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Surgery of reptiles (1): Chelonians

_Aural abscesses_

Aural abscesses are a common clinical presentation in aquatic turtles characterized by unilateral or bilateral swelling of the tympanic membranes. The association among aural abscesses and hypovitaminosis A has been proposed but could not be proven and etiology of aural abscesses is more likely to be multifactorial. Surgical treatment consists of incision of the tympanic membrane and surgical debridement of the tympanic cavity under general anesthesia. A single vertical, two cross incisions, or a circular incision (180-360 degrees) are made on the tympanum. By use of a cotton tip, debris and caseous material in the tympanum is gently removed. Culture and sensitivity testing may be performed from the debris or the tympanum. The tympanic cavity is lavaged, packed with an antimicrobial ointment and managed as an open wound to allow healing by second intention. Appropriate changes in management and diet are crucial to avoid recurrences.

_Eosophagostomy tube placement_

Esophagostomy tube placement is typically recommended in anorectic chelonians, given the difficulty of oral administration of food and/or medication. Curved mosquito hemostats are inserted in the mouth and pushed on the side of the neck. Gentle pressure favors displacement of the jugular vein and carotid artery. A small skin incision is made over the tip of the mosquito exposing the external muscular layer of the esophagus. The esophageal wall is incised and the tip of the forceps is exposed. The feeding tube is grasped and passed through the incision and directed cranially. Once visualized through the mouth, the tube is gently curved and pushed into the esophagus towards the stomach up to the level of the predetermined length of the tube. A standard roman sandal suture (syn. Chinese finger knot) with an optional purse-string pattern around the tube is performed. Confirmation of the proper positioning of the tube is usually not necessary, but may be performed by administration of contrast media through the tube.
Celiotomy

In chelonians, the two main approaches to the coelom are plastron osteotomy and prefemoral fossa coeliotomy. With the increased availability of laparoscopic and endosurgical equipment, prefemoral fossa coeliotomy has gained popularity due to the reduced invasiveness compared to plastron osteotomy. However, in certain species and for certain surgeries, plastron osteotomy is still required as it permits a better maneuvering of cranial coelomic organs.

Prefemoral fossa coeliotomy

Prefemoral fossa celiotomy (syn. prefemoral coeliotomy) is currently considered the surgical access of choice for most reproductive surgeries and for diagnostic endoscopy. In particular in semiaquatic and aquatic turtles, this approach avoids prolonged post-surgical dry-docking, which is necessary following plastron osteotomy. It should be also considered for urinary bladder and intestinal surgery. This approach is particularly indicated in species with a relative small plastron and in semiaquatic and aquatic species. The chelonian is placed in ventral, dorsal or lateral recumbency depending on species, size, and indications for surgery. The skin, subcutaneous tissue, and the transverse and oblique abdominal muscles, and coelomic membrane are transected and the coelomic cavity accessed. The use of ring retractors is extremely useful to enhance access and visibility. Care should be taken to avoid trauma to the urinary bladder upon entering the coelom. Cystocentesis should be performed if the bladder is distended and impairs surgical access to the coelom. Closure of the body wall should be performed in 2-3 layers. It may not always be possible to close the coelomic membrane. Closure of the muscles and skin are routine. If substantial amounts of subcutaneous tissue is present, then an additional subcutaneous sutures should be considered. The healing times after prefemoral coeliotomy (approximately 4 weeks) are substantially shorter than after a plastron osteotomy (approximately 1 to 2 years). In aquatic and semi-aquatic chelonia, early return to the aquatic environment is critical to allow normal behaviour, food intake and defecation. The prefemoral approach significantly shortens
the post-surgical duration, during which time the turtle must be maintained out of water. Therefore, the prefemoral approach should be considered the preferred surgical approach to the coelom in aquatic and semi-aquatic chelonian species.

