Anesthesia, Sedation, and Pain Management of Donkeys and Mules

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KEYWORDS

• Donkey • Mule • Anesthesia • Analgesia • Pain

KEY POINTS

- There are major differences in behavior and physiology between donkeys, mules, and horses.
- The response to pain is less evident in donkeys and mules compared with horses.
- These differences affect duration and use of sedatives, analgesics, and anesthetics.
- Anesthetic management of donkeys and mules is similar to horses but with subtle differences.

INTRODUCTION

Previous tutorial articles[1,2] have covered some of the differences in physiology, behavior, and pharmacology that exist between donkeys and horses. Although donkeys and mules have a reputation for being "stubborn," recent research carried out at the Donkey Sanctuary showed that donkeys and mules outperformed horses in a test of spatial cognition and perseveration abilities and mules outperformed dogs.[3] These species-related differences have numerous implications for anesthetic and analgesic strategies in donkeys and mules. Numerous publications have discussed differences in pharmacokinetics of anesthetics and analgesics,[4–7] whereas 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 and scientific knowledge from equine studies can be used together in order to develop optimal strategies for anesthesia and analgesia in donkeys and mules. Since the last time the authors published a review article of anesthesia and analgesia in donkeys and mules,[1] several new studies have been published emphasizing a need for continued research and information on these "alternative" equines. Furthermore, Grint and colleagues[8]

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published a survey on the current use of analgesics prescribed for donkeys in practice and to collect opinions from veterinary surgeons and donkey owners on the importance of different pain-related behaviors in donkeys.

PREANESTHETIC EVALUATION AND PATIENT PREPARATION

Preoperative evaluation of the donkey or mule should be as thorough as it would be for a horse, including weighing the animal when possible. When weight scales are not available, body weight estimators based on heart girth and height to the withers are available from the Donkey Sanctuary (www.thedonkeysanctuary.org.uk).[9] It is critically important to recognize that normal parameters for temperature, respiratory and heart rates, as well as hematological and biochemical parameters may be significantly different for donkeys than in horses; the number of differences that exist between mules and horses has not been documented. Up-to-date reference ranges can be obtained from the Donkey Sanctuary (www.thedonkeysanctuary.org.uk) and from Erin L. Goodrich and Erica Behling-Kelly's article, "Clinical Pathology of Donkeys and Mules," in this issue of the clinics. Normal values for adrenocorticotropic hormone and insulin differ between donkeys and horses, while other values (eg, cortisol) are not different.[10] Preoperative assessment and treatment of pain should also be diligent; donkeys and mules may not exhibit pain as openly as horses, so more severe pain may be overlooked. Regan and colleagues[11] developed an ethogram to record behavioral expressions of pain in working donkeys and showed improvement in these behaviors after the administration of a nonsteroidal antiinflammatory drug (NSAID; flunixin meglumine). Frequency of changes in head carriage, eye closing, limb shifting, and self-grooming decreased after NSAID administration.[12] These investigators also documented that pain responses to castration were similar to that seen in ponies and horses; therefore, appropriate analgesics should be used in donkeys.

In the opinion and experience of one investigator (NSM), failure to adequately treat pain preoperatively may lead to cardiovascular decompensation after induction of anesthesia. Appropriate NSAID use in donkeys is well reviewed by Grosenbaugh[2]; there is minimal mule-specific information.[4] However, NSAIDs are the mainstay of analgesic drugs used. Although some differences between sizes/breeds of donkeys have been documented for analgesics such as phenylbutazone,[13] as well as injectable anesthetics,[14] there is little information about many other breeds of donkeys or mules throughout the world. As a general rule, NSAIDs have a shorter half-life in donkeys (there is minimal data for mules) so may need to be given at shorter intervals than in horses. Pharmacokinetic properties of flunixin meglumine in mules are similar to horses.[4] Comparative studies of drugs such as tramadol, which has been shown to have low bioavailability in Italian donkeys[15] might show differences in other breeds.

INTRAVENOUS CATHETERS AND PREMEDICATIONS

Jugular catheter placement is facilitated with good restraint (**Fig. 1**), and the catheter must be long enough (the investigator prefers at least 9 cm or more) to penetrate the thicker skin and fascia of the donkey while still remaining in the vein. 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,[16] as well as a fascial layer. This may make it more difficult to visualize the vein, and the catheter may need to be introduced at a slightly different angle compared with the horse. This difference may not be as great in the mule (depending on what type of mule it is), but mules may be even less tolerant of needles than donkeys; use of a lidocaine "bleb," placed subcutaneously over the vein, is recommended for increased tolerance to catheter placement. Transdermal

Fig. 1. Restraint and preparation for intravenous catheter placement.

lidocaine can be used to improve patient tolerance; 20 to 30 minutes must be allowed for sufficient transdermal absorption to anesthetize the skin.

