AUSTRALIAN COMMITTEE
ASSOCIATION OF AVIAN VETERINARIANS

Endoscopy Workshop

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Avian and Exotic Endoscopic Anatomy and Diagnosis

A Seminar and Laboratory

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Overview

! UNIQUE ANATOMY of the avian respiratory system

  S large volume air sacs with thin, clear walls that invaginate the coelom

! focal, directed illumination with magnification (FDIM)

  S fine diameter, rigid endoscopes offer precise illumination with superb optics

! especially useful in SMALL AVIAN PATIENTS (eg less than 1000 gr)

  S small diameter, superior optics, focal illumination = decreased patient trauma

ARE YOU USING ENDOSCOPY EFFECTIVELY?

History

S development of the rod lens by Hopkins revolutionized rigid endoscope design, allowing the production of high quality, fine diameter endoscopes

S zoological veterinarians (Mitchell Bush, Bill Satterfield) and practitioners (Greg Harrison and Raymond Kray) described and promoted the usefulness of smalldiameter rigid arthroscopes in the late 1970's and early 1980's.

S endoscopy for "surgical sexing" (identification of sex in monomorphic species) was the client-driven force that enabled the development of diagnostic endoscopy

S improved endoscopic technology especially systems created with specific animal needs in mind have been slow to enter veterinary medicine

PHYSICAL PRINCIPLES OF FIBEROPTIC ENDOSCOPY

Rod Lenses

- Professor Harold Hopkins patented the concept of fine diameter cylindrical or "rod" lenses which increased light transmission by decreasing the glass/air interface between lenses
- markedly improved optics in small diameters when compared to conventional convex lens systems

Glass Fibres

- transmission of light through glass fibers based upon the principle of internal reflection
- different refractive indices achieved by special "cladding" or coating of outside of fibers to facilitate internal transmission of light
- degree of curvature directly proportional to amount of light lost (eg. straight cable = maximal light transmission)
- match cable bundle diameter to telescope bundle size for best light transmission

EQUIPMENT

1. **Rigid Endoscopes**

   - available in a wide variety of diameters and lengths
   - fine diameters most suitable for patients under one kilogram

   1.9mm :

   - finest diameter currently available using high quality optics (rod lenses)
   - less light transmitted and smaller image size obtained at ocular therefore best suited for patients weighing 20 - 200 grams or in small spaces (eg. infraorbital sinuses, external ear canal)
   - fragile, especially in longer lengths, recommend 110 to 120 mm maximum

   2.7mm :

   - most frequently recommended diameter for avian endoscopy in birds less than 3000 grams
   - modern designs (eg. Storz 64108 BS) provide an excellent compromise between diameter and light transmission with excellent resolution

- S length of 170 to 190 mm offers most flexibility (with care can be used in small patients yet offers sufficient reach for larger birds)

4.0-5.00mm :

- S larger diameter = greater light transmission = improved viewing in larger cavities
- S recommended for use in birds weighing more than 3000 grams (e.g. large raptors, cranes, some ratites, anseriformes) or for certain
  endodocumentation procedures
- S most modern 4.0 and 5.0 mm endoscopes utilise new distal lens designs that provide a wider viewing field (e.g. Hopkins II system)

2. Flexible Endoscopes

- S distal tip flexible in one or two planes (L - R, U - D)
- S body or shaft of endoscope inherently flexible so best suited for examination of tubular organs
- S variable lengths, diameters
- S viewing system of one of two types:

a) *coherent flexible glass fibers*

- S all original flexible endoscopes used this system
- S poor image quality due to finite number of glass bundles (equivalent to decreased pixel elements)
- S further degradation with use as fibers break due to flexion

b) *CCD at distal tip*

- S system currently available only in gastroscopes larger than 10 mm, although Olympus has recently introduced a 5.0 mm bronchoscope with CCD technology price= $60,000
- S improved image quality over comparable diameter glass fiber system due to increased number of pixels, digital (electronic) processing, and no fiber "drop out" in viewing system due to wear
- S digital processing permits unique storage, manipulation and printing of examination data not possible with older fiber viewing systems
- S far more costly than glass fiber versions

3. Light Sources

a) Tungsten Halogen:

