Fluoroscopic-guided Shoulder Arthroscopy in a Yellow-headed Snapping Turtle (*Elseya irwini*) with Focal Degenerative Joint Disease

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Abstract: The yellow-headed snapping turtle, *Elseya irwini*, is an Australian freshwater species that is very rare in captivity. A routine radiographic examination of a captive female showed a moderate loss of bone across the left glenohumeral joint. No clinical signs had been observed. Results of computed tomography showed pathologic changes in both the proximal humerus and glenoid; no other joints were affected. Under general anesthesia, fluoroscopic-guided arthroscopy was used to assess the joint and obtain tissue samples for further diagnostics. All tissue cultures (aerobic bacterial, fungal, and mycobacterial) were negative. Histopathology showed chronic degeneration of the joint capsule and glenoid. The results gave a presumptive diagnosis of focal degenerative joint disease (osteoarthritis). Arthroscopy can provide a minimally invasive surgical technique to evaluate joint pathology in turtles.

Key Words: arthroscopy, computed tomography, degenerative joint disease, *Elseya irwini*, osteoarthritis.

Introduction

The yellow-headed snapping turtle, *Elseya irwini*, is a large, side-necked, freshwater chelonian endemic to the Broken River and Burdekin River systems in northeastern Queensland, Australia (Cann, 1998). The species was first identified in 1993 and was placed within the suborder Pleurodira, family Chelidae (Cann, 1998). The turtles are typically found in areas of high water flow with sand or rock substrates. They are thought to be omnivorous, feeding on plants, snails, crayfish, and fish. Prominent sexual dimorphism exists: females are larger, up to 5.9 kg (13 lb) body weight and 30 cm (11.8 in) carapace length, with pale heads and a yellow, horny sheath on the crown; males can measure up to 1.7 kg (3.7 lb) body weight and 25 cm (9.8 in) carapace length and have an unremarkable brown head coloration. Breeding characteristics are unknown. A specialized, gill-like organ in the cloacal mucosa allows for some gas exchange while submerged (Cann, 1998). Little else is known about this species and very few specimens are found in captivity.

Case Report

In August 2008, a 3.8 kg (8.4 lb) adult female yellow-headed snapping turtle, *Elseya irwini*, was presented for a routine examination. The turtle had been wild-caught in 1994 as an adult and donated to the facility in 2004. The medical history included a fall of 0.6 m (2 ft) in 2004 that resulted in a fracture of the left side of the nuchal scute. The history was otherwise unremarkable. The turtle was housed in a 7,600 L (2,000 gal) recirculating freshwater system with full-spectrum lighting, a water temperature of 29–30.5°C (84–87°F), and a basking area of 38–49°C (100–120°F). Diet consisted of fish, crustaceans, and extruded pellets (Mazuri Crocodilian Diet, Purina Feed, St. Louis, MO); various leafy greens were offered but not routinely consumed.

On examination, the turtle was in good body condition with normal strength and locomotion. Physical exam was unremarkable. A complete blood count showed a white blood cell count of 4,895 cells/μL with 32% heterophils and 57% lymphocytes. This was comparable to previous samples taken from this species, although the white cell count was at the low end of the published reference values for captive New Guinea snapping turtles (*Elseya novaeguineae*) (Anderson *et al*., 1997). The plasma biochemical profile showed elevated aspartate transferase (977 U/L); a median value of 76 U/L was reported in the New Guinea snapping turtles (Anderson *et al*., 1997). Creatine kinase could not be measured due to equipment error. Routine survey radiographs showed moderate bone lysis across the left shoulder joint involving both the humerus and the glenoid (Fig. 1).

Computed tomography (CT) was carried out using a dual source 64 multi-detector CT with slice collimation of 0.6 mm and scan reconstruction with 0.75-mm slice thickness (Siemens Definition Scanner, Siemens Medical Solutions, Malvern, PA). Scan parameters were 120 kVp and 150 mAs. Three-dimensional images were reconstructed in real-time using volume-rendering techniques (Leonardo workstation and InSpace software, Siemens Medical

