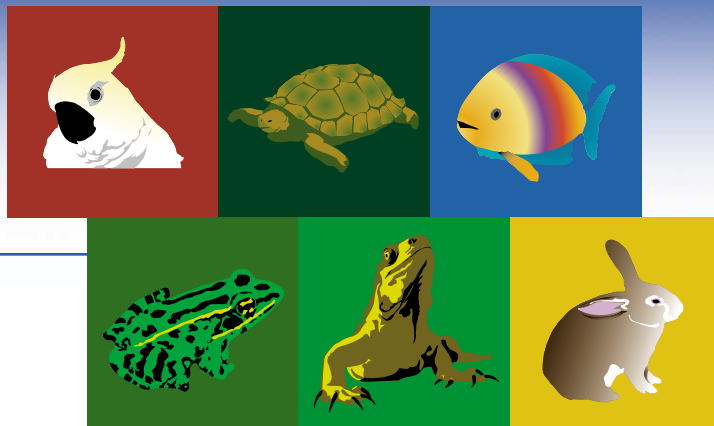


Diagnostic Challenge



History

A 1.5-year-old male Mali uromastix (*Uromastyx maliensis*) was presented with a 1-month history of a swollen left forelimb. The owner first noticed the swelling after finding the lizard hanging, by the affected limb, from the screened top of its enclosure. The swelling had progressed dramatically over a 2-week period and, at presentation, the uromastix was unable to ambulate.

The uromastix was acquired by the owner from a pet store 8 months before presentation. It was housed singly in a 3 × 2 × 1.5-foot glass enclosure, with a screened top and ground walnut shell as substrate. Heat was provided with an under-tank heating pad and incandescent lighting. The light source remained on 24 hours per day. The temperature in the enclosure was estimated to range from 15°C (60°F) at night to 32°C (90°F) during the day, although the owner could not confirm exact temperatures. A full-spectrum light source was not provided, and environmental humidity was not measured. The lizard's diet consisted of romaine lettuce and kelp with no additional supplementation.

On physical examination, the lizard weighed 210 g and was in good body condition. The only significant abnormality was a firm swelling of the entire left forelimb extending from the carpus to the shoulder (Fig 1). The patient was able to move the limb voluntarily, but it was not used for ambulation. Blood obtained from the ventral coccygeal vein was submitted for complete blood count (CBC) and plasma chemistry analysis. Because published hematologic and plasma chemistry reference intervals are not available for *Uromastyx maliensis*, reference intervals obtained from the International Species Information System for *Uromastyx aegyptius* (mean ± 2 standard deviations) were used to interpret the results. The CBC abnormalities included an immature population of heterophils with toxic changes and a monocytosis ($4.7 \times 10^3/\mu\text{L}$; reference range, $0\text{--}4.0 \times 10^3/\mu\text{L}$), although the total leukocyte count was within normal limits ($13.5 \times 10^3/\mu\text{L}$; reference range, $4.3\text{--}18.6 \times 10^3/\mu\text{L}$). Hyperglobulinemia (4.9 g/dL; reference range 1.0–4.6 g/dL) was present on the plasma chemistry panel. Analgesia was initiated with carprofen (2 mg/kg by mouth; Rimadyl, Pfizer Animal Health, Exton, PA USA), and the patient was hospitalized. Survey radiographs were obtained the following day (Figs 2 and 3).

At this time, please evaluate Figures 1, 2, and 3, the history, results of the physical examination, and diagnostic tests. Make a list of differential diagnoses before continuing, and develop a therapeutic plan.



Figure 1. A 1.5-year-old Mali uromastyx (*Uromastyx maliensis*) with severe swelling of the left forelimb.



Figure 2. Dorsoventral radiographic image of the uromastyx.



Figure 3. Cranial-caudal radiographic image of the left forelimb.

