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General Principles, Instruments, and Equipment

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Introduction

Many surgeries in exotic animal are analogous to those performed in other species. The size of some patients makes surgery more challenging. Appropriate preoperative work up, patient preparation, surgeon preparation, perioperative antibiotic therapy, thermal support, and hemostasis are essential for a successful outcome. Preemptive, multimodal analgesia has long been known to improve recovery from surgery and is especially important with wildlife and exotic prey species. Additionally, in recent years, patients' anxiety has become an important consideration when these patients have to be hospitalized. Use medications evaluated for the species having surgery to develop a preemptive analgesic and antianxiety treatment plan. When prey species experience anxiety, stress, fear, and pain, they often die for no apparent reason. Alternatively, they may recover from the surgical event only to die a day or two later, likely from these stresses. In pet species, it appears that if they are accustomed to being handled by humans they are more likely to survive the perioperative period. If multiple procedures need to be accomplished, as a general rule, it is better to perform multiple short anesthetic events and surgeries than to try to do everything under one long anesthetic event. This is especially true when imaging is needed for surgical planning. It is best to anesthetize the patient for imaging, then recover it and evaluate the study. Once a diagnosis is made and a plan developed, anesthetize the patient the next day for the surgical procedure.

It is important that patients resume eating for nutritional support as soon as possible after surgery. Many small patients are not able to undergo long periods of anorexia because they do not have the energy stores to support themselves because in their natural environment they are constantly eating. The nutritional needs of the patient must be addressed and supplemented as needed either per os, using a feeding tube, or intravenously.

Presurgical Considerations

Prior to performing surgery, it is vital to evaluate the patient and address any abnormalities. In many situations, fasting is recommended; however, sometimes it is not necessary. Hemodynamic support is important for all but the shortest surgical procedures. Patient and surgeon aseptic techniques should be followed for all surgeries regardless of size and species. Perioperative or therapeutic antibiotic therapy needs to be considered. Because small patients become hypothermic quickly, thermal support is essential even for diagnostic procedures done under anesthesia.

Patient Support

Small exotic animals are especially prone to developing perioperative complications such as hypovolemia from blood loss, hypothermia, and renal and respiratory compromise. It is important to evaluate the patient systemically prior to anesthesia and surgery and to address any abnormalities preoperatively. During anesthesia and surgery, provide fluid therapy to support the cardiovascular system. Monitor body temperature and take measures to minimize hypothermia. Take appropriate steps to minimize blood loss and take precautions to minimize the risk of surgical site infections.

Data Base

The ideal preoperative data base includes a complete blood count, serum or plasma biochemistry panel, and a urinalysis. Additional diagnostics may be indicated based on the species and the medical problem being addressed. For example, mice and rats are prone to mycoplasmosis pneumonia, and preoperative chest radiographs are indicated prior to anesthesia in these species. While it may be difficult to obtain a urine sample from a small rodent, they are prone to developing renal insufficiency later in life, so it is important to evaluate urine specific gravity and a dipstick for proteinuria. These can be done with two drops of urine

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that can be obtained by placing the patient in a plastic or glass container for several minutes. In ferrets, it is important to determine the blood glucose level prior to anesthesia because they are prone to forming insulinomas. In very small patients, it may not be feasible to take enough blood for all of the abovementioned diagnostics. At a minimum determine a hematocrit, total protein, blood urea nitrogen (azotemia test strip), glucose, and urine specific gravity.

Preoperative Fasting

Various species such as equids, rabbits, and rodents are not able to vomit for physiologic reason, so fasting to prevent aspiration pneumonia is not necessary. Additionally, if attempting to decrease gastrointestinal contents for a surgery, it can take days to make a difference because the majority of ingesta is within the hindgut. A short fast is recommended to allow these species to swallow any food material to reduce the risk of food entering the trachea during intubation. A prolonged fast in small mammals can result in a negative energy balance which increases their risk for developing complications after surgery (Jenkins 2000). Many small patients have low hepatic glycogen stores and may develop hypoglycemia during a prolonged fast (Harkness 1993; Redrobe 2002). Administer fluids containing dextrose subcutaneously (SC), intravenously (IV), or intraosseously (IOs) in patients prone to developing hypoglycemia. The gastrointestinal transit time in ferrets is rapid, and a prolonged fast is not recommended. An hour fast in ferrets is long enough for the stomach to empty minimizing the risk of developing aspiration pneumonia. On the other end of the spectrum, some reptiles may only eat once a week or even less often so there is no need for a fast.

Hemodynamic Support

Small patients have a small total blood volume and what may appear to be minimal hemorrhage can be life-threatening. If the patient is anemic and surgery can be postponed, it should be postponed until the hematocrit is into the normal range. It would be a rare event that surgery made a hematocrit increase, typically the opposite is the norm. Consider a blood transfusion from a conspecific, if more than minimal hemorrhage is anticipated or if the patient is anemic preoperatively. Strict attention to intraoperative hemostasis is essential when performing surgery on any small patient.

In patients experiencing serious blood loss during surgery, crystalloid or colloid fluid therapy should be administered as quickly as possible for cardiovascular support. More ideal, blood from a conspecific should be used, but often this is not available. Preplanning by having a conspecific blood donor available can be life-saving. In ferrets, there are no blood types and no reports of transfusion reactions. It is safe to use any ferret as a blood donor. In many species, blood typing may not be known. If it is unknown whether a species has blood types, a crossmatch should be performed prior to administering a blood transfusion.

