

Long-bone fractures in llamas: six cases (1993–1998)

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Objective—To determine clinical and radiographic findings, treatment, and outcome for llamas with long-bone fractures.

Design—Retrospective study.

Animals—6 llamas.

Procedure—Medical records of llamas admitted between 1993 and 1998 because of long-bone fractures were reviewed. Data collected included age, sex, type of fracture, method of fracture repair, and postoperative complications. The Fisher exact test was used to compare age and sex of the llamas with long-bone fractures with those of the hospital population of llamas. All owners were contacted by telephone to determine perceived postoperative problems and whether the llamas were able to perform as expected.

Results—Mean age was 160.8 days (range, 23 to 365 days). There was 1 male and 5 females. Fractures were more likely to occur in young llamas (≤ 1 year old) than in adults. Five of the fractures were attributed to traumatic episodes. Long bones affected included the tibia ($n = 2$), radius (2), femur (1), and humerus (1). Internal fixation with lag screws, plating, or both was performed on fractures of all llamas except 1; that llama was treated by use of confinement to a stall. None of the llamas had intraoperative complications, but postoperative complications were reported in 2 llamas. All fractures healed eventually, and clients were pleased with outcomes.

Conclusions and Clinical Relevance—Long-bone fractures in llamas are uncommon. Several types of long bone fractures can be successfully repaired by use of internal fixation, resulting in few complications and minimal convalescent time. (*J Am Vet Med Assoc* 2000;216:1291–1293)

Llamas are similar to other small ruminants in that they are considered more amenable to repair of long-bone fractures than are larger food-producing animals or horses. Their relatively small size, ability to bear weight on 3 limbs for an extended amount of time, stoic demeanor, and tendency to remain recumbent during convalescence are major reasons that llamas respond well to internal fixation of long-bone fractures.^{1–3} Because long-bone fractures are infrequent in llamas, reports on management of long-bone fractures in llamas are sparse. Repair of radial and ulnar frac-

tures^{2,4} or metacarpal fractures, using plate fixation or external coaptation,¹ has been described. Management of a llama with a femoral fracture complicated by polyostotic aneurysmal cysts has been reported.⁵ Therefore, the purpose of the study reported here was to determine the distribution and outcome of various long-bone fractures in llamas examined at our veterinary medical teaching hospital between January 1993 and December 1998. Our hypotheses were that long-bone fractures could be managed successfully by use of internal fixation methods and that young llamas were overrepresented among llamas with long-bone fractures.

Criteria for Selection of Cases

Medical records of all llamas admitted to our veterinary medical teaching hospital between January 1993 and December 1998 were reviewed. All llamas with radiographic confirmation of a long-bone fracture were included in the study. Radiographic evidence of long-bone fractures and follow-up radiographs, when available, of llamas that underwent internal fixation were reviewed.

Procedures

Information obtained from the medical records included signalment, medical history, results of physical examination, and treatment. All owners were contacted by telephone to determine perceived postoperative problems and whether outcome for the llamas was as expected. Radiographs were reviewed to determine type of fracture and evaluate healing or evidence of complications after internal fixation.

Statistical Analysis

Sex and age distributions of llamas with long-bone fractures were compared with those of all llamas admitted to our veterinary medical teaching hospital between January 1993 and December 1998. A Fisher exact test was used to detect significant differences of age and sex between the 2 groups.⁶ Values of $P < 0.05$ were considered significant.

Results

Animals—During the period of the study, 306 llamas were admitted to our facility. Of these, 6 met the criteria for inclusion in the study (ie, radiographic confirmation of a long-bone fracture). Body weights were not recorded for most llamas.

The 6 llamas with long-bone fractures comprised 1 male and 5 females. There were 130 male and 170 female llamas admitted to our hospital for reasons other than long-bone fracture during the study period.

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All llamas in the study were sexually intact. Sex of llamas with long-bone fractures did not differ significantly ($P = 0.374$) from that of the general hospital population.

