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Objective—To describe the use of a novel intramedullary interlocking nail for femoral fracture repair in newborn calves and outcome associated with this treatment modality.

Design—Retrospective case series.

Animals—25 calves.

Procedures—Medical records from calves referred for femoral fracture repair between November 2008 and June 2009 were included. Signalment, clinical findings, and results of lameness examination and complete radiographic examination were recorded. Details of surgical technique, orthopedic fixation, associated complications, and outcome were also noted.

Results—25 Charolais calves were included in the study. All fractures were closed and located in the diaphysis; 18 extended to the distal metaphysis, 1 was located proximally, and 6 were midshaft fractures. Fractures were localized to the left femur in 17 calves and to the right femur in 8 calves. An interlocking nail was used as the sole means of internal fixation in 16 calves and was reinforced in 9 calves. Two calves were euthanized for reasons related to the surgery, and 4 died of unrelated reasons. Long-term prognosis was considered excellent for 15 calves and fair for 4 calves. Age, body weight, overall musculoskeletal strength at initial evaluation, affected limb, configuration and location of the fracture, need for reinforcement of the repair, and quality of the reduction had no significant association with positive outcome of the surgery.

Conclusions and Clinical Relevance—The novel intramedullary interlocking nail used in the present study was associated with a good prognosis for surgical repair of femoral fractures in newborn calves regardless of the location of the fracture. (J Am Vet Med Assoc 2011;238:1490–1496)

Femoral fractures are common in newborn calves and are typically located either in the femoral neck, proximal femoral physis, or femoral shaft.1,2 The interface of metaphyseal and diaphyseal bone at the point at which cortical bone changes from dense lamellar bone to woven bone has been identified as a weak point in the length of the bone shaft of growing mammals.3,4 The configuration of femoral shaft fractures can be oblique or spiral,5–10 and overriding of the fracture fragments and periosteal stripping may be present.

Treatment is surgical with open reduction and internal fixation, as stall rest associated with external coaptation often leads to treatment failure.11,12 Fixation can be achieved with the use of orthopedic plates (cobra-head plate, 90° blade plate, or broad dynamic compression plate), external fixators, or intramedullary implants (pins or nails).3–10,13–15 Orthopedic plates and screws, external fixation, and intramedullary stack pinning have been compared by use of an in vivo model of transverse osteotomy in newborn dairy calves.11 In that study,11 intramedullary stack pinning provided superior results, compared with those of the other methods. However, this was associated with some degree of malalignment and overriding. In a report of 12 calves < 1 month of age in which diaphyseal femoral fractures were repaired with intramedullary pinning, St-Jean et al16 reported that fractures were considered to have healed satisfactorily in 10 calves. More recently, Nichols et al17 reported on the use of intramedullary pinning with and without other orthopedic implants (cerclage wires and type I external fixators) and the use of an interlocking intramedullary nail for the treatment of mid-diaphysis and distal diaphysis femoral fracture in calves < 2 months of age. These authors reported a success rate of 50% at 6 months after discharge from the hospital, and distal location of the fracture in the femoral diaphysis was determined to be an unfavorable prognostic factor.17

Interlocking nails have been evaluated by use of an in vitro transverse osteotomy model in dairy calf femurs and are considered to be a suitable means of repair for these types of fractures.18 The purpose of the study reported here was to describe the use of a novel intramedullary inter-
locking nail for femoral fracture repair in newborn calves and the outcome associated with this treatment modality. Age at evaluation, body weight, overall musculoskeletal strength during the initial evaluation, affected limb, configuration and location of the fracture, need for additional reinforcement of the repair, and quality of the reduction were analyzed to determine whether these variables were associated with a positive surgical outcome.

Materials and Methods

Case selection criteria—Calves with a femoral shaft fracture that were admitted to and treated at the Clinique Vétérinaire, Decize, France, between November 2008 and June 2009 were included in the study. Information collected from the medical records included signalment, results of physical examination, assessment of passive transfer of maternal immunity based on PCV and serum total protein concentration, time between fracture occurrence and evaluation, overall musculoskeletal strength, fracture etiology, and fracture location and configuration.