Anesthesia results in loss of fluids because of dry gases making parenteral fluid administration vital for most surgical procedures. It can be difficult to achieve vascular access in small patients. Vascular access provides a route for the administration of fluids during anesthesia at the standard rate of 10 ml/kg/hr and, maybe more importantly, provides a route for administration of emergency drugs in the event of a crisis. An IOs catheter can be placed relatively easily in most species even in small patients. SC administration of fluids is much less effective than IV or IOs and is an ineffective route for administration of emergency drugs. A single dose of 10 ml/kg SC of 4% dextrose has been recommended for short procedures in healthy small exotic mammals (Redrobe 2002). Fluids administered subcutaneously or intraperitoneally are slowly absorbed and not appropriate for treatment of severely ill, dehydrated, or shocky patients.

Maintain vascular access in the postoperative period if at all possible. Continue to administer fluid at least at a maintenance rate until the patient has completely recovered and is eating and drinking well.

Perioperative Antibiotic Therapy

The aim in administering perioperative antibiotics is that the blood level of antibiotic will be effective in preventing incision site infection from target organisms. In most cases, the target organisms are normal skin flora that cannot be completely eliminated during patient skin preparation. The antibiotic should be administered prior to making an incision, which is when the first exposure occurs and should continue until the surgery is complete so any blood clots that form will have therapeutic levels of antibiotic. If the patient is already receiving antibiotics for treatment of an infection and has therapeutic circulating levels of antibiotics effective against the target organisms, additional IV perioperative antibiotic is not needed. If the therapeutic antibiotic is not expected to be effective against the surgical target organisms, perioperative antibiotic administration of an antibiotic expected to be effective against the surgical target organisms should be administered perioperatively. For example, if a patient is receiving cephalexin for a skin infection, but the surgery is in the perineal area where fecal contamination is a concern, adding a perioperative antibiotic against which fecal flora are likely to be sensitive is appropriate. There is no evidence that continuing to administer a perioperative antibiotic for a brief period of time postoperatively is beneficial for preventing surgical site infections (SSIs) and may select for resistant organisms.

Surgeon Aseptic Preparation

The goal of surgeon aseptic preparation is to reduce the incidence of SSI. In human medicine, SSI has been shown to delay wound healing, increase antibiotic use, increase hospital stay, and increase costs, and can result in fatal consequences. Minimizing the risk of SSI in exotic animals is essential for many reasons. Surgeons should wear a cap, mask, gloves, surgical gown, and shoe covers for all surgical procedures (Figure 1.1). Procedures should be done in the cleanest environment possible. A dedicated operating room is ideal, but avoid doing surgery in rooms where abscesses are treated, dirty procedures are performed, or there is fecal contamination.

In one study, glove perforation occurred in 67% of surgeries underscoring the need for hand antisepsis to reduce skin flora before gloving (Verwilghen et al. 2011). Scrubbing is *not* recommended because it removes protective mechanisms on the skin surface and exposes more potentially pathogenic bacteria. Additionally, it causes small abrasions and excoriations damaging the surgeon's skin and increasing the risk of colonization by pathogenic organisms.

Alcohol-based hand rubs are recommended because they have rapid action, are faster to use, and cause less skin damage compared with antiseptic soaps. Alcohol-based hand rubs do not require water. It has been estimated that on average 20 l of water are used per hand when using antiseptic soaps. Additionally, many water faucets and municipal water sources are contaminated with *Pseudomonas* sp. and other Gram negative organisms that can recontaminate the hands. There is no reason to do a one-minute hand wash with a neutral soap before applying the hand treatment, and it has been shown that omitting hand washing prior to applying Sterilium® (Medline Industries, www.medline.com) increases its efficacy (Verwilghen et al. 2011). The World Health Organization recommends alcohol-based hand rubs over antiseptic soaps because of their superior efficacy both *in vitro* and *in vivo*, better skin tolerance, lower environmental impact, and no risk of recontamination from rinsing with contaminated water.

Patient Preparation

Regardless of the patient size or species, standard aseptic technique is essential for reducing the risk of SSI. Commonly, exotic animals are more likely to develop SSI than domestic animals because their housing often require them to be in proximity to their urine and feces. Prepare an appropriate area around the proposed surgical incision. Some species like chinchillas and rabbits have fragile skin

Figure 1.1 The surgeon must adhere to proper aseptic technique wearing clean scrubs (a). A cap, mask, and shoe covers, and sterile gown and gloves are proper attire regardless of the size and species of the patient (b).

that can easily be damaged during clipping for surgery. For most mammals, a No. 40 clipper blade is used; however, in patients with very fine fur a No. 50 clipper blade (Oster Professional Products, McMinnville, TN) is better suited. The teeth of the No. 50 blade are closer together than those of the No. 40, making it more difficult for the patient's skin to get caught between the teeth and be cut. Move slowly over the skin and keep the skin in front of the clipper blade flattened. Clean and lubricate the blade frequently to help decrease the risk of damaging the skin.

In birds, it is best to pluck feathers which then regrow rapidly; however, it is best not to pluck primary flight and tail feathers as this can damage the follicle resulting in abnormal feather growth. Some birds, such as penguins, have very small dense feathers that are very difficult to pluck. Use a No. 10 clipper blade for these birds. The No. 10 blade teeth are farther apart and clip the feathers at the base. Cut or clipped feathers will not be replaced until the shaft is molted and replaced naturally.