Diagnosis

Radiographs revealed severe soft tissue swelling and complete lysis of the distal humerus, with destruction of the elbow joint on the dorsoventral and cranial-caudal views (Figs 4 and 5). Because of the natural dorsoventral compression of the uromastyx, the lateral decubital radiographic image was unremarkable. Expansile lesions were noted at the proximal humerus, and there was loss of the humeral head. Due to the extensive nature of the skeletal defect, surgical repair of the fracture was not considered possible, and amputation of the limb at the scapulo-humeral joint was elected. Antibiotic therapy was initiated with ceftazidime (20 mg/kg intramuscularly every 72 hours; Fortaz, GlaxoSmithKline, Research Triangle Park, NC USA). Carprofen was discontinued, and butorphanol tar-

trate (0.5 mg/kg intramuscularly every 12 hours; Torbugesic, Fort Dodge Animal Health, Fort Dodge, IA USA) was administered for analgesia.

Anesthesia was induced with propofol (10 mg/kg intravenously; Propoflo, Abbott Laboratories, North Chicago, IL USA). The patient was intubated with a 16-gauge intravenous catheter sleeve (Quik-Cath, Baxter Health Care Corp., Deerfield, IL USA), and anesthesia was maintained with 3% isoflurane (Isoflo, Abbott Laboratories, North Chicago, IL USA) and 250 mL/h of oxygen. Positive pressure ventilation was provided at a rate of 6 breaths per minute. Heart rate and cloacal temperature were monitored throughout the procedure. Supplemental heat was provided with a water-circulating heating pad and an overhead heat lamp. The patient was maintained between

32°C and 35°C (90-95°F) during the procedure.

An elliptical incision was made circumferentially around the proximal humerus. A sample of the yellow, purulent material expressed from the incision was collected for aerobic bacterial and fungal cultures. Blunt dissection separated the skin from the underlying soft tissues and isolated the muscle bellies surrounding the humerus, which were individually transected. Several muscle bellies were friable and infiltrated with a whitish, caseous material. Vessels were ligated as needed. Nerves were infused with 2% lidocaine (lidocaine 2% injectable, The Butler Co., Columbus, OH USA) and transected.

The humerus was isolated from the overlying soft tissues. Grossly, the humeral diaphysis had been replaced by yellow, caseous material. A cotton-tipped applicator was used to collect the caseous material for aerobic and fungal culture. The remaining proximal one fourth of the humerus was disarticulated from the scapula, and the joint space lavaged with a copious volume of sterile 0.9% saline solution. The remaining muscle was closed over the joint space with 4-0 polydioxanone (PDS II, Ethicon, Inc., Somerville, NJ USA). To increase the effect of intralesional antimicrobial therapy due to the observed inflammation and tissue necrosis, a 5-mm diameter polymethylmethacrylate (PMMA) bead impregnated with cefazolin (Ancef, SmithKline Beecham, Philadelphia, PA USA) was sutured to the muscle layer, and the overlying skin closed in an everting pattern with 4-0 PDS (Fig 6). Recovery from anesthesia was uneventful. The amputated limb was placed in 10% formalin and submitted for histopathologic evaluation.

Postoperatively, butorphanol was continued twice daily for 5 days, then once daily for 3 days.

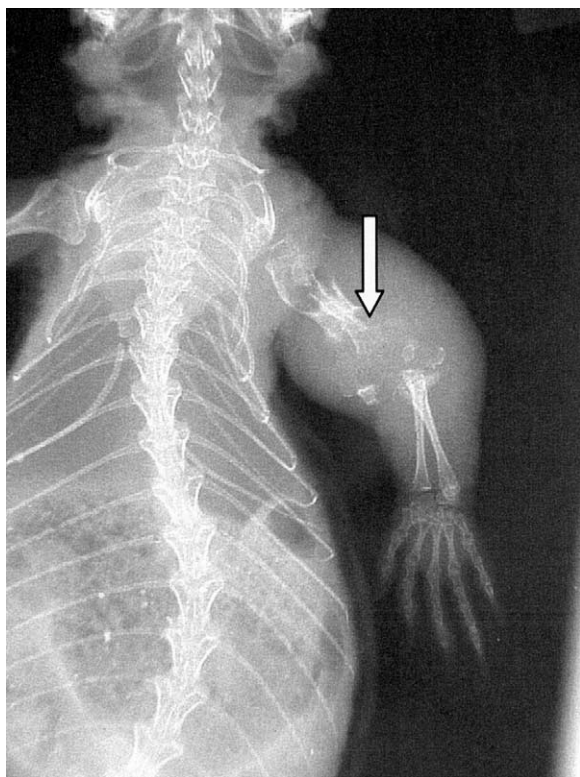


Figure 4. Dorsoventral radiographic image of the uromastyx. Note the severe lysis of the humerus (arrow).

