 10 mg $kg^{-1}$ and butorphanol 0.1 mg $kg^{-1}$ (RKB); medetomidine 0.1 mg $kg^{-1}$, ketamine 9 mg $kg^{-1}$ and butorphanol 0.1 mg $kg^{-1}$ (MKB); and medetomidine 0.1 mg $kg^{-1}$ and ketamine 10 mg $kg^{-1}$ (MK). Initial drug doses were calculated based on a body mass of 10 kg. Additional anaesthetic requirements, time to drug effect, duration of action and recovery from anaesthesia were recorded. Heart rate and rhythm, respiratory rate and rhythm, rectal and subcutaneous microchip temperature and oxygen saturation were recorded every 5 minutes. Depth of anaesthesia was assessed using: muscle tone; palpebral and pedal reflexes; and tongue relaxation at these time points. Blood samples and a tracheal aspirate were obtained under anaesthesia. Atipamezole was administered if the badger had not recovered within 60 minutes Parametric data were analysed using ANOVA for repeated measures, and nonparametric data using Friedman's, and Cochran's Q tests: $p < 0.05$ was considered significant.

**Results** All combinations produced good or excellent muscle relaxation throughout the anaesthetic period. RKB had the shortest duration of anaesthesia (16.8 minutes compared with MKB 25.9 minutes and MK 25.5 minutes) and antagonism was not required. RKB depressed respiratory rate less than MK and MKB. There was no significant difference between techniques for heart rate and rhythm.

**Conclusions and clinical relevance** All combinations provided anaesthetic conditions suitable for sampling and identification procedures in adult badgers. The RKB protocol provided a significantly shorter period of anaesthesia when compared with the combinations containing medetomidine.

*Keywords* anaesthesia, badgers, butorphanol, ketamine, medetomidine, romifidine.

## Introduction

Sedation and anaesthesia are required for safe handling and treatment of wild badgers. They are most frequently used to facilitate sampling

procedures, the collection of physiological data and tattooing for identification.

Badgers, like ferrets, polecats, mink, weasels, American martens and otters are members of the Mustelidae family. The use of several anaesthetic and sedative techniques in Mustelidae has been reported (Belant 1992; Fernandez-Moran et al. 2001; Fournier-Chambrillon et al. 2003). Most research has involved ferrets, many of which are domesticated and therefore presented to veterinary surgeons for commonplace elective, as well as emergency procedures. Of the combinations evaluated in ferrets those containing either xylazine or medetomidine combined with ketamine, with or without butorphanol, were found to be the most effective (Ko et al. 1997, 1998a,b).

Sedative and anaesthetic techniques in badgers based on ketamine, acepromazine, midazolam, xylazine, medetomidine and butorphanol have been described (Mackintosh et al. 1976; Agren et al. 2000; de Leeuw et al. 2004; Thornton et al. 2005). However, the combination that produces reliable and safe anaesthesia with predictable onset and duration of action, good muscle relaxation and desirable recovery characteristics has not been identified.

Ketamine used alone provides satisfactory conditions for tattooing, blood, faecal and oesophageal mucus sampling (Mackintosh et al. 1976; de Leeuw et al. 2004; Thornton et al. 2005). The doses required to produce anaesthesia in these studies varied from 9.5 to 31 mg $kg^{-1}$ and prolonged recoveries (up to 3 hours) were reported (Mackintosh et al. 1976). Moreover, ketamine anaesthesia was characterized by poor muscle relaxation, salivation and the retention of swallowing and laryngeal reflexes (de Leeuw et al. 2004). These made certain clinical procedures, such as tracheal sample collection, difficult or impossible. For this reason, the use of ketamine alone was not investigated in our study.

Ketamine has been used in combination with acepromazine (Mackintosh et al. 1976) and midazolam (Thornton et al. 2005) for sedation and anaesthesia in badgers. Sedation with ketamine (10.6–21.9 mg $kg^{-1}$) and acepromazine (0.21–0.53 mg $kg^{-1}$) administered intramuscularly (IM) allowed blood sampling, although animals remained heavily tranquillized for up to 6 hours (Mackintosh et al. 1976). Thornton et al. (2005) investigated the use of low-dose midazolam (0.4 mg $kg^{-1}$) with ketamine (15 mg $kg^{-1}$) and high-dose midazolam (1 mg $kg^{-1}$) with ketamine (10 mg $kg^{-1}$). Anaesthesia was unpredictable and frequently inadequate: it was not produced in two of six badgers receiving the high-dose midazolam–ketamine combination, despite the administration of two incremental doses.

Ketamine has been used in badgers in combination with $\alpha_2$-agonists, i.e. xylazine and medetomidine for the surgical implantation of radio transmitters (Agren et al. 2000). In this study, incremental doses were required, although the total given, along with induction and recovery characteristics, was unreported. Ketamine and medetomidine have also been used with the analgesic drug butorphanol (de Leeuw et al. 2004; Thornton et al. 2005). Depth of anaesthesia was satisfactory for collection of blood and oesophageal mucus with medetomidine, ketamine and butorphanol doses of 0.04, 8.0 and 0.8 mg $kg^{-1}$ respectively. The use of romifidine has not been reported in badgers or other Mustelidae.

The aim of this study was to evaluate the anaesthetic effects of combinations of ketamine, medetomidine, romifidine and butorphanol based on reliability, duration of action, muscle relaxation and recovery in the European badger.

## Materials and methods

### Animals and instrumentation

Sixteen healthy adult badgers (eight males and eight females) captured in areas of Ireland confirmed to be free of tuberculosis were studied. Their weights ranged between 8 and 15 kg. The animals were kept in 200 $m^2$ grass enclosures in groups of one to four individuals. Group housing was undertaken to facilitate the requirements of an associated study, with the size of the group determined by the social group of origin. The badgers were fed daily and provided with fresh water *ad libitum*. In each enclosure there were two large wooden setts (1.5 m × 1.5 m) containing smaller nest boxes (0.75 m × 0.75 m) in which the badgers slept. The environment was enriched with concrete tunnelling, trees, grass, foliage and a small pond. The badgers had been acclimatized to their new surrounding for a minimum of 4 weeks before the study commenced. Animals were identified with tattoos, hair clipping and with microchips that transmitted body temperature at the site of implantation (subcutaneously over the dorsal