Arthropyath caused by a lead bullet in a dog

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**Case Description**—A 3-year-old spayed female Labrador Retriever was evaluated for progressive left forelimb lameness 21 months after being shot in the elbow with a lead bullet.

**Clinical Findings**—Physical examination findings were consistent with moderate osteoarthritis of the left elbow joint. Orthogonal radiographic views of the elbow revealed multiple metallic fragments in and around the joint space as well as signs of osteoarthritis.

**Treatment and Outcome**—The elbow joint was evaluated arthroscopically. A lead-based bullet fragment was seen in the lateral synovial compartment and removed in multiple pieces. Excess fibrin and synovium were removed, and microfractures were created in exposed subchondral bone to stimulate neovascularization and fibrocartilage formation. In a follow-up telephone conversation 4 months after surgery, the owner reported a marked improvement in the lameness.

**Clinical Relevance**—Removal of lead intra-articular foreign bodies may be indicated even if the material is not believed to be mechanically interfere with joint motion. (J Am Vet Med Assoc 2008;232:886–888)
ed. Multiple full-thickness articular cartilage erosions were seen involving the trochlea of the humerus and the ulnar trochlear notch. The areas void of articular cartilage were surrounded by fibrillated cartilage. Pinpoint dark objects, presumably metal fragments, were visible adhered and incorporated into the proliferative synovium. The anconeal process and medial side of the medial coronoid process appeared normal. A 7- to 9-mm bullet fragment (measured via radiographs) was observed in the lateral compartment of the elbow joint (Figure 2). Although the fragment was freely movable when manipulated with a right angle probe, its size prevented movement through the humeral-ulnar articulation into the medial compartment of the elbow joint. Adjacent articular cartilage erosion and fibrillation suggested local mechanical trauma induced by the fragment.

A craniomedial instrument portal was used to aid in removing the bullet fragment. The fragment was soft and fragmented further when grasped, which necessitated removing the fragment in multiple sections. Fibrin and hyperplastic synovium were removed with a mechanical shaver. Microfractures were created in exposed subchondral bone with a micropick and mallet in an attempt to stimulate neovascularization and fibrocartilage formation. The joint was thoroughly lavaged with lactated Ringer's solution. Radiography performed immediately after surgery confirmed the removal of an intra-articular metal fragment but revealed the continued presence of periarticular and intraosseous metal fragments (Figure 1).

The dog received cefazolin (22 mg/kg [10 mg/lb], IV, q 90 min) during the surgery and polysulfated glycosaminoglycanb (4.4 mg/kg, SC) immediately after surgery. A cold compress was applied to the elbow for 10 minutes and a soft bandage was placed and left for 24 hours to minimize swelling after surgery. The dog was discharged the following day with instructions for the owner to assist with passive range-of-motion exercises (gentle repeated flexion and extension), restrict exercise, and gradually increase low-impact exercise (slowly increasing walks) over the course of 4 weeks.

Follow-up assessments were performed via telephone reports from the owner. Four weeks after surgery, the owner reported that there was a marked improvement in the lameness. It was also reported that the dog continued to bear weight on the limb for the entire length of walks allowed during the period (approx 8 blocks distance). Four months after surgery, the owner reported further improvement, describing a subtle lameness that was noticeable only after prolonged exercise.

**Discussion**

Reports of intra-articular foreign bodies in dogs are rare and include the removal of a canine tooth crown from a dog's elbow joint via arthrotomy and the ultrasonographic detection of an intra-articular porcupine quill that was subsequently retrieved from a dog's elbow joint during necropsy. Radiolucent intra-articular foreign bodies are difficult to diagnose radiographically, and radio-opaque foreign bodies can be difficult to localize accurately as intra-articular versus periarticular. Arthroscopy is therefore a good method of diagnosing as well as treating intra-articular foreign bodies because it provides superior inspection of the joint space, foreign material, and damage to intrasynovial structures, compared with radiography and ultrasonography.

