Case Report Rapport de cas

Anesthesia techniques used for field castration of 10 intractable horses

Bruce C. Stover, Nigel A. Caulkett

Abstract — Dealing with an intractable horse is a reality for nearly every equine or mixed animal veterinarian. Establishing an adequate level of sedation prior to induction of anesthesia for various clinical procedures involves little margin for error regarding the safety of the veterinarian, handler, and patient. This is further compounded by the extreme difficulty of gaining venous access required to obtain rapid and reliable results. This case series describes a technique of intramuscular sedation used for field castration of 10 captive, formerly wild horses, which may be useful for various other types of intractable horses.

Key clinical message:
An alternative method to sedate intractable horses for induction of anesthesia is outlined. The techniques described are accessible for most veterinary practitioners, providing small-volume, fast, and reliable intramuscular sedation.

Résumé — Techniques d'anesthésie utilisées pour la castration sur le terrain de 10 chevaux réfractaires. Faire face à un cheval réfractaire est une réalité pour presque tous les vétérinaires équins ou mixtes. L'établissement d'un niveau adéquat de sédation avant l'induction de l'anesthésie pour diverses procédures cliniques implique peu de marge d'erreur en ce qui concerne la sécurité du vétérinaire, du manipulateur et du patient. Ceci est encore aggravé par l'extrême difficulté d'obtenir l'accès veineux nécessaire pour obtenir des résultats rapides et fiables. Cette série de cas décrit une technique de sédation intramusculaire utilisée pour la castration au champ de 10 chevaux captifs, autrefois sauvages, qui peut être utile pour divers autres types de chevaux réfractaires.

Message clinique clé :
Une méthode alternative pour calmer les chevaux réfractaires pour l'induction de l'anesthésie est décrite. Les techniques décrites sont accessibles à la plupart des vétérinaires praticiens, fournissant une sédation intramusculaire de petit volume, rapide et fiable.

Sedation and anesthesia of horses typically require venous access for expedient and reliable results because pharmacokinetic parameters parallel behavioral, analgesic, and physiologic effects (1). Gaining venous access in intractable or fractious horses, be they wild, feral, or domestic, can be challenging and may place the handler or the animal at risk of injury. Alternatively, IM injection often requires 2 to 3 times the IV dose to increase the intensity and duration of sedation and can take 15 to 30 min to reach peak effect (2). Intramuscular injection can be accomplished manually providing adequate restraint is available or by remote drug delivery (RDD) i.e., *via* dart, if a low volume, highly concentrated combination can be administered. When safe to do so, manual injection is preferred to minimize the risk of tissue trauma associated with RDD (3). Once the animal is deeply sedated, venous access may be safely obtained and induction drugs administered by IV injection. The main focus of this case series is the use of a low volume IM sedation technique followed by IV induction of anesthesia with diazepam and ketamine for field castration of 10 captive, formerly wild horses at varying stages of gentling at the Wild Horses of Alberta Society (WHOAS) facility. Field castration techniques are described in detail for the benefit of practitioners working with mature stallions.

Department of Veterinary Clinical and Diagnostic Sciences, University of Calgary Faculty of Veterinary Medicine, 11877, 85th Street NW, Calgary, Alberta T3R 1J3.

Address all correspondence to Dr. Bruce Stover; e-mail: bruce.stover@ucalgary.ca

Case descriptions

Horses at the WHOAS facility ranged from yearling colts to mature breeding stallions. Prior to arrival at the facility, all the horses were wild (i.e., living freely in nature in the eastern slopes of the Rocky Mountain range in Alberta, Canada, and assumed to have been previously unowned by any person). Gentling had been initiated, and training to accept a halter and lead line

Figure 1. Use of a neck rope to enable intramuscular hand injection of sedation of a captive, formally wild horse at the Wild Horses of Alberta Society facility in Alberta, Canada.

accomplished to varying degrees before castration. Routine pre-anesthetic physical examinations were not performed due to safety considerations surrounding the intractable nature of the horses. Each horse was restrained in a custom chute system with a taut lead line and/or a neck rope (Figure 1), and simple distraction techniques were employed, such as rubbing or simulation *via* pressure near the injection site. An IM injection of medetomidine, acepromazine, and butorphanol was then administered in the neck close to a neck twitch (i.e., a section of skin being manually pinched between the fingers and thumb). Drug doses were calculated based on visual weight estimations, age, and temperament and are presented in Table 1.

