

# Use of a condylar screw plate for repair of a Salter-Harris type-III fracture of the femur in a 2-year-old horse

Christopher R. Byron, DVM; John A. Stick, DVM, MS, DACVS; Jennifer A. Brown, DVM; Joel Lugo, DVM

- ▶ Femoral fracture repair is rarely attempted in adult horses because of their large body mass and subsequent predisposition to severely comminuted fracture configurations.
- ▶ Traditional fracture fixation plates are often inadequate for repair of femoral condylar fractures in horses because of the limited space in the distal fragment for placement of bone screws; solutions to this problem have included use of angled blade plates, condylar buttress plates, and cobra-head plates.
- ▶ In horses, fixation of femoral condylar fractures with a condylar screw plate designed for fixation of femoral condylar fractures in humans may also result in a successful outcome.

A 2-year-old sexually intact male Paint horse weighing 427 kg (940 lb) was admitted to the Veterinary Teaching Hospital at Michigan State University with a 1-week history of right hind limb lameness. The horse was found lame at pasture and had been stall rested since that time. The day before admission, the horse became recumbent in the stall and could not rise unassisted. Once standing, non-weight-bearing lameness of the right hind limb was noticed. Initial treatment with procaine penicillin, IM, and phenylbutazone, IV, was initiated, and the horse was referred.

Physical examination revealed non-weight-bearing lameness of the right hind limb. Signs of pain were evident during manipulation of the proximal portion of the right hind limb, and no evidence of external swelling was observed. The horse became recumbent during the examination and was unable to rise. General anesthesia was planned immediately so that radiographs of the proximal portion of the limb could be obtained. Results of a CBC and serum biochemical analyses were within reference ranges, other than slightly high  $\gamma$ -glutamyltransferase activity. On the basis of the history and physical examination findings, a pelvic fracture was suspected.

A 14-gauge catheter was placed in the right jugular vein, and the horse was sedated with xylazine hydrochloride (0.66 mg/kg [0.3 mg/lb], IV). Anesthesia was induced with ketamine hydrochloride (2.2 mg/kg [1 mg/lb], IV) and diazepam (0.08 mg/kg [0.04 mg/lb], IV). Anesthesia was maintained with

guaifenesin, ketamine, and xylazine. No abnormalities were seen on pelvic radiographs, but a displaced Salter-Harris type-III fracture was seen on radiographs of the stifle joint (Fig 1). The sagittal component of this fracture was located in the intercondylar space, and the transverse component exited on the medial aspect of the distal femoral physis. The horse was transported to a padded recovery stall while still anesthetized, and head and tail ropes were applied to assist with recovery. The horse remained recumbent after recovery, and the ropes were removed. Several hours passed before the horse stood unassisted.

Internal fixation of the fracture with a condylar screw plate<sup>a</sup> designed for fixation of femoral condylar fractures in humans was planned for the next day. Administration of ampicillin (22 mg/kg [10 mg/lb], IV, q 8 h) and gentamicin (6.6 mg/kg [3 mg/lb], IV, q 24 h) was started the night before surgery and continued for 11 days after surgery. Administration of phenylbutazone (4.4 mg/kg [2 mg/lb], IV, q 12 h) was started the night before surgery and continued for 2 days after surgery. An additional dose of ampicillin (22 mg/kg, IV) was administered 2.5 hours after the initiation of surgery.