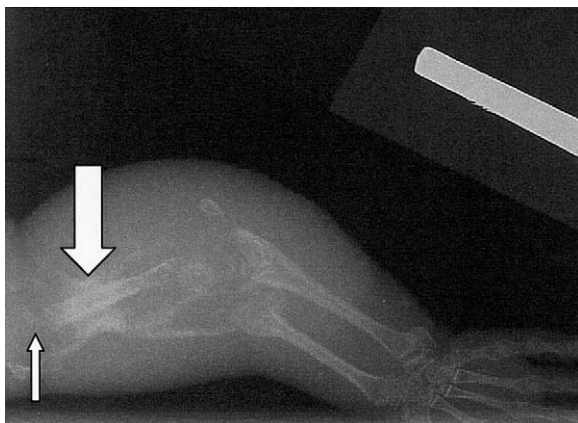


Figure 5. Cranial-caudal radiographic image of the left forelimb. Expansile lesions can be observed at the proximal humerus (large arrow) and the humeral head cannot be visualized (small arrow).

Ceftazidime was also continued at the same dose and frequency. A fecal sample obtained at the time of anesthetic recovery indicated numerous oxyurid ova. The patient was treated with fenbendazole (25 mg/kg by mouth every 24 hours; Panacur, Intervet, Inc., Millsboro, DE USA) for 3 treatments. Histopathologic examination of the amputated limb revealed extensive osteolysis of the humerus, accompanied by multifocal, coalescing pyogranulomatous inflammation with intralésional colonized bacteria (Fig 7). The histopathologic disease diagnosis was a bacterial infection. There was no evidence of neoplasia.

Microbiological samples obtained from the subcutis and bone

were streaked on to blood agar and MacConkey agar plates and incubated for 24 hours at 37°C under aerobic conditions. Growth was found on the blood agar after 24 hours of incubation. Colonies on blood agar from both the skin and bone samples were morphologically similar, with 2- to 3-mm diameter nonhemolytic gray colonies. Gram stains of these colonies revealed monomorphic populations of Gram-positive cocci. An API Staph Strip (Bio Merieux Vitek, St. Louis, MO USA) was used to characterize the bacteria. A *Micrococcus* sp. was isolated from the subcutis, and a *Staphylococcus hyicus* was isolated from the bone. Antimicrobial sensitivity testing of the isolates with the Kirby-Bauer dish diffusion technique indicated



Figure 6. Intraoperative view of the AIPMMA bead sutured in place.

sensitivity to ceftazidime, ciprofloxacin, enrofloxacin, chloramphenicol, amikacin, gentamicin, penicillin, piperacillin, ticarcillin, and doxycycline.

A resolving monocytosis (1.1×10^3) was seen on a CBC performed 1 week postoperatively. A second fecal sample obtained at that time was negative for oxyurid ova. There was no radiographic evidence of osteomyelitis in the scapula or coracoid 2 weeks postoperatively, which prompted removal of the PMMA bead.

For the second surgery, the patient was sedated with butorphanol, 0.5 mg/kg intramuscularly, and a ring block was performed with 2% lidocaine (0.05 mL). A 1-cm incision was made 3 mm dorsal to the original surgical site, and the bead was bluntly dissected from a moderate amount of yellow proteinaceous material that had accumulated around it. Culture samples were obtained from the bead surface and the surgical site. The surgical site was then debrided and flushed with sterile 0.9% saline solution. The incision was closed in a horizontal mattress pattern with 4-0 polydioxanone. The patient recovered from the second procedure uneventfully and was discharged 3 days later. The cultures collected at the second surgery were negative.

