A 3-month-old 400-g (14-oz) sexually intact female chinchilla (Chinchilla lanigera) was examined because of an acute onset of right hind limb non-weight-bearing lameness. The patient lived with 2 other chinchillas in a cage with a metal tube frame that contained 3 wooden climbing platforms and measured approximately 60 (height) X 32 (width) X 24 (depth) inches. The other chinchillas were apparently healthy. The owner fed a diet consisting of fresh hay ad libitum and a small volume of commercial chinchilla pellets once daily. The owner brought the chinchilla to our hospital immediately upon discovering the problem. Physical examination revealed a bright and alert chinchilla that was showing signs of pain and non-weight-bearing lameness of the right hind limb. The right pes was swollen, the distal portion of the digits were deviated laterally to an abnormal extent, and an open wound on the medial aspect of the metatarsus exposed the second metatarsal bone (Figure 1). The second metatarsal bone was not protruding from the wound, and there was no sign of gross contamination. There were no other abnormalities evident during the physical examination. For analgesia, buprenorphine* (0.05 mg/kg [0.023 mg/lb], IM) was administered.†

With the chinchilla conscious, a dorsoplantar radiograph of the right hind limb was obtained. This revealed oblique, displaced fractures of all 4 metatarsal bones (Figure 1). Because of the open wound, the chinchilla received 1 dose of enrofloxacin‡ (10 mg/kg [4.5 mg/lb], SC). Surgical repair of the fractures by means of open reduction with a combination of intramedullary pinning and external fixation to provide maximal stability was offered to the owner. The chinchilla was taken to surgery within 2 hours after admission.

The patient was sedated with midazolam§ (1 mg/kg [0.45 mg/lb], IM). General anesthesia was induced and maintained with 3% isoflurane¶ in oxygen delivered via a facemask for the duration of surgery as well as for acquisition of immediate postoperative radiographs. A multiparameter monitor¶ was used throughout anesthesia. Heart rate and rhythm were monitored by electrocardiography, respiratory rate was assessed by visual observation of thoracic move-

A 3-month-old sexually intact female chinchilla (Chinchilla lanigera) was examined for sudden onset of non-weight-bearing lameness of the right hind limb.

**CLINICAL FINDINGS**

On physical examination, the right pes was swollen. An open wound on the medial aspect of the metatarsal region exposed the second metatarsal bone, and the pes was displaced laterally. Radiographs of the right pes revealed oblique displaced fractures of the 4 metatarsal bones.

**TREATMENT AND OUTCOME**

Surgical treatment was elected, and enrofloxacin was administered prior to surgery. The protruding fragment of the second metatarsal bone was excised, and the third and fourth metatarsal bones were repaired with intramedullary pins and external skeletal fixation. The chinchilla was bearing weight on the affected limb 9 days after surgery with only mild lameness. The implants were removed 35 days after surgery when radiographs showed bony union of the third and fourth metatarsal bones and continued reduction of the fractures of the second and fifth metatarsal bones. Fifty-six days after surgery, the chinchilla was bearing full weight on the limb, and radiographs showed bony union of the third, fourth, and fifth metatarsal bones.

**CLINICAL RELEVANCE**

Findings suggested that intramedullary pinning combined with an epoxy resin external fixator may be an effective technique for metatarsal fracture repair in chinchillas. This method allowed physiologic positioning of the limb and functional hind limb use during fracture healing. Prospective studies of fracture healing in exotic small mammals are indicated. (J Am Vet Med Assoc 2016;249:801–806)
ments, and pulse rate and arterial oxygen saturation were detected by pulse oximetry. A tarsal ring block was performed prior to the start of surgery with a combination of lidocaine (0.4 mL/kg [0.18 mg/lb], SC) and bupivacaine (1 mg/kg, SC) diluted in 0.8 mL of sterile saline (0.9% NaCl) solution.

The patient was positioned in dorsal recumbency with the right hind limb extended caudally and fixed in position. The metatarsal region was then aseptically prepared and draped for surgery. A 1.5-cm linear incision was made over the dorsal aspect of the metatarsus and the digital extensor tendons. The accompanying blood vessels were retracted medially and laterally to expose the fracture site. There is an open wound exposing the second metatarsal bone (Figure 1C).—Anatomic illustration of the dorsoplantar aspect of the bones of the left pes of a chinchilla. The first metatarsal bone is absent, and the fifth metatarsal bone is a small bone located proximally at the plantar aspect of the third and fourth metatarsal bones. Digit V in a chinchilla resembles digit I of a declawed cat, and the radiograph of the pes may appear misleadingly inverted.

