

# Caudal epidural analgesia using lidocaine alone or in combination with ketamine in dromedary camels (*Camelus dromedarius*)

**Authors:**

Omid Azari<sup>1</sup>  
Mohammad M. Molaei<sup>1</sup>  
Amir H. Ehsani<sup>2</sup>

**Affiliations:**

<sup>1</sup>Department of Clinical Sciences, Shahid Bahonar University of Kerman, Iran

<sup>2</sup>Faculty of Veterinary Medicine, Shahid Bahonar University of Kerman, Iran

**Correspondence to:**

Omid Azari

**Email:**

omidazari@yahoo.com

**Postal address:**

PO Box 76169133, Kerman, Iran

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This study was performed to investigate the analgesic effect of lidocaine and a combination of lidocaine and ketamine following epidural administration in dromedary camels. Ten 12–18-month-old camels were randomly divided into two equal groups. In group L, the animals received 2% lidocaine (0.22 mg/kg) and in group LK the animals received a mixture of 10% ketamine (1 mg/kg) and 2% lidocaine (0.22 mg/kg) administered into the first intercoccygeal (Co1–Co2) epidural space while standing. Onset time and duration of caudal analgesia, sedation level and ataxia were recorded after drug administration. Data were analysed by U Mann-Whitney tests and significance was taken as  $p < 0.05$ . The results showed that epidural lidocaine and co-administration of lidocaine and ketamine produced complete analgesia in the tail, anus and perineum. Epidural administration of the lidocaine-ketamine mixture resulted in mild to moderate sedation, whilst the animals that received epidural lidocaine alone were alert and nervous during the study. Ataxia was observed in all test subjects and was slightly more severe in camels that received the lidocaine-ketamine mixture. It was concluded that epidural administration of lidocaine plus ketamine resulted in longer caudal analgesia in standing conscious dromedary camels compared with the effect of administering lidocaine alone.

## Introduction

Ruminants are generally not considered to be good subjects for general anaesthesia, mainly because of hazards of regurgitation and inhalation of ruminal contents or saliva into the lungs if the airway is left unprotected. Thus, regional anaesthesia produced by the perineural or epidural injection of anaesthetic agents is most frequently employed in these species (Hall, Clark & Trim 2001). Caudal epidural anaesthesia is simple and inexpensive and requires no sophisticated equipment. It is routinely used in ruminants for obstetric manipulation, caudal surgical procedures and as an adjunct treatment for control of rectal tenesmus (Lee *et al.* 2003).

Lidocaine is routinely used for caudal epidural analgesia in ruminants, but large volumes can cause ataxia or even recumbency. To facilitate reproductive manipulations, the onset of analgesia should be faster and shorter and should not interfere with the motor system (DeRossi *et al.* 2010b).

Ketamine is a potent non-competitive antagonist of N-methyl-D-aspartate receptors, which are involved in the transmission and modulation of nociceptive information by the spinal cord (Rainer & Marcel 1998; Yamamura *et al.* 1990). Ketamine can induce regional analgesia by several mechanisms. Ketamine may block the Na<sup>+</sup> channels (Appel, Dudziak & Palm 1979) and thus produce regional analgesia in a manner similar to local anaesthetics. It also interacts with opioid, monoaminergic and muscarinic receptors and voltage-sensitive Ca<sup>2+</sup> channels (Gomez de Segura *et al.* 1998).

Epidural administration of ketamine alone or in combination with lidocaine or other sedative agents has been reported to produce perineal analgesia in a number of ruminant species, for example cattle (DeRossi *et al.* 2010a; Lee *et al.* 2003; Marsico *et al.* 1999), water buffaloes (Singh *et al.* 2006) and goats (Kinjavdekar *et al.* 2007).

Dromedary camels play a significant role in the socio-economic affairs of nomadic people in providing meat, milk and wool. They are also used for transportation (Al-Ani 2004; Tegegne 1991). Approximately 90% of the world's camels are dromedaries (Al-Ani 2004). Many of the principles of veterinary anaesthesia that apply to other ruminant species also apply to the camelids (Pereira *et al.* 2006). Also of interest to the anaesthetist is that camels may be susceptible to toxicity from some drugs at doses used commonly in other ruminants (Hall *et al.* 2001).

There are currently only a few published studies about epidural analgesia in camels. Epidural analgesia has been investigated in South American camelids such as llamas and alpacas (Fowler 1998; Grubb, Riebold & Huber 1993). In recent years, clinicophysiological effects of epidural administration of various sedative agents, such as xylazine and ketamine alone or in combination with local anaesthetics, have been investigated in dromedary camels (Azari *et al.* 2012a, 2012b; Molaei *et al.* 2010), but to the authors' knowledge, there are no documented data about epidural co-administration of lidocaine and ketamine in dromedary camels. The purpose of the present study was to serve as a preliminary investigation of epidural administration of lidocaine and a combination of lidocaine and ketamine in dromedaries.