The overall musculoskeletal strength was scored on a 3-point scale: 1 (strong) = able to stand without assistance, 2 (weak) = needs assistance to stand but is able to remain standing without assistance, and 3 (recumbent) = recumbent and unable to stand even with assistance. Location of the fracture was established by use of the distal extremity of the fracture line on the radiographs and classified as metaphyseal or diaphyseal. Configuration of the fracture was classified as simple (oblique or spiral) or multiple, and the number of additional fragments was recorded. Displacement of the distal bone segment was measured directly on the mediolateral radiographic view as the distance between the proximal end of the distal bone segment and the distal end of the proximal bone segment for the parent bone.

Surgical technique—Gentamicin sulfate 3 mg/kg [1.4 mg/lb], 1M, q 24 h) and amoxicillin trihydrate 30 mg/kg [13.64 mg/lb], 1M, q 48 h) were administered beginning at the time of surgery and continued for 3 and 10 days, respectively. General anesthesia was induced with a combination of tiletamine hydrochloride 2 mg/kg [0.9 mg/lb, IV] and zolazepam 2 mg/kg, IV) and maintained with isoflurane in oxygen via a rebreathing anesthetic circuit system after endotracheal intubation. The calf was positioned in lateral recumbency with the affected limb positioned uppermost. Hair on the entire limb was clipped, and the limb was prepared for surgery by use of an aseptic technique.

A lateral approach to the femur was performed by making a curvilinear incision from the greater trochanter to the lateral epicondyle. The tensor fascia lata muscle was incised following the cranial border of the biceps femoris muscle, exposing the vastus lateralis muscle. The vastus lateralis muscle was incised in the direction of the muscle fibers to gain access to the fracture site.

The fracture hematoma was evacuated, and the fracture site was lavaged with warm isotonic saline (0.9% NaCl) solution. The proximal diaphyseal medullary cavity was then reamed with a 13-mm trocar point pin in a retrograde fashion to the level of the femur between the greater trochanter and the femoral neck. The distal bone fragment was reamed with the same pin to allow normograde advancement of the implant after reduction. An implant consisting of a custom-made 302 stainless steel, 190-mm-long, 10-mm-diameter interlocking intramedullary nail, on which 4-mm-diameter diverging pins were welded in specific grooves (Figure 1), was then introduced into the proximal bone segment in a retrograde fashion until the distal extremity of the nail was within the medullary cavity. The pins consisted of 2 short and 2 long diverging pins. Care was taken to ensure that the orientation of the implant in the medullary cavity allowed the short pins to enter the dorsal aspect of the distal femoral condyle. The fracture was then reduced with traction of the leg and manipulation of the proximal segment by use of the handle that fits the proximal extremity of the nail (Figure 1). The reduction was maintained with Verbrugge bone-holding forceps, after which the centromedullary implant was placed in a normograde fashion into the distal bone segment by use of the handle and a mallet, allowing the expanding pins to enter the condyles ventrally and the trochlear ridges dorsally. With a custom drill guide, two 3.5-mm cortical screws were inserted to lock the intramedullary nail in the proximal diaphyseal shaft to counteract rotational forces. After completion of internal fixation, 2 cm of the proximal extremity of the implant exited the femur through the trochanteric fossa. The deep fascia of the vastus lateralis muscle was sutured in a continuous pattern, with interrupted cruciate sutures used to close the superficial fascia of the vastus lateralis muscle, biceps femoris muscle, and tensor fascia lata. Polyglactin 910 No. 1 was used for all soft tissues. The skin was closed in a simple continuous pattern with nonabsorbable suture material.

Radiographs were obtained after surgery, and calves were allowed to recover in their stalls. Fracture reduction was evaluated radiographically and classified as...
excellent (> 75% apposition of the fracture segments), good (> 50% apposition of the fracture segments), or poor (≤ 50% apposition of the fracture segments). Calves were discharged the following day without external coaptation, and owners were asked to keep calves confined to a dry stall for 8 weeks.