S moderate intensity of 150 to 250 Watts
S warm colour temperature (3200-3400 Kelvin)
S relatively inexpensive replacement bulbs
S useful for general diagnostic purposes
S 250 W versions can be used for video in many birds

b) Xenon:

S high intensity of 500 to 1000 Watts
S daylight-like colour temperature (5500 Kelvin) but with increased blue portion of the spectrum
S more costly, specialized lamp with high temperature output
S best suited for endovideo use

4. Hand Instruments

a) Biopsy Forceps

i. Rigid

S original biopsy technique described by Kollias and Harrison used 3.0 mm (9 Fr) elliptical cup forcep
S had to be manipulated along shaft of telescope
S iatrogenic trauma was possible due to blind passage
S stiff inflexible shaft, large biopsy harvested

ii. Flexible

S traditionally used with flexible endoscopes
S introduced with new rigid avian diagnostic system developed by author (Karl Storz Veterinary Endoscopy, Goleta, CA, 64108 BS 2.7 mm telescope with 67065 CC sheath)
S can be easily and atraumatically delivered to distal lens surface, accurately guided to target
S available in several cup sizes and shapes:

* 3 Fr, 5 Fr elliptical cups (61071 ZJ, 67161 Z respectively)
  S routine use for small, medium birds
* 5 Fr round cups (071 Z)
  S less tissue penetration due to cup shape

b) Grasping Forceps

i. Rigid

- "alligator" forceps and other types have been endoscopically guided as secondary instruments
- similar problems as with guidance of rigid biopsy

ii. Flexible

- routinely used in flexible endoscopic applications
- variety of shapes, jaw types available
- excellent for foreign body retrieval, grasping debris and blunt dissection
- 2 types of forceps introduced with rigid diagnostic set:
    - a) Fine (3 Fr) - small object retrieval, (61071 TJ) - blunt dissection
    - b) Coarse (5 Fr) - larger foreign bodies (67161 T)

c) Scissors

- semi-flexible 3 FR scissors are available for the diagnostic set (62501 EK)
- superb for incising air sacs, peritoneal cavities

d) Infusion Needles

- a long, 22 g infusion / aspiration needle was introduced as a part of the rigid avian diagnostic set (071 X)
- Teflon guide eases passage of needle in sheath and can be used to control depth of needle penetration
- tip may be used as a sharp for the incision of air sac or pleura / peritoneum or energized by connecting to a radiosurgical unit (e.g. Ellman Surgitron)

e) Catheters

- sterile 3.5 and 5 Fr feeding catheters (Sovereign, Sherwood Medical, St Louis, MO) may be used for the aspiration or infusion of liquids under precise guidance

ANAESTHESIA

1. Isoflurane

2. Others

APPLIED ANATOMY

Visualization:

- describe lesions accurately in terms of:
  - ***LOCATION***
  - ***COLOUR***
  - ***SIZE***
  - ***SHAPE***
  - ***CONSISTENCY***

Approaches

1. *External Acoustic Meatus*

   - highly variable structure among orders
   - must use 1.9mm to examine Amazona, Psittacus
   - 2.7mm useful in Ara, Cacatua, most raptors
   - 4.0mm may be used in some Strigiformes due to large size

   - Structures:
     - epithelium of ear canal
     - tympanum (note projects outwards)
     - columella
     - extracolumellar cartilage

2. *Oropharynx*

   - while easily accessed through the bill, great care must be taken while examining species such as psittacines who may damage equipment and personnel due to beak strength
   - anesthesia frequently required for thorough examination
   - FDIM especially useful in small patients where visualization of oral lesions may be very difficult with conventional equipment

- S Structures:

  - ‣ papillae
  - ‣ choana
  - ‣ infundibular cleft
  - ‣ nasal septum
  - ‣ conchae
  - ‣ salivary glands