Following treatment of the third and fourth metatarsal bones, an attempt to insert a pin into the fifth metatarsal bone was made. However, the 0.8-mm-diameter intramedullary pin, the smallest available at our hospital, was too large to fit the medullary cavity and, consequently, the fifth metatarsal bone was not pinned. In preparation for external fixation, an additional 0.8-mm-diameter intramedullary pin was inserted in a transverse plane through the proximal ends of all 4 metatarsal bones. The open wound exposing the second metatarsal bone was then lavaged with 20 mL of sterile saline solution. The skin incision and the wound were closed with 4-0 absorbable suture in a single-layer, simple interrupted pattern. Immediate postoperative radiographs were obtained, which confirmed appropriate positioning of implants and fracture reduction (Figure 2). With the patient still anesthetized, the exposed ends of all pins were then bent dorsally such that they converged over the dorsal aspect of the metatarsus. An ovoid mass of activated epoxy resin putty was placed and molded over the pin ends to form an external fixator. Care was taken to ensure a 5-mm gap between the skin surface and the resin mass to accommodate postoperative swelling (Figure 3). The patient was then allowed to recover from anesthesia, which took place without apparent complications. The duration of surgery was approximately 50 minutes.
Moderate soft tissue swelling of the treated limb developed after surgery but resolved within 3 days without treatment, at which time the chinchilla was beginning to place the limb on the ground. Postoperative management included buprenorphine\(^a\) for 3 days (0.05 mg/kg, IM, q 8 h), meloxicam\(^i\) for 10 days (1 mg/kg, PO, q 12 h), and enrofloxacin\(^m\) for 21 days (10 mg/kg, PO, q 12 h). Twice-daily lavage of the metatarsal region, especially where the pins protruded through the skin, with 0.2% chlorhexidine solution\(^n\) was prescribed until the pins were removed. The patient was discharged 48 hours after surgery.

All follow-up examinations, diagnostic tests, and procedures were performed at our hospital. Nine days after surgery, the chinchilla was bearing weight on the treated right hind limb, with only mild lameness and slight supination evident. The sutured skin incision and initial wound were clean and appeared to be healing normally. A small abrasion was noted on the cranial aspect of the right tibia, apparently a result of contact with the adjacent epoxy putty. Local wound care with 0.2% chlorhexidine solution\(^n\) was prescribed, and a light bandage was wrapped around the tibia to protect the skin from further abrasion. The owners were instructed to change the bandage weekly until implant removal. Fifteen days after surgery, the chinchilla was bearing weight on the foot without any lameness. The patient continued to display mild supination when ambulating.

Thirty-five days after surgery, weight bearing still appeared normal with no clinical or radiographic evidence of complications (Figure 3). Follow-up radiography revealed bony union of the third and fourth metatarsal bones and continued reduction of the fractures of the second and fifth metatarsal bones. The intramedullary pins were removed. The chinchilla was premedicated with a combination of buprenorphine\(^a\) (0.05 mg/kg, IM) and midazolam\(^c\) (1 mg/kg, IM) for sedation and analgesia. Anesthesia was induced and maintained with 3% isoflurane\(^d\) in oxygen delivered via a facemask. The intramedullary pins were cut close to the epoxy putty, and the transverse pin was cut laterally on both sides of the limb. The epoxy putty was removed. After aseptic preparation of the limb, all the intramedullary pins were extracted. Radiographs acquired after removal of all implants confirmed fractured healing.

