

Anesthesia of white-tailed deer and other cervids

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Introduction

White-tailed deer (*Odocoileus virginianus*) and other cervids such as mule deer (*Odocoileus hemionus*) and elk (*Cervus elaphus*) may require sedation or anesthesia for a variety of procedures in theriogenology practice, such as semen collection and standing or laparoscopic artificial insemination. This lecture will focus on field anesthesia but will touch on anesthesia of hospitalized cervids where applicable.

Keywords: Anesthesia, cervids, deer, elk,

Pre-anesthetic preparation

Anesthesia of cervids often requires that veterinarians ignore principles of safe anesthetic practice, such as a thorough pre-anesthetic history, physical examination, and bloodwork. A reasonable history might be obtained from the owner or farm employees. There are some uncommon situations in which an examination and venipuncture may be possible, such as if a cervid is hospitalized or sick or tame enough to handle. Packed cell volume, total protein, electrolytes, acid-base status, blood glucose, lactate, and creatinine are important values to obtain, if possible, prior to anesthesia, as they are frequently dramatically deranged by illness, labor, or stress of capture.¹ If at all possible, deer with fluid, acid-base, or electrolyte derangements should be stabilized before inducing general anesthesia. The jugular veins are prominent and easily used for intravenous (IV) injections or catheterization. In a field situation, preanesthetic stabilization is often impossible, and veterinarians must be prepared to treat preexisting problems during anesthesia. Deer are, of course, prey species and are remarkably stoic and adept at hiding clinical signs of illness and pain until they are near death.

Prior to elective anesthesia, healthy cervids should be fasted for 24-36 hours to reduce the risk of ruminal tympany, and water should be withheld for 12 hours. Pediatric cervids that are still nursing should not be fasted. Field capture should be reserved for the coolest part of the day, as these species are prone to hyperthermia. A field anesthetic should be thoroughly planned, with consideration given to such variables as weather, terrain, and available personnel and equipment.

Drug delivery

Cervids can be injected intramuscularly (IM) with immobilizing anesthetic drugs in a two general ways: 1) physical restraint followed by hand- or pole syringe-injection and 2) remote drug delivery. The method selected depends on many factors such as the temperament of the patient and available personnel, facilities, and equipment. There is evidence that physical restraint/struggling and prolonged pursuit times (longer than five minutes) result in severe metabolic perturbations, including myocardial damage, and may predispose to capture myopathy.^{1,2}

The cranial and caudal thigh muscles are often used for remote drug delivery because they are the largest muscle groups and further away from the thoracic cage than neck or proximal thoracic limb muscles; however, the sciatic nerve can be damaged by darting the caudal thigh. Except for perhaps the largest males, smaller cervid species such as white-tailed deer and mule deer have delicate musculoskeletal systems and can easily be seriously injured by darts.

The weight of the patient must first be estimated to calculate drug doses if a scale is not available; mature white-tailed deer weigh approximately 60-150 kg, mule deer 75-135 kg, and elk 230-318 kg.⁵ Small and/or tame cervids can sometimes be moved into a smaller enclosure, then manually caught, restrained, and hand-injected. Deer can seriously injure handlers with their antlers and by kicking. Larger and/or more fractious cervids can be run through a chute or similar physical restraint device and hand-injected. Pole syringes are designed for use in animals that have been restrained in a small, enclosed area. The pole syringe affords less control than hand injection but may be safer for both animal and veterinarian in larger, more fractious animals.

Deer may be injected remotely with a blow dart using a blowpipe. Blow darts are clear plastic, two-chambered darts that use compressed gas added to the posterior chamber to push drug(s) added to the anterior chamber into the animal; because of their sharp needles and light weight, they are meant to be used with blowpipes.³ Blowpipes are long, lightweight tubes with a mouthpiece on one end; the dart is placed in one end, and the operator blows into the tube to propel the dart.³ They are inexpensive and very quiet. Maximum effective range is about 10-15 m.⁴ Greatest accuracy is obtained when used indoors. Practice is required to attain proficiency. Due to their light weight, limited mass, and low velocity, blow darts cause minimal tissue trauma.^{3,4}