**Plastron osteotomy**

The size of the plastron osteotomy (syn. plastrotomy) is dependent on the indication for surgery (e.g., size of eggs, bladder stones, GI foreign bodies, etc.) and is limited cranially by the heart and caudally by the pelvic girdle. The animal is placed in dorsal recumbency. Various instruments (e.g., a rotary tool equipped with a cutting circular blade, an oscillating sagittal saw, etc.) may be employed to create the incision into the plastron. Three sides of the flap should be incised at a 45-degree angle to obtain slightly beveled incisions. The fourth side is only partially incised and is used as a hinge. A periosteal elevator is used to complete the three full-thickness incisions of the plastron and to elevate the flap. The flap is reflected cranially or caudally and covered with moist gauze. The coelomic membrane is visualized and a ventral midline incision is performed taking care to avoid the ventral abdominal veins. In chelonians, after plastron osteotomy the coelomic membrane is gently sutured with a fine monofilament absorbable suture in a simple interrupted or continuous pattern. The lack of suturing of the coelomic membrane has been suggested to be associated with increased risk of postoperative adhesions. The bony flap is repositioned and sutured (in young or demineralized chelonians) or stabilized by means of epoxy resins, fiberglass mesh, or metal plates and screws. Plastron osteotomy is generally associated which prolonged surgical procedure time, prolonged recovery and is thought to be significantly more painful compared to the prefemoral soft tissue approach. The plastron flap may become a sequestrum and provide temporary protection to the developing bone. Eventual postsurgical complications are usually serious, require prolonged treatment and includes: lack of revascularization of the bone flap and consequent necrosis, infection with consequent coelomitis, and dehiscence of the bone flap margins. A further limitation of the technique is the need for dry-docking
of aquatic turtles. Even with application of fiberglass patch postoperative leakage may occur, leading to infection. Healing times of the bone flap are variable, but are considered to be around 1 to 2 years.

Endoscopy-assisted prefemoral oophorectomy and salpingectomy

A technique for exteriorization and excision of ovaries and oviducts of chelonians through the prefemoral fossa has been described. The technique relies on the assistance of standard endoscopic equipment (e.g., 2.7 mm, rigid endoscope). Depending on species, size and individual morphology, oophorectomy, salpingectomy, and/or salpingotomy may be performed through the prefemoral approach. Chelonians are preferably placed in dorsal recumbency, although ventral, or lateral recumbency may be indicated in particular instances (e.g., unilateral egg dystocia). A rigid endoscope is introduced into the coelom following through standard prefemoral coeliotomy approach. The reproductive tract is identified and gently grasped with atraumatic grasping forceps preferably by an avascular connective area of the ovary. Care must be taken to avoid rupture of ovarian follicles. Once all ovarian follicles are exteriorized and the mesovarium is visible, the ovarian vasculature in the mesovarium is ligated and transected. Hemostasis and complete excision of the ovarian tissue should be confirmed with the endoscope. If the oviduct is diseased and surgical removal is intended, the ipsilateral oviduct is exteriorized, ligated and transected through the same prefemoral incision. The procedure is then repeated for the contralateral ovary and oviduct. Often the procedure may be performed for the contralateral ovary via the same prefemoral incision. However, performing salpingectomy or salpingotomy of the contralateral oviduct is usually not possible, and coelomic access is required through the contralateral prefemoral fossa. Retained eggs in the oviduct and ectopic eggs free within the coelom can also be removed using this technique.

Cystotomy

In general, to resolve the presence of cystic calculi or ectopic eggs in the urinary bladder in chelonians, the surgical procedure should be elected in the following order: (1) Transurethral
endoscopic retrieval, mechanical destruction (eggs) or lithotripsy (calculi); (2) Pre-femoral fossa coeliotomy and cystotomy; (3) Standard coeliotomy and cystotomy. Removal of uroliths through a prefemoral fossa approach is not always feasible. In a case series of 10 desert tortoises (Gopherus agassizii) good candidates for the prefemoral fossa approach were large tortoises (over 15 cm in carapace length), with small calculi (less than twice the length of the fossa) that did not have a laminated radiographic appearance. Note that in the pre-operative evaluation, radiographs, computed tomography, ultrasound and cystoscopy are essential to reach a definitive diagnosis. In rare instances, (e.g., neoplasms, chronic prolapses of the urinary bladder) partial cystectomy may be indicated.

Reading list


The Crested Gecko (*Rhacodactylus ciliatus*)

Husbandry and Medical Care

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The Crested Gecko is a fairly recent addition to the ever-growing popular pet reptile market. The species was first described in 1866 as *Correlophus ciliatus*, but has now been renamed to *Rhacodactylus ciliatus*. Until 1994 they were believed to be extinct, but the species was rediscovered. Because of their ease of care they can be considered as some of the healthiest and most trouble free of all reptiles to keep (de Vosjoli, 2003). The Crested Gecko or New Caledonian Crested Gecko as it is sometimes referred to, has hair-like projections above the eyes, which look like eyelashes. The toes and the tip of the tail are covered with small hairs called setae, which are essential for climbing on smooth surfaces. In addition to the hairs, the toes have claws for climbing on surfaces to which their toes cannot cling with the hairs.

The Crested Gecko is primarily found in the southern part of New Caledonia. As with most geckos, the Crested Gecko has no true eyelids and keeps its eyes moist by using its tongue to clear away debris.