Twenty-one days after implant removal (56 days after surgery), the chinchilla was bearing weight on the right hind limb, which now had a normal range of motion, despite the persistence of mild supination when ambulating. Radiography of the distal limb revealed bony union of the third, fourth, and fifth metatarsal bones (Figure 4). A telephone conversation with the owner 18 months later indicated the chinchilla was apparently healthy and the owners were satisfied with the outcome.
Discussion

The most common fractures in client-owned (ie, pet) chinchillas, rabbits, and rodents affect the hind limbs. Such injuries often occur when the foot becomes trapped in the bottom grill of the cage. Several authors have suggested that these animals are predisposed to limb fractures because of their relatively long thin leg bones. Whereas this remains a theory, chinchillas and rabbits, which are behaviorally specialized for the half-bounding gait, have considerably narrower tibiae and metatarsal bones, compared with similarly sized gait-generalized runners such as opossums and rats. Few reports have described fracture repair in chinchillas. External fixation, intramedullary pinning, or a combination of these modalities has been described for treatment of fractures of the femur and tibia in chinchillas. A systematic review did not reveal any reports describing the surgical repair or even treatment of a metatarsal fracture in chinchillas (Supplemental Appendix S1, available at http://avmajournals.avma.org/doi/suppl/10.2460/javma.249.7.801). In our clinical experience, general practitioners may be uncertain regarding how to treat fractures in chinchillas. A review of discussions on the Veterinary Information Network Message Boards from 2010 through 2015 revealed 19 cases of long bone diaphyseal fracture in chinchillas. Two cases involved the femur, 1 involved the humerus, 7 involved the tibia, 5 involved the radius and ulna, and 4 involved the metatarsal bones. Practitioners asked about the use of intramedullary pins, amputation, or external splinting as suitable treatment methods. Five animals were not treated, 6 had amputations of the fractured limb, 5 had splints, and 3 had intramedullary pinning. Of the 4 metatarsal bone fractures, 2 resulted in limb amputation, 1 was splinted, and 1 was not treated. Unfortunately, typical management for metatarsal and metacarpal bone fractures in rabbits and hystricognath rodents such as guinea pigs, chinchillas, and degus is external coaptation because many clinicians consider the metatarsal bones too small for surgical fixation. When orthopedic surgery is performed in small mammals, non-union is a reported complication but is considered to be of minimal clinical importance. We disagreed with these suppositions and, for this reason, pursued optimal fracture reduction in the patient of this report.

Options for the treatment of metacarpal and metatarsal bone fractures in cats and dogs include cage rest with or without support dressings, external coaptation with an assortment of splint types, and a range of surgical methods such as intramedullary pinning and related techniques. The use of external skeletal fixation has also been described.

General practitioners may be faced with conflicting opinions regarding various treatment options, with a lack of high-quality evidence to guide clinical decision making. Various definitions and outcome measures have been published for dogs. There appears to be agreement on medical treatment with external coaptation when fractures are minimally displaced, only 1 or 2 metacarpal or metatarsal bones are involved, and at least 1 of the major weight-bearing bones (ie, the third and fourth metatarsal bones) is intact. Surgical treatment is recommended when more than 2 bones are involved, both the third and fourth metatarsal (or metacarpal) bones are fractured, the fracture is open, the fractures are displaced or comminuted, or the fractures involve a joint.

In the patient of the present report, surgical treatment was elected for several reasons. The fracture was open; all 4 metatarsal bones, including the main weight-bearing bones (ie, the third and fourth metatarsal bones), were fractured; and the fractures were displaced (in chinchillas, digit I is absent, and digit V is small and located proximally). Moreover, we considered external coaptation would not benefit this patient for 2 reasons. First, chinchillas are behaviorally highly specialized to use the half-bound gait that they rarely, if ever, use any other gait except for leaping. Second, in climbing cages, chinchillas reportedly spend 25% to 30% of their time moving from different levels as they engage in various behaviors. As such, we felt that treatment aimed at rapidly restoring function to the affected hind limb was essential for this animal’s welfare.

