CLINICAL MANAGEMENT OF BLADDER STONES IN TORTOISES

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Cystotomy to remove a bladder stone is the most common surgery of chelonians in our practice in the Phoenix metropolitan area. Although no pattern is evident as yet, our impression is that there are years where we see several stones in a month and other years where they are far less common. Nevertheless, we typically perform several chelonian cystotomies a year.

COMPOSITION OF BLADDER STONES

Tortoise bladder stones are largely composed of urates, compounds composed of uric acid and metals such as sodium, potassium, or calcium. The Sonoran desert tortoise (*Gopherus agassizii*) is the best studied tortoise with regard to physiology and is known to form nitrogenous wastes into urea or uric acid depending on their state of hydration. Urea is the main nitrogenous waste when a tortoise is well hydrated and has access to plenty of drinking water or moist food plants. Urea requires less energy to form than uric acid but it is more toxic than uric acid and therefore requires more water to keep it dilute enough to avoid damage tissue. Uric acid requires an additional investment of energy but is relatively insoluble in water and much less toxic than urea. Uric acid will crystallize out of solution at low concentrations and can be voided from the body in a paste that allows the tortoise to retain much more water per unit of nitrogen excreted than for urea. Thus, there is an advantage for a tortoise to excrete urea when water is abundant because more energy is conserved and used for other purposes and the nitrogenous wastes are eliminated from the body without reaching harmful levels. When water is not abundant, the energetic cost of searching for sufficient water to dilute the urea would outweigh any energy conserved by not converting the urea to uric acid. Xeric-adapted tortoises such as the Sonoran desert tortoise tend to produce uric acid preferentially as a nitrogenous waste product compared to rainforest tortoises such as redfoot tortoises (*Geochelone carbonaria*).

FORMATION OF BLADDER STONES

The exact pathophysiology of tortoise bladder stones is unknown. The bladder acts as a water storage organ during times of water stress and water can be extracted from the urine if needed. There are cilia lining the chelonian bladder that likely keep solid material in the bladder, such as microcrystals of urates, in suspension. Even when the urate levels are high, the suspension remains fluid and easier to void through the urethra than larger crystals—kind of like what a Slushee™ machine does with ice.

It seems likely that tortoises that do not drink enough water and do not urinate often may be more at risk. Dissolved solutes, such as, can become very concentrated in the urine of a tortoise that is not drinking and consequently not completely emptying its bladder on a regular basis. Theoretically, mineral crystallization results from urine retention leading to urine supersaturation with mineral constituents until an ionic balance appropriate for crystal aggregation occurs. An additional complication with tortoises and reptiles in general, is that urine is not sterile since the bladder communicates with the proctodeum (the opening of the gastrointestinal tract into the cloaca). Some organisms, such as the flagellated protozoa *Hexamita*, are often found in the urine of tortoises with bladder stones. (Since *Hexamita* is a well known pathogen of the urinary tract, treatment with metronidazole is needed when it is diagnosed.) It is possible that the bladder cilia are not functioning normally in tortoises that develop bladder stones. Tortoise urine is influenced by diet and water consumption and likely has many complicated interactions between nitrogenous wastes, electrolytes, proteins, other waste products, and bladder microbial populations. Extrapolating from mammals, certain proteins and ions within urine act as promoters or inhibitors to crystal formation; in tortoises, there may be substances that inhibit ciliary movements. Whatever the factors that promote uroliths in tortoises, once a nidus is formed that is too large to pass through the urethra, a bladder stone results.

COMMON PRESENTATIONS

In my experience, the Sonoran desert tortoise (*Gopherus agassizii*) and African spurred tortoise (*Geochelone sulcata*) account for the majority of bladder stone cases (uroliths). Since these are the most common species kept as pets in Arizona, it is not too surprising they account for the majority of our patients. Any species of tortoise may develop bladder stones. Nevertheless, when all of the commonly seen species of tortoises at our practice are included (eg, leopard tortoise *Geochelone pardalis*, European tortoises *Testudo* spp., redfoot tortoises *Geochelone carbonaria*, Indian star tortoises *Geochelone elegans*, and Aldabra tortoises *Geochelone gigantea*), the vast majority of bladder stone cases are desert tortoises and African spurred tortoises with leopard tortoises a distant third. Bladder stones have been found in juvenile tortoises fewer than 2 inches (5 cm) in length and adult tortoises weighing over 70 pounds (35 kg). Bladder stones may be hard and firm or hard and friable.

There is no single sign that indicates a tortoise has a bladder stone. Some tortoises may lose their appetites; others may simply be less active. More serious signs are straining or failure to defecate. Gravid females may repeatedly dig nests and strain to lay eggs without success. Some tortoises appear paralyzed or paretic in their hind limbs or may walk with an exaggerated limp on one or both sides, a sign sometimes described as a wheelbarrow gait. It is common that a tortoise is presented with another problem, such as an upper respiratory infection, and the bladder stone is detected in the course of the examination and diagnostics. Because this condition is so prevalent in my clinical practice, it is

always on the differential diagnosis for any sick tortoises and is a compelling reason I recommend regular radiographic screening as part of the diagnostic work-up as well as part of the annual preventive medicine program for tortoises.

Although a bladder stone is an often painful condition in people, especially when small fragments break off and are voided through the urethra, a tortoise typically shows no signs of discomfort until the bladder stone has grown large enough to irritate and inflame the bladder, or compress its intestine, oviducts, or nerves enervating the hind legs.

