ENDOSCOPIC SURGERY IN SMALL MAMMALS: THE FUTURE IS ALREADY HERE!

Dr Stephen J. Hernandez-Divers, BVetMed, CBiol, MIBiol, DZooMed, MRCVS, Diplomate ACZM
College of Veterinary Medicine, University of Georgia
Athens, GA

INTRODUCTION
A large, and it seems ever increasing, variety of small mammals are being presented to the exotic animal clinician. In addition to the usual rabbits, ferrets and rodents, we are now seeing sugar gliders, hedgehogs, small primates, and even small exotic felids and foxes. There is obviously a huge diversity between these taxonomic groups, but they all have something in common – they are small with the majority weighing <3 kg. Because of their small size and fragility, it is important that any diagnostic or surgical modality be as atraumatic as possible. Imagine a future where rodent ovariection is performed laparoscopically, ferret adrenalectomy does not necessitate laparotomy, and where the rabbit retrobulbar abscess can be treated via endoscopic oral surgery without the need for enucleation? The future may already be here. The development of domestic animal rigid endoscopy, coupled with the recent application of fine-diameter telescopes in exotic mammals and the development of human pediatric laparoscopy equipment has now brought endosurgery within the grasp of exotic animal veterinarians.

EQUIPMENT

The basic rigid telescope system, as advocated for the evaluation of small mammals, has been developed from human cystoscopy equipment (summarized in Table 1).1,2 Probably the most commonly used endoscope is the 30° Hopkins telescope (2.7 mm x 18 cm) connected to a xenon light source by a fiber-optic cable (Karl Storz Veterinary Endoscopy America Inc, Goleta, CA, USA). The telescope is housed within an examination and protection sheath (3.5 mm) or an operating sheath (14.5 Fr) that possesses twin insufflation/irrigation ports and a 5-Fr instrument channel. Biopsy forceps (3 Fr and 5 Fr), grasping forceps (3 and 5 Fr), single-action scissors (3 Fr), injection/aspiration needle with Teflon guide, wire basket retrieval device, and radiosurgery needles are most commonly used by means of the operating sheath. A smaller 1.9-mm telescope and 1.0mm semi-rigid needle-scopes are also available for working with small patients or in very tight areas. Endoscopic cameras are no longer considered an optional item, there are essential for endosurgery.

The recent development of 2- and 3-mm human pediatric laparoscopy equipment (Karl Storz Veterinary Endoscopy America, Inc) has facilitated the development of multiple-entry endoscopy in small exotic species, including mammals (summarized in Table 2).
While the original sheathed telescope is still used to provide visualization, additional operating cannulae provide access ports for inserting additional instruments. Instrument triangulation permits surgery within the thorax or abdomen without the need for major laparotomy. Access ports are created using a 2.5- or 3.5-mm cannula and trocar. Once inserted, the trocar is removed and a 2 or 3-mm instrument is inserted.

In order to effectively operate endoscopically, it is necessary to ensure hemostasis. There are limited instruments and applications related to diode or CO\textsubscript{2} laser endosurgery; however, a multitude of radiosurgery instruments and probes are available that can be connected to a variety of radiosurgery units including the 3.8 and 4.0-MHz Surgitron units (Ellman International Inc, Hewlett, NY) commonly used in exotic animal practices.

**OTOSCOPY**

With the rabbit positioned in sternal recumbency, the telescope can be gently inserted down the external pinna until the aural sulcus, a blind ending diverticulum off the vertical canal can be seen. By continuing ventrad, the vertical canal deviates medially, becomes the horizontal canal, and terminates at the oval tympanum. Epithelial lesions and exudates are appreciated and the integrity of the tympanum easily assessed. It is simple to determine whether tympanic perforation and otitis media are evident. Lesions and exudates can be biopsied for cytologic, histopathologic and microbiologic investigations. Sterile saline is used to irrigate and clear debris as necessary.

