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Official Journal of the International Society of Feline Medicine  
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**Clinical Practice**

Special issue 'Endoscopy and endosurgery, Part 1'

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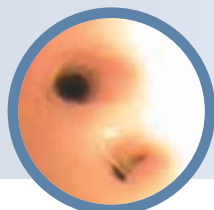
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# Through the keyhole: expanding the scope of feline medicine

Endoscopy and endosurgery have been at the forefront of human medicine for many years. As equipment costs have reduced, these disciplines have started to become more widely adopted in veterinary medicine. Attention, however, has been largely directed towards minimally invasive techniques in the dog, where keyhole incisions seem to offer a greater advantage due to the patient's relatively large body size. Unfortunately, very few publications have focused primarily on the cat. Accordingly, few practitioners have developed a true understanding of feline-specific endoscopy, and little attention has been paid to specific equipment and techniques required for our feline patients.

Some surgeons may argue that the small incisions required as routine in the feline patient make a minimally invasive or endoscopic approach redundant. However, the same advantages apply as with larger patients; namely, vastly improved visualisation, a magnified image, reduced tissue trauma, reduced perioperative pain and a more rapid recovery. Furthermore, it is possible to access sites that are difficult or impossible to approach adequately using conventional operative surgery – the pulmonary tree, gastrointestinal tract, nose, urethra and bladder.

As surgeons we invariably cause trauma, and thus pain, to our patients, and rely on the body's natural inflammatory and repair mechanisms to heal the damage. There has been much discussion and research over the past 20 years on methods and drugs to reduce postoperative pain. No one would argue that it is better to cause less trauma and pain in the first place than to try and control it afterwards. So if a procedure can be carried out minimally invasively, at least as safely as with open surgery, then it is surely in the interests of our patients to offer these techniques. Indeed, in many cases minimally invasive surgery provides a safer alternative to conventional operative surgery.

The purpose of this two-part *JFMS* Special Issue series, dedicated to endoscopy and endosurgery in the cat, is to provide an overview of minimally invasive procedures that can be integrated into everyday patient

care in all scenarios – whether general practice, emergency and critical care, or the referral / specialist hospital setting. It is not intended to be exhaustive, as new procedures are constantly being developed in this rapidly evolving field. We hope for some, it will help cultivate an interest and understanding about the equipment and skill acquisition required to develop this service in clinical practice. For others, it may simply provide a valuable information platform in deciding when and what to refer for an endoscopic procedure.

As can be seen from the breadth of information covered within these articles, there is hardly an orifice that cannot be explored with an endoscope, and if a suitable orifice does not exist, you can make one! It is important to appreciate, however, that any piece of equipment is only as good as the skill of its operator. While these articles can describe the generalities of endoscopic technique, along with the usefulness of the various procedures, they cannot provide the hands-on experience and training needed to become proficient in these skills. Formal tuition, coupled with a great deal of practice, can help the practitioner in offering an exciting and valuable service to their clientele and providing the gold standard in patient care. After all, it is our patients that ultimately matter most.

We are absolutely delighted to offer this practical feline-specific resource, packed with knowledge, experience and expertise delivered by international leaders in this field. We would like to gratefully acknowledge the support and enthusiasm surrounding this massive project, especially from our colleagues, family and friends, as well as those behind the scenes at *JFMS*. We owe a particular thank you to our colleagues who have agreed to become contributors and have delivered a truly exceptional piece of work ... all dedicated to cats!

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**If a procedure can be carried out minimally invasively, at least as safely as with open surgery, then it is surely in the interests of our patients to offer these techniques.**





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# INTRODUCTION TO ENDOSCOPY IN THE CAT

## Where to start? What to buy?



Elise Robertson and Philip Lhermette

### The decision to buy: key investments

The decision to offer an endoscopy service will usually depend, among other things, on practice demographics, staffing, practitioner interest, and relative proximity to practices offering similar services. Two further key considerations concern the required investments in training and in equipment.

#### Investment in training

Once the decision has been reached to purchase an endoscope, either flexible or rigid, every effort should be made to become proficient in its use. Initially, the learning curve can be relatively steep and at times frustrating, especially in smaller feline patients in a private practice setting. Endoscopy courses will often be advertised through veterinary teaching hospitals, private continuing education companies, conferences and endoscope companies. The authors advise looking for courses that offer at least several consecutive days of formal practical training. Although single-day courses may provide adequate introductory level experience, there is simply not enough time to gain the necessary endoscope handling skills needed for feline endoscopy.

For flexible endoscopy, practical training should include proper handling techniques, learning how to 'drive the scope' through the upper gastrointestinal tract smoothly and efficiently, subtle techniques needed for traversing the pyloric canal and intubating the pylorus, colonoscopy and ileoscopy, biopsy techniques, and foreign body retrieval. For rigid endoscopy, training should include instruction on the safe handling of instrumentation and techniques for atraumatic entry into the nose, bladder, abdomen and thorax. Anaesthetic considerations and the use of ancillary aids such as electrosurgery should also be covered and practical exercises in instrument handling using a laparoscopic trainer form the basis of the manual skills necessary to perform any endoscopic procedure.

With training, practice and persistence, these skills will become easier, more time-efficient and profitable for the clinic. In the beginning, new endoscopists should allow for long procedure times, and avoid booking too many other cases on chosen endoscopy days. This will provide a more forgiving setting in which to become comfortable and proficient in

**Practical relevance:** For many years, endoscopy and minimally invasive surgery have been considered 'standard' in human healthcare. With the expansion of the used medical equipment market, and the falling cost of new equipment, veterinary practitioners are now starting to appreciate first-hand the benefits of performing endoscopic procedures: for example, vastly improved visualisation of the surgical site, reduced tissue trauma, minimal postoperative pain and faster recovery times, especially in feline patients. In addition, clients almost always choose a less invasive procedure if the capabilities are present, and will often consent to these procedures sooner than they would to conventional surgery.

**Aim:** This article aims to guide the general feline practitioner towards a basic understanding of endoscopic and ancillary equipment, and in the direction of appropriate training required to perform routine endoscopic procedures.

**Evidence base:** The authors draw on information provided in a combination of published texts, articles, reviews and their own clinical experience to provide a practical information guide for the clinician interested in feline endoscopy.



With practice and dedication, most committed practitioners can become skilled in the use of routine endoscopy in a relatively short time.



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performing basic endoscopic examinations and procedures. In addition, initial case selection for the beginner endoscopist should favour a successful outcome and thus increase operator confidence. For example, gaining confidence with uncomplicated gastric foreign body removal in a large dog is advisable before attempting ileocolic intubation in a juvenile cat with chronic small bowel disease.

The most important part of the learning curve in endoscopy is the ability to recognise normal from abnormal. This often requires many years of experience. As is the case with successfully mastering any technical procedure, if proper skills and sample procurement are underdeveloped, even the most sophisticated endoscopes will offer very little value and diagnostic reward. With practice and dedication, however, most committed practitioners can become skilled in routine endoscopy in a relatively short period of time.

### Investment in equipment

For the feline practitioner, the selection of appropriate equipment will depend on its intended use, durability and financial outlay. Beyond expense, consideration must be given to the probability and frequency of usage, and versatility of the equipment.

All too often, a lower purchase price is ranked above quality and intended use when making purchasing decisions! This can result in an empty investment, as even the most skilled endoscopists would find performing a complete and diagnostically accurate examination difficult using an inappropriately sized or poor quality endoscope. For example, in gastrointestinal endoscopy, careful thought must be given to the insertion tube diameter and length of the gastroscope. A cheap 12.8 mm x 100 cm human colonoscope would be relatively useless for feline upper and lower gastrointestinal procedures due to the high risk of serious iatrogenic damage to the oesophagus, stomach/pylorus and colon. Great care must be exercised at all times when traversing a cat's narrow pylorus, as possible perforation is a real risk. Therefore, veterinarians purchasing their first endoscope should consider a single, high-quality endoscope that may be used for both upper and lower gastrointestinal endoscopy in cats and small dogs (see later).

The decision as to whether to purchase new or secondhand and, if the latter, what to be aware of, is discussed later. Advice should always be sought from an experienced endoscopist or veterinary endoscopy company as to the minimum range of equipment that will be required for the procedures that the practitioner anticipates performing in the practice.



**Figure 1** Flexible fiberoptic endoscope handpiece. Note the eyepiece on the control panel



**Figure 2** Video gastroscope handpiece. Note the absence of an eyepiece on the control panel



**Figure 3** 3.0 mm flexible video-uretero-renaloscope. ©2013 Courtesy of KARL STORZ GmbH & Co KG

## Types of endoscopes

### Flexible endoscopes

Flexible endoscopes are often used for examining hollow, tubular structures with convoluted and tortuous paths (ie, gastrointestinal system, respiratory tract and male urinary tract). Flexible endoscopes may be subdivided into fiberoptic endoscopes and video endoscopes.<sup>1-4</sup> The two types differ in the method of sensing and transmitting images.

❖ **Fiberoptic endoscopes** (Figure 1) The image is carried from the distal tip of the endoscope to the eyepiece (or oculus) via coherent bundles of optical glass fibres, spatially arranged so that they maintain their relative positions from the tip of the insertion tube to the oculus. A 'video' image can be achieved with this system by attaching an endoscopic charge-coupled device (CCD) video camera to the eyepiece and transmitted to a TV monitor.

❖ **Video endoscopes** (Figures 2 and 3) The image is transmitted electronically to a video monitor from the distal tip of the endoscope where it is sensed by a CCD chip, and transmitted to a TV monitor. Video imaging offers distinct advantages in terms of operator comfort, superior image magnification and quality, and case documentation that can be integrated into clinical notes, and enhances client communication. Images of gross lesions can also be sent with biopsy samples to the laboratory, giving the pathologist more information and improving diagnostic potential.

Although fiberoptic endoscopes are less expensive than video endoscopes, the latter have recently become financially attainable for those in general practice. The main technical factor limiting the widespread use of true videoscopes has been the difficulty in achieving insertion tube diameters of <6 mm to allow their use in smaller veterinary patients. Technology is constantly evolving, however, and with the miniaturisation of CCDs, and the introduction of complementary metal oxide semi-conductor (CMOS) sensor technology, flexible high-definition video endoscopes with insertion tube diameters as small as 2.5 mm are becoming available on the human market. Currently, this technology is likely to be beyond the pocket of most veterinary surgeons but it will inevitably become more affordable in the future.

## Rigid endoscopes

Rigid endoscopes do not bend, which limits their usefulness in the gastro-intestinal and respiratory tracts. However, they vary in their distal tip viewing angle, commonly from 0° to 30° in veterinary endoscopes (Figure 4). A 30° endoscope allows the operator to see around corners and, by rotating the insertion tube along its long axis, visualise a wider area in a restricted space such as the trigone of the bladder.

The procedures for which rigid endoscopes are most suitable are conventionally named according to the anatomic region in which they are used:

- ❖ Laparoscopy
- ❖ Thoracoscopy
- ❖ Rhinoscopy
- ❖ Sinusoscopy
- ❖ Urethrocystoscopy
- ❖ Otoscopy
- ❖ Arthroscopy
- ❖ Fistuloscopy

Many of these procedures will be discussed in accompanying articles in this Special Issue series.

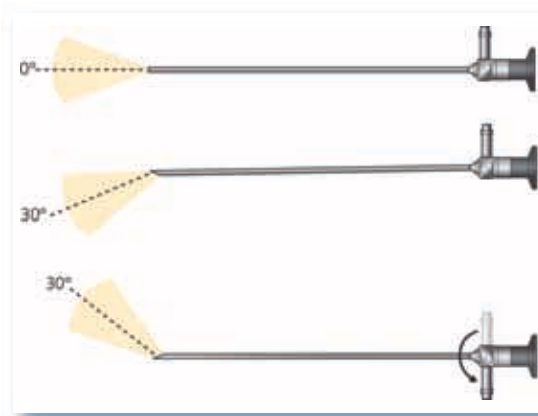


Figure 4 Viewing angle of 0° and 30°

## Basic endoscope anatomy

### Flexible endoscopes

The basic flexible endoscope (Figure 5) consists of three main components: insertion tube, handpiece and umbilical cord.

#### Insertion tube

This is a long flexible tube that is inserted into the patient. It contains:

- ❖ Coherent glass fibreoptic bundles (fibrescopes) or electronics (videoscopes, Figure 6) to transmit the images to the handpiece.
- ❖ Non-coherent fibreoptic bundles to provide illumination at the tip.
- ❖ Control cables to allow manoeuvring of the tip.
- ❖ An irrigation channel.
- ❖ A biopsy channel.
- ❖ A suction channel.

#### Handpiece

The handpiece controls the endoscope functions and movement of the insertion tube.

- ❖ There are one or two buttons on the top that are colour-coded: red = suction, blue = air and water control.
- ❖ On gastroduodenoscopes, there are control wheels:
  - A larger inner wheel for upward and downward tip deflection;
  - A smaller outer wheel for movement of the tip left and right.
- ❖ Bronchoscopes have a single lever that controls two-way deflection (Figure 7).
- ❖ A friction brake lever may be used to fix the tip deflection in any given direction.
- ❖ An instrument channel, located on top of the handpiece, accommodates a variety of instruments including biopsy forceps, basket retrievers and cytology brushes, and can also serve as a suction channel.
- ❖ An eyepiece is for direct viewing or attachment of a camera linked to a monitor (fibrescopes).
- ❖ Programmable buttons are for white balance control and for capturing images/video (videoscopes).

#### Umbilical cord

The umbilical cord plugs into the light source or video processor. It contains:

- ❖ Fittings for insufflation, irrigation and suction.
- ❖ A pressure compensation valve for pressure testing, air transport and gas sterilisation.
- ❖ In the case of videoscopes, a video cable connector on the distal end of the umbilical cord, which connects to a video processor to transmit the image to a monitor.

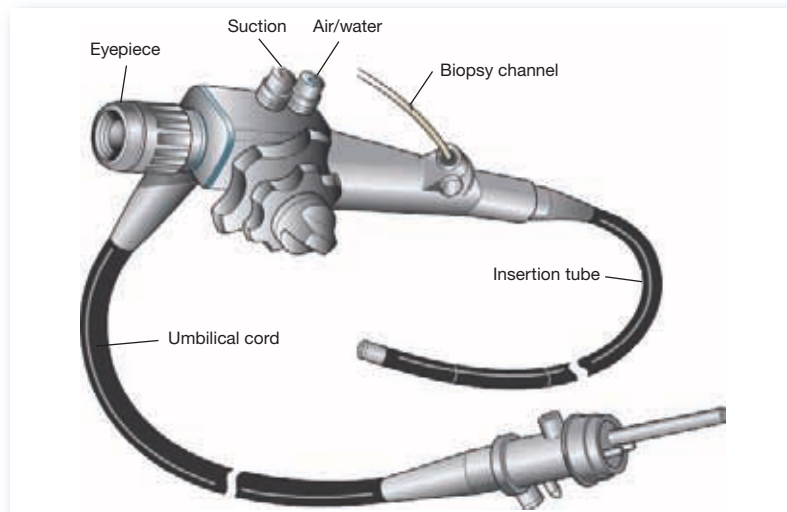


Figure 5 Flexible endoscope anatomy



Figure 6 Tip of video endoscope insertion tube. (a) Working channel, (b) light source, (c) viewing lens/CCD chip and (d) air/water channel





**Figure 7** Fiberoptic bronchoscope with two-way tip deflection

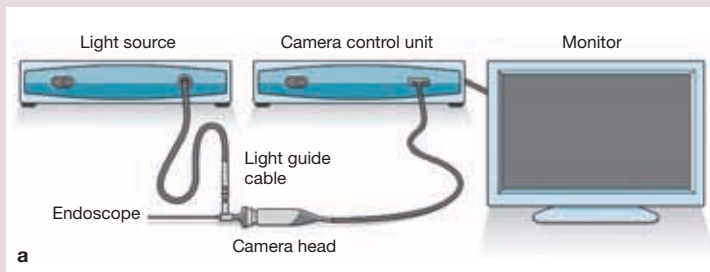


**Figure 8** Fiberoptic light-transmitting cable used to connect to the light post of the bronchoscope handpiece

It should be noted that some fibrescopes, such as ureterscopes and bronchoscopes (Figure 7), do not have an umbilical cord. They often require a light-guide cable (Figure 8) that attaches to the light post of the handpiece. In these endoscopes the pressure compensation valve will be positioned on the handpiece.

Looking at the endoscope's tip, the working channel, fiberoptic light guides, air/water nozzle, and video chip or viewing lens can be seen (Figure 6). The tip of a bronchoscope is connected by two cables to the lever that allow two-directional tip angulation. A gastroduodenoscope has four cables that enable four-way deflection of the tip when the control knobs are turned.

## The endoscopy 'imaging chain'<sup>1-7</sup>

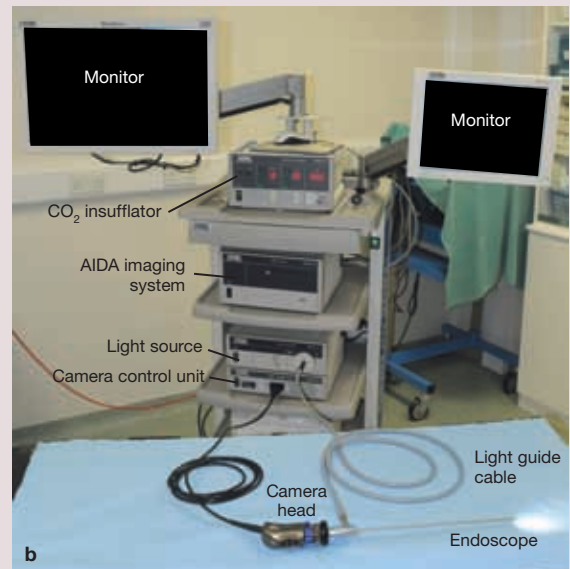


**Figure 9** (a,b) The video imaging chain

The video imaging chain starts with the light source and ends with the video monitor (Figure 9 a,b).

### Light source

- ✦ This component is essential in order to deliver light through the endoscope and illuminate the area of interest.
- ✦ On many flexible endoscopes, the light-transmitting cable



**Figure 10** A single camera control unit (top) and xenon light source (bottom) with connector for a fiberoptic light cable

is permanently incorporated into the endoscope with a connector in the umbilical cord. This plugs directly into the light source.

- ✦ A separate flexible light guide cable is used for rigid endoscopes.
- ✦ Most common light sources are xenon, tungsten, halogen and metal halide. Xenon light sources are considered the best because they produce a light that is most similar to full spectrum sunlight (Figure 10).
- ✦ In addition to the quality of the light source, the diameter of the endoscope and fiberoptic transmission capacity will also influence illumination.

Continued on page 971



## Rigid endoscopes

A rigid endoscope consists of a stainless steel insertion tube containing solid glass rod lenses surrounded by light guide fibres, an oculus or eyepiece, and a light guide connector. A flexible fiberoptic light guide cable connects the light guide connector to the light source.

Rigid endoscopes vary in length, diameter of the insertion tube and viewing angle. In feline endoscopy the most commonly used rigid endoscopes will have a diameter of 2.7 mm or less and a viewing angle of 0° to 30°. These endoscopes are delicate and will always be used in a supporting sheath such as a cystoscope sheath or examination sheath. A camera is invariably used, especially in operative surgery, and clips onto the oculus to give a high quality image.

## Choosing the appropriate endoscope

There are a variety of different makes, sizes, diameters and functions available when shopping for an endoscope. Unfortunately, there is no 'one size fits all' endoscope that will perform all procedures (eg, gastrointestinal endoscopy, bronchoscopy, rhinoscopy, cystoscopy) in all veterinary patients sufficiently well. Nonetheless, in feline practice, versatility is certainly an important factor when considering equipment investment – and, therefore, the selected endoscope should be able to perform as many functions as possible.

The key factors in selecting an endoscope are listed on page 972. Given that it is not possible for a single endoscope to be used for all endoscopic procedures in small animal practice,

Continued from page 970



**Figure 11** Camera head for a basic endoscopic video camera system

### Video camera and monitor chain

- ✦ A basic endoscopic video camera system consists of a camera head (Figure 11), camera control unit (CCU) and monitor.
- ✦ In the case of a video endoscope system, no camera head or adapter is needed as these electronic components are contained within the hand unit and CCD chip. This connects directly to the CCU and the image is then projected to the monitor.
- ✦ Some newer model CCUs are compatible with all endoscopes (fiberoptic, video and rigid), making them a very versatile option and minimising space requirements. Systems are also available that incorporate a light source, insufflation pump, digital capture system/recording system, and integrated flat screen monitor for viewing in a single portable unit (Figure 12).
- ✦ The monitor completes the imaging chain and provides the final display for viewing the endoscopic image. The CCU usually has more than one output and the camera is best connected directly to the monitor for optimum image quality (Figure 9b). The other output can be used to connect to an image capture device such as hard disc video recorder or a still image capture unit.
- ✦ A monitor is required for a video endoscope and is highly recommended for fiberoptic and rigid endoscopes as it allows



**Figure 12** The Telepack Vet X is a portable endoscopy system. It is compatible with flexible fiberoptic endoscopes, video endoscopes and rigid endoscopes. ©2013 Courtesy of KARL STORZ GmbH & Co KG

for a much larger image to be seen compared with the relatively small image seen through the eyepiece.

### Additional devices

- ✦ **Digital capture system (still capture and video recorders)**  
For documentation of procedures; this is important for clinical files, will enhance client communication and provide valuable information for the histopathology laboratory.
- ✦ **Air/irrigation/suction pump and CO<sub>2</sub> insufflation pump**  
Most endoscopic procedures require some combination of air or CO<sub>2</sub> insufflation, irrigation and/or suction to create an imaging space for a thorough examination, flushing debris and allowing extraction of irrigant/insufflated gases after the procedure. This virtual space may be gaseous (gastroduodenoscopy or laparoscopy), or may be fluid-filled, which is typical for rhinoscopy, arthroscopy, otoscopy or cystoscopy. Laparoscopy procedures require a CO<sub>2</sub> insufflator to provide a working space within the abdomen. The reason CO<sub>2</sub> is chosen rather than room air is that CO<sub>2</sub> reduces the risk of a gas embolism in the patient.

### Key factors in selecting an endoscope

- ❖ Rigid or flexible
- ❖ Insertion tube length
- ❖ Diameter
- ❖ Biopsy channel size
- ❖ Quality and cost
- ❖ Video or fibreoptic (flexible endoscopes)
- ❖ Angle of view (rigid endoscopes)
- ❖ Type of procedures anticipated based on practice case load\*

\*An exclusively feline practice will have different requirements, in terms of endoscope length and insertion tube diameter, compared with a small animal practice dealing with large and giant breed dogs.

separate endoscopes for examination of the respiratory tract, gastrointestinal tract and peritoneal cavity (laparoscopy) are usually needed.

For gastrointestinal endoscopy, a good 'universal' size flexible endoscope for most small/medium dogs and larger cats would have an outside insertion tube diameter  $\leq 7.9$  mm, a biopsy channel of 2 mm or more (the larger the channel, the larger and more diagnostic the biopsy samples that can be retrieved), four-way tip control, a working length of approximately 100–140 cm, air insufflation and water spray capabilities, and excellent optics. In fibreoptic endoscopes, smaller insertion tubes may result in compromised image quality due to decreased numbers of both coherent and non-coherent fibreoptic bundles required for image transmission and illumination, respectively. In addition, the smaller the biopsy channel, the more limited the range of accessories (especially balloon dilators and some foreign body retrieval forceps) that can be used (see later). However, smaller diameter endoscopes (eg, paediatric gastroscopes) are easier to pass through the pylorus into the duodenum. For upper and lower gastrointestinal endoscopy, the authors recommend an insertion tube of  $\leq 7.9$  mm x 100–140 cm working length endoscope for most feline patients, but a smaller 5.5 mm x 100 cm paediatric gastroscope can be useful in those patients requiring ileoscopy.

The most common rigid endoscope used in feline practice is the 2.7 mm x 18 cm 30° endoscope (Figure 13). This endoscope is used in a variety of sheaths depending on the procedure. An examination sheath is used for laparoscopy and thoracoscopy, and a cystoscopy sheath (Figure 13) is used for rhinoscopy, urethrocystoscopy and otoscopy. An arthroscopy sheath may be substituted for the cystoscopy sheath in these latter procedures as it has a smaller cross-sectional area; but



**Figure 13** From top: rigid 2.7 mm x 10 cm 30° oblique endoscope, cystoscopy sheath and arthroscopy sheath



**Figure 14** 1.9 mm telescope with integrated sheath

**Versatility is an important factor when considering equipment investment for feline practice. The selected endoscope should be able to perform as many functions as possible.**



there is one major disadvantage – it lacks an instrument channel.

An alternative is the 9.5 Fr operating telescope, which is a 1.9 mm telescope permanently built into a cystoscopy sheath. It has a length of 14 cm and a 3 Fr instrument channel, making it ideal for urethrocystoscopy, rhinoscopy and otoscopy in most cats (Figure 14).

Factors to consider when sourcing endoscopic equipment, including the relative advantages of purchasing new over second-hand instruments, are discussed in the box on page 973.

### Ancillary instrumentation

#### Accessories for flexible endoscopes

Accessories for flexible endoscopes include biopsy forceps, a variety of foreign body retrieval forceps, sheathed cytology brushes, aspiration tubes and balloon dilating catheters. These accessories assist in and enhance functionality, adding versatility for both diagnostic and therapeutic interventions.

There are a number of tissue biopsy forceps available including standard oval cup, fenestrated oval cup (Figure 15) and alligator forceps (Figure 16). The fenestrated cup forceps do not cause as much crush artefact and tend to yield larger samples. The alligator-type forceps with a serrated edge generally grip the mucosa better than smooth edged forceps. Fenestrated oval cupped alligator forceps provide a good combination of grip, sample size and reduced artefact. Both fenestrated and non-fenestrated cupped biopsy forceps are available with a central needle or spike that

## Buyer beware . . . to avoid an empty investment<sup>1,4</sup>

All too often, financial factors appear to be the major determinant in endoscope selection. Online auction sites offering endless supplies of 'bargain' priced endoscopes can be enticing. However, buyer beware! There is usually a good reason why these endoscopes were retired from their original job in the first place.

Bargain flexible endoscopes may have poorer quality optics, as well as many broken fibres and awkward handling characteristics, leading to user frustra-

**Purchase a quality instrument suitable for your practice needs. You will see a relatively quick return on your investment due to superior diagnostic capabilities and subsequently increased use.**

tion and poor diagnostic capabilities. Spares may no longer be available and defects may not be apparent on cursory examination. What appeared to be a good deal can turn out to be wasted money on a product that is unusable, unserviceable, or not appropriate for the vast majority of procedures encountered in everyday practice. The endoscope eventually

ends up in a storage cupboard collecting dust!

The temptation of buying an endoscope for parts, with the intention of 'restoring' an unusable endoscope, should be resisted as repair work can be extremely expensive. Money would be better spent on a newer, high-quality piece of equipment, which, with proper care, would be financially functional and viable for hundreds of procedures.

Rigid endoscopes are simpler in structure and design and are also less expensive. Good secondhand endoscopes can be found and if the optics appear clear and the instrument has no obvious damage it is likely to be functional. However, newer endoscopes invariably have better optics and transmit more light, giving superior image quality.

It is, therefore, recommended to purchase a quality instrument suitable for your practice needs. You will see a relatively quick return on your investment courtesy of superior diagnostic capabilities and subsequently increased use. With appropriate care, these endoscopes will last for many years. Currently available instrumentation includes endoscopes designed for use in humans and endoscopes manufactured specifically for veterinary use. Purchasing new equipment not only provides you with a manufacturer's guarantee but usually includes training for you and your staff on cleaning and maintenance, which will greatly lengthen the useful life of the instrument.

### Assess for excessive wear or damage

If considering buying secondhand, be aware of any excessive wear or damage to any part of the instrument. This is important with fibrescopes, where multiple black dots in the field of view represent broken fibre bundles caused by excessive bending or torsion of the insertion tube. An endoscope damaged in this way should not be purchased. A delay in movement of the flexible tip when the control knob is turned may indicate stretched guide wires and may limit the degree of flexion of the tip. In addition, there should be no 'fogging' when looking through the eyepiece and no scratches or condensation on either the eyepiece or insertion tip viewing lens. Many defects in used flexible endoscopes are not immediately apparent and may be expensive or impossible to repair.

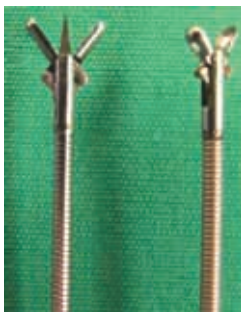
Rigid endoscopes are relatively simple instruments by comparison. Ensure that the view through the oculus is clear and shine a light through the insertion tube; if this does not reveal multiple broken fibres when looking at the light guide post, it is a reasonable bet that the endoscope is at least functional.

tends to anchor the forceps into the mucosa, preventing them from sliding down the tissue. Opinion varies from operator to operator as to which type of forceps is the best, cupped (fenestrated versus non-fenestrated) or alligator.

Biopsy forceps are designed to be used in the biopsy channel of the endoscope. The outer diameter of the forceps should be slightly smaller than the endoscope's biopsy channel. For example, for a biopsy channel measuring 2.0 mm, the forceps should be

1.8 mm diameter and be about 50 cm longer than the channel. Biopsy forceps should *never* be used for foreign body retrieval.