The 6 llamas with long-bone fractures ranged from 23 to 365 days old (mean, 160.8 days). Of the 300 llamas admitted to the hospital for reasons other than long-bone fractures during the study period, 87 were ≤ 12 months old, whereas 213 were > 12 months old. Llamas with long-bone fractures were significantly ($P = 0.001$) younger than the general hospital population of llamas. Of the 93 llamas that were ≤ 1 year old, 6 (6.4%) had a long-bone fracture.

Clinical history and examinations—Three of the 6 llamas with long-bone fractures were acutely lame and unable to bear weight on the affected limb, and 3 were evaluated because of chronic lameness. Of the 3 llamas with chronic lameness, 1 was lame and unable to bear weight on the affected limb for 4 weeks (humeral fracture), 1 was lame for 2 weeks but able to bear weight on the affected limb (dorsal cortical tibial fracture), and 1 was lame for 10 weeks but also able to bear weight on the affected limb (femoral sequestrum).

All llamas were evaluated for lameness. Clinical findings during initial examination were lameness and the inability to bear weight on the affected limb (4 llamas), lameness but able to bear weight on the affected limb (2), crepitus (4), resentment of manipulation of the affected limb (5), muscle atrophy (1), and contractural deformity of the ipsilateral carpus (1). The llama with a femoral fracture originally was admitted because of chronic lameness and a large sequestrum of the proximomedial diaphysis of the left femur. Seven days after surgery to remove the sequestrum, the llama became acutely lame and unable to bear weight following pathologic fracture at the site of sequestrum removal. All fractures were confirmed and defined with radiography.

Long bones affected included the humerus ($n = 1$), radius (2), tibia (2), and femur (1). All fractures were considered to have a traumatic cause except for the femoral fracture that occurred 7 days after removal of a large sequestrum. Types of fractures were simple oblique (humerus, $n = 1$; radius, 1; femur, 1), comminuted (radius, 1), Salter-Harris type II (proximal portion of the tibia, 1), and complete, nondisplaced dorsal cortical fracture (tibia, 1). All fractures, except for the Salter-Harris type II fracture, involved only the diaphyseal portion of the bones.

Treatment and outcome—Five of the llamas were treated by use of internal fixation, and 1 (tibial fracture) was treated only by confinement to a stall. Internal fixation was accomplished by use of lag screws alone ($n = 1$) or dynamic compression plates with lag screws (4). Dynamic compression plates were 4.5-mm broad plates ranging from 8 to 12 holes, and fracture reduction with plates was accomplished by use of 1 plate for each fracture. In the llama in which lag screws were the only means of internal fixation, 4.0-mm partially threaded, cancellous screws were used.

The 5 llamas that underwent internal fixation were able to bear weight on the affected limb within 3 days

after surgery. Postoperative complications were recorded in 2 llamas. Implant failure (bending of the plate and partial pull out of lag screws) and worsening of carpal contractural deformity were recorded in 1 llama. The dynamic compression plate used to repair the humeral fracture was bent 5 days after surgery. The dynamic compression plate and screws were not removed, on the basis of a request by the owner, and long-term passive flexion and extension of the carpus resolved the carpal contractural deformity. In the other llama, infection of the incision and implants were recorded. Incisional infection without radiographic evidence of infection associated with the implants was apparent in the llama with the femoral fracture 14 days after surgery; it was treated by flushing the area with a chlorhexidine solution. Six months after surgery, this llama was admitted to our facility because of multiple draining tracts. Radiography at that time revealed the tracts originated from the femoral implants. The infection resolved following implant removal and antimicrobial treatment.

Perioperative antimicrobial treatment included procaine penicillin G (22,000 U/kg [10,000 U/lb] of body weight, IM), ceftiofur sodium (4.4 mg/kg [2 mg/lb], SC), or cefazolin (25 mg/kg [11.4 mg/lb], IV). Postoperative antibiotic treatment included procaine penicillin G (22,000 U/kg, SC, q 12 h), ceftiofur (4.4 mg/kg, SC, q 12 h), cefazolin (25 mg/kg, IV, q 8 h), ampicillin (14.5 mg/kg [6.6 mg/lb], SC, q 12 h), or oxytetracycline hydrochloride (20 mg/kg [9.1 mg/lb], SC, q 24 h). Selection of antibiotics for perioperative and postoperative administration was made on the basis of clinicians' judgement, results of bacterial culture and antibiotic susceptibility testing, or both. For example, ampicillin was administered to the llama with the femoral fracture on the basis of results of bacterial culture and susceptibility testing performed after implant removal, and oxytetracycline was administered to the llama with the humeral fracture because of the detection of *Eperythrozoon* organisms during examination of a blood smear and concurrent mild anemia. Antimicrobial drugs were administered to 4 llamas for 7 days after surgery. Prolonged antimicrobial treatment was used in the llama with the femoral fracture (10 days after implant removal) and the llama with the humeral fracture (30 days after surgery).