## Materials and methods

### Camels

Ten immature male dromedary camels (12–18 months of age), weighing 250 kg – 350 kg, were used in this study. The animals were housed in a pen, fed grass (hay) supplemented with concentrate and had free access to water. Camels were judged to be in good health based on clinical evaluation. Food was withheld for 24 h and water for 12 h prior to the experiment. The trials were conducted in the morning. During the course of the experiments the ambient temperature fluctuated between 25 °C and 27 °C.

### Trial procedure

The animals were assigned randomly to one of two groups. In group L, 0.22 mg/kg lidocaine 2% (Pasteur Institute, Tehran, Iran) was injected epidurally, whilst in group LK, a combination of 0.22 mg/kg lidocaine 2% and 1 mg/kg ketamine 10% (Alfasan, Woerden, Holland) was injected epidurally. The volume injected was equalised between the groups by adding sterile saline to the lidocaine dose in group L. Before each treatment, the animals were restrained in sternal recumbency and the skin over the sacrococcygeal area was prepared surgically. The injections were administered into the extradural space through the first intercoccygeal space, using an 18-gauge, 3.7 cm long hypodermic needle. The epidural space was confirmed by the hanging drop technique and lack of resistance to injection. Following drug injection, the camels were walked into a chute and observed for any drug-induced side-effects. The observers were unaware of the drug dose administered per test.

Analgesia was tested in the tail, anus, perineum and upper hind limb using a pinprick method. This constituted the insertion of a 23-gauge needle through the skin into the underlying tissues at the tail base, anus, perineum and upper hind limb area.

The needle was inserted at slightly different sites for each test. Complete analgesia was defined as the lack of response to pin pricks. The existence or lack of response to pin pricks for each site was assessed, recorded and compared between the groups. However, the main focus of the study was on the onset time and duration of complete perineal analgesia

and only these data were subjected to statistical comparison. The time between the injection and loss of sensation was considered the onset time of complete analgesia. Duration of complete perineal analgesia was determined by testing the response to stimulation of the skin of the perineum at time 0 (before injection) and again after 1 min, 3 min, 5 min, 10 min and 15 min. Thereafter response was tested every 5 min until the end of complete analgesia by observing response to noxious stimulation.

Ataxia was assessed by observing the hind limb position and swaying and leaning against the chute. Responses were recorded as ataxic or not ataxic. Sedation was scored on a four-point scale in each camel for each dose: 1 = alert (no sedative effect); 2 = mild sedation (reduced alertness without any other signs); 3 = moderate sedation (drowsiness and slight drooping of head); 4 = deep sedation (marked drowsiness and drooping of head).

### Data analysis

Data analyses were performed using SPSS software (SPSS 16.0, Chicago). Data were tested for normality using the Kolmogorov-Smirnov test. The onset time and duration of complete perineal analgesia and sedation levels were analysed using the non-parametric U Mann-Whitney test to compare the data between the two groups. A value of  $p \leq 0.05$  was considered significant. Results are presented as medians (range). Ataxia was compared between the groups descriptively.

## Ethical considerations

The experimental protocols were approved by the Research Ethics Committee of the Shahid Bahonar University of Kerman, Iran.

## Results

Ataxia was observed in all camels following epidural administration of lidocaine and a lidocaine-ketamine mixture. The animals in group LK were more ataxic compared with those in group L, but recumbency did not occur in any of the animals. Abduction of the hind limb was observed in all camels and two camels in group LK also showed swaying movement. All five animals that received lidocaine only were alert and nervous; however, all the animals that received a combination of lidocaine and ketamine became mildly or moderately sedated during the study, as indicated in Table 1.

**TABLE 1:** Onset and duration of perineal analgesia and sedation scores following epidural administration of lidocaine and a combination of lidocaine and ketamine in dromedary camels.

Group	Onset (min)		Duration (min)		Sedation score
	Median	Range	Median	Range	
L	15	10–20	55	40–60	5 camels: score 1
LK	15	5–20	75*	60–90	2 camels: score 3** 3 camels: score 2

Sedation scores: 1, alert; 2, mild sedation; 3, moderate sedation; 4, deep sedation.

L, lidocaine; LK, lidocaine and ketamine.

\*Significant differences between the groups ( $p \leq 0.05$ )

Note: In each column, \*  $p = 0.05$  and \*\*  $p = 0.005$  compared to the group L.