Figure 4—Dorsoplantar (A) and lateral (B) radiographs of the right hind limb of the patient in Figure 1 acquired 56 days after surgery. Notice the good alignment and bony union of the third, fourth, and fifth metatarsal bones.
The small size of the metatarsal bones in chinchillas did not allow the placement of a commercially available bone plate in this patient. Several studies describe the use of intramedullary pinning to repair metatarsal and metacarpal bone fractures in dogs and cats. The disadvantage of retrograde pinning, as performed in the patient of this report, is the potential for iatrogenic joint injury caused by penetration of the metatarsophalangeal (or metacarpophalangeal) joint by the pin. In cats, a dowel intramedullary pinning technique has been described that avoids joint penetration by drilling a hole in the dorsal cortex. Normograde insertion via the drilled hole avoids penetration of the articular surfaces and subsequent arthritis. Other disadvantages of intramedullary pinning are the risk of bone splintering during pin insertion, and the risk of bending the pins when the required pin diameter is very small. The dowel intramedullary pin technique allows the use of larger diameter pins, thus reducing the chance of bending the pin, but there is no evidence to indicate that this technique improves outcome, compared with external coaptation for treating patients with comminuted fractures. In particular, because implants placed in this manner cannot be removed, this procedure may not be suitable for patients with open fractures that are at risk for the development of osteomyelitis. In the chinchilla of the present report, we were uncertain whether the decision to shorten the second metatarsal bone (because of removal of the devitalized fracture fragment) intraoperatively might have had subsequent functional consequences. However, because of the potential for infection posed by leaving this devitalized fragment in situ and the poor prognosis for osteomyelitis, the fracture was repaired in this manner. Fortunately, this did not appear to result in clinically important consequences, because the fracture ultimately healed and the chinchilla was able to ambulate bearing full weight on the affected right hind limb with no apparent signs of pain 56 days after surgery.

External skeletal fixation may be preferred for surgical treatment of open fractures. Various studies have described the use of external skeletal fixation for treatment of metacarpal and metatarsal bone fractures in veterinary patients. A traction device has been described in dogs, with use of epoxy putty to replace connecting bars. In the patient of the present report, digit alignment and optimal reduction were our main objectives. We elected to use an external fixation technique originally described by Fitzpatrick et al. This technique has been referred to as the SPIDER frame. A major advantage of the SPIDER frame is that the dorsal contouring of the pins allows the animal to place its paw in a physiologic position with the external skeletal fixation in situ. Also, because there is no splint or bandage required, wound care is easily managed, including for patients with open wounds (ie, open fracture). A complete frame can be designed by contouring the distal (ie, exposed) ends of the pins and adding a proximal transverse pin. The frame minimizes the risk of pin “pull-out” and provides additional stability, compared with use of intramedullary pinning alone. This is advantageous particularly in cases when not all of the fractured bones can be pinned. Skin abrasion from the epoxy putty, as we observed in our patient, has been reported as a minor short-term complication that resolves after implant removal.

Although treatment of fractures in exotic small mammals is often modeled after treatments used in dogs and cats, the small size of these patients often discourages general practitioners from performing surgery. In the chinchilla of the present report, combined intramedullary pinning and external skeletal fixation with the SPIDER frame was relatively simple to perform and effective for the treatment of multiple displaced oblique metatarsal bone fractures affecting the right hind limb. Importantly, the technique allowed functional hind limb use during fracture healing. Prospective studies of fracture treatment in exotic small mammals are needed.

Footnotes

a. Vetergesic Multidose (buprenorphine, 0.3 mg/mL), Reckitt Benckiser Healthcare Ltd, Slough, Berkshire, England.
b. Baytril (enrofloxacin 5%), Bayer Corp, Loos, France.
c. Midazolam (5 mg/mL), Aquttant, Lyons, France.
d. Vetrfluane (isoflurane 100%) inhalation vapor liquid, Virbac, Carros, France.
e. Life Scope BSM-2551K, Nihon Kohden, Tokyo, Japan.
f. Laocaine (lidocaine chloride 1%), Intervet, Angers, France.
g. Baytril (enrofloxacin 5%), Bayer Corp, Loos, France.
h. Saline (0.9% NaCl) solution, B Braun Medical France SAS, Boulogne, France.
i. 0.8-mm Kirschner wire, DePuy Synthes, Etupes-Cedex, France.
j. 4-0 Biosyn undyed 30-inch P-12 cutting, Coudiden France SAS, Elancourt, France.
k. FastFix Putty, Securos, Neuhausen, Germany.
l. Metacam solution buvable (meloxicam suspension, 1.5 mg/mL), Boehringer-Ingelheim, Ingelheim-Rhein, Germany.
m. Baytril (enrofloxacin 2.5%), Bayer, Loos, France.
n. Chlorhexidine aqueuse (chlorhexidine 0.2%), Axience SAS, Pantin, France.
r. Weiss S. Verhaltensuntersuchungen an Chinchillas in ausgestalteten Kletterkäfigen [in German]. Dr Med Vet thesis, Faculty of Veterinary Medicine, Ludwig Maximilian University, Munich, Germany, 2005.

References