For many years, it has been suggested that alcohol be avoided for skin preparation of small patients because evaporative cooling might cause clinically important hypothermia. A study in mice compared the effect of skin preparation on hypothermia (Skorupski et al. 2017). They compared alcohol alone, povidone iodine alone, povidone iodine alternating with alcohol or saline or warmed saline. Alcohol alone or alternating with povidone iodine caused a dramatic drop in surface and core temperatures, but it rebounded quickly. When alcohol was used alone, the these temperatures returned to nearly the level of the control animals within minutes; however, when alternating with povidone iodine, this was not observed to occur. The authors theorized that the alcohol evaporates very quickly and the cooling stops, whereas povidone iodine and saline evaporate over a longer period of time resulting in more profound hypothermia. Using warmed saline did not modify this effect. The coldest core temperatures were observed in all povidone iodine treatment groups, and this hypothermia persisted. The authors suggested the povidone iodine takes longer to evaporate than saline, resulting in these low body temperatures. The authors concluded that using alcohol for rodent aseptic preparation causes less hypothermia and should be encouraged.

In that study, three applications alternating povidone iodine with either saline or alcohol was used. In veterinary, surgery tradition has been to apply alternating patient skin preparation solutions such as povidone iodine or chlorhexidine alternating with alcohol or saline. The author has been unable to find any scientific evidence for this protocol. It is not applied to humans where a single application of a skin preparation solution is applied prior to making an incision. In fact, the instructions for use on the stock bottle of chlorhexidine indicate to apply the solution and allow it to remain in place for two minutes, then wipe it off and be done.

In another study, an alcohol-based skin preparation was compared to chlorhexidine for reducing skin surface bacteria (Maxwell et al. 2018). The alcohol-based skin preparation sprayed onto the surgical site and allowed to dry was equally as effective as chlorhexidine used according to manufacturer instructions. Make sure the alcohol has completely evaporated prior to using electrosurgery or a CO_2 laser that can ignite the alcohol.

It is not necessary to scrub the patient's skin and actually may be contraindicated. Scrubbing not only irritates the skin, but it also exposes deeper and more pathogenic bacteria to the skin surface potentially contaminating the deeper tissues when the incision is made. A study in horses comparing mechanical and nonmechanical sterile preoperative skin preparation with chlorhexidine gluconate showed there was no difference between a five-minute mechanical scrub and a five-minute application with no scrubbing (Davids et al. 2015). The manufacturer's instructions for using chlorhexidine direct that it be applied to the site and allowed to remain for two minutes before wiping it off. Wiping it off with either saline or alcohol may remove the chlorhexidine negating its residual activity and should, therefore, not be done. A need for alternating between a preparation solution and saline or alcohol has never been established in any species. A newer skin preparation product, ChloraPrep™ One Step (BD Medical, www.bd.com) is applied to the skin for 30 seconds and left to dry for 30 seconds after which the skin is ready for incision. The World Health Organization Global Guidelines for Prevention of Surgical Site Infections states "The panel recommends alcohol-based antiseptic solutions based on chlorhexidine gluconate for surgical skin preparation in patients undergoing surgical procedures" (www.who.int/gpsc/ssi-guidelines/en/).

Patient Draping

Proper aseptic technique is indicated for all surgical patients regardless of size and species. Place quarter drapes around the surgical site and then cover with a patient drape with a fenestration around the site. Currently, disposable paper drapes are commonly used for both quarter drapes and patient drapes. Avoid the tendency to make a small sterile field as it is then easy to contaminate yourself by accidentally touching objects on the table outside the sterile field. Create a sterile field of the entire table top and take appropriate action to reestablish a sterile field if contamination occurs (Figure 1.2). When working with very small patients, it may be beneficial to use a clear plastic drape over the patient to allow respiration to be monitored; however, other respiratory monitoring devices such as end-tidal CO_2 monitors allow monitoring of respiration more accurately and do not require the ability to visualize the patient.