Several types of grasping forceps and retrieval baskets are available for foreign body removal. There are three basic types of graspers: three- or four-pronged wire forceps (Figure 17), 'rat tooth' forceps and 'duckbill' forceps. The



**Figure 15** Fenestrated cupped biopsy forceps with (left) and without (right) central spike



**Figure 16** Alligator forceps with non-serrated edge



**Figure 17** Three-pronged grasping forceps



**Figure 18** Wire basket foreign body retriever



**With a combined kit of a single loop snare, three- or four-pronged grasper and a wire basket most foreign bodies can be retrieved.**



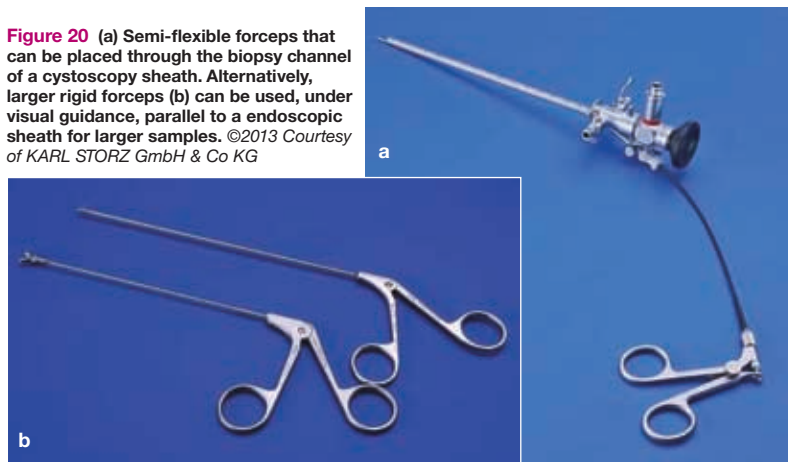
pronged forceps are useful for large irregular objects, the rat tooth forceps for grasping fabric or other soft material and the duckbill forceps for flat objects like coins. Single loop wire snares and three- or four-loop wire baskets (Figure 18) are required to remove large or smooth objects like stones. It is recommended to have at least two, and preferably three, different foreign body retrieval instruments. A single loop snare, three- or four-pronged grasper and a wire basket are good options. With these three instruments, most foreign bodies can be retrieved.

**Figure 19** Balloon dilator catheters



Guarded cytology brushes and aspiration catheters are also available. Balloon dilators of 6–8 cm lengths and 15–20 mm inflatable diameter (Figure 19) are recommended for gastrointestinal tract strictures and are usually used with a pressure gauge to prevent overdistension and rupture of the balloon.

**Figure 20** (a) Semi-flexible forceps that can be placed through the biopsy channel of a cystoscopy sheath. Alternatively, larger rigid forceps (b) can be used, under visual guidance, parallel to an endoscopic sheath for larger samples. ©2013 Courtesy of KARL STORZ GmbH & Co KG



### Accessories for rigid endoscopy

Instrumentation for rigid endoscopy will depend on the procedures undertaken. For rhinoscopy and cystoscopy, semi-flexible biopsy forceps and grasping forceps appropriate to the size of the instrument channel in the cystoscope are used (5 Fr for the larger 14.5 Fr cystoscope and 3 Fr for the smaller 9.5 Fr operating cystoscope) (Figure 20a). A pair of larger rigid biopsy forceps with a 3 mm cup and 1.5 mm shaft (Karl Storz 69133) (Figure 20b) is extremely useful for obtaining larger biopsies during rhinoscopy and can be used alongside the endoscope or placed blind following localisation of the lesion with the endoscope.

A selection of three or more laparoscopic cannulae will be required for operative surgery. For feline laparoscopy, a 3 mm examination sheath is used with a 2.8 mm x 18 cm 30° endoscope and this is placed through a 3.9 mm Ternamian EndoTip cannula (Karl Storz, Germany) or 3.9 mm operating cannula with a sharp trocar (Figure 21). Commonly 5 mm hand instruments are used and require one or two 6 mm threaded positive-profile cannulae (either Ternamian tipped or with sharp trocar). Alternatively, 3 mm paediatric instruments may be used with appropriate trocars.

A range of hand instruments, including those listed in the box below, will be required for routine procedures. More specialist instrumentation may be required for advanced procedures.

**Figure 21** 3.9 mm threaded cannula and trocar



### Hand instruments for routine laparoscopic procedures

- ❖ Veress needle
- ❖ 5 mm endoscopic biopsy forceps (cup and/or punch type)
- ❖ 5 mm endoscopic grasping forceps
- ❖ 5 mm endoscopic Babcocks forceps
- ❖ 5 mm endoscopic scissors
- ❖ 5 mm bipolar cutting devices (eg, Powerblade or Ligasure)
- ❖ Or bipolar forceps
- ❖ 5 mm palpation probe with cm markings
- ❖ 5 mm suction irrigation wand or monopolar hook with suction

These various instruments will be used alongside the basic imaging chain. Further information will be given in articles on laparoscopy in the second instalment in this Special Issue series.



## Storage<sup>8</sup>

Endoscopes and accessory components (eg, biopsy forceps) should be stored in a dedicated area within easy access, so that damage is prevented but equipment is readily available for use when required.

A recommended storage solution for flexible endoscopes is a storage cabinet, allowing the endoscopes to hang straight and vertical and dry without stressing the interior fibres (Figure 22). It is not recommended that flexible endoscopes are stored in their transport cases for any significant length of time. This can damage the fibreoptic bundles, which retain a memory of their curvature, and results in deformation of the insertion tube, especially with smaller diameter endoscopes. A small enclosed case also provides an ideal environment for bacterial growth.

Rigid endoscopes and hand instruments should be stored in a padded drawer with separators (Figure 23) to prevent damage to endoscopes and also to electrical insulation on the shafts of monopolar and bipolar instruments. A proprietary tool box with suitable drawers can make a useful storage cabinet.

**Figure 22** Cabinet with hanging facilities for endoscope storage



**Figure 23** Suitable storage for rigid endoscopes

## Care and cleaning of endoscopic equipment/accessories

While detailed information about cleaning and maintenance of equipment goes beyond the scope of this article, the authors' general advice is always to follow the manufacturer's recommendations for cleaning, disinfecting and storing endoscopes, accessories and the various components. This will significantly prolong the life of the equipment and lower the risk of iatrogenic infections to the patient and contamination of samples. Although most modern endoscopes are marked as safe for immersion, the manufacturer's instructions should always be consulted before a piece of equipment is fully immersed in fluids. Fibreoptic endoscopes are generally paired with a leak-tester which is used to detect small air leaks before they cause major damage to the endoscope. A leak test should always be performed before a flexible endoscope is immersed in fluid and the endoscope should remain pressurised all the time it is immersed.

User-related damage is usually caused by inappropriate cleaning practices. It is, therefore, advisable to select specific staff members to be well trained on cleaning procedures for

both flexible and rigid endoscopic equipment. Biopsy and retrieval instruments are extremely delicate and prone to damage, and deserve the same meticulous care as endoscopes. Biopsy forceps should be carefully cleaned with an enzymatic solution to dissolve proteinaceous materials, then disinfected and well lubricated.

For specific cleaning protocols compatible with your purchased equipment contact the relevant manufacturer(s). Company representatives are very helpful with offering advice and may even come to the practice to train staff members on endoscope care and maintenance. It can be useful to laminate a cleaning guide and supply list specific to the model of endoscope used in the practice to expedite the procedure in the busy clinic environment.

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## Conflict of interest

The authors do not have any potential conflicts of interest to declare.

## KEY POINTS

- ❖ Veterinary practitioners are starting to appreciate the benefits of minimally invasive procedures and are incorporating endoscopic techniques into everyday practice.
- ❖ In addition to the benefits of reduced tissue trauma, minimal postoperative pain and faster recovery times, especially in feline patients, the endoscopist enjoys vastly improved visualisation of the surgical site through excellent illumination and a high quality magnified image – often of sites that are impossible or difficult to access in any other way.
- ❖ This, together with clients' awareness, and sometimes personal experience, of minimally invasive procedures has created an expectation and demand for these services in the veterinary sector.
- ❖ Endoscopes are now more widely available outside of the referral setting, and financially accessible to those in general practice. With purchase of suitable equipment, and appropriate investment in training, a committed practitioner can readily learn basic endoscopic techniques.
- ❖ The budding endoscopist should strongly consider participating in hands-on 'wet-lab' courses and ongoing training provided by experienced endoscopists to rapidly achieve a level of competence that justifies the high initial investment in providing this type of service.



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# GASTROINTESTINAL ENDOSCOPY IN THE CAT

## Equipment, techniques and normal findings

Christiane Stengel, Elise Robertson and Reto Neiger

### GI endoscopy – principles and prerequisites

Endoscopy is an integral part of the evaluation of gastrointestinal (GI) disease in companion animals, and is commonly used when non-invasive investigations and trial therapy have failed to provide a diagnosis and resolution of clinical signs. GI endoscopy includes examination of the mouth, oesophagus, stomach, proximal small intestine, ileum, colon and rectum. The mouth, oesophagus and also the rectum and descending colon may be examined with either a rigid or flexible endoscope.

The preferred instrument is a flexible endoscope, which becomes essential for complete visualisation of the stomach and intubation of the small and proximal large intestine.

Endoscopy rarely has therapeutic intent, except for foreign body retrieval, polyp removal, stricture dilation or feeding tube placement (percutaneous endoscopic gastrostomy [PEG] or jejunostomy tube).

The main reason to perform endoscopy is to obtain biopsies for histopathological investigation.

Endoscopy should be performed only when indicated – and not because the equipment is available and has to be used. A thorough medical investigation involving less invasive tests, including laboratory examinations (eg, haematology, biochemistry, faecal examination, urinalysis, total T<sub>4</sub>), radiography and, in particular, abdominal ultrasound, needs to be performed prior to endoscopy.<sup>1</sup> In most patients, trial therapy (anthelmintics, antibiotics, diet) should also be undertaken prior to endoscopic evaluation.

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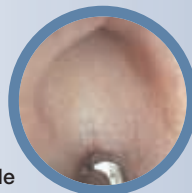


**Practical relevance:** Feline gastrointestinal (GI) endoscopy is in high demand, particularly by cat owners already aware of the clinical benefits and availability of this procedure within the human healthcare system. This article will provide a basic introduction to GI flexible endoscopy, covering important aspects of endoscope selection, clinical indications, and basic techniques required to perform a thorough and diagnostically meaningful examination in the cat.

**Clinical challenges:** Challenges associated with implementing endoscopy in GI tract investigations can include lack of appropriate/suitable-sized equipment to perform a thorough examination in the cat, insufficient operator training/understanding in how to 'drive the scope' through the GI tract, and/or lack of confidence in differentiating normal from abnormal.

**Audience:** This article is intended to familiarise and motivate the feline practitioner to develop basic endoscopic skills. Clinical proficiency can only be obtained through use of appropriate equipment, formal training and hours of practice in distinguishing normal from abnormal.

**Evidence base:** The guidance contained in this article is based on a combination of the published literature, the authors' personal experience and the experience of colleagues.



#### MULTIMEDIA

Six video recordings showing equipment handling and a variety of gastrointestinal endoscopy techniques in cats are included in the online version of this article at [jfm.sagepub.com](http://jfm.sagepub.com)  
DOI: 10.1177/1098612X13508248

The risks and possible benefits to the patient in gaining a diagnosis must be balanced against the anaesthetic risk as well as the risks posed by the procedure itself. Part of the process of minimising procedure-related risks is to use adequate and fully functioning equipment. The endoscopist should also have a high level of proficiency, as GI endoscopy in cats is more demanding in skill than in dogs, due to the small size of the animal and the decreased tolerance to anaesthesia. It takes patience and much practice to perform upper and lower GI endoscopy effectively and training should start with a comprehensive endoscopy course, with both lectures and wet labs, before attempting this procedure in sick patients.

GI endoscopy in cats can only safely and adequately be performed under general anaesthesia. Therefore, an assistant competent in maintaining and supervising anaesthesia needs to be present throughout the entire procedure, as the endoscopist may be too engrossed in his/her task to also supervise the animal. The assistant should understand endoscopy and the inherent risks in order to anticipate possible complications (ie, over-inflation of the stomach, stretching of colon).

## Equipment for GI endoscopy

### Flexible endoscopes

The imaging chain in endoscopy includes the endoscope, imaging system (camera, camera head and monitor) and illumination system (light source and cable). Cost factors and, in turn, the versatility of application of an endoscope, its durability and ease of guidance are often the key determinants in the selection of endoscopic equipment in veterinary practice. One single flexible endoscope might be used for a variety of procedures in the GI tract (and also respiratory tract in dogs). The versatility of an endoscope depends on its length, diameter of the insertion tube, diameter of the working channel and tip deflection capabilities; its ease of guidance only depends on length and outer diameter. Another important



**Figure 1** A veterinary-specific feline video gastroscope (outer diameter 5.9 mm, working channel 2.0 mm, length 110 cm). ©2013 Courtesy of KARL STORZ GmbH & Co KG



**Figure 2** Distal tip of video endoscope; note the working channel (a), fibreoptic light guide (b), lens (c) and air/water nozzle (d). ©2013 Courtesy of KARL STORZ GmbH & Co KG

factor to be considered before purchase of endoscopic equipment is the optical and imaging system.

In simple terms, the ideal endoscope is thin but has a large instrumentation channel (see box). The latest models of endoscope specially designed for use in veterinary companion animals include a video endoscope, 140 cm long, with a 7.9 mm outer diameter and an instrumentation channel of 2.8 mm, and a feline-specific video endoscope, 110 cm in length with a 5.9 mm insertion tube (Figure 1) (both endoscopes Karl Storz, Germany).

The video endoscope is one of two basic types of flexible endoscopes used in veterinary medicine; the other is the fibroptic endoscope. They differ in the method of sensing and transmitting the image. In the fibroscope the image is carried from the insertion tube tip to the eyepiece via bundles of coherent optical glass fibres, resulting in a pixelated image. The image can then be viewed directly through the eyepiece or indirectly by attaching an endoscopic charge-coupled device (CCD) video camera to the eyepiece. The picture is then transferred via the imaging system onto a monitor.<sup>2</sup> In the video endoscope, the image is sensed by a CCD chip located in the distal tip of the insertion tube (Figure 2) and transmitted electronically to a video monitor. As there is no eyepiece these endoscopes need to be connected to a monitor. The image quality of the video endoscope is far superior to that of the fibroscope, but the equipment is also more expensive. If a good quality fibroscope is combined with a high intensity light source and a good quality video camera, the resulting image is in most instances sufficient for adequate visualisation.

### What size endoscope?

A flexible endoscope suitable for upper and lower GI endoscopy in cats is typically 100 cm long and should have four-way tip deflection. Careful thought should be given to the insertion tube, particularly the diameter. To be able to pass the endoscope through the pylorus into the duodenum and through the ileocolic junction into the ileum in the feline patient the outer diameter should not exceed 9 mm (and preferably should be <8 mm). Length is not as important unless large felids (tiger, lion, cheetah) will be examined. If the same endoscope is also to be used in dogs a length of >130 cm is recommended.

To obtain adequate-sized biopsies, the instrumentation channel should be at least 2.0 mm.



For both types of endoscope an imaging system offers distinct advantages, not only in improved visualisation and comfort for the operator but also in terms of documentation, client information and teaching purposes. Taking and recording images and video sequences helps the owner to understand the procedure and possibly the disease affecting her/his animal.

Flexible endoscopes consist of three major parts: the insertion tube, handpiece and umbilical cord. The insertion tube is the most complex part because it contains fibreoptic bundles for light transmission and image transmission (fibrescope), channels for insufflation, irrigation and suction/instrumentation, deflection cables (two or four) and several layers of protective sheathing along its entire length.<sup>3</sup> The last several centimetres of the endoscopic tip make up the bending section. In this portion the insertion tube can be deflected in one or two planes (up and down, left and right). This movement is controlled by deflection cables which are connected to deflection knobs on the handpiece of the endoscope. Smaller diameter endoscopes can only deflect the tip in one plane (one- or two-way tip deflection: up and down); however, endoscopes designed for GI use (gastro-, duodeno-, colonoscopes) are equipped with four-way tip deflection (Figure 3). In most endoscopes the up-deflection is  $\geq 180^\circ$ , while the deflection in the other three directions is about  $90^\circ$ . The tip deflection enables the endoscopist to guide the endoscope in almost any forward direction by coordinated movement of up/down, right/left and twisting of the whole insertion tube and handpiece about its longitudinal axis.

The fibreoptic light transmission bundles end at the distal tip in one or two light guide lenses close to the objective lens (Figure 2). In order to adequately illuminate the GI tract, especially the stomach, GI endoscopes usually contain two light guide lenses located on either side of the objective lens in the tip. The objective lens is either connected to the fibre-optic image transmission bundles or to the CCD chip.

The irrigation channel ends at the irrigation nozzle, which is located on the tip close to the objective lens. The water jet exiting this nozzle is directed over the objective lens to remove mucus or debris which might obstruct the view by sticking to the lens. Through the

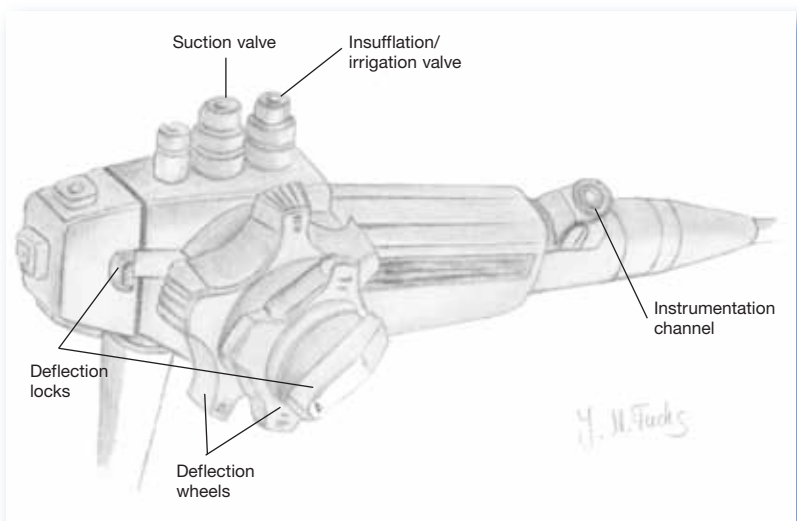


**Figure 3** Four-way tip deflection

insufflation channel room air can be blown into the lumen to distend the GI tract, thereby enabling a clear view of the mucosa for complete and thorough examination. The instrumentation/suction or accessory/working channel is used for passage of accessory flexible instruments into the patient and for suction of fluids and air.

The handpiece also contains the deflection knobs with the deflection locks, the opening of the instrumentation channel and the valves for insufflation/irrigation and suction (Figure 4). In the fibrescope, the handpiece ends with the eyepiece and it also contains a dioptre adjustment ring to manually focus the objective lens. The handpiece of some video endoscopes has programmable buttons for control of various functions (ie, light gain, magnification, image freeze).

The light guide connector connects the umbilical cord to the light source and includes fittings for insufflation and irrigation. Most light sources used for GI endoscopy contain an integrated air pump for insufflation, which also provides the positive pressure that forces the irrigation water from an attached bottle through the irrigation channel. A separate suction pump can be attached to the suction connector on the light guide connector. Also located on the light guide connector is the pressure compensation port, which is used for leakage testing with a manometer-type pressure tester and to prevent damage from external pressure changes (gas sterilisation, shipping by air) by attaching a pressure compensation cap to the valve. In video endoscopes the connection for the video cable is also on the light guide connector, together with an air- and water-tight fitting cap, which is left in place when the equipment is not in use.



**Figure 4** Handpiece

### Cleaning and disinfection

The endoscope needs *always* to be cleaned and disinfected between patients.<sup>4</sup> Information about the cleaning procedure and approved disinfectants for the specific endoscope needs to be obtained from the manufacturer. Note that the pressure compensation cap should never be left in place when cleaning or soaking the endoscope, as it will allow fluid to enter the inner workings, causing irreparable damage. When cleaning a video endoscope, the air-/water-tight fitting cap needs to be tightly screwed onto the light guide connector.

### Accessory instrumentation

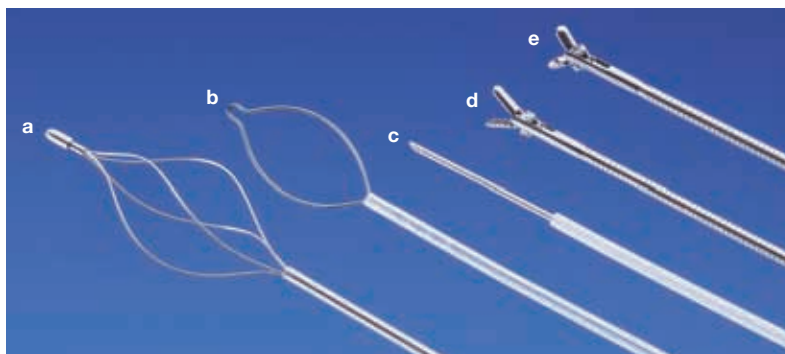
A large selection of accessory instrumentation is available for use with endoscopes (Figure 5). The instruments most widely used in feline endoscopy are biopsy forceps and foreign body grasping instruments. Other potentially useful instruments include injection/aspiration needles and polypectomy snares. A detailed overview of instrumentation for flexible endoscopy is available in the first article in this Special Issue of *JFMS*.

To obtain tissue samples from the GI mucosa the most widely used instruments are pinch biopsy forceps. These are small flexible forceps with opposing cups at the end. The cups come in different configurations: smooth or serrated edge, closed or fenestrated cup, with or without a central needle (Figure 6). Fenestrated cups are reported to produce larger biopsy specimens with less crush artefacts.<sup>5</sup> The central needle in some biopsy instruments aids in stabilising the forceps in the mucosa but can lead to artefacts in the tissue sample. Oval cups give a larger biopsy sample than round cups for the same diameter of instrument.

The most important feature of endoscope instruments is their size and handling. The diameter should never exceed the instrument diameter recommended by the manufacturer of the endoscope to avoid damage to the instrumentation channel and the endoscope itself. Furthermore, instruments should never be forced through the instrumentation channel, and only be passed with the bending section in an almost straight position.

### Rigid endoscopes

Rigid endoscopes can be used for evaluation of the oral cavity, oesophagus and distal large intestine (descending colon and rectum). These endoscopes are composed of a telescope, which is used in conjunction with an operating sheath or cannula. The telescope is a metal tube containing high-quality optical glass lenses (rod lens system) and light bundles. The outer diameter of a rod lens tele-



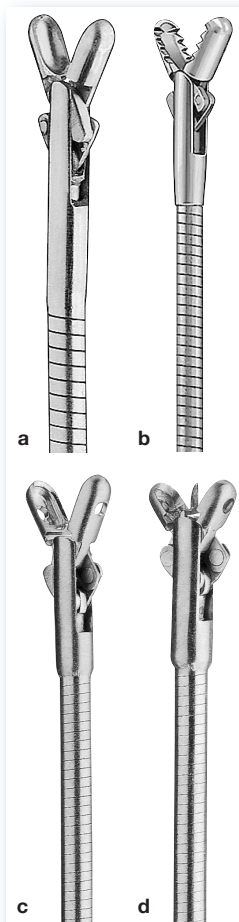
**Figure 5** Commonly used accessory instruments for flexible GI endoscopy: (a) four-wire basket retrieval instrument, (b) snare, (c) injection needle, (d) alligator grasper, (e) non-fenestrated biopsy forceps without central spike. ©2013 Courtesy of KARL STORZ GmbH & Co KG

scope ranges from 1.9–10 mm, the length from 10–40 cm and viewing angle from 0° to 30°. More detailed information on rigid endoscopes can be found in the first article in this Special Issue.

For GI endoscopy an operating sheath is locked onto the telescope. It serves to protect the telescope and the patient, but also facilitates the ingress/egress of fluids or gases through the two side ports and the introduction of diagnostic and surgical accessory instrumentation through the port of the working channel.

Rigid endoscopes used for oesophagoscopy and proctoscopy in humans use a blunt-tip obturator that fits inside the endoscope to facilitate insertion of the instrument into the oesophageal or rectal lumen. These endoscopes also come with an attachable light source and an air insufflation mechanism, mostly in the form of a bulb insufflator. The diameter varies between adult (18–25 mm) and paediatric (9–12 mm); the length is usually about 25 cm. The paediatric size is most suited to feline patients.

In oesophagoscopy rigid endoscopes are mostly used for foreign body removal or balloon dilation of strictures. Examination of the large intestine with rigid endoscopes is limited to the rectum and descending colon (ileum, caecum, ascending and transverse colon cannot be visualised). However, most inflammatory disorders involve the whole colon diffusely and biopsies obtained from the distal part are mainly diagnostic. Large intestinal tumours and polyps are most often located in the distal colon and rectum and can therefore be adequately evaluated, biopsied or removed with rigid instruments. Biopsy forceps with an angulated tip might be used in parallel with the endoscope in rigid oesophagoscopy and colonoscopy, enabling the endoscopist to place the cups perpendicular to the mucosa. However, visualisation of mucosal detail and use and control of biopsy forceps is superior with flexible endoscopes.



**Figure 6** Different types of biopsy forceps: (a) smooth-edged, non-fenestrated; (b) serrated-edged, non-fenestrated; (c) smooth-edged, fenestrated without central spike; (d) smooth-edged, fenestrated with central spike. ©2013 Courtesy of KARL STORZ GmbH & Co KG

## Equipment handling

### Endoscope

Flexible endoscopy is performed in a standing position, as sitting constrains the movement of the endoscopist's arm and upper body. The endoscopist always stands in front of the patient. The handpiece of the flexible gastroscope is designed to be held in the left hand. The thumb of the left hand controls the larger inner deflection knob (up/down), while the index finger controls the suction valve (upper valve) by depressing it (Figure 7). The insufflation/irrigation valve (lower valve) is controlled either with the index finger as well, or with the middle finger. When the hole in the middle of this valve is closed with the fingertip without depressing the valve, air is diverted through the air channel. Irrigation is activated by depressing this valve completely. The left hand also provides rotational torque of the insertion tube by bending the wrist out and in (supination/pronation) (see video 1). Twisting the whole insertion tube around its longitudinal axis (so-called 'torquing') avoids damaging it through trying to twist it around itself.

The right hand advances and retracts the insertion tube in and out of the patient and inserts the accessory instruments. The left/right (smaller, outer) deflection knob is worked either by the thumb of the left hand or by the right hand.

When rigid endoscopy is performed, the endoscopist sits in front of the patient, with the endoscope in either the right or left hand. The light guide cable and the cable of the camera head hang downwards. The hand holding the endoscope advances and retracts the rigid part of the endoscope and also rotates the endoscope around its axis as needed. The index or middle finger of the hand holding the endoscope controls the opening and closing of the side ports. The other hand is used to hold the patient in the correct position while the endoscope is advanced; in colonoscopy this hand pinches the anus closed to prevent air from leaking out. This hand also introduces and retracts any accessory instrumentation through the working port of the sheath. The air insufflation line is attached to one side port



**Figure 7** Illustration showing the handpiece in the endoscopist's left hand

and the assistant insufflates air into the lumen of the examined organ with a bulb insufflator or another device (ie, pressure bag, syringe).

### Accessory instrumentation

Accessory instruments are advanced through the instrumentation channel by the endoscopist. The upper opening of the channel is covered by a rubber instrumentation channel cap, which closes the channel to prevent leaking of insufflated air or enables suction to be applied through the channel. The lid of this cap can either be opened to introduce the accessory instrument or the instrument is passed through a minute opening in the rubber lid which seals around the instrument. Force should *never* be used when pushing an instrument through the channel, especially when resistance is met.

When the instrument is passed through the deflectable part of the tip, it is advisable to straighten the tip, advance the instrument until it can be seen in the field of view and then deflect the tip again as needed. It is mandatory *never* to retrieve foreign bodies into or through the instrumentation channel. Instead, the foreign body is grasped tightly, pulled close up to the tip of the endoscope and the entire endoscope, together with foreign body grasper and foreign body is removed from the patient. The only materials that it is permissible to retrieve through the instrumentation channel are endoscopic biopsies inside the biopsy forceps.

Sometimes, and especially when a foreign object is retrieved from the oesophagus or stomach, a separate rigid foreign body grasper is used parallel to the endoscope. In cats this foreign body grasping device has to be small enough to fit into the oesophagus together with the endoscope. Some rigid endoscopes can be used in conjunction with a sheath that has an integrated foreign body forceps, which is bigger than an accessory instrument used through the working channel of a flexible endoscope (Figure 8).



**The only materials that it is permissible to retrieve through the instrumentation channel are endoscopic biopsies inside the biopsy forceps.**



**Figure 8** Distal tip of a rigid endoscope with foreign body grasper



## Biopsy techniques

The quality of endoscopically obtained biopsies greatly influences the likelihood of an accurate histopathological diagnosis of a specific mucosal lesion.<sup>6</sup> In general, at least six adequate samples need to be collected from the feline gastric and duodenal mucosa to reliably detect abnormalities.<sup>7</sup> An adequate biopsy should have a full thickness mucosa and at least three or four intact, and if possible contiguous, villi.<sup>8</sup> Samples containing submucosa are preferred (Figure 9). These requirements can be challenging to meet in the feline intestine due to the small intestinal diameter and thus limited ability to direct the forceps tip into the mucosa at a suitable angle and depth.<sup>9</sup>

Various techniques are used for sampling the GI mucosa with a flexible forceps. Each endoscopist will have their preferred method and any technique that yields adequate tissue specimens without damaging the intestinal wall integrity is acceptable. Biopsies can be collected by the endoscopist alone; however, having an assistant to operate the forceps is beneficial.

The best biopsies are obtained if the forceps is advanced perpendicularly to the desired area (see video 2). The tip of the endoscope is positioned perpendicularly in front of the mucosa, the biopsy instrument is passed through the operating channel until the tip and the hinges of the cups are visible, and the jaws are opened and advanced into the mucosa with some pressure. Adequate forward pressure displaces the mucosa away from the endoscope and leads to gentle bowing of the instrument shaft. The jaws are closed and the forceps is retracted through the working channel, thereby tearing the tissue out of the mucosa. With the exception of gastric mucosa in the area of the pylorus, it is not necessary to forcefully tug or jerk the forceps backwards.

To avoid damage to the working channel it is generally advisable to straighten the endoscope tip as much as possible or at least to let go of the deflecting knob before retracting the biopsy forceps. This is clearly mandatory if a forceful jerk is deemed necessary.

In animals with a small diameter intestinal lumen (especially cats) this procedure might not be feasible. In this case the forceps is advanced into the intestinal lumen, and then opened and retracted almost against the tip of the endoscope. The tip is then deflected into the mucosa as obliquely as possible to attain as perpendicular an orientation as possible. During this manoeuvre it is often impossible to see the mucosa (due to 'red-out'). The tissue samples are then obtained by gently pressuring the jaws of the forceps into the mucosa without turning the tip of the instrument away again.