Choices for sedation and premedication were previously reported.[17] Since that publication, Latzel[18] reported on the pharmacokinetics of xylazine in mules compared with horses. The half-life of xylazine in mules was 15 minutes shorter than that in the horse, and the horse dose (0.6 mg/kg intravenously [IV]) did not provide sufficient sedation in the mules. They recommended a dose 50% higher in mules compared with that in horses. This is consistent with the authors' practice for sedation of mules but not usually required for donkeys. Alpha-2 agonists (xylazine, detomidine, romifidine, and dexmedetomidine) have all been used in donkeys and mules; these drugs are often combined with an opioid (eg, butorphanol, morphine) to increase the degree of sedation and analgesia provided. The degree of sedation and analgesia achieved is dose dependent with sedation lasting longer than analgesia.[19] For donkeys, all alpha-2 agonistic drugs can be dosed similar to what is used in horses, whereas dosages for mules should be higher. The recent introduction of detomidine oral gel has been found to be useful for donkeys and mules, which may be difficult to inject (NSM. Personal observation); the label oral detomidine dose for horses seems to provide good sedation in donkeys when adequate time (40 minutes) is allowed for absorption (**Fig. 2**). Lizarraga investigated sedation and analgesia with 2 doses of oral detomidine

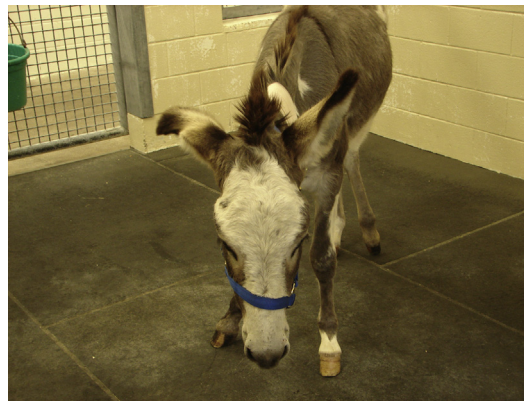

Fig. 2. Sedation with oral detomidine gel in a donkey.

gel and found sedation with both doses, which was deeper with the higher dose (40 μg/kg compared with 20 μg/kg).[20] The investigators do not have experience on the use of this product in mules; a higher dose might be necessary to provide good sedation. As is the case with horses, doses of drugs used for sedation will vary considerably depending on degree of sedation required, temperament and training of the patient, route of administration, as well as other drugs used. Choice of drug used for sedation and premedication also depends on availability and familiarity with that particular drug. As a general rule, intramuscular (IM) administration will require 2 to 3 times the usual IV dose and will take longer to reach maximal effect.

INDUCTION AND SHORT-TERM INJECTABLE ANESTHESIA

Ketamine-Based Anesthesia

Numerous drug combinations with ketamine have been used for induction and short-term maintenance with injectable drugs[17] (**Table 1**). Intermittent boluses of xylazine and ketamine can be used but need to be given more frequently than in horses: approximately every 10 minutes compared with 15 to 20 minutes in

Table 1
Suggested drug doses for sedation, induction, maintenance, and analgesia of donkeys and mules

	Dose (mg/kg)	Route	Expected Duration
Sedation			
Xylazine	1.0 (0.4–1.5)	IV, IM	15–20 min
Romifidine	0.08 (0.05–0.1)	IV, IM	30–60 min
Detomidine	0.01 (0.005–0.02)	IV, IM, sublingual	20–40 min, longer for sublingual
Dexmedetomidine	0.005	IV, IM	20–30 min
Acepromazine	0.03 (0.02–0.05)	IV, IM, sublingual	30 min–2 h
Induction			
Ketamine	2.2–2.5	IV	10–15 min
Diazepam/ midazolam	0.05 (0.02–0.1)	IV	10–15 min with ketamine
Propofol	2.0	IV	10–15 min
Propofol	0.5	IV	10–15 min used with ketamine
Alfaxalone	2.0	IV	10–15 min
Thiopental	6–8	IV	20 min
Telazol	1.0	IV	20–30 min
Maintenance			
Triple drip	Guaifenesin 50 mg/mL, ketamine 2 mg/mL, Xylazine 0.5 mg/mL	IV	Up to 60–90 min
Analgesics			
Butorphanol	0.03 (0.02–0.05)	IV, IM	30–60 min
Buprenorphine	0.006	IV, IM, sublingual	6 h
Morphine	0.1	IV, IM	2–3 h

Data from Matthews N, Taylor T, Hartsfield S. Anaesthesia of donkeys and mules. Equine Vet Educ 2005;7:102-107.

