

How to Get 15 Minutes More Out of Your Field Anesthesia Technique

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1. Introduction

Approximately 50% of equine veterinarians anesthetize horses for short-duration procedures every week.¹ The most frequently used technique is the administration of intravenous (IV) ketamine or ketamine in combination with a benzodiazepine (diazepam or midazolam) after sedation with xylazine.¹ The combination of xylazine and ketamine became popular after the publication of a 1977 paper describing the use of a new technique for short-term anesthesia in the horse.² Xylazine-ketamine anesthesia has been administered to many horses during the past 40 years with relatively good results. Modifications of the xylazine-ketamine technique have been made as practitioners have encountered problems and have sought to improve the quality of the anesthetic protocol. The major problems associated with xylazine-ketamine anesthesia are related to 1) inadequate xylazine sedation prior to ketamine administration producing induction failure, 2) inadequate muscle relaxation during recumbency, and 3) too short a duration of anesthesia. Many of the shortcomings of xylazine-ketamine anesthesia have been overcome by adding muscle relaxant drugs to the anesthetic protocol, typically either guaifenesin or a benzodiazepine such as diazepam or midazolam. The addition of the muscle relaxant shortens the

time to recumbency, improves the quality of the anesthesia and increases the duration of anesthesia from 14 minutes when xylazine and ketamine alone are used to approximately 20 to 25 minutes.³⁻⁵ Typically, 15 to 20 minutes of anesthesia is sufficient time for experienced practitioners to perform a variety of simple surgeries such as castration, removal of a small skin mass or debridement and closure of a wound. Occasionally, unforeseen circumstances or complications necessitate lengthening of the anesthetic period. The purpose of this paper is to propose methods for extending the duration of short-term IV anesthesia by 15 minutes.

2. Extending Xylazine-Ketamine Anesthesia Beyond 15 to 20 Minutes

Repeating Xylazine-Ketamine

If anesthesia needs to be extended because of unforeseeable circumstances, such as encountering a hernia while castrating a stallion, an additional dose of xylazine-ketamine can be administered. The drugs are given at the rate of 30% to 50% of the initial dose (xylazine 0.5 mg/kg and ketamine 1.1 mg/kg), combined in the same syringe.⁶ The administration of a second dose of the combination extends the anesthetic period approximately 10 minutes. The administration of additional doses

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beyond the single redosing is discouraged because the quality of the anesthetic state and the recovery from anesthesia worsen in the experience of the author. The constant infusion of a combination of xylazine and ketamine is reported.⁷ Infusion of xylazine (35 ug/kg/min) and ketamine (120 ug/kg/min) maintained anesthesia for 60 minutes in a group of research horses not subjected to surgery.

Guaifenesin Recipes

One of the most popular methods of extending IV anesthesia for up to 60 minutes after xylazine-ketamine anesthesia is to use a guaifenesin recipe (combination). Guaifenesin is approved for use in the horse but is not marketed in the United States. Guaifenesin is available in 1-L bags from compounding pharmacies. Guaifenesin (5%) solution can be combined with xylazine and ketamine to produce a solution that is called "GKX" or "Triple Drip."⁸ "Triple Drip" is formulated by taking 1 L of 5% guaifenesin and adding 1000 to 2000 mg of ketamine and 500 mg of xylazine. The combination is administered to effect up to a rate of 2 mL/kg of body weight/hour. The combination produces excellent muscle relaxation and suitable analgesia. The combination is not usually used for induction of anesthesia because of uncertainty when recumbency will occur. If an extended period of anesthesia is anticipated, the infusion can be started after induction once the horse has been positioned for surgery. The degree of muscle relaxation and lack of movement are the best indicators of the depth of anesthesia. The quality of recovery is generally good if the anesthetic period is kept to less than 1 hour. "Triple Drip" should not be used for anesthetics greater than 1 hour in duration unless oxygen supplementation and respiratory support is provided.