The horse was premedicated with xylazine hydrochloride (0.66 mg/kg, IV), and anesthesia was induced with ketamine hydrochloride (2.2 mg/kg, IV) and diazepam (0.08 mg/kg, IV) and maintained with isoflurane delivered with oxygen in a semiclosed system. The horse was positioned in dorsal recumbency with the right hind limb elevated by a ceiling-mounted hoist. The right stifle area was shaved and aseptically prepared for surgery, and the area was draped routinely. A craniocaudal fluoroscopic image of the right stifle joint indicated that manipulation of the limb with the hoist resulted in complete reduction of the fracture. A 15-cm-long incision was created over the cranial aspect of the stifle joint between the middle and lateral patellar ligaments and extended through the joint capsule to expose the sagittal fracture plane. During visual inspection, reduction of the fracture appeared to result in good joint surface continuity with moderate disruption of the cartilage along the cranial aspect of the fracture line. A 20-cm-long incision was created over the distomedial aspect of the femur, just caudal to the medial trochlear ridge of the femur. Blunt dissection was used to separate the sartorius, vastus medialis, and vastus intermedius muscles and expose the distomedial aspect of the femur. The transverse fracture plane was palpated, and reduction was confirmed. The axis of the distal aspect of the femur was marked in 2 planes by placement of a Kirschner wire distal to the femoral condyles and a second Kirschner wire cranial to the

From the Department of Large Animal Clinical Sciences, College of Veterinary Medicine, Michigan State University, East Lansing, MI 48824-1314. Dr. Byron's present address is 16125 Main Market Rd, Burton, OH 44021.

The authors thank Marsha Bower, Pam Bunce, and Sheila Wing-Proctor for technical assistance.

Address correspondence to Dr. Byron.

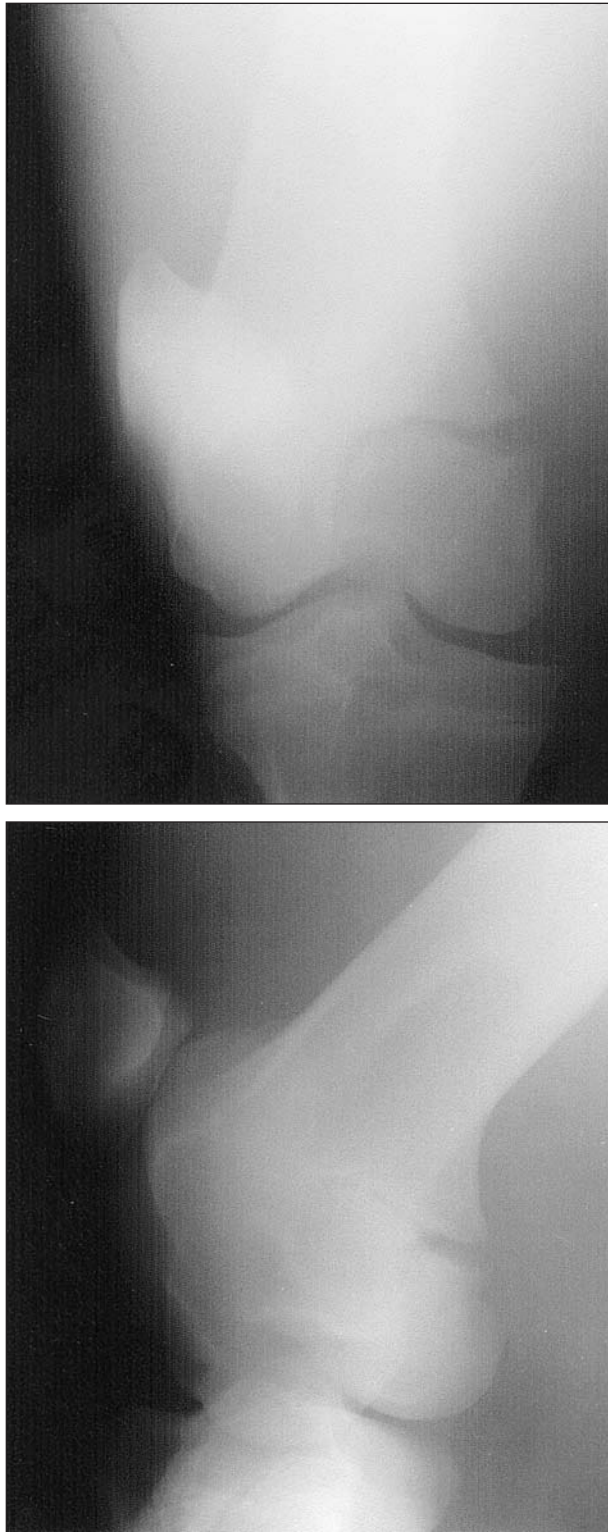


Figure 1—Craniocaudal (top) and lateromedial (bottom) radiographic views of the distal portion of the right femur of a horse. Notice the displaced Salter-Harris type-III fracture; the fracture line exits the medial aspect of the femur.