horses because donkeys metabolize ketamine more rapidly than horses.[17] Dar and Gupta[21] evaluated the effect of ketamine and diazepam bolus administration (2.2 mg/kg IV and 0.03 mg/kg IV, respectively) in mules after premedication with xylazine (1.3 mg/kg IV). The mules showed hypertonicity of the pelvic limbs during induction with acceptable levels of anesthesia and antinociception. However, muscle relaxation was deemed incomplete. Duration of anesthesia was short (15.3 ± 1.6 minutes). Because xylazine-ketamine (or similar combinations) may not provide enough time for the surgical procedure, various combinations of guaifenesin with ketamine and xylazine (G-K-X) were evaluated in donkeys.[7] These investigators found that G-K-X (guaifenesin 50 mg/mL, ketamine 2 mg/mL, xylazine 0.5 mg/mL) produced satisfactory anesthesia following premedication with xylazine (1.1 mg/kg IV). Induction was accomplished by rapid gravity administration of the mixture until the donkey became recumbent, then the infusion was slowed and maintained as indicated by monitoring anesthetic depth (approximately 1.5 mL/kg/h of the mixture mentioned earlier). For larger donkeys and mules, 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. This study was prompted by early experience with guaifenesin in donkeys, which showed that donkeys may be more sensitive to guaifenesin while metabolizing ketamine more rapidly, hence needing higher concentrations of ketamine. Matthews and colleagues[22] showed a mean recumbency dose of guaifenesin of 131 ± 27 mg/kg for donkeys, whereas this dose was 211 ± 8 mg/kg for horses. Although donkeys were more sensitive to guaifenesin, they metabolized it more quickly, based on higher clearances (546 ± 73 mL/h/kg) for donkeys compared with horses (313 ± 62 mL/h/kg).

Molinaro Coelho and colleagues[23] described inductions of general anesthesia in donkeys with a ketamine/propofol combination (1.5 mg/kg and 0.5 mg/kg IV, respectively). Maintenance was performed with a continuous rate infusion (CRI) of ketamine (0.05 mg/kg/min and 0.15 mg/kg/min IV, respectively). This study is further described in the section on propofol. Vullo and colleagues[24] described a G-K-X anesthesia maintenance protocol in mules, which, compared with the G-K-X mixture evaluated by Taylor and colleagues[7] in donkeys, required an increase in xylazine dose from 0.5 mg/mL to 1.0 mg/mL.

Thiopental

Thiopental was used for induction (7 mg/kg IV) and maintenance (8 mg/kg IV) of anesthesia for 100 minutes after premedication with atropine, acepromazine, and xylazine in donkeys.[25] Induction and maintenance quality were reported to be good, but recovery was slow; standing time was 92 minutes after anesthesia was finished. Smooth and uneventful inductions with thiopental (6 mg/kg IV) after premedication with xylazine (1.3–1.6 mg/kg IV) were described in mules.[24] Anesthesia was maintained with triple drip for field castrations.

Propofol

Propofol has been reported for use in donkeys.[17] A recent report compared propofol bolus administration (2 mg/kg IV) with thiopental bolus (10 mg/kg IV) after premedication with xylazine (1 mg/kg).[26] Induction time was slightly faster and of better quality with thiopental, but recovery was better with propofol (less attempts to obtain sternal recumbency and shorter duration of recovery). Induction apnea was seen with thiopental, but not with propofol. Propofol (1 mg/kg IV) was also used with ketamine (2 mg/kg IV) and compared with ketamine alone (3 mg/kg IV) after premedication

with xylazine (1 mg/kg IV).[27] The combination of ketamine and propofol produced better induction, better muscle relaxation, longer anesthesia time, and smoother recoveries than with ketamine alone. In this study, the propofol substituted for benzodiazepines, providing better muscle relaxation than was seen without. This was probably because of not only the muscle relaxing effects of propofol but also the lower dosage of ketamine that was used.

In a similar study, donkeys were premedicated with xylazine (1 mg/kg) and induced with either ketamine (1.5 mg/kg) and propofol (0.5 mg/kg) or ketamine (2.2 mg/kg) and diazepam (0.05 mg/kg).[23] Anesthesia was maintained for 60 minutes with a CRI of either ketamine (0.05 mg/kg/min) and propofol (0.15 mg/kg/min) or a mixture of ketamine (2 mg/mL), xylazine (0.5 mg/mL), and guaifenesin (50 mg/mL) given at 2 mL/kg/h. Both combinations led to satisfactory anesthesia procedures but produced hypoxemia (without administration of oxygen). Intermittent shortages of diazepam and midazolam have led to drug substitutions in an attempt to provide balanced anesthesia. In addition, the lack of commercial guaifenesin in some countries has led to its substitution by use of low-dose propofol. Larger doses of propofol usually produce apnea and arterial desaturation in horses, but as demonstrated by the aforementioned studies, apnea does not seem to be a problem with lower doses in combination with ketamine in donkeys. However, one study[28] used 2 mg/kg propofol for induction in donkeys premedicated with acepromazine (0.04 mg/kg IV) followed by propofol infusion for 30 minutes (CRI of 0.2 mg/kg/min). No apnea was reported in this study although very mild hypoxemia did occur. In the investigators' opinion, it is wise to be prepared to intubate and provide short-term ventilation (eg, with a demand valve or Ambu bag and small oxygen tank) whenever propofol is used.