Outcome—Follow-up information was obtained 10 days after surgery via examination of the calf or telephone conversation with the owner or the referring veterinarian. Data collected included lameness evaluation and surgical wound appearance. Lameness was scored on a 4-point scale: 0 = no lameness; 1 = mild weight-bearing lameness and walking without prompting; 2 = moderate weight-bearing lameness, guarding of the limb at rest, and walking only after prompting; and 3 = non–weight-bearing lameness.

Information regarding long-term outcome was collected via telephone conversation with owners 6 months after surgery by the same individual (JB). Data collected were degree of lameness, estimated body weight, estimated body weight of comparable herdmates, and overall owner satisfaction. Owner satisfaction was rated on the following scale: excellent = owner willing to pay for this surgery on another calf if needed in the future, good = owner would consider surgery for a valuable calf, and poor = owner would not consider surgery as an option in the future for another calf.

Whether there was a positive or negative surgical outcome was determined for all calves. An animal that was ambulatory even with a grade 1 lameness score and animals that died for reasons unrelated to the surgery were considered to have a positive surgical outcome; calves that died for reasons unrelated to the surgery within 3 weeks after surgery were excluded from analysis. A negative surgical outcome was defined as failure of the internal fixation or persistence of grade 2 or 3 lameness at the time of the 6-month follow-up.

Statistical analysis—Age at evaluation, body weight, affected femur (left or right), overall musculoskeletal strength at initial evaluation, type of fracture, location of the fracture, need for a supplemental orthopedic implant to stabilize the repair, and quality of the reduction were analyzed for association with positive surgical outcome. Age was classified as ≤ 2 days or > 2 days. Body weight was classified as ≤ 60 kg (132 lb) or > 60 kg. Data were analyzed by use of a Fisher exact test for comparing proportions, and the Mantel-Haenszel $\chi^2$ test was used to evaluate trends across 3 levels. Values of $P < 0.05$ were considered significant.

Results

Calves—Twenty-five Charolais calves were included in the study; 17 were male and 8 were females. Four calves had the hind limb double-muscle trait. Mean age at evaluation was 3 days (median, 3 days; range, 1.5 to 6 days), and mean body weight was 56.6 kg (124.52 lb; median, 55 kg [121 lb]; range, 45 to 65 kg [99 to 143 lb]). On initial physical examination, 16 calves were considered weak and were able to stand with minor assistance, 5 were considered strong and were ambulatory on 3 legs, and 4 were recumbent. Two recumbent calves had concurrent musculoskeletal diseases: one had femoral nerve paresis of the contralateral limb, and the other showed signs of pain during palpation of its back. Mean rectal temperature, heart rate, and respiratory rate were 38.8°C (101.84°F; median, 38.9°C [101.02°F]; range, 38° to 39°C [100.4° to 102.02°F]), 123 beats/min (median, 120 beats/min; range, 100 to 132 beats/min), and 42 breaths/min (median, 40 breaths/min; range, 32 to 68 breaths/min), respectively. Results of thoracic auscultation were normal, no umbilical infection was present, and there was no history of diarrhea for all 25 calves. Mean PCV (reference range, 26% to 40%) and serum total protein concentration (reference range, 60 to 80 g/L) were 27.4 (median, 25.8%; range, 18% to 45.1%) and 55.7 g/L (median, 56 g/L; range, 24 to 69 g/L), respectively. One calf was considered to have had failure of passive transfer of immunity on the basis of a low serum total protein concentration (24 g/L).

Fracture characteristics—Fractures occurred during assisted delivery in 24 calves and following external trauma by the dam in 1. Twenty-one fetuses were in a cranial longitudinal dorsosacral position, and 3 fetuses were in a caudal longitudinal dorsosacral position. All of the fractures were closed. Left and right femurs were fractured in 17 (68%) and 8 (32%) calves, respectively. Fractures were classified as simple oblique in 14 (56%) calves and comminuted with between 1 and 4 fragments in 11 (44%) calves. All fractures were located in the femoral diaphysis; 18 (72%) extended to the distal metaphysis, 1 (4%) was located in the proximal metaphysis, and 6 (24%) were midshaft fractures. Proximal displacement of the distal segment was present and was considered severe in all cases, with a mean displacement of 7.69 cm (median, 7.8 cm; range, 5 to 10.5 cm; Figure 2).