In general, larger forceps yield better quality tissue specimens. However, the intestinal mucosa is relatively thin in the feline patient and adequate samples may be obtained with smaller instruments (working channel 2.2 mm).

With rigid endoscopy a perpendicular angle of the biopsy forceps cups to the mucosa can rarely be achieved unless an angulated tip forceps is used. For forceps that are passed through the

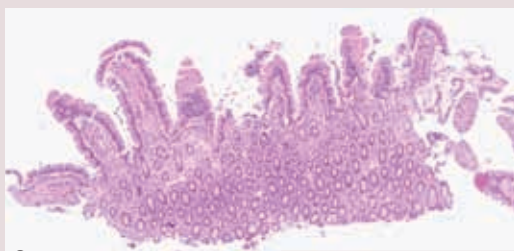
working channel it is helpful to cover the port opening with an instrumentation channel cap. The instrument is passed through the capped hole and then advanced out of the sheath until the jaws can be seen in the field of view. The forceps is opened and retracted up to the tip of the sheath. The endoscope is then angulated towards the mucosa/mass as much as possible, taking care not to injure the animal by excessive manipulation. The open cups are advanced tangentially into the mucosa and closed as soon as a small mucosal fold has developed at the cups' tip. The endoscope is angulated back into the lumen to ascertain that mucosa has been grasped and the biopsy forceps is retracted out of the working channel. To biopsy a mass, the cups are pushed into the tissue, closed and then the biopsy forceps is either retracted through the working channel or removed together

with the whole endoscope to retrieve a bigger tissue sample.

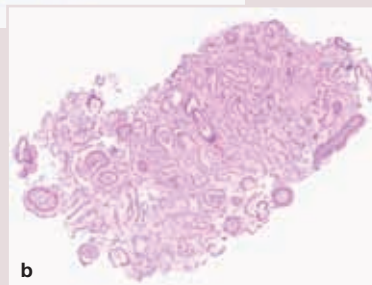
If an angulated tip forceps is used, this is passed beside the endoscope into the lumen. The lumen has to be sealed around endoscope and forceps. Air is then insufflated until the lumen is again

visible and the forceps is advanced until the tip can be seen endoscopically. The jaws are opened and the cups pushed perpendicularly into the mucosa/mass, then closed and pulled back out of the patient.

After obtaining the specimen, the biopsy forceps is removed from the endoscope and the tissue sample is carefully removed from the jaws. Placing the jaws containing the sample into a container filled with isotonic saline and then 'washing off' the sample by shaking the tip of the forceps helps to avoid damaging the edges of the cups (see video 3). Similarly, the tissue sample can be rinsed from the cups with a stream of isotonic saline instead of manipulating it out with a needle. The container with both sample and saline then needs to be carefully decanted to remove as much saline as possible, and formalin is added to obtain a 10:1 ratio of liquid to tissue. Specimens should be sent in the fixative to the pathology laboratory as quickly as possible for histopathological examination.



**Figure 9** Histopathology of two endoscopically taken duodenal biopsies. Sample (a) shows nicely orientated villi and has adequate depth to make a meaningful diagnosis; sample (b) was too superficial and lacks normal villous orientation, precluding a diagnosis. Courtesy of Dr M Henrich, Institute of Veterinary Pathology, University of Giessen, Germany



### Submission of samples

Submission of a complete history and macroscopic evaluation report to the pathologist is vital to obtain best results. Furthermore, tissue samples can be used for other laboratory investigations (ie, culture or PCR) or to create touch imprints for cytological evaluation.<sup>10</sup> The endoscopic evaluation report should accompany the tissue.

✦ Standardised reporting forms can be downloaded from the WSAVA GI Standardization Group at [www.wsava.org/guidelines/gastrointestinal-guidelines](http://www.wsava.org/guidelines/gastrointestinal-guidelines)

## Anaesthesia for GI endoscopy

Intubation with a cuffed endotracheal tube is mandatory in cats undergoing GI endoscopy because of the risk of gastro-oesophageal reflux. The safest anaesthetic regime is one the operator is familiar with, but inhalation anaesthesia is preferable. Even if injection anaesthesia is used throughout the procedure, the animal has to be intubated and the cuff inflated at all times. A mouth gag must always be used for cats undergoing upper GI endoscopy to prevent damage to the endoscope (Figure 10). Rather than a spring-loaded mouth gag, it is advisable in cats to use a chopped down and slightly padded syringe or needle cap to avoid compression of the maxillary artery and associated post-anaesthetic blindness.<sup>11,12</sup> This potential complication is due to the fact that cats lack the inner carotid artery that is present in dogs.

Some anaesthetic agents affect intestinal motility and sphincter function, making passage through the cardia and pylorus potentially more difficult.<sup>13</sup> Atropine and other anticholinergic



**Figure 10** Cat lying in left lateral recumbency with non-spring-loaded mouth gag

drugs should not be used unless necessary to increase heart rate, as these drugs may alter gastric motility patterns and increase pyloric tone. Pure opioid agonists may also increase pyloric tone and should ideally be avoided.

Fluid support should be given during anaesthesia. Dehydrated animals need to be rehydrated before anaesthesia unless endoscopy needs to be performed as an emergency procedure. In hypoproteinaemic patients colloid administration should be considered to ensure reasonable oncotic pressure.

Anaesthesia monitoring during upper GI endoscopy includes, as a minimum, assessment of heart and respiration rates and pulse oximetry. Air insufflation is essential in upper GI endoscopy to open the lumen and move the mucosa away from the endoscope tip. Overinflation of the stomach can cause cardiorespiratory compromise and both the endoscopist and assistant should monitor the degree and possible effects of insufflation.<sup>14</sup>

### Preparing the patient for GI endoscopy

General anaesthesia is required for GI endoscopy (see box). Food should be withheld for 12–18 h before endoscopy of the upper GI tract, while water can still be provided up to 2 h before the procedure. For lower GI tract endoscopy food should be withheld for at least 24 h to ensure no further passage of ingesta from the small into the large intestine. If the owner is unable to withhold food (ie, multiple cat household, cat complaining severely, outdoor cat) it is advisable to hospitalise the patient prior to the procedure to ensure proper fasting.

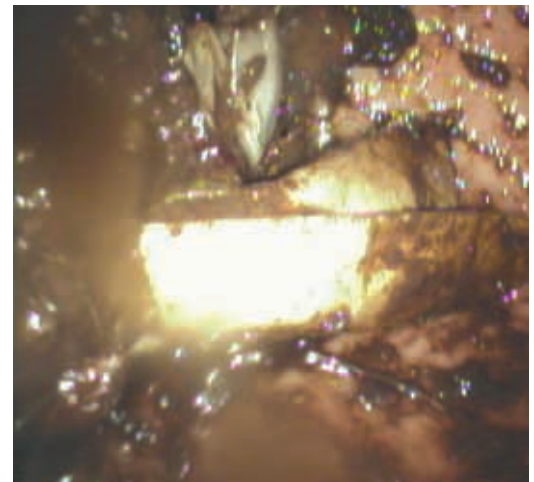
Normally the feline stomach empties within 12 h.<sup>15</sup> Therefore, finding retained food in the stomach of a properly fasted animal may give useful information about a possible anatomical or mechanical outflow obstruction or gastric motility disorder. In these cases a significant amount of gastric or duodenal ingesta may compromise the examination since the entire mucosa cannot be visualised (Figure 11). Lesions or even foreign bodies might be missed. If necessary, fluid can be aspirated through the working channel; or, if too much food is present, fluid can be aspirated through a separate gastric tube alongside the endoscope. In some instances it is sufficient to gently turn the animal around the endoscope to visualise the entire mucosa.

**Finding retained food in the stomach of a properly fasted cat may give useful information about a possible anatomical or mechanical outflow obstruction or gastric motility disorder.**



If a barium contrast study has been performed, upper GI endoscopy should be postponed for at least 24 h to allow complete clearance of the barium from the mucosal surface. Any residual barium should never be aspirated through the instrumentation channel as this might adhere to the channel's inner lining and clog the lumen.

For lower GI endoscopy removal of all faeces from the descending colon is required. Fasting and administration of enemas is usually sufficient to evacuate almost all faecal material. GI lavage solutions (ie, Klean-Prep;

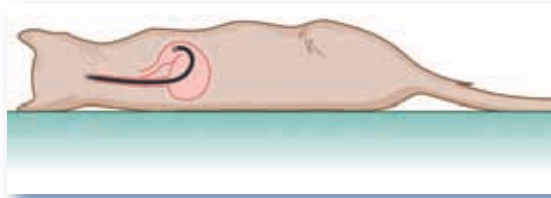


**Figure 11** Endoscopic view of food-filled stomach

Norgine GmbH, GoLyteLy; Braintree Laboratories) can be administered to cats the day before colonoscopy via a naso-oesophageal tube. While two doses of about 30 ml/kg, 2–4 h apart, has been recommended,<sup>16</sup> cats (and possibly dogs) may vomit during administration of these lavage solutions and aspiration can lead to severe complications.<sup>17</sup> Therefore, some authors state that the use of oral lavage solution is not appropriate in cats.<sup>18</sup> Warm water enemas, administered every 1–2 h until the water is clear, can be effective in cleaning out the colon. A well lubricated rubber tube is passed gently into the colon no further than the pre-measured length from the anus to the last rib, and warm water is slowly infused into the colonic lumen under gravitational feed. Extreme care should be taken not to overdistend the colon as this might lead to vomiting in cats. The last enema is applied no later than 2 h before the procedure.

For flexible GI endoscopy the patient should always be placed in left lateral recumbency. This positions the gastric antrum and pylorus uppermost (Figure 12), which significantly improves the opening of these structures by the insufflated air, allowing any fluid to fall into the fundus.

Evaluation of the mucosa and passage of the stomach and pylorus is then possible. In an animal lying in right lateral recumbency



**Figure 12** Cat in left lateral recumbency during gastroscopy, depicting the correct location of the endoscope entering the antrum

it is much more difficult to clearly identify all parts of the stomach or pass into the antrum. The only exception to this positioning is for the placement of a PEG feeding tube, which is inserted through the left flank in an animal lying in right lateral recumbency. For flexible colonoscopy the patient is also placed in left lateral recumbency, so the descending colon lies downward while the transverse and ascending colon are facing up. This position is helpful to adequately open the lumen of the proximal colon by air insufflation and reduces fluid accumulation around the ileocaecocolic junction.

For rigid endoscopy, the patient is positioned in sternal recumbency for oesophagoscopy and in sternal or right lateral recumbency for proctoscopy and colonoscopy.

Before the patient is anaesthetised the endoscopic equipment is checked and set up. Once ready, the tip of the insertion tube can be lubricated with water-soluble gel or with oral secretion along its passage through the oral cavity, taking care to avoid the objective lens.

### Sequence of upper GI endoscopic examination

Usually only a quick inspection of the oesophagus and stomach is performed on the way to the duodenum, so that apparent lesions are not confused with artefacts caused by the endoscope. It is believed that a delay in passing the pylorus makes this more difficult with time; therefore, the stomach and oesophagus are re-examined fully at the end of the procedure.

## Oesophagoscopy

After carefully extending the head and neck (hyperextension must be avoided), the insertion tube is passed carefully along the midline of the hard palate through the oropharynx and guided dorsal to the endotracheal tube until the upper oesophageal sphincter (UOS) comes into view (see video 4). The UOS appears as a star-shaped area of folded mucosa dorsal to the larynx (Figure 13). This is a low-resistance sphincter and the tip of the endoscope can easily be passed by applying insufflation and very gentle pressure. The introduction of the endoscope through the oral cavity and into the upper oesophagus can be performed blindly, but visual guidance is preferred. If a rigid endoscope is used it is passed through the oral cavity under strict visual supervision as rigid instruments can all too easily damage the mucosa.

The cervical oesophagus is normally collapsed so a red-out obscures visibility briefly. Insufflation is continued once the UOS is passed, but forward motion is halted until the oesophageal lumen is visible as a straight tube with a slight bend at the thoracic inlet. The tip is adjusted into the centre of the lumen and the endoscope is advanced through the oesophagus in a slow continuous movement (there should be no or very little resistance). To keep the lumen from collapsing, intermittent or continuous air flow is applied as required. Over-insufflation should be avoided. Occasionally, slight manual compression of the upper oesophagus is needed to prevent

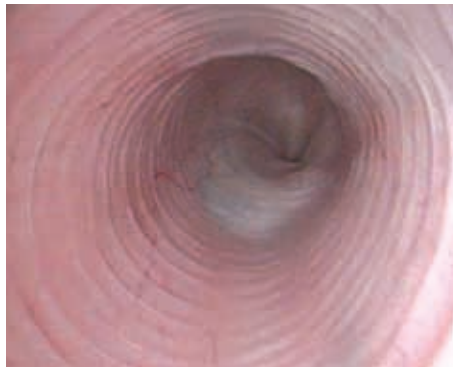


**Figure 13** Endoscopic view of the upper oesophageal sphincter



escape of the insufflated air. Generally, mild insufflation is needed to extend the lumen of the thoracic oesophagus.

While passing the endoscope along the length of the oesophagus the entire mucosal circumference is inspected for mucosal colour, texture and possible pathological lesions, so as not to confuse these with iatrogenic changes when withdrawing the endoscope. A fuller investigation is performed on the way back out of the patient.



**Figure 14** Endoscopic view of the lower third of the oesophagus, showing typical circular wave-like ripples

#### Normal oesophageal mucosa

Normal oesophageal mucosa in the cat is smooth, glistening and pale pink, and superficial mucosal vessels can be seen. As the feline oesophagus is composed of striated muscle in the proximal two-thirds and smooth muscle in the distal third,<sup>19</sup> the distal part has the appearance of circular wave-like ripples, sometimes called the 'herring bone' effect (Figure 14). Over the base of the heart the pulsation of the aorta can be seen (see video 4).

At the gastro-oesophageal junction the oesophagus appears as a slit-like opening that passes obliquely at about a 30° angle through the diaphragm into the stomach. The lower (or gastro-) oesophageal sphincter (LOS) is a high-pressure zone that keeps the stomach closed between swallows. During endoscopy it may be closed or open. To pass the endoscope into the stomach the tip is deflected slightly left and upward and the endoscope is advanced under direct visual inspection with slight pressure and variable air insufflation until the gastric lumen is reached. A short red-out can be seen when passing. Little resistance should be encountered. If forward motion is impeded when entering the stomach it is usually because the tip has missed the LOS. The endoscope should be withdrawn and redirected prior to repeat intubation.

Biopsies are rarely taken of the oesophagus

because the mucosa is very thin and relatively tough. Masses, however, should always be biopsied.

## Gastroscopy

A full examination of all areas of the stomach should be performed in every patient and all landmarks have to be identified properly. The endoscopist needs to be familiar with the luminal gastric anatomy to successfully manoeuvre the endoscope through the stomach, obtain a retroflexed view of the fundus and cardia, advance around the lesser curvature/incisura angularis into the antrum and traverse the pyloric canal into the duodenum. The stomach is only briefly examined on the way in so as to note the gross appearance; a full examination and taking of biopsies is performed after duodenoscopy as prolonged insufflation and examination of the stomach stimulates pyloric closure and makes intubation more difficult.

#### Initial examination

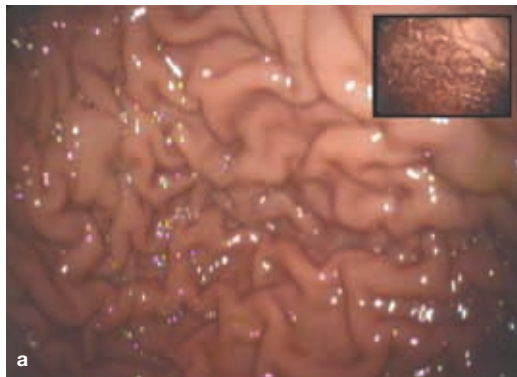
The initial view on entering the stomach is of rugal folds of the stomach's greater curvature (Figure 15a). During this preliminary examination of the stomach it is important to note the gross appearance of the rugal folds, the ease with which the gastric wall distends during insufflation and if fluid or ingesta is present.

#### Normal gastric mucosa

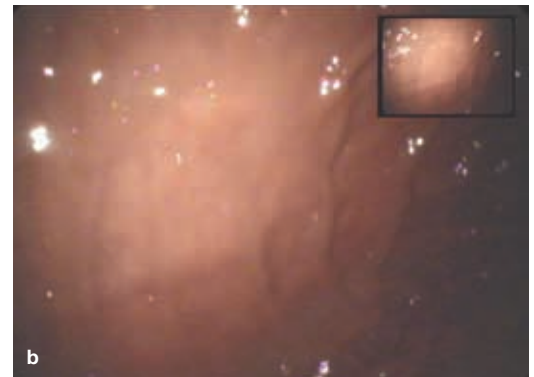
The mucosa of the stomach is pale pink and the rugal folds should separate and stretch easily (see video 5).

In cats the stomach is usually already air filled and the mucosa visible after insufflating the oesophagus. If the stomach is still completely or partially collapsed the mucosa lies close to the tip and the view is quite limited. Before attempting to advance the endoscope further, air is insufflated until the lumen is visible.

The degree of gastric distension is judged by increased flattening of the folds (Figure 15b) – at maximal insufflation, a completely



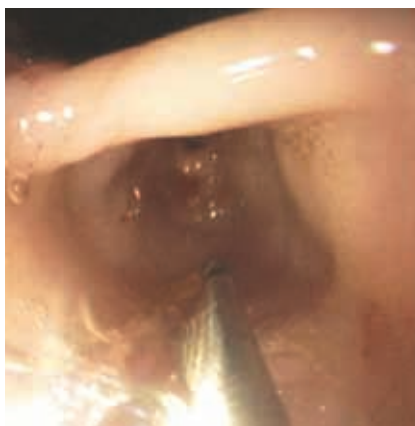
**Figure 15** (a) Clearly visible rugal folds in the stomach when only little air is present. (b) Rugal folds are flattened when air fills the gastric lumen



smooth mucosa is seen. Generally, the least distension necessary to pass the endoscope through the stomach is when the rugal folds are separated and begin to stretch. This allows orientation and identification of gross lesions (ulcers, foreign bodies, masses) while avoiding over-distension, which hinders movement of the diaphragm and potentially risks serious cardiopulmonary compromise. Minimal distension of the stomach at this stage also reduces the likelihood of pyloric contraction, making passage through to the duodenum considerably easier. It furthermore reduces the occurrence of paradoxical movement, whereby a loop of insertion tube pushes the greater curvature away and results in the tip of the insertion tube moving further away from the pylorus as the endoscope is inserted.

If the cat has been properly fasted, the stomach in most cases will be completely empty. A small amount of liquid is not considered abnormal. Large amounts of liquid, especially bilious fluids, may suggest reflux of intestinal fluid into the stomach; this may occur in cats that have been treated with enemas, or that have a gastric motility disorder, duodenogastric reflux disorder or an intestinal obstruction. As bile is irritating to the gastric mucosa, the mucosa may appear reddened if there is significant gastric biliary retention. Small amounts of fluid do not need to be removed for proper evaluation of the stomach, but if a larger amount of fluid obscures the view of the mucosa, this needs to be aspirated. Alternatively, the cat can be gently turned on its back to move the fluid to another position while inspecting the hitherto concealed part of the mucosa. The patient is then returned to left lateral recumbency.

In cats, insufflation can be achieved in mere seconds. If the stomach does not distend the



**Figure 16** Endoscopic view of the incisura

**A full examination of all areas of the stomach should be performed in every patient.**



cause might be a blocked air/water channel port, reflux of air through the oesophagus or gastric wall disease that prevents mucosal distension.

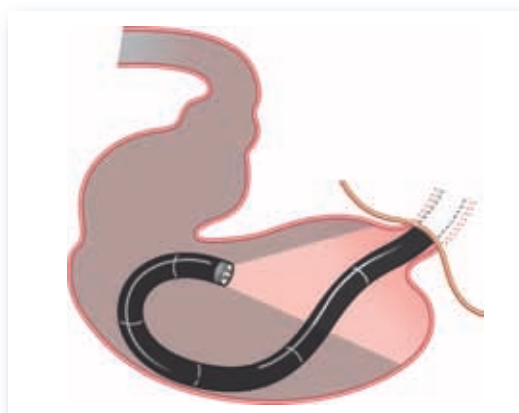
Once correct orientation is achieved the endoscope is advanced along the greater curvature by lifting the tip upward and pushing it gently forward using rotational torque if necessary. With the patient in left lateral recumbency and the endoscope held in the conventional manner, the view is predictable. In order to reach the antrum an important landmark is the incisura angularis (Figure 16). By lifting the tip and advancing the endoscope the incisura comes into view almost automatically. Sometimes the tip has to be deflected down again slightly. The antrum is below the incisura, while the cardia is above it and can be viewed by increased retroflexion of the tip. Once this landmark is reached the endoscope is advanced through the antrum and pylorus into the duodenum.

### Full examination

A complete examination of the stomach is performed following examination and biopsy of the duodenum (see later). First the greater curvature up to the incisura is inspected, then the cardia and fundus, before going into the antrum (see video 5).

To examine the cardia and fundus of the stomach the endoscope needs to be retroflexed (Figure 17). This so-called 'J-manoeuvre' provides a view of the inside of the cardia and the fundus. In cats the J-manoeuvre is started when the endoscope is at the middle part of the gastric body, opposite the incisura angularis. The tip is lifted up (counter-clockwise deflection of inner control knob) and the endoscope is advanced further. First the incisura is visualised directly. This can sometimes not be achieved in cats due to their small size and reduced working space.

By deflecting the tip up almost completely the cardia comes into view. In this retroflexed view the endoscope can be seen entering the stomach (Figure 18). Sometimes this manoeuvre



**Figure 17** Retroflexed endoscope in the stomach



**Figure 18** View of the cardia and fundus provided by a retroflexed (J-manoeuvre) endoscope



**Figure 19** Endoscopic view of the stomach, showing endoscopic artefacts



**Figure 20** (a,b) Different endoscopic appearances of the feline pylorus

vre extends the LOS and air will leak into the oesophagus, necessitating further air insufflation to provide adequate distension. For close-up viewing of the cardia the endoscopist's right hand retracts the insertion tube, thereby pulling the tip towards the mucosa. By applying rotational movement to the insertion tube and turning the outer deflection knob for a lateral view, a circumferential examination of the proximal stomach can be accomplished. While the endoscope is retroflexed slowly the mucosa is further inspected. Leaving the tip in the proximal stomach and turning the deflection controls into a neutral position the body of the stomach is viewed. Alternatively, by advancing the endoscope while the tip is still deflected an additional view of the proximal stomach is provided. When the incisura is reached the tip is straightened until the antrum can be seen.

In cats, the angle of the lesser curvature can

be very acute and a slide-by technique might be necessary to pass into the antrum. This slide-by technique can be used to advance around tight flexures in the stomach or intestine. Using this technique the endoscope tip is deflected in the direction required to follow the lumen. As the deflected tip impinges on the outer radius of the gastric/intestinal bend a red-out is seen. If this red-out seems to be moving it is generally safe to advance until the next straight part, in this case the antrum, can be visualised. With this manoeuvre mucosal damage can occur, leading to linear streaks of hyperaemia or mucosal haemorrhage (Figure 19). Another method to avoid such artefacts is to pre-deflect the tip within the body of the stomach and then advance into the antrum.

The pylorus can generally be readily identified at the antral end of the stomach and has a variety of appearances (Figure 20). The

## Intubation of the pyloric canal

To intubate the pyloric canal the pylorus is always kept in the centre of the endoscopic field of view (see video 6). As the pyloric position changes with respiratory movement and peristalsis, small adjustments by up/down deflection and insertion tube rotation might be necessary. The aim is to move forward continually while readjusting and keeping the pylorus in the centre of view. During intubation of the pylorus red-out frequently occurs and it is often easiest to aim at the darkest area, which usually is the lumen. The field of view is often blurred. Intermittent puffs of air can assist in sliding the tip through the pyloric canal. Often the endoscope tip can be directed into the pyloric canal by turning it slightly left and up (both wheels in counter-clockwise direction) while advancing forward gradually.

Once the tip is inside the pyloric canal the vision is blurred as the pyloric wall closes around the tip. Turning both deflection control wheels clockwise then turns the tip in the direction of the proximal duodenum immediately beyond the pylorus.

**The amount of pressure one dares to exert is a matter of experience and judgement.**

While attempting to advance the endoscope through the narrow pylorus of the cat considerable force may be generated against the pyloroduodenal junction and it may be necessary to have the assistant hold the patient's body in a stable position. In some cases the tip cannot be aligned properly with the pyloric opening. It can still be possible to advance the endoscope by putting the tip against the peripyloric wall and gently pushing the insertion tube forward. The tip often deflects into the pylorus as the area of the orifice stretches by the advancing insertion tube.

The amount of pressure one dares to exert is a matter of experience and judgement. An experienced endoscopist recognises a situation in which it is unlikely that the pylorus can be passed.

It is difficult to pass an endoscope of >9 mm outer diameter through a cat's pylorus; however, a 9 mm diameter endoscope can be passed in most cats. In small cats (<2.5 kg, 5 lb) or cats with a narrow pyloric canal (Siamese, Burmese, Tonkinese) a smaller endoscope of <8 mm is preferred.<sup>20</sup>



pylorus may be persistently closed or can exhibit a variable degree of dilation; sometimes reflux from the duodenum can be observed. Occasionally the location can be difficult to identify because of peristaltic waves, antral masses or fluid obscuring the view. Pyloric folds are extremely rare in cats.

The biggest mistake when trying to advance into the antrum and intubate the pylorus (see box on page 987) is overdistension. With increased intraluminal pressure the stomach assumes a round shape, the antral opening is flattened and antral contractions are stimulated. It then becomes difficult to enter the antrum and find the pylorus. In this case air must be aspirated and the manoeuvre to advance into the antrum repeated with a less inflated stomach.

In those cases in which the pylorus is open, passage can be achieved quite easily. However, the pylorus can be closed tight and offer significant resistance. It is, therefore, imperative to carefully monitor the cat's heart and respiratory rate, especially during difficult passages in which the pyloroduodenal junction and proximal duodenum might be stretched and distorted. Transient bradycardia secondary to an increase in vagal tone and/or respiratory depression may occur.<sup>18</sup> If the endoscopic procedure results in significant cardiopulmonary compromise, the endoscope should be withdrawn, the stomach emptied of air and the patient stabilised, before another attempt is made.

## Duodenoscopy

Once the junction of the pylorus to the duodenum is reached the mucosal colour changes from pale pink to pinkish red (Figure 21). If the lumen is not clearly visible at this point insufflation might be necessary to distend the intestinal lumen. Further gentle advancement usually provides a view into the descending duodenum, seen as a straight tunnel. In some cases minor forward or backward adjustments are needed to free the tip from the mucosa. If these manoeuvres do not provide a clear view of the intestinal lumen, the endoscope is retracted under constant insufflation until the view can be obtained. No forward movement should be attempted without clear visualisation and no force should be used.

The endoscope can usually be advanced easily through the descending duodenum to the caudal duodenal flexure and almost always up the ascending duodenum and into the proximal jejunum.

Variable degrees of insufflation are required to maintain luminal distension and a clear view of the mucosa. As there is already a bend

in the endoscope's insertion tube in the stomach, forward movement in the descending duodenum can in some cases be facilitated by withdrawing the endoscope slightly, thereby reducing the loop in the stomach. Forward movement is sometimes accelerated at this point and great care must be taken not to move the tip against the mucosal surface. While the insertion tube is slowly advanced the intestine is closely examined to assess the appearance of the mucosal surface and to observe for lesions. To obtain circumferential views the insertion tube can be rotated around its longitudinal axis.

After reaching the pelvic flexure of the duodenum, the duodenum ascends a short distance before reaching a ventrally directed bend. This bend is the juncture between the duodenum and jejunum. Gradual advancement of the endoscope can be continued as long as the lumen can be viewed clearly and no resistance is met. Because the curves of the intestine move easily only minor adjustments in tip deflection are required. In some cats the loop in the stomach cannot be straightened and pyloric resistance remains high, preventing further advancement past the pelvic flexure of the duodenum. Sometimes massaging the intestinal loops transabdominally relaxes the intestinal musculature and may help to facilitate further examination. As soon as resistance is met the endoscope should be retracted.

The mucosa continues to be closely examined and biopsies are taken along the way.

### Normal duodenal and jejunal mucosa

The colour of the normal feline duodenal and jejunal mucosa is cream to slightly reddish pink and the presence of the villi gives it a velvety to villous appearance. Peyer's patches (aggregated lymphoid nodules), which can routinely be seen in the canine duodenal mucosa, are not as readily identifiable in cats, although aggregated lymphoid nodules do occur.

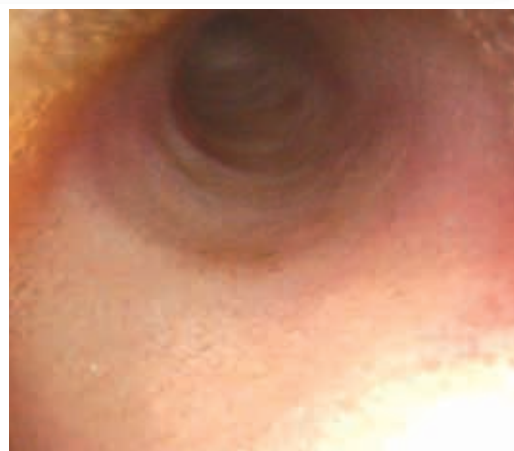
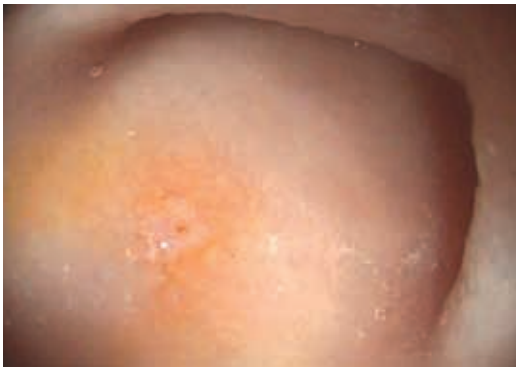


Figure 21 Endoscopic view of normal feline duodenum



**Figure 22** Endoscopic view of the duodenal papilla

The major duodenal papilla, which represents the combined opening of the pancreatic and the biliary ducts, is located close to the convex curve formed by the antrum, pylorus and proximal duodenum. It is a round to oval disc, 1.5–2 mm in diameter, and appears almost white against the surrounding reddish mucosa (Figure 22). As the endoscope is retracted through the proximal duodenum and pyloric canal this area is closely inspected as it will not have been viewed on the way in. Pyloric ulcers or tumours can be detected during this examination.