Alfaxalone

A recent study compared midazolam (0.05 mg/kg IV) and alfaxalone (1 mg/kg IV) with midazolam (0.05 mg/kg IV) and ketamine (2.2 mg/kg IV) following premedication with xylazine (2 mg/kg IM, followed by 0.5 mg/kg IV after 60 minutes) in donkeys.[29] Inductions were quicker with alfaxalone but recoveries were smoother and shorter in the ketamine group. Hypoxemia occurred with both drug combinations.[29]

MAINTENANCE WITH INHALANT ANESTHETICS, SUPPORT, AND MONITORING

Maintenance with inhalant anesthesia is recommended for longer procedures (>60 min) and for older or high-risk patients (horses older than 20 years of are considered geriatric).[30] Endotracheal intubation can usually be achieved blindly, although it may be slightly more difficult than in horses, due to anatomic differences in the donkey.[16] Occasional cases of hypoplastic trachea or abnormal conformation (especially in dwarf donkeys) may make the use of a laryngoscope or a flexible endoscope necessary. The donkey's upper airway conformation may need to be considered if the head seems abnormal. Halothane, isoflurane, or sevoflurane can be used; no apparent differences in minimum alveolar concentrations have been noted between horses and donkeys.

Heart and respiratory rates, blood pressure, eye signs (including eyelid reflex and positioning of the eyeball), swallowing reflexes, and muscle relaxation should all be monitored. Respiratory rates are usually higher in anesthetized donkeys than in horses and respiratory depression seen with isoflurane in horses does not seem to be as great a problem in donkeys; that is, the "breath holding" seen in horses rarely occurs in donkeys. A review of the authors' clinical records for a year yielded anesthetic records for 16 miniature and standard donkeys and 19 mules. When allowed to breathe

spontaneously on injectable or inhalational anesthetics, respiratory rates for donkeys averaged 19 to 32 bpm and for mules 18 to 27 bpm. No Mammoth asses or draft mules were anesthetized, so it is possible that the higher breathing rate might be associated with smaller body size. When mechanically ventilated, a respiratory rate of approximately 10 bpm was used with tidal volumes adjusted to produce normocapnea.

As in horses, blood pressure seems to be the most reliable indicator of depth of anesthesia in donkeys; rapid increase usually indicates the patient is too light and likely to move. Blood pressure can be measured indirectly (using a cuff placed on tail or limb) or directly using an arterial catheter attached to an aneroid manometer or pressure transducer. The invasive measurement is the gold standard, whereas indirect measurement by means of oscillometric techniques merely enables assessment of trends in blood pressure.[31] Percutaneous placement of the arterial catheter is facilitated by cutting through the skin with a sterile needle before introducing the catheter to prevent "burring" of the catheter by the thick skin and fascia. A branch of the maxillary artery (facial or transverse facial artery) or lateral metatarsal artery is easiest to catheterize, but large auricular arteries are also available (Fig. 3).

Administration of intravenous fluids (such as lactated Ringer solution) is recommended at 5 to 10 mL/kg/h, especially during inhalant anesthesia, to support blood pressure. Appropriate positioning to protect radial and peroneal nerves and padding to prevent myositis is also recommended. Myositis seems to be less of a concern in donkeys than in horses (presumably because of smaller muscle mass) but might be a problem in larger donkey breeds or larger mules (ie, draft); therefore prevention of myositis is indicated.

Treatment of other anesthetic complications (eg, hypotension) should be the same as would be done for horses. Donkeys respond very well to dobutamine infusion when being hypotensive and not dehydrated, hypovolemic, or septic.

PERIOPERATIVE ANALGESICS

Butorphanol (CRI, 0.02–0.04 mg/kg/h IV), ketamine (CRI, 0.4–0.6 mg/kg/h IV), or lidocaine (CRI, 1.5 mg/kg/h IV) can be used to provide intraoperative analgesia in combination with inhalant anesthesia when needed, but there is no information specific to the use of these drugs in donkeys compared with horses; clinical judgment must be used. The same is true for alpha-2 agonist CRIs; some (mainly visceral) analgesia may be provided but they may be more helpful to lower inhalant dose needed while providing some support of blood pressure. Local blocks (with lidocaine, mepivacaine, or bupivacaine) can also be used for specific procedures (eg, pastern arthrodesis,