Midazolam Replacement for Guaifenesin

Midazolam, a water-soluble benzodiazepine, can be used to replace guaifenesin in "Triple Drip" and other α_2 agonist-ketamine combinations for extending short-term field anesthesia.⁹⁻¹¹ The usual quantities of xylazine (500 mg) and ketamine (1000-2000 mg) are added to 1 L of isotonic fluids. Midazolam (25 mg or 5 mL/L) is added instead of guaifenesin. The resultant solution is dosed at the same rate as conventional "Triple Drip" (2 mL/kg/hr, IV). Smaller volumes (250-500 mL) can be formulated if the anticipated duration of anesthesia is shorter than 60 minutes, reducing cost and wastage. The effects are similar to conventional "Triple Drip" and the cost may be less expensive depending on your source of guaifenesin.

3. What if I Know I Need Additional Time Before I Induce Anesthesia?

There are two anesthetic regimens that produce 30 to 40 minutes of anesthesia from a single injection. The combination of xylazine and tiletamine-zolazepam can be used to produce good-quality anesthesia for

30 to 40 minutes.¹² Tiletamine is a drug similar to ketamine and zolazepam is a benzodiazepine, similar to diazepam and midazolam. Xylazine (1.1 mg/kg) is administered IV in order to produce profound sedation and relaxation. Tiletamine-zolazepam (1.1 mg/kg) is given following the onset of full sedation. Induction is smooth and tends to be somewhat quicker than that seen with xylazine and ketamine. 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 crisp as seen with the xylazine-ketamine combination because of the greater degree of muscle relaxation. Detomidine and detomidine-butorphanol have also been used prior to tiletamine-zolazepam. The addition of detomidine prolongs the anesthetic duration but the quality of the recovery suffers. The 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.¹³ 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 has been administered after xylazine sedation at a rate of 0.007 mL/kg, IV (app 3 mL/450 kg). The combination produces excellent induction to anesthesia with intraoperative arterial blood pressures higher than those seen with most other techniques. Duration of anesthesia is longer than xylazine and ketamine and recoveries usually require assistance.

4. Discussion

Xylazine and ketamine have been successfully used to produce short-term IV anesthesia in horses for over 30 years. The addition of diazepam or midazolam extends the period of anesthesia and augments the quality of the anesthetic period by producing improved muscle relaxation. Longer periods of anesthesia can be produced by administering additional doses of xylazine and ketamine but guaifenesin or midazolam recipes incorporating xylazine and ketamine produce improved results in terms of the quality of the anesthetic period and smoother, but typically, longer recoveries from anesthesia. The improvement in the quality of anesthesia is primarily due to the augmented muscle relaxation and minimal additive sedation produced by the administration of guaifenesin or a benzodiazepine, such as midazolam. As stated, the addition of these drugs typically extends the duration of anesthesia but at a cost of prolonging the recovery period and causing the horses to be somewhat weaker and potentially have a degree of ataxia when they attempt to stand, compared to short-duration xylazine-ketamine anesthesia. Typically, such horses benefit from assistance, such as steadying the head and tail as the horse moves to regain its feet.

Horses are more difficult to anesthetize than the other common domestic species. Total IV anesthesia may be safer than inhalant anesthesia, perhaps because it is usually of shorter duration.¹⁴ Both oxygenation and cardiovascular function are affected deleteriously when horses are placed in lateral recumbency, thus every step should be taken to minimize the duration of anesthesia. Suboptimal oxygenation is apparently well tolerated for up to 60 minutes of anesthesia but oxygen supplementation should be considered for all anesthetized horses. Typically, respiratory rate and depth of respiration and pulse rate and strength are the primary parameters measured during field anesthesia. They should be assessed at 5-minute intervals and recorded at least every 10 minutes. Respiratory rate and pattern are good monitors of anesthetic depth when horses are anesthetized with protocols incorporating ketamine. As the depth of anesthesia increases, respiratory rate slows and horses increasing “breath hold” at peak inspiration (apneustic breathing). If the “breath hold” lasts longer than 2 to 3 seconds, the infusion rate should be slowed. Persons performing IV anesthesia on a regular basis routinely should consider the purchase of an oxygen tank and regulator in order 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. The techniques described produce tolerable levels of cardiovascular depression but as anesthesia is extended the importance of monitoring increases.

Acknowledgments

Declaration of Ethics

The Author has adhered to the Principles of Veterinary Medical Ethics of the AVMA.

Conflict of Interest

The Author has no conflicts of interest.

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