3. *Examination of Ingluvies, Proventriculus and Ventriculus*

a. **Ingluvies**

- S the crop may be examined using rigid or flexible equipment
- S best results are achieved in birds under 800 grams using rigid 2.7 or 4.0 mm endoscopes of appropriate length
- S **rigid diagnostic system *or* flexible endoscope** with forceps may be used for foreign object retrieval using air or saline insufflation
- S FDIM greatly enhances diagnosis of crop disease, visual inspection of lesions and debris

b. **Proventriculus and Ventriculus**

- S flexible or rigid endoscopes may be used depending upon the size of the bird
- S passage of the flexible endoscope across the crop and into the thoracic esophagus may prove difficult in small to medium sized birds
- S the added length of the typical flexible endoscope is most useful in large birds, especially if a 10.0 mm CCD endoscope can be employed to improve image quality
- S best visualization in smaller patients is achieved with the Storz rigid avian diagnostic system introduced through an INGLUVOTOMY into the thoracic esophagus
- S Storz system sheath has infusion port for saline flushing or air insufflation as well as instrument port for flexible grasping forceps introduction and has been used for foreign body retrieval in birds from 300 to 1200 grams

4. *Air Sacs (Approaches - see Diagram)*

a. **Interclavicular**

One Approach (#12):

- S patient is fasted to empty crop, proventriculus
- S dorsal recumbency
- S skin incised over the caudo-ventral border of the thoracic inlet, taking care to avoid the ingluvies
- S ingluvies is gently displaced to the right side
- S small incision made on midline through glistening clavicular air sac membrane
- S Structures:
  - ‣ trachea
  - ‣ syrinx
  - ‣ bifurcation (left and right primary bronchi)
  - ‣ esophagus
  - ‣ heart base
  - ‣ brachiocephalic trunk
  - ‣ carotid arteries
  - ‣ thyroid, parathyroid

b. **Cranial Thoracic (CrTAS)**

One Approach (# 1, 2):

- S lateral recumbency (L or R)
- S ventrolateral thoracic wall, caudal to the last sternal rib
- S region of the lateral notch
- S Structures:
  - ‣ lung
  - ‣ pulmonary artery
  - ‣ heart (pericardial sac)
  - ‣ liver
  - ‣ ribs
  - ‣ confluent wall of cranial and caudal TAS

c. **Caudal Thoracic (CaTAS)**

This is **THE MAJOR INSERTION POINT** for routine avian endoscopy examinations

Two Approaches:

i. Cranial to Femur (# 3,4)

- lateral recumbency (L or R) with the wings extended dorsally
- L entry allows examination of the largest number of structures
- upper leg is extended and held caudally
- insertion point is located by visualizing the center of a triangle formed by the cranial muscle mass of the femur, the last rib and the ventral border of the synsacrum
- this entry frequently places the endoscope between the seventh and eighth ribs

ii. Caudal to Femur (# 5,6) RECOMMENDED

- same positioning as i. except upper leg is extended cranially
- entry site located where the semimembranosus muscle (M flexor cruris medialis) crosses the last rib
- semimembranosus is reflected dorsally and blunt entry is made through the body wall just caudal to the last rib
- the view from both points is similar however insertion i. positions the tip of the endoscope in the cranial to middle portion of the air sac while insertion ii. enters at the caudal border
- potential access to both the CrTAS and AAS

Structures:

- lung with large ostium
- proventriculus
- liver
- confluent walls of cranial and caudal TAS
- confluent walls of caudal TAS and AAS

d. **Abdominal (AAS)**

Three Approaches:

i. **Via Caudal Thoracic** (**MOST COMMONLY USED**)

- S previously described approaches to CaTAS (# 3,4,5,6)
- S must pass through confluent air sac wall to enter AAS