Surgery—Surgical time was recorded for all patients; mean surgical time was 101.4 minutes (median, 90 minutes; range, 75 to 150 minutes). Periosteal
stripping of the proximal and distal bone segments was present in all calves. Two (n = 21), 3 (2), or 4 (2) screws were inserted in the proximal diaphyseal bone segment to lock the intramedullary nail (Figures 3 and 4). One screw was inserted in the distal bone segment in 4 calves. Additional cerclage wires around the diaphysis were used to augment the repair in 9 calves, and one 3.5-mm cortical screw positioned in lag fashion to hold a bone fragment was also inserted in 2 of those calves.

Intraoperative complications occurred in 4 calves. In 1 calf, the distal femoral shaft fractured during nail insertion, and repair necessitated insertion of a 3.5-mm cortical screw in lag fashion and 2 additional cerclage wires. In 1 calf, 1 lateral pin failed to enter the medullary cavity and the nail had to be replaced; a custom hook was introduced in the most proximal hole of the nail, and the implant was pulled out of the distal bone segment until it lodged within the medullary cavity of the proximal bone segment. The fracture was reduced for a second time, and the nail was then driven into the distal bone segment to achieve stabilization of the fracture. Nail insertion was too distal in 2 calves, resulting in protrusion of the dorsal pins lateral to the trochlear ridge into the femoropatellar joint. Large cortical fragments from the dorsal cortex had been removed from the fracture bed during surgery in 4 calves because of the lack of vascular supply. Fracture reduction was considered excellent in 14 calves, good in 8 calves, and poor in 3 calves. Poor fracture reduction was attributed to either a short distal bone segment, a fracture of the femoral shaft during nail insertion, or difficulty in stabilizing the fracture during insertion of the nail.

Outcome—All calves recovered from surgery. One calf died of diarrhea 5 days after surgery and was not included in the statistical analysis. One calf developed acute lameness 7 days after surgery, consistent with failure of the repair, and was euthanatized 15 days after surgery. All but 1 of the remaining 22 calves were lame on the affected limb 10 days after the surgery. Grade 1 lameness was present in 13 calves, grade 2 lameness was present in 6 calves, and grade 3 lameness was present in 2 calves. Wound healing was uneventful in 20 calves. Two calves had minimal swelling 10 days after surgery, which subsequently resolved.

Long-term follow-up information was obtained between 6 and 11 months after surgery for the 22 calves that survived at least 3 weeks after surgery. One calf died of unknown causes 1 month after surgery, and 2 died of diarrhea 2 months after surgery. Of the remaining 19 calves, 15 had no apparent growth retardation, compared with their herdmates. One calf had persistent grade 2 lameness, and 2 calves had persistent grade 3 lameness (including the calf with signs of back pain on initial examination) associated with slight apparent growth retardation characterized by a reduced daily weight gain and a smaller size, compared with herdmates of the same age. Owner satisfaction was rated as excellent for 13 calves, good for 6 calves, and poor for the remaining 4 calves.

Excluding the calf that died 5 days after surgery, a positive surgical outcome was achieved in 20 of 24 calves. None of the studied variables were significantly (P < 0.05) associated with a positive surgical outcome (Table 1).
This is in agreement with results of a previous study in neonatal calves in vitro nails have been used to evaluate femoral fracture repair adequately to allow bone healing. Standard interlocking surgical outcome in the present study, suggesting that this seal femoral fractures was not associated with a poor sur tal diaphyseal fracture repair. Distal location of diaphyseal fractures in these animals constitutes a challenge. The novel locking intramedullary nail associated with the diverging pins used in the present study has been found to provide sufficient stability during fracture healing. The central nail provides the axial alignment of the femoral shaft. The diverging pins in the distal fragment and their association with the locking screws placed proximally counteract the rotational forces applied to the femoral shaft during ambulation. In a previous study of cattle, a significant effect of the location of the fracture was reported, with results indicating that intramedullary stack pinning is unlikely to provide sufficient stability for distal diaphyseal fracture repair. Distal location of diaphyseal femoral fractures was not associated with a poor surgical outcome in the present study, suggesting that this novel interlocking nail stabilized the distal bone segment adequately to allow bone healing. Standard interlocking nails have been used to evaluate femoral fracture repair in neonatal calves in vitro with a mid-diaphyseal osteotomy model. Standard interlocking nails use screws that are placed in the proximal and distal fracture segments. However, femoral fractures in neonatal calves often extend to the distal end of the dorsal cortex, precluding screw insertion distal to the fracture line. In the present study, the combination of a nail designed with diverging pins obviated the need for screw placement in the distal fragment. This implant was also used in midshaft and proximal diaphyseal fractures. This is because the locking screw holes are positioned throughout the implant length, providing sufficient versatility for use with various fracture configurations. A locking screw should be inserted distal to the fracture whenever possible to improve the rigidity of the repair by decreasing the unsupported length of the bone. If screws are located distal to the growth plate, the orthopedic repair will act as a transphysseal bridge, impairing the longitudinal growth of the femur. Removal of the distal screws should therefore be recommended after 6 weeks in these patients.

