SNAKE CLINICAL PROCEDURES AND DIAGNOSTICS

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There are very few pathognomonic signs in reptile medicine, and it is generally very difficult to make a diagnosis in the examination room. Definitive diagnosis is important to maximize therapeutic success, while reducing the negative impacts of providing veterinary care. In general, diagnosis relies upon the demonstration of a host pathological response (eg, cytology, histopathology, and serology) and the causative agent (eg, microbiology, toxicology). Diagnosis is often straightforward if appropriate samples can be collected, processed and interpreted. This article focuses on the most common techniques and procedures and is far from complete. Further details can be found in published texts.

CHEMICAL RESTRAINT

While some procedures can be performed in the conscious snake, sedation or anesthesia can facilitate procedures, and reduce trauma to the animal. A review of snake anesthesia appears elsewhere in these proceedings, and detailed reviews are available elsewhere.

HANDLING & EXAMINATION

A detailed review of husbandry and past medical history is required prior to physical exam. The head of an aggressive snake or a snake of unknown disposition should be identified and restrained before opening the transportation bag and removing the animal. Venomous snakes should be anesthetized prior to physical contact. In general, the head of the snake is held behind the occiput using the thumb and middle finger to support the lateral aspects of the cranium. The index finger is placed on top of the head. The other hand is used to support the serpentine body. Larger pythons and anacondas are powerful and potentially dangerous. When dealing with large, even docile boids, a second, third, or even fourth handler will be required to help control the body during the examination. It is usually safer and more convenient to sedate a large pugnacious snake than to struggle on and risk injury to the snake, client, or staff. A complete physical examination should be performed, starting if possible, with a hands-off approach to assess mentation and resting respiratory rate. The physical examination should start with a resting heart rate and be followed by an evaluation of neurologic function, muscle tone and strength, integument, infra-orbital pits (where present), nostrils, eyes, oral cavity, and cloaca. The entire head, body and tail should be palpated, and any internal abnormalities recorded as a percentage or fraction of snout-to-vent length. The gender should be determined from tail length/confirmation, or probing the inverted hemipenes.

DIAGNOSTIC IMAGING

Snakes can be difficult to position and restrain for radiographic examinations unless anesthetized. If the purpose of the examination is simply to rule out radiodense foreign bodies, the snake may be allowed to coil in its natural position while the radiograph is taken. If detailed examination of the skeletal, respiratory, and digestive system is desired, the snake must be extended. A plastic restraint tube can be utilized for this purpose; however, this may produce some radiographic artifact. In larger snakes, several films will be needed to radiograph the entire length of the body. It is important to properly label each exposure in order to keep track of all the different views. Lateral views are best taken using horizontal beams to avoid displacement artifact of the viscera. However, standard laterals with the snake taped in lateral recumbency can be useful especially where horizontal beams are not possible or safe to undertake. The interpretation of dorsoventral views is hindered by the spine and ribs, but can still be useful when dealing with obvious lesions including eggs and mineralized masses.

Traumatic fractures, spondylitis/spondylosis, osteomyelitis, and congenital abnormalities are common indications for examining the skeletal system of snakes. Fractured ribs with periosteal bone formation are a common finding in snakes. Another common finding is exuberant vertebral periosteal bone formation. On radiographs, this appears as several "fused" vertebrae. Common indications for radiographically evaluating the digestive system include hypertrophic gastritis, foreign body ingestion/impaction, constipation, hepatomegaly and other masses. Contrast studies are useful in diagnosing intestinal obstruction and constipation. In addition, contrast material in the gastrointestinal tract can often outline and help determine the origin of a non-specific intracoelomic masses; intraluminal or extraluminal. Cardiomyopathy has been reported in snakes, which can be indicated by cardiomegaly on radiographs. Metastatic mineralization of large blood vessels is often apparent around the heart due to the negative contrast afforded by the adjacent lung(s). The superimposition of other organs such as liver and stomach over the lung fields can make the radiographic interpretation of respiratory disease challenging. Common indications for evaluating the respiratory system are rhinitis, suspected neoplastic and infectious disorders of the trachea and lung, as well as abscesses or granulomas. The kidneys are not always radiographically evident, unless enlarged or mineralized. Disease processes that can cause renomegaly include renal gout and neoplasia. Eggs of oviparous species are leathery and poorly calcified, but can often be appreciated on plain radiographs. In viviparous species fetal skeletons become visible as they mineralize late in gestation. The hemipenes of some species may appear mineralized and can be detected radiographically.
Common indications for evaluating the reproductive system include dystocia, apparent infertility and reduced fecundity. The presence of any swelling is an indication for radiography. Abscesses, which can either be extracoelomic or intracoelomic and associated with a specific organ or the coelomic wall are common findings in snakes. Ultrasonography is particularly useful for evaluation of soft tissues, especially the reproductive system, liver, and kidneys. Copious gel (or a water bath) is required to reduce artifact caused by air trapped under the scales. CT and MRI are used rarely, on a case by case basis.