ii. **Pre Pubic (#7,8)**

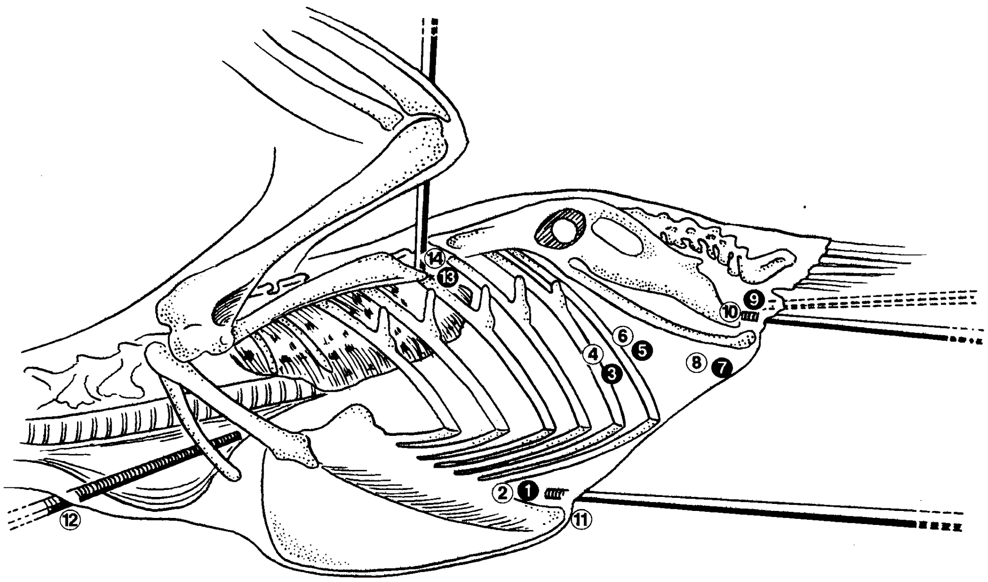
- \- entry directly ventral to acetabulum, approximately mid way between the last rib and the pubis and just dorsal to the ventral border of the *flexor cruris medialis*
- S directly enters AAS

iii. **Post Ischial (#9,10**)

- S entry dorsal to pubic bone, caudal to ischium, dorso-lateral to vent
- S endoscope first enters the caudal (and only superficial) portion of the intestinal peritoneal cavity and must be pushed through the confluent IPC/AAS wall to enter the airsac

Structures:

- ▸ Left AAS
- ▸ proventriculus
- ▸ ventriculus
- ▸ spleen
- ▸ adrenal gland
- ▸ gonad(s)
- ▸ kidney
- ▸ intestine



5. *Peritoneal Cavities*

a. Ventral Hepatic Peritoneal

- surrounds the entire ventral surface of the liver
- divided on midline by ventral mesentery into L and R VHPC, may not always be complete

Two Approaches:

i. Ventral Midline (# 11)

- entry on or just slightly to the side of midline, just caudal to the border of the sternum
- frequently a large fat pad present at caudal VHPC
- endoscope will enter L or R VHPC, opposite side may be entered by passing through the ventral mesentery
- provides best access to both the R and L liver lobes

ii. Caudal Thoracic Air Sac (L or R) (# 3,4,5,6)

- the liver appears tantalizingly approachable from the CaTAS but the confluent air sac / peritoneal membrane MUST be incised to allow handling of the organ
- this approach convenient when performing traditional examination and liver lesions noted

- contraindicated when ascites present as fluid will spill from VHPC into air sac and possibly lung

b. Intestinal Peritoneal

- post ischial insertion points (#9,10) as for AAS
- is a ***potential space***, can be insufflated
- IPC straddles the midline, running fron the region of lungs caudal to cloaca

6. *Pleural Cavity via Intercostal*

- intercostal space just caudal to end of scapula in most species
- enter just dorsal to level of scapula
- intercostal muscles are very thin, dissect carefully
- the visceral pleura is very thin, pleural space may be almost nonexistent
- in species the pleural space is large enough to be entered

ENDOSCOPIC BIOPSY AND SPECIMEN COLLECTION

1. Kidney

a. *Approaches*

- enter CaTAS to approach the AAS (#3,4,5,6) or directly to AAS (#7,8,9,10)

b. *Techniques*

- cranial, middle or caudal divisions?
- cup or spoon shaped biopsy forcep

c. *Indications*

- polyuria / polydipsia
- persistently elevated uric acid levels
- abnormal gross appearance of renal parenchyma

2. Liver

a. Approaches

- #11 or #3,4 or 5,6 **(see VHPC section)**

b. *Techniques*

- S examine liver surfaces thoroughly (dorsal and ventral): focal or diffuse lesions?
- S caudal or lateral borders are easily grasped for representative samples of diffuse hepatic disease
- S focal lesions may be more challenging to harvest
- S hemorrhage is rare in patients with adequate coagulation parameters due to the crush/cut of forceps (stimulates tissue thromboplastin release)

c. *Indications*

- S evidence of hepatic disease non-responsive to treatment
  - * CLINICAL: abnormal yellow or green urates
  - * RADIOGRAPHIC: hepatomegaly or abnormal silhouette
  - * BIOCHEMICAL: AST (+CPK), LDH, Bile Acids