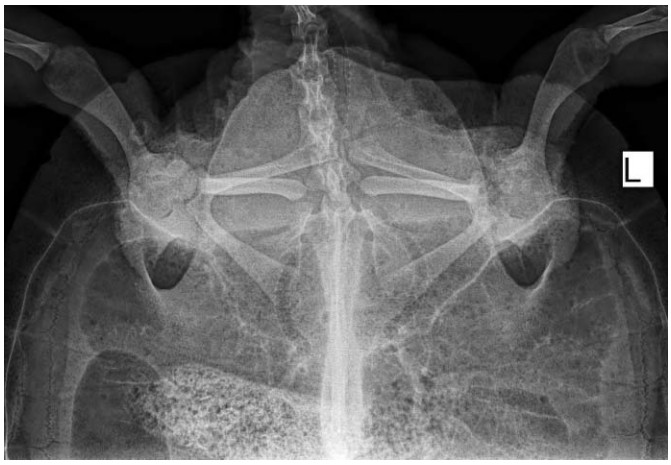

Figure 1. Dorso-ventral radiograph showing lysis of the left proximal humerus and glenoid.

Solutions). The CT showed loss of bone at the humeral head and glenoid with small fragments of bone visible around the joint (Fig. 2). The other joints were unaffected.

Fine-needle aspirates of the left shoulder joint were collected. The forelimb was extended cranially to allow palpation of the caudal aspect of the joint. The site was aseptically prepared and 0.3 mg/kg lidocaine was infiltrated intradermally (Lidocaine, 20 mg/mL, Vedco, Inc., St. Joseph, MO). Two aspirates were taken based on palpation using a 22-gauge, 1-in needle on a 3-mL syringe inserted into the caudolateral compartment, but no fluid was obtained. Cytologic examination showed only normal blood cells with no fungi, bacteria, crystals, or abnormal cell morphology. Aerobic culture yielded no bacterial growth.

The turtle was anesthetized for fluoroscopic-guided arthroscopy and biopsies using ketamine at 3 mg/kg IV (Ketaset, 100 mg/mL, Fort Dodge Animal Health, Fort Dodge, IA), medetomidine at 0.15 mg/kg IV (Domitor, 1 mg/mL, Pfizer Animal Health, New York, NY), and isoflurane at 1–5% following intubation (IsoSol, Vedco, Inc.). Intermittent positive-pressure ventilation was used throughout the procedure. The turtle was also given warmed fluids at 10 mL/kg SC along with 4 boluses at 2 mL/kg per cloaca using a 1:1 ratio of lactated Ringer's solution and 0.45% saline with 2.5% dextrose (Baxter Healthcare Corporation, Deerfield, IL), ceftazidime at 20 mg/kg IM (Ceftazidime, 2 g, Sandoz, Inc., Princeton, NJ), buprenorphine at 0.02 mg/kg IM (Buprenorphine, 0.3 mg/mL, Bedford Laboratories, Bedford, OH), and intra-articular bupivacaine hydrochloride at 0.3 mg/kg (Marcaine, 2.5 mg/mL, Pfizer Animal Health).

The turtle was placed in a V-tray in a dorsoventral oblique position with the left shoulder elevated within the fluoroscopy unit (Premier Encore Fluoroscan, Fluoroscan Imaging Systems, Inc., Bedford, MA). After the site was aseptically prepared, a 22-gauge, 1.5-in needle was guided fluoroscopically into the caudolateral compartment of the shoulder. On aspiration using a 6-mL syringe, no fluid was obtained. Ten milliliters of 0.9% saline (Baxter Healthcare Corporation) was injected into the shoulder, ensuring that the needle was in the joint, and distending the joint for arthroscopy. A 2-mm stab incision was created alongside the needle, and a 1.9-mm trochar and cannula system was guided fluoroscopically into the shoulder following the same plane as the needle. The trochar was removed and a 1.9-mm, 30° oblique arthroscope was inserted (Dyonics, Smith and Nephew, Andover, MA). An intra-articular saline infusion was started. Using standard triangulation techniques, a needle was guided into the craniolateral compartment of the shoulder joint. A 2-mm stab incision was created alongside the needle and a blunt trochar and cannula system was inserted into the joint through the cranial portal (Fig. 3). The same technique, applied to the cadaver of a Mary River tortoise, *Elusor macrurus*, allowed excellent visualization of the glenoid cavity, humeral head, joint capsule, and two

