Perioperative Care of the Exotic Mammal

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State-of-the-art improvements in how we feed and provide medical and surgical care for exotic mammals has resulted in a greater lifespan for these beloved family pets. Many exotic mammal owners are dedicated to the health and well-being of their pets and expect the best in medical care including perioperative care. Utilizing the practice team to provide superior medical and surgical care is the goal. All team members including the veterinary assistant, veterinary technician and the veterinarian in charge need to understand the peculiarities of exotic mammal care when a patient is presented for a surgical procedure. Using the wealth of knowledge available on small animal anesthesia and peri-surgical support as a foundation, the exotics veterinarian needs to include awareness of physiological parameters unique to the exotic mammal. All team members need to understand that these small species have high metabolic rates, are prone to anesthetically related hypothermia, are in some cases catecholamine driven prey animals (the rabbit) that stress easily, and many have an anatomy that makes intubation difficult. As a result of the small thoracic size in comparison to body mass exotic mammals are more predisposed to cardiovascular and respiratory complications when anesthetized. Team organization and readiness is essential at minimizing anesthetic and surgical time and thereby limiting perioperative complications and hospitalization time. All equipment needed for anesthesia and patient support as well as the surgical suite and post op recovery area needs to be in place prior to proceeding with any surgical procedure. Drugs anticipated for sedation, analgesia, anesthesia and potential emergencies need to be calculated and ready to use. Anesthetic monitoring equipment needs to be functioning properly and the anesthetist needs to understand how they function, what parameters they are measuring, what these measurements mean and what to do if things go awry. The bottom line is that good overall preparation and a knowledge of appropriate perioperative options available for patient care will maximize success in before, during and after the exotic mammal goes to the operative suite.

Instrumentation

In general the surgeon can use a feline spay pack for most routine exotic mammal surgeries such as ovario-hysterectomies, castrations and lumpectomies. A separate pack of fine, delicate instruments, preferably developed for microsurgery is added to aid in the tissue handling of these small patients and are prerequisite for more detailed surgery such as ferret adrenalectomies, GI surgery, or exotic mammal cystotomies. In choosing microsurgery instruments, consider: length (5-7 inches standard), rounded handle so they can be rolled between surgeon's thumb and first finger, and counter balancing which allows the instrument to rest comfortably in the surgeon's hand, thus reducing muscle fatigue. The microsurgery pack used for small exotic mammals should consist minimally of a microsurgical needle holder, scissors and thumb forceps. The author prefers a ring-tipped microsurgical forceps (Sontec Instruments, Centennial, CO). The fine ring tip provides for better holding power with minimal tissue damage. Other instruments that aid in exotic mammal surgery include the Statinsky vascular clamp used with right sided ferret adrenalectomies and a Hemoclip® applicator for application of ligation / hemostasis clips.

Magnification

Some form of magnification is of great benefit to the exotic mammal surgeon. In patients weighing less than 100 grams, such as hamsters, gerbils, or mice, an operating microscope should be considered, however, in many cases, loupes can provide adequate magnification. For those on a budget, hobby loupes provide an inexpensive form of magnification. Surgical magnification loupes such as the Surgi-Tel® (General Scientific Corporation, SurgiTel, Ann Arbor, MI) are essential for surgeons (especially those over the age of 40!) looking for surgical field clarity and magnification. They have the added benefit of allowing the surgeon to look through the lenses with the head held in an upright, ergonomically correct position.

Hemostasis

- radiosurgery
- hemostatic clips- for vasculature and small pedicle ligation
- hemostatic agents: Gelfoam (Pfizer, New York, NY)- absorbable gelatin sponge
    - Surgicel (J & J, Ethicon Inc., Somerville, NJ)
    - oxidized regenerated cellulose

A hemostatic sandwich constructed of Gelfoam surrounded by Surgicel makes an excellent tool for control of nonspecific hemorrhage.

Suture materials

The surgeon's goal in choosing a suture material for tissue repair is to restrict loss of tissue function and to limit the adverse effects of the repair. Absorbable suture material of sizes between 4-0 and 8-0 are generally used. Non-reactive materials (Note: rabbits are particularly prone to abdominal adhesions) most commonly used include: polydioxanone (PDS, Ethicon Inc Ethicon Inc, Somerville, NJ, Somerville, NJ), polyglactin 910 (Vicryl, Ethicon Inc, Somerville, NJ)), and poliglecaprone (Monocryl, Ethicon Inc, Somerville, NJ). If limited to one suture, the author would choose 4-0 PDS as this is a good size and material suitable for most small exotic mammal surgery. As a general rule, for skin closure an intradermal suture pattern is preferred as exotic mammals, rabbits and rodents in particular, are known for their tendency to rapidly remove external skin sutures. The author uses cyanoacrylate tissue adhesive to "neaten up" any gaps in the intradermal closure.