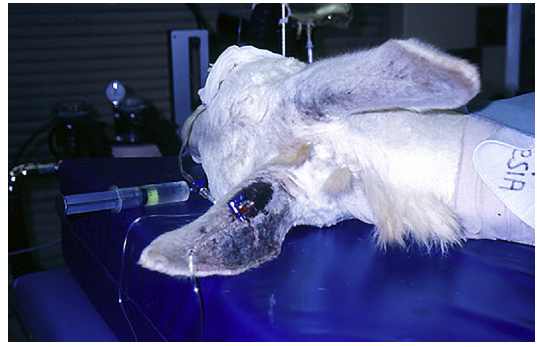

Fig. 3. Arterial catheter placed in ear for direct blood pressure measurement.

castration, ocular or dental surgery) to achieve analgesia. The intraoperative use of intrafunicular lidocaine during castration in donkeys resulted in lower levels of isoflurane required for maintenance of anesthesia. Transdermal fentanyl patches have been used on donkeys and may be effective for some types of pain; however, information specific to absorption of fentanyl and resulting analgesia in donkeys is greatly needed. The pharmacokinetics of tramadol has been reported, but no information about efficacy is available.[15] In general, there is a lack of information on the use of analgesics, especially opioids, in the donkey.

RECOVERY

Donkeys usually recover well from injectable or inhalant anesthesia 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 nasogastric tube into the upper airway. Lack of analgesia can produce a rough recovery, but donkeys are not prone to becoming excited or hysterical in recovery as horses. Many donkeys will require a "boost" on the tail and may get up hind end first as a cow, whereas others will get up in the same manner as a horse. Because of their size, most donkeys can be assisted by hand and do benefit from this.

LOCAL ANESTHETIC TECHNIQUES

Similar to human anesthesia and anesthesia of other species, the use of locoregional anesthetic techniques can be beneficial in a modern multimodal approach.[32] Both during general anesthesia and in standing surgical procedures, these techniques can be a valuable additive. Some specific examples of local anesthetics are discussed in the following section.

Epidural Anesthesia

Epidural anesthesia was described in the donkey by Shoukry and colleagues.[33] Most common indications include rectal or vaginal prolapse or to treat melanomas on the tail and in the 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 laminitis. Burnham[34] 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. The needle can be directed at an angle of 30 degrees 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 with the horse. Correct placement of extradural needles can be supported by means of an acoustic device to identify the extradural space. This technique was described for horses by Iff and colleagues[35] and has also been proved useful in other species, such as dogs and cats.[36] Numerous studies have been published on the use of different types of analgesic drugs for epidural application in horses.[37] Not all of these drugs have been described for donkeys, but in a recent publication, Marzok and El-Khodery[38] described the analgesic and sedative effects of lidocaine, tramadol, and the combination of both drugs for caudal epidural anesthesia in donkeys. They found that epidural combination of tramadol and lidocaine (0.5 mg/kg and 0.2 mg/kg, respectively) produced an antinociceptive effect in the perineum, which was rapid in onset (within 6 minutes) and had a longer duration of action (180 minutes)

than lidocaine alone (duration of 75 minutes). Torad and Hassan[39] found the combination of nalbuphine and lidocaine (at dosages of 0.2 and 0.11 mg/kg, respectively) to lead to rapid onset (6.7 minutes) and long duration (147 minutes) of epidural anesthesia in donkeys. Hamed and colleagues[40] described the sedative and analgesic effects of epidural dexmedetomidine and xylazine in donkeys. They administered dexmedetomidine (5 μg/kg) and xylazine (200 μg/kg) in a cross-over design. All donkeys showed mild sedation and ataxia. Dexmedetomidine produced quicker onset (5.8 minutes) and longer duration of analgesia (160 minutes) compared with xylazine (14.2 minutes and 116 minutes, respectively). Although not specifically addressed in donkeys, according to the investigators, epidural morphine (0.1–0.2 mg/kg) would be the first choice for epidural analgesia, because of its good analgesic properties and relatively long duration of effect due to its hydrophilicity.

Local Anesthetic Techniques for Castration

Intrafunicular lidocaine (5 mL of 2% lidocaine) during total intravenous anesthesia has been used for field castration in mules.[24] Suriano and colleagues[41] compared intrafunicular lidocaine (10 mL lidocaine 2% with adrenaline) with saline injection during unilateral castration in 10 donkeys (one side with saline and the other side with lidocaine injection, 1 month apart). In lidocaine-injected castrations, heart rate (but not blood pressure) was lower compared with saline-injected castrations. Furthermore, end-tidal isoflurane requirements were lower during lidocaine-injected castrations. These findings correspond with the studies that have been performed in horses, where lidocaine is most often injected intratesticularly instead of injecting into the spermatic cord.[42]

Local Anesthetic Techniques of the Head

Both in standing and recumbent animals, local anesthetic 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.[43,44] Hagag and Tawfiek[45] recently described the use of ultrasound-guided maxillary nerve blocks in donkeys on cadavers and in 9 live donkeys (**Fig. 4**). Just as in horses,[46] this technique shows promising results for clinical application in donkeys and mules. In a case report by McCluskie and Tremaine,[47] caudal auricular and auriculopalpebral branches of the trigeminal and facial nerve were desensitized with mepivacaine in a recumbent donkey for surgical removal of an auricular sarcoid with a technique that was described for horses.[48]

