How to Produce Twenty Minutes of Equine Anesthesia in the Field

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1. Introduction

Every week, 50% of equine veterinarians anesthetize horses for short periods of time.[1] More than 90% of equine veterinarians use ketamine as the primary anesthetic drug for short-term anesthesia, with many incorporating diazepam to augment muscle relaxation.[1] The widespread application of ketamine for anesthesia in horses probably represents its relative efficacy and safety and thus the level of confidence that equine veterinarians have in its use. This report will provide recommendations on how to maximize the use ketamine for short-term field anesthesia in the horse.

2. Background Information

Ketamine is a dissociative anesthetic that produces its effects through antagonism at N-methyl-D-aspartate (NMDA) receptors in the brain and spinal cord. Ketamine anesthesia in most species is characterized by indirect stimulation of the cardiovascular system and maintenance of respiration and respiratory reflexes.[2] Animals receiving ketamine show varying degrees of muscle hypertonus, and purposeful or reflexive skeletal muscle movements may occur.[2] The presence of active ocular reflexes coupled with the increases in muscle tone complicate monitoring of anesthesia.[2] The use of ketamine for equine anesthesia was introduced to veterinary medicine in 1977.[3] The report described the use of the only available α_2 agonist at the time, xylazine, given before or in combination with ketamine for short term intravenous (IV) anesthesia. This combination produces an excitement-free induction and recovery, maintenance of normal cardiovascular function, moderate respiratory depression, and adequate muscle relaxation.[3] The average duration of anesthesia was approximately 16 minutes, and horses stood for 12 minutes after a single administration of the anesthetic combination.[3] Subsequent publications have confirmed the safety of the technique in horses but have noted some potential problems that the practitioner should recognize. Major reported problems associated with the use of xylazine and ketamine in the horse include inadequate sedation before ketamine administration producing induction failure, inadequate muscle relaxation during recumbency, and too short a duration of anesthesia.[4,5]

3. Alternative or Additional Sedatives and Analgesics

Since the introduction of xylazine-ketamine anesthesia, two additional α_2 agonists have been approved for use in horses in the United States: detomidine and romifidine. The combination of these agents with

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ketamine for short-term IV anesthesia has been investigated. Detomidine (0.02 mg/kg IV) in combination with ketamine produces induction of anesthesia similar to that of xylazine-ketamine with potentially better muscle relaxation.[6] The depth of anesthesia as shown by the ease of continuing anesthesia with thiopental was thought to be superior to xylazine-ketamine, but the recovery from anesthesia tended to be less coordinated when detomidine was used, presumably because of its greater duration of action. Romifidine (0.1 mg/kg IV) in combination with ketamine is not recommended unless additional muscle relaxation is provided. This is because romifidine may not produce sufficient sedation and muscle relaxation for satisfactory anesthesia.[7]

Acepromazine and butorphanol have been given in conjunction with xylazine or romifidine before ketamine administration. Acepromazine increases the sedation seen after α_2 agonist (romifidine) administration and may prevent hypertension.[8] Induction was more rapid than with romifidine alone. Butorphanol should provide additional analgesia, and, in one study, it appeared to reduce the response to stimuli and facilitate smooth recovery by prolonging the duration of the anesthetic period.[9]

4. Improving Muscle Relaxation and the Quality of Anesthesia

The addition of the benzodiazepines diazepam or midazolam to the xylazine-ketamine combination produces improved sedation and muscle relaxation at minimal cost to the cardiovascular system.[10] Benzodiazepines produce muscle relaxation and some sedation through stimulation of γ-aminobutyric acid receptor–chloride channel complexes in the central nervous system. Diazepam or midazolam is given at a dose of 0.05 to 0.1 mg/kg IV immediately before or in combination with the standard dose of ketamine (2.2 mg/kg IV). The addition of diazepam or midazolam increases the duration of anesthesia to 20 to 25 minutes. Guaifenesin (50 mg/kg IV) is a centrally acting skeletal muscle relaxant that is administered after sedation with an α_2 agonist just before an IV bolus of ketamine is given.[11] Five percent to 10% solutions of guaifenesin are given because of the risk of hemolysis; thus, administration of a large volume (250–500 mL) is required, resulting in a period of ataxia at induction.[12] Intravenous catheterization is particularly useful when guaifenesin is used because of the large volume and the potential for vasculitis and cellulitis if it is administered perivascularly.[13] Guaifenesin produces some sedation but primarily is used to augment muscle relaxation. The quality of anesthesia is similar to diazepam-ketamine.[10] One advantage of guaifenesin administration is that additional quantities of drug are easily given to effect.