In a previous study, calves with no external coaptation following surgery for repair of femoral fractures were able to use the affected limb faster than were those maintained in an Ehmer bandage or a modified Thomas splint. In the present study, calves were discharged the day after surgery with no external coaptation. How ever, the hospitalization time should be extended for patients in which instability or delayed healing may be more likely, such as those in which there is a large cortical defect after internal fixation because of removal of avascular bone fragments.

In the present study, surgery was performed without complication in 21 calves. No sciatic nerve injury

### Discussion

In the present study, a satisfactory outcome after repair of a diaphyseal femoral fracture with a novel intramedullary nail was achieved in 20 of 24 (83.3%) calves. This is in agreement with results of a previous study of 12 calves of various breeds treated with intramedullary pinning, in which 10 were considered to have healed satisfactorily. The femur in neonates has thin cortices and a wide medullary cavity, such that repair of femoral fractures in these animals constitutes a challenge. The novel locking intramedullary nail associated with the diverging pins used in the present study has been found to provide sufficient stability during fracture healing. The central nail provides the axial alignment of the femoral shaft. The diverging pins in the distal fragment and their association with the locking screws placed proximally counteract the rotational forces applied to the femoral shaft during ambulation. In a previous study of cattle, a significant effect of the location of the fracture was reported, with results indicating that intramedullary stack pinning is unlikely to provide sufficient stability for distal diaphyseal fracture repair. Distal location of diaphyseal femoral fractures was not associated with a poor surgical outcome in the present study, suggesting that this novel interlocking nail stabilized the distal bone segment adequately to allow bone healing. Standard interlocking nails have been used to evaluate femoral fracture repair in neonatal calves in vitro with a mid-diaphyseal osteotomy model. Standard interlocking nails use screws that are placed in the proximal and distal fracture segments. However, femoral fractures in neonatal calves often extend to the distal end of the dorsal cortex, precluding screw insertion distal to the fracture line. In the present study, the combination of a nail designed with diverging pins obviated the need for screw placement in the distal fragment. This implant was also used in midshaft and proximal diaphyseal fractures. This is because the locking screw holes are positioned throughout the implant length, providing sufficient versatility for use with various fracture configurations. A locking screw should be inserted distal to the fracture whenever possible to improve the rigidity of the repair by decreasing the unsupported length of the bone. If screws are located distal to the growth plate, the orthopedic repair will act as a transphysseal bridge, impairing the longitudinal growth of the femur. Removal of the distal screws should therefore be recommended after 6 weeks in these patients.

As with any intramedullary implant, the implant used in the present study does not allow for any compression of the fragment of the foot but maintains bone length and alignment. Secondary bone healing with a large callus formation was observed. The periosteal stripping that is typically present in patients with femoral fractures because of the major overriding of the fragments associated with muscular contraction may result in delayed bone healing because the blood supply is compromised. Therefore, longer observation and confinement of these patients may be required.