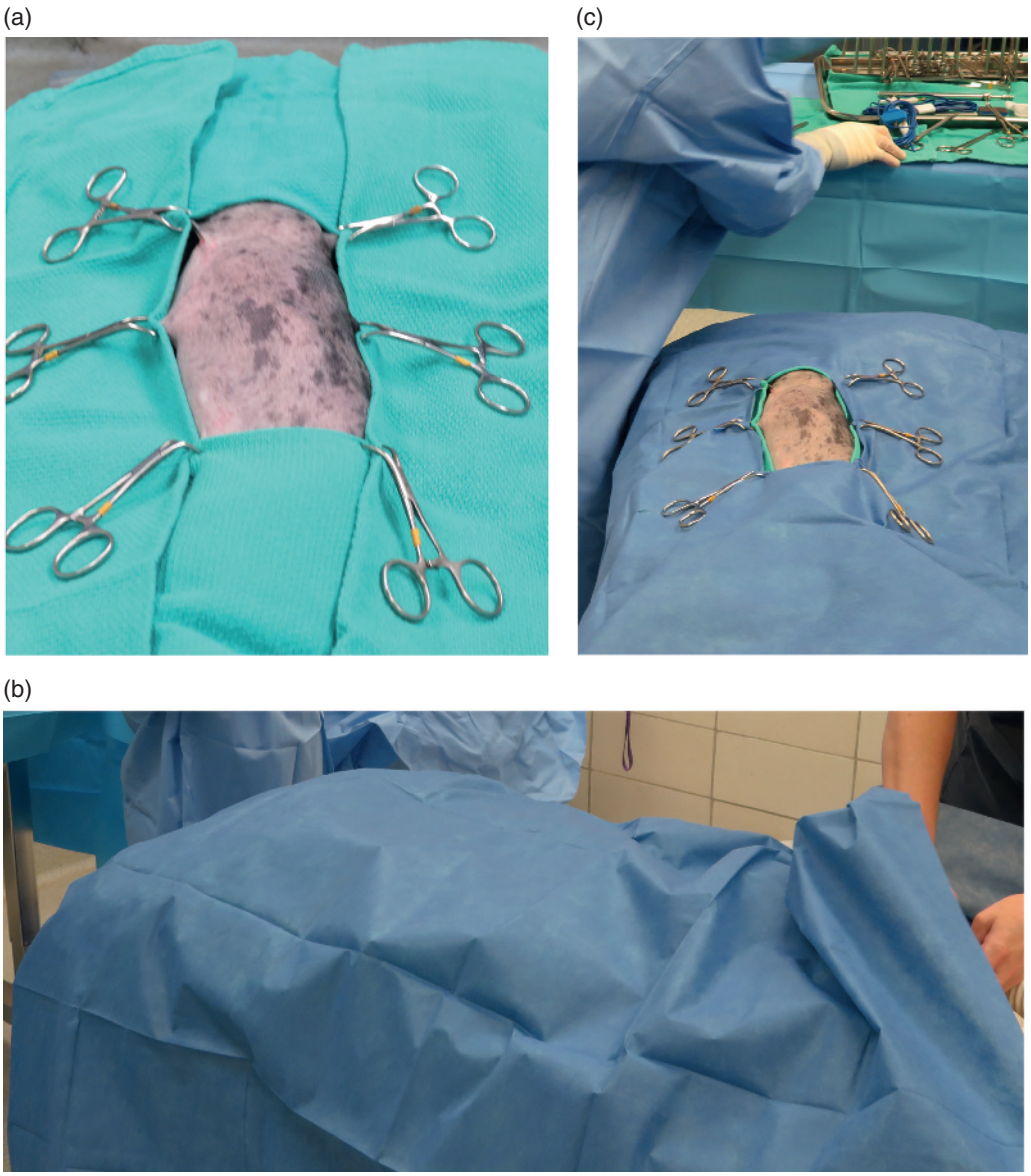

Figure 1.2 This 1.2 kg patient is being draped for a thoracotomy. First quarter drapes of Huck towels are placed to isolate the surgical field (a). Then the patient is covered with a patient drape large enough to create a sterile field of the entire table (b). The instruments are on the back table, and this is pulled up to the patient drape to complete the sterile field (c).

Thermal Support

Hypothermia during anesthesia is a major concern for many reasons including decreased metabolic functions and excretion of anesthetic agents. Many small exotic animals have a large body surface area/volume ratio predisposing them to developing hypothermia during anesthesia. The body temperature of a rat can drop 18 °F (10 °C) after 20 minutes of anesthesia (Harkness et al. 2010). Use an esophageal or rectal temperature probe to continuously monitor the patient's body temperature. The normal temperature for a given species may not be known; however, once the patient is anesthetized insert a temperature probe to determine its body temperature. Then monitor the temperature and how much it drops during anesthesia. Even in poikilotherms, this is very helpful and can help make decisions about the need to provide additional thermal support.

A short anesthesia and operative time accomplished by having all the necessary equipment ready and accessible will help to minimize hypothermia. It is best to use patient warming devices with temperature control such as forced warm air and warm water blankets. It can be difficult to place a warm air blanket around a small patient. These devices blow warm dry air, so pay particular attention to keeping the cornea lubricated to reduce the risk of creating corneal ulcers. This is

especially important with small patients where the head is hard to visualize under the blanket. It is considered beneficial to use more than one patient warming device. For example combine a circulating warm water blanket under the patient and a forced warm air device around and over the patient where possible. For most small exotic animals set the circulating warm water blanket and forced warm air device at 104 °F (40 °C) because these patients have a high body temperature. Drape the patient as quickly as possible to help hold heat in under the drapes.

Use warm (101–103 °F; 39–40 °C) saline for abdominal and thoracic lavage. Fill the body cavity with the warm saline and do not immediately remove it. Allow it to dwell within the body for several minutes. Repeat this process until the body temperature begins to rise. Once the downward trend in body temperature reverses and the body cavity has been closed, in most cases, the temperature will continue to rise assuming other patient warming devices are in place. For most species, if the body temperature drops below 96 °F (35.5 °C) during the surgery, stop the procedure and instill warm saline into the body cavity before continuing the procedure. Repeat the process before closing.

Instrumentation and Equipment

Hemostatic Aids

The average cotton-tipped applicator (CTA) holds approximately 0.1 ml of blood when completely soaked and a 4×4 gauze sponge holds 10 ± 2 ml (Hughes et al. 2007). The total blood volume of small mammals is 57 ml/kg of body weight (Jenkins 2000; Bennett 2009). If a patient loses 10–15% of total blood volume (approximately 1% of body weight), it is generally considered safe. Most mammals experience hypovolemic shock and release large amounts of catecholamines with loss of 15–20% of the total blood volume. Loss of 20–30% of the total blood volume can have life-threatening consequences (Jenkins 2000; Bennett 2009). As an example, if a 50 g mouse loses more than five CTAs full of blood, it is equivalent to more than 20% of the blood volume (Harkness 1993). Table 1.1 shows approximately 20% of the blood volume of common rodent pets.