**BLOOD**

The ability to collect quality blood samples is essential in any animal class. Complete or selective hematologic and biochemical evaluations are possible but the accuracy of results is often adversely affected by poor venipuncture, handling or laboratory skills. The production of poor quality blood data can be useless or even worse, misleading to the clinician. Likewise, the ability to administer intravenous medications, especially anesthetics, or place intravenous catheters also relies on proficient veniplication technique. Venipuncture is generally a blind technique in snakes. Despite a continuous trickle of published blood ranges, there is still a relative dearth of hematologic or biochemical data for reptiles compared to domesticated animals. In addition, blood values can vary dramatically with species, environment, nutrition, age, breeding status, hibernation and disease status. Given this variability published ranges may be of limited value. More reliance should be placed upon establishing an individual’s observed range and using serial sampling to monitor the progress of hematologic and biochemical changes rather than relying on a single result. The two common sites for venipuncture in snakes are the caudal (ventral tail) vein and the heart (Figure 1).

The caudal (tail) vein is accessed caudal to the cloaca, between 25 and 50% down the tail. It is wise to avoid the paired hemipenes of males (that may extend up to 14 to 16 subcaudal scales caudal from the vent), and the paired cloacal musk glands of both sexes (that may extend up to 5 subcaudal scales). The needle is angled at 45 to 60 degrees and positioned in the ventral mid line. The needle is advanced in a craniodorsal direction, while maintaining slight negative pressure. If the needle touches a vertebral body it is withdrawn slightly and redirected more cranially or caudally. This vessel is most easily entered in larger snakes and lymphatic contamination is possible but generally uncommon.

With the snake restrained in dorsal recumbency, the heart is located approximately 22% to 33% from snout to vent. The heart is palpated and immobilized. The needle is advanced at 45 degrees in a craniodorsal direction into the apex of the beating ventricle. Blood often enters the syringe with each heartbeat. It is wise to maintain digital pressure for 30 to 60 seconds following this technique. This technique has been employed in snakes of all sizes from 10 g neonates to 100+kg constrictors. Nevertheless, good chemical/physical restraint is essential if significant cardiac trauma is to be avoided.

**INTEGUMENT**

Dermatologic disease is a frequent presentation and there are various levels at which the clinician can intervene and collect biological samples. Shed skin, skin scrapes, impression smears, scale and skin biopsies can all be collected. The skin and associated structures are perhaps the easiest to sample for laboratory analysis due to their accessibility. However, they can also be the most demanding to interpret as contamination and secondary changes often mask the underlying primary complaint. Various ectoparasites may be clearly seen on

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**Figure 1.** (a) Blood collection from the caudal (ventral tail) vein of a Boa constrictor – note the venipuncture site is in the ventral midline and caudal to the cloaca (arrow). (b) Dorsoventral radiograph of a corn snake following a barium enema – note the outline of a caudal mass, external to the intestinal tract. This well demarcated and encapsulated mass was surgically excised, and proved to be a granulosa cell tumor
Figure 2. (a) Shed skin from a snake that was suffering from severe mite infestation and self-inflicted wounds from the intense pruritus. One of these lesions can be appreciated from the abnormal slough (arrow). Insert, the common snake mite, *Ophionyssus natricis*, was recovered from the shed skin. (b) Endoscopic view of a Ball python (*Python regius*) with granulomatous pneumonia (arrow). The diagnosis of pulmonary mycobacteriosis was made following biopsy as lung lavage proved unrewarding.