After completion of the upper GI endoscopy procedure, the stomach is completely deflated using suction. If there is gastric content (bile, liquid, food) in the oesophagus this needs to be aspirated or lavaged to prevent aspiration during recovery from anaesthesia and to prevent oesophagitis and possible stricture formation at a later date. The cat has to be supervised closely during recovery and the endotracheal tube is removed as late as possible.

### Colonoscopy and proctoscopy

First a digital rectal examination is performed to ensure that a rectal mass or stricture is not missed. The endoscope is well lubricated up to a length of about 20 cm and inserted 1–2 cm into the rectum. Air insufflation is started while an assistant closes the perianal tissue



**Figure 23** Lymphoid follicle (arrow) in the mucosa of the colon; faecal material is visible towards the 5 o'clock position

tightly around the insertion tube to prevent air leakage. Enough air is insufflated to distend the rectal and colonic lumen so that the colon is seen as a 'tunnel' and the colonic mucosal folds straighten. A partial fold separates the rectum from the descending colon but straightens almost completely with air insufflation. An inability to distend the colonic lumen may indicate severe fibrosis with chronic inflammation, the presence of a stricture or inadequate closure of the anal canal.

With intermittent or constant air insufflation (as needed) the endoscope is slowly advanced as far as possible up the colon. The tip of the endoscope is kept in the centre of the lumen by turning the inner angulation knob and by rotational torque of the endoscope. No, or only minor, resistance should be encountered. If the centre of the lumen cannot be seen the endoscope is slowly withdrawn while more air is insufflated until the mucosa is visible again.

As the endoscope is advanced through the descending colon the mucosa is inspected and lesions noted.

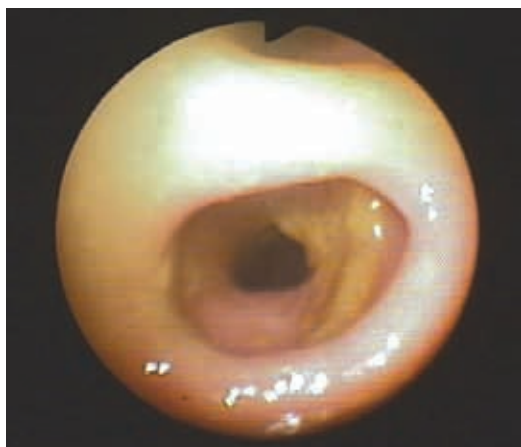
#### Normal colonic mucosa

The colonic mucosa is pale pink, smooth and glistening, and submucosal blood vessels can usually be seen throughout the entire colon. Lymphoid follicles, with a diameter of 2–3 mm and an umbilicated centre, may be visible in the mucosa (Figure 23).

Hyperaemia should be carefully interpreted. While it may indicate mucosal inflammation, it can also occur secondarily to warm water enema, and trauma from the rubber tube or endoscope.

The flexure at the junction of the descending colon and transverse colon represents an approximate 90° change in direction upward (from left to right), but may also be less distinct and less than 90° in cats. To enter the transverse colon the tip of the insertion tube is advanced almost against the mucosa of the flexure's outer curve. Air is insufflated and the tip deflected gradually up while the endoscope is advanced until the 90° bend is achieved. Visualisation might be lost for a brief moment until the transverse colon is entered and distended by insufflation.

In most cats, insufflation of the descending colon leads to distension of the complete large intestine. Once the endoscope is in the transverse colon the tip is straightened and centred in the middle of the lumen. If the lumen of the transverse colon is not visible, slight rotational torque and angulation of the outer deflection knob will often help to obtain 'tunnel vision'. The endoscope is then advanced slowly up to the flexure marking the beginning of the ascending colon. The endoscope should slide easily along the mucosa. However, as the



**Figure 24** Ileocolic junction with a view of the entrance into the ileum. The opening to the caecum is at the 12 o'clock position

feline intestinal tract is very pliant, manual support of the endoscope's insertion tube from the outside might be needed in some instances. The transverse colon of the cat is very short (2–4 cm) and the flexure to the ascending colon again may be less distinct than in the dog. Advancement around this flexure is achieved by a similar technique to that used to navigate into the transverse colon, but the tip must now be deflected caudally.

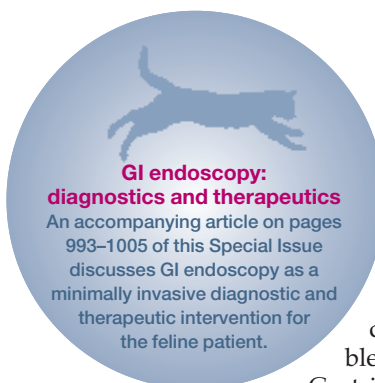
The feline ascending colon is equally short (about 1–2 cm) and at the end the ileocolic sphincter enters in a slit-like opening (Figure 24) adjacent to the caecocolic junction. Due to the small ileal diameter, ileal intubation is rarely possible in cats, unless using a paediatric gastroscope (<5.5 mm insertion tube diameter). If it is attempted, extreme caution is warranted to prevent colonic rupture. If necessary, blind biopsies can be collected from the ileum. The caecocolic junction is usually completely or partially open in cats and, as the caecum is short (1–3 cm), it can be inspected fully without entering its lumen.

Biopsies are taken on the way out. A perpendicular orientation of the forceps to the mucosa can only be achieved at the flexures, in the caecum and from luminal masses. Care has to be taken not to cause a caecal inversion when biopsies are taken. Most areas of the feline colon must be sampled tangentially to the mucosa. The risk of biopsy-related colonic perforation is increased with rigid colonoscopy and the use of angulated tip forceps parallel to the endoscope.

At the end of the lower GI endoscopy procedure, the endoscope is completely withdrawn; evacuation of the air in the colon is achieved by cessation of anal compression. Insufflation of the large intestine can result in distension of the small intestine and ultimately of the stom-

## KEY POINTS

- ❖ Endoscopy is an integral part of the evaluation of the gastrointestinal (GI) system in feline patients.
- ❖ It is minimally invasive and almost atraumatic with a low risk of procedure-related morbidity and mortality in the hands of an experienced clinician.
- ❖ It should only be performed if less invasive procedures (eg, laboratory testing and diagnostic imaging) have been non-diagnostic, including trial therapy (diet, anthelmintics, antibiotics).
- ❖ Obtaining biopsies is an integral part of GI endoscopy and should be undertaken in every cat, regardless of macroscopic appearance.
- ❖ It is vital for the clinician to understand the difference between normal and abnormal findings.



ach, leading to potential respiratory distress. If overdistension of the stomach has occurred, it can be relieved by passing a tube into the stomach and evacuating passively or by attaching the tube to a suction pump. During recovery from anaesthesia the cat is supervised closely and extubated as late as possible, as some animals tend to vomit.

Gastric evacuation makes vomiting much less likely.

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## Conflict of interest

The authors do not have any potential conflicts of interest to declare.

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# GASTROINTESTINAL ENDOSCOPY IN THE CAT

## Diagnostics and therapeutics

Reto Neiger, Elise Robertson and Christiane Stengel

### Role of endoscopy in GI disease

Nowadays, flexible endoscopy is a routine procedure in the diagnostic work-up of cats with gastrointestinal (GI) signs, such as retching, regurgitation, vomiting or diarrhoea, albeit one that should be used only after less invasive procedures have failed to yield a final diagnosis. The results of abdominal palpation, haematology, biochemistry (including plasma thyroxin levels, trypsin-like immuno-reactivity and vitamin B<sub>12</sub> levels), complete faecal analysis (including *Giardia* species and *Trichostrongylus axei*) and, as in all sick cats, feline leukaemia virus and feline immunodeficiency virus testing should always be assessed. Appropriate diagnostic imaging such as plain or possibly contrast radiographs and, most importantly, abdominal ultrasound should also contribute to a full GI system evaluation.

It is important to be aware that endoscopy has some major limitations in the investigation of many GI problems. Motility abnormalities, functional diseases (dietary hypersensitivity, antibiotic-responsive disease, etc), lesions outside the GI tract (liver, pancreas, etc) or even submucosal disease cannot be visualised endoscopically; nor is it possible to investigate the entire GI tract with flexible endoscopes currently available.

If indications are well chosen, the equipment is appropriate and the clinician experienced in the procedure, endoscopy can help to diagnose many diseases in the oesophagus, stomach and intestine, and to treat some problems minimally invasively.

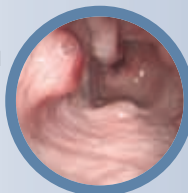


**Practical relevance:** Endoscopic examination of the feline gastrointestinal (GI) tract is a minimally invasive method for obtaining biopsy samples of the GI mucosa, which is often necessary for a diagnosis of chronic GI diseases. In addition endoscopy has several therapeutic indications including foreign body retrieval, oesophageal stricture dilation and placement of a percutaneous gastrostomy tube.

**Clinical challenges:** Initially, practitioners must learn the subtle manipulations necessary to efficiently guide the endoscope through the GI tract to obtain biopsy samples of high diagnostic quality, and develop skills for implementing interventional procedures (eg, foreign body removal). Another challenge in mastering GI endoscopy is the ability to recognise normal from abnormal, which requires many years of practice and experience. Endoscopy is a diagnostic and interventional procedure that should be performed only in conjunction with a thorough history, physical examination, appropriate laboratory evaluation, and radiographic and/or ultrasonographic imaging.

**Audience:** This review is intended to familiarise both the general and referral practitioner with GI endoscopy as a minimally invasive diagnostic and therapeutic intervention for the feline patient.

**Evidence base:** The guidance contained within this article is based on a combination of the published literature, the authors' personal experience and the experience of colleagues.



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If the indications are well chosen, however, the equipment is appropriate for the patient, and the clinician is experienced in the procedure, endoscopy can not only help to diagnose many diseases in the oesophagus, stomach and intestine, but may even help to treat some problems minimally invasively.

Flexible GI endoscopy has the major advantage over exploratory coeliotomy of allowing one to precisely access areas of pathology and take multiple biopsies from these areas in a minimally invasive manner. There are rarely complications associated with wound healing or dehiscence (particularly in cats with low serum protein concentration) and thus animals can be treated immediately with immunosuppressive drugs, especially steroids.

### Diagnostic endoscopy

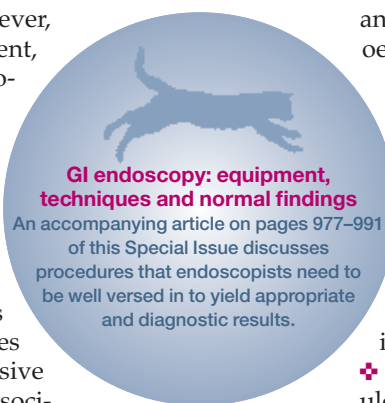
Most commonly, the clinical signs and preliminary diagnostics will dictate if an oesophagoscopy, gastroduodenoscopy or colonoscopy procedure is needed. It is unknown whether complete endoscopy of the upper and lower GI tract is as commonly indicated in cats as it is in dogs.

## Oesophagoscopy

Overall, oesophageal diseases are uncommon in cats and represent about 0.05–1% of all admissions in a referral situation.<sup>1,2</sup> Common clinical signs that might necessitate an oesophagoscopy are retching, dysphagia, regurgitation and possibly ptyalism; it should be remembered, however, that differentiating vomiting from regurgitating in cats can be difficult and is often not possible for owners.

Plain radiographs of the thorax should always be obtained in cats with these clinical signs and may diagnose a radiodense foreign body or gas/distension around a possible non-radiodense foreign body, megaesophagus, gastro-oesophageal intussusception<sup>3</sup> or mediastinal mass. Contrast radiographs with liquid contrast (iodine-based or barium) or contrast agent mixed with food might be indicated in some cats and several abnormalities such as a stricture, radiolucent foreign body, vascular ring anomaly, gastro-oesophageal intussusception or tumour can be diagnosed with this modality. A swallow study (fluoroscopy) is needed to diagnose functional oesophageal motility problems, which can occur in cases of dysautonomia or dystrophic myopathy, or may be idiopathic.<sup>2</sup>

If the problem cannot be diagnosed by these various means, endoscopy may be indicated



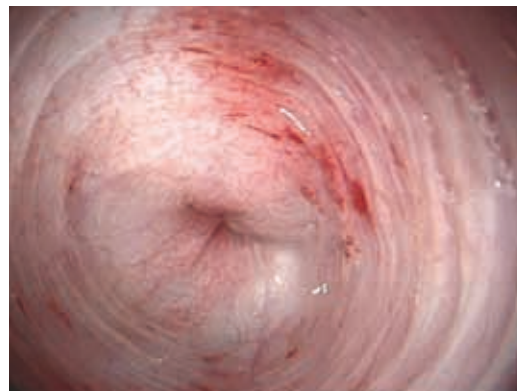
and is the only modality that will diagnose oesophagitis.

Possible abnormalities found during oesophagoscopy are summarised below. The exact location of an oesophageal lesion is difficult to ascertain unless it is directly over the base of the heart where pulsation of the aorta can be seen. To record abnormal findings, the distance from the upper incisors should be 'guesstimated' based on the length markings on the endoscope.

❖ Mucosal erythema, irregularity, erosion and ulceration indicate an **oesophagitis** (Figure 1).

❖ A **stricture** is characterised by a circumferential narrowing, commonly in the exact centre of the lumen, which cannot be passed (Figure 2). It is important not to confuse this with difficulties in passing the cardia, which might be a problem in some cats.

**Figure 1** Oesophagitis in an 11-year-old domestic shorthair cat with a history of 2 months of vomiting and pre-treatment with long-acting dexamethasone



**Figure 2** Oesophageal stricture in a 1-year-old cat 4 weeks after clindamycin tablet administration

### Possible abnormalities that may be identified during oesophagoscopy in cats

- ❖ Oesophagitis (due to drugs [doxycycline, clindamycin], chemical ingestion, reflux, foreign body)
- ❖ Eosinophilic oesophagitis
- ❖ Stricture (see oesophagitis)
- ❖ Foreign body (trichobezoar, fish hook, toy, bone, etc)
- ❖ Tumour (squamous cell carcinoma, lymphoma, undifferentiated sarcoma, others)
- ❖ Vascular ring anomaly
- ❖ Gastro-oesophageal intussusception
- ❖ [Megaesophagus]



**Figure 3** Adenocarcinoma of the oesophagus in a 6-year-old domestic shorthair cat with a 3 week duration of regurgitation

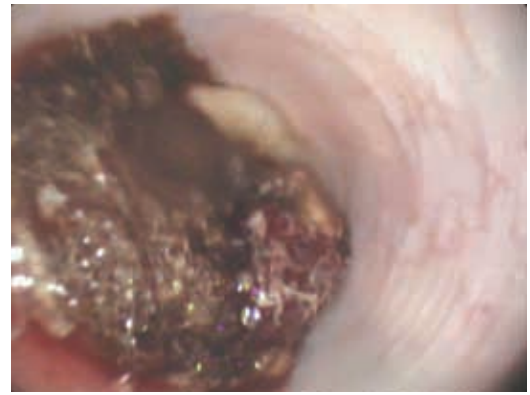
❖ **Tumours** of the feline oesophagus are rare. They mostly present as masses protruding into the lumen (Figure 3), which tend to be ulcerated and friable. Sometimes oesophageal lymphoma may appear simply as a very irregular mucosa with a 'cobble-stone' appearance.

❖ **Foreign bodies** (Figure 4) are readily diagnosed and can often be removed endoscopically (discussed later).

❖ An extraluminal compression can be due either to a mass in the mediastinum (lymphoma, cyst, thymoma) or a **vascular ring anomaly** (eg, persistent right aortic arch). While, in the former, bulging of the mucosa with cranial dilation is visualised, the latter often has a typical band crossing the oesophagus with a cranial diverticula (Figure 5).

❖ Protrusion of gastric rugal folds into the oesophagus is the hallmark of a **gastro-oesophageal intussusception**.

❖ Generalised dilation of the entire oesophagus is the definition of a **megaesophagus** and is a rare finding in cats. This problem, which might be secondary to dysautonomia or myasthenia gravis, is commonly diagnosed on plain or contrast radiographs. Oesophagoscopy is rarely indicated and may even be contraindicated due to the high risk of aspiration pneumonia during induction or recovery from



**Figure 4** Blood clot in the oesophagus of a cat with marked oral bleeding

**Figure 5** Endoscopic view of the oesophagus of a 1-year-old cat with persistent right aortic arch. A band compressing the lumen from the outside can be seen from the 6 o'clock to 2 o'clock position in a clockwise rotation



**Common clinical signs that might necessitate an oesophagoscopy are retching, dysphagia, regurgitation and, possibly, ptyalism.**

#### Recording of findings

All findings, normal and abnormal, should be carefully recorded immediately after any endoscopy procedure. Besides photographic recording (if possible), the clinician should report the entire procedure in detail.

❖ Standardised reporting forms can be downloaded from the GI Standardization Group at <http://www.wsava.org/guidelines/gastrointestinal-guidelines>

anaesthesia. A dilated oesophagus during air insufflation is difficult to differentiate from a dilated oesophagus due to a megaesophagus. Froth, fluid and fermenting food might be seen in megaesophagus, together with signs of oesophagitis. Furthermore, it might be difficult to pass through the lower oesophageal sphincter as the endoscope might be diverted into some blind-ending folds, or a diverticulum.

#### Gastrosocopy

The most common indication for gastroscopy is chronic vomiting for which a diagnosis cannot be achieved with laboratory or diagnostic imaging methods and therapeutic trials. Acute vomiting is rarely an indication unless a foreign body is suspected and requires immediate intervention, or there is severe haematemesis which is unresponsive to medical management. Other indications for gastroscopy in cats might include undiagnosed weight loss, anorexia, nausea/ptyalism or melaena.

In the normal stomach, rugal folds, which run in parallel towards the antrum, are easily distended with air. The endoscopist should be careful to avoid overdistension, which is not an uncommon problem.



**Figure 6** Gastroscopic views of foreign bodies. (a) Ear plug in the stomach of a 2-year-old Maine Coon cat. (b) Trichobezoar in the antrum of a 15-year-old cat



The most common abnormalities seen during gastroscopy are **foreign bodies** (including trichobezoars, Figure 6), and **irregular mucosa** (petechial haemorrhage, erosions, friable, cobble-stone appearance) (Figure 7). Ulcers (Figure 8) are also seen, but are rare in cats.<sup>4</sup> Food in the stomach >12 h post-feeding indicates a motility problem. This might be a primary pathology, but is more commonly identified secondarily to gastritis or other inflammatory GI conditions.



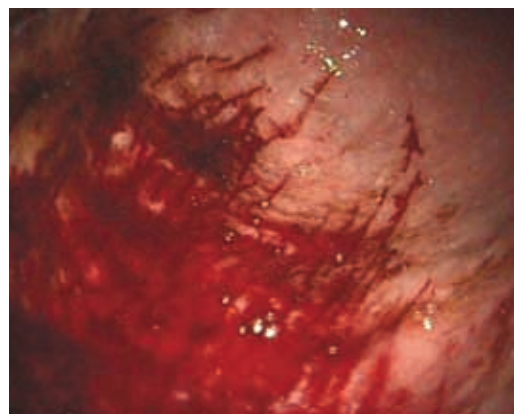
**Figure 7** Irregular mucosa with cobble-stone appearance in the greater curvature of a 10-year-old domestic shorthair cat. In the background, towards the 3 o'clock position, the entrance to the antrum can be seen. The cat had histologically marked lymphoplasmacytic gastritis

**Acute gastritis** in cats can be due to ingestion of plant material, drugs (eg, non-steroidal anti-inflammatory drugs [NSAIDs], steroids, antibiotics), dietary indiscretion, 'stress' or any severe disease and hypotension. Normally endoscopy of the stomach in these patients is not necessary and symptomatic therapy with a proton pump inhibitor, sucralfate, an antiemetic drug and dietary management is all that is required.<sup>5</sup> The endoscopic appearance in cases of acute gastritis might be completely normal, or

might show petechial bleeding and erosions, especially in the antrum (Figure 9).



**Figure 8** (a) Typical ulcer with rim can be seen (2 o'clock position) close to the entrance to the antrum (towards the 11 o'clock position). Lymphoma was diagnosed by histology. (b) Small ulcer in the incisura angularis (top towards fundus, bottom towards antrum), which proved histologically to be an adenocarcinoma



**Figure 9** Acute gastritis with severe bleeding in a 12-year-old domestic shorthair cat with vomiting and an invasive cutaneous adenocarcinoma



The most common indication for gastroscopy is chronic vomiting for which a diagnosis cannot be achieved with laboratory or diagnostic imaging methods and therapeutic trials.



## Collection of endoscopic biopsies of both normal and abnormal areas of the stomach for histopathological examination is mandatory in all cats undergoing diagnostic gastric endoscopy.

**Chronic gastritis** is much less well studied in cats than in dogs and is part of the inflammatory bowel disease (IBD) complex (Figure 7). As in acute gastritis, the mucosa often looks normal but may appear irregular, friable or show petechial or larger areas of haemorrhage. For this reason, collection of endoscopic biopsies of both normal and abnormal areas of the stomach for histopathological examination is mandatory in all cats undergoing diagnostic gastric endoscopy. Gastric biopsies could also be further evaluated for a *Helicobacter* species infection (by CLOtest, impression smear, etc). However, it is most likely that spiral organisms do not play a pathogenic role in cats.<sup>6</sup>

**Peptic ulcers** in the stomach of cats have rarely been reported.<sup>4</sup> However, the most common causes appear to be tumours (Figure 8) and NSAID ingestion. When biopsies are taken, it is important to harvest them from the rim and not from the centre of the lesion; firstly because of the inherent risk of perforating the stomach and, secondly, because histology of the central portion would normally only reveal necrosis and may fail to identify underlying neoplasia.

Masses in the stomach can either be benign, such as **polyps** (Figure 10), or malignant, most commonly **lymphoma**. While the former generally are smooth and small, and the latter is often associated with irregular, potentially ulcerated mucosa, and can be of variable size, only a histological examination can differentiate benign from malignant masses.



**Figure 10** Gastric polyp (arrow) in the antrum of a 6-year-old domestic shorthair cat with chronic vomiting

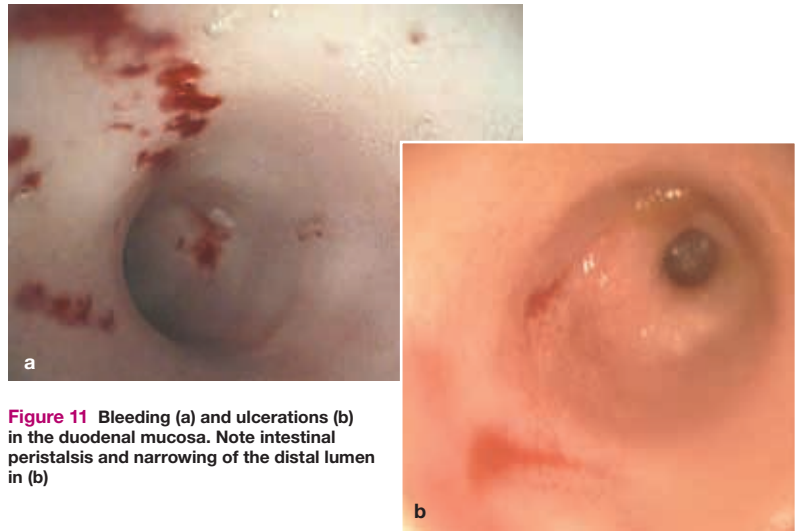


## Duodenoscopy

Duodenoscopy is mostly performed as part of an upper GI endoscopy procedure – oesophago-gastro-duodenoscopy. Besides those indications already mentioned under gastroscopy, chronic diarrhoea, weight loss, abdominal pain and thickened bowel loops on physical examination are common presentations for which duodenoscopy is indicated in cats. Like all endoscopic procedures, duodenoscopy should only be performed if other procedures have not provided a diagnosis or improvement in clinical signs.

Potential abnormal findings are inflamed mucosa with increased friability, granularity/areas of focal bleeding (Figure 11a), mass, foreign body, ulcer (Figure 11b), intussusception and parasites. Unfortunately, there is often a marked discrepancy between the macroscopic appearance and final histological diagnosis – underlining the critical importance of collecting biopsies during all endoscopic examinations. Differentiation between lymphoplasmacytic IBD and small-cell lymphoma is difficult and should be confirmed by immunohistochemistry.<sup>7</sup>

Intestinal parasites should not be seen in a patient treated with appropriate anthelmintics prior to undergoing endoscopic examination. Nevertheless, both roundworms and tapeworms can be encountered and typically try to move away from the endoscope tip.



**Figure 11** Bleeding (a) and ulcerations (b) in the duodenal mucosa. Note intestinal peristalsis and narrowing of the distal lumen in (b)

In the duodenum, there is often a marked discrepancy between macroscopic appearance and final histological diagnosis – underlining the critical importance of collecting endoscopic biopsies.





**Figure 12** Bleeding colon in a 10-year-old domestic shorthair cat with signs of large bowel diarrhoea. Histologically, a moderate lymphoplasmacytic infiltration was seen

## Colonoscopy

Large intestinal disease in cats commonly results in large bowel diarrhoea or constipation. It must be remembered that vomiting is another frequent complaint in cats with large bowel disease.<sup>8</sup> Furthermore, haematochezia can be due to local problems in the large intestine or anorectal disease, and must be differentiated from generalised coagulopathies. Once again, a thorough investigation for systemic disease is warranted for all these problems, including haematology, biochemistry, coagulation testing, faecal analysis (sedimentation, ELISA, PCR, fungal culture) and diagnostic imaging.

In cats with constipation the most common aetiologies are idiopathic megacolon (62%), pelvic canal stenosis (23%) and neuropathies (6%)<sup>9</sup> – none of which require colonoscopy for a diagnosis. Nerve injury, Manx cat sacral nerve deformity, dysautonomia, perineal hernia, intestinal foreign bodies, dietary indiscretion/hypersensitivity, anal, rectal or colonic atresia and prostatic diseases are other, rare causes of constipation/obstipation in cats, which can generally be diagnosed without endoscopy.

The commonest large intestinal disease in cats is some form of colitis. This can be limited to the colon or may be part of IBD of the entire intestinal tract. As mentioned earlier, macroscopic appearance can range from fairly normal to markedly irregular, with friable thickened mucosa and lymphoid hyperplasia (Figure 12). This can undoubtedly be grossly mistaken as neoplasia; thus it is essential to collect an adequate number of biopsies and not to overinterpret the gross visual picture.

Colonic tumours, especially lymphoma, can look identical to inflammatory colitis and must be differentiated by histopathology, and often immunohistochemistry, for definitive diagnosis. Other large intestinal tumours in cats include adenocarcinoma and leiomyosarcoma,

**Colitis can be mistaken for lymphoma. It is, therefore, essential to collect an adequate number of biopsies and not to overinterpret the gross visual picture.**



**Figure 13** Irregular mass in the colon of a 13-year-old Abyssinian cat with haematochezia, which proved to be an adenocarcinoma

both of which are more focal and often invade the lumen, producing an irregular proliferative appearance (Figure 13). Obtaining diagnostic biopsies might be difficult in both as superficial samples will often only reveal inflammation.

Other rare findings in cats include ileocolic or ileocaecal intussusception (often diagnosed by ultrasound prior to endoscopy) and rectal stricture.

## Therapeutic endoscopy

Besides its diagnostic purposes, endoscopy is also used for therapeutic intervention and management. This mainly includes removal of foreign bodies from the oesophagus and stomach, stricture dilation and feeding tube placement, and these procedures are discussed in turn below.

Endoscopic placement of stents has rarely been performed in the GI tract,<sup>10,11</sup> but might become more important in the future when adequate biodegradable stents are available.

Other therapeutic endoscopic techniques have been used infrequently, such as endoscopic jejunoscopy placement, balloon dilation of a rectal stricture,<sup>12</sup> or polyp removal. In addition, endoscopic laser surgery will surely become useful in the GI tract when this technique becomes more available. For a review of these rarer procedures, the reader is referred to other texts.<sup>13</sup>

## Foreign body removal

Due to their fastidious eating behaviour, GI foreign bodies are much less common in cats compared with dogs. Nevertheless, a variety of objects can be found in the oesophagus, stomach (Figure 6) and intestine. Endoscopy for foreign body removal from the oesophagus and stomach is approached in an identical manner to diagnostic endoscopy. Before the procedure is initiated, however, the endoscopist must evaluate if the procedure can be performed successfully by assessing the type (sharp ends, needle, ball) and size of the foreign object, the available retrieval instruments, as well as their own experience.

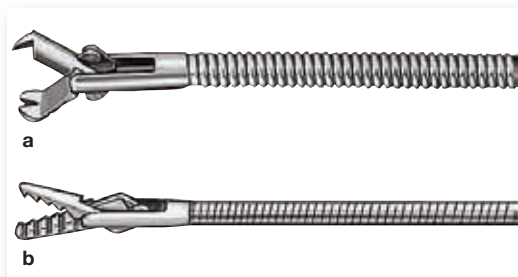
**Foreign bodies that are not candidates for endoscopic removal**

Oesophageal and gastric foreign bodies that can rarely be removed endoscopically include large/wide trichobezoars, rubber objects that have been in the stomach for prolonged periods of time, large round objects (stones) or fish hooks with three-barbed hooks. Foreign bodies in the intestine that are rarely removable endoscopically include thread or cloth passing the pylorus, both of which pose a major risk of intestinal plication during attempted removal.

Various foreign bodies can rarely be removed endoscopically (see box) and, certainly, it is clinically unwise to make a prolonged attempt to retrieve an object that could be removed via exploratory surgery (potentially without even opening the stomach) in a fraction of the time.