Magnification is an aid for hemostasis (see Chapter 3). What would seem a small amount of blood to the naked eye observer appears to be major blood loss when magnified drawing the surgeon's attention to the hemorrhage and the need to arrest it. Additionally, small vessels can be identified and controlled more easily when working under magnification.

Hemostatic clips are available in various sizes including microclips. These are very useful for controlling hemorrhage in small patients, where it is difficult to accurately place a ligature. Additionally, they can be applied in deep, hard-to-reach locations. With some types of hemostatic clips, both straight and right-angled appliers are also available (Figure 1.3). This applier makes it easier to get under a hemostat to apply a clip to a severed vessel.

Table 1.1 Loss of approximately 20% of total blood volume results in cardiovascular compromise with potentially life-threatening consequences.

Species	20% of blood volume (ml)
Gerbil	1.2
Hamster	1.4
Rat	4.0
Guinea pig	4.5

Twenty percent of the approximate blood volume of rodents.
Source: Harkness (1993), Jenkins (2000), Harkness et al. (2010).

Sterile CTAs are useful for atraumatic tissue dissection and manipulation. They can be used to apply pressure to damaged vessels allowing a clot to form. Use moistened CTAs when using them for tissue manipulation and dissection and dry ones to absorb fluids.

Absorbable gelatin sponge is made from treated purified gelatin solution. It is capable of absorbing many times its weight in blood and also provides a scaffolding for clot formation. It is completely absorbed in 4–6 weeks. Surgicel (Ethicon, Inc., Sommerville, NJ) is oxidized regenerated cellulose resembling cloth. It is a hemostatic aid that adheres nicely to moist tissues, but is not capable of absorbing much fluid and does not adhere well to dry tissue. Gelatin sponges are thick and absorb more fluid than oxidized regenerated cellulose but are prone to becoming dislodged from the tissue.

Topical thrombin is commercially available and when applied uses the patient's fibrinogen to form a fibrin clot. It is most useful for oozing and minor bleeding from capillaries and venules where standard surgical techniques are ineffective at halting the hemorrhage. It can be applied directly to the source of hemorrhage or can be applied onto gelatin sponge that is then placed over the site of hemorrhage. A hemostatic "taco" can be made of gelatin sponge wrapped in oxidized regenerated cellulose and soaked in topical thrombin and is very effective for controlling hemorrhage (Figure 1.4).

Electronic Hemostatic Devices

Electrocautery

Electrocautery uses direct current electricity to heat metal until it is red hot. The red hot tip is applied to the source of hemorrhage to heat and coagulate tissues. Electrocautery causes heat damage to adjacent tissues that then undergo necrosis minimizing its value in many situations. Cautery pens (Convenient

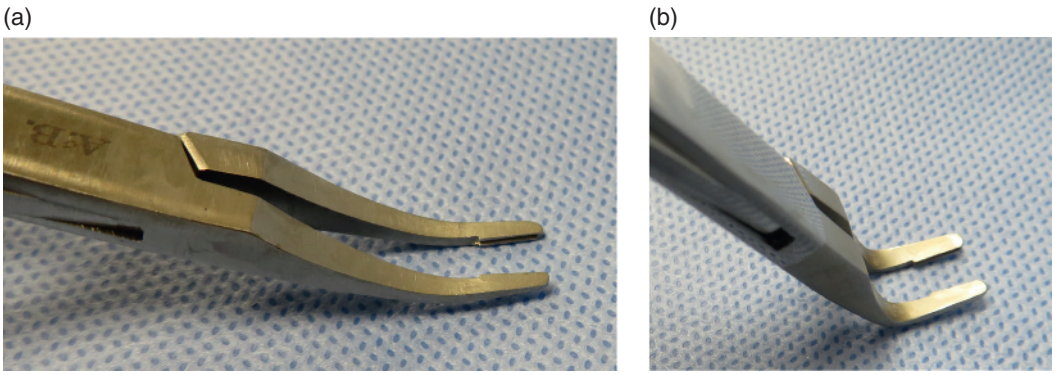

Figure 1.3 Straight and right-angled hemostatic clip appliers are available. Compared with the standard applier (a), the right-angled appliers (b) can be inserted into a small body cavity to place a hemostatic clip at nearly a right angle, while the standard applier requires the handles to be almost perpendicular to the vessel, making it difficult to place through a small approach into a body cavity.

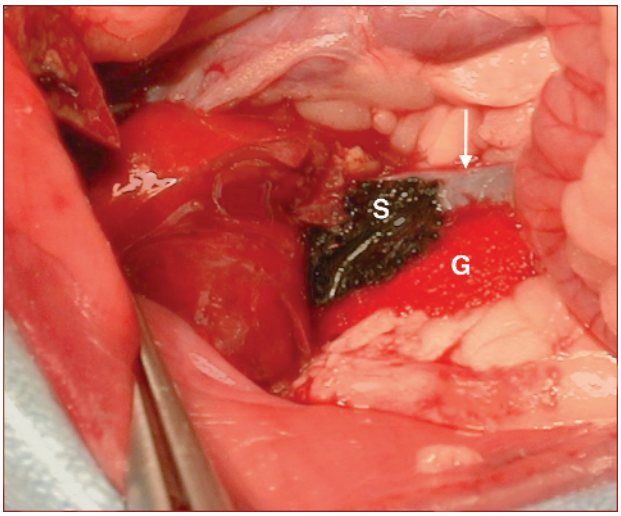

Figure 1.4 A "hemostatic taco" made of gelatin sponge (G) wrapped in oxidized, regenerated cellulose (S) and soaked in topical thrombin has been applied to the caudal vena cava (arrow) after right adrenalectomy.