the surface of the skin, around nostrils, eyes, and skin folds (Figure 2). Mites, ticks, lice, maggots, flies can often be physically removed and submitted in specimen containers for taxonomic identification. The shed skin of reptiles is also a valuable asset and should be inspected for evidence of parasitism. Suspected mites can be collected direct from the snake using a wet cotton-tipped applicator, and transferred to a microscope slide for closer inspection and identification. Skin lesions are best cleaned and partially debrided using aseptic techniques prior to the collection of clinical samples. Microbiologic swabs should be taken from the periphery of the lesion but deep to any exposed areas. Impression smears can be taken after the lesion has been cleaned with sterile saline and gently dabbed dry with sterile gauze. Skin scrapes may be useful especially when dealing with drier more proliferative lesions. Where the clinician requires a skin biopsy the removal of a single scale may be all that is required as scales contain both epidermal and dermal elements. A small volume (0.02–0.1 mL) of local anesthetic (eg, 2% lidocaine) is injected subcutaneously in the area(s) of interest. Using aseptic techniques a single scale is then elevated and cut close to its insertion into the skin using a scalpel blade. If a larger sample is required then a combination of local, regional or general anesthesia and sharp excision or a skin punch biopsy instrument is effective. A single suture closes the deficit.

RESPIRATORY SYSTEM

The ability to diagnose pathologic changes within the respiratory system of snakes is often straightforward following lung lavage for the collection of cytologic and microbiologic samples. The collection of tissue biopsies requires anesthesia and surgical or endoscopic techniques. The upper respiratory tract including the nares, buccal cavity, glottis and cranial trachea can be visualized and often sampled directly without anesthesia. Small diameter swabs permit the collection of samples, although the greatest concern comes from bacterial contamination by oral commensals. Swabs can be submitted for microbiology or rolled onto glass slides for staining and cytologic evaluation. The simplest method of obtaining a representative sample from the lower respiratory tract is by lavage. Although a lung wash or lavage can be carried out in the conscious reptile, the discomfort of such a procedure probably warrants some degree of sedation or light anesthesia. A sterile catheter of appropriate size is placed through the glottis (or better still through a sterile endotracheal tube pre-placed into the trachea) taking great care not to touch the oral membranes. The catheter is advanced caudal to the heart (>30% snout-vent) but in large specimens it may not be possible to reach the lung(s) and a tracheal lavage is performed. Once in place, 0.5 to 1.0 mL of sterile saline per 100 g bodyweight can be infused. Sample recovery is often aided by rotating the snake, and lifting the head and tail to accumulate fluid at the dependent area, near the catheter tip.

Lavage samples do not permit an appreciation of lung architecture. For this, and many other histopathologic exams, tissue biopsies are preferred. Surgical access to the lung can be achieved using a standard celiotomy or transcutaneous pulmonoscopy. In snakes, the respiratory active anterior part of the lung is typically located between 12% and 45% snout-vent. However there is great species variation with regards to
lung anatomy including the presence of a tracheal lung in some elapid snakes and vipers, both left and right lungs in boas, and only a right lung in most other snakes.

**GASTROINTESTINAL SYSTEM**

In cases of severe diarrhea or regurgitation, material for laboratory submission will be forthcoming and may be collected and presented along with the animal by well-educated owners or keepers. In addition, many reptiles will spontaneously defecate and urinate when handled during the examination process. It is important to appreciate that, like birds, the stools of reptiles are composed of fecal, urate and urine components and that the cloaca is a common chamber for the gastrointestinal, urinary and reproductive systems. For example, wet and dry stools due to polyuria must be differentiated from true diarrhea, and cloacal bleeding may be intestinal, reproductive or urinary in origin. Fecal material can be submitted for a variety of parasitologic, cytologic and microbiologic tests. The submission of only fecal material in appropriate sterile containers will prevent further mixing, mutation and contamination by urates and urine during transportation and processing. Microbiologic results from deposited feces should be interpreted with caution as contamination from other organ systems can occur in the cloacal proctodeum prior to elimination, while environmental contamination invariably occurs after elimination. The fresher the material, the more meaningful the laboratory results, although some parasitologic investigations (e.g., helminth egg examination) can be performed on refrigerated material up to 4 weeks or more after elimination.

Unfortunately, the slow intestinal transit times of most reptiles often necessitate a more direct approach to obtain material. A cloacocolonic lavage can be performed on most conscious reptiles and provides the clinician with a diagnostic sample. A sterile lubricated round-tipped catheter is inserted into the cloaca and cranially towards the colon. A relatively large catheter should be used as this helps prevent kinking of the tube and perforation of the intestinal wall. On no account should the catheter be forced. Once in place, 0.5 to 1.0 mL sterile saline per 100 g bodyweight should be gently infused through the catheter and repeatedly aspirated until a sample is obtained. It is possible to infuse an additional 1.0 mL/100 g if no sample is forthcoming. The direct collection of fecal material from the distal colon using a lubricated gloved hand offers another practical option in large boas.