In general, however, endoscopic foreign body removal is much quicker than surgery in the hands of an experienced clinician, requiring normally less than 30 mins from the point of anaesthesia induction. Other advantages of endoscopy over surgery are minimal invasiveness and rapid discharge from the clinic. Owners must be made aware of potential complications (unsuccessful procedure, oesophageal perforation) and thus should provide consent for surgical intervention during the same anaesthesia in these cases. In cats with severe oesophagitis following foreign body removal, placement of a temporary gastrostomy feeding tube should be strongly considered (see later) and ideally should be discussed with the owner prior to performing the procedure.

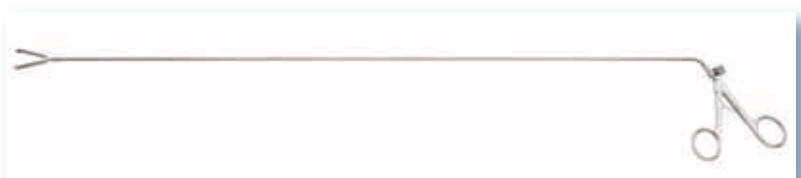
Foreign body removal instruments can either pass through the working channel or are pushed alongside the endoscope. Rat tooth forceps, alligator forceps (Figure 14), multi-prong forceps, basket forceps and snares are available for 2.8 mm working channels and most of them for 2.0 mm working channels. While it is not necessary to have all of these instruments available, with one type of prong and one type of grasper many objects can be successfully removed.



**Figure 14** Foreign body retrieval instruments that can be used through the working channel of a flexible endoscope: rat tooth forceps (a) and serrated-edge alligator forceps (b). ©2013 Courtesy of KARL STORZ GmbH & Co KG



**In the hands of an experienced clinician, endoscopic foreign body removal is generally much quicker than surgery, normally requiring less than 30 mins from the point of anaesthesia induction.**



**Figure 15** Foreign body grasping instrument (length 60 cm) that is used alongside the endoscope for retrieval of bones and other large objects. ©2013 Courtesy of KARL STORZ GmbH & Co KG

The choice of instrument lies mainly in the hands of the endoscopist and sometimes different instruments will need to be tried to grasp the object satisfactorily. It is of paramount importance that no foreign object is ever pulled into the working channel of the endoscope and that the endoscope is not damaged by the prongs if they are used alongside the insertion tube. Foreign body prongs used in this way have a much better gripping strength, with the endoscope used solely to visualise the object. These must be small enough to pass alongside the endoscope without traumatising the cat's oesophagus.

A very long and sturdy instrument has recently become commercially available and may help ease the removal of more complicated foreign bodies (Figure 15). Other instruments that can be used in a similar manner are laparoscopic grasping forceps. A plastic overtube (eg, old endotracheal tube cut to size) can help to protect the mucosa and endoscope during the removal of sharp and pointed objects (eg, needles, fish hooks). The endoscope is introduced through the tube and the object is pulled into the lumen of the tube. The endoscope, object and tube are then removed as one unit.

**Oesophageal foreign body**

Cat owners will often be aware of the possibility of an oesophageal foreign body causing clinical signs such as retching or gagging. Since needles and fish hooks may still have thread or line attached, careful sublingual inspection should be performed during the clinical examination. The thread or line should never be cut until the foreign body has been removed, irrespective of the technique used. Thoracic radiographs must be carefully inspected for pneumomediastinum and/or fluid accumulation indicating potential oesophageal perforation.



Foreign body removal is approached in a similar way to diagnostic oesophagoscopy. The cat is placed in left lateral recumbency so that the oesophagus is positioned above the aorta. A careful inspection of the mucosa for potential foreign body-related injury is undertaken during air insufflation. In the case of a perforated oesophagus, respiratory compromise may occur and should be anticipated. Once the foreign body has been visualised it should be gripped firmly with a foreign body grasper or forceps. Pointed objects are initially pushed aborally to dislodge them from the mucosa and then the pointed tips are grabbed and pulled towards the endoscope. While some traction is needed, force should never be used to remove a foreign object. Careful rotational torque may help to dislodge bony objects. If a foreign body grasper is used alongside the endoscope, the endoscope should first be withdrawn. Rarely, the foreign object is lost just before passing the upper oesophageal sphincter – in these cases it is best to remove the object with a long curved grasping forceps under laryngoscopic control.

After removal, the oesophagus should be inspected for mucosal damage caused by lodgement of the object and/or its removal. Moderate to marked oesophagitis is treated with oral liquid sucralfate; steroids are most likely not helpful. In severe cases a gastrostomy feeding tube should be considered.

### Gastric foreign body

Foreign objects are uncommon in the stomach of cats. While not all such foreign bodies are the cause of clinical signs, and some may be incidental findings during diagnostic imaging, gastric foreign bodies normally require removal. Immediately after induction of anaesthesia, and just before endoscopy, a control abdominal radiograph should be taken to ascertain that the object has not moved into the small intestine.

While endoscopy for gastric foreign body removal is started in left lateral recumbency, it may be necessary to rotate the cat to dorsal or even right lateral recumbency should visualisation or grabbing of the object be difficult. This is commonly the case when the object lies in the fundus directly adjacent to the cardia; due to the small size of the feline stomach, the endoscope sometimes bypasses the object and grabbing is not possible when the animal is positioned on its left side.

The object dictates the type of removal instrument used. Sharp objects are removed as discussed above for oesophageal foreign bodies – a rubber tubing sleeve over the endoscope can assist with retrieval and protect the mucosa of the stomach and oesophagus from lacerations. Stones or rubber objects (both rare

in cats) are grabbed with a basket or prong forceps. Pulling them through the cardia may be difficult – it is easiest to have the object as close to the endoscope as possible. Pulling both as a single unit slowly, with intermittent/simultaneous insufflation, will eventually assist in removal.

### Duodenal foreign body

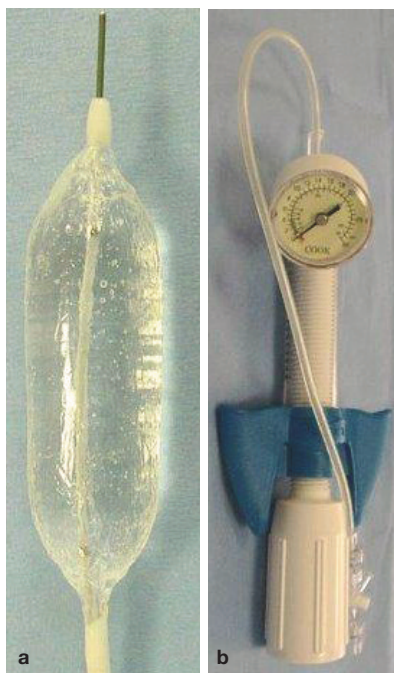
It is very uncommon to be able to grab and remove foreign bodies from the duodenum in cats. These objects need surgical removal as many complications are possible, such as perforation and intussusception. Duodenal foreign bodies may also be simply too large or too out of reach to properly grasp for safe removal.

### Stricture dilation

Once inflammation of the oesophagus extends deeply enough into the muscularis mucosa, healing may result in intramural fibrosis and subsequent stricture formation (Figure 2). In cats, the most common underlying causes are potentially ulcerogenic drug formulations (eg, doxycycline and clindamycin) and their retention within the oesophagus, and foreign body trauma (eg, trichobezoar). Reflux during anaesthesia or ingestion of caustic substances as a cause of oesophageal stricture is a very rare finding in cats. While bougienage has been described to dilate oesophageal strictures, this has largely been replaced by balloon catheter dilation.<sup>14</sup> This procedure, which

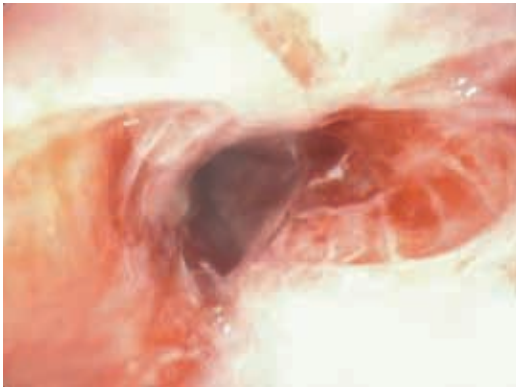
involves dilating a balloon within the stricture to cause stretching and tearing, is quick and safe, resulting in few complications if performed carefully.

Used cardiac balloon catheters are cheap and very effective. In cats, the required length is commonly 6–10 cm, and diameter 1.0–1.2 cm (Figure 16a). Under endoscopic control, a guide wire is first placed through the stricture and the balloon catheter is then passed over the wire along the endoscope into the stricture. There are balloon catheters available that can be used through the working channel of the endoscope; however, these are expensive and for single-use only. Once within the stricture, the endoscope is withdrawn a few centimetres, and the balloon is inflated with water (better than air) via a syringe or pump connected to a pressure gauge. Once the pres-



**Figure 16** (a) Balloon catheter (length 4 cm, inflated to width 10 mm). (b) Manometer for use during balloon dilation of oesophageal strictures. Images courtesy of Dr M Schneider, Small Animal Clinic, University of Giessen, Germany

**To prevent re-stricture formation, balloon dilation is repeated twice weekly until there is no significant stricture visible endoscopically.**



**Figure 17** Tear in the oesophageal mucosa after balloon catheter dilation

sure that is permitted for the particular balloon has been reached (Figure 16b), the balloon is kept in place for 1–2 mins and then deflated. Endoscopic visual inspection after the procedure should reveal some tears and bleeding (Figure 17). If these signs are not visible, either the dilation was not wide enough or the balloon slipped, and the procedure must be repeated.

To prevent re-stricture formation, the procedure is repeated twice weekly until there is no significant stricture visible endoscopically. Re-dilation when regurgitation recurs is another approach, albeit often less successful in the long run.

After balloon dilation, the cat is treated for severe oesophagitis with oral liquid sucralfate, a proton pump inhibitor, an antiemetic drug and soft food. There are no studies showing that prednisolone will help to prevent stricture formation. In severe cases, endoscopically guided intralesional injection of triamcinolone (0.4 mg/kg) into the cranial edge of the stricture until a bleb is formed is probably more justified. In cats with moderate tears of the oesophagus, placement of a gastrostomy feeding tube might be considered. Major, life-threatening tears are a rare occurrence (4–9%) and will result in mediastinitis and potentially tension pneumothorax. Surgical repair is needed but carries a risk of further stricture formation.

In cases with recurrent stricture formation despite frequent re-ballooning (>10 times), placement of an expandable stent can be considered (Figure 18).<sup>10,11</sup> Unfortunately, there are so far no biodegradable stents for cats available for the oesophagus and complications of permanent stents, such as aboral migration, pressure necrosis and occlusion by hair or food, are serious risk factors to consider and discuss with the owners.

## PEG tube placement

Feeding is paramount in sick and debilitated patients and enteral feeding is preferred as it improves enterocyte health and decreases bacterial translocation from the GI tract.<sup>15</sup> While force-feeding and use of naso-oesophageal feeding tubes may be ideal in the short term, neither generally allow adequate caloric intake in severely sick patients and feeding may even be impossible in cats with anatomical or functional problems of the oral cavity or oesophagus. Percutaneous endoscopic gastrostomy (PEG) tubes have multiple advantages inasmuch as commercial food and special diets for specific diseases (eg, chronic kidney disease, liver problems) can be administered, the daily caloric requirement is easily met, most oral drugs can be given through the tube (avoid crushing tablets with coating to resist gastric acidity) and the time required for feeding is much reduced, not only in a hospital setting but also at home. The major drawback of PEG tubes is the cost of the tube (especially commercial kits) and of the endoscopic placement.

### Cases that are not suitable for PEG tube placement

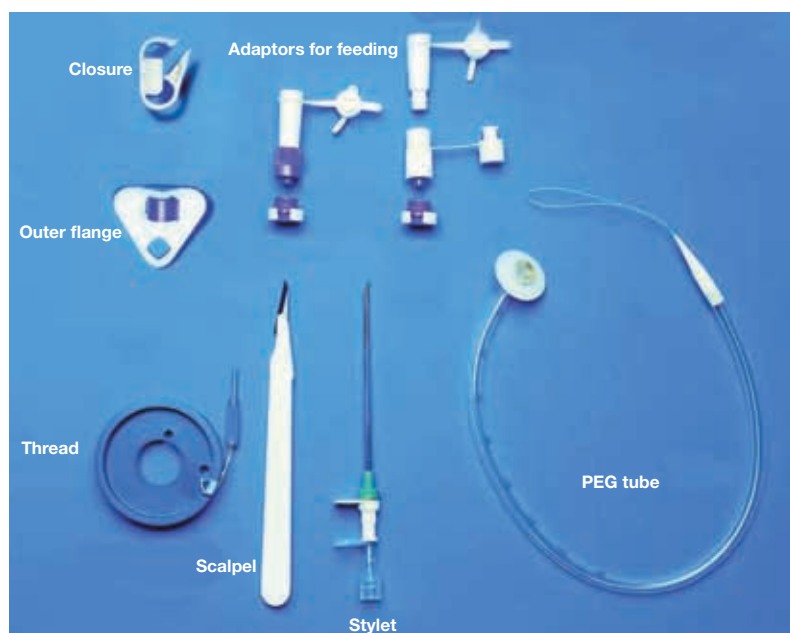
PEG tubes should not be placed when only short term usage is anticipated (<7 days), in cats that are not good anaesthetic candidates or when complications such as severely compromised wound healing or severe coagulopathy are present. Whether permanent PEG tubes should be placed in animals with megaoesophagus is unclear, but this problem is rare in cats anyway.

PEG tubes can be placed during laparotomy, when the cat undergoes this procedure for other causes, or blindly (eg, using an Eld applicator). The safest and probably quickest procedure (5–10 mins in experienced hands with commercial kits), however, is endoscopic placement.

**Figure 18** Metallic stent in the oesophageal lumen of a cat in which balloon catheter dilation of a stricture was unsuccessful. Reproduced with permission from Glanemann et al (2008)<sup>10</sup>







**Figure 19** Components of a commercial human PEG tube set (Freka), 15 Fr size, which can be easily used in the cat

### Types of PEG tubes

There are two types of PEG tubes available: commercial kits (from human medicine), which contain all materials for quick placement, and 'home-made' kits, which are

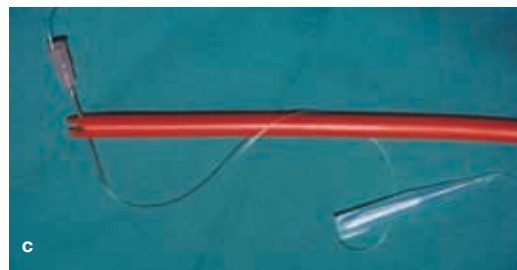
cheaper but more cumbersome and, therefore, time-consuming. A third type of tube, the so-called low-profile PEG tube (or 'button'), is available as a replacement for the initial tube or to be placed from the outset – but there is hardly any experience with these in cats so far.

### Commercial kits

Commercial PEG tubes are made of either silicone or polyurethane and can withstand gastric acidity for the animal's lifetime. In cats 16–20 Fr size is used. The inner flange is different between different brands but all are suitable for cats. The commercial kits contain – besides the feeding tube with conical end – the following materials, which are also needed in 'home-made' kits: large over-the-needle catheter (16 G), double looped strong suture material (long enough to extend from mouth to side of abdomen, ie, 70–100 cm), scalpel, material to fix the feeding tube on the outside (clips or suture) and an adaptor for the feeding syringe (Figure 19).

### Home-made kits

Home-made kits for PEG tubes include mushroom tip catheters, commonly Pezzier urinary catheters. With a pipette tip, a needle and a strong suture material as a guide wire a similar device as the commercial PEG tube is created (Figure 20).<sup>13</sup>



**Figure 20** (a) Materials used for a 'home-made' PEG tube using a Pezzier urethral catheter. (b) Part of the catheter is used as an inner flange. (c) A pipette tip is used as a conical dilator and threaded over the catheter. (d) The thread of the catheter is attached to the thread exiting the mouth. (e) The PEG tube is secured to the body wall using Chinese finger-trap sutures



## Endoscopic placement of a PEG tube

- ❖ With the cat lying in *right* lateral recumbency, the left flank caudal to the ribs is clipped generously and surgically prepared.
- ❖ After introducing the endoscope into the stomach, sufficient air is insufflated to push the gastric wall against the abdominal wall and displace the abdominal organs (spleen, intestine) – in cats, not too much air must be given.
- ❖ The site for tube placement is determined both by transillumination of the endoscope light through the body wall (Figure 21a) and by gently pushing the sterile sheath of the over-the-needle catheter into the prepared site on the flank in the direction of the stomach (Figure 21b); this will show as an indentation in the stomach endoscopically (Figure 21c). The best place is at the junction between the body and antrum. This normally translates in cats as 2 cm caudal to the last rib and 5 cm ventral to the vertebral column.
- ❖ The endoscope is withdrawn just to the cardia in order to prevent its accidental puncture. The over-the-needle catheter is pushed through the abdominal and gastric wall at an angle of about 45°.
- ❖ As soon as the catheter can be seen endoscopically (Figure 21d), the stylet is removed, the thread is fed into the stomach and grabbed via the endoscope with a preplaced grasper (*not* a biopsy forceps) (Figure 21e).
- ❖ The thread is pulled, together with the endoscope, out of the mouth (Figure 21f).
- ❖ The gastrostomy tube is attached by first threading the button through the loop coming out of the mouth and then through the loop on the end of the tube (Figure 21g). A knot is formed in the middle by pulling both ends (Figure 21h).
- ❖ The thread entering the abdominal and gastric wall is pulled so that the attached feeding tube is passed into the stomach via the mouth. Once the conical end appears in the flank, a very small (1–2 mm) incision is made in the skin to allow the tube to be pulled into place (Figure 21i,j).



**Figure 21** (a) Transillumination of endoscope light through the gastric and abdominal wall



(b) Applying gentle pressure on the abdominal and gastric wall using the sterile sheath of an over-the-needle catheter



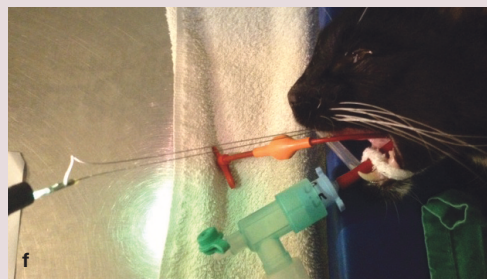
(c) Indentation in the stomach wall viewed endoscopically



(d) Over-the-needle catheter, before stylet removal, seen just inside the stomach



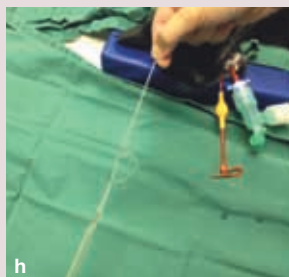
(e) Thread grasped with pre-placed grasper



(f) Thread exiting the stomach is pulled via the mouth using grasping forceps



(g) Inner flange (MILA International) is first passed through the loop coming out the mouth



(h) Both ends are pulled until a knot is formed in the middle



(i) A small (1–2 mm) skin incision is made to allow the conical tip with the PEG tube to be pulled through the abdominal wall



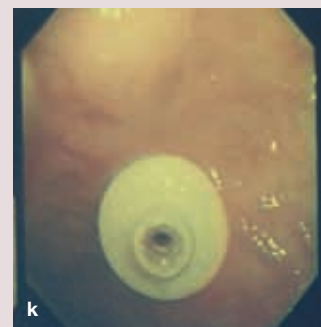
(j) Tube exiting from the incision site

Continued on page 1004

## Endoscopic placement of a PEG tube

Continued from page 1003

- ✦ The inner flange remains in the stomach adjacent to the mucosa (Figure 21k). If there is too much distance between the gastric wall and the peritoneum, seepage of gastric content into the abdominal cavity and peritonitis could potentially occur; if there is too much pressure, pressure necrosis in the mucosa could result. Hence, it is important to pull the inner flange snug but not too tight into the mucosa.
- ✦ Most commercial PEG tubes have clips to fix the tube, and no suturing is needed. The conical end is cut off and the remainder of the fittings, including a syringe adaptor port, are attached according to the manufacturer's instructions (Figure 21l).
- ✦ Once in place, the site is lightly wrapped with an occlusive dressing; a shirt-like body or stretch netting is commonly sufficient in cats and no Elizabethan collar is needed. Daily cleaning of the stoma with an antibiotic or iodine cream is important.



(k) Inner flange (button) of a PEG tube seen after feeding tube placement with a gastroscope

### Placement of home-made kits

Placement is the same as with a commercial kit, except that a knot is needed when attaching both threads (from feeding tube and from stomach), an outer flange should be created from tubing and the feeding tube is secured on the outside with Chinese finger-trap suture (Figure 20e).



(l) The conical tip is cut from the tubing secured to the body wall

### PEG placement

With both types of kit, placement is approached in the same way – a thread or suture material is pushed via a needle through the abdominal and gastric wall into the gastric lumen, grabbed endoscopically and pulled via the oesophagus through the mouth. The PEG tube is then attached and pulled via the thread into place. The procedure is described on page 1003 and above.

If biopsies are needed, these should be taken before PEG tube placement.

### PEG tube feeding

Feeding can commence 24 h after tube placement, initially with one-half of the daily calorie requirements. After 1 day, the full amount can be given. In the first few days the cat is given five or six meals daily, but as early as day 4 or 5 feeding can be reduced to three meals daily. While problems with PEG tube feeding are rare, they can arise and should be dealt with according to established guidelines.<sup>15</sup>

PEG tubes can stay in place for many months, even lifelong. Replacement with low-profile devices (buttons) can be considered. It is important, however, to leave a new PEG tube in place for a minimum of 7 days, and in animals with wound healing disorders, even longer (up to 21 days) in order for proper stoma formation. Tube removal in cats should

**Figure 22** PEG tube removal endoscopically once the cat is eating again. The tube is clipped on the outside once it is safely grabbed with foreign body retrieval instruments on the inside



always be carried out endoscopically as the inside flange of commercial kits is too big to pass naturally when the tube is cut on the outside (Figure 22).

### Funding

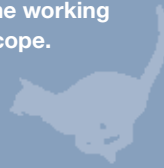
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### Conflict of interest

The authors do not have any potential conflicts of interest to declare.

## KEY POINTS

- ❖ Endoscopy of the GI tract can be used both diagnostically and therapeutically in feline patients.
- ❖ A thorough work-up with laboratory testing and diagnostic imaging must be conducted prior to diagnostic endoscopy.
- ❖ Obtaining a good history will help to decide which GI endoscopic procedure (oesophagoscopy, complete upper GI endoscopy, lower GI endoscopy) needs to be performed.
- ❖ Placement of PEG tubes endoscopically is quick and easy, and should be considered in all cats expected to be anorectic for a prolonged period.
- ❖ Foreign body removal from the oesophagus or stomach can be achieved with a foreign body grasper through the working channel or long forceps used alongside the endoscope.



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# UPPER RESPIRATORY TRACT ENDOSCOPY IN THE CAT

## A minimally invasive approach to diagnostics and therapeutics

David S Sobel



### Clinical indications and patient presentation

Cats in need of evaluation of the upper respiratory tract present in various ways, but there are multiple commonalities that should signal to the clinician the potential utility of using endoscopy in diagnosis and also intervention.

Compared with canine practice, where the coughing dog is often the most common clinical presentation, cats often present with more subtle signs of respiratory distress. Often the first signs of nasal or paranasal disease are nasal discharge and sneezing. Depending on the particular case and the particular pathology, the discharge may be unilateral or bilateral and careful note should be made of this as well as whether one nostril seems to have more substantial discharge compared with the other. The discharge may range from mucoid to mucopurulent, to serous, to hemorrhagic, or any combination of these, with a wide overlap in visual appearance between the various forms. Epiphora or discharge at the nasolacrimal puncta may also be present, either primarily or in concert with discharge at the nares. Acute or chronic epistaxis should always alert the clinician to the potential for primary nasal disease. The color and odor of the discharge is of particular importance to note.

Owners may also report subtle signs of dyspnea, which in the cat can often be evident as a slight increase in the abdominal component of respiration. This is an important observation in assisting the clinician in localizing the disease pattern to the lower or upper respiratory tract.

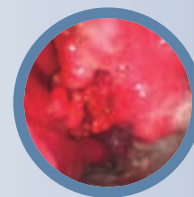
Coughing, gagging or retching, which some owners may misinterpret as vomiting if productive, should alert the clinician to the suspicion of pharyngeal or laryngeal disease. Careful examination and appropriate diagnostics should differentiate pulmonary or cardiac causes of coughing from upper respiratory disease.

Clients may also note audible wheezing, and stertor should be differentiated from stridor on physical examination. Often owners will offer that their cat seems to be a 'noisy sleeper', as the subtle sounds of stertorous breathing may only be evident in the quiet of sleep. Careful anamnesis, physical examination and observation of the patient can aid the clinician in differentiating the genesis of these auditory signs. Stertor is usually heard as a low-pitched snoring or snuffling sound. This is most commonly caused by turbulent air flow across the mucosal surfaces of the pharynx, nasopharynx and/or soft palate. Stridor, by

**Clinical challenges:** Endoscopy of the feline upper respiratory tract has always taken a bit of a back seat to exploration of the canine nose and paranasal sinuses, pharynx and trachea, due to some anatomic limitations and lack of availability of appropriate-sized equipment.

**Practical relevance:** With proper training, however, even the inexperienced endoscopist can find that endoscopy and endoscopic surgery can be of tremendous utility in feline practice. What had previously been largely off-limits sites, in terms of direct visualization and surgical intervention, the feline rhinarium, paranasal sinuses, pharynx and trachea are now anatomic areas that can be effectively visualized in most clinical scenarios. Moreover, endoscopic surgery is now an area gaining significant appreciation for its diagnostic and therapeutic benefits.

**Audience:** This article will not serve as a complete treatise on disease processes of the upper respiratory tract in cats, but rather is intended as a technical and instructional reference point on upper airway endoscopy for veterinary surgeons, both in first opinion as well as referral small animal practice.



### MULTIMEDIA

Three video clips showing diagnostic rhinoscopy in a cat with adenocarcinoma of the dorsal nasal meatus, and use of laser endosurgery to ablate and debulk the lesion, are included in the online version of this article at [jfms.com](http://jfms.com)  
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comparison, is of lower respiratory tract origin within the larynx, trachea or proximal portions of the main stem bronchi.

Changes in appetite are a subtle but important sign of nasal disease. As cats are so much more attuned to the odor of their food, any pathology that interferes with their ability to smell may impact appetite, and weight loss and anorexia may ensue. The cat that seems interested in food, sniffs at the food dish and then walks away should undergo careful examination of the nose to ensure that an anatomic obstruction to olfaction is not present. Additionally, cats that seem to have difficulty in prehending or swallowing may well have anatomic lesions affecting the pharynx, nasopharynx or posterior nares that can interfere with these activities. A cat that extends its neck while eating in an attempt to aid in the passage of food may have pharyngeal pathology. Pain may be evident on mastication or swallowing that is accompanied by this cervical extension.



**Compared with dogs, where coughing is the most common clinical sign of upper respiratory disease, cats often present with more subtle signs of respiratory distress.**

Less commonly, owners may appreciate facial swellings or facial asymmetry that may suggest nasal pathology.

### Physical examination and anamnesis

During the examination, a careful and thorough history should be obtained, paying special attention to the cat's age at onset, and duration (chronic vs intermittent) and seasonality of the clinical problem. Attention to the cat's body condition and weight is also important, and a careful assessment as to the trend in the same should be made. Discussion with the owner as to the cat's appetite and whether there are certain foodstuffs that are more enticing to the cat (ie, more aromatic, and/or when warmed to slightly above room temperature) or easier to prehend and swallow is important. As mentioned, owners may often comment that there has been a change in the sound of the cat's breathing pattern, and may particularly notice this at night.

Physical examination that focuses on the upper respiratory tract should be comprehensive (see box below), although there are clear limitations to what can be achieved in the conscious feline patient.

### Suggested approach to the physical exam

- ✦ The examination should be commenced by standing back and looking at the cat overall. Assessment should be made as to whether there is an abdominal component to respiration and whether the cat seems distressed while breathing in the relative calm of the consulting room.
- ✦ The clinician should next examine the cat's head from a vantage point, looking directly at the nasal planum. Subtle variations in facial symmetry can sometimes be appreciated. Swellings or depressions, facial drooping or paresis should all be noted. Signs of cranial nerve anomalies should also be noted as this may play a role in localizing a potential extracranial lesion. Evidence of anisocoria should be documented as well as pupillary light reflexes, both direct and consensual.
- ✦ Next the cat's head is palpated along the rhinarium and frontal sinuses in an attempt to appreciate any subtle soft areas, swellings or evidence of pain.
- ✦ If the cat is amenable, it is worthwhile trying to evaluate for the presence of airflow from each nostril. This can be done in a number of ways. Often by lending a cheek to the level of the cat's nose, the clinician can appreciate a difference in airflow between the two nostrils. This can more precisely be visualized by holding a cold glass microscope slide up towards the nares. The condensation seen on the slide should confirm airflow across each side of the rhinarium.

- ✦ Observation of any nasal discharge should also be noted, with details of color, clarity, viscosity and odor. Whether the discharge is bilateral or unilateral and whether there is similar discharge at the nasal puncta should be documented.
- ✦ If the patient is cooperative, an oral examination should be attempted. Halitosis (beyond that of normal kitty breath) in the absence of dental disease is an important clinical sign. Swellings or defects in the hard and soft palate should be noted. Dental disease, particularly of the upper arcade, can be associated with or the direct cause of nasal disease and should be made note of. If possible, visualization of the posterior pharynx should be attempted but often the awake feline patient is resistant to this examination.
- ✦ External palpation of the cervical area, and the trachea in particular, is performed next. A cough or gag that is easily induced by palpation of the trachea is an important clinical observation.
- ✦ Auscultation of the airway with a stethoscope is carried out only once all of this is completed. A pediatric or neonatal stethoscope is a great aid to accurate auscultation of the feline respiratory tract. The ventral pharynx, trachea and lungs should be listened to independently. With practice, the clinician should also be able to auscult and percuss the rhinarium to evaluate for fluid or soft tissue densities and appreciate deviations in airflow across the rhinarium.

