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Review Article

Anaesthesia and analgesia of the donkey and the mule

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Summary

The number of donkeys and mules throughout the world is stable, and awareness of their use and concern for welfare, pain recognition and treatment are receiving increasing veterinary interest. Therefore, accurate information about anaesthesia and analgesia in donkeys and mules is important to ever more equine practitioners. Since donkeys are physiologically and pharmacologically different from horses, knowledge on species specific aspects of anaesthesia and analgesia are very important. Mules combine elements from both donkey and horse backgrounds, leading to great diversity in size, temperament and body type. Physiologically, they seem to resemble horses more than donkeys. This review highlights the current knowledge on various anaesthetic and analgesic approaches in donkeys and mules. There is still much information that is not available about donkeys; in many circumstances, the clinician must use available equine information to treat the patient, while monitoring carefully to observe for differences in response to therapy compared to the horse.

Introduction

Previous review articles in this journal (Matthews *et al.* 2005) and elsewhere in this edition (Grosenbaugh *et al.* 2011) have covered some of the differences in physiology, behaviour and pharmacology that exist between donkeys and horses. These species-related differences have numerous implications for anaesthetic and analgesic strategies in donkeys. Numerous publications have appeared that discuss differences in pharmacokinetics of anaesthetics and analgesics (Coakley *et al.* 1999; Mealy *et al.* 2004; Sinclair *et al.* 2006; Taylor *et al.* 2008), while, at the same time, much of the available knowledge on donkeys is from clinical experience and does not come from scientific research. However, this empirical knowledge and scientific knowledge from equine studies can be used together in order to develop optimal strategies for anaesthesia and analgesia in donkeys.

Preanaesthetic evaluation and case preparation

Preoperative evaluation of the donkey should be as thorough as it would be for a horse, including an accurate estimate of bodyweight (Svendsen 2008a). It is critically important to recognise that normal reference values for temperature, respiratory and heart rates as well as haematological and biochemical parameters (Svendsen 2008b) may differ from horses. Normal values for ACTH and triglycerides are higher in healthy donkeys, while values for insulin are significantly lower in donkeys compared to horses, and other values (e.g. cortisol) are not different (Dugat *et al.* 2010). Preoperative assessment and treatment of pain should also be diligent; donkeys may not exhibit pain as openly as horses, so more severe pain may be overlooked (Ashley *et al.* 2005). Failure to treat pain adequately preoperatively may lead to cardiovascular decompensation after induction of anaesthesia. Appropriate use of nonsteroidal anti-inflammatory drugs is reviewed by Grosenbaugh *et al.* (2011).

Although some differences between sizes and breeds of donkeys have been documented for analgesics such as phenylbutazone, as well as injectable anaesthetics (Matthews *et al.* 2001), there is very little information about many other breeds of donkeys throughout the world. Comparative studies of drugs such as tramadol, which has been shown to have low bioavailability in Italian donkeys (Giorgi *et al.* 2009), might show differences in other breeds. Donkeys are also more likely to be hyperlipaemic when stressed or ill; hyperlipaemia needs to be treated as early as possible to ensure survival of the patient.

Intravenous catheterisation and premedication

Jugular catheterisation is facilitated by good restraint. The catheter should be long enough (the authors prefer at least 9 cm), because donkeys often have a thicker skin and fascia compared to horses. A relatively long catheter will reduce the risk of catheter dislodgement during the different phases of the anaesthetic procedure. Although the jugular vein is in the same location as in the horse, it is covered by the cutaneous *colli* muscle, which is thicker than in the horse (Herman 2009), as well as a fascial layer. This may make it more difficult to visualise the vein and the catheter may need to be introduced at a slightly different angle compared to the horse (**Fig 1**). Use of a lidocaine 'bleb', placed subcutaneously over the vein, is recommended for increased tolerance to catheter placement. Transdermal lidocaine can be used for donkeys that are 'needle shy'; 20–30 min must be allowed for sufficient transdermal absorption to anaesthetise the skin.

Sedative and analgesic effects of detomidine have been described in donkeys by Mostafa *et al.* (1995). 5–10 µg/kg bwt provided adequate sedation and 20–40 µg/kg bwt provided good to deep analgesia. Choices for sedation and premedication have also been reported by Matthews *et al.* (2005). Since these publications, Latzel (2008) reported on the pharmacokinetics of xylazine in mules compared to horses. The half-life of xylazine in mules was 15 min shorter than in the horse and the horse dose did not provide sufficient sedation. They recommended a dose 50% higher in mules. This is consistent with our practice for sedation of mules, but is not required for donkeys. Higher requirements for romifidine were also reported

Fig 1: Intravenous catheter placement in a miniature donkey.