A similar technique can be used to collect samples from the stomach. A relatively large, round-tipped catheter can be inserted into the stomach of most conscious reptiles. The catheter should pass to the mid-body region before instilling 0.5 to 1.0 mL sterile saline per 100 g bodyweight. Such samples can be examined as a fresh wet preparation for parasites or stained to demonstrate micro-organisms. Microbiologic cultures are often worthy but care is required in their interpretation as contamination from the respiratory system and oral cavity is possible.

For the collection of gastric or intestinal biopsies, standard coeliotomy and excisional biopsies can be undertaken but endoscopy is much less invasive. In snakes the small intestine can be readily entered via the gastric pylorus. It is unwise to endoscopically biopsy the large bowel as the intestinal wall is often thin and easily perforated. Even excisional biopsies of the large intestine can be challenging to ensure adequate closure and the prevention of leakage.

**URINALYSIS**

The clinician may assess the osmoregulatory system of reptiles by sampling urine and biopsies from the kidney. Urinalysis is less helpful in reptiles than mammals. The reptilian kidney cannot concentrate urine and so urine specific gravity is of limited use in the assessment of renal function. Furthermore, renal urine passes through the urodeum of the cloaca before entering the posterior colon. Urine is therefore not necessarily sterile. The clinical picture is further complicated by the fact that electrolyte and water changes can occur across the cloacocolonic mucosa. Despite these biochemical drawbacks, urine samples are useful for cytologic assessments of inflammation, infection, and for the identification of renal casts.

**REPRODUCTIVE SYSTEM**

The advent of minimally invasive endoscopic techniques has brought about an increase in urogenital evaluation and sampling. The rigid endoscope can be used to examine the cloaca and, if patent, the oviducts of female snake enabling the collection of exudates and retained egg material in some cases.

**COELOMIC VISCERA**

Visceral biopsy remains a powerful tool for conclusively reaching a diagnosis, indicating specific therapies and providing a more accurate prognosis. Fine needle aspirates are generally poorly diagnostic compared to tissue samples. Biopsies may be collected for histopathology and microbiology. Samples may be collected percutaneously (generally with ultrasound guidance from large organs like the liver), surgically (all organs), or endoscopically (all organs). Correlation between biochemical tests and histopathology are generally lacking but serial blood sampling and biopsy currently offers the best diagnostic and monitoring approach to hepatic disease.

**Liver Biopsy**

Blood biochemistry, radiography, ultrasonography and endoscopy may indicate the existence of a hepatopathy but they seldom provide the definitive diagnosis. The elongated liver of snakes is seldom totally visible from a single coeliotomy approach. Biopsies are best collected using ligation or wedge techniques to avoid post-biopsy hemorrhage. Endoscopic techniques are typically less invasive, permit closer examination of more of the organ and enable the collection of multiple biopsies.
Figure 3. (a) Renal biopsy of a Boa constrictor following standard coeliotomy. In this case, vascular Hemoclips have been used to isolate a small kidney lobule prior to sharp excision. (b) Cloacocolonic internal examination in a large python using a lubricated gloved arm.

Renal Biopsy

A variety of infectious, degenerative and neoplastic renal diseases have been reported in snakes. The poor regenerative capabilities of the kidney make early diagnosis essential. The relatively poor diagnostic value of urinalysis and the late detection of renal disease by blood biochemistry further exemplify the importance of functional renal assessments and renal biopsy early in the diagnostic process (Figure 3). A standard coeliotomy between 85% and 95% snout-vent-length will generally access the kidneys, although ultrasonographic localization of the kidneys preoperatively is recommended to ensure surgical access where the left and right kidneys overlap. Excisional biopsies are easily collected by using suture or vascular clips to isolate a renal lobule. Snake endoscopy is more difficult that in chelonians or lizards due to the multiple fascial planes that have to be negotiated to reach the kidneys. However, evaluation of size, color and shape of the kidneys via smaller surgical entry is possible, and permits the collection of multiple small biopsies.

REFERENCES