Power projection systems must be used to dart deer at greater distances (up to 40 m) after stalking on foot or from a vehicle or helicopter.⁴ Blowgun projectors (e.g., DAN-INJECT of North America or Telinject USA, Inc.), which add an external source of compressed gas (e.g., air from a foot pump or compressed carbon dioxide [CO₂] from a portable bottle), are the type used most commonly in zoological parks for deer.^{3,4} They are quiet and reasonably accurate. They are used most often with molded nylon, two-chambered plastic darts which also use compressed gas to push drug(s) into the animals.³ These darts are heavier, more robust, have better ballistic properties, and can withstand greater impact forces than blow darts.³ They thus have a greater range and can be used outdoors.³ They usually cause only minor tissue trauma unless fired at close range; it is still possible to fracture long bones with these darts, however. Darts that use an explosive discharge mechanism can induce severe tissue damage in small, lean animals and are not recommended.

Drug combinations

The selection of drugs should take into consideration such factors as the patient itself (age, species, temperament—which can range from tame and easily approachable to wild and unapproachable, and preexisting health problems); onset and duration of action of drugs, their side effects, and whether or not they can be antagonized; the concentration of drug available; intended duration and type of procedure; and the animal's enclosure. If a procedure will inflict pain (e.g., laparoscopy, cesarean section) then a plan for preemptive and postoperative analgesia should be made.

The theriogenologist should be aware of the advantages and disadvantages/side effects of each drug class. Advantages of ultrapotent opioids such as carfentanil include rapid onset, reliability, potency, and reversibility with opioid antagonists like naltrexone.⁴ Carfentanil is usually combined with a sedative like xylazine to decrease muscle rigidity and CNS excitement; however, carfentanil-based protocols can still cause respiratory depression, hypoxemia, hypertension, CNS excitation, and hyperthermia and present significant human safety risks.⁴ Cyclohexamines (e.g., ketamine, tiletamine [in combination with zolazepam as Telazol[®]]) have a rapid onset and a wide margin of safety with only moderate cardiopulmonary changes, preserve laryngeal reflexes somewhat, and provide some analgesia, but when used alone, can cause hyperthermia, hypersalivation, convulsions, and catecholamine release.⁴ Alpha₂-agonists are analgesic and useful in combination with ultrapotent opioids or cyclohexamines but are unreliable when used alone in wild cervids. At the doses required in cervids, they significantly depress respiratory and cardiovascular function; common side effects include hypoxemia, hypertension, bradycardia, rumenal tympany, and disruption of thermoregulation.⁴ Highly concentrated forms of these drugs, which will allow the use of small volumes in a dart, are available commercially (e.g., ZooPharm, Inc., Ft. Collins, CO); all must be handled carefully to avoid accidental human injection.

Following administration of any drug(s), cervids should be left undisturbed, with stimulation kept to a minimum. However, the veterinarian should observe the animal for problems during induction. Once the animal has become recumbent, then wait another five minutes or so, then approach cautiously and apply blindfold and hobbles.

Cervids often have very different drug requirements depending on their temperaments. Excited animals will likely require higher doses. Tame white-tailed deer and mule deer confined in an enclosure can be injected with 2-3 mg/kg of xylazine to produce recumbent sedation; elk require about 1 mg/kg.⁵ Elk can also be sedated with 1.5-2 mg/kg of xylazine administered intranasally.⁶ Cervids administered xylazine or other α₂-agonists alone may appear to be immobilized but can rouse suddenly if stimulated. Using α₂-