trochlear ridges. The guide wire included with the implant system was inserted freehand at the level of the medial epicondyle, midway between the epicondyle and the medial trochlear ridge, using the Kirschner

wires as markers to ensure proper alignment. This guide wire was placed parallel to the distal Kirschner wire in the craniocaudal view and parallel to the cranial Kirschner wire in the axial view. Correct placement of the guide wire was confirmed by obtaining a craniocaudal fluoroscopic image. A measuring device was then placed over the guide wire, and the insertion depth was determined to be 80 mm. The implant reamer was assembled, set to a drilling depth of 75 mm, and placed over the guide wire. Drilling for the lag screw hole and plate barrel hole and countersinking were simultaneously accomplished. The site was irrigated with saline (0.9% NaCl) solution containing amikacin (0.375 mg/mL) and sodium penicillin G (20,000 U/mL) throughout the procedure. The drill hole was tapped to a depth of 75 mm, and a 75-mm lag screw was selected and inserted over the guide wire. A 6-hole, 25-mm barrel plate was contoured with difficulty to an aluminum template and inserted over the lag screw. An osteotome was used to remove bone proximal to the lag screw hole for improved plate-bone contact. Craniocaudal fluoroscopic images revealed that the lag screw was too long, so the 75-mm screw was removed and replaced with a 70-mm screw. The plate was replaced, aligned with the long axis of the femur, and beginning with the most proximal plate hole, affixed to the femur with 5.5-mm cortical screws. A 6.5-mm cancellous screw with a 32-mm thread was inserted through the hole closest to the lag screw in an attempt to achieve greater compression of the bone fragment to the parent bone. A compressing screw was inserted into the lag screw. The site was lavaged copiously and closed in 4 layers. The vastus medialis and sartorius muscles were each apposed with size-0 polydioxanone suture in a simple continuous pattern. Subcutaneous tissues were apposed with size-0 polydioxanone suture in a simple continuous pattern. Skin was closed with size-2 polypropylene suture in a vertical mattress pattern. The cranial incision was lavaged copiously and closed in 4 layers. The joint capsule, deep fascia, and superficial fascia were each closed with size-0 polydioxanone suture in a simple continuous pattern. Skin was closed with size-2 polypropylene suture in a vertical mattress pattern. Stent bandages were placed over both incisions, and the horse was transported to a padded stall for recovery. Xylazine (0.2 mg/kg [0.09 mg/lb], IV) and butorphanol (0.01 mg/kg [0.005 mg/lb], IV) were administered immediately after surgery. Morphine (0.1 mg/kg [0.045 mg/lb]) was given by caudal epidural administration, and the horse was allowed to recover unassisted.

The horse recovered without complications. Immediately after surgery, weight-bearing was intermittent, and the horse was frequently recumbent. However, the horse was able to rise unassisted throughout the postoperative period. Two days after surgery, the dosage of phenylbutazone was reduced to 3.3 mg/kg (1.5 mg/lb), IV, every 12 hours, and administration was continued for another 12 days. Moderate serous drainage was noticed on day 4 after surgery and continued until discharge from the hospital; treatment included antimicrobial administration and daily bandage changes. On radiographs obtained 6 days after

surgery, fragment apposition appeared to be good without any shifting of the implants (Fig 2). Eleven days after surgery, administration of ampicillin and gentamicin was discontinued, and enrofloxacin (5 mg/kg [2.3 mg/lb], IV, q 12 h) was administered for 3 days.