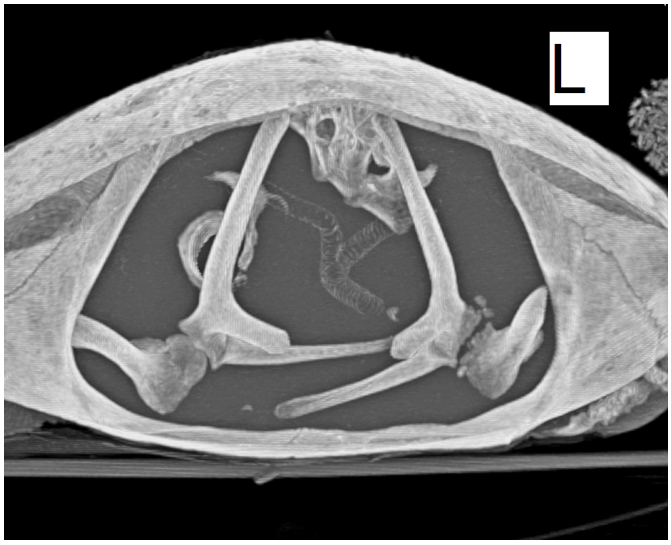

Figure 2. Computed-tomography image: Three-dimensional reconstruction showing lysis of the left proximal humerus and glenoid. The right glenohumeral joint is unaffected.

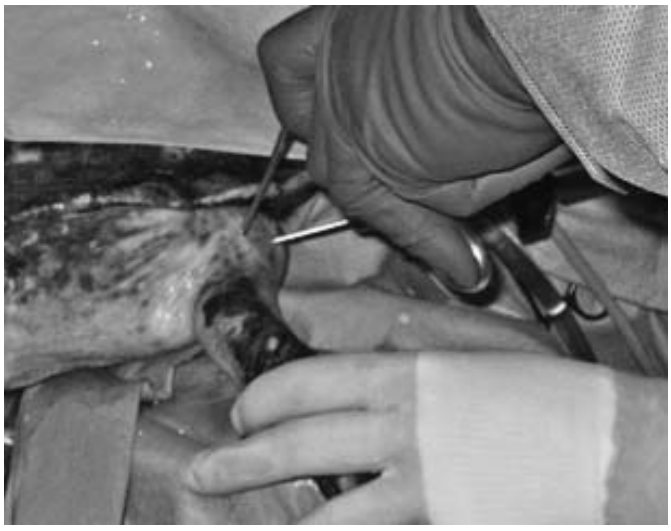

Figure 3. Arthroscopy of the left shoulder: The left forelimb is retracted cranially and the cannula systems are visible in the craniolateral and caudolateral compartments, containing the arthroscopic biopsy forceps and arthroscope, respectively.

intra-articular glenohumeral ligaments. In the yellow-headed snapping turtle, the caudal compartment of the shoulder could be visualized, including the humeral head and one glenohumeral ligament. The central and caudal humeral head showed abnormal cartilage with partial thickness fibrillation and fissuring (grade II lesions based on the modified Outerbridge scoring system for arthroscopy; Schulz, 2003). The glenoid was no longer recognizable, having been replaced by fibrous tissue, and the craniomedial to caudomedial joint capsule had a frayed appearance. There was some dark mottling of the soft tissues, later confirmed histologically as melanosis. The normal architecture of the medial compartment could not be visualized. Range-of-motion and stress tests showed no signs of instability. Arthroscopic biopsy forceps were inserted into the cranial instrument portal in order to biopsy the joint capsule and ligaments. Jamshidi needles were used to biopsy the glenoid, humeral neck, and humeral head under fluoroscopic guidance (Kendall monoject, 11-gauge, 4-in, Covidien, Mansfield, MA). Part of the tissue samples from the joint capsule and glenoid were used for aerobic bacterial, fungal, and mycobacterial cultures, and the remaining samples were fixed in 10% buffered formalin for histopathology. Following further saline flushing, the skin incisions were closed using 3-0 polypropylene (Prolene, Ethicon Inc., Somerville, NJ) in a horizontal mattress pattern. Neither the medetomidine nor buprenorphine needed to be reversed. Anesthetic recovery was uneventful.

Histopathology samples showed a chronic degenerative process; there was multifocal, severe degeneration and fragmentation of the dense collagenous material from the joint (either tendon or ligament) and diffuse, moderate degeneration of the glenoid (Fig. 4). The sections of the humerus were grossly normal. There was a slight increase in melanomacrophages in the glenoid tissue but no other inflammatory changes were observed. No etiological agent was found on hematoxylin and eosin, acid-fast, or periodic acid-Schiff stains. Cell morphology was normal.