DIAGNOSIS

Some bladder stones are so large that the tortoise's owner may be able to feel them but they may be mistaken for shelled eggs in a known female tortoise. Some bladder stones are just large enough for an experienced veterinarian to detect by palpating just in front of the hind legs. I have found that smaller bladder stones are easier to palpate if the tortoise is held with the head elevated so the body is between a 45° and 90° incline and I gently rock the tortoise from side to side. Stones that are too small to feel otherwise may lightly bounce off your fingertips. Some clinicians claim that detection of small bladder stones is enhanced by holding the tortoise with its hind end submerged in water but I don't see the logic in that.

Occasionally, if the stone has become lodged in the pelvic canal AND the tortoise is cooperative enough to allow a digital cloacal exam, it may be palpated by inserting a finger in the cloaca. However, radiographs (x-rays) are needed to determine the size and shape of the bladder stone (or stones) and if there are any other complications. As mentioned previously, since bladder stones are sometimes found as the underlying cause of a seemingly unrelated illness, I offer a screening radiograph as an option in the work-up of any sick Sonoran desert tortoise, African spurred tortoise, or leopard tortoise.

I typically recommend blood work, particularly looking at hematocrit, albumin, uric acid, calcium, and phosphorus, to assess a tortoise before surgery. A well-hydrated patient with elevated phosphorus and normal to low calcium may signal underlying renal disease, particularly when coupled with significant elevations of uric acid. Low hematocrit and low albumin often indicate poor surgical risk and signal poor post-operative healing. A dorsoventral (DV) radiograph and horizontal lateral are useful to identify the size of the stone as well as surgical landmarks so you do not accidentally cut into the pelvic or pectoral girdle during plastronotomy. A urinalysis can help clarify if the tortoise has been eating or not; a healthy tortoise has urine with an alkaline pH, a tortoise in a catabolic state typically has neutral to acidic urine. A wet mount of the urine may pick up *Hexamita* and other abnormalities.

In some cases, other illnesses may have to be managed before a tortoise can undergo surgery. Rehydration may be needed and diuresis to assess if phosphorus is reversibly elevated. Assist feeding with Critical Care for Herbivores (Oxbow Hay Company) may be helpful to promote an anabolic state. Antibiotics and anti-inflammatories may be needed to manage existing infections. However, in some cases the patient has to go to surgery with a less than ideal physiological state simply because the stone is large enough to preclude much improvement otherwise.

Since tortoise bladder stones cannot be dissolved medically, surgery is required for a cure. In rare cases, the bladder stone may be removed by manipulation through the cloaca. Some bladder stones may be removed by placing the tortoise in a lateral position and making an incision in the inguinal skin just in front of a hind leg with the bladder wall exteriorized and stay sutures placed. Most cases require that a portion of the plastron shell is removed temporarily so that the bladder may be accessed ventrally. In these cases, an epoxy patch is used to hold the cut shell in place during post-operative healing. The patch will need to be changed several times before the shell is healed. It may take over a year for some tortoises to fully heal. During surgery, I examine the different internal organs and biopsy any that look abnormal. If these tissues are submitted to a pathologist, the knowledge gained may help with long-term management of the tortoise.

Postoperatively, tube-feeding EXPAND and injectable fluids EXPAND may be needed for nutritional support and pain relievers may be prescribed to help the tortoise feel better. I usually surgically implant an esophagostomy tube in debilitated tortoises so that they can more easily receive oral medication and nutritional support for a long time postoperatively. Some tortoises may need to be hospitalized for several days until they are passing urine and stool regularly. In some cases cisapride (1 mg/kg PO SID) may be needed to promote defecation. Most tortoises will be put on enrofloxacin (10 mg/kg IM SID x 14 days) and ampicillin (20 mg/kg IM SID x 7–14 days) but large sulcatas have bad reactions to injectable enrofloxacin and are usually managed with amikacin (2.5 to 5 mg/kg IM q 48–72 hours) and ampicillin. The tortoise is scheduled for recheck appointments 7 to 10 days postoperatively and thereafter every 2 to 4 weeks so that the incision can be monitored and, in the case of a plastron surgery, the shell patch can be changed as needed. Occasionally, the bone underlying the patch may die and need to be removed. A bandage is then used until a firm fibrous substitute for the shell has formed. In time, this will become bone and covered with keratin. At these recheck exams, I often do bloodwork, urinalysis, and fecals to assess how the tortoise is recovering.

A tortoise recovering from bladder surgery should be isolated so it may be carefully monitored. It is essential to keep the cage warm. A basking light, typically a 60- to 100-watt spotlight, should be set-up on one end of the tank. The temperature underneath the spotlight should reach 95–100°F. The other end of the cage should be about 15–20°F cooler. I recommend that the owner uses an infrared (laser) thermometer to directly measure the temperature of the tortoise. If it spends all its time under the light, the cage may be too cool. If it spends all its

time at the cool end of the cage, the basking spot may be too hot. Some source of floor heat, such as a heat tape, is useful for night-time heat. Ultraviolet B light may stimulate healing. ZooMed's *Reptisun 5.0 UV Bulb* or *10.0 UV Bulb* and T-Rex *Active UV Heat* appear to be excellent sources of ultraviolet-B light. They should be set up to illuminate the area around the basking light. The *Active UV Heat* can serve as the basking light. These bulbs need to be replaced every 6 to 12 months, even if they are still shining, because their ultraviolet output decreases over time. The tortoise should have a shallow water bowl for drinking but it should not be soaked until the incision has healed or the patch has been on long enough that there is good granulation tissue beneath. The appetite needs to be closely monitored. When the tortoise begins feeding on its own, its feeding tube may need to be removed. It is also important to monitor urine and fecal output throughout recovery.