Cautery Kit; Jorgensen Labs; www.jorvet.com) may be useful to cauterize small vessels in small exotic mammals if electrosurgery is not available. They have a fine wire tip and are battery-operated. Keep in mind that the longer the heat is applied to the tissue, the more thermal necrosis occurs.

Electrosurgery

Electrosurgery uses high-frequency alternating current to generate energy. There is an active electrode and an indifferent electrode or ground. With monopolar electrosurgery the current exits the generator, passes to the active electrode, and concentrates at the tip which contacts the patient. After creating a thermal event at the tip, the current disperses throughout the patient's body, exits through the ground plate, and is carried back to the generator to complete the electrical circuit. Therefore, the patient is within the electrical circuit. If the ground plate only contacts a small area of the patient's skin burns and subsequent necrosis can result because the current concentrates where it exits the patient. The Surgitron® Dual Frequency 120 (Ellman International, Inc., Hewlett, NY) generates 4.0 MHz current which is in the radio frequency wavelength. Current is received by the indifferent electrode acting as an antenna. Because the current is in the radio frequency, the area of contact between the patient and the ground plate is irrelevant and thermal injury should not occur. This is helpful with small patients where it might be difficult to disperse the current exiting the patient adequately.

The bipolar electrosurgical forceps are primarily used for hemostasis, but can also be used for tissue dissection resulting in minimal hemorrhage. The same generator is used, but the patient is not within the electrical circuit so the current only affects tissue within the tips of the forceps. Bipolar forceps are most useful near structures that would be adversely affected by the current such as the heart, brain, spinal cord, etc., or for hemostasis deep within body cavities. When using bipolar to dissect or cut tissue, grasp the tissue in the forceps and activate the current while pulling the forceps. The tissue within the tips will be affected by the current providing hemostasis for small vessels within the tissue grasped. In birds, this technique is useful for making a skin incision. Grasp the skin with the forceps and activate the current to create a small defect in the skin. Then insert one limb of the forceps under the skin for 1–2 cm, oppose the other limb of the forceps, activate the current, and withdraw the forceps, thus cutting the skin. Bipolar mode is available on most electrosurgical units including the Surgitron®.

Vessel Sealing Devices

LigaSure™ (Medtronic, Minneaplis, MN) is a vessel/tissue sealing system that is commonly used in veterinary surgery. The ForceTriad™ (Medtronics, Minneapolis, MN) combines the LigaSure technology with monopolar and bipolar

electrosurgery. While the specific technology is proprietary, LigaSure™ is a type of bipolar electrosurgery. The generator senses the electrical impedance of the tissues within the tips and delivers the amount of current needed to melt the elastin and collagen; it then allows the elastin and collagen to re-form, creating a permanent seal in a single application. It generates less than 1 mm of heat lateral to the seal and is Food and Drug Administration (FDA)-approved to seal vessels up to 7 mm diameter. A wide range of handpieces are available for open surgical procedures and for minimally invasive surgeries.

Harmonic Scalpel

Ethicon® Harmonic Scalpel (Ethicon US, LLC, www.ethicon.com/na) is an ultrasonically activated cutting instrument that converts electrical energy to mechanical energy. The blade vibrates at 55,500 Hz creating heat that coagulates vessels and cuts tissue. Hand pieces are available in various sizes and types for both open surgical procedures and minimally invasive surgery. It is FDA-approved to seal vessels up to 5 mm diameter and does not create smoke. The tissue is compressed between a Teflon anvil and the vibrating blade. There are two settings, one to seal the tissue and another to cut through the tissue.

Carbon Dioxide Laser

The carbon dioxide (CO_2) laser (Aesculight; LuxarCare LLC, Bothell, WA) gained popularity in veterinary surgery in the 1990s and continues to be in common use today. CO_2 lasers produce a beam of intense light at a wavelength that is highly absorbed by water molecules. It cuts tissue when the beam is very focused and coagulates for hemostasis when it is more diffused. The CO_2 laser seals vessels <0.6 mm, so most skin incisions are bloodless with minimal or no bruising. It also seals lymphatic vessels and nerves so there is less swelling and reportedly less pain associated with incisions compared with those made using a scalpel. When used with correct technique, the amount of lateral heat damage is minimal (Harkness et al. 2010); however, when used incorrectly, lasers can cause significant thermal damage.

In addition to being able to incise skin and other tissues, CO_2 lasers can also be used to fulgurate or destroy tissue, such as a tumor or the tissue bed after a tumor has been removed in an effort to eliminate residual microscopic disease. Use a high-power setting and keep the tip as close to the tissue as possible when cutting tissue. Do not touch the tip to the tissue. If there is hemorrhage, move the tip farther from the tissue, which will diffuse the beam and coagulate vessels. Use a smaller tip to create a small spot of light which will then cut better with less collateral heat. A wider tip will not cut as well and will cause more heat damage, but will also control hemorrhage better by coagulating vessels. Proper safety training for all personnel is important when using surgical lasers.