Like all Rhacodactylus geckos, Crested Geckos have webbing on the legs and digits. This is most likely due to the fact that they are an arboreal species. This should be taken into consideration when keep them in a vivarium, and a vertical stratification is highly recommended. A good vivarium should be 4-6 feet tall however they also do well in small enclosures such a 20 gal high (24”x12”x 16”). Good ventilation is important just as with all tropical species. The temperature does not need to be significantly higher than standard room temperature (75°F (25 °C)) and most people do not install separate heating elements for the vivarium. Misting the vivarium on a daily basis will help to keep a relative high humidity. The main problem of a low humidity level is dysecdysis. Some experts recommend winter cooling and others do not think it is adequate, no negative effects has been reported on either husbandry practice. Most breeders separate the females from the males for a few of months out of the year. The geckos are primarily nocturnal, and will generally spend the daylight hours sleeping in a secure hiding place close to, or on the ground, in the cage. In the wild they rarely come out of the canopy since larger geckos living in the trunk and brush will readily eat them. Due to this fact a UV light source is not really needed and they thrive well without any special lighting. However, one of the authors (JM) generally recommends a full spectrum light source for at least 2-4 hours a day.

This species of gecko is a true omnivore, eating a variety of insects and fruit. Small insects should be fed in addition to fruit baby food or fruit mash, which can be easily supplemented with vitamins and minerals. There are also commercial diets on the market that can be used in lieu of baby food.
The Crested Gecko will not regrow its tail once lost. Autotomy is common in the wild as the cells around the base of the tail are brittle, allowing autotomy to happen immediately when threatened or caught by a predator. The loss of a tail in captivity is primarily a cosmetic problem and is not problematic from a health or husbandry concern. It has been reported that most adults in the wild do not have their tails. In captivity one health issue seems very prevalent is the Floppy–Tail Syndrome. The tail flops to the side or over the back of the gecko when it is resting vertically in a head-down position. There is no cure for this condition but it seems that animals are not impacted by this condition. It has been speculated that the condition occurs because of extensive hanging upside down on cage furniture, however it also appears to happen in the wild.

Currently the export of wild New Caledonian Crested Geckos is prohibited, but breeding in captivity is relatively easy, assuring a good supply of new animals for the pet trade without posing a threat to the wild population. This also makes them relatively parasite free.

While they have not been kept in captivity for a very long period to determine an average life span in captivity, they are thought to be able to live for up to 20 years.

The female will usually lay two eggs, which hatch 60–90 days after being laid. The reproduction is relatively high in captivity as eggs are often deposited every four weeks if the female is healthy.

Crested Geckos have a small calcium sac on the roof of the mouth, which should be visible during the physical exam. If this sac is not clearly visible, a female does not have enough calcium in her system and she is suffering from calcium deficiency. It appears that nutritional secondary hyperparathyroidism can have a very rapid onset in this species. It can be seen if calcium supplementation has not been optimal for a few weeks.

In short, as mentioned above due to ease of their care and relatively few health problems, the crested gecko appears to be an optimal pet for new reptile client.

Literature:


Surgery of reptiles (2): Squamates

Reptile skin has the tendency to invert after incision, especially in squamates. Therefore, a slightly everting suture pattern (e.g., horizontal mattress) is recommended to ensure first intention wound healing. Healing of the skin can be accelerated if reptiles are maintained at the upper end of their preferred temperature range. Often, definitive skin healing with disappearing of the scab occurs after the first or the second ecdysis. Current recommendation for closure of coelomic breaches is to employ absorbable synthetic monofilament suture material (e.g., poliglecaprone 25, polyglyconate).

Phallectomy

Male snakes and lizards have paired copulatory organs, i.e., hemipenes, which lie in respective sacs caudal to the cloaca in the ventral tail. Phallectomy is employed to resolve hemipenile disorders. Hemipenile prolapse is very common presentation. If the tissue is already necrotic or the prolapse is recurrent, amputation is required. Amputation is be performed in toto, as hemipenes do not contain the urethra. In squamates amputation of a single hemipene does not preclude reproduction, while in chelonians phallectomy precludes reproduction. The reptile is positioned in dorsal recumbency and the hemipene is surgically prepped. In small individuals, two transfixing ligatures are placed at the base of the hemipene. The tissue is excised distal to the ligatures. The hemipenile stump can be closed with a simple continuous or a purse-string suture, in particular in larger species.