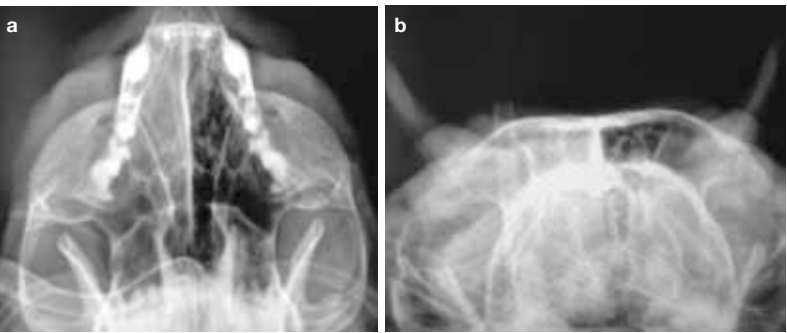


## Diagnostic investigation

Once the client consultation and initial physical examination have been undertaken the remainder of the diagnostic investigation is best completed under general anesthesia. Depending on the particulars of the case in hand, a complete blood count (including platelets) and biochemistry profile should be performed as part of a minimum database. Interpretation of results should attempt to identify co-morbidity that might affect the patient's safety under general anesthesia, as well as other pathologies that might be clinically relevant. If epistaxis is part of the clinical presentation a coagulation panel should be evaluated. As epistaxis can also be associated with hypertension blood pressure measurement should be performed. If so indicated, other causes of hypertension should be ruled out prior to general anesthesia.

With the patient under anesthesia, a complete and detailed oral examination should be conducted, including direct visual examination of the pharynx and larynx. Dental examination, including assessment of periodontal pocketing, should be performed with an eye towards identifying dental pathology that might have oronasal implications. Assessment for the presence of mass lesions dorsal to the soft palate should be made by visualization and palpation.

Survey radiographs are helpful and an important part of the work-up, but are often not definitive in describing the pathology.



**Figure 1** Radiographs showing a nasal and frontal sinus mass, which was subsequently diagnosed as a lymphosarcoma. (a) Open mouth ventrodorsal view. (b) Frontal sinus skyline view. Images courtesy of Middlesex County Animal Hospital, MA, USA

**Survey radiographs are helpful and an important part of the work-up, but are often not definitive in describing the pathology.**



frontal sinus skyline views (Figure 1b). High quality digital dental radiography, if available, provides a degree of resolution that is very valuable in dental radiography, as well as imaging of the rhinarium; in particular, bisecting angle views of the upper canine teeth are often of significant diagnostic value. Digital radiography has made the use of standard radiographic equipment of much greater value in examinations of the head and rhinarium.

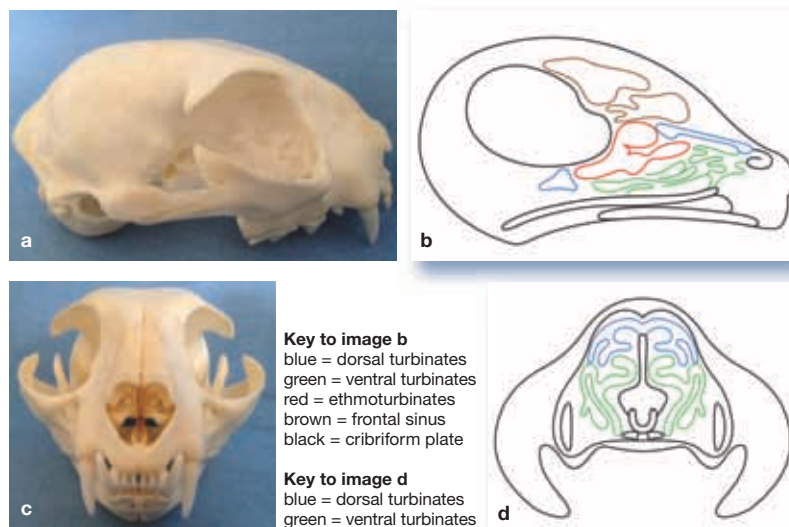
It is worth noting, although somewhat out-with the scope of this article, the utility of both magnetic resonance (MR) and computed tomography (CT) imaging. These modalities provide excellent resolution and definition of pathology of the rhinarium and paranasal sinuses. One distinct advantage of these technologies is their ability to clearly define soft tissue lesions. While referral centres (both academic and private practice) increasingly have access to these scanners, they are still not readily and widely available in many areas. When feasible, however, owners should be offered access to these imaging modalities. In an ideal scenario, one would be able to perform either CT or MR imaging during the same anesthetic procedure as the endoscopy. Often though this is not practicable and the procedure may need to be staged.

Imaging notwithstanding, there is still no substitute for histopathology as the gold standard for definitive diagnosis.

## Functional anatomy pertinent to rhinoscopy, pharyngoscopy and tracheoscopy

The cat has essentially the same nasal and pharyngeal anatomy as the dog, albeit in a more compressed and smaller space (Figure 2). This has clinical implications in terms of equipment choices (see boxes on pages 1010–1011) and endoscopic approaches.

The rhinarium itself is divided into three primary open spaces or meati: the dorsal nasal



**Figure 2** Nasal and pharyngeal anatomy in the cat. (a) Lateral view of the skull. (b) Diagram of a sagittal section through the skull to demonstrate the turbinate bones. (c) Rostral view of the skull. (d) Diagram of a transverse section through the skull at the level of the canine tooth. Adapted from Reed and Gunn Moore (2012)<sup>1</sup>

meatus, the ventral nasal meatus and the middle nasal meatus. Anatomically these are bounded by the dorsal, ventral and ethmoidal nasal conchae. Within the dorsal nasal meatus are the dorsal nasal and ethmoidal turbinates. The most clinically sensitive structure in the dorsal nasal meatus is the cribiform plate. This bony wall separates the rhinarium from the calvarium and brain case, and contains the nerves communicating olfactory sensation from their receptors on the ethmoid turbinates. The cribiform plate is highly vascular and pathology associated with this structure often has epistaxis as a salient clinical feature. This has important implications for endoscopic therapy (see later).

The dorsal nasal meatus is bounded, as mentioned, by the dorsal nasal concha laterally and the ethmoid concha ventrally. The ventral nasal meatus communicates with the pharynx via the posterior nares. The opening of the Eustachian tube can be visualized in some feline patients as a thin slit on the lateral wall of the nasopharynx caudal to the choanae.

The most problematic feature of the anatomy of the feline patient is the relatively

**The most problematic feature of the anatomy of the feline patient is the relatively compressed space that the dorsal and ventral nasal meati occupy.**



compressed space that the dorsal and ventral nasal meati occupy. This limits equipment choices (see later). It can also make differentiating the ventral from dorsal meatus, as well as visualization of other anatomic landmarks, difficult as these structures are often in such close proximity that identifying them as discrete structures can be confusing, particularly for the practitioner not well experienced in endoscopic techniques.

The nasal planum and nares are also quite tricky to manipulate, compared with the dog. The nares are much narrower than their canine counterparts. The entry to the rhinarium and dorsal nasal meatus is essentially parallel to the long axis of the nose (distinct from the dog where a slight ventral approach is necessary to introduce the endoscope safely into the dorsal nasal meatus, and subsequently into the ventral meatus). This means that the path of least resistance in the cat is entry into the dorsal

## Endoscopic equipment choices

The basic set of imaging instrumentation should include a high quality endoscopic camera, light source and video monitor. Some form of digital recording device (hard drive, CD/DVD capture device, etc) is of great help in documenting the procedure for client education, legal and publishing purposes.

As to endoscopes specifically, the most commonly used rigid endoscope in the author's hands is a 2.7 mm 30° endoscope (Figure 3a) housed within a pediatric cystoscopy cannula or sheath. The cystoscopy cannula adds to the outer diameter of the endoscope unit, increasing it to 4.8 mm. However, the oval shape of the sheath, with its blunted and tapered tip, makes it relatively less traumatic. In addition, it allows for a more laminar

flow of irrigant fluid over the lens of the endoscope, aiding in keeping the field of vision clear and free of debris. Other endoscopists have advocated using a protective or arthroscopy sheath that is available for the 2.7 mm 30° scope. This sheath is certainly narrower and keeps the overall diameter of the operating unit down, but is more traumatic to the nasal mucosa and irrigant has a tendency to pass along the long axis of the telescope rather than across the lens. Furthermore, the lack of an operating channel means that if the operator needs to pass an instrument along with the endoscope (for foreign body retrieval, biopsy, etc) it must be introduced alongside the scope, making it harder to manipulate and mitigating any gain in reducing the

Continued on page 1011

**The most commonly used rigid endoscope in the author's hands is a 2.7 mm 30° endoscope housed within a pediatric cystoscopy cannula or sheath.**



**Figure 3** A selection of rigid and flexible rhinoscopes commonly employed in feline practice: (a) 2.7 mm 30° rigid scope; (b) 1.9 mm 30° rigid scope; (c) 3.7 mm two-way deflection flexible endoscope. ©2013 Courtesy of KARL STORZ GmbH & Co KG

nasal meatus. As discussed below, entry into, and identification of, the ventral nasal meatus is more difficult than in the dog.

The anatomy of the frontal sinuses is essentially the same, except for the obvious differences in size between the species. The communication of the frontal sinuses with the rhinarium is difficult to visualize and even more difficult to traverse endoscopically, except in the most pathologic of states.

The larynx of the cat is similar in structure to that of the dog and, as such, tracheoscopic examination is similar. However, the tendency of the cat towards laryngospasm should the arytenoids be manipulated too aggressively should be kept in mind. The diameter of the lumen of the trachea has important implications with regard to equipment and procedural choices.

### Endoscopic procedures

The following procedures will be discussed:

- ✦ Rigid antegrade rhinoscopy
- ✦ Sinusoscopy
- ✦ Tracheoscopy

## Rigid antegrade rhinoscopy

### Preparation of patient and equipment

Once the decision has been made to perform an endoscopic intervention of the upper airways anesthesia considerations are determined by the specific clinical case at hand and any significant co-morbidity that the pre-anesthetic investigation has uncovered.

The use of inhalant anesthetic gas delivered by endotracheal tube is generally considered the standard of care (continuous rate infusion of propofol can also be considered).

As rhinoscopy often involves the copious use of irrigant fluids, protection of the airway is of vital importance to minimize the risk of aspiration pneumonia, which is one of the primary potential complications of feline rhinoscopy (see left).

### Minimizing the risk of aspiration pneumonia

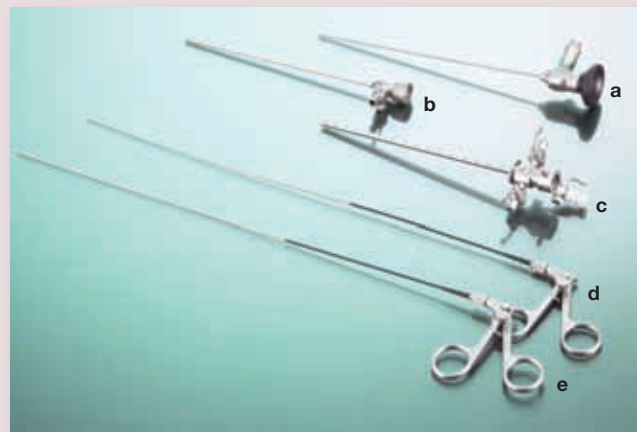
Making sure a well-fitting endotracheal tube is used with a properly inflated cuff is the first line of defense against the risk of aspiration pneumonia. Secondly, simple gauze sponges can be packed into the caudal pharynx rostral to the larynx. Alternatively, feminine hygiene 'mini pads', cut to size and with a slit in the center to accommodate the endotracheal tube, are very helpful for absorbing any irrigant that should make its way down the trachea. They are very thin and low profile and have a markedly greater absorbency than either gauze or cotton wool. The surgeon must, of course, keep track of how many foreign items are placed in the pharynx to ensure that all are retrieved at the end of the procedure.

### Continued from page 1010

size of the equipment in the nose. Needless to say, the diameter of this equipment makes for a tight fit in all but the largest feline patients. However, it is impressive to see how well the endoscope fits in the feline rhinarium once the nares are traversed, clearly these being the size-limiting factor in the use of this telescope. Note that it is difficult to pass this endoscope completely through the ventral nasal meatus to the level of the posterior nares.

Other operators have advocated using a smaller rigid endoscope to allow for more dexterous manipulation of the scope and ancillary instrumentation. To this end a 1.9 mm 30° scope, with appropriately sized associated instrumentation, is available (Figure 3b). This kit offers a much easier fit in the feline rhinarium and allows for easier manipulation of the telescope and associated instrumentation around the nose. However, this equipment does have limitations. Small optical size results in decreased light transmission and smaller fields of view, so optical quality is often inferior to that provided by the larger endoscope. The smaller diameter of the operative sheath allows for less irrigant to pass and can make for more debris present in the field of view. Lastly, this smaller endoscope is notably more fragile. If you are hard on your equipment (like this author!) it can prove an expensive addition to your kit should it need replacing.

For the purposes of retroflexed 'J' maneuver pharyngoscopy and tracheoscopy, a flexible endoscope is needed. Most commonly a small diameter (<5 mm) two-way deflecting flexible fiberoptic endoscope is used (Figure 3c). While there are videoscope versions of these endoscopes available, most veterinary practitioners find that the high quality fiberoptic scopes



**Figure 4** (a) 2.7 mm 30° rigid telescope, (b) protective sheath for telescope, (c) multipurpose cannula for telescope, (d) grasping forceps and (e) biopsy forceps. ©2013 Courtesy of KARL STORZ GmbH & Co KG

are excellent investments for a variety of clinical procedures.

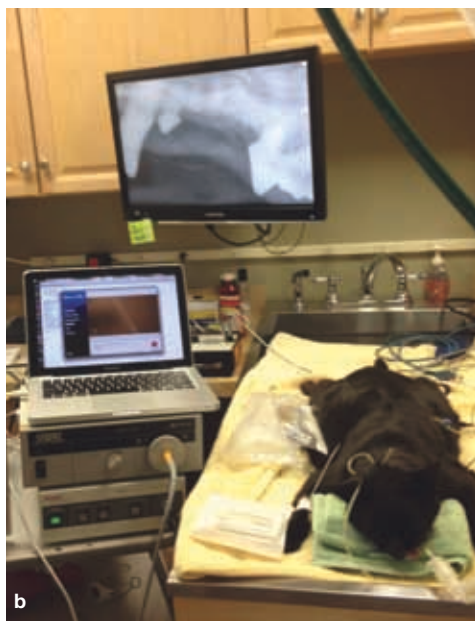
Most manufacturers have a full range of accessories available for their endoscopes. This includes, but is not limited to, biopsy forceps, foreign body retrieval forceps, brushes, graspers and aspiration cannulae (Figure 4).

The author has also found tremendous utility in the clinical use of diode lasers as an adjunct to endoscopic diagnostic surgery (see later). These diodes deliver their energy via a small diameter flexible quartz fiber, making them ideal for endoscopic applications. These diode lasers are widely available in wavelengths ranging from 810 nm up to about 980 nm.





**Figure 5** Theatre set-up for a mobile endoscopy practitioner, demonstrating patient positioning in sternal recumbency (a) as well as positioning of monitor, camera and light source level with the patient's pelvis (b). Images courtesy of Middlesex County Animal Hospital, MA, USA



While the patient is being prepared for and induced under general anesthesia, the endoscopist should be readying their surgical space and equipment set-up.

Equipment should be thoroughly sterilized as per manufacturers' instructions. Sterile irrigation solution should be hung on an intravenous pole near the head of the patient. The author usually uses 0.9% saline in 1 l bags for this purpose, attached to a standard intravenous or giving set. However, any clear additive-free physiologic solution can be used (lactated Ringer's solution, Normosol, etc, all without added dextrose).

Given the mess that can be created with the use of aggressive irrigation, performing the procedure on a 'wet table' is of great utility. This will help keep the operatory cleaner and, if nothing else, will make the nurses much happier with the reduced clean up.

With the patient under general anesthesia and intubated, preparation for the procedure can begin. The author usually starts with the cat positioned in sternal recumbency. The head is propped up with soft towels (Figure 5a) to elevate the rhinarium to allow for access. However, care should be taken to avoid tipping the nasal planum too far dorsally; overextension of the cervical spine in this manner will increase the risk of aspiration of irrigation solution. The author usually tries to have the head elevated with a slight downward deflection of the nasal planum.

The endoscopic equipment tower is generally placed at the level of the patient's pelvis facing forward (Figure 5b). This allows the operator to sit at the patient's head and be presented with a more or less true orientation of image on the video monitor. A surgical

stand with equipment and disposable supplies is generally placed at the level of the surgeon's shoulder on the same side as the tower, although this is subject to individual preference. The anesthesia machine is carefully positioned on the opposite side of the equipment tower. A mouth gag or dental speculum is placed to keep the mouth open. A maxillary mouth gag provides a measure of safety to ensure that the jaw is not held under excessive tension for a long period of time, risking the rare complication of central blindness.

### Pharyngoscopy

The first procedure of the work-up is retroflexed or 'J' maneuver pharyngoscopy. With the cat's mouth open, the flexible endoscope is manipulated so that the operative or bending end is flexed into a hook or 'J' position. The endoscope is advanced into the mouth and the scope hooked over the soft palate so that the optical end of the endoscope is facing rostrally. Bearing in mind that the view on the video monitor is reversed and inverted, this allows for examination of the posterior nares.

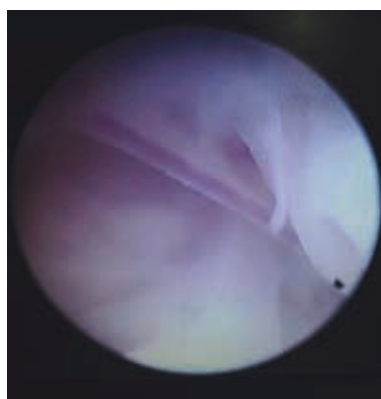
Any mass or structural lesions noted to be obscuring the openings of the posterior nares (Figures 6 and 7) can be biopsied or aspirated. If a mass such as a nasopharyngeal polyp is observed, and can be retracted caudally over the edge of the soft palate with the aid of an endoscopic grasping forceps, a diode

laser or some other form of thermal energy can be used to transect the stalk directly. Alternatively, for more rostral lesions that cannot be manually manipulated, small diameter diode laser fibers can be introduced through the instrument channel to ablate the tissue. Effusions noted at the posterior nares can be retrieved for cytologic analysis via brushes or aspiration cannulae. The operator should be aware that while many two-way deflecting endoscopes allow for bending beyond 180°, the presence of any instrument in the channel through the bending portion of the endoscope will decrease the maximum range of the endoscope. Forcing the endoscope beyond the point of resistance runs the risk of damaging the wires of the bending end of the instrument.

With the flexible endoscope still in the pharynx the flexion can be relaxed to give the operator a very good 360° visualization of the



**Figure 6** Retroflexed 'J' maneuver endoscopic image of the caudal nares and choanae, demonstrating nasal lymphosarcoma presenting as a nodular mass lesion



**Figure 7** Nasal lymphosarcoma can present in a variety of gross appearances. Here nasal lymphoma is a pale space-occupying mass in the dorsal nasal meatus

entire pharynx, including both the dorsal and ventral surfaces of the hard and soft palates, the roof of the pharynx, tonsillar crypts and the larynx itself.

### Rostral rhinoscopy

With that portion of the procedure completed, the mouth speculum can be removed and rostral rhinoscopy performed with the rigid endoscope of the operator's choice. The author usually assembles the endoscope, light guide cable and camera in such a way that he can hold it pistol-style; that is, so that the light guide post of the endoscope, the light guide cable and the cable of the camera all drape in such a manner as to keep the camera orientated in an upright position. This ensures that the image produced by the camera is in the same orientation as that of the endoscope. The result is a true (rather than inverted) image on the monitor.

With the non-endoscope-holding hand, the surgeon gently displaces the nasal planum dorsally and gently inserts the well lubricated endoscope through the nares (Figure 8). As noted earlier, the scope will by default enter the dorsal nasal meatus. Once the endoscope is inside the nose, the irrigation can be turned on via gravity feed (usually no pump is necessary, although the occasional blast of saline via a syringe can help free the operative field of tenacious mucoid debris). The minimum amount of irrigant flow is used to keep the operative field clear. Small hand movements translate to dramatic motion of the tip of the endoscope in such a small location. So care must be taken to make advancements, retractions and lateral motions of the endoscope incremental and slow. While some degree of hemorrhage is unavoidable in rhinoscopy, a delicate approach will minimize iatrogenic trauma.



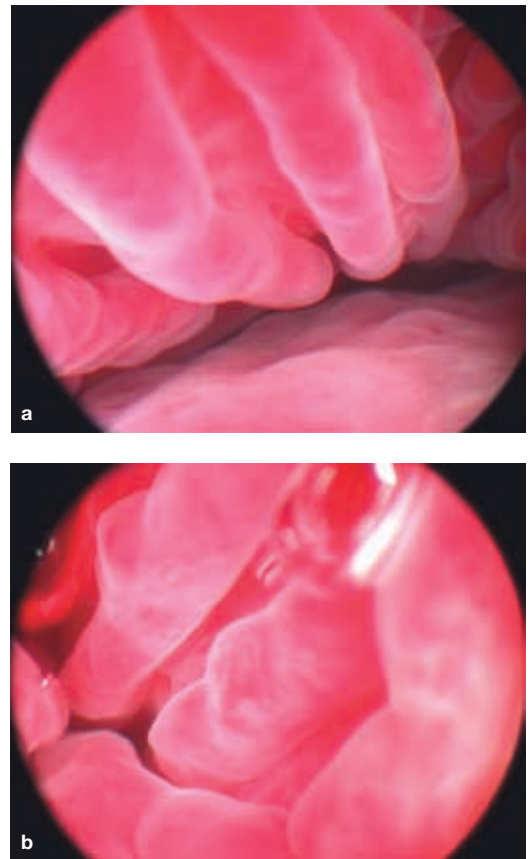
**Figure 8** Rostral rigid rhinoscopy. The surgeon can be seen deflecting the nasal planum dorsally to facilitate entry of the endoscope into the rhinarium. Courtesy of Middlesex County Animal Hospital, MA, USA

The dorsal nasal meatus should be examined as thoroughly as possible, rotating the endoscope very slightly right and left to navigate the ethmoid turbinates. It is very rare to be able to advance the endoscope all the way to the cribriform plate unless there is such dramatic and destructive disease that the turbinate structures are largely gone.

Careful note should be made of the colour and texture of the mucosa and the architecture of the turbinates.

### Note all gross findings

A thin pink mucous membrane is normal and tears easily. However, the mucosa of the turbinate structures can become markedly thickened and deeply red in color, and bleed excessively and easily with minimal manipulation of the tissue. The normal turbinate structure is round with soft curves (Figure 9a). Pathology can often erode the mucosa over the turbinate bones to the point that they become virtually denuded of mucosa; or the other extreme, of marked thickening and erythema, may be observed. Severe chronic inflammatory processes often have atrophy of the turbinate structures as one of their salient visible features (Figure 9b). While none of these observations are pathognomonic for specific diseases, it is important to make note of all gross findings.



**Figure 9** Gross endoscopic appearance of normal feline turbinate structure (a) and swollen, edematous turbinates (b). Note the smooth rounded linear appearance of the normal turbinates as compared with the blunted, irregular and tortuous appearance of the more abnormal turbinates. These findings are non-specific but are commonly associated with inflammatory rhinitis of various etiologies. Courtesy of Philip Lhermette



Next the endoscope should be retracted (moved rostrally) slightly to allow for some observation of the ventral nasal meatus. The turbinate structures of the ventral nasal meatus are generally far less tortuous and essentially this is a path towards the posterior nares. Size being the limiting factor, it can be difficult to navigate the endoscope through the entirety of the ventral nasal meatus to the posterior nares. Polyps or masses may be observed obscuring passage through the ventral meatus as well as protruding from the slit-like opening of the Eustachian tube. If it proves impossible to confirm patency of the ventral nasal meatus through to the posterior nares, an instrument can be inserted via the endoscope through the ventral meatus, beyond the visual field of the surgeon. With a finger in the cat's mouth the surgeon can feel over the back edge of the soft palate whether the instrument has come through, thus confirming patency.

Masses or polyp-type lesions noted in the rhinarium can be biopsied using the slender flexible endoscopic forceps designed for use with the particular endoscope, or a more robust rigid forceps inserted alongside the endoscope should space allow. A degree of hemorrhage is expected after biopsies are taken. It is good practice to perform a careful and delicate examination of the entire nose before biopsies are taken or masses resected. The resultant hemorrhage, while normal, can hamper further examination.

#### Diode laser therapy for nasal mass lesions

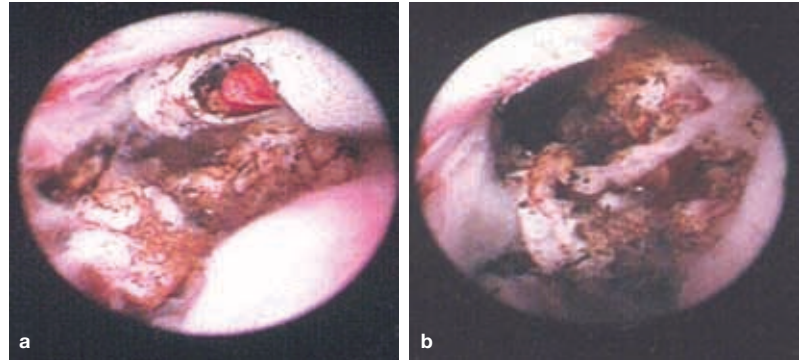
The diode laser, particularly at a wavelength at or near 810 nm, is a valuable tool in the management of mass lesions in the feline nose (Figures 10 and 11). These diodes perform especially well in fluid media (such as in irrigant solutions or hemorrhage) with minimal attenuation of energy. There is also a unique benefit to 810 nm due to the increased absorption of light at that wavelength by biological pigments (particularly hemoglobin, as well as melanin and others). This allows the operator to achieve excellent surgical results with a reduced amount of energy imparted to the patient, minimizing the risks of collateral thermal injury.

The fiber is introduced to the surgical site via the instrument channel of the endoscope (Figure 12) and the tip of the fiber is held in direct apposition to the tissue of interest ('direct contact mode'). In this manner, the tissue can be ablated and largely resected whether the lesion is neoplastic or benign. While it would be an overstatement to suggest that this approach is likely to produce clean surgical margins and, as such, complete resection, it is an excellent adjunctive therapy and

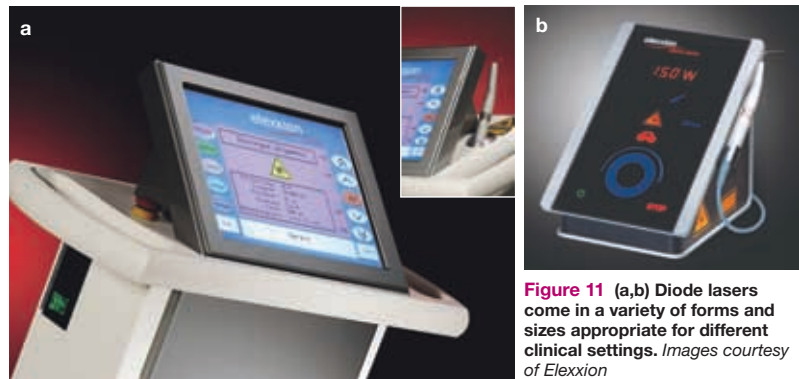
can provide prolonged management of clinical signs.<sup>2-4</sup>

#### Examination of the contralateral side

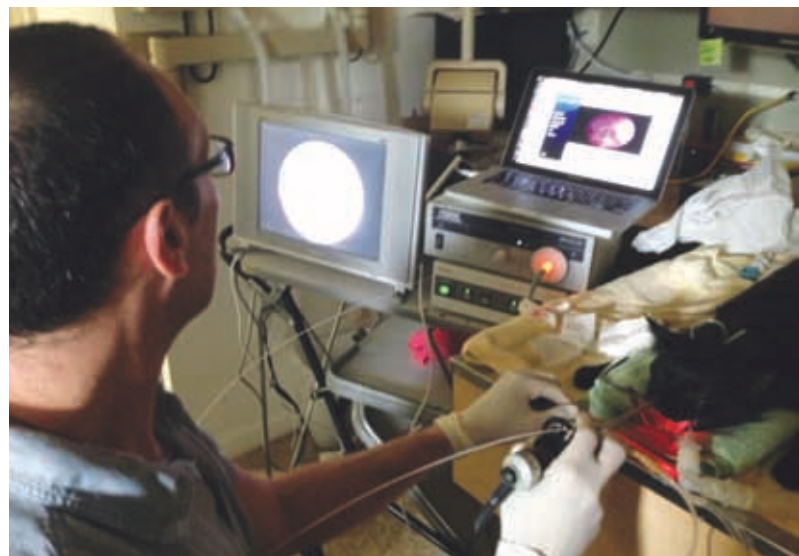
With the examination of one side complete, the rostral rhinoscopy procedure is performed in an identical manner on the contralateral side.



**Figure 10** (a,b) A right-angled laser fiber can be of great value in ablating lesions that occur at oblique angles relative to the long axis of the fiber. Here the diode laser is shown ablating a nasal adenocarcinoma



**Figure 11** (a,b) Diode lasers come in a variety of forms and sizes appropriate for different clinical settings. Images courtesy of Elexxion



**Figure 12** Surgeon pictured threading the laser fiber through the operating channel of the endoscope. Courtesy of Middlesex County Animal Hospital, MA, USA



## Sinusoscopy

If radiographs, CT/MR imaging or physical examination suggest the need, an endoscopic approach to the frontal sinuses can be undertaken. As there is no natural opening in this location the surgeon must, of course, provide some means of endoscopic ingress to the sinuses.

The dorsal-most point of the frontal sinus is identified by marking a point at the dorsal-most aspect of the orbit and approximately 2 cm towards the midline. This should correspond to the top of the dorsal shelf of the frontal sinus. In cases of pathology, this bone may be thin or completely eroded. Often there is a visible swelling over this site (the path of least resistance being the thinnest portion of the bone). With this point identified, the area is clipped, prepped and draped for aseptic surgery. A small incision is made with an #11 blade, the subcutaneous fascia retracted and the bone exposed.