In a previous study, calves with no external coaptation following surgery for repair of femoral fractures were able to use the affected limb faster than were those maintained in an Ehmer bandage or a modified Thomas splint. In the present study, calves were discharged the day after surgery with no external coaptation. However, the hospitalization time should be extended for patients in which instability or delayed healing may be more likely, such as those in which there is a large cortical defect after internal fixation because of removal of avascular bone fragments.

In the present study, surgery was performed without complication in 21 calves. No sciatic nerve injury

### Table 1—Results of univariate analysis of variables potentially associated with a positive outcome for 24 neonatal calves with femoral fractures stabilized with an intramedullary interlocking nail.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Factors</th>
<th>No. of calves</th>
<th>No. with positive outcome</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (d)</td>
<td>≤ 2</td>
<td>15</td>
<td>12</td>
<td>0.572</td>
</tr>
<tr>
<td></td>
<td>&gt; 2</td>
<td>9</td>
<td>8</td>
<td>0.158</td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>≤ 60</td>
<td>14</td>
<td>13</td>
<td>0.224</td>
</tr>
<tr>
<td></td>
<td>&gt; 60</td>
<td>10</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Affected femur</td>
<td>Left</td>
<td>17</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Right</td>
<td>7</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Overall musculoskeletal strength*</td>
<td>Strong</td>
<td>4</td>
<td>4</td>
<td>0.353</td>
</tr>
<tr>
<td>Type of fracture</td>
<td>Simple</td>
<td>13</td>
<td>12</td>
<td>0.202</td>
</tr>
<tr>
<td></td>
<td>Comminuted</td>
<td>11</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Distal extremity of the fracture</td>
<td>Diaphysis</td>
<td>7</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Metaphysis</td>
<td>17</td>
<td>13</td>
<td>0.169</td>
</tr>
<tr>
<td>Additional internal fixation</td>
<td>No</td>
<td>15</td>
<td>11</td>
<td>0.129</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>9</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Fracture reduction†</td>
<td>Excellent</td>
<td>13</td>
<td>11</td>
<td>0.203</td>
</tr>
<tr>
<td></td>
<td>Good</td>
<td>8</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Poor</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Calves were considered to have a positive outcome if they were ambulatory with no (grade 0 on a scale from 0 to 3) or mild (grade 1) lameness at the time of follow up ≥ 6 months after surgery. One calf that died 5 days after surgery because of diarrhea was excluded from the analysis.

*Overall musculoskeletal strength at admission was scored on a 3-point scale: strong = able to stand without assistance; weak = needs assistance to stand but is able to remain standing without assistance; and recumbent = recumbent and unable to stand even with assistance. †Fracture reduction was rated as excellent (> 75% apposition of the fracture segments), good (> 50% apposition of the fracture segments), or poor (< 50% of the fracture segments).
was observed in any of the 25 calves, even when the orthopedic implant was placed in a retrograde fashion. Normograde pinning of the femur is recommended to prevent sciatic nerve injury; however, retrograde pinning has been reported\(^3\) to be successful in calves. For the patients in the present report, specific care was taken during surgery to prevent a medial location of the implant in the trochanteric fossa to avoid sciatic nerve injury.

Intraoperative complications occurred in 4 calves in the present study. In 1 calf, the distal bone segment fractured during introduction of the nail. The fragment was stabilized with one 3.5-mm cortical screw in lag fashion and 2 cerclage wires. The shape of the extremity of the diverging pins in the intramedullary nail used in this report is flat. Modifying this shape to a sharp end could facilitate pin insertion in soft bone and reduce the force necessary to insert the implant in the distal fragment and therefore decrease the risk of iatrogenic secondary fracture. In 2 calves, dorsal pins protruded through the lateral trochlear ridge into the femoropatellar joint on the postoperative radiographs. The implants were not removed. Neither of the calves developed lameness thereafter. With bone growth, the protruding pins were probably embedded so that the implants were contained within the bone without inducing arthritis. One calf had an acute failure of the orthopedic repair. In that calf, a 5-cm-long cranial fragment was removed from the fracture bed because of lack of blood supply, thus creating a large cortical bone defect. Even if the caudal cortex remained intact after the reduction, this defect in the cranial cortex could have resulted in excessive instability and failure of the repair.