Limb amputation

Indications for amputation of limbs in lizards and chelonians are severe trauma or infection, severe joint infections, which are refractory to treatment, as well as non-healing chronic fractures or neoplasia. In general, chronic infected distal limb wounds and joint infections, in particular with associated osteomyelitis usually do not respond to medical therapy and wound management, and instead limb amputation should be considered. Amputation of the forelimbs should be performed
through the scapulohumeral joint and amputations of the hindlimbs through the coxofemoral joint. Midshaft amputation of the humerus or femur are not recommended, since it is very likely that the remaining limb stump will be traumatized by attempted ambulation. In female reptiles used for breeding purposes or planned to be released in the wild, amputation of the hindlimb might interfere with successful reproduction, since digging of nesting sites may be impaired. Limb amputation is performed using the same techniques as in mammals. Complications are uncommon.

Tail amputation

Amputation of an infected, traumatized or necrotic tail is a common problem in lizards. Surgical amputation of the tail is recommended in order to achieve primary wound healing following surgical resection of the diseased distal tail and closure of the amputation site. Radiographs should be taken prior to surgical amputation in order to evaluate for underlying bone involvement. Amputation of a significant portion of the tail in arboreal lizards (e.g. green iguana), has substantial effects on their ability to balance and climb. Therefore owners should be informed that the enclosure may require adjustment following tail amputation and that changes in locomotion are possible. The patient is anesthetized and placed in ventral recumbence. The tail amputation site is surgically prepped and a tourniquet is placed. The location of the hemipenes should be considered in cases of proximal tail amputation. Symmetric wedge incisions of the skin are made on lateral aspects of the tail in lizards with laterally flattened tails (e.g. iguanas) or on the dorsal and ventral aspect in lizards with dorso-ventrally flattened tails (e.g. bearded dragons). The skin incision should be made distal enough to allow for tension free wound closure following amputation, but at the same time be proximal enough to avoid incomplete excision of diseased tissue. The soft tissue and bone are transected. The ventral tail vein may require ligation in larger lizards. The amputation site is lavaged and assessed for hemorrhage following release of the tourniquet. The muscles should be apposed over the vertebrae with simple interrupted sutures. The skin edges are trimmed and closed with horizontal mattress sutures. The amputation site can be bandaged for the first few days following surgery, in order to aid
in absorption of wound discharge. Suture removal is recommended 4-6 weeks following amputation. Regrowth of the tail is possible after surgical amputation, but not commonly seen.

**Coeliotomy**

Surgical approaches to the coelom greatly vary depending on the species. Appropriate preparation of the reptile patient for coeliotomy is mandatory. Sterile scrub brushes may be employed to provide effective cleaning of reptiles. Once anesthetized, the patient is instrumented, placed in the recumbency indicated for the surgical procedure and surgically prepped. In general, the size of the incision will depend on the indications for coeliotomy. During the opening of the coelomic membrane, the surgeon should pay attention for signs of free gas or liquid in the coelom, associated with gastrointestinal (GI) tract and urinary bladder perforation, respectively. After entering the coelom, all the organs that are visible should be carefully inspected.

**Lizards**

In lizards, there are three main approaches to the coelom include paramedian, median and flank approach. The paramedian and median approaches are generally indicated in lizards that are dorsally compressed (e.g., families *Iguanidae, Agamidae, Gekkota*). In chameleons and other lizards that are laterally compressed (e.g., basilisks), the coelom may be easily approached through the flank. The paramedian approach is generally preferred over the median approach to avoid the ventral midline abdominal vein, a large vessel that runs just over the linea alba. An incision of the skin is made parallel to the midline. The incision may be made with a scalpel blade or dissecting devices (e.g., lasers, radiosurgical and electrosurgical equipment). In a study conducted on green iguanas, radiosurgery and laser both produced bloodless incisions, but radiosurgery caused significantly less collateral tissue damage in the skin and the muscle. The distance of the incision from the midline will depend on the size of the lizard. The incision is extended cranially and caudally using scissors, taking care to avoid the ventral abdominal vein. In some instances, the ends of the incision may need to be
prolonged at a 90-degree angle, forming a sort of “L” or “H”. The skin is retracted and the musculature is dissected by use of blunt scissors, cotton-tipped applicators, laser or electrosurgical equipment. Sharp dissection of the musculature should be avoided in order to minimize bleeding.

**Snakes**

In snakes, a paraventral coeliotomy is indicated for most surgeries. Obviously, a single incision does not permit access to all the organs. Therefore, an incision needs to be made at the level of the organ of interest. The skin is incised between the first and second row of lateral scales, and the resulting surgical wound is scalloped. This incision avoids distortion of the ventral scutes once the skin is sutured in an everting pattern.

**Closure of the coelom in snakes and lizards**

In squamates, the coelomic membrane and muscular wall are fragile and do not hold sutures. Therefore closure of the coelom relies on the skin sutures. In small to medium sized squamates, the coelomic membrane, muscularis and subcutis are sutured together in a simple continuous suture pattern with monofilament absorbable sutures. The skin is sutured with fine monofilament nonabsorbable sutures (e.g. nylon) in an everting pattern as previously discussed.

