What Is Your Diagnosis?

In collaboration with the American College of Veterinary Radiology

Figure 1—Transverse ultrasonographic images with (A) and without (B) color-flow Doppler ultrasonography of a caudal coelomic mass in a 14-year-old 0.95-kg presumed female California kingsnake (*Lampropeltis getula californiae*) with a 6-month history of 2 visible swellings in the coelomic cavity and a 1-month history of anorexia and 2 visible swellings in the coelomic cavity that first appeared 6 months before presentation.

History

A 14-year-old 0.95-kg presumed female California kingsnake (*Lampropeltis getula californiae*) was presented to the Washington State University Veterinary Teaching Hospital Exotics Service for anorexia of a 1-month duration and evaluation of 2 visible swellings in the coelomic cavity that first appeared 6 months before presentation. Prior to the onset of clinical signs, the snake's appetite and shedding cycle were reported to be clinically normal. The snake was housed in a 200-gallon terrarium with appropriate hide boxes, soaking area, and paper-based bedding. However, there was no supplemental heat provided beyond room temperature. The snake was on a species-appropriate diet of frozen, then thawed mice and had no previous history of medical issues.

On physical examination, the snake had a body condition score of 3/5 (with 3 being ideal) and was bright, alert, and responsive. There was an incidental finding of mild exophthalmos of the left eye that easily and fully retropulsed. On palpation of the coelomic cavity, 2 large masses were palpated, each approximately 6 X 4 cm. The masses were spaced approximately 4 cm apart and occurred at roughly the junction of the caudal and middle third of the body. Cloacal probing confirmed that the snake was female. The remaining findings on physical examination were considered within reference limits. A CBC and biochemical panel were declined by the owner.

Ultrasonography of the coelomic masses was performed (**Figure 1**).

Formulate differential diagnoses, then continue reading.

Diagnostic Imaging Findings and Interpretation

Ultrasonography of the coelomic cavity demonstrated 2 thick-walled, complex, and cavitated masses. Within these structures, a number of ovoid foci, with thin hyperechoic rims and no evidence of blood flow on color flow Doppler ultrasonography, were appreciated. These ovoid foci were clustered and spread out and were located between and caudal

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Figure 2—Same images as in Figure 1. A—An ovary contains a single, peripherally hyperechoic, centrally anechoic, ovoid structure (*), consistent with a retained follicle. B—A different region of the cystic ovary has peripherally thickened walls containing multiple septa (arrows) and anechoic fluid.

to the 2 structures presumed to be enlarged cystic ovaries (**Figure 2**).

The ultrasonographic images, in conjunction with the paired nature of the masses, were indicative of ovarian or reproductive disease. Differential diagnosis included cystic or neoplastic ovaries or follicular stasis.

Fine-needle aspiration of the more cranial mass yielded 15 mL of brown fluid. Cytology revealed a moderate number of degenerate cells with a low number of RBCs and heterophils. No infectious agents were detected. Specific gravity was > 1.035 , protein concentration was > 7.0 g/dL, and PCV was $< 3\%$.

Treatment and Outcome

The snake underwent ovariectomy and recovered without complications. Postoperative care included carprofen (2 mg/kg [2 mg], IM, q 48 h for 1 week) and ceftazidime (20 mg/kg [20 mg], IM, q 48 to 72 h for 4 weeks). Histologic evaluation of the ovaries revealed severe dilation of the ovarian follicles and filling of the lumen with erythrocytes and fibrin. The follicular walls consisted of fibrous connective tissue with few heterophils and fewer mononuclear leukocytes. Additionally, some follicles were filled with macrophages, multinucleate giant cells, and homogenous eosinophilic material resembling yolk proteins. Diagnosis was hemorrhagic ovarian follicles, secondary to follicular stasis. No infectious organisms or neoplastic cells were seen. At 18 months after surgery, the snake had no complications or further abnormal clinical signs.

Comments

Ultrasonography is the imaging modality of choice for evaluating reproductive function, stage, and disease in snakes.¹ The gonads are located in the last third of the body lateral to the abdominal aorta

with the right gonad being slightly more cranial to the left.¹ At the beginning of the reproductive cycle, the follicles are round and anechoic.¹ They grow in size, and their echogenicity on ultrasonography increases prior to ovulation.¹ Preovulatory follicles are normally uniform, round, and anechoic or hypoechoic.¹ As time passes, more echogenic layers appear, the echogenicity becomes more heterogeneous, the surface becomes less smooth and less demarcated, and echogenic debris can begin to appear if there is inflammation.¹ The use of ultrasonography in the snake of the present report allowed identification of soft tissue swellings in the region of the ovaries and guided sampling. Although the final diagnosis was dependent on histopathology, ultrasonography provided the determination of reproductive or ovarian disease, as opposed to gastrointestinal obstruction or other gastrointestinal disease, and was vital in determining appropriate treatment options (surgery).