A variety of methods can be used to make a hole through the frontal sinus bone. If accessible, a surgical drill (eg, Hall air drill or similar) can be used. A sterilized Dremel or small craft drill can also be used quite effectively. Alternatively, a very small diameter Michele trephine can be used, although often even the smallest available trephine is too large for feline patients. A Steinmann pin and Jacobs chuck of appropriate diameter for the endoscope to be used is often the simplest and most expeditious way of drilling a hole into the sinus.

Once access to the frontal sinus is obtained a rigid endoscope is generally used to examine the interior of the sinus. Often aggressive irrigation is needed to allow adequate visualization. Once the space is relatively clean, samples of tissue for histopathology, bacterial or fungal culture can be obtained and masses can be ablated or debulked. Closure of the access hole is generally accomplished with skin sutures only.

## Tracheoscopy

Tracheoscopy for diagnostic purposes is generally performed with a flexible fiberoptic two-way deflection endoscope. Depending on the size of the patient, scopes with diameters of less than 4.8 mm are usually used. With care, rigid endoscopes can also be employed for tracheoscopy. Visualization with rigid scopes distal to the thoracic inlet can be difficult and potentially dangerous, however. Tracheal tears and perforations are a rare but serious complication of overzealous rigid endoscopy of the trachea.

Ideally, the endoscope should be small enough to allow for it to be used within the

lumen of an endotracheal tube. However, the diameter of endoscopes commonly employed in feline practice makes this rarely possible. With larger feline patients that will accommodate an endotracheal tube of relatively greater diameter the patient can be maintained under inhalant gas anesthesia, with the anesthetic and oxygen flow maintained through a 'Y' adaptor via a side port. The central aperture of the adaptor is usually equipped with a silicon or latex gasket that allows for an endoscope to be passed with minimal loss of gas and oxygen. In this instance the endoscope is inserted beyond the distal tip of the endotracheal tube and the distal trachea is examined. To examine more proximal portions of the trachea, the cuff of the tube is deflated and the tube slowly removed with the endoscope still in place. This allows the endoscopist to visualize aspects of the trachea that were otherwise obscured by the presence of the endotracheal tube.

More commonly, the size of the endoscope relative to the size of the patient's trachea makes concurrent placement of an endotracheal tube and endoscope impossible. In this instance, the patient is generally maintained under general anesthesia with intermittent boluses or a continuous infusion of propofol or similar short-acting injectable anesthetic agents. The author often passes a flexible silicone catheter into the trachea connected to passive flow-by oxygen to supplement the ambient air. It is important to keep in mind that complete airway control is not obtained in this instance and the anesthetist must be prepared to perform emergency intubation should it become necessary.

This same approach can be used to perform bronchoscopic examination of the lower airways with bronchoalveolar lavage and other lower airway studies (see accompanying article in this Special Issue on lower respiratory tract endoscopy).

Visual examination of the trachea is easily performed using these techniques. Cytologic samples can be obtained with endoscopic brushings and fluid aspirates. Biopsies of mass lesions can also be taken, but great care is required as iatrogenic pneumomediastinum and pneumothorax can be caused relatively easily by perforation of the tracheal membranes.



**Care must be taken to make advancements, retractions and lateral motions of the endoscope incremental and slow. Small hand movements translate to dramatic motion of the endoscope tip in such a small location as the feline airways.**

## Role of endoscopy in selected URT pathologies

A few of the more common nasopharyngeal and tracheal disorders for which endoscopy can be of great diagnostic and therapeutic benefit are briefly discussed below. The reader is directed to the list of references and additional reading on page 1017 for more detailed information.

### Lymphoplasmacytic/eosinophilic rhinitis

This non-specific inflammatory response is the histopathologic evidence of what is often assumed to be an immune-mediated condition.<sup>5</sup> The presentation can be relatively non-specific. Often cats present with serous or mucoid bilateral nasal or oculonasal discharge. In some cases there may be a concurrent bacterial component, which can manifest as a mucopurulent discharge. Owners frequently report seasonality to the clinical signs, although this is inconsistent. In its most severe and chronic presentation, there may be epistaxis or a blood tinge to the discharge.

At endoscopy, the most striking feature associated with this non-infectious rhinitis is the marked atrophy and blunting of the nasal turbinates (Figure 13). The normally smooth contours of the turbinate structures are often diminished, replaced by sharp and angled margins. Mucosa may be focally thin to the point of the underlying bone being visible; however, there may be concurrent regions of marked thickening and erythema of the mucosa. Severe cases may result in bony changes to the nasal septum and inflammation of such a magnitude that the posterior nares are occluded.

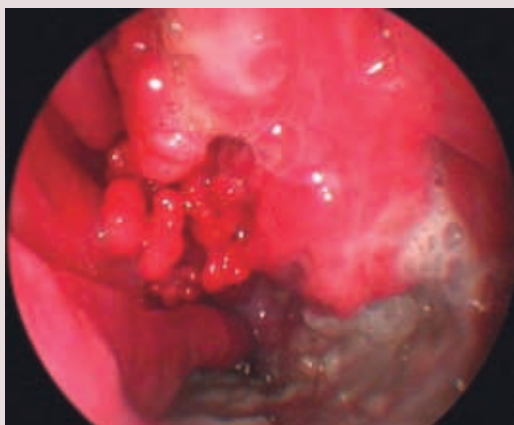
The diagnosis is made by histopathology with concurrent exclusion of other etiologies. An underlying allergic mechanism is often assumed but is rarely documented in feline patients. Therapy is often aimed at the inflammatory response rather than the underlying etiology. As such, corticosteroids, both oral systemic and inhaled/topical, are a standard therapy.

### Nasopharyngeal polyps

These lesions should not be considered to be discrete from lymphoplasmacytic rhinitis, as these polyps are often thought to be the mass-like manifestation of the same or similar inflammatory responses as described above. The lesions can occur within the ear and grow through the Eustachian tube, into the pharynx and rhinarium. A common presenting finding is the cat with gagging or dysphagia. On simple oral examination, the practitioner can in some cases visualize the polyp hanging above the caudal edge of the soft palate into the pharynx. Commonly the lesion may not be quite so evident and retroflexed pharyngoscopy may reveal the lesion at the level of the posterior nares or emanating from the Eustachian tube. The lesions may also be primarily noted in the rhinarium itself.

Large polyps hanging over the edge of the soft palate can often be removed with gentle and consistent tractions, the force of traction producing vasospasm at the stalk and resulting in

limited hemorrhage. More safely, the stalk of the lesion can be transected with a laser or other form of thermal energy. Lesions elsewhere can also be managed with laser therapy. In the author's experience, topical steroid therapy as a sole treatment is often ineffective. However, studies have demonstrated a recurrence rate of 30% regardless of how the initial lesion was managed.<sup>6</sup>



**Figure 13** Severe lymphoplasmacytic rhinitis. Courtesy of Philip Lhermette

Histopathologic examination reveals an inflammatory response similar to that seen in lymphoplasmacytic or eosinophilic rhinitis.

### Foreign body rhinitis

In the author's experience, the most frustrating problem in dealing with nasopharyngeal foreign bodies is the real likelihood that by the time the endoscopy is performed, the offending material may be long gone.

Removal of identified foreign material, be it grass, plant awns, sticks, etc, is relatively straightforward. However, the foreign body reaction that ensues can be more problematic and long standing. In cases where a foreign body is

suspected, but nothing is found, histopathology and bacterial culture/sensitivity should be performed and subsequent treatment based on the results of clinical pathology.

### Nasopharyngeal stenosis

Atresia or stenosis of the choanae or posterior nares is an uncommon problem in the feline patient. The stenosis or occlusion may be unilateral or bilateral. Potential causes are congenital atresia, neoplasia, chronic inflammation or trauma. The author has tried on multiple occasions to alleviate the stenosis with the use of a diode laser. With the exception of some success in the case of neoplasia, the laser has been of limited value. Re-obstruction seems to occur relatively quickly following laser correction. Several studies have demonstrated the utility of self-expanding nitinol stents placed under both endoscopic and fluoroscopic guidance.<sup>7-10</sup>

### Dental disease

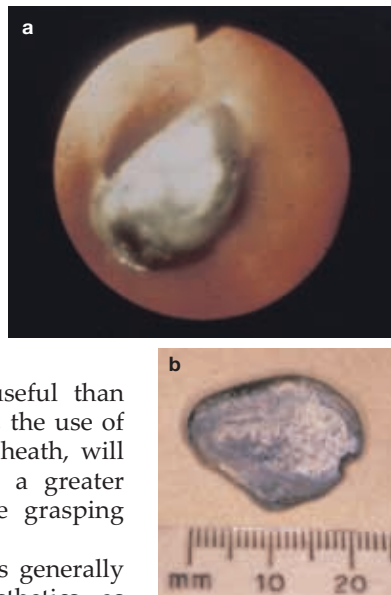
This common cause of nasal disease should not be overlooked. Severe periodontal disease and the subsequent osteomyelitis can result in oronasal fistulae that can present with severe bilateral or unilateral mucopurulent nasal discharge. Careful oral examination and dental radiography are critical in discerning the role that dental disease plays in the clinical presentation.

Tooth extraction, endodontic therapy and associated ancillary medical management may be all that is necessary to alleviate the nasal signs in these patients.

### Tracheal foreign body retrieval

For the purpose of tracheal foreign body retrieval rigid endoscopy is usually performed (Figure 14). Unfortunately, given the size of our feline patients it is often difficult to use a flexible endoscope of adequate size to allow for the use of appropriate retrieval devices. The smaller flexible endoscopes are more limited in the types of retrieval devices available, and these are less robust and generally less useful than their larger counterparts. As such, the use of a rigid scope, with a protective sheath, will allow the endoscopist to utilize a greater range of both rigid and flexible grasping instruments.

In these instances, the patient is generally maintained under injectable anesthetics, as noted earlier. Great care must be taken to avoid iatrogenic tracheal injury associated with removal of the offending foreign body. It is prudent for the surgeon to be prepared to perform an emergency tracheostomy in the event that the trachea is damaged in the process of removing the foreign body, or



**Figure 14** (a,b) Tracheal foreign bodies are an infrequent cause of respiratory distress in cats. When attempting endoscopic retrieval the size of the foreign body and the location within the trachea must be considered. Images courtesy of Alasdair Hotston Moore

### KEY POINTS

- ✦ The size of our feline patients does present some hurdles that need to be overcome to effectively use minimally invasive diagnostics and therapeutics in the management of nasopharyngeal and tracheal disease.
- ✦ Fortunately, the development of technologies that allow for appropriately sized instrumentation has facilitated access to these difficult to examine anatomic locations.
- ✦ With good training, patience and appropriate instrumentation both the general practitioner and referral feline veterinarian will find tremendous utility in endoscopic examination and minimally invasive surgery of the upper respiratory tract of the cat.

should the retrieval prove unsuccessful and an airway needs to be obtained distal to the site of the obstruction.

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### Conflict of interest

The author does not have any potential conflicts of interest to declare.

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# LOWER RESPIRATORY TRACT ENDOSCOPY IN THE CAT

## Diagnostic approach to bronchial disease

Jonathan D Dear and Lynelle R Johnson



### Why consider bronchoscopy over blind sampling?

Endoscopy of the respiratory tract is invaluable in the diagnostic work-up of animals with respiratory disease. Laryngeal examination is indicated for cats with upper airway complaints such as voice change or inspiratory difficulty and can easily be performed as a sole procedure or immediately prior to lower airway evaluation. The cat with a cough, respiratory difficulty or tachypnea is likely to have lower airway or parenchymal disease and is best examined by bronchoscopy.

Bronchoscopic evaluation of the respiratory tract allows visualization of airway abnormalities as well as collection of bronchoalveolar lavage (BAL) samples to investigate respiratory tract disease in cats.<sup>1,2</sup> Due to the small airway diameter in cats, necessitating specialized endoscopic equipment, and the potential for life-threatening bronchoconstriction in feline patients, bronchoscopy is often reserved for severe, refractory or tertiary referral cases. Despite the potential risk associated with the procedure, bronchoscopy can be performed safely in the vast majority of cases when the

animal is examined by an experienced individual.<sup>3</sup>

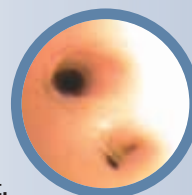
Clinicians sometimes elect to perform blind endotracheal BAL due to concerns about anesthesia or the lack of appropriate equipment.<sup>4</sup> While this technique might provide an appropriate cytology sample, bronchoscopy offers many advantages over blind sampling techniques through the ability to visualize the airway and to obtain samples from specific lung lobes.<sup>5</sup> Airway lesions tend to be less dramatic in cats than in dogs; nonetheless, there is more to learn by performing a complete examination of the airways.

**Practical relevance:** Respiratory endoscopy is a useful diagnostic tool to evaluate the airways for the presence of mass lesions or foreign material while allowing for sample collection for cytologic and microbiologic assessment. While bronchial disease (eosinophilic or neutrophilic) is the most common lower respiratory disease identified in cats, infectious, anomalous and neoplastic conditions can clinically mimic inflammatory bronchial disease. Diagnostic imaging is unable to define the etiology for clinical signs of cough, tachypnea or respiratory difficulty, necessitating visual evaluation and collection of airway samples. Endoscopy allows intervention that can be life-saving and also confirmation of disease, which is important given that life-long medication is likely to be required for management of inflammatory airway disease.

**Patient group:** Cats with either airway or pulmonary disease benefit from laryngoscopy, tracheoscopy and bronchoscopy to determine an etiologic diagnosis. In the best situation, animals that require these procedures present early in the course of disease before clinical decompensation precludes anesthetic intervention. However, in some instances, these tests must be performed in unstable cats, which heightens the risk of the procedure. Cats that do not respond to empiric medical therapy can also benefit from bronchoscopic evaluation.

**Clinical challenges:** Due to the small size of feline airways and the tendency for cats to develop laryngospasm, passage of endoscopic equipment can be difficult. Bronchoconstriction can lead to hemoglobin desaturation with oxygen and respiratory compromise.

**Evidence base:** This article reviews published studies and case reports pertaining to the diagnostic approach to feline respiratory disease, focusing specifically on endoscopic examination of the lower airways in cats. It also discusses appropriate case selection, equipment, endoscopic techniques and visual findings based primarily on the authors' experiences.



**A thorough laryngeal examination is warranted in any cat anesthetized for a respiratory procedure because hyperemia, accumulation of secretions and edema are often found with lower airway disease.**

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### Safety concerns and precautions

Proper patient selection and risk assessment is essential to optimize timing of intervention and collection of airway samples. Cats with severe respiratory distress are stabilized in oxygen and stress is reduced to the lowest level possible prior to consideration of endoscopy. Treatment and prevention of bronchoconstriction by judicious use of a  $B_2$  agonist such as terbutaline is also indicated.<sup>3,6</sup> Specialized endoscopes with an outer diameter less than 4 mm are preferred to perform feline

bronchoscopy safely and to minimize risk to the patient. Adequate oxygenation must be supplied through jet ventilation or placement of a tracheal catheter. Furthermore, the endoscopist should be well versed in the normal appearance and anatomy of the feline airways to allow rapid evaluation and efficient collection of airway samples. Advanced training allows shortened anesthesia time and better patient outcome.

### Indications

Endoscopic examination of the respiratory tract undoubtedly contributes to diagnostic assessment and also allows therapeutic intervention in cats with obstructive large airway disease. As mentioned above, laryngoscopy is indicated for cats with clinical signs related to upper airway obstruction such as stertor or stridor. Gagging, voice change and inspiratory noise or effort are also indications for laryngoscopy. Some of these signs can be seen with cervical tracheal lesions and will require tracheoscopy. Radiographs of the region are helpful in localizing the lesion and determining whether laryngoscopy, tracheoscopy or bronchoscopy might be required. Importantly, a thorough laryngeal examination should be performed in any cat anesthetized for a respiratory procedure because hyperemia, accumulation of secretions and edema are often found in conjunction with lower airway disease and can contribute to clinical signs.

A common indication for bronchoscopy is to document a specific cause for acute or chronic coughing. Coughing is usually associated with an infectious or inflammatory etiology. However, other causes include airway collapse, bronchiectasis or foreign body aspiration. Bronchoscopy can also be helpful in determining the etiology for respiratory difficulty or tachypnea associated with lung disease. However, caution is particularly war-

**Bronchoscopy should be avoided in cats with severe obstructive upper or lower airway disease that cannot be stabilized, severe parenchymal disease or unidentified compromise of ventilation or perfusion.**



ranted in these cases because of the risks associated with anesthetizing a cat in respiratory distress.

Bronchoscopy with BAL is useful primarily in airway-oriented processes; its utility is limited in cases of interstitial lung disease and respiratory neoplasia due to the lack of cellular infiltration into the airways. While an endoscopic biopsy or brushing can detect neoplasia that is endobronchial, these lesions are rare and typically require a lung biopsy to obtain a histologic diagnosis.<sup>7,8</sup>

Another advantage of performing bronchoscopy rather than blind BAL is the unique ability to undertake therapeutic interventions. For example, bronchoscopy can be used to visualize and remove foreign material.<sup>9</sup> It can also assist in debulking or removing airway-associated masses.<sup>10</sup> Finally, airway samples can be collected from specific sites for cytologic or histopathologic evaluation using endoscopic brushes, transbronchial aspiration needles and endoscopy biopsy forceps.

In instances where surgical disease might be encountered (ie, significant laryngeal disease, obstructive tracheal or bronchial masses, or when there is the potential for pneumothorax to develop because of bullous disease), it is essential that appropriate surgical facilities are available following the diagnostic procedure. This will decrease patient morbidity as well as potential mortality and will facilitate transfer of care. While bronchoscopy can be safely performed in many animals, the procedure should be avoided in cats that are not suitable for anesthesia. This includes cats with severe obstructive upper or lower airway disease that cannot be stabilized, cats with severe parenchymal disease or those with unidentified compromise of ventilation or perfusion.

### Endoscopy of the respiratory tract: clinical indications and contraindications

#### Indications

- ❖ Chronic cough
- ❖ Hemoptysis
- ❖ Foreign body removal
- ❖ Laryngeal examination
- ❖ Endobronchial biopsy
- ❖ Selective intubation for video-assisted thoracoscopic surgery
- ❖ Unexplained pulmonary infiltrates

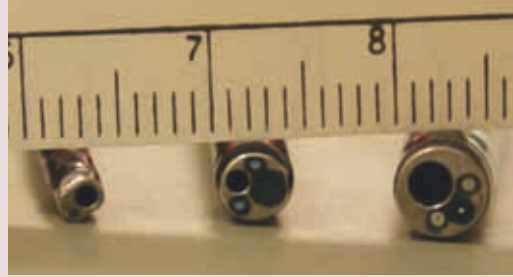
#### Contraindications

- ❖ Unexplained oxygen dependency
- ❖ Multisystemic disease precluding safe anesthesia
- ❖ Upper airway obstruction without capabilities for tracheostomy placement or mechanical ventilation



## Equipment for bronchoscopic evaluation

Specialized endoscopes are required for bronchoscopic evaluation of cats. The ideal flexible endoscope would have an insertion tube outer diameter of 2.5–4.0 mm (Figure 1), working insertion tube length of 55–60 cm (longer endoscopes are cumbersome to manipulate within the airway), a biopsy channel diameter of 1.2–2.0 mm, an excellent light source and, preferably, image capture capability for archiving findings. By convention, two-way deflection endoscopes are used most commonly for respiratory endoscopy. Larger endoscopes (ie, pediatric gastroscopes) have a larger biopsy channel and four-way tip deflection, which are useful for foreign body removal. However, the larger insertion tube diameter precludes evaluation



**Figure 1** The outer diameter of scopes used for feline bronchoscopy and laryngoscopy ranges from 2.5–4.0 mm. This image shows flexible endoscopes with an outer diameter ranging from 2.5–5.0 mm

of all airways in the cat as well as ‘wedging’ into distal airways for BAL fluid collection.

Rigid endoscopic telescopes can be also be used for evaluation of the upper airways and trachea. Extreme care should be taken to avoid iatrogenic damage to the trachea – perforation can lead to pneumothorax or pneumomediastinum. These scopes also do not allow directed sampling of the airways through BAL.

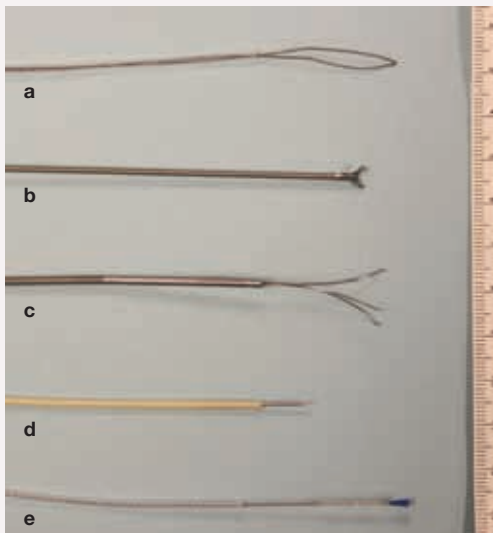
Appropriate ventilation of feline patients can be difficult during bronchoscopy and is one of the more challenging aspects of the procedure. Some endoscopists elect to stabilize the animal under gas anesthesia and periodically extubate for bronchoscopic examination. Specialized adaptors

attached to an endotracheal tube allow administration of oxygen and anesthetic gas during the procedure; however, bronchoscopes used in cats will obstruct the lumen of the adaptor and endotracheal tube, resulting in hypoventilation and hypercapnia. Smaller bronchoscopes (2.8–3.8 mm) and ureteroscopes are also too delicate to pass through endotracheal tube adaptors and thus adaptors attached to the endotracheal tube are rarely used in feline bronchoscopy.

### Ancillary tools

Ancillary supplies that are useful for sample collection include endoscopic cytology (and microbiology) brushes, transbronchial aspiration (Wang) needles, and a variety of flexible and rigid biopsy instruments and snares (Figure 2). The size of the biopsy channel must be taken into consideration when selecting these instruments. For a 1.2 mm channel (generally found in 2.8–3.8 mm endoscopes), instruments such as biopsy forceps and brushes are sized at 1.0 mm, while in a 5.0 mm endoscope with a 2.0 mm channel, a greater variety of instruments can be used, including wire snares, three-prong grabbers, and Wang needles with a diameter of 1.8 mm.

In some practices, suction trap devices are used to collect BAL samples via a tracheal catheter or endoscopic biopsy channel and these can be utilized in line with house suction (Figure 3).



**Figure 2** A variety of instruments are available for bronchoscopic procedures. Generally the outer diameter of the instrument must be 0.2 mm less than the instrument channel of the scope to safely pass the length. Pictured here are 1.8 mm instruments: (a) loop snare, (b) retrieval forceps without spike (spiked forceps are useful for biopsy), (c) three-pronged grabber, (d) Wang needle and (e) guarded microbiology brush (unguarded cytology brushes are also available). Many of these instruments are also available in 1.0 mm diameter for smaller scopes with a 1.2 mm channel



**Figure 3** Suction trap used for collecting BAL samples

### Cleaning of equipment

Lower respiratory endoscopy should be considered a clean procedure and, therefore, facilities should exist for proper cleaning of both endoscopes and ancillary supplies. After finishing the procedure, suction, air and water channels (if present) should be leak tested and gross organic material removed from the scope manually with a commercially available enzymatic cleaner. Next the scope should either be disinfected with high-level glutaraldehyde or sterilized by autoclave, as appropriate. Endoscopic instruments should similarly be cleaned using an ultrasonic cleaner with enzymatic cleaning solution followed by autoclave sterilization.

**Pulse oximetry is valuable as a baseline assessment prior to bronchoscopy and useful for ongoing patient monitoring following the procedure and into treatment.**

### Patient assessment and preparation

It is important to gauge the severity of respiratory compromise and to localize disease prior to performing respiratory investigations because clinical signs can worsen during recovery from anesthesia. Respiratory rate and effort are easy clinical parameters to assess. In addition to thoracic and cervical radiographs, pulse oximetry is recommended prior to anesthesia. If SpO<sub>2</sub> readings do not exceed 95%, hypoxemia is likely and arterial blood gas measurement is recommended when possible. While hypoxemia is not necessarily a contraindication to bronchoscopy, pulse oximetry is valuable as a baseline assessment prior to the procedure and useful for comparison with post-procedural values. Similarly, pulse oximetry is useful as a baseline for ongoing patient monitoring following bronchoscopy and into treatment.

Bronchoscopy is typically performed with the patient in sternal recumbency with the head elevated near the edge of the table, although some clinicians prefer lateral recumbency. Terbutaline (0.01 mg/kg SC) administered before the procedure and immediately before BAL reduces the risk of life-threatening bronchoconstriction and enhances the safety of the procedure.<sup>3,6</sup> While inhaled albuterol might be equally effective, bronchoconstriction

**When assessing laryngeal motion, it is critical to ensure that abduction corresponds to inspiration, as paradoxical laryngeal motion can be mistaken for normal movement.**

could limit deposition of the drug at the site where it is needed. It is also unclear whether inhaled products could alter airway samples, thus parenteral drugs are used more commonly.

Intravenous access is required for anesthetic induction and to allow for resuscitation in the event of an untoward anesthetic reaction. Pre-oxygenation is performed for 5 mins prior to the procedure to delay desaturation with oxygen. For respiratory endoscopy, a combination of propofol and a benzodiazepine provides a smooth and balanced anesthetic induction; however, it is most important that the anesthetic regimen is tailored to the patient. Propofol often causes apnea during induction and at times it is necessary to administer doxapram to stimulate the respiratory cycle for proper assessment of laryngeal movement. A summary of intravenous protocols is provided in Table 1.

In cases of upper airway obstruction (laryngeal paralysis or airway-associated masses), preparations should be made to provide for temporary tracheostomy if needed to allow appropriate recovery. In the case of absent ventilation following extubation, the animal should be re-intubated and mechanical ventilation provided.

### Laryngoscopy procedure

Immediately on induction, a careful laryngeal examination should be performed, especially when there is clinical evidence of upper airway disease or obstruction. It is important that laryngeal function is evaluated under a light plane of anesthesia. Rigid telescopes are easier to maneuver within the caudal oropharynx and provide excellent illumination and magnification. It is essential to have an assistant announce the respiratory cycle to the clinician to allow monitoring for appropriate laryngeal movement (abduction of the arytenoid cartilages during inspiration). Paradoxical laryngeal motion can be mistaken for normal movement; therefore, it is critical to ensure that the abduction (outward movement of the arytenoid cartilages) corresponds to inspiration.

The assistant also monitors anesthesia throughout the procedure and assists with collection of airway samples. Rigid cup biopsy forceps or long (laparoscopic) Metzenbaum scissors can be used to obtain diagnostic samples of laryngeal tissue, which is fibrous and elastic in nature. Several samples from the lesion should be collected because concurrent inflammation can mask neoplastic infiltrates. Feline laryngeal neoplasia is not commonly reported in the veterinary literature; however, lymphoma and carcinoma of laryngeal tissue

**Table 1** Drugs used for respiratory endoscopy

Drug	Dose	Route
<b>Anesthetic agents</b>		
Propofol (10 mg/ml) and midazolam (2 mg/ml)	2–4 mg/kg slowly, then CRI (0.1–0.4 mg/kg/min) and 0.1–0.3 mg/kg	IV
Ketamine (100 mg/ml) and diazepam (5 mg/ml)	1.0 mg/kg (to effect) and 0.2–0.5 mg/kg (to effect)	IV
<b>Local anesthetic agents</b>		
Lidocaine (2%)	1 drop per vocal fold	Topically
Aerosolized lidocaine (10%)	1 spray	Aerosol
<b>Bronchodilator</b>		
Terbutaline (1 mg/ml)	0.01 mg/kg	IV, IM or SC
<b>Anti-inflammatory</b>		
Dexamethasone SP (4 mg/ml)	0.05–0.2 mg/kg	IV, IM or SC





## Normal and abnormal appearance of the feline airways

Feline airways are normally round in appearance with minimal mucus accumulation or mucosal irregularities. Abnormalities that can be recognized include epithelial irregularities, airway collapse, airway stenosis, mucus impaction or bronchiectasis (Figure 6). Infectious, inflammatory and neoplastic disease processes all lead to similar abnormalities in the mucosa, underlining the importance of cytologic assessment and microbiologic

cultures.<sup>2</sup> On occasion, endobronchial neoplasms can be identified (Figure 7) and, in such cases, brush cytology or histopathology samples can be obtained for laboratory evaluation. Each lobar bronchus and lower divisions should be evaluated for signs of disease such as purulent or bloody material and for inhaled foreign bodies, although most foreign bodies in feline airways are found within the trachea or at the carina (Figure 8).<sup>9,16,17</sup>



**Figure 6** Bronchoscopic images showing a combination of gross findings including (a) airway collapse, (b) stenosis, (c) hyperemia and (d) mucus plugging. Unfortunately, gross findings correlate poorly with cytologic or histopathologic diagnoses



**Figure 7** Endobronchial neoplasia is rarely identified in the cat. This is an image of a tracheal adenocarcinoma prior to debulking using an endoscopic snare. A catheter used for jet ventilation is in the foreground



**Figure 8** Piece of gravel found within the trachea of a cat, which was removed using a three-prong grabber and basket retrieval forceps

## Bronchoalveolar lavage

Prior to performing BAL, the endoscope should be withdrawn orally, the external surface wiped with saline-soaked sponges and the biopsy channel flushed with sterile saline to remove any airway material. The endoscope can then be reintroduced and advanced into the lower airways, taking care to avoid oropharyngeal contamination while maintaining a luminal view. This will minimize contamination of the endoscope tip and iatrogenic contamination of lavage samples.

BAL is performed by gently advancing the distal tip of the flexible endoscope deep into the terminal airways. Aliquot volume depends on the size of the endoscope and the size of the

airway being occluded. In general, 3–5 ml aliquots of warm sterile saline are instilled at each lavage site up to a total of 10–20 ml per cat (total volume 2.5–5 ml/kg).<sup>3</sup> During BAL fluid collection, the tip of the endoscope should be agitated slightly to prevent adherence of the channel to the mucosal wall. If negative pressure is found during aspiration, pressure should be relieved temporarily and the tip of the endoscope should be withdrawn and repositioned before subsequent suction attempts.

BAL samples are collected via the endoscopic biopsy channel into a 20 ml syringe using hand suction. Alternatively, a suction trap can be employed to collect the sample for submission. Approximately 50–75% return of fluid should be anticipated.