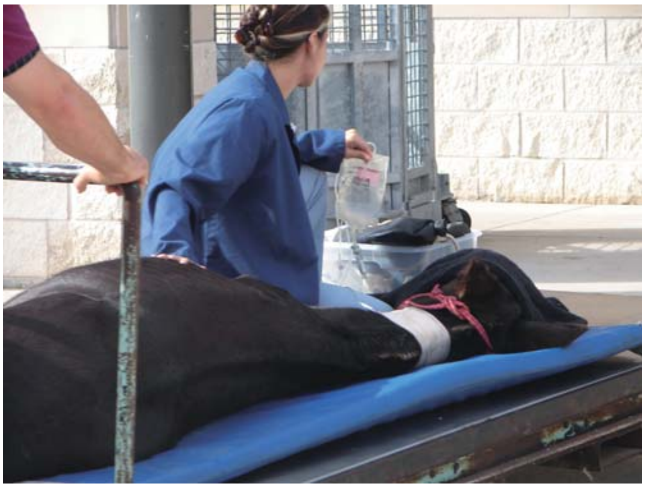

Fig 2: G-K-X anaesthesia used during transport of a miniature mule.

in untamed mules by Alves *et al*. (1999). The recent introduction of detomidine oral gel has been found to be very useful for donkeys and mules that are difficult to inject (N. Matthews, personal observation); the label dose appears to provide reliable and profound sedation in donkeys when adequate time (40 min) is allowed for absorption. The authors do not have experience with the use of this product in mules; a higher dose might be necessary to provide good sedation, based on higher requested dosages of injectable α_2-agonists in mules (Matthews *et al*. 2005; Latzel 2008).

Induction and maintenance with injectable anaesthetics

Numerous drug combinations have been used for induction and maintenance with injectable drugs (see Tables 2 and 3 in Matthews *et al*. 2005). Intermittent boluses of xylazine and ketamine can be used, but need to be given more frequently than in horses: approximately every 10 min compared to 15–20 min in horses, since donkeys metabolise ketamine more rapidly than horses. Taylor *et al*. (2008) evaluated various combinations of guaifenesin (G) with xylazine (X) and ketamine (K) and found that G-K-X (guaifenesin 50 mg/ml, ketamine 2 mg/ml, xylazine 0.5 mg/ml) produced satisfactory anaesthesia, with smooth, excitement-free induction without muscle spasms, following premedication with 1.1 mg/kg bwt xylazine. Induction was accomplished by rapid gravity administration of the mixture until the donkey became recumbent; the infusion was then slowed and maintained as indicated by monitoring anaesthetic depth (approximately 1.5 ml/kg bwt/h). For larger animals, where restraint of the patient during induction might be difficult, a xylazine/ketamine induction can be used, and then the G-K-X mixture started for maintenance. This mixture can be used when transport of the patient is required (**Fig 2**).

Thiopental was used for induction (7 mg/kg bwt i.v.) and maintenance (8 mg/kg bwt) of anaesthesia for 100 min (Emami *et al*. 2006) after premedication with atropine, acepromazine and xylazine. Induction and maintenance quality were reported to be good, but recovery was slow; standing time was 92 min after anaesthesia was finished.

Propofol has been reported for use in donkeys (Matthews *et al*. 2005). A recent report compared propofol bolus (2 mg/kg bwt) to thiopental bolus (10 mg/kg bwt) after premedication with xylazine (1.0 mg/kg bwt) (Abd-Almaseeh 2008). The mean weight of these animals was 136 kg and 2 mg/kg bwt of propofol (1% solution) does not lead to excessively high volumes (25–30 ml). Thiopental induction was performed with 10 mg/kg bwt (5% solution), which leads to comparable volumes. Differences in quality of induction were probably related to different induction times (40 s for propofol and 18 s for thiopental). Recovery from propofol induction was smooth, with single coordinated attempts to stand and minimal to no ataxia. Recovery from thiopental induction was predominantly acceptable to good, with 3–4 attempts to regain sternal recumbency. Apnoea was seen with thiopental, but not with propofol. Propofol (1 mg/kg bwt) was also used with ketamine (2 mg/kg bwt) and compared to ketamine alone (3 mg/kg bwt) after premedication with xylazine (1.0 mg/kg bwt) (Abass *et al*. 2007). The mixture of ketamine and propofol produced better induction, better muscle relaxation, longer anaesthesia time and smoother recoveries than ketamine alone.