Preanesthetic blood work up

All patients benefit from preanesthetic blood analysis. The main goal of perioperative supportive care is to minimize the adverse physiologic effects of anesthesia, surgery and pre-existing disease. This begins with a thorough patient history and physical exam including the weight in kilograms. Recommended pre-surgical diagnostic tests vary with the case history and intended surgery. Complete blood count and serum chemistries are ideal

prior to all surgeries and the availability of accurate in-house diagnostic analyzers that require minimal volumes of blood allows for analysis the day of surgery. Fluid therapy can be tailored to the patients specific needs or anesthetic risks based on the physical exam and blood analysis.

Numerous collection sites have been described for exotic mammals, and include the auricular vein (rabbit), lateral saphenous, cephalic, and the jugular vein or other great vessels of the heart. In the rabbit the author most often collects from the lateral saphenous vein. For larger specimen requirements the author with draw from the jugular vein in the anesthetized rabbit. For the ferret, guinea pig, and hedgehog the author collects from the great vessels of the heart accessed at the proximal sternal notch. In most cases a 25 ga (0,50mm) needle and tuberculin syringe is used for collection. Careful restraint is essential to prevent patient handling injury and to minimize stress and collection technique errors that may be alter hematology and blood chemistry results. The author has seen prolonged and difficult blood draws decrease potassium and white blood cell levels and falsely elevate BUN and ALT enzymes. As a result, sedation may be necessary prior to blood collection in anxious patients.

Fluid therapy (see notes under Rabbit Medicine Overview)

Recognizing and treating shock (see notes under Rabbit Medicine Overview)

Analgesia, sedation

To alleviate the apprehension and stress associated with the hospital environment many exotic mammal patients benefit when given a sedative 20-30 minutes prior to procedures requiring restraint or anesthesia. The author routinely uses the sedative midazolam (Baxter Healthcare Corp, Deerfield, IL) (Table 1) for a variety of diagnostic procedures and out-patient treatments including imaging, blood or cytological specimen collection and grooming procedures. Used prior to surgery, sedatives make anesthetic induction, anesthesia itself, and recovery all go more smoothly. For surgery patients analgesics are given at the same time in order to initiate preemptive pain control as inhalant anesthetics produce unconciousness but are poor analgesics. Well-recognized benefits of the administration of preanesthetics in patients include reduced stress associated with restraint and induction, and lowering of the mean alveolar concentration (MAC) of inhalant agents required to achieve a surgical plane of anesthesia.

Table 1. Published doses of preanesthetics, anesthetics and analgesics.(1,2,3) Drugs highlighted in bold print are ones commonly used by the author.

Drug	Dosage (mg/kg)	Comment
Midazolam[a]	0.25-0.50 IM or IV 0.5- 2.0 IM	Anti-anxiety tranquilizer, pre-anesthetic; use in combination with an opioid or ketamine When used alone
Butorphanol[b]	0.2-0.8 IM, IV, SQ	Opioid analgesic
Buprenorphine[c]	0.02-0.06 mg/kg IM	Opioid analgesic
Oxymorphone[d]	0.05- 0.2 SQ or IM	Opioid analgesic, preop with midazolam or for additional analgesia
Dexmedetomidine[e]	0.1-0.2 IM/IV	α-agonist, preop sedation and analgesia Preanesthetic; can be combined with ketamine Can be reversed with atipamezole
Meloxicam[f]	0.3-0.5 SQ/PO	NSAID, q12h for anlagesia
Lidocaine[g] 2%	1.0	Local anesthetic- rapid onset; can be used in combination with bupivicaine for longer analgesia
Bupivicaine[h] 1.25%	1.0	Local anesthetic-slower onset; can be combined with lidocaine for longer analgesia
Ketamine[i]	1 mg/kg (low dose)	Pre-anesethetic and for additional sedation

- Midazolam, 5 mg/ml, Baxter Healthcare Corp, Deerfield, IL, USA.
- Torbugesic, 10 mg/ml, Fort Dodge Animal Health, Fort Dodge, IA, USA.
- Buprenex, 0.3 mg/ml, Reckitt Benckiser Pharmaceuticals Inc, Richmond, VA, USA.
- Numorphan, 1 mg/ml, Endo Pharmaceuticals Inc, Chadds Ford, PA, USA.
- Dexdomitor, 0.5mg/ml, Pfizer Animal Health, New York, NY, USA.
- Metacam, 5mg/ml, Boehringer Ingelheim VetMedica Inc, St Joseph, MO, USA.
- Lidocaine 20mg/ml, Agri Laboratories, St Joseph, MO, USA.
- Marcaine 12.5mg/ml, Hospira, Lake Forest, IL, USA.
- Ketaset, 100 mg/ml, Fort Dodge Animal Health, Fort Dodge, IA, USA

Anesthetic induction and maintenance

Anesthetic induction using the injectable anesthetics propofol (Propoflo, Abbott Animal Health, N Chicago, IL) and etomidate (Bedford labs, Bedford, OH) have been described. In rabbits, propofol has been shown to cause a persistent dose-dependent hypotension and depression of myocardial contractility and cardiovascular function and therefore may not be the ideal induction agent in the rabbit. Etomidate on the other hand is very cardiovascular friendly and some veterinarians reserve the use of this drug for anesthetic induction of rabbits with known cardiac disease.