- S Bile acids elevated greater than twice reference range for more than 14 days

***TIP*:** in my experience clinicians frequently wait too long to perform hepatic endoscopy/ biopsy due to fear of the procedure, leading to non specific "**BIOPSY OF CHRONICITY"**

3. Air Sac

a. *Approaches*

- S cranial or caudal air sac approaches (#1,2 or 3,4,5,6)
- S airsacculitis frequently discovered on routine CaTAS examinations (e.g. for sex identification)

b. *Techniques*

- S cup biopsy OR grasping forceps may be used to harvest air sac debris for cytology, microbiology
- S biopsies best collected from edge of air sac puncture such as between CaTAS and AAS, very hard to handle, place on piece of cucumber or cardboard

c. *Indications*

- S radiographic irregularities
- S assessment of findings during routine exam.

4. Lung

a. *Approaches*

- S caudal-medial portion may be approached from the caudal or cranial thoracic air sacs (#1,2 or 3,4,5,6)
- S dorso-lateral surface is best accessed by the intercostal approach. (#13,14)

b. *Techniques*

- S from caudal positions combined air sac and pleura is thick and may need to be incised (eg use 071 X needle or scissors) or electrosurgical needle
- S avoid deep penetration of parenchyma to help prevent trauma to major blood vessels
- S use of FDIM enhances accuracy of biopsy collection, especially focal lesions

c. *Indications*

- S diffuse pulmonary disease
- S focal granulomatous disease
- S radiographic, clinical, auscultative findings

5. Ventriculus

- S serosal / muscularis biopsies of the ventriculus can be diagnostic for Proventricular Dilation Disease (Neuropathic Gastric Dilation, Wasting Disease)
- S choose at least two sites near a blood vessel to maximize collection of nerve tissue
- S enter caudal portion of left CaTAS (left caudal border of ventriculus or left of midline, just caudal to sternum
- S may require heavier (eg 7 or 9 Fr) biopsy forcep

Reptile Endoscopy

Bush described the use of rigid endoscopes for the evaluation of reptiles in the ground breaking book *Animal Laparoscopy* published in 1980. Other workers applied this technology to a number of orders of reptiles. Schildger described the use of a small diameter pediatric cystoscope with an integral sheath in 1992. This system allowed the insertion of 3 FR (one millimeter) hand instruments through the channel in the integral sheath. Targeted biopsies could be collected under direct visualization. Insufflation was also possible using a laparoflator connected to one of the infusion ports on the sheath. Reptile medicine is currently in a rapid growth phase reminiscent of avian medicine in the early 1980's. A number of endoscopic applications for reptiles are likely to arise out of work already completed in avian endoscopy.

The focal, directed illumination and magnification achieved with modern rod lens endoscopes such as the Storz 018 BS is highly applicable to work in a variety of reptiles species. The author has utilized the previously described avian sheath and 2.7 mm endoscope system with 5 Fr instruments to exam and collect specimens from chelonians (turtles and tortoises) and the green iguana. Insufflation is achieved in a manner similar to that described by Schildger. Carbon dioxide from a manual or electronic laparoflator is infused through one of the lateral stopcocks of the sheath at a pressure of 10 mm Hg. Fine regulation of intracoelomic pressure was possible by selectively venting the valve of the opposite stopcock. A white rubber fitting (White rubber sealing bonnet, 27550 C, Karl Storz Veterinary Endoscopy, Goleta, CA, 93117) placed over the instrument port prevents excessive air leakage during instrument placement. Biopsys of the liver, kidney and spleen may be routinely collected by introducing a flexible cup biopsy forcep through the rubber fitting and into the instrument channel. As in the bird, the forcep tip may be guided precisely to the site of collection. It may be necessary to incise the peritoneum over the kidney in some species with a semi-rigid scissor (501 EK, Karl Storz Veterinary Endoscopy, Goleta, CA, 93117).