Magnification

Magnification is a vital part of efficiently performing surgery on small exotic animals, but it is also useful for delicate procedures in any size animal (see Chapter 3).

Focal Light

Overhead surgery lights are not adequate for surgery in small exotic animals and are becoming obsolete being replaced by head-mounted focal light sources that illuminate whereever the surgeon is looking, including deep into body cavities. These lights illuminate a smaller area allowing better visualization of the tissues. Inexpensive head-mounted cool focal lights are available with or without magnifying loupes from many sources (LED Headlight; MDS, Inc., Brandon, FL). SurgiTel loupes (General Scientific Corporation, Inc., Ann Arbor, MI) are available with different light options that mount onto the frame to illuminate the surgeon's field of view.

General Scientific Corporation, Inc., also offers SurgiCam HD, a head-mounted digital video camera with 3× magnification. The procedure can be viewed on a monitor, and images, and videos can be captured onto a computer.

Retractors

In the past, spring-loaded eyelid retractors have been recommended for abdominal wall retractors in small patients. The tension cannot be adjusted and is often too much for small patients. Heiss and Alm Self-Retaining Retractors work well as abdominal and tissue retractors in companion exotic animals (Figure 1.5). The Lone Star™ Retractor (Veterinary Specialty Products, Inc., Mission, KS) consists of a plastic frame and silastic bands with tissue hooks on the ends (stays) (Figure 1.6). Be sure to look for the models with all components that are fully autoclavable. Place the stay hooks in the tissue and using an appropriate amount of tension, pull and insert the silastic bands into the notches of the frame to retract tissue. These retractors are very versatile and have a wide range of applications.

Instrumentation

In the past, many surgeons have turned to using ophthalmic instruments for surgery in small exotic animals; however, they are not well suited for this purpose. Being made for surgery on a superficial structure, the eye, they are short making them more difficult to control and to manipulate tissues deep in a body cavity. Microsurgical instruments are manufactured so they are of a standard length and only the tips are miniaturized (Bennett 2009) (see Chapter 3). They are long enough for the instrument to

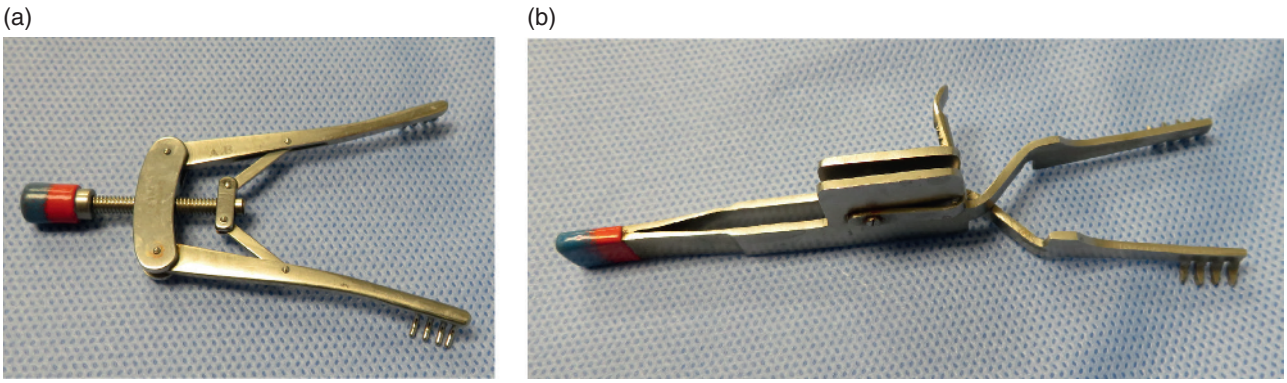

Figure 1.5 An Alm retractor (a) uses a thumb screw to open the jaws, while the Heiss retractor (b) has a quick release ratchet mechanism.

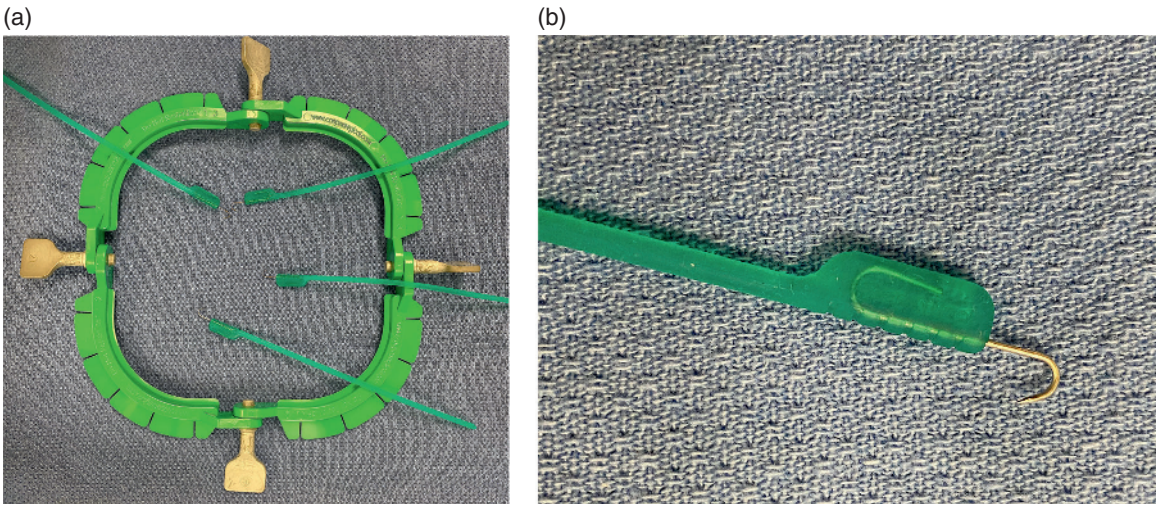

Figure 1.6 The Lone Star retractor system consists of a plastic ring with notches around the perimeter (a) and silastic bands with tissue hooks that are placed in the tissue to be retracted (b). Insert the bands into the notches in the ring to maintain tissue retraction.