In order to perform standing surgery in donkeys, proper sedation is a first requisite. Sedative and analgesic effects of detomidine have been described in donkeys by Mostafa and colleagues.[49] They showed that 5 to 10 μg/kg IV provides adequate sedation, with concurrent good to deep analgesia with doses of 20 to 40 μg/kg IV. Although donkeys seem to have similar clinical response to alpha-2 agonists than horses, mules clinically seem to require approximately 50% more xylazine compared with donkeys and horses.[17] Higher requirements for romifidine were also reported in untamed mules.[50] Protocols for standing surgery can be composed of sedatives in CRIs, combined with systemic opioids and local anesthetic techniques. Such a protocol has been described for horses[51] and used for donkeys as well. Dosages used in horses (romifidine: 80 μg/kg loading dose and 30 μg/kg/h CRI; butorphanol: 18 μg/kg loading dose and 25 μg/kg/h CRI) can be extrapolated to donkeys. The CRI dosages should be used as a guideline and adapted to clinical effect (just as in horses). As an alternative for butorphanol, morphine could be used in premedication at a dosage of 0.1 to 0.2 mg/kg IV. A CRI administration is then not used by the

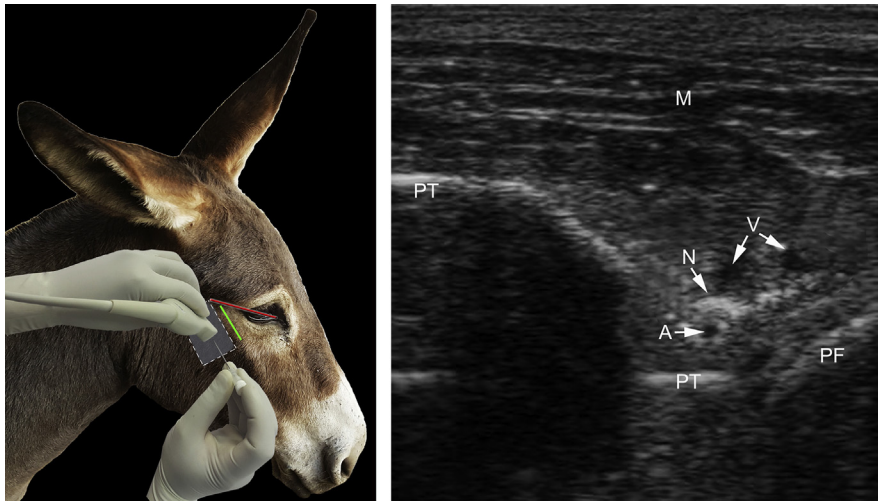

Fig. 4. Ultrasound-guided maxillary nerve block in donkeys. (*Left*) Acoustic window for ultrasound-guided maxillary nerve blockade (*dotted white lines*). The transducer is positioned caudal to the facial crest (*green line*), ventral to an imaginary line connecting the medial and lateral canthi and extending beyond the facial crest (*red line*). The needle is inserted about 1 cm ventral to the probe. (*Right*) Ultrasonogram of the pterygopalatine fossa in a donkey beneath the masseter muscle (M) demonstrating the maxillary nerve (N) related to branches of the deep facial vein (V), the infraorbital artery (A), and bounded by the perpendicular plate of the palatine bone (PT) and fascia of the periorbital cone (PF). (*From* O'Neill H, Garcia-Pereira F, Mohankumar P. Ultrasound-guided injection of the maxillary nerve in the horse. Equine Vet J 2014;46:180-184; with permission.)

investigators because of the longer duration of effect. Aziz and colleagues[52] 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), a technique that is described for horses[53] and used by the investigators. Adding epidural morphine to this standing anesthesia protocol led to decreased surgical time, improved patient comfort, and reduced sedation needed to perform ovariectomy.

REFERENCES

1. Matthews N, van Loon JPAM. Anaesthesia and analgesia of the donkey and mule. Equine Vet Educ 2013;25:47–51.
2. Grosenbaugh DA, Reinemeyer CR, Figueiredo MD. Pharmacology and therapeutics in donkeys. Equine Vet Educ 2011;23:523–30.
3. Burden F, Thiemann A. Donkeys are different. J Equine Vet Sci 2015;35:376–82.
4. Coakley M, Peck K, Taylor T, et al. Pharmacokinetics of flunixin meglumine in donkeys, mules and horses. Am J Vet Res 1999;60:1441–4.
5. Mealy K, Matthews N, Peck K, et al. Pharmacokinetics of R(-) and S(+) carprofen after administration of racemic carprofen in donkeys and horses. Am J Vet Res 2004;65:1479–82.
6. Sinclair M, Mealy K, Matthews N, et al. Comparative pharmacokinetics of meloxicam in clinically normal horses and donkeys. Am J Vet Res 2006;67:1082–5.