As a general rule the author prefers anesthetic induction using isoflurane or sevoflurane delivered through a tight fitting anesthetic mask. Induction with an anesthetic mask is much smoother, safer and easier when the patient is sedated with pre-anesthetic drugs. The size and shape of the anesthetic mask chosen depends on the size and shape of the patient's face, with the smallest possible mask that fits snuggly and reduces escape of anesthetic gases being the goal. The author prefers to start with a high oxygen flow rate of 2-4 L/min with the vaporizer set to the highest available concentration. High oxygen flow rates and induction with vaporizer concentrations set at 5 % for isoflurane and 7-8% for sevoflurane tends to speed anesthetic induction. Once anesthetized, the vaporizer setting is then reduced to a setting near the minimum alveolar concentration (MAC). For exotic mammals, the MAC for isoflurane is between 1.28% to 1.63% and for sevoflurane is between 2.3% to 2.7% (3) and is influenced by the type and amount of preanesthetic used. Preanesthetic agents include sedatives and analgesics, and each practitioner or veterinary anesthetist develops a hospital preference. Since all anesthetic agents, including isoflurane and sevoflurane, (4) have dose-related respiratory and cardiovascular depressant effects, any lowering of the MAC using a balanced anesthetic approach should be advantageous. During induction the author restrains exotic mammals in a towel with gentle but firm restraint in a calm setting to ease induction and reduce patient struggling and stress.

A non-rebreathing system such as the Bain or Ayres T piece is used for delivery of anesthetic gases. The human pediatric circuits are inexpensive and can be re-used numerous times. These systems rely on a high oxygen flow rate to remove CO2. Oxygen flow with these systems should be two to three times the patient's minute ventilation (approximately 200-350ml/kg/min). For some vaporizers the minimum oxygen flow rate required to maintain vaporizer accuracy is 350 mL/min and should be the lower limit regardless of patient size.

Ventilation is the act of tidal breathing to allow fresh gas (oxygen) to reach the alveoli and to allow exhaled gases (CO2) to be removed from the lungs.(3) With inhalation anesthesia, ventilation also facilitates inhalant gas delivery and removal from the lungs. Current recommendations for ventilatory support include 2 to 6 breaths per minute using tidal volumes ranging from 10 to 15 mL/kg, with peak airway pressures of less than 10 cm H20.(5) Some veterinarians prefer to use a ventilator to control anesthetic breathing. Depth and frequency of ventilation are initially set to mimic pre-anesthetic respiration and then modified to maintain end tidal capnography (ETCO2) readings of between 35-45 mmHg.(2) The advantages of intermittent positive-pressure ventilation include adequate delivery of oxygen and inhalant anesthetic agents, while waste gases, particularly CO2, are reliably eliminated in these small patients.

Intubation

Intubation allows for assisted ventilation and resuscitation in case of respiratory arrest, and also reduces leakage of waste anesthetic gas with exposure of personnel. As a result, intubation is recommended over face mask anesthetic maintenance except when working in the oral cavity of herbivores as the endotracheal tube can disrupt visualization. Endotracheal tubes of 2.0 to 3.5 mm size are suitable for most exotic mammal patients. Ferret intubation is fairly routine and similar to the feline patient. Rabbit intubation is challenging as the tracheal opening is difficult to visualize due to the rabbit's oropharyngeal anatomy. The thick, fleshy tongue, small mouth opening, long narrow oral cavity and laryngeal spasm all add to the difficulty of intubation without the visual aid of endoscopy. Tracheal intubation is performed using the blind technique, an endoscopic-guided technique (endoscope side-by-side or over-the-top) or with the aid of a laryngoscope. The advantage of direct visualization with an endoscope is that an endotracheal tube that snugly fits the trachea can be chosen. Anesthetically rabbits are more stable and balanced anesthesia is much easier to maintain when intubated with an appropriate sized tube that maximizes inner tube diameter and minimizes length.. Multiple attempts at unsuccessful intubation may result in traumatic laryngeal edema and subsequent labored respirations. If unsuccessful at intubation after 3-5 attempts it is often more ideal to maintain anesthesia with use of a tight fitting facemask.