Phenylbutazone and butorphanol tartrate were used for analgesia in 2 llamas. One dose of phenylbutazone (4.4 mg/kg, IV) was given to the llama with the femoral fracture after surgery. Butorphanol (0.22 mg/kg [0.1 mg/lb], IV) was administered perioperatively to one of the llamas with a radial fracture, and phenylbutazone (4.4 mg/kg, IV) was administered to that llama for 48 hours after surgery.

Follow-up information was obtained on all llamas via telephone conversation with owners. Follow-up information was obtained 4 months to 5 years after llamas were admitted to our hospital. Owners were pleased with the outcome in all llamas, and the llamas were performing their intended function, which, in most cases, was use as breeding stock. All llamas, except the one with the humeral fracture, did not have lameness or deformity of the affected limb. The llama

with the humeral fracture reportedly was moderately lame, but the contractural deformity of the carpus was not apparent.

Discussion

Long-bone fractures in llamas were infrequent at our hospital during the period of 1993 to 1998. Of the llamas admitted with fractures, all had fractures of the proximal portion of the affected limbs, and all the llamas were young (≤ 1 year old). Analysis of our results suggests that llamas ≤ 1 year old are predisposed to long-bone fractures. There was insufficient evidence to detect a difference with respect to sex. The authors realize that strong conclusions cannot be made on the basis of statistical analysis of such a low number of cases, and conclusions cannot be made about the general llama population because of the biased nature of the study population.

Postoperative complications that developed in 2 llamas included implant failure and increased severity in a contractural limb deformity as well as infection of implants. Implant failure in the llama with the humeral fracture and continued nonuse of the affected limb, without evidence of radial nerve paresis, contributed to worsening of a contractural limb deformity in that limb. This was the only surgically repaired fracture in which there was a substantial delay before the llama was admitted to our hospital for examination, which may have contributed to the complications after surgery. The other llamas that had chronic lameness did not have a fracture at the time of initial examination to the hospital (ie, femoral fracture occurred 7 days after surgical removal of a sequestrum) or were not treated surgically (ie, llama with the dorsal cortical tibial fracture was managed by use of confinement to a stall). Postoperative complications after repair of the pathologic femoral fracture were expected because of the inherent infectious nature of sequestra; however, the fracture healed satisfactorily, and the chronic draining tracts subsided after implant removal and antibiotic treatment.

Long-bone fractures are uncommon in llamas. However, the size, stoic demeanor, and usually amenable disposition of llamas makes them ideal can-

didates for internal fixation of long-bone fractures, compared to horses and most food-producing animals.¹⁻³ Because of these factors, internal fixation devices used for other species may be applicable in llamas.^{1-4,7} Repair of phalangeal and metacarpal or metatarsal fractures has been reported^{1,3,7} and may be achieved by application of a cast or use of transfixation pins along with a cast. Two other successful methods of bone-plate fixation of fractures in the proximal portion of the radius and ulna have been described.^{2,4}

Llamas are used for several purposes, from show animals to pack animals and pets. Despite the capacity in which llamas are expected to perform, most llama owners view their animals as pets or companions. Thus, most llama owners choose treatment of surgical and medical conditions of their animals that will provide the least amount of discomfort and minimal amount of convalescent time with little regard for financial considerations. With respect to most long-bone fractures, internal fixation minimizes convalescent time, allows for a rapid return to normal activities, reduces the duration of hospitalization, and minimizes aftercare.⁸ Long-bone fractures in llamas can be treated successfully by use of internal fixation with minimal postoperative complications.

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