### BAL procedure in human medicine

The BAL procedure has not yet been standardized in veterinary medicine. In human medicine, the first aliquot of BAL is discarded because it contains primarily bronchial components, and it is well known that second and third aliquots have a different cellular composition.<sup>18,19</sup> This is rarely done in cats because of the overall small lung volume that is lavaged and concerns about reflex bronchoconstriction. Furthermore, although statistically significant, there is not a clinically relevant difference between cell counts in subsequent aliquots of BAL fluid.<sup>20</sup>

Standardization of BAL fluid analysis, interpretation and its relation to clinical disease state is currently lacking in veterinary medicine. A differential cell count is typically used to assess the predominant type of inflammation present, with 'normal' reference intervals for cats of 65–80% macrophages, up to 20% eosinophils, 10% lymphocytes and 7% neutrophils.<sup>20,21</sup> The value of total cell counts has not been established although 200–400 cells/ $\mu$ l has been reported as being an accepted reference range.<sup>20,21</sup> Multisegment airway lavage is recommended in animals that are stable throughout the procedure, and airway samples are submitted separately for cytologic analysis. A recent study found different cytologic interpretations in samples from separate lobar sites in approximately half of cases with diffuse lower respiratory tract disease.<sup>21</sup> Interestingly, different cytologic findings at two sites were even found in cats that had normal thoracic radiographs.

### Suppurative inflammation

Suppurative inflammation is characterized by airway neutrophilia and can indicate a sterile or infectious process (Figure 9).<sup>22</sup> Sterile suppurative inflammation is encountered most commonly in chronic bronchitis but also in bronchiectasis or with neoplasia. Septic suppurative inflammation, characterized by degenerate neutrophils with intracellular bacteria, could be considered a reliable indicator of bacterial pneumonia, although culture of such samples is essential to identify species and antimicrobial susceptibility patterns.

### Eosinophilic inflammation

Bronchoalveolar fluid of normal cats can have up to 20% eosinophils and, thus, airway eosinophilia is not always specific for underlying disease in a cat lacking respiratory signs.<sup>20,23</sup> However, the presence of excessive eosinophils (>20%) with the corresponding clinical signs of cough, wheeze or tachypnea (in the absence of other disease) is suggestive of feline bronchial disease (Figure 10). Other causes of airway eosinophilia include eosinophilic pneumonitis or granuloma, cardiorespiratory parasites such as *Dirofilaria*, *Aelurostrongylus*, *Eucoleus* or *Paragonimus* species, systemic hypersensitivity due to external or internal parasites, larval migration of gastrointestinal parasites (*Toxocara* species), certain fungal (*Coccidioides* species) organisms or viral (feline herpesvirus-1) pneumonia. These causes should be further investigated with fecal evaluation (Baermann technique and sedimentation) for larvae, fungal titers or heartworm antibody and antigen testing.

### Pyogranulomatous inflammation

The majority of nucleated cells identified within a BAL sample should be macrophages and the presence of an elevated cell count with normal differential can be difficult to interpret.

However, the presence of activated macrophages and neutrophils, with or without lymphocytes and eosinophils, is suggestive of pyogranulomatous inflammation. This generally occurs in response to significant airway insult and is usually due to chronic disease such as fungal (*Histoplasma capsulatum*) infection, chronic aspiration pneumonitis, smoke inhalation, bronchiectasis or neoplasia.

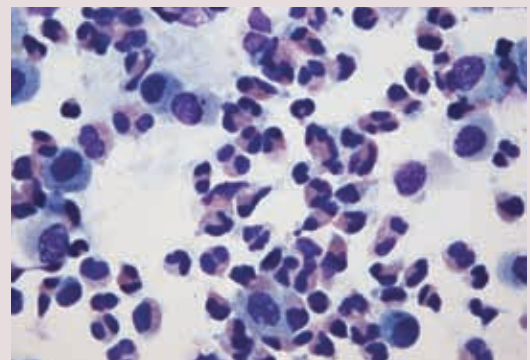
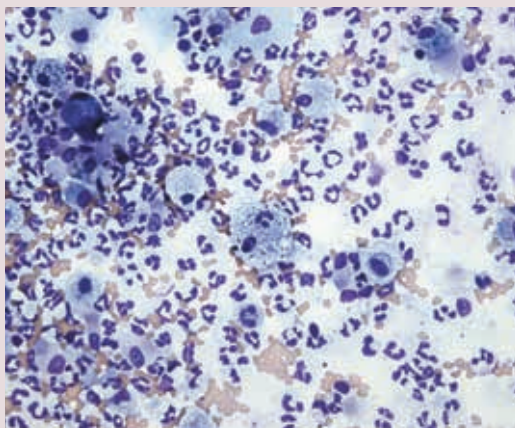
### Hemorrhagic inflammation

Pulmonary hemorrhage can be found with rodenticide intoxication (vitamin K antagonists), *Dirofilaria* or *Paragonimus* species infection, trauma or erosive neoplasms, although these are infrequently encountered in feline patients. Evidence of previous airway hemorrhage (ie, erythrophagocytic macrophages) is common in cats with both congestive heart disease and chronic respiratory disease including feline bronchial disease, neoplasia and pneumonia.<sup>24</sup>

### Neoplastic inflammation

Endobronchial neoplasms are rarely identified in cats but occasionally malignant cells associated with primary or metastatic carcinomas will exfoliate into bronchoalveolar fluid. Pulmonary involvement with lymphoma can also be detected, although this is rare.<sup>25</sup> Cytologic markers of malignancy include cellular crowding, variation in cell size or nuclear size and shape, increased nuclear/cytoplasmic ratio and mitotic figures. These conditions can be difficult to confirm cytologically because dysplastic epithelial abnormalities associated with severe, chronic inflammation often mimic neoplastic change. Furthermore, inflammatory changes associated with necrotic lesions within a neoplasm can hinder identification of neoplastic cells. Review of several samples, advanced imaging (computed tomography) and alternate sampling techniques can be required to confirm the presence of an underlying neoplasm.

**Figure 9** Suppurative inflammation is characterized by either degenerate or non-degenerate neutrophils and is consistent with infectious or inflammatory airway disease. Such samples should be carefully scrutinized for the presence of organisms, although *Mycoplasma* species are rarely identified cytologically due to lack of a cell wall



**Figure 10** Eosinophils can make up to 20% of normal BAL cytology in the cat. Excessive eosinophils (>20%) are suggestive of asthma or inflammatory airway disease

**BAL microbiology**

Only one BAL sample or a pooled specimen from two sites is submitted for microbial culture. Organisms that have been reported as lower respiratory pathogens of cats include *Escherichia coli*, *Bordetella bronchiseptica* as well as *Pasteurella*, *Staphylococcus*, *Streptococcus*, *Pseudomonas* and *Mycoplasma* species, although specific parameters for distinguishing infection from airway contamination have not been described for cats and many of these organisms could also represent oropharyngeal contaminants.<sup>26</sup> The role of anaerobes in feline pneumonia has not been described. Presumably the presence of intracellular bacteria could be used to confirm infection, although absence does not exclude the possibility of an infectious etiology. Organisms can be present in small quantities that elude cytologic confirmation, and *Mycoplasma* species, thought by some to be a common cause of bronchopneumonia in cats, are rarely identified cytologically due to their lack of a cell wall. Culture using *Mycoplasma*-specific medium or polymerase chain reaction is generally needed to document the presence of these organisms.<sup>5,26</sup>

**Infectious, inflammatory and neoplastic disease processes all lead to similar abnormalities in the mucosa, underlining the importance of cytologic assessment and microbiologic cultures.**

**Foreign body removal**

Though uncommon, foreign bodies have been reported in the lower airways of a small number of cats. Focal, persistent alveolar infiltrates increase the degree of suspicion for this differential, although radiographic changes are absent in up to one-third of cases.<sup>9</sup> If a foreign body is found or suspected, the endoscopist should evaluate each branch of the lower airways systematically for additional foreign bodies, paying close attention to areas of thick mucoid, purulent inflammation or bifurcations with proliferative lesions, although most foreign bodies in cats lodge at the trachea or carina.<sup>9</sup> Three-pronged grabbers, snares, and biopsy or alligator forceps can all be used to isolate material and withdraw it orally with the endoscope. After removing one foreign body, the site of implantation should be inspected for residual or additional material.

**Postoperative care and potential complications**

Following completion of bronchoscopy and BAL procedures, the cat should be re-intubated with an endotracheal tube and maintained on oxygen and gaseous anesthetic for 10 mins

to restore oxygen saturation prior to recovery. Anesthetic recovery should take place in a quiet location to minimize stimulation and patient anxiety. Following extubation, flow-by oxygen can be useful if the patient tolerates the proximity of a mask or tube. General anesthetic monitoring and post-procedural monitoring are continued until the animal is fully recovered from the procedure. It is not uncommon for crackles to be auscultated at the site of lavage for 4–12 h after the procedure; however, respiratory distress is generally not encountered.

The most significant complication encountered post-procedure is airway obstruction. This may be caused by inflammation and obstruction of the upper airway (resulting from biopsy or a pre-existing lesion), accumulation of pharyngeal secretions, or severe bronchoconstriction exacerbated by the procedure. In cases where obstruction due to upper airway inflammation is anticipated, dexamethasone (0.05–0.2 mg/kg IV) can be administered prior to extubation. Additional doses of terbutaline (IM or SC) can be considered when significant bronchoconstriction is encountered, as evidenced by reduced hemoglobin saturation with oxygen after BAL.

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**Conflict of interest**

The authors do not have any potential conflicts of interest to declare.

**KEY POINTS**

- ❖ Airway endoscopy with bronchoalveolar lavage (BAL) can provide crucial diagnostic information and, when combined with clinical history, physical examination and thoracic radiographs, offers a complementary assessment of the upper and lower airways of cats.
- ❖ Bronchoscopic evaluation provides several advantages over blind BAL sampling techniques including the ability to visually obtain directed lavage samples and to perform other diagnostic and therapeutic procedures.
- ❖ With appropriate case selection, anesthetic monitoring and training, laryngoscopy, tracheoscopy and bronchoscopy are rewarding additions to a clinician's diagnostic armamentarium.





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# Your Cat's Environmental Needs

## Practical Tips for Pet Owners



We wish to thank Ceva Animal Health for sponsoring this document. Copies of this brochure can be found online at [www.catvets.com/guidelines/client-brochures](http://www.catvets.com/guidelines/client-brochures) or [www.icatcare.org/vets/guidelines](http://www.icatcare.org/vets/guidelines).



# Your Cat's Environmental Needs

## Practical Tips for Pet Owners

### *Addressing your cat's physical and emotional needs enhances its health and quality of life.*

Behavior problems are a leading cause of pets being surrendered or euthanized. These problems often occur in cats because their needs have not been fully met. Cats need resources to perform their natural behaviors and have control over their social interactions. As owners, we can enhance our cats' health and wellbeing by ensuring all their needs are met in the home environment. You might ask: "What can be stressful for a beloved cat with food, water, and a roof over its head?" Read on to find out.

### WHAT ARE ENVIRONMENTAL NEEDS?

Environmental needs include a cat's physical surroundings – indoors, outdoors, or both – as well as their social interactions with humans and other pets. Cats often do not express obvious signs of stress, pain, or sickness that we can easily recognize. If we are proactive and meet appropriate environmental needs throughout a cat's life, we can potentially avoid environmental stressors that can cause unwanted behaviors and even impact medical health.

### MEETING THE NEEDS OF YOUR CAT



**1 Provide a safe place.** Every cat needs a safe and secure place where it can retreat to so that it feels protected or which can be used as a resting area. The cat should have the ability to exit and enter the space from at least two sides if it feels threatened. Most cats prefer that the safe space is big enough to fit only themselves, has sides around it, and is raised off the ground.

Good examples of safe places are a cardboard box, a cat carrier, and a raised cat perch. There should be at least as many safe places, sized to hold a single cat, as there are cats in a household. Safe places should be located away from each other, so that cats can choose to be on their own.



**2 Provide multiple and separated key environmental resources.** Key resources include food, water, toileting areas, scratching areas, play areas, and resting or sleeping areas. These resources should be separated from each other so that cats have free access without being challenged by other cats or other potential threats. Separation of resources not only reduces the risk of competition (which may result in one cat being physically

prevented access to resources by another cat), stress, and stress-associated diseases.

**3 Provide opportunity for play and predatory behavior.** Play and predatory behaviors allow cats to fulfill their natural need to hunt. Play can be stimulated with the use of interactive toys that mimic prey, such as a toy mouse that is pulled across a floor or feathers on a wand that is waved through the air. Cats need to be able to capture the "prey", at least intermittently, to prevent frustration. Early in a cat's life introduce interactive

### UNDERSTANDING THE NEEDS OF YOUR CAT AND THEIR BEHAVIOR

The needs of today's cats have changed little from those of their wild ancestor, *Felis lybica*, the African wildcat.



- Cats are solitary hunters, spending much of their day searching the environment for hunting opportunities. They need to protect themselves from perceived dangers, which include unfamiliar individuals or environment.
- Cats are territorial animals. They feel threatened when their territory is disturbed, either by another animal or physically.
- Cats use scent, posturing, and vocalizations to communicate their unhappiness if they feel threatened.
- Cats have a superior sense of smell and hearing. Stress can occur due to strong or strange smells or sounds, which are undetectable or insignificant to us.
- Cats are social animals, but their social structure differs from ours. Cats may be content as a single cat or living with other cats, preferably related cats such as siblings.

play so they learn to avoid going after your hands and feet for play. Using food puzzles or food balls can mimic the action of hunting for prey, and provides more natural eating behavior. You can encourage your cat's interactive play by rotating your cat's toys so they do not get bored and rewarding with treats to provide positive reinforcement for appropriate play. If you have more than one cat, remember to play with them individually.

**4 Provide positive, consistent, and predictable human-cat social interaction.** Cats' individual preferences determine how much they like human interactions such as petting, grooming, being played with or talked to, being picked up, and sitting or lying on a person's lap. To a large extent this depends on whether, as kittens, they were introduced to and socialized with humans during their period of socialization from 2–7 weeks of age. It is important to remember that every cat interacts differently and to respect the cat's individual preferences. Remember to remind guests and all household members not to force interaction and instead let the cat initiate, choose, and control the type of human contact.

**5 Provide an environment that respects the importance of the cat's sense of smell.** Unlike humans, cats use their sense of smell to evaluate their surroundings. Cats mark their scent by rubbing their face and body, which deposits natural pheromones to establish boundaries within which they feel safe and secure. Avoid cleaning their scent off these areas, especially when a new cat is introduced into the home or there are other changes with pets, people, or the environment of the home. The use of synthetic facial pheromones, such as Feliway® can mimic a cat's natural pheromones and provide a calming effect in a stressful or unfamiliar situation. Some smells can be threatening to cats, such as the scent of unfamiliar animals or the use of scented products, cleaners, or detergents. Threatening smells and the inability to rub their scent can sometimes lead to problematic behaviors such as passing urine or stools outside the litter box, spraying, and scratching in undesirable areas. In some cases, stress-related illness may develop. If any of these problems occur, contact your veterinarian right away.

Addressing environmental needs is essential for the optimum wellbeing of your cat. Most behavior concerns, such as inappropriate elimination, aggression, scratching, and others, can be caused by one of the following:

- not providing cats with the resources they need
- not understanding the cat's social relationships with other cats or people
- an underlying medical problem

***By understanding and providing for your cat's environmental needs, you can help your cat to live a long and happy life.***

**You are an important member of your cat's healthcare team.**

**You can be instrumental in helping with the success of treatments and improved healthcare for your cat.**



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## iCatCare

## Excellence rewarded in three ways

At the International Cat Care (iCatCare) 2013 awards ceremony in London on September 6, the charity, which is the parent body of ISFM,

recognised contributions made by individuals and companies in improving the lives of cats in three award categories.

## ISFM Easy to Give Awards

These awards, recognising the efforts of pharmaceutical companies in making prescription-only medicines (POMs) that are easy to administer to cats, were presented for: **Semintra** (Boehringer Ingelheim), an angiotensin receptor blocker used in the treatment of chronic kidney disease; **Activyl** (MSD Animal Health), a flea spot-on treatment; and **Kesium Chewable Tablets** (Alstoe Animal Health), a palatable form of amoxicillin/clavulanic acid.



Ross Tiffin (far right), iCatCare Strategy and Development Adviser, presents the Boehringer Ingelheim team with an Easy to Give Award for Semintra. The Easy to Give logo can now be displayed on product advertising and packaging



Claire Bessant (right), iCatCare Chief Executive, presents a Cat Friendly Award to Maggie Roberts (centre) and Nicky Trevorrow (left) of Cats Protection

## Cat Friendly Awards

These awards, recognising non-POM products that have made a real difference to cat wellbeing and welfare, were given for: **Feliway** (Ceva); **Hide, Perch and Go box** (British Columbia Society for the Prevention of Cruelty to Animals); and **Feline Fort** (Cats Protection, UK). The two latter products are designed around the cat's need to hide and feel secure, marking the beginning of new thinking in cat rescue.

## Welfare Awards

Presented for the first time this year to recognise individuals' outstanding contributions to the welfare of cats, these inaugural awards went to **David Yates** of the RSPCA Greater Manchester Animal Hospital, UK, and **Melvyn Driver** of MDC Exports. David has collected data from thousands of feline neuterings, worked on anaesthetic protocols and made information available to others to use and learn from. Melvyn's traps and squeeze-back cages allow safe handling of cats, especially ferals, with minimum stress.



David Yates (left) receives his iCatCare Welfare Award from Dr Andy Sparkes, Veterinary Director of the charity

## Award

## Feline research award announced



William Murphy, Associate Professor of Genetics at the Department of Integrative Biosciences, College of Veterinary Medicine and Biomedical Sciences at Texas A&M University, USA, is the recipient of this year's Excellence in Feline Research Award presented by the Winn Feline Foundation and the American Veterinary Medical Foundation. The award recognises Dr Murphy's contributions to feline genomics, addressing feline species phylogeny and developing comparative maps by radiation hybrid analysis.

The award was presented by Winn Past-President, Susan Little, in August at the Merial-NIH Veterinary Scholars Symposium, held at Michigan State University. As well as a cash prize of US\$2500, the award includes a crystal cat statue, the 'Winnie'.



## Young Scientist Awards 2014

Applications are invited for the European Advisory Board on Cat Diseases (ABCD)/Merial Young Scientist Clinical and Research Awards 2014, which aim to reward innovative and outstanding work by promising young professionals in the field of feline infectious diseases and/or immunology. The original work should have been accepted for publication in a referenced journal. The £1000 awards, funded by Merial, will be presented at the ISFM Riga Conference in June 2014, where winners will be invited to give a short presentation or present a poster of their findings.

Application forms and full details can be downloaded from [www.abcd-vets.org](http://www.abcd-vets.org). Application deadline 1 February 2014.

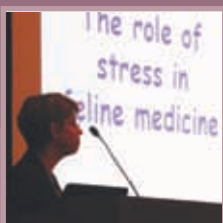
For more information on these awards go to [www.icatcare.org](http://www.icatcare.org).





## Trio of feline themes in Texas

Over 650 veterinary attendees, exhibitors and guests gathered in Dallas, Texas, in September for the 2013 AAEP Conference. The themes were feline dentistry, pain management and nutrition.



Dr Susan Little presents to a packed house during the pre-conference ABVP/AAFP Seminar and Social. She covered stress in feline medicine, senior cats with cancer, feline idiopathic cystitis and kitten diarrhea

### Education



Dr Robin Downing (pictured) and Dr Sheilah Robertson showcased many cutting-edge pain management topics, as well as covering end-of-life issues and hospice care



Dr Claudia Kirk (pictured) and Dr Deb Zoran presented an array of nutrition sessions, including nutrition from kittenhood to geri's, hepatic lipidosis, adverse food reactions, management of obesity, nutrition for hospitalized cats, and top nutraceuticals in pet foods, among many others



Dr Elizabeth Colleran and Jim Thomas present during an early morning breakfast session on 'New feline findings and solutions to increase cat visits', which stemmed from the BVCUS III: Feline Findings research



Dr Jan Bellows (pictured) and Dr Cindy Charlier covered a broad range of practical topics in feline dentistry

For more photos from the 2013 AAEP Conference, visit the AAEP's Facebook page at [www.facebook.com/CatVets](http://www.facebook.com/CatVets).

### At the Helm



The AAEP's 2013 Board of Directors assemble for an in-person Board meeting in Dallas

### ATTENDEE FEEDBACK

- ✦ 'This (was) my first time at AAEP and I would happily re-attend. The level of material presented seems more advanced than that in most vet conferences. I really learned so much!'
- ✦ 'This was my first AAEP conference. (It was) one of the best conferences I have attended in 31 years.'
- ✦ 'Great lectures, food and sponsors. I am so glad that I came and am looking forward to next year!'
- ✦ 'Excellent as always – AAEP rocks!'





Social and networking time during the Exhibitors' Welcome Reception, sponsored by Bayer Healthcare



AAFP attendees visit over 55 exhibitors during meal and coffee breaks to learn more about and try out new products and services

The AAFP's first conference vendor demonstration, presented by Dr Mike LaRosh from Bayer HealthCare, attracted many eager-to-learn attendees



## Exhibit Hall



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## Offsite Event



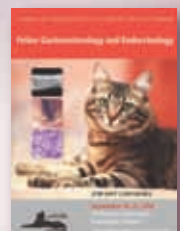
The Best of the West Offsite Event gathered 'cowboys and cowgirls' ready for some down-home southern comfort food, as well as those wanting to move-it on the dance floor to a live country-rock band, and those looking to let loose and have a good time with their friends and colleagues



### Save the date!

## Getting geared for Indianapolis

The 2014 AAFP Conference will be held in Indianapolis, Indiana, from September 18-21. The theme will be feline gastroenterology and endocrinology and will include sessions on diagnosis and management of feline diabetes, pancreatitis, inflammatory bowel disease, gastrointestinal and liver disease, hyperthyroidism, and more.



For information visit  
[www.catvets.com/education](http://www.catvets.com/education)

## Environmental Needs Guidelines – update

- ✦ The AAFP and ISFM Feline Environmental Needs Guidelines, published in March this year, are now available in Spanish at [www.icatcare.org/vets/guidelines](http://www.icatcare.org/vets/guidelines).
- ✦ The client brochure supporting the guidelines, 'Your cat's environmental needs: practical tips for pet owners', can be found on pages 1029–1030 of this issue and is also available to download from the AAFP and iCatCare websites.
- ✦ In the first seven months since being posted online at [jfms.com](http://jfms.com), the Environmental Needs Guidelines were accessed over 7300 times.

## Permethrin campaign posters

Help to warn clients about the dangers of permethrin to cats by downloading these iCatCare posters for display within the practice.



The posters have been produced as part of the charity's campaign for better regulation of the sale of permethrin-containing products in the UK. One poster invites clients to sign up to a petition; the other encourages clients to seek advice on safe flea treatments from their vet. They are available from:

[www.icatcare.org/permethrin](http://www.icatcare.org/permethrin)

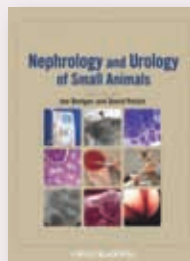
## Books

### Bite-sized reviews

#### Nephrology and urology of small animals

Joe Bartges and David Polzin (eds). Wiley-Blackwell, Oxford, 2011.

Hardback, 904 pages. Price £102.00. ISBN 978081381717



**Positives** This book provides an exhaustive compilation of information on renal physiology, and diagnostic testing and therapeutic techniques for renal and urological disorders. It is useful for veterinary clinicians who have a particular interest in veterinary nephrology and urology or are working or studying at a specialist level. It also covers other important topics such as the pathophysiology of certain renal and urological diseases, fluid, electrolyte and acid-base disorders and hypertension. The book includes a chapter on urinary disorders of avian and exotic companion animals, which some may find helpful. There are a lot of very useful and detailed images, which are of good quality. The book also aims to provide and successfully achieves an evidence-based approach.

**Negatives** From this UK reviewer's perspective, some of the chapters, such as those on haemodialysis, renal scintigraphy and lithotripsy, are not relevant. As this is an American textbook, the units are not standard international and some of the drugs that are discussed are not available in the UK.

**Target audience** Veterinary clinicians with a particular interest in veterinary nephrology and urology and those working at a more specialist level.

**Comment** This is a very comprehensive textbook that would be of use to all those interested in veterinary nephrology and urology. However, it is more suited towards those working at an advanced level.

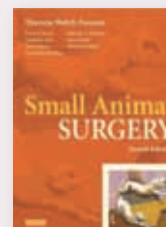
**Ratings** (out of five cats)

- ✦✦✦ Feline-specific content
- ✦✦✦ Practice resource
- ✦✦✦ Value for money
- ✦✦✦ Overall reviewer rating

Natalie Finch  
BVSc PhD MRCVS  
iCatCare Senior Clinical Training  
Scholar in Feline Medicine

#### Small animal surgery

4th ed. Theresa Welch Fossum (ed). Mosby, Elsevier, St Louis, 2012. Hardback, 1640 pages. Price £124.00. ISBN 9780323100793



**Positives** This is a very well illustrated textbook with most images in colour in a very user-friendly format. The new edition has new and updated chapters with more information on newer and more advanced techniques including minimally invasive procedures and advanced imaging. It also provides access to a website enabling updates on chapters, access to video demonstrations and case studies.

**Negatives** The information provided is not as detailed as some surgical textbooks but does convey the key details. The additional data accessed via the website appears quite limited, with only a few case studies and videos currently available.

**Target audience** Practitioners and veterinary students.

**Comment** Although advanced procedures are not routinely performed in first opinion practice, it is good that they have been included to broaden the reader's knowledge and it enables more discussion with clients prior to potential referrals.

**Ratings** (out of five cats)

- ✦✦ Feline-specific content
- ✦✦✦✦ Practice resource
- ✦✦✦ Value for money
- ✦✦✦✦ Overall reviewer rating

Katie Hamilton  
BVSc MACVSc(SAS)MRCVS



## 2013 AAEP Feline Vaccination Advisory Panel Report

**M A Scherk, R B Ford, R M Gaskell, K Hartmann, K F Hurley, M R Lappin, J K Levy, S E Little, S K Nordone and A H Sparkes**

Regrettably, an error appeared in the 'Injectable vaccine administration' box on page 798: the pictures in Figures 8 and 9 were swapped with each other. (*The error appears in the printed copies of the journal, and in online versions downloaded before mid-October 2013.*) The amended box is reproduced here in full.

DOI of original article: 10.1177/1098612X13500429

### Injectable vaccine administration

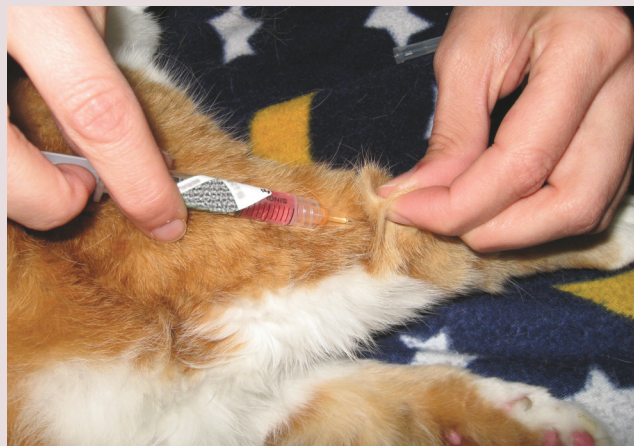
#### Vaccination site recommendations

There is a lack of clinical information to make evidence-based vaccine site recommendations. The majority of safety and efficacy data comes from licensing studies in which vaccines are administered subcutaneously in the interscapular region. Due to concerns of potential sarcoma development, practitioners may consider giving vaccines in other locations. Current research indicates that radical surgical resection of injection-site sarcomas, including margins of 5 cm when possible, is associated with the highest response rate and long-term survival.<sup>75</sup> A 2009 paper reported an increase in lateral abdominal injection-site sarcomas since the publication of the Vaccine-Associated Feline Sarcoma Task Force vaccination recommendations in 1996.<sup>76</sup>

The Advisory Panel recommends, as in the 2006 Guidelines, that veterinarians administer:

- ✦ FPV, FHV-1, FCV vaccines below the right elbow (Figure 7).
- ✦ FeLV vaccines below the left stifle (Figure 8).
- ✦ Rabies vaccines below the right stifle (Figure 9).

Vaccines should be administered as low on the leg as possible. Caution is warranted when vaccinating cats resting in a crouched position as this may result in inadvertent injection of the skin fold of the flank. Veterinarians should note that data on the safety and efficacy of administering vaccines in very distal limb locations are lacking. Figure 10 shows recommended vaccination sites, as well as sites to avoid.



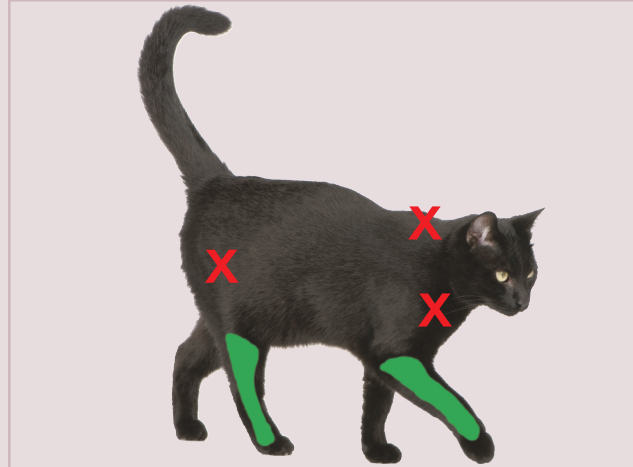
**Figure 7** Administration of FPV, FHV-1, FCV vaccine subcutaneously below the right elbow. Courtesy of Dr Susan Little



**Figure 8** Administration of FeLV vaccine subcutaneously below the left stifle. Courtesy Dr Susan Little



**Figure 9** Administration of rabies vaccine subcutaneously below the right stifle. Courtesy Dr Susan Little



**Figure 10** Regions indicated in green are recommended. Those in red are key sites that should be avoided. Image ©Stockphoto.com/GlobalP





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