Pin migration has been reported\(^3\) to occur in 50% of calves treated with intramedullary pinning. One advantage of the use of the novel intramedullary implant used for the patients in the present report is the absence of risk of implant migration because the pins are welded to the nail and the nail is locked in place with screws, precluding any dislodgement during bone healing.

The holding power of 4.5-mm cortical, 5.5-mm cortical, and 6.5-mm cancellous orthopedic screws has been compared.\(^9\) No significant difference was demonstrated between screws, but the holding power of 4.5-mm cortical screws was significantly greater in the diaphysis, compared with the holding power in the metaphysis.\(^10\) No data are available for the 3.5-mm cortical screws that were used in the present study. Long-term follow-up radiographs were not obtained, so the frequency of screw pullout or complications related to the screws is unknown. Use of larger-diameter cortical screws, as has been reported in vitro studies,\(^14,20\) could be performed with modification of the locking holes. However, it remains unknown whether this would have resulted in a stronger construct.

None of the calves in the present study developed an orthopedic infection. Particular attention was given to evacuation of the fracture hematoma, and constant irrigation of the surgical site was performed with sterile isotonic saline solution. A combination of gentamicin sulfate and amoxicillin trihydrate was used for antimicrobial prophylaxis during the postoperative period. This protocol offers the advantages of broad-spectrum coverage, but legislation varies between countries for animals that may enter the food chain, and appropriate withdrawal times should be respected by the owners. An alternate choice could have been the use of cephalosporin sodium. The risk of orthopedic infection depends on the stability of the internal fixation, blood supply at the fracture site, and competence of the patient’s immune system. In newborn calves, absence of any concurrent infection and adequate passive transfer of immunity should be ensured before surgery. In a study\(^9\) of 77 calves with femoral fracture, Ferguson et al\(^2\) found that the presence of any concurrent disease reduced the success rate by 50%.

The novel implant used in the present study was associated with a good prognosis for surgical repair of femoral fractures in newborn calves. The results are comparable with those previously reported.\(^3\) However, no biomechanical data are available comparing the various types of internal fixation for femoral fracture repair in newborn calves.

**References**


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\(^b\) Pangram 4%, Virbac France SAS, Carros, France.

\(^c\) Duphamox LA, Fort Dodge Santé Animale, Tours, France.

\(^d\) Zoletil, Virbac France SAS, Carros, France.
From this month’s AJVR

Shedding of chlamydiae in relation to titers of serum chlamydiae-specific antibodies and serum concentrations of two acute-phase proteins in cats without conjunctivitis

Bodil Ström Holst et al

Objective—To investigate shedding of chlamydiae from conjunctiva and genital tracts of cats without clinical signs of conjunctivitis or other infectious disease in relation to their titers of serum antibodies against chlamydiae and to serum amyloid A (SAA) and serum α1-acid glycoprotein (AGP) concentrations.

Animals—62 healthy cats.

Procedures—Serum from each cat was analyzed for antibodies against chlamydiae and for SAA and serum AGP concentrations. Swab samples from the conjunctival sac and genital tract were analyzed with a real-time PCR assay for Chlamydiaceae.

Results—4 of 8 of cats with high antibody titers (ie, 1,600) shed chlamydiae, but only from the conjunctiva. Chlamydiae could not be detected from cats with lower antibody titers nor from any genital tract samples. In cats with antibody titers of 1,600, mean ± SD SAA concentration was significantly higher when chlamydiae were detected in conjunctival swab samples (3.9 ± 1.0 mg/L) than the concentration when no chlamydiae were detected (1.4 ± 1.0 mg/L). However, SAA concentration was greater than the limit for an acute-phase response in only one of those cats. There was no significant difference in serum AGP concentrations between cats with high titers that were or were not shedding chlamydiae. Nine of 30 (30%) cats (5 with and 4 without detectable serum antibodies against chlamydiae) that had been mated developed reproductive disorders.

Conclusions and Clinical Relevance—Clinically normal cats with high chlamydiae-specific antibody titers can shed and thus transmit chlamydiae. Venereal spread from cats without clinical signs of infection is likely not common. (Am J Vet Res 2011;72:806–812)