Maintenance with inhalational anaesthetics, support and monitoring

Maintenance with inhalational anaesthesia is recommended for longer procedures (>60 min) and for older or sicker patients. Endotracheal intubation can usually be achieved blindly, although it may be slightly more difficult than in horses, due to anatomical differences in the donkey (Herman 2009). These differences relate to the nasal passages, which are relatively narrow, and the pharyngeal recess that is much more extensive in the donkey compared to the horse. Furthermore, the entrance to the larynx (the *aditus laryngis*) has a more caudal angulation in the donkey with a narrowing of its dorsoventral diameter. Halothane, isoflurane or sevoflurane can be used; no apparent differences in minimum alveolar concentrations have been noted between horses and donkeys (**Fig 3**).

Heart and respiratory rates, blood pressure, eye signs and muscle relaxation should all be monitored. Respiratory rates are usually higher in anaesthetised donkeys than in horses and

Fig 3: Miniature donkey maintained with inhalant anaesthesia.

respiratory depression seen with isoflurane in horses does not appear to be as great a problem in donkeys, i.e. 'breath-holding' seen in horses does not occur in donkeys. A review of our clinical records for the last year yielded anaesthesia records for 16 miniature and standard donkeys and 19 mules. When allowed to breathe spontaneously on injectables or inhalational anaesthetics, respiratory rate for the donkeys averaged 19–32 breaths/min and mules averaged 18–27 breaths/min. No Mammoth Asses or draught mules were anaesthetised, so it is possible that the higher rate might be associated with smaller body size. When mechanically ventilated, a respiratory rate of 10 breaths/min was used with tidal volumes ranging from 8–15 ml/kg bwt and adjusted if necessary to produce normocapnia.

Arterial blood pressure appears to be the most reliable indicator of depth of anaesthesia in donkeys; rapid increase usually indicates the plane of anaesthesia is too light and likely to move. Arterial blood pressure can be measured indirectly using a cuff or directly using an arterial catheter attached to an aneroid manometer or transducer. Percutaneous placement of the arterial catheter is facilitated by puncturing the skin with a sterile needle to allow introduction of the catheter and to prevent 'burring' of the catheter by the thick skin and fascia. A branch of the maxillary artery or lateral metatarsal artery is easiest to catheterise, but large auricular arteries are also available.

Administration of i.v. fluids (such as lactated Ringer's solution) is recommended at 5–10 ml/kg bwt/h, especially during inhalational anaesthesia, to support arterial blood pressure. Appropriate positioning to protect radial and peroneal nerves and padding to prevent myositis are also recommended. Myositis appears to be less of a concern in donkeys than in horses (presumably because of lower muscle mass), but prevention is still wise.

Recovery

Donkeys usually recover well from anaesthesia, but often take longer to attempt standing than horses. As with horses, attention must be paid to ensure a patent airway; 'snoring' noises may indicate partial airway obstruction, which can be relieved by straightening the donkey's head and neck or passing a small nasopharyngeal tube into the upper airway. Lack of analgesia can produce a rough recovery, but donkeys are not prone to becoming excited in recovery as horses are. Many donkeys will require a 'boost' on the tail and may get up hind end first like a cow while others will get up in the same manner as a horse.

Standing surgery in donkeys

In order to perform standing surgery in donkeys, proper sedation is a first requisite.

Protocols for standing surgery can be composed of sedatives in constant rate infusions (CRI), combined with systemic opioids and local anaesthetic techniques. Such a protocol that is used in horses is described by van Dijk *et al.* (2003) and has been used for donkeys as well. In this protocol, detomidine 10 µg/kg bwt i.v. is combined with buprenorphine 6 µg/kg bwt i.v. After these initial bolus injections, detomidine CRI (0.16 µg/kg bwt/min) is provided. Aziz *et al.* (2008) describe laparoscopic ovariectomy in standing donkeys using xylazine sedation and local infiltration of the laparoscopic portal sides with lidocaine. This protocol could be combined with epidural morphine (0.1 mg/kg bwt), a technique that is described for horses (van Hoogmoed and Galuppo 2005) and is also used in these dosages in both equine and donkey patients by the authors. Adding epidural morphine to this standing anaesthesia protocol led to decreased surgical time, improved patient comfort and reduced the sedation needed to perform ovariectomy.

Perioperative analgesics

Butorphanol (0.02–0.04 mg/kg bwt/h), ketamine (0.4–0.6 mg/kg bwt/h) or lidocaine (1.5 mg/kg bwt/h) can be used to provide intraoperative analgesia when needed, but there is no information specific to the use of these drugs in donkeys compared to horses; clinical judgement must be used. Local blocks (with lidocaine or bupivicaine) can also be used for specific procedures (e.g. pastern arthrodesis, castration) to achieve analgesia. Transdermal fentanyl patches have been used on donkeys and may be effective for some types of pain; however, information specific to analgesia in donkeys is greatly needed. The pharmacokinetics of tramadol have been reported, but no information about efficacy is available (Giorgi *et al.* 2009). In general, there is a lack of information on the use of analgesics, especially opioids, in the donkey.