agonists alone is not recommended for wild cervids and will likely not provide adequate immobilization for more invasive procedures such as laparoscopy or semen collection. Brief, non-invasive procedures such as physical examination, weighing, and venipuncture may be possible. Adding 1-3 mg/kg ketamine IM to the xylazine will decrease the chance of sudden arousal and is necessary for more invasive procedures such as laparoscopy or semen collection.⁵ Excited white-tailed deer that are not approachable will require higher doses of ketamine (up to 6 mg/kg).⁷ Ketamine plus xylazine induces immobilization in less than 15 minutes provides approximately 30 minutes of immobilization after approach.⁷ The more specific α_2 -agonist, medetomidine (0.1 mg/kg) lasts longer than xylazine and permits the use of lower doses of ketamine (2.5 mg/kg).^{4,8} Xylazine plus Telazol[®] is another effective combination for invasive procedures. White-tailed deer and mule deer can be immobilized with 1.5 mg/kg xylazine plus 3 mg/kg Telazol[®], while elk can be immobilized with 1 mg/kg xylazine plus 2 mg/kg Telazol[®].⁵ This combination lasts about 45 minutes to one hour.⁵ Carfentanil (10 μ g/kg) plus xylazine (0.3 mg/kg) has been used in white-tailed deer and mule deer/white-tailed deer hybrids; the quality of immobilization was considered inferior to medetomidine plus ketamine because of more frequent patient movement.⁸ Onset of action is at least as fast as ketamine plus an α_2 -agonist and provides at least an hour of immobilization.⁸ Elk have also been immobilized with carfentanil (10 μ g/kg) and xylazine (0.1 mg/kg).⁵

A new drug combination consisting of butorphanol, azaperone, and medetomidine (BAM) was introduced by ZooPharm several years ago and has been evaluated in white-tailed deer undergoing non-invasive procedures.⁹ Concentrated formulations of butorphanol, azaperone, and medetomidine are mixed to create a solution of 27.3 mg/mL butorphanol, 18.2 mg/mL azaperone, and 10.9 mg/mL medetomidine, which is dosed at 0.3-0.5 mL/fawn, 1-1.5 mL/adult doe, and 2-2.25 mL/buck. This is equivalent to a very high medetomidine dose of 190-250 μ g/kg. Induction times can be quite variable, and white-tailed deer will still sometimes move when stimulated.⁹ Immobilization will last for several hours unless the butorphanol and medetomidine are antagonized with naltrexone and atipamezole; the azaperone component is not reversible. Whether or not BAM is suitable for common theriogenology procedures in the field has not been extensively studied.

For cesarean sections, propofol is the recommended induction drug in dogs and domestic small ruminants, as it is rapidly metabolized and results in increased neonatal vigor, and may be the best option for hospitalized cervids that can be injected IV.¹⁰ Anesthesia can then be maintained with an inhalant such as isoflurane delivered via endotracheal tube.

Xylazine can be antagonized using the α_2 -antagonist yohimbine at 0.1-0.2 mg/kg IM.⁴ Atipamezole, a specific α_2 -antagonist, is used to antagonize medetomidine typically at three to five times the medetomidine dose IM.^{4,5} The dose of an antagonist should be based on the length of time that has elapsed since the agonist was injected. Ultrapotent opioids should be antagonized with naltrexone IM.^{4,5} Remember that antagonizing α_2 -agonists and opioids also antagonizes the analgesia provided by these drugs.

Neuroleptic agents can be useful for tranquilizing cervids for non-painful procedures. Azaperone, a butyrophenone tranquilizer similar to acepromazine, may reduce stress in tame cervids for non-painful procedures. It has no analgesic effects and is not pharmacologically reversible. A dose of 0.2 mg/kg IM will last up to six hours.⁵

Anesthetic complications

Hypoxemia (arterial blood partial pressure of oxygen [PaO₂] less than 80 mm Hg) is probably the most common complication in deer and can be caused by a combination of 1) hypoventilation caused by anesthetic drug effects on the medullary ventilatory center and respiratory muscle relaxation and 2) ventilation-perfusion (V:Q) mismatching. In lateral and especially dorsal recumbency, the rumen and other abdominal organs splint the diaphragm and prevent full contraction and thus, alveolar expansion, resulting in progressive atelectasis, especially of dependent lung regions. This is compounded by gravitational redistribution of blood flow in the lungs and potentially by the procedure itself. Insufflation of the peritoneal cavity for laparoscopy may splint the diaphragm as well if insufflation pressure is too high. Intranasal oxygen supplementation has been proven effective at raising the fraction of inspired oxygen and PaO₂, and a readily available source of oxygen is recommended.^{4,5} Pulse oximetry is highly recommended.