Rabbit intubation can be technically aided by

- Patient relaxation via preanesthetic sedation. Ketamine (1.0mg/kg IM) in combination with midazolam (0.25mg/kg IM) or ketamine (1.0mg/kg IM) with dexmedetomidine (0.1-0.2mg/kg IM) as preanesthetics will provide five-plus minutes of good restraint and relaxation for intubation (compared to 10 - 20 seconds following gas induction).
- If deeper anesthesia is required, maintain the animal on an inhalant anesthetic by holding a small face mask over the nose during induction. Rabbits are obligate nasal breathers and can be maintained with gas anesthesia applied via a face mask.
- To deter laryngeal spasm use a 2% lidocaine gel (Lidocaine hydrochloride oral topical solution, Pharmacal, Amityville, NY) swabbed on the epiglottis. My licensed vet techs like to coat the tip of the enodtracheal tube with the lidocaine gel and coat the laryngeal area, put the rabbit back on a face mask a few minutes while the gel takes affect, and then reinsert the endotracheael tube for intubation.
- For the blind approach; introduce an endotracheal tube into the oral cavity and over the tongue while listening for the sound of air movement as the tube advances. The tube is positioned over the glottis when the sound of air movement is the loudest. The tube is gently rotated while moving forward and back until the tube slides into the trachea. Do not force entry of the tube into the trachea.
- For endoscopically assisted intubation start by using gauze to open the mouth fully and hyperextend the head and neck. Gently pull the tongue to one side of the incisors and insert the endoscope to visualize the epiglottis and ensure that it is not engaged above the soft palate. Applying mild dorsal pressure on the soft palate will cause the epiglottis to fall ventrally and expose the glottis. Use the endoscope to visualize the endotracheal tube entering the trachea in the side-by-side technique. Endotracheal tubes of 2.0 to 3.5 mm size are suitable for most rabbits

Anesthetic monitoring

The importance of anesthetic monitoring cannot be underestimated. By preventing, identifying, and correcting hypotension, bradycardia, arrhythmias, hypoxemia, hypercapnia, and metabolic disturbances, anesthetic monitoring will minimize patient morbidity. In general, the same principles and techniques of anesthetic monitoring used in dogs and cats can be applied to the exotic mammal. A good veterinary technician or anesthetist is essential in managing the perioperative support and anesthetic depth of these small patients as physiologic status can change rapidly. Using physical exam parameters such as heart rate, rhythm and strength, respiratory rate, capillary refill time and body temperature the anesthetist can assess tissue perfusion and intravascular volume. Equipment designed to aid in the assessment of patient anesthetic depth as well as the cardiovascular and respiratory systems while under anesthesia include electrocardiography, Doppler flow detection and blood pressure measurements, pulse oximetry and end-tidal CO2 determination. Utilize equipment that will give you the most information with least problems; ultrasound dopplers, end-tidal capnography and ECGs are often easier to use.

Thermoregulation

Hypothermia is common in small anesthetic patients due to the large surface area: patient volume, the cooling effect of anesthetic gases, and suppression of thermoregulation by preanesthetic drugs and analgesics. The author uses several methods to maintain core body temperature including incubated recovery cages (Snyder http://www.snydermfg.com), a surgery table with built in conductive heat and a forced air warming system such as the Bair Hugger® (Arizant Healthcare, Eden Prairie, MN). The forced air warming systems use a heat blanket that provides convective heat and is a very a worthwhile investment if your are going to be doing surgery on smaller species. The advantage of convective heat vs. radiant heat (heat lamps) or conductive heat (heated surgery tables or water circulating heating pads) is that convective heat actually warms the patient vs. only preventing heat loss. Surgical stockinette (Tex-Care Medical, Burlington, NC) filled with rice and microwaved to warm, make great portable heat blankets when anesthetized patients are in radiology or on the pre-op prep table.

Post operative considerations

Body temperature should be carefully monitored during surgery and recovery. Recovery in an incubated cage (75-80° F or 24-27° C) is ideal--monitor so patient is not overheated as ferrets are prone to heat prostration. Maintenance fluids delivered via an infusion pump should be continued. Post-op analgesia is recommended for 2-3 days. Due to the high metabolic rate of small exotic mammals, it is important to resume food consumption as soon as the patient is adequately awake. Ferrets can eat 6-8 hours post-op for most routine procedures. Herbivores should be offered grass hay and leafy greens within 2-3 hours post recovery from routine surgeries in order stimulate GI movement and prevent gut stasis. Rabbits should be protected from stress related to the noise, sight, or odor of potential predators (dogs, etc), as they are not likely to eat well if environmentally stressed. Anorectic post op patients should be syringe fed until eating on their own in order to prevent hypoglycemia, hepatic lipidosis and GI stasis in herbivores. Oxbow Critical Care and Carnivore Care (Oxbow Animal Health, Murdock, NE) are recommended for herbivores and carnivores respectively.

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