Local anaesthetic techniques

Similar to anaesthesia of man and other species, the use of local anaesthetic techniques can be beneficial in a modern multimodal anaesthetic approach (Lamont 2008). Both during general anaesthesia and in standing surgical procedures, these techniques can be a valuable additive. Some specific examples of local anaesthetics follow.

Epidural anaesthesia

Epidural anaesthesia has been described in the donkey by Shoukry *et al.* (1975). Most common indications include rectal or vaginal prolapse or to treat melanomas in the tail and perineal region, but it can also be used for long-term analgesia after hindlimb surgery or with painful conditions in the hindlimb such as septic arthritis or Einschuss. Burnham (2002) gives a nice description of the anatomy of the sacral and coccygeal vertebrae. The first intercoccygeal space in the donkey is narrower than the second and therefore the latter is more suited for caudal epidural puncture (**Fig 4**). The needle can be directed at an angle of 30° from the horizontal and can be introduced into the vertebral canal, because there are no large tail muscles. The spinal processes of the sacral and coccygeal segments are more easily palpated in the donkey compared to the horse (Burnham 2002). Correct placement of extradural needles can be supported by means of an acoustic device to identify the extradural space. This technique is described for horses by Iff *et al*. (2010) and has also been proven useful in other species. Robinson and Natalini (2002) have described the clinical use of epidural local anaesthetics, opioids, α_2-agonists, ketamine and other analgesics in horses. Although these analgesics are not all experimentally described in donkeys, they have shown clinical efficacy in this species as well. Various analgesic possibilities for extradural administration are described in **Table 1**.

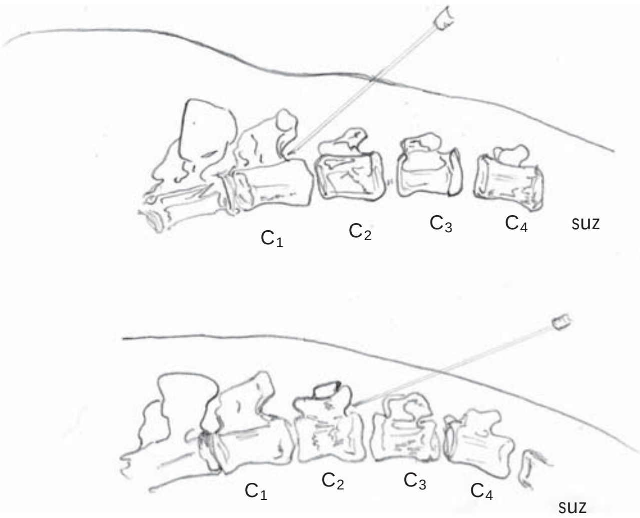

Fig 4: Epidural administration in the horse (upper panel) and in the donkey (lower panel), with permission from S.L. Burnham (2002). In the horse caudal epidural administration is routinely performed between the first and second coccygeal vertebra, while in the donkey the preferred location is between the second and third coccygeal vertebra.

Local anaesthetic techniques of the head

Both in standing and recumbent animals, local anaesthetic techniques can be a useful adjunct for surgery of the head. Various studies describe several nerve blocks of the equine head and these techniques can equally be applied in donkeys (Tremaine 2007). We performed surgery in a standing sedated donkey with help of lidocaine infiltration in a case of extensive sarcoids on the head (**Fig 5**). In a case report by McCluskie and Tremaine (2009), caudal auricular and auriculopalpebral branches of the facial nerve were desensitised with mepivacaine in a recumbent donkey for surgical removal of an auricular sarcoid with a technique that was described for horses (McCoy *et al*. 2007).

Conclusion

Donkeys differ from horses behaviourally, physiologically and pharmacologically. These differences must be taken into account when formulating an individual anaesthetic or analgesic protocol. As much information is not available, the

TABLE 1: Epidural administration of analgesics and local anaesthetics

Drug	Dosage (mg/kg bwt)	Onset of action	Duration of effect
Lidocaine	0.22–0.35	5–15 min	60–90 min
Lidocaine+adrenaline	0.22–0.35	5–15 min	120–180 min
Bupivacaine (0.5%)	0.06	10–30 min	2.5–4 h
Xylazine	0.10	10–30 min	2.5–4 h
Detomidine	0.010–0.020	10–15 min	2–3 h
Morphine	0.1	20–30 min	18–24 h
Ketamine	0.5	5–10 min	30–60 min

Fig 5: Local infiltration anaesthesia in a standing donkey for surgery of a sarcoid on the head.

clinician must monitor the patient carefully and adjust the protocol as required by that individual donkey, without relying on information specific to horses.

Authors' declaration of interests

No conflicts of interest have been declared.

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