Horses were observed for time to onset of ataxia (Table 2) in the chute and subsequently moved to a larger pen for induction and surgery, thus allowing a safe environment for the progression towards deep sedation. A lead line, secured to a pen panel for added restraint, enabled induction of anesthesia in the standing horse by IV administration of diazepam and ketamine. Doses are presented in Table 1.

Post-induction heart and respiratory rates (Table 3) were collected in all 10 horses. Heart and respiratory rates were measured and recorded within 10 min of induction. Blood gas parameters (Table 3) corrected for body temperature were measured in arterial heparinized blood samples collected from the transverse facial artery in 5 of 10 horses within the first 15 min post-induction using a hand-held analyzer (iSTAT 1; Abbott Laboratories, Abbott Park, Illinois, USA).

After induction, horses were placed in dorsal recumbency with their hind limbs restrained using a 2-inch braided cotton rope. Eye lubrication (Optixcare eye lube) was applied and their eyes were protected with a towel. The scrotal area was prepared routinely for surgery using povidone-iodine and 70% isopropyl alcohol. Intratesticular injection of 10 mL of 2% lidocaine with epinephrine per testicle was performed, followed by the final surgical preparation.

A closed surgical castration technique (4) was initiated with 2 parallel testicle-length incisions, 1 on either side of the median raphe through the scrotal skin and fascia. The parietal tunic was grasped, and the scrotal fascia stripped free using sterile gauze until exposure of the cremaster and parietal tunic was sufficient for application of an emasculator. Serra emasculators were applied to the cremaster and spermatic cord. In mature horses, the emasculation of the cremaster and spermatic cord was achieved individually, facilitated by further blunt dissection of the cremaster from the spermatic cord (4), and the median raphe was removed. In all cases, ligation of the spermatic cord and cremaster was performed with a Modified Miller's knot (i.e., strangle knot) (5) using catgut chrom USP 3 (B. Braun surgical, Barcelona, Spain). Care was taken to ensure minimal tension on the spermatic cord during placement of the emasculator. Emasculators were left in place for approximately 3 min, and release of the cord was controlled *via* hemostatic forceps upon removal of the emasculator to ensure appropriate hemostasis had been achieved. Scrotal incisions were stretched manually and left to heal by second intention. Wolf teeth were removed, and a freeze-brand was placed on the right hip.

Intraoperative phenylbutazone (20%, Rafter 8 Products) was administered IV at 4 mg/kg (2 mL/100 kg). Because of the increased risk of and difficulty in dealing with any post-surgical complications, ceftiofur was administered during surgery and again 4 d later by IM injection at 6.6 mg/kg (3.3 mL/100 kg). Also, horses received a parenteral multivalent viral vaccine (Vetera EWT + WNV, encephalomyelitis-West Nile virus vaccine; Boehringer Ingelheim Vetmedica, St. Joseph, Missouri, USA).

Horses were placed in lateral recumbency after the procedure and evaluated for times to achieve sternal recumbency and to establish a standing position (Table 2). Atipamezole was administered where recoveries were considered prolonged, generally 90 min post-induction (Table 2). Average time from induction to completion of surgery was 19.9 ± 3.4 min. Two horses required an IV top-up of anesthetic agents at the initiation of surgery due to slight limb movement and tension: horse 5 received 50 mg of xylazine and 100 mg of ketamine, and horse 7 received 200 mg of ketamine.