7. Taylor E, Baetge C, Matthews N, et al. Guaifenesin-ketamine-xylazine infusions to provide anesthesia in donkeys. J Equine Vet Sci 2008;28:295–300.
8. Grint N, Johnson C, Clutton R, et al. Spontaneous electroencephalographic changes in a castration model as an indicator of nociception: a comparison between donkeys and ponies. Equine Vet J 2015;47:36–42.
9. Svendsen ED. Heart girth Nomogram. In: Duncan J, Hadrill D, editors. The professional handbook of the donkey. 4th edition. Wiltshire (United Kingdom): Whittet Books; 2008. p. 400.
10. Dugat S, Taylor T, Matthews N, et al. Values for triglycerides, insulin, cortisol, and ACTH in a herd of normal donkeys. J Equine Vet Sci 2010;30:141–4.
11. Regan F, Hockenhull J, Pritchard J, et al. Identifying behavioural differences in working donkeys in response to analgesic administration. Equine Vet J 2016; 48:33–8.
12. Grint N, Murrell J, Whay H. Investigating the opinions of donkey owners and veterinary surgeons towards pain and analgesia in donkeys. Equine Vet Educ 2015; 27:365–71.
13. Matthews N, Peck K, Taylor T, et al. Pharmacokinetics of phenylbutazone and oxyphenbutazone in miniature donkeys. Am J Vet Res 2001;62:673–5.
14. Matthews N, Taylor T, Sullivan J, et al. A comparison of 3 combinations of injectable anesthetics in miniature donkeys. Vet Anaesth Analg 2002;29:36–42.
15. Giorgi M, Del Carlo S, Sgorbini M, et al. Pharmacokinetics of tramadol and its metabolites M1, M2 and M5 in donkeys after intravenous and oral immediate release (fasted/fed) single-dose administration. J Equine Vet Sci 2009;29:569–74.
16. Herman CL. The anatomical differences between the donkey and the horse. In: Matthews N, Taylor T, editors. Veterinary care of donkeys. Ithaca (NY): International Veterinary Information Service; 2009. Available at: www.ivis.org.
17. Matthews N, Taylor T, Hartsfield S. Anaesthesia of donkeys and mules. Equine Vet Educ 2005;7:102–7.
18. Latzel S. Clinical and pharmacological studies on elimination kinetics of xylazine (Rompun®/Bayer) in mules. Dissertation (thesis). 1st edition. Munich (Germany): Ludwig-Maximilians-University, Faculty of Veterinary Medicine; 2008. Verlag Dr. Hut, Munich.
19. Lizarraga I, Castillo-Alcala F, Robinson L. Comparison of sedation and mechanical antinociception induced by intravenous administration of acepromazine and four dose rates of dexmedetomidine in donkeys. Vet Anaesth Analg 2017;44: 509–17.
20. Lizarraga I, Castillo-Alcala F, Varner K, et al. Sedation and mechanical hypoalgesia after sublingual administration of detomidine hydrochloride gel to donkeys. J Am Vet Med Assoc 2016;249:83–9.
21. Dar K, Gupta A. Total intravenous anaesthesia in adult mules. Vet Anaesth Analg 2016;43:204–8.
22. Matthews N, Peck K, Mealey K, et al. Pharmacokinetics and cardiopulmonary effects of guaifenesin in donkeys. J Vet Pharmacol Ther 1997;20:442–6.
23. Molinaro Coelho CM, Duque Moreno JC, Goulart D, et al. Evaluation of cardiorespiratory and biochemical effects of ketamine-propofol and guaifenesin-ketamine-xylazine anesthesia in donkeys (Equus asinus). Vet Anaesth Analg 2014;41:602–12.
24. Vullo C, Carluccio A, Robbe D, et al. Guaiphenesin-ketamine-xylazine infusion to maintain anesthesia in mules undergoing field castration. Acta Vet Scand 2017; 59:67–75.