**Cystotomy**

Cystotomy may be indicated for removal of cystic calculi and ectopic eggs from the urinary bladder. In recent years alternative techniques to routine cystotomy, in particular in chelonians, have been reported, which are less invasive. These less-invasive techniques include transurethral endoscopic techniques (cystoscopy) or prefemoral endoscopy-assisted cystotomy. However, if such approaches fail, e.g., when dealing with cystic calculi of large size, cystotomy may be required. Access to the coelom is routinely performed through a paramedian incision in lizard. In small-to medium species, manipulation and exteriorization of the urinary bladder should be reduced to the minimum, due to the
risk of trauma of the thin bladder wall. Stay sutures on the urinary bladder wall and moist gauze around the surgical site minimizes urine leakage into the coelom. In lizards, a longitudinal incision is made in the ventral aspect of the bladder. The bladder stones or eggs present in the urinary bladder are removed. Eventually, retrograde use of endoscope may be useful to ascertain the removal of all the material. The urinary bladder wall closed with a monofilament suture in a single or double inverting layer. A rounded, atraumatic needle and minimal traction are mandatory to avoid rupture of the urinary bladder wall during suture in small-to-medium sized reptiles.

**Nephrectomy**

In snakes, neoplasms or degenerative disorders of kidneys are not uncommon, and unilateral nephrectomy is associated with an acceptable prognosis if the remaining kidney is functional. Often, a swelling of the caudal third of the snake is present. Standard coeliotomy is performed at the level of the affected kidney. The contralateral kidney should be grossly inspected. The affected kidney is isolated from the surrounding tissue. The renal vein and the renal arteries are ligated. The ureter is ligated distal and the kidney removed. A unilateral gonadectomy may need to be performed as the vas deferens in males and the oviduct in females are in contiguity with the kidney.

**Reading list**


Main reptile digestive disorders: diagnosis and treatment
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Reptiles have a great gastrointestinal variability due to evolutionary adaptation, which results in additional difficulties for veterinarians making recommendations about prevention, diagnosis and treatment of digestive disorders.

Beak and oral cavity
The teeth of squamate reptiles are usually limited to the jaw margins but in some species are also present on the palate. Most snakes have six rows of teeth, one on each side of the mandible and two on each side of the maxilla. Lizards have either acrodont or pleurodont dentition. Agamids, chameleons, and tuataras have true acrodont teeth that do not shed. Pleurodont teeth of squamates are loosely attached to the dorsolateral surface of the mandible and ventrolateral surface of the maxilla and are constantly shed and replaced throughout life. Although turtles and tortoises have toothless jaws, keratin sheaths cover their maxillary and mandibular crests. Beak-like keratin ridges (rhamphotheca) along the rostral and lateral aspects or the maxilla (rhampotheca) and mandible (gnathotheca) are developed. The beak of chelonians allows for prehension and cutting of food, but is not suitable for chewing; therefore, ingested food is swallowed whole.

Inspection of the oral cavity
In snakes and lizards, the mouth can be gently opened with a rubber spatula, a tongue depressor, or a wooden applicator stick, being careful not to damage any of the teeth or the gingiva. In small to medium sized chelonians, the head is gently blocked with the hand and with minimal pressure on the mandible the oral cavity can be opened and inspected. Alternatively, the rhinotheca can be hooked to gently extend the retracted head and neck from under the shell. This procedure should be performed with extreme caution because there is significant risk to damage the beak or to fracture cervical vertebrae.

Rostral trauma
One common condition in reptiles maintained in captive environments, is rostral trauma and secondary wound infection. This occurs as a sequel to rubbing the face on cage walls and covers and is especially frequent in snakes and certain lizards (e.g., Physignathus sp.).

**Metabolic bone disease**

Metabolic bone disease can cause changes in the oral cavity of reptiles, especially the mandible and maxilla. Poorly-mineralized periosteal reactions that are caused by an increase in calcium mobilization from bone are directly related to low blood levels of calcium from inadequate Vitamin D3 or dietary calcium. This causes a weakening in the bone that makes the jaw more pliable (rubber jaw). The treatment consists in increased sunlight exposure (unfiltered sunlight should be preferred over UVB emitters)(Selleri and Di Girolamo, 2012), change in management (hibernation should be suggested in hibernating species) and diet. Administration of exogenous calcium is suggested, however its effectiveness has yet to be proven.