Current literature suggests that the presence of intra-articular lead results in direct chemical toxicosis as well as mechanical trauma. Reports in human literature describe a delay of several years for the clinical signs of arthritis to develop after the initial healing of a gunshot wound to a joint. Humans frequently have radiographic, gross, histologic, and ultrastructural evidence of subsynovial lead accumulation. Over time, the radiograph—
ic appearance of a joint progresses to form a so-called lead arthrogram, in which the joint capsule is diffusely radio-opaque, which completely obscures the joint. On the basis of the findings in a case series of 3 humans with lead arthropathies and sub synovial lead accumulation, it was hypothesized that lead fragments may be dissolved by synovial fluid over time.\textsuperscript{3} Histologic and ultrastructural examination of 2 lead arthropathy cases resulted in the findings of intracellular accumulations of lead, calcium, and phosphorus complexes in the mitochondria of macrophages, osteoclasts, and synoviocytes, as well as extracellular incorporation of the same accumulations in sub synovial interstitium and newly forming trabecular bone.\textsuperscript{2} Trabecular bone with lead accumulations had abnormally sparse osteoclastic activity as well as focal areas of necrosis. These findings led the authors to conclude that there was a direct toxic effect of lead on the cells of joint tissues. In experimentally induced lead arthropathy in which lead cylinders were implanted into rabbit femoral condyles such that they would not mechanically interfere with joint motion, investigators found a higher degree of osteoarthritis than in control rabbits with stainless-steel implants.\textsuperscript{9,10} Because of direct chemical toxicity, it is recommended to remove any lead exposed to synovial fluid even if it does not mechanically interfere with motion.

Although intrasynovial bullet fragments are frequently reported in human literature, there are no such specific reports in dogs. In a previous report of a lead pellet found in the pastern of a horse with a 6-month history of lameness, there was no mention of radiographic signs of sub synovial lead accumulation (lead arthrogram), but extensive black granular pigment in the synovium was detected histologically.\textsuperscript{11} Radiography of the dog in this report did not reveal a lead arthrogram. However, in comparing the radiographs obtained directly after the gunshot wound and 21 months later, there was dispersal of metallic densities within and around the joint over time. This dispersal pattern could have been caused by mechanical erosion of soft tissue by the bullet fragments and the subsequent lodging of fragments into these erosions. Whether this dispersal pattern was also attributable in part to synovial dissolution and lead precipitation in the subsynovial tissue is unknown. Although not performed on this case, results of synovial histologic or electron microscopic examination with inspection of the subsynovial tissue for lead may have supported the theory of lead dissolution and subsequent precipitation in this case.

Bullet imbedded in soft tissues are generally not considered a concern regarding systemic lead absorption and toxicity because the foreign material is walled off by fibrous tissue and because lead does not dissolve well in serum (or, presumably, extracellular fluid). Exceptions are in cases of lead bathed in CSF or synovial fluid. There are numerous reports\textsuperscript{4,5,8} of systemic lead toxicity secondary to intra-articular lead in humans. There are no such reports in the veterinary literature. In a recent clinical report\textsuperscript{6} involving a man with symptoms of systemic lead toxicity who had a gunshot wound to the right elbow joint 6 years prior, serum lead concentration was high (143 µg/dL [reference range, < 10 µg/dL]) and synovial fluid lead concentration was > 1,000 µg/dL. The dog in this report did not have a clinical history or clinical signs suggestive of systemic lead toxicity, but a CBC with morphologic evaluation of RBCs, serum lead concentration, and synovial fluid lead concentration would have helped to determine whether subclinical lead toxicity was present secondary to intra-articular lead.

The dog reported here with a lead bullet–induced arthropathy improved clinically following arthroscopic removal of the fragments from the left elbow joint. On the basis of the clinical outcome of this case and information available in the literature, removal of intra-articular foreign material is indicated to reduce mechanically induced articular cartilage damage and synovitis. Lead may cause direct chemical toxicity to joint tissues and therefore may warrant removal even if the foreign body is not thought to mechanically interfere with joint motion. Intra-articular lead has been reported to cause systemic toxicity in humans, and this may be an additional reason to remove intra-articular lead foreign bodies in other animals.

References