5. Alternatives to Ketamine

Tiletamine-zolazepam[a] can be administered to sedate horses to produce good-quality anesthesia for 30 to 40 minutes.[14] Alpha-2 agonists are administered to produce sedation and relaxation. Tiletamine-zolazepam is given IV after the onset of full sedation. The quality of anesthesia is similar to that with xylazine-diazepam-ketamine in that muscle relaxation is excellent. Respiration is depressed but remains adequate for the period of recumbency. Recoveries are not as smooth as that seen with the xylazine-ketamine combination because of the greater degree of muscle relaxation. The IV administration of a combination of ketamine (0.5 mg/kg), tiletamine-zolazepam (0.7 mg/kg), and detomidine (0.01 mg/kg) has been investigated for anesthesia for castration.[15] The combination is prepared by reconstituting 500 mg of tiletamine-zolazepam powder with 4 mL of ketamine (100 mg/mL) and 1 mL of detomidine (10 mg/mL). The mixture is given after xylazine sedation at a rate of 0.007 mL/kg, IV (~3 mL/450 kg). The combination produces excellent induction to anesthesia with intraoperative arterial blood pressures higher than those seen with most other techniques. The duration of anesthesia is longer than that with the use of xylazine and ketamine, and recoveries may require assistance. Propofol is an IV anesthetic that has been investigated in the horse both alone and in combination with ketamine and other drugs. Propofol has not been widely adopted in equine ambulatory practice because of concerns related to respiratory depression, including apnea.[16] Recently, alfaxalone, a progesterone analog, has also been investigated as an anesthetic in sedated horses.[17]

6. Recommendations

A history should be obtained and physical examination should be performed and recorded before induction of anesthesia. Preanesthetic blood work does not need to be extensive for short procedures and should be guided by the physical status of the patient. Written permission for anesthesia should be secured from the responsible party before sedation. Intravenous catheterization improves the safety of anesthesia by ensuring that medications are administered appropriately and reduces the manipulation and stimulation associated with injection. It is important to choose an area for anesthetic induction that also provides good footing for the horse during recovery. Turf or most riding arenas provide good footing. The area should be at least 4×4 meters in size and should be free from obstruction. Provision should be made for recording of the anesthetic drugs administered and an evaluation of their effects. Observations (at a minimum heart rate and respiratory rate) should be made continuously and recorded at 5- to 10-minute intervals.[18]

Xylazine and ketamine have been successfully used to produce short-term intravenous anesthesia in horses for more than 30 years. Although deto-

midine and romifidine can be used for sedation before ketamine administration, their substitution does not appear to provide additional benefit. A key concept of equine anesthesia is the maxim: "Never anesthetize an excited horse." Initial doses of xylazine of 1.0 mg/kg IV usually produce profound sedation within 5 minutes of administration. The horse assumes a head-down posture, with its nose at a level below its knees. Frequently, some ataxia and muscle relaxation will be evident, with the horse shifting its weight back and forth and occasional buckling of the knees. If this level of sedation is not attained, additional IV xylazine should be administered in 0.2 mg/kg increments until the horse is completely obtunded. Butorphanol (0.01 mg/kg IV) can be added to augment sedation and analgesia.

Once the horse is sedate, diazepam (0.05–0.1 mg/kg IV) or midazolam (0.05–0.1 mg/kg IV) should be administered in combination with ketamine (2.2 mg/kg IV). Recumbency occurs approximately 60 seconds after administration. The horse should be rolled to lateral recumbency and then should be positioned as desired. The halter should be removed or padded to prevent facial paralysis. Approximately 20 minutes of anesthesia should be anticipated. Ideally, an assistant should remain near the horse's head during anesthesia to control sudden movements.

It is important to recognize that the assumption of recumbency is associated with the development of ventilation-perfusion mismatches and that the shunting of blood through the lungs results in less-than-optimal oxygenation. The suboptimal oxygenation is well tolerated for short periods, but oxygen supplementation should be used for procedures longer than 60 minutes. Respiratory function should be monitored closely. Persons who routinely perform IV anesthesia should consider the purchase of an oxygen tank and regulator to facilitate emergency oxygenation and ventilation of the patient. Horses can be ventilated by adapting a nasogastric tube onto a pressure-reducing valve attached to an oxygen tank. The tube is slid up one nostril, and the nasal openings are occluded. The nostrils are released when the chest wall rises to a normal inspiratory level. The process is repeated until spontaneous ventilation resumes.

Position the horse in lateral recumbency for recovery, and attach a lead rope to the halter to control the horse once it stands.[19] Most horses will roll to sternal recumbency within 45 minutes then stand shortly thereafter. Do not closely restrain the head of the horse as it attempts to stand. Horses tend to place their front feet forwardly and then push themselves to a standing possession with the use the rear legs.

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[a]Telazol, Zoetis, Florham Park, NJ 07932.