Discussion

The risk of severe injury and mortality associated with general anesthesia of horses is considerable (6,7). The additional complications involved with the management of intractable or fractious horses compound these factors. Heavy sedation achieved by IM injection can provide an increased margin of safety when used in wild or intractable animals (8). To be suitable for IM injection, drug combinations must be of a low volume, provide fast and reliable induction or sedation, be reversible, be safe for users, and provide dependable recoveries (8,9).

Numerous drug combinations have been used for anesthesia of wild or feral equids (10). Most commonly, drug combinations including ketamine or tiletamine — zolazepam (Telazol, Zoletil) mixed with α-2 agonists have been described for use in domestic and feral horses and donkeys (8–11). These various combinations have proven largely effective in their corresponding studies; however, the authors have reported many to be unreliable in their respective study populations. Animal welfare concerns have resulted in diminished use of succinylcholine (9). Ultra-potent opioids, although effective, have become less readily available due to the recent opioid crisis, and many practitioners are reluctant to handle these drugs due to human safety concerns (10). Other drugs require specialized handling precautions, involve

Table 1. Doses of medetomidine, acepromazine, and butorphanol administered intramuscularly for sedation, diazepam and ketamine administered intravenously for induction of anesthesia, and atipamezole administered as a reversal agent during field castration of 10 captive, formerly wild horses.

		Intramuscular sedation			Intravenous induction		Reversal
Horse	Estimated weight (kg)	Medetomidine (mg/kg BW)	Acepromazine (mg/kg BW)	Butorphanol (mg/kg BW)	Diazepam (mg/kg BW)	Ketamine (mg/kg BW)	Atipamezole (mg/kg BW)
1	200	0.015	0.05	0.02	0.05	2.5	—
2	200	0.015	0.05	0.02	0.05	2.5	—
3	200	0.015	0.05	0.02	0.05	2.5	—
4	300	0.015	0.03	0.013	0.03	2.0	—
5	150	0.016	0.05	0.02	0.07	2.6	—
6	400	0.030	0.05	0.02	0.05	2.5	0.03
7	500	0.024	0.05	0.02	0.06	2.4	—
8	400	0.030	0.05	0.02	0.07	3.0	0.09
9	450	0.027	0.04	0.018	0.07	2.7	0.10
10	450	0.022	0.03	0.013	0.07	2.7	0.09
Mean	325	0.021	0.04	0.018	0.06	2.5	0.08
SD	129	0.006	0.007	0.003	0.01	0.25	0.03

"—" indicates no reversal agent was administered; BW — body weight; SD — standard deviation.

Table 2. Time in minutes from initial administration of intramuscular sedation (medetomidine, acepromazine, and butorphanol) to onset of ataxia, administration of intravenous induction dose (ketamine and diazepam), administration of reversal agent (atipamezole), and achieving sternal recumbency and standing after surgery in 10 captive, formerly wild horses anesthetized for field castration.

Horse	Ataxia (min)	Induction (min)	Reversal (min)	Sternal (min)	Standing (min)
1	10	15	—	51	75
2	13	21	—	68	68
3	8	8	—	61	61
4	5	9	—	67	68
5	8	12	—	68	68
6	17	34	99	112	125
7	13	20	—	97	115
8	14	18	73	89	104
9	11	14	62	66	68
10	12	19	54	77	77
Mean	11.1	17	72	75.6	82.9
SD	3.5	7.5	19.6	18.5	22.9

"—" indicates no reversal agent was administered; SD — standard deviation.

the use of products which are increasingly difficult to acquire, or require an emergency drug release in Canada (e.g., Telazol). As a result, we believe there is a need to continue to search for safe, economical, and readily available protocols for the sedation and induction of wild or intractable horses.