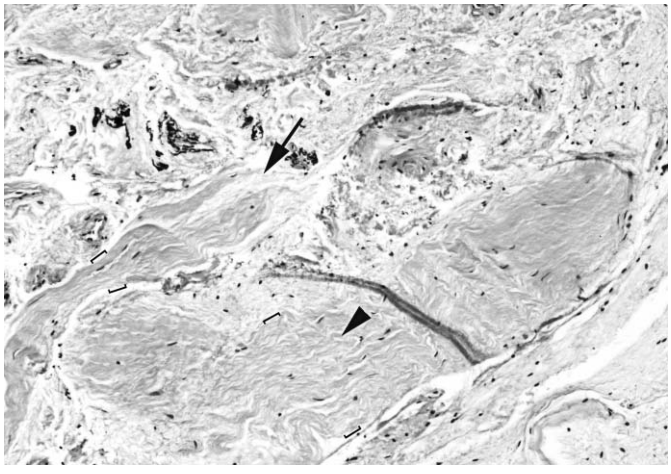

Figure 4. Histopathology of soft tissue from the abnormal shoulder showing two ligaments or tendons identified by their typical parallel fibers with regular periodicity (square brackets indicate boundaries). The structures are frayed (arrow) and disorganized (arrowhead), indicating marked damage or total rupture. Minimal inflammatory infiltrate is present.

Aerobic bacterial culture, fungal culture, and mycobacterial cultures were run using tissue from the joint capsule and glenoid. All cultures were negative. The cost of polymerase chain reaction- screening for multiple infectious agents, such as *Mycoplasma* spp. and non-tuberculous *Mycobacterium* spp., was considered prohibitive.

The turtle did well postoperatively. After 24 h in cloacal depth water, the turtle was moved to a 250 L (65 gal) hospital system within the same temperature ranges as above. There was some left forelimb lameness and mild soft tissue swelling after surgery which resolved over 7 days. The turtle was maintained on meloxicam 0.1–0.2 mg/kg IM every 2–3 days for 4 doses (Metacam, 5 mg/mL, Boehringer Ingelheim Vetmedica, St. Joseph, MO), and ceftazidime 20 mg/kg IM every 3 days for 12 doses, pending the histopathology and culture results. Sutures were removed 20 days post-surgery. The turtle was returned to the 7,600 L (2,000 gal) enclosure 32 days post-surgery.

Conservative management was elected for this turtle. This consisted of providing optimal environmental conditions and maintaining an appropriate body weight and a balanced diet rich in fish oils. Exercise was controlled by limiting handling and avoiding changes to her aquatic environment. In the 3 yr since surgery, regular recheck examinations have shown on-going remodelling of the left glenohumeral joint but no further lysis. The other joints remain unaffected and the turtle continues to show no apparent clinical signs.

Discussion

Radiography and computed tomography allowed accurate localization of the joint lesion in this yellow-headed snapping turtle. Other potential non-invasive diagnostics to assess joint lesions include ultrasonography, magnetic resonance imaging, and skeletal scintigraphy (Solano *et al*., 2008; McLellan *et al*., 2009; Goldhammer *et al*., 2010). In particular, skeletal scintigraphy may have been useful to assess if there was active bone turnover in the joint (Solano *et al*., 2008). However, definitive diagnosis requires more-invasive diagnostics such as joint aspirates, percutaneous biopsies, or arthrotomy or arthroscopy with visual assessment and biopsies.

Joint aspirates have been used in reptiles to evaluate changes in the synovial fluid (Casimire-Etzioni *et al*., 2004; Raidal *et al*., 2006; Alleman and Kupprion, 2007). Even using fluoroscopic guidance, no synovial fluid could be obtained from the abnormal joint in this yellow-headed snapping turtle. It is possible that the degenerative changes to the joint and the disruption of the joint capsule prevented normal production and accumulation of synovial fluid.

Arthrotomy and arthroscopy allow visualization of joint lesions and targeted biopsies. Compared to arthrotomy, arthroscopy shows similar or higher diagnostic sensitivity (Pozzi *et al*., 2008; Niemeyer *et al*., 2011) with significantly shorter recovery times and less risk of secondary complications (Vatistas *et al*., 1995; Greer *et al*., 2003; Hoelzler *et al*., 2004). Arthroscopic biopsy remains the gold standard in domestic animals (McLellan *et al*., 2009; Goldhammer *et al*., 2010).

The anesthetic protocol selected for this athroscopy has consistently provided a smooth induction, a steady level of anesthesia, and a good recovery for longer procedures in *Elseya* spp. at the National Aquarium, Baltimore, MD.