Suture removal was scheduled 3 to 4 weeks after discharge; unfortunately, the patient did not return to the hospital because of conflicts with the owner's schedule. Phone communication with the owner revealed that the lizard was doing well at home and appropriate husbandry changes had been made.

Comments

There are several potential inciting causes for reptiles to develop

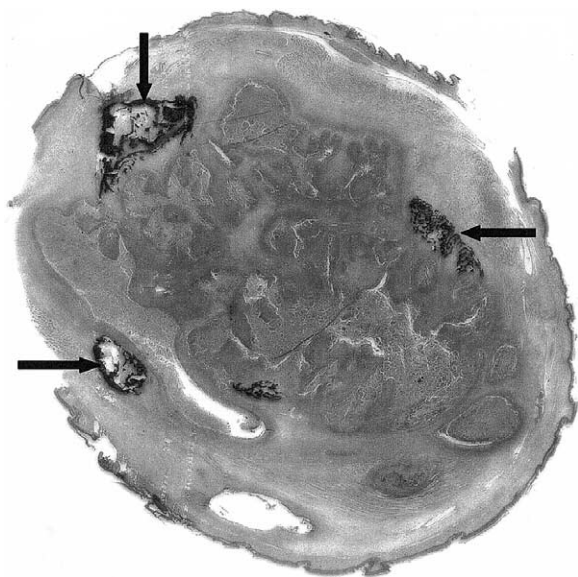


Figure 7. Cross-section of the left humerus. Note the severe osteolysis of the humerus and multiple coalescing pyogranulomas completely replacing the bone marrow space. Arrows indicate remaining bone.

osteomyelitis. Being ectothermic, reptiles rely on their external environment to regulate their core body temperature and immune function. Captive reptiles that are not provided an appropriate environmental temperature may be subject to opportunistic infections. In the wild, the reptile diet generally consists of a variety of sources of nutrients. Immunogens consumed by these animals may elicit a protective immune response. Because of the limited availability of appropriate reptile foods in captivity, these animals may not be provided with this natural immune stimulation. In addition, reptiles not provided with an adequate diet may be subject to energy deficiency, thus reducing the body's natural ability to allocate energy for an appropriate inflammatory response.

Trauma from a fracture or penetrating wound may serve as a pathway for the introduction of an opportunistic pathogen. Osteomyelitis also may occur from the hematogenous spread of pathogens from a nidus of infection originating elsewhere in the body.¹ The cause of the osteomyelitis in this

case was unclear; however, it was possibly the result of several factors, including a traumatic incident and immunosuppression due to inappropriate husbandry (environmental temperature, diet).

Pathogens isolated from lytic bone are often indigenous flora. These organisms are opportunists and, under conditions of immunosuppression, may result in disease.¹ Gram-negative organisms, such as *Pseudomonas* spp., *Escherichia coli*, *Salmonella* spp., and *Proteus* spp., as well as Gram-positive organisms, including *Staphylococcus* spp. and *Streptococcus* spp., are indigenous flora that can cause osteomyelitis in reptiles.¹ Fungal osteomyelitis has also been reported. Recently, a case of mandibular osteomyelitis in a Panther chameleon (*Furcifer pardalis*) was successfully treated with itraconazole.² The organisms isolated from this uromastix, including *Staphylococcus hyicus* and *Micrococcus* sp., are ubiquitous in the environment and skin surface, suggesting that a penetrating wound initiated the osteomyelitis, although there was no evidence of such a wound at the time of presentation.

Diagnosis of osteomyelitis is based on radiographic findings, microbiological culture, and histopathology. The most common radiographic changes reported with chronic osteomyelitis include soft tissue swelling, bone lysis, and periosteal proliferation, although the periosteal reaction is less prominent in reptiles than in mammals.^{1,3} When these changes are present radiographically, a presumptive diagnosis of osteomyelitis can be made; however, neoplasia cannot be ruled out without histopathologic confirmation.