In this case series, reliable sedation was induced with an initial dose of medetomidine of 0.015 mg/kg in many of the smaller horses but had to be increased to approximately 0.02 to 0.03 mg/kg in the larger, more mature stallions (Table 1). Medetomidine was used in these horses due to its potency and small volume requirement with the compounded formulation. Detomidine is often a good option in fractious horses but not always reliable in very fractious horses. Selectivity of a drug for the α-2 receptor is an indication of potency. Medetomidine has an α-2:α-1 selectivity of 1620:1; whereas detomidine has a selectivity of 260:1. More potent α-2 agonists can be administered at a lower dose and volume (12). Detomidine (10 mg/mL), administered at a dose of 40 μg/kg would require a volume of 2 mL in a 500 kg horse. Medetomidine (30 mg/mL) administered at a dose of 20 μg/kg to a 500 kg horse requires a volume of 0.33 mL. The small volume requirements and potency facilitate rapid IM injection. Based on our experience with these horses, we would recommend administering the IM sedation at an estimated dose of 0.02 mg/kg of medetomidine, 0.05 mg/kg of acepromazine, and 0.02 mg/kg of butorphanol. At the drug concentrations used in these animals, this equates to an IM sedation volume of 0.47 mL/100 kg, or 2.35 mL in a 500 kg horse. This low volume is easy to administer by hand injection, pole syringe, or RDD. Caution must be used when dealing with highly concentrated drugs and the use of appropriate personal protective equipment (i.e., gloves, coveralls, eye protection) by trained personnel is recommended (13). Medetomidine, administered at a dose of 10 μg/kg, IV, was shown to produce a similar degree of sedation as 1 mg/kg of xylazine but ataxia was more pronounced (14).

In the current study, ataxia was also pronounced and a cautious approach to the animal is recommended when the induction drugs are administered. The increased dose of medetomidine appeared to result in longer duration of recumbency, which necessitated the use of atipamezole to speed recovery. In horse 6 (Table 1), atipamezole was administered IM in a 1:1 ratio with little result. Increasing the atipamezole dose to a 3:1 ratio and administering half the volume IV and half IM appeared to give better results. It is recommended that atipamezole be available for reversal when using this protocol. The time from completion of surgery to recovery was relatively prolonged. Appropriate padding should be provided for horses experiencing a prolonged down time.

Recoveries were smooth and reliable, with horses typically standing on the first attempt. If recovery was prolonged, horses were manually rolled into sternal recumbency and would typically stand with this stimulation. It is important to note that overstimulation can result in excitement and rough recoveries. Once in sternal recumbency, it is advantageous to remove any source of stimulation, allowing the horse to stand of its own accord.

Assessment of blood gas parameters illustrated little impact on ventilation but some degree of hypoxemia, likely the result

Table 3. Descriptive statistics of heart and respiratory rate and arterial blood gas parameters measured within 15 minutes post-induction of anesthesia for field castration of 10 captive, formerly wild horses.

	Heart rate (beats/min)	Respiratory rate (breaths/min)	pH	Partial pressure of CO_2 (mmHg)	Partial pressure of O_2 (mmHg)	Bicarbonate (mmol/L)	Base excess (mEq/L)	L-lactate (mmol/L)
Mean	48	11	7.42	42.46	53.75	27.44	2.6	1.2
SD	8	3	0.03	2.5	6.1	1.86	2.1	0.4

SD — Standard deviation.

of V-Q mismatching because horses were in dorsal recumbency at the time when samples were obtained. Only 1 blood gas sample was obtained from these horses as we did not want to stimulate the horse during the recovery period. It is possible that PaO_2 may have further decreased with prolonged recumbency. Supplemental inspired oxygen should be considered when using this protocol.

Ligation of the spermatic cord and cremaster was performed to minimize the risk of hemorrhage. This technique was adopted through a combination of previous experience with domestic horses, consultations with equine surgeons, and by reviewing the literature; although efficacy data for the prevention of hemorrhage, herniation, and eventration vary based on study along with the post-surgery infection rate associated with ligature placement (4,5). To date, the authors have performed over 75 castrations on feral horses and have had only 1 case of post-surgical complication; that case involved infection. No post-surgical complications were observed during, or upon follow-up to this case series.

It is important to note that this protocol was used for castration of healthy horses. More detailed studies of the cardiovascular effects of this protocol should be performed before it can be advocated for horses suffering from significant trauma or hemorrhage.