25. Emami M, Seifi H, Tavakoli Z. Effects of totally intravenous thiopental anesthesia on cardiopulmonary and thermoregulatory system in donkeys. J Appl Anim Res 2006;29:13–6.
26. Abd-Almaseeh Z. Comparative anesthetic protocols: propofol and thiopental in xylazine premedicated donkeys. J Anim Vet Adv 2008;7:1563–7.
27. Abass B, Al-Hyani O, Al-Jobory A. Anesthesia in xylazine premedicated donkeys with ketamine and ketamine-propofol mixture: a comparative study. Iraqi J Vet Sci 2007;21:117–23.
28. Naddaf H, Baniadam A, Rasekh A, et al. Cardiopulmonary effects during anaesthesia induced and maintained with propofol in acepromazine pre-medicated donkeys. Vet Anaesth Analg 2015;42:83–7.
29. Maney J, Durham H, Goucher K, et al. Induction of anesthesia and recovery in donkeys sedated with xylazine: a comparison of midazolam-alfaxalone and midazolam-ketamine. Vet Anaesth Analg 2018;45:539–44.
30. Seddighi R, Doherty T. Anesthesia of the geriatric equine. Vet Med Res Rep 2012;3:53–64.
31. Yamaoka T, Flaherty D, Pawson P, et al. Comparison of arterial blood pressure measurements obtained invasively or oscillometrically using a Datex S/5 compact monitor in anaesthetised adult horses. Vet Anaesth Analg 2017;44:492–501.
32. Lamont LA. Multimodal pain management in veterinary medicine: the physiologic basis of pharmacologic therapies. Vet Clin North Am Small Anim Pract 2008;38:1173–86.
33. Shoukry M, Saleh M, Fouad K. Epidural anesthesia in donkeys. Vet Rec 1975;97:450–2.
34. Burnham S. Anatomical differences of the donkey and mule. AAEP Proc 2002;48:102–9.
35. Iff I, Mosing M, Lechner T, et al. The use of an acoustic device to identify the extradural space in standing horses. Vet Anaesth Analg 2010;37:57–62.
36. Ertelt K, Turkovic V, Moens Y. Clinical practice of epidural puncture in dogs and cats assisted by a commercial acoustic puncture assist device-epidural locator: preliminary results. J Vet Med Educ 2016;43:21–5.
37. Natalini C. Spinal anesthetics and analgesics in the horse. Vet Clin North Am Equine Pract 2010;26:551–64.
38. Marzok M, El-khodery S. Comparative analgesic and sedative effects of tramadol, tramadol-lidocaine and lidocaine for caudal epidural analgesia in donkeys (Equus Asinus). Vet Anaesth Analg 2015;42:215–9.
39. Torad F, Hassan E. Epidural lidocaine, nalbuphine and lidocaine-nalbuphine combination in donkeys. J Equine Vet Sci 2016;37:1–5.
40. Hamed M, Abouelnasr K, Ibrahim H, et al. Comparative sedative and analgesic effects of epidural dexmedetomidine and xylazine in donkeys (Equus asinus). J Equine Vet Sci 2017;59:104–9.
41. Suriano R, Varasano V, Robbe D, et al. Intraoperative analgesic effect of intrafunicular lidocaine injection during orchiectomy in isoflurane-anesthetized Martina Franca donkeys. J Equine Vet Sci 2014;34:793–8.
42. Haga H, Lykkjen S, Revold T, et al. Effect of intratesticular injection of lidocaine on cardiovascular responses to castration in isoflurane-anesthetized stallions. Am J Vet Res 2006;67:403–8.
43. Tremaine W. Local analgesic techniques for the equine head. Equine Vet Educ 2007;19:495–503.

44. Hermans H, Veraa S, Wolschrijn C, et al. Local anaesthetic techniques for the equine head, towards guided techniques and new applications. Equine Vet Educ 2017. doi: 10.111.eve.12757.
45. Hagag U, Tawfiek M. Blind versus ultrasound-guided maxillary nerve block in donkeys. Vet Anaesth Analg 2018;45:103–10.
46. O'Neill H, Garcia-Pereira F, Mohankumar P. Ultrasound-guided injection of the maxillary nerve in the horse. Equine Vet J 2014;46:180–4.
47. McCluskie L, Tremaine W. Surgical removal of an aural sarcoid in a donkey using ultrasonic shears. Vet Rec 2009;164:561–3.
48. McCoy A, Schaefer E, Malone E. How to perform effective blocks of the equine ear. AAEP Proc 2007;53:397–8.
49. Mostafa M, Farag K, Zomor E, et al. The sedative and analgesic effects of detomidine (domosedan) in donkeys. Zentralbl Veterinarmed A 1995;42:351–6.
50. Alves G, Faleiros R, Gheller V, et al. Sedative effect of romifidine in untamed mules. Cienc Rural 1999;29:51–5.
51. Marly C, Bettschart-Wolfensberger R, Nussbaumer P, et al. Evaluation of a romifidine constant rate infusion protocol with or without butorphanol for dentistry and ophthalmologic procedures in standing horses. Vet Anaesth Analg 2014;41:491–7.
52. Aziz D, Al-Badrany M, Taha M. Laparoscopic ovariectomy in standing donkeys by using a new instrument. Anim Reprod Sci 2008;107:107–14.
53. Van Hoogmoed L, Galuppo L. Laparoscopic ovariectomy using the endo-GI stapling device and endo-catch pouches and evaluation of analgesic efficacy of epidural morphine sulfate in 10 mares. Vet Surg 2005;34:646–50.