**Beak overgrowth**

Disorders or the beak can be congenital (e.g., mandibular prognathism) or acquired (e.g., trauma and infection). Rhamphothecal overgrowth has been linked to several possible underlying disease conditions (e.g., nutritional deficiencies and secondary nutritional hyperparathyroidism). Beak overgrowth can be corrected using a rotary grinding tool (e.g., Dremel) in order to let the tortoise able to prehend food. However, correction of the diet is mandatory.

**Stomatitis**

Stomatitis is common in reptiles and is characterized by inflammation of the mucosa. Bacterial, fungal, and viral infections may cause stomatitis. Bacterial stomatitis are managed by debridement of necrotic tissue and systemic and topic antibiotic. Usually setting of the vivarium should be corrected.

The most common cause of viral stomatitis in chelonians is herpesvirus infection. The virus replicates in the oral epithelium that may potentiate oral transmission to other
susceptible individuals. Tortoises who have clinical herpesvirus infections most commonly exhibit signs of stomatitis and glossitis with diphtheritic membranes that cover the dorsal surface of the tongue and the hard palate, and even the glottis and esophagus.

**Periodontal disease**

Certain lizards have acrodont teeth that are not replaced throughout life or after loss. Therefore, there is progressive lesion with age of acrodont teeth. In lizards with acrodont teeth, periodontal disease is common because the gingiva is attached laterally, directly on the bone jaws. Differently, in lizards with pleurodont teeth, the gingival margins attach close to the level of the mandibular and maxillary crests, similar to mammals, resulting in no periodontal bone exposure. Lizards affected by periodontal disease may not show clinical signs. In such cases, gingival erythema, consistent with gingivitis, focal or generalized gingival recession resulting in abnormal exposure of mandibular bone may be evident. In severe cases of periodontal disease, infection of the periodontal bones is also observed. Once periodontal disease has been diagnosed, treatment should include removal of dental calculus, debridement of periodontal pockets, and debridement of infected bone. Systemic and local antimicrobial therapy is required. Chlorhexidine solution may be easily applied topically by owners using cotton-tipped applicators. The prognosis for severe periodontal disease is guarded to poor.

**Esophagus**

The reptile esophagus transports the ingesta to the stomach, may serve as a temporary storage for food, and in certain species aids in both mechanical and enzymatic digestion. Depending on the species, the lining of the proximal esophagus is characterized by longitudinal folds, while the distal esophagus has broad and flat folds. Sea turtles have characteristics conical and cornified papillae lining the esophagus.

**Ingestion of foreign bodies**

Food items (e.g., fishbone), substrates (e.g., bark), plant material (e.g., grass seed) or fish hooks may all act as esophageal foreign bodies in reptiles. Clinical signs in reptiles with
esophageal foreign bodies can include regurgitation and open mouth breathing. Removal should be attempted through the oral cavity, by means of direct or endoscopic visualization. Whenever removal from the oral cavity is not feasible, esophagotomy is performed. With the animal in lateral or dorsal recumbency and the neck extended, the esophageal lumen is accessed laterally or ventrally in proximity of the foreign body. The foreign body is visualized and removed. In certain instances, the insertion of an endoscope through the incision may assist in the identification of the foreign body. The esophageal incision is closed with simple interrupted sutures. The skin is closed with an interrupted horizontal mattress pattern. In large reptiles, the esophageal suture should be over sewn with continuous inverting suture, and the musculature should be closed in a separate layer with a continuous suture pattern. A supraplastralional coelomic approach has been described in a loggerhead sea turtle in which cervical esophagotomy did not allow retrieval of the foreign body. A transverse incision is made at the junction of the cervical skin and the cranial edge of the plastron. The subcutaneous tissues and musculature is retracted to expose the ventral esophagus. Esophagotomy is then performed as described above.

Esophagostomy tube placement

Esophagostomy tube placement is typically recommended in anorectic chelonians, given the difficulty of oral administration of food and/or medication. It may also be indicated in aggressive, chronically ill squamates. Curved mosquito hemostats are inserted in the mouth and pushed on the side of the neck. Gentle pressure favors displacement of the jugular vein and carotid artery. A small skin incision is made over the tip of the mosquito exposing the external muscular layer of the esophagus. The esophageal wall is incised and the tip of the forceps is exposed. The feeding tube is grasped and passed through the incision and directed cranially. Once visualized through the mouth, the tube is gently curved and pushed into the esophagus towards the stomach up to the level of the predetermined length of the tube. A standard roman sandal suture (syn. Chinese finger knot) with an optional purse-string pattern around the tube is performed. Confirmation of the proper positioning of the tube is usually not necessary, but may be performed by administration of contrast media through the tube.
Stomach
The reptile stomach is generally formed by a corpus and pars pylorica. The difference between these two parts may be grossly evident or subtle. The primary functions of the reptile stomach are to store and digest food. In some reptile species, stomach is highly distensible and enables them to store large meals. As in other animals, digestion of food occurs both via enzymatic and mechanical processes, however it may be significantly altered by body (and environmental) temperature, hydration status, food type, and meal size.