balance in the hand while the tips extend beyond the surgeon's hand into the patient's body cavity (Figure 1.7). They should be counterbalanced to minimize hand fatigue. Round handles are recommended because the instruments should be rolled between the thumb and first two fingers rather than using wrist action. Having round handles is most important for needle holders because the curved needle has to be passed through the tissue using this rolling action between the thumb and fingers. Even with scissors and forceps, it is easier to roll them if the handles are round. Many surgeons prefer needle holders without box lock for delicate tissue because when the lock is set, the needle can jump and tear tissues. Hold a microsurgical instrument as if you were holding a pen (Figure 1.8a). An across-the-palm grip is inappropriate (Figure 1.8b). As a starting point, a microsurgical pack should contain a microsurgical needle holder, a microsurgical scissors, and microsurgical thumb forceps (Figure 1.9). Add other microsurgical instruments to the pack with increasing experience.

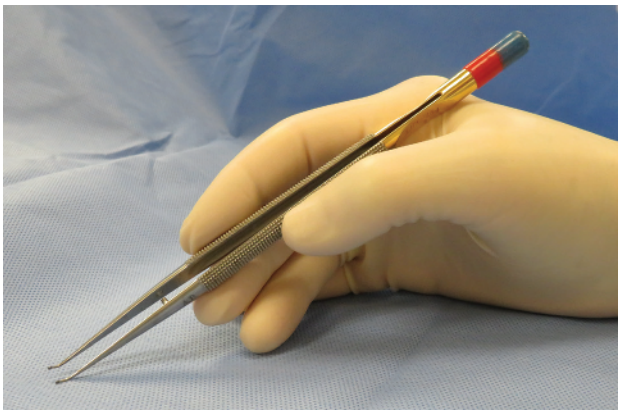

Figure 1.7 Microsurgical instruments should be a standard length with miniaturized tips that extend beyond the hand into the tissue and should be counterbalanced to minimize hand fatigue.

Suction and Irrigation

Ophthalmic bulb syringes work well for tissue irrigation in small exotic animals (Figure 1.10). Alternatively, use a

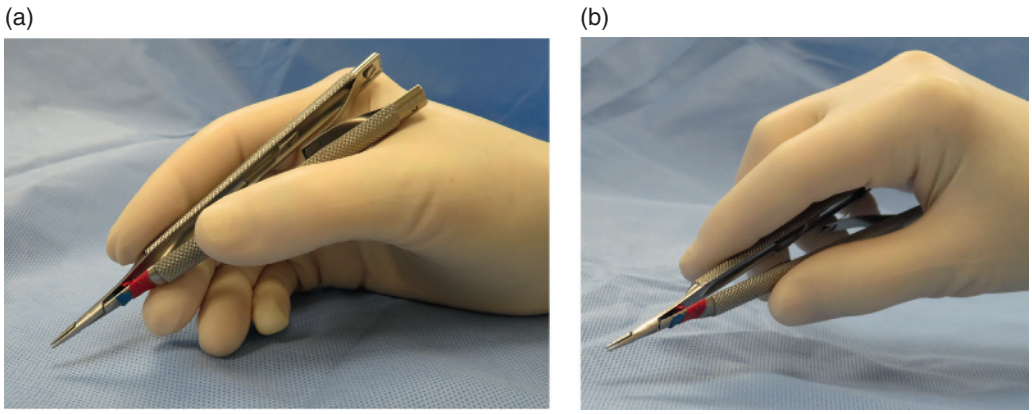

Figure 1.8 Hold the instruments like a pen (a) and not across the palm (b) for better control and the ability to roll the instrument.

Figure 1.9 The basic microsurgical pack should consist of a needle holder, scissors, and forceps.

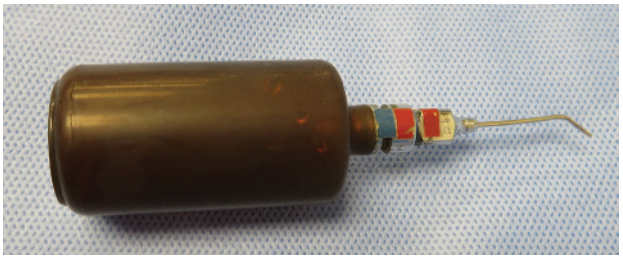

Figure 1.10 Ophthalmic bulb syringe is useful for irrigation in small patients.

syringe with a needle attached and bend the needle at the hub repeatedly until it breaks off to minimize the risk damaging tissue with the needle. Fine Barron suction tips have a release hole providing two degrees of suction; stronger suction with the hole covered and more delicate suction with the hole open. If tissues suck up against the tip, place the corner of a gauze over the end of the suction tip so it is not able to suck up tissue.

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