Because the machine relies on the detection of a pulse to provide a reading, it may not work reliably in animals with poor peripheral perfusion from hypertension or hypovolemia.

The veterinarian must ensure the immobilized cervid has a patent airway and is ventilating adequately. If the airway is obstructed, positioning the animal in sternal recumbency and extending the neck may help, but the veterinarian should be prepared to intubate with a cuffed endotracheal tube. A long laryngoscope, a stylet to stiffen the tube, or a plastic guide tube will facilitate intubation. Cervids are most easily intubated in sternal recumbency with neck extended and nose pointed upward. They may salivate profusely, necessitating swabbing or suctioning, or, if they are too lightly anesthetized or if the pharynx is stimulated during repeated intubation attempts, may actively regurgitate and aspirate rumen contents. (They may also passively regurgitate at any time.) Intubation must be swift, and the cuff must be inflated immediately to help protect against aspiration. Cervids are not routinely intubated in the field for brief procedures (< 20 minutes), which is acceptable as long as a patent airway is maintained, the rate and pattern of breathing appears to be adequate, and the patient is positioned properly. Sternal recumbency is safest, but if the patient is in lateral recumbency, the neck should be extended and a rolled towel placed under the poll to elevate the head above the level of the rumen with the nose tipped down toward the ground. It is recommended that cervids in dorsal recumbency be intubated, and they may require positive pressure ventilation (PPV). Patients undergoing laparoscopy may also require PPV. A mildly elevated arterial carbon dioxide (CO₂) partial pressure (PaCO₂, > 60 mm Hg) is usually well-tolerated, but a higher PaCO₂ may prolong recovery and cause a dangerously low blood pH (< 7.2). Monitoring end-tidal CO₂ to assess ventilation can also be performed in the field using portable capnometers in intubated animals. Both oxygenation and ventilation are most accurately assessed by monitoring arterial blood gases, which can be done in the field using portable analyzers. The auricular and femoral arteries are easy to access in most cervids.

Cervids are also prone to hyperthermia. A rectal temperature should be monitored every five minutes. A rectal temperature higher than 41°C is an emergency, and the animal must be aggressively cooled (e.g., using cool IV fluids) or the anesthetic drugs pharmacologically reversed. Hyperthermia in the face of hypoxemia is particularly dangerous because it increases metabolic oxygen requirement, especially in metabolically active tissues such as the brain and myocardium.

Capture myopathy is a potentially serious or even fatal complication that results from massive sympathetic outflow from the stress of capture. Four forms have been recognized: the acute death syndrome, delayed peracute death syndrome, ataxic-myoglobinuric syndrome, and muscle rupture syndrome.⁴ Common clinical signs of the acute form include hyperthermia, tachycardia, tachypnea, cyanotic mucous membranes, metabolic acidemia, and hypotension.⁴ Prevention (e.g., by limiting chase times and physical restraint and avoiding capture in warm weather) is easier than treatment, which consists of supportive care such as oxygen supplementation, IV fluids, and anti-inflammatory drugs.

Ruminal tympany and dart impact trauma are other potential complications. Ruminal tympany can be relieved by sitting the animal up in sternal recumbency to facilitate eructation, passing an orogastric tube, trocarizing the rumen (as a last resort), or antagonizing anesthetic drugs such as α_2 -agonists that decrease rumen motility.

Pain management

Very little information is available in the literature on effective, safe analgesia in cervids; extrapolation from domestic sheep and goats is usually necessary. Injectable non-steroidal anti-inflammatory drugs (NSAIDs, such as flunixin, ketoprofen, or carprofen) are excellent choices for mild to moderate pain as long as the patient has no specific contraindications for their use. Local anesthetics such as bupivacaine combined with a vasopressor such as epinephrine or an α_2 -agonist to prolong duration of effect are useful for procedures such as ring blocks for velvet antler removal or line blocks for cesarean section. Preservative-free morphine and α_2 -agonists can be administered epidurally for cesarean sections. ZooPharm, Inc. now also manufactures sustained-release buprenorphine that may prove useful in cervids. More information on analgesia is available from the author on request.

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