Cryptosporidiosis
Cryptosporidiosis is a common problem affecting several reptile species. In reptiles, cryptosporidiosis is usually not self-limiting, and is therefore associated with mortalities. Cryptosporidiosis is transmitted via the fecal–oral route. The clinical signs most frequently reported in snakes include chronic regurgitation, weight loss, and hypertrophic gastritis. In some cases, hypertrophic gastritis may be so severe that the stomach is clearly evident during physical examination. In snakes, gastroscopic biopsy of the stomach has sensitivity of 71.4% and specificity of 100% in diagnosing cryptosporidium (Cerveny et al., 2012). The prognosis is generally guarded as there is no effective treatment to date.

Gastric foreign bodies
Gastrointestinal foreign bodies and impaction are extremely common in lizards and chelonians, due to nonselective feeding habits, active pica or geophagy. These cases usually result in moderate to severe cases of impaction with need of immediate resolution. Minimally invasive surgical techniques are preferred whenever possible. To date, with the availability of endoscopy it is possible to retrieve gastric foreign bodies and obtain gastric biopsies. However, in some instances endoscopic retrieval of foreign bodies may not be feasible, and endoscopic biopsies of the stomach may not be diagnostic. In such cases, surgical access to the stomach is required. Standard coeliotomy is performed as indicated in the species. The stomach is identified and stay sutures are
applied to maintain the stomach at the level of the surgical site. Traction of stay sutures should be avoided in small to medium sized reptiles, as the gastric serosa is thin and prone to rupture. A stab incision with a scalpel is performed along the greater curvature. After removal of stomach content and foreign bodies, the stomach is lavaged and inspected. The stomach is approximated in two layers using monofilament absorbable sutures.

_Gastric ulceration_

Gastric ulceration is generally uncommon in reptiles, however stomach ulcers have been reported in a series of green iguanas (Kubisch et al., 2006). The presenting complaints of those iguanas with stomach ulceration were aspecific, i.e., anorexia and lethargy. In one of the cases, the iguana vomited hemorrhagic gastric contents. In another case, perforation of the stomach led to chronic peritonitis and ascites. A diagnosis of gastric ulceration is made on clinical signs, presence of anemia, and gastroscopy. To treat the clinical signs of gastric ulceration, sucralfate and H2-blockers are recommended, in addition to reducing stressful factors.

_Gastric neoplasia_

Gastric neoplasms and especially, neuroendocrine gastric carcinomas are frequently encountered in bearded dragons. The gastric carcinomas were highly malignant, with metastatic spread to liver being reported in most cases. In a recent report, a complete gastrectomy was attempted in a diamond python because of gastric adenocarcinoma, but the snake died the night following the procedure.

**Intestine**

The intestine is the primary site for the absorption of nutrients and continues the process of food digestion. The length of the intestine varies in reptile species depending on their nutritional adaptation. In general, there is a decreasing trend in length (longer>shorter) from the herbivore intestine, omnivore intestine and carnivore intestine. The small intestine and colon in herbivorous reptiles are macroscopically different, while in carnivorous species this difference may be minimal. Like in some herbivorous mammals,
in herbivorous chelonians and lizards the colon hosts fermentations.

Parasites
Oxyurids are the most common nematodes encountered in reptiles. There is uncertainty on the degree of pathogenicity of these parasites in reptiles; in the author’s experience high densities of these worms can lead to impaction or weight loss. There is also some evidence that oxyurids play an important role in the digestion of food herbivorous reptiles. The life cycle of oxyurids is direct, and these the eggs are spread via the oral fecal route. In severely infested individuals, 2-3 administration of fenbendazole (25 mg/kg, q 14 days) are usually enough to relieve the infection.
Protozoa are another common parasite in healthy and diseased reptiles. The majority of the gastrointestinal protozoa are considered nonpathogenic. Treatment is suggested in individuals showing signs of protozoal enteritis.
Coccidia are obligate pathogens in reptiles, are generally host specific, and are extremely common in bearded dragons. Coccidia are transmitted via the fecal–oral route. Trimethoprim/sulfa (20 mg/kg orally once a day for 10-12 days) reduce shedding in infected bearded dragons.