The results of this study demonstrated that complete analgesia occurred in the tail base, anus and perineum of all the camels following epidural administration of either lidocaine or a lidocaine-ketamine mixture, but hind limb analgesia was not produced by either treatment. Data analysis showed that there was no significant difference in onset time of complete perineal analgesia between the groups ( $p > 0.05$ ), but duration of complete perineal analgesia in group LK was significantly longer than in group L ( $p \leq 0.05$ ). The median onset and duration of complete perineal analgesia in group L and LK are presented in Table 1.

## Discussion

Recently, several researchers have focused on the epidural administration of ketamine to induce caudal analgesia in horses (Gomez de Segura *et al.* 1998), ponies (Doherty, Goiser & Rohrbach 1997), dogs (DeRossi *et al.* 2011; Rao *et al.* 1999), cats (DeRossi *et al.* 2009) and various species of ruminants, such as cattle (DeRossi *et al.* 2010a; Kamiloglu *et al.* 2003; Lee *et al.* 2003; Marsico *et al.* 1999; Moulvi *et al.* 2011), water buffaloes (Singh *et al.* 2006), sheep (Dadafarid & Najafpour 2008) goats (DeRossi *et al.* 2005; Kinjavdekar *et al.* 2007) and dromedary camels (Azari *et al.* 2012b). However, to our knowledge there are no documented data in current veterinary literature about epidural administration of a lidocaine-ketamine mixture in dromedary camels. This study investigated the application of a combination of lidocaine and ketamine for epidural anaesthesia compared with epidural injection of lidocaine alone in dromedaries.

In a previous study, injection of epidural ketamine at a dose of 2 mg/kg in dromedary camels produced perineal analgesia, but all the animals became recumbent. Injection of 1 mg/kg epidural ketamine did not produce satisfactory perineal analgesia and it was therefore concluded that neither dose of ketamine injected epidurally was suitable for standing surgical procedures in dromedary camels (Azari *et al.* 2012b).

The results of the present study showed that the combination of ketamine at a dose of 1 mg/kg with lidocaine significantly prolonged caudal epidural analgesia in comparison with epidural lidocaine alone, although there were no significant differences in onset time of perineal analgesia between the two groups.

It has been reported that epidural co-administration of ketamine and lidocaine provided very effective and long duration of post-operative analgesia in children (Gunduz *et al.* 2006). Co-administration of ketamine and lidocaine epidurally increased duration of caudal analgesia in cats and dogs compared with administration of lidocaine or ketamine alone (DeRossi *et al.* 2009; DeRossi *et al.* 2011).

Moulvi *et al.* (2011) evaluated caudal analgesic effects following epidural injection of lidocaine and a combination of lidocaine and ketamine in cow calves. They stated that the mixture of lidocaine and ketamine produced a more rapid action and induced deeper caudal analgesia compared

with lidocaine alone. DeRossi *et al.* (2010a) used ketamine, lidocaine and a combination of ketamine and lidocaine to induce caudal analgesia in heifers and concluded that epidural ketamine (0.5 mg/kg), lidocaine (0.2 mg/kg) or their combination (ketamine 0.25 mg/kg + lidocaine 0.1 mg/kg) produced satisfactory analgesia, without discomfort or ataxia in heifers.

In another study, dorsolumbar epidural administration of a combination of lidocaine and ketamine in male cattle resulted in longer duration of caudal analgesia, without any side effects, than following the administration of ketamine or lidocaine alone (DeRossi *et al.* 2010b).

In the present study, animals of both groups showed varied signs of ataxia. Slightly more ataxia was observed in group LK. This observation could be attributed to the local anaesthetic action of ketamine, which may enhance the motor nerve blockade effect of lidocaine at the spinal cord level. Intrathecal ketamine has been shown to produce local anaesthetic effects in animals and humans and to result in a complete motor nerve blockade (Gebhardt 1994). It has been suggested that absorption of epidural ketamine into the systemic circulation may produce signs of ataxia and sedation (Gomez de Segura *et al.* 1998; Lee *et al.* 2003).

## Conclusion

The results of the present study showed that epidural administration of a combination of ketamine (1 mg/kg) and lidocaine (0.22 mg/kg) significantly increased duration of perineal analgesia in dromedaries and produced suitable sedation without discomfort or noticeable ataxia, compared with the effects of lidocaine alone. This combination may therefore be used in clinical situations where longer duration of regional analgesia is required. Further research is needed to study the mechanism of interaction of lidocaine and ketamine at the spinal cord level and dose optimisation between lidocaine and ketamine in dromedaries.

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## Competing interests

The authors declare that they have no financial or personal relationship(s) that may have inappropriately influenced them in writing this article.

## Authors' contributions

O.A. (University of Kerman) was the project leader. O.A. and M.M.M. (University of Kerman) were responsible for experimental and project design, O.A. and A.H.E. (University of Kerman) performed most of the experiments and O.A. wrote the manuscript.

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