In chelonians (turtles and tortoises) an entry incision was made in left prefemoral region after it was surgically prepared using standard techniques of skin cleansing. The incision was equidistant from the horizontal margins of the carpace and plastron and approximately midway between the femur and the cranial portion of the carapace margin, similar to a surgical approach described previously for laparotomy . A fine mosquito forcep was introduced through the body wall in a cranio-medial direction. The jaws were opened to gently spread the muscle layers. In lizards such as the Green Iguana (*Iguana iguana*) an incision is made in the region analogous to the mammalian “paralumbar fossa” caudal to the last rib. The fine musculature of the body wall may be spread using a mosquito forceps as in the chelonians. While insufflation with an inert gas such as carbon dioxide is not always necessary in chelonians, it is essential in the lizard to allow adequate visualization. From this insertion point looking cranially the operator can view the liver, spleen, stomach, lung and heart. There is no diaphragm present. With increased intracoelomic pressure the lungs may not inflate well and intermittent positive pressure ventilation (IPPV) is recommended at 2-3 breaths per minute.

Summary

Rigid endoscopy in birds and reptiles has never offered more potential to the exotic animal practitioner. Improved instrumentation designed to more fully meet the needs of the avian or reptile clinician has led to easier implementation of clinical sampling with greater diagnostic return. Improved imaging technologies, especially endovideo cameras, have dramatically altered the way endoscopic techniques can be demonstrated and taught. It is now possible to participate in intensive two day courses for avian and reptilian endoscopy. These same technologies are making it possible for colleagues to consult on cases in a manner not possible before. The potential for new endosurgical procedures is great.

ENDODOCUMENTATION

1. Still Photography

Newer high speed films have allowed acceptable imaging with less light required. The higher the ISO value of the film, the more sensitive it is to light but the larger the grain structure present. This may lead to unsuitable graininess if the end use requires enlargement of the original image.

The 35 mm format is used for still endophotography because of its comparable size in relation to the normal ocular image and because of the ease of handling of modern 35mm single lens reflex cameras.

As in all other types of photography the key limiting factor besides equipment considerations is LIGHT. The quality and amount of light that can be delivered to the site is limited by the design of the endoscope and the type of light source used. It is soon evident that specialized, high intensity lighting is required to record good quality photographic images. Various manufacturers have developed systems to enable photographic imaging using endoscopic equipment. The most successful of these use a flash generator that is fired in synchronization with the camera's shutter and are controlled by a through the lens (TTL) metering system.

For the past six years we have achieved excellent results using a powerful flash generator (Model 600, Karl Storz Endoscopy, Tuttlingen, Germany) with TTL control. The high output of this unit has enabled me to use fine grained transparency films in the ISO 50-100 range. The strobe effect of the flash has the added benefit of stopping motion.

Uses:
- case documentation (for medical record, colleague, client)
- publications

2. Video Documentation

The greatest practical advances in endodocumentation have occurred in the field of video imaging. Improvements in the CCD chips allow greater sensitivity to low light levels combined with higher resolution when recorded on formats such as S VHS and Hi8.

Specialized endovideo cameras consist of a soakable hand piece that contains the CCD chip, a focusable lens and a quick connector. This unit is attached to the controller by a sealed cable. The controller, which contains all of the electronic circuitry for the camera, is placed out of the surgical field.

The sterilized camera may be used for the real time visualization of procedures and is preferred by some clinicians as an aid to performing certain manipulations. The procedure is observed on a monitor without the need for the surgeon to view the ocular. Portions or all of the examination can be recorded for later review. This can be a valuable research tool allowing comparison of many different examinations.

Still images can be captured from recorded material using a video printer. These prints are adequate for the medical record or for client use but are seldom suitable for publication.

Uses:

- an aid to performing instrumented procedures, avoids need to keep head at eyepiece during instrument manipulation, ***improved ergonomics***
- case documentation, particularly useful in showing relationships in space and time
- teaching, demonstrations (eg. for clients, colleagues), excellent ethical marketing tool to let clients know what you can do

Recommended Reading:

Taylor M: Endoscopic examination and biopsy techniques. In Ritchie BW, Harrison GJ and Harrison LR (eds): Avian Medicine: Principles and Application, Lake Worth, Wingers Publishing Inc, 1994, pp 327-354.