Fecalomas
Fecalomas (syn. fecalith) may form has a result of dehydration or in carnivores as a consequence of feeding prey too large too frequently. Palpation, radiography (plain and with contrast media administration) and ultrasonography are usually required to achieve a definitive diagnosis. In some cases, especially in snakes, it is possible to remove the fecalomas after endoscopic visualization, abundant irrigation and manual massage. However, this procedure should be performed carefully, as there is significant risk of traumatization of the intestine. In cases in which less invasive treatments are not feasible, standard coeliotomy is performed. In large chelonians, the prefemoral fossa approach may also be employed. In snakes, coeliotomy is performed in proximity of the intestinal section of interest. The intestinal wall is inspected and palpated. Possible abnormal findings during intestinal obstructions include a change in color of the affected tract (dark red to violet), vascular stasis and congestion. The mesentery has a variable length and
may prevent exteriorization through the coeliotomy incision. A stab incision is performed between two stay sutures and the content of the intestine is evacuated. In cases of intestinal impaction caused by substrate or excessive food intake, difficulties may be encountered when trying to remove all the content from the intestine. Multiple incisions or removal of all the material from a proximal single incision through gently retrograde massage of the bowel (i.e., “milking”), are viable options. The intestine is lavaged with warm fluids. The enterotomy incision is closed using monofilament absorbable suture in a two-layer simple interrupted or continuous pattern. In most cases, before and after radiographs are a valuable tool for communication with the owner.

**Intestinal neoplasia and ischemic conditions**

Intestinal neoplasia and ischemic conditions (intussusceptions and volvulus) are sporadically observed in reptiles. These cases require a prompt diagnosis and immediate treatment. Radiography (plain and with contrast media administration), ultrasonography and CT are useful to achieve a definitive diagnosis. After stabilization of the patients, enterectomy of the affected site may be indicated. End-to-end anastomosis is technically feasible in reptiles and is performed when ischemic, necrotic, neoplastic segments of intestine are present. Although in an experimental study in Burmese pythons (*Python molurus bivittatus*), the middle third of the small intestine was resected without complications in 21 snakes (Secor et al., 2000), in general these surgeries carry an uncertain prognosis in clinical cases. After placement of intestinal ocluding forceps, the diseased section of the bowel is transected. Anastomosis of the two cut ends is performed with a simple continuous suture on either side of two simple interrupted sutures at the dorsal and ventral aspects of the intestinal lumen. Standard techniques may be employed to resolves differences in bowel diameter of the orad and aborad bowel segments. Usually, disparities can be resolved just by suture spacing techniques. Alternatively, the smaller bowel segment can be cut at a 30 - 45 degrees angle or the larger bowel segment can be partially closed. If the two ends of the intestine cannot be approximated without excessive tension, a permanent enterostomy should be considered. The intestinal mucosa is sutured to the body wall with absorbable monofilament sutures in a simple interrupted pattern. A catheter is placed in the enterostomy site to maintain patency. The aborad
segment of the intestine is closed with a purse-string suture. In a pine snake (*Pituophis melanoleucus*) that underwent enterostomy as a consequence of ileocolic intussusception, dehiscence of the enterostomy site, with leakage of the intestinal contents and a fibrinous peritonitis occurred, with death of the snake at day 30 following surgery (Wosar et al., 2006).

*Colonic neoplasia*

If colonic lesions occur near the cloaca, biopsy or resection of masses had also been successfully performed after exteriorization of the colon through the cloaca. Briefly, the cloaca may be partially everted by manual pressure. Once the lesion is localized, the affected area of the bowel is excised and an end-to-end anastomosis is performed.

**Cloaca**

The cloaca and vent is the end of the gastrointestinal tract, urinary tract and reproductive tract (in female reptiles). The cloaca is comprised of the urodeum, coprodeum, and proctodeum. Urinary bladder, ureters, and reproductive tract open into the urodeum, while the colon opens into the coprodeum is the terminus of the colon. Both these structures empty into the proctodeum.

*Cloacal calculi*

Cloacal stones are common in chelonians and should be treated immediately because they obstruct the urinary and gastrointestinal tract. Diagnosis is made by visualization of a dilated cloaca, plus radiography and endoscopic inspection. Usually a dental bur or a rotary tool (e.g., dremel) are adequate for destruction of the stone. The procedure should be performed gently and with a forceps maintaining the stone. If inadvertently the stone is pushed, there is risk that it falls in the urinary bladder.

**References and further readings**

Banzato T, Selleri P, Veladiano IA, Martin A, Zanetti E, Zotti A. Comparative evaluation of the cadaveric, radiographic and computed tomographic anatomy of the heads of green iguana (*Iguana iguana*), common tegu (*Tupinambis merianae*) and bearded