Intravenous or intraosseus fluids would have provided a more direct route of hydration during the anesthesia, but alternative routes were used. The dose of buprenorphine is lower than suggested by analgesia studies in red-eared sliders, *Trachemys scripta elegans* (Kummrow *et al*., 2008), but this dose was used due to apparent sedative effects in *Elseya* spp. The dosing interval for meloxicam was chosen in part to reduce handling requirements. However, a subsequent paper has shown that a shorter meloxicam interval is indicated in green iguanas (*Iguana iguana*) (Divers *et al*., 2010).

The shoulder arthroscopy was straightforward and provided diagnostic samples that could not be obtained using aspirates or percutaneous biopsies. Fluoroscopy is not routinely used to guide arthroscopy in domestic animals but, given the novel anatomy of this species, it allowed placement of the trochars and biopsy needles with minimal tissue trauma and good sample fidelity. While the use of endoscopy is reported in reptiles for examination of the coelomic cavity, respiratory, urogenital, and gastrointestinal tracts, no reports of arthroscopy in reptiles could be found.

With lysis limited to the left glenohumeral joint, the two most likely differentials were a localized infectious arthritis or degenerative joint disease (osteoarthritis). Neoplasia, articular gout, articular or periarticular 'pseudo-gout' (e.g., hydroxyapatite or calcium pyrophosphate deposition disease), and rheumatoid or immune-mediated mechanisms were considered less likely based on the clinical signs and distribution (Wenker *et al.*, 1999; Casimire-Etzioni *et al.*, 2004; Mader, 2006; Chambers *et al.*, 2009; Jones and Fitzgerald 2009).

Infectious arthritis is usually described as an infection within a mobile (diarthrodial) joint with an associated inflammatory infiltrate and bone remodelling—predominantly lysis in reptiles (Fitzgerald and Vera, 2006). Reported causes of infectious arthritis in reptiles include *Mycoplasma alligatoris* in American alligators, *Alligator mississippiensis*; *Serratia marcescens* in a common tegu, *Tupinambis teguixin*, a West African dwarf crocodile, *Osteolaemus tetraspis*, and a green sea turtle, *Chelonia mydas*; *Staphylococcus hyicus* in a Mali uromastyx, *Uromastyx maliensis*; *Enterococcus* sp., *Mycobacterium chelonae*, and *Nocardia* sp. with an unidentified fungal pathogen in Kemp's Ridley sea turtles, *Lepidochelys kempii*; and an unidentified bacterial pathogen in a leatherback sea turtle, *Dermochelys coriacea* (Ackerman *et al.*, 1971; Ogden *et al*., 1981; Heard *et al.*, 1988; Brown *et al.*, 2001; Harms *et al.*, 2002; Greer *et al.*, 2003; Riggs *et al.*, 2005; Innis *et al*., 2010).

Degenerative joint disease, or osteoarthritis, has been defined as a progressive disease of synovial joints due to biomechanical joint stress, with structural and compositional changes to bone, cartilage, meniscus, synovium, and other soft tissues (Lane *et al*., 2011). Clinical signs are characterized by joint pain, stiffness, and joint instability (Lane *et al*., 2011). There may be variable degrees of inflammation without systemic effects (Johnston, 1997; Lane *et al.*, 2011). There should be no evidence of an infectious etiology, although this may be hard to prove in reptiles as many pathogens are difficult to culture and molecular techniques remain limited (Johnston, 1997; Solano *et al*., 2008). There may be a history of non-penetrating trauma or joint dysplasia, and progression should be slower with no dissemination to other joints (Johnston, 1997; Fitzgerald and Vera, 2006). Very few reports exist of degenerative joint disease in reptiles (Raidal *et al.*, 2006).

In this case, it is possible that the fall of 0.6 m (2 ft) 4 yr prior to presentation was the inciting trauma, although reviews of the radiographs taken at that time show no obvious damage to the left shoulder. Based on the history, diagnostics, and clinical course over 3 yr, the current diagnosis is chronic degenerative joint disease restricted to the left shoulder.

Management options for degenerative joint disease can be surgical, medical, or conservative. Surgery (e.g., arthroplasty) was considered to carry too many potential risks. Medical management options include non-steroidal anti-inflammatories and poly-sulfonated glycosaminoglycans, but there is no information available on their long-term use in reptiles and long-term medication of this individual turtle was considered impractical. Based on this information and the lack of clinical signs in this individual, conservative management was elected.

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