Hematologic and plasma chemistry changes may further support the diagnosis of osteomyelitis. The CBC abnormalities reported in this case (immature heterophils, with toxic changes and a monocyctosis) are consistent with a chronic active inflammatory process. Toxic heterophils are particularly indicative of bacterial infection.⁴

Antibiotic-impregnated polymethylmethacrylate (AIPMMA) beads have been used in human and equine medicine for the local treatment of chronic infections. Chronic infectious osteomyelitis is difficult to treat because it may not respond to systemic antibiotic therapy, possibly due to limited blood supply surrounding the affected area and adversely affecting antimicrobial delivery.⁵ Additionally, reptile abscesses are often caseous and inspissated, which decrease the ability of antimicrobials to penetrate the infectious core of the lesion. Pharmacokinetic studies have shown that AIPMMA bead implantation provides high antibiotic concentrations at the implantation site but low concentrations in serum and urine.⁶ This localizing effect of the AIPMMA beads makes the use of antimicrobials that produce adverse systemic side effects, such as gentamicin, possible.

A variety of antibiotics may be incorporated into PMMA. Drug choice should be based on sensitivity of the organisms present. Antibiotics that are inactivated by heat should not be used in PMMA beads, because the material generates significant heat during the curing process. The most common antibiotics used in human and equine medicine PMMA bead impregnation are cephalosporins (cefazolin, moxalactam), gentamicin, vancomycin, and ticarcillin.⁵ Aminoglycosides are often preferred for use in reptile patients, because many of the pathogens isolated from these patients are Gram-negative organisms.⁷ Gram-positive bacteria may also cause osteomyelitis in reptiles, as in our case, which reinforces the importance of performing bacteriologic culture and antimicrobial sensitivity testing. AIPMMA beads must be used in conjunction with aggressive surgical debridement. The antimicrobial agents in AIPMMA beads are only able to penetrate a short distance; therefore, resection of caseous debris and necrotic material is essential.⁷

In this uromastyx, the AIPMMA bead was inserted into the surgical site, because there was a significant amount of inflammation and tissue necrosis. The initial plan was to suture the bead beneath the muscle layer directly in contact with the affected bone. Because a large amount of the surrounding musculature was abnormal and required debridement, this was not possible. Therefore, the bead was inserted superficial to the muscle layer. We were unable to determine if the antibiotic from the

AIPMMA bead penetrated the muscle to the bone. Because the muscle also appeared infected, we suggest the cefazolin may have had a local effect on the muscle layers based on the patient's response to therapy.

The patient in this case was able to ambulate without difficulty after amputation. This may be due, in part, to the dorsoventrally compressed body conformation of the uromastyx. A uromastyx may have difficulty in the wild after having lost the use of a limb, because its ability to escape predators would be hindered. Because uromastyx are predominantly herbivorous, the decreased ability of a 3-legged patient to capture prey is not a concern, especially with captive specimens similar to our patient.

This case was submitted by Shannon M. Riggs DVM, Veterinary Teaching Hospital, University of California-Davis School of Veterinary Medicine, Davis, CA 95616; Mark A. Mitchell, DVM, MS, PhD, Department of Veterinary Clinical Sciences, Louisiana State University, School of Veterinary Medicine, Baton Rouge, LA 70803; Jamie Williams, MS, DVM, DACVR, Department of Anatomy and Radiology, University of Georgia College of Veterinary Medicine, Athens, GA 30602; Dae Young Kim, DVM, MS, PhD, Dip. ACVP, Department of Veterinary Pathobiology, University of Missouri College of Veterinary Medicine, Columbia, MO 65211; Orlando Diaz-Figueroa, DVM, MS, Affiliated Veterinary Specialists, Maitland, FL 32751; and Maya Bewig, DVM, Department of Veterinary Clinical Sciences, Louisiana

State University School of Veterinary Medicine, Skip Bertman Drive, Baton Rouge, LA 70803.

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1055-937X/05/1403-\$30.00
doi:10.1053/j.saep.2005.06.008

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