For ultrasonography, snakes can be positioned in dorsal recumbency if tractable or sedated.² Sometimes submerging the caudal portion of the patient in warm water allows for reduction of air reverberation artifact.² Ovaries are located cranial to the kidneys but may be in the same plane or level if the patient is ovulating.² Oviducts are located medial to the kidneys but lateral to the ureters.² Follicular stasis is diagnosed when there are large follicles persisting for a prolonged time²; therefore, it is not a diagnosis that can be based solely on imaging as species differences and patient history must be taken into account.

In the wild, the California kingsnake (*Lampropeltis getula californiae*), typically 2.5 to 4 feet long, is found in California, Oregon, Nevada, Utah, Colorado, New Mexico, Arizona, and Mexico.³ It lives in a wide variety of habitats including forests, woodlands, chaparrals, grasslands, marshes, farmlands, ranches, deserts, and brushy suburban areas and is mostly a ground dweller but can climb low branches and shrubs.³ The California kingsnake is diurnal (active

during the day) but can become nocturnal if it is hot.³ Sexual maturity occurs at 3 or 4 years of age.³ Mating occurs between May and August and between 2 and 24 eggs can be laid.³

Breeding behavior (folliculogenesis and/or ovulation) is stimulated by a variety of factors including temperature, humidity, light cycle, or social changes.⁴

Normal follicular development in reptiles involves vitellogenesis or the formation/accumulation of yolk in the liver.⁵ Estrogen stimulates the liver to convert lipid found in the body's fat stores to vitellogenin.⁵ The liver enlarges and becomes yellow.⁵ The follicles then absorb vitellogenin and become mature ova.⁵ The ovum becomes an egg when albumin and a shell are added in the oviduct.⁵ Formation of egg yolk protein requires calories, nitrogen, and micronutrients.⁵ When there is inadequate nutrition, reproduction becomes compromised.⁵

Reproductive disorders in snakes include infertility, prolapse, hypocalcemia, dystocia, and follicular stasis.^{4,6}

Dystocia (egg retention within the oviduct or postovulatory egg binding) is common in snakes.^{2,7} Dystocias can be obstructive or nonobstructive.² Obstructive dystocia is due to the inability to pass ≥ 1 egg or fetus through the oviduct and cloaca.² There may be fetal or maternal abnormalities, for example, large or malformed eggs or renomegaly, respectively.² Nonobstructive dystocias are when the eggs or fetuses and the female snake appear anatomically normal.² Causes of nonobstructive dystocias include poor husbandry, inappropriate temperature, inappropriate humidity, inappropriate nest site, malnutrition, dehydration, or social stressors.^{2,4} Retained eggs can be palpated, visualized, or both.⁴ Clinical signs may be absent or nonspecific such as anorexia, lethargy, straining, or cloacal prolapse.^{4,7} Radiography can confirm presence of young in viviparous species.⁴ However, radiography is less useful for oviparous species of snakes.^{2,4} Their eggs are poorly outlined on radiographs, as the eggshells have little to no calcium.^{2,4} Ultrasonography may also be useful to identify viviparous young or retained eggs.^{2,4}

Follicular stasis, also known as preovulatory egg binding or retained follicles, is common in lizards, less common in chelonians, and rare in snakes.^{4,6} Possible causes include inappropriate husbandry, lack of appropriate environmental cues, lack of nesting substrate, or inappropriate nutrition.⁶ Recent exposure to a mate after prior isolation may also lead to stasis. These follicles can become inspissated, necrotic, or rupture and lead to yolk coelomitis.⁶ Clinical signs include anorexia, lethargy, and abdominal distention.⁶ Laboratory findings include hypercalcemia,

hyperalbuminemia, hyperproteinemia, high alkaline phosphatase activity, anemia, leukopenia, and heteropenia.⁶ Diagnosis is with ultrasound.⁶ Gold standard treatment is ovariectomy.⁶ However, multiple celiotomies in snakes may be necessary to remove the entire ovary.⁶

Acute spontaneous ovarian hemorrhage can also occur in captive reptiles.⁸ This occurs when there is rupture of ≥ 1 ovarian artery and hemorrhage into the ovary and surrounding connective tissues.⁸ Clinical signs can include acute distress, pale mucous membranes, lethargy, hypovolemic shock, and death.⁸ Etiology is unknown, with theories including obesity, hypovitaminosis-C, or both causing vascular weakness.⁸

The California kingsnake of the present report developed masses in the coelomic cavity and anorexia but no other clinical signs at the time of presentation. Diagnosis of follicular stasis was based on a sequence of events, ultimately leading up to surgery and histopathology. Ultrasonography was beneficial in supporting the initial determination of reproductive disease and in determining treatment option. The cause of follicular stasis in the snake of the present report was unknown, as its husbandry and nutrition seemed appropriate and there was no recent exposure to a mate. There is still much more to research and learn about reproductive behaviors in reptiles, including snakes, and how to prevent reproductive illnesses or disorders in these species.

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