The authors acknowledge the use of estimated weights as being a potential limitation to the interpretation of the results of this case series; however, the procedures were performed under field conditions and a scale was not available. This is likely representative of many or most clinical situations for field anesthesia of intractable horses.

In conclusion, this case series outlines an effective method to sedate intractable horses for induction of anesthesia that would be available to most veterinary practitioners and suitable for various procedures. The techniques described provide suitable alternatives to conventional sedation or induction protocols, allowing for fast, reliable IM sedation, which is important when dealing with feral or intractable horses. It is our experience that this protocol may offer an increased margin of safety for the patient, veterinarian, and handler. The increased duration of anesthesia provided could be a significant asset, useful for mature castrations or other significant surgical procedures in the field.

Acknowledgments

The authors extend their gratitude to the Wild Horses of Alberta Society for logistical support, Dr. Merle Olson of Bow Valley Research for in-kind contribution of pharmaceuticals, the University of Calgary Faculty of Veterinary Medicine for equipment, numerous volunteers (particularly Tony Stevens) for their technical assistance, and Dr. Claire Windeyer for help preparing this manuscript. CVJ

References

1. Mama KR, Grimsrud K, Snell T, Stanley S. Plasma concentrations, behavioural and physiological effects following intravenous and intramuscular detomidine in horses. Equine Vet J 2009;41:772–777.
2. Doherty T, Valverde A. Manual of Equine Anesthesia and Analgesia. Oxford, UK: Blackwell Publishing, 2006:132.
3. Cattet MRL, Bourque A, Elkin BT, Powley KD, Dahlstrom DB, Caulkett NA. Evaluation of the potential for injury with remote drug-delivery systems. Wildl Soc Bull 2010;34:741–749.
4. Kilcoyne I. Equine castration: A review of techniques, complications and their management. Equine Vet Educ 2013;25:476–482.
5. Gandini M, Comino F, Caramello V, Giusto G. Evaluation of three ligatures in simulated equine open castration. Vet Surg 2020;49:704–709.
6. Wagner AE. Complications in equine anesthesia. Vet Clin North Am Equine Pract 2008;24:735–752.
7. Johnston GM, Eastment JK, Wood J, Taylor PM. The confidential enquiry into perioperative equine fatalities (CEPEF): Mortality results of Phases 1 and 2. Vet Anaesth Analg 2002;29:159–170.
8. Bernal SD, Lanz S, Schmutz I, Leeb T, Spadavecchia C. Induction of general anaesthesia by blowpipe darting in a fractious companion horse. Vet Rec Case Rep 2018;6:e000629.
9. Woolnough AP, Hampton JO, Campbell S, et al. Field immobilization of feral 'Judas' donkeys *(Equus asinus)* by remote injection of medetomidine and ketamin and antagonism with atipamezole. J Wildl Dis 2012; 48:435–443.
10. Matthews NS, Petrini KR, Wolff PL. Anesthesia of Przewalski's horses *(Equus przewalskii przewalskii)* with medetomidine/ketamine and antagonism with atipamezole. J Zoo Wildl Med 1995;26:231–236.
11. Romagnoli N, Rinnovati R, Lambertini C, Spadari A. Short-term general anesthesia with tiletamine/zolazepam in horses sedated with medetomidine for castration under field conditions. J Equine Vet Sci 2018;67:50–54.
12. Sinclair M. A review of the physiological effects of α2-agonists related to the clinical use of medetomidine in small animal practice. Can Vet J 2003:885–897.
13. Caulkett N, Shury T. Human safety during wildlife capture. In: West G, Heard DJ, Caulkett N, eds. Zoo animal and Wildlife Immobilization and Anesthesia. 2nd ed. Ames, Iowa: Blackwell, 2014:181–187.
14. Bryant C, England G, Clarke K. Comparison of the sedative effects of medetomidine and xylazine in horses. Vet Rec 1991;129:421–423.