**RHINOSCOPY**

The rabbit must be intubated and positioned in sternal recumbency. With the head held down both nares are flushed with warm sterile saline to clear mucous and debris from the nasal cavities. Use of a 1.9mm telescope within a 10 Fr operating sheath permits saline irrigation and biopsy in animals down to about 1.5kg, below that a 1.0 mm semi-rigid miniscope can be used. By gently advancing the telescope past the alar fold, it is possible to examine the dorsal, middle and ventral nasal meatus, dorsal and ventral nasal conchae, and even the ethmoid labyrinth. The nasal membranes are highly vascular and care is required to avoid trauma and hemorrhage. The use of saline irrigation greatly aids visualization. Biopsies of lesions and exudates can be collected as required. Biopsy instruments may have to be inserted independent of the scope if a sheath cannot be used because of the small working space. Post-biopsy hemorrhage is minor.

**STOMATOSCOPY**

The very small oral commissure tends to preclude thorough examination of the cheek teeth in many small herbivores and insectivores. The rigid endoscope is ideally suited to examine the oral cavity in these small mammals, and offers considerable advantages over the use of an otoscope. Under general anesthesia the mouth is held open using a dental rack, or dental gag and pouch dilators. It is suggested that small mammals be fasted for at least an hour to enhance visualization, as food material is often retained in the oral cavity of herbivores after eating. The telescope within a protective sheath may then be inserted into the oral cavity for a detailed examination. The upper arcades may be examined with the endoscope’s deflected angle facing dorsal. In order to examine the lower arcades, the telescope is rotated 180\degree (keeping the camera in the normal position). Lingual, buccal, and occlusal aspects of all teeth can be evaluated using a dental probe to palpate each tooth in an attempt to elicit movement or other evidence of tooth pathology. Any malocclusion can be corrected with a motorized dental hand piece, taking care to either protect the telescope within a sheath, or remove it during dental burring. Tooth removal and the targeted treatment of tooth root abscesses may also be treated under endoscopic guidance. The telescope is also of considerable assistance when attempting intubation in small herbivores.

![Figure 1. A, Performing rhinoscopy in a rabbit. B, Endoscopic view of an abscess within the ventral nasal meatus.](image-url)
Figure 2. A, Endoscopic view of a dental spur on the lingual surface of lower left premolar 2 in a rabbit; B, Endoscope-guided catheterization and injection of antibiotic-impregnated bioactive ceramic into the vacated root socket of left upper molar 3 in a rabbit with a periapical infection and retrobulbar abscess.

GASTROINTESTINAL ENDOSCOPY
While flexible endoscopes are preferred for most gastro-intestinal examinations, the rigid scope can be used to assess the esophagus, stomach, and from an anal approach, the lower colon and rectum in many small mammals. The stomachs of rodents and rabbits are never empty and food debris can hinder visualization. However, examination of small carnivores (e.g. ferrets, felids, foxes) is very rewarding and gastric biopsy collection can greatly increase the accuracy of *Helicobacter* diagnosis in ferrets.

UROGENITAL ENDOSCOPY
Cystoscopy is a technique to diagnose, and potentially treat, diseases of the lower urinary tract. In small mammals transurethral cystoscopy is limited to females. Endoscopic evaluation of the lower urinary tract is possible in males but requires a laparoscopic approach to the bladder first. Vaginoscopy is utilized to diagnose diseases of the distal reproductive tract, and is generally performed as an adjunct to cystoscopy in the diagnostic investigation of hematuria, as this is often associated with uterine adenocarcinoma, endometrial hyperplasia, or uterine polyps.

The anesthetized mammal is positioned in dorsal recumbency. Warm saline infusion is used to create the endoscopic working space. All portions of the lower urinary tract should be examined, and it is generally necessary to rotate the telescope 180° to complete the evaluation. Biopsies and microbiologic samples for culture can be collected using 3 Fr instruments inserted via the instrument channel.

LAPAROSCOPY
Laparoscopy requires abdominal insufflation with CO2 and the creation of a pneumoperitoneum. This places increased pressure upon the diaphragm, and therefore it is important for anesthetized small mammals to be both intubated and provided with some form of respiratory support. The Vetronics Ventilator (BAS Vetronics, 2701 Kent Avenue, West Lafayette, IN 47906-1382, USA) has proven to be useful for intermittent positive pressure ventilation in small mammals undergoing laparoscopy. In general a ventral approach is preferred with the camera positioned in the midline and two instruments ports positioned either side. However, telescope and instrument placement should be dictated by the organs of interest, the procedure to be undertaken, and the preferences of the endoscopist.

In general a cut-down technique to the linea alba and surgical insertion of the sheathed telescope is used, but a veress needle or endo-tip cannula can sometimes be helpful to avoid damage to the voluminous intestinal tract. Insufflation pressures are typically 8-10 mmHg and should never exceed 14 mmHg. It is often helpful to place a purse-string suture around the instrument cannulae in order to maintain position, especially in mammals with thin abdominal musculature. Once within the abdomen an evaluation of most organs can be undertaken, although rotation of the animal and/or movement of viscera using palpation probes may be necessary. Liver, spleen, and pancreas can be biopsied with ease; however, biopsy of the kidneys may require some debridement of peri-renal fat. Larger lesions may be identified endoscopically and then exteriorized through a targeted minilaparotomy incision. Laparoscopy has been used to investigate various disease presentations including splenomegaly, suspected adrenal disease, neoplasia, etc. In addition, routine laparoscopic ovariectomy may become routine.
Figure 3. A, Operating room scene with two endoscopists utilizing two monitors and pediatric laparoscopy equipment to ovariectomize a capuchin monkey; B, Endoscopic view illustrating the use of 3 mm bipolar forceps (b) to isolate the vascular supply to the ovary (o) and debride from its connections to the uterus (u).

Figure 4. A, Surgical field of a ferret undergoing laparoscopy - note the insufflated abdomen, telescope (c) and separate instrument port through which a palpation probe (p) is being used. B, Endoscopic view of the liver after the collection of two biopsies (b).

Figure 5. A, Ventral view of the rabbit indicating the paraxiphoid entry points (x) caudal to the last rib either side of the manubrium; B, Thoracoscopic view of the caudal aspect of the right caudal lung lobe of a rabbit; C, Thoracoscopic view of the heart (h), lung lobe (l), pericardiophrenic artery (a) and closely associated phrenic nerve (n).
THORACOSCOPY
Respiratory tract disease is not uncommon and many conditions can be treated if an accurate diagnosis is made early enough. The thoracic cavity of most small herbivores is particularly small and thoracoscopy should not be undertaken lightly. Survey radiographs and the involvement of an experienced anesthesiologist are critical. For diagnostic purposes, a paraxiphoid approach, with soft tissue tunneling through the ventral aspect of the diaphragm is possible. Biopsies and simple surgical interventions (e.g. pericardectomy) may be undertake using a single entry method. Multiple trocars and cannulae positioned through the intercostal spaces can be considered for more extensive procedures.

SUMMARY
One of the most substantial limitations to successful surgery in exotic pet medicine is the relative small size of most small mammals, and the limited surgical access afforded by standard techniques. Both of these limitations can be largely overcome with the use of endoscopy which provides focal magnification, illumination, and surgical access within the ear, nose, mouth, abdomen, thorax, and bladder, etc. With specific regard to laparoscopy, the absence of a large suture line has reduced post-operative complications associated with self-mutilation and wound dehiscence in rodents, lagomorphs, and small primates.

Each of the described techniques have both advantages and disadvantages; however, reports from human surgeons indicate that considerable benefits may be gained from minimally-invasive endoscopic surgery. The efficacy, complications, or long term effects of endosurgery have not been extensively documented in exotic mammals, although on-going research at the University of Georgia continues to critically evaluate these procedures.

The ability to perform endosurgery is not innate and extensive training is undertaken by human surgeons using artificial teaching devices and supervised instruction by experienced endoscopists. Non-recovery endosurgery laboratories using anesthetized (non-recovery) animals at the end of their research lifespan offer an unparalleled opportunity for establishing competence before embarking on clinical cases. Such courses are regularly held as part of the Veterinary Endoscopy Training Symposia at the University of Georgia, and further details are available from: www.gactr.uga.edu/conferences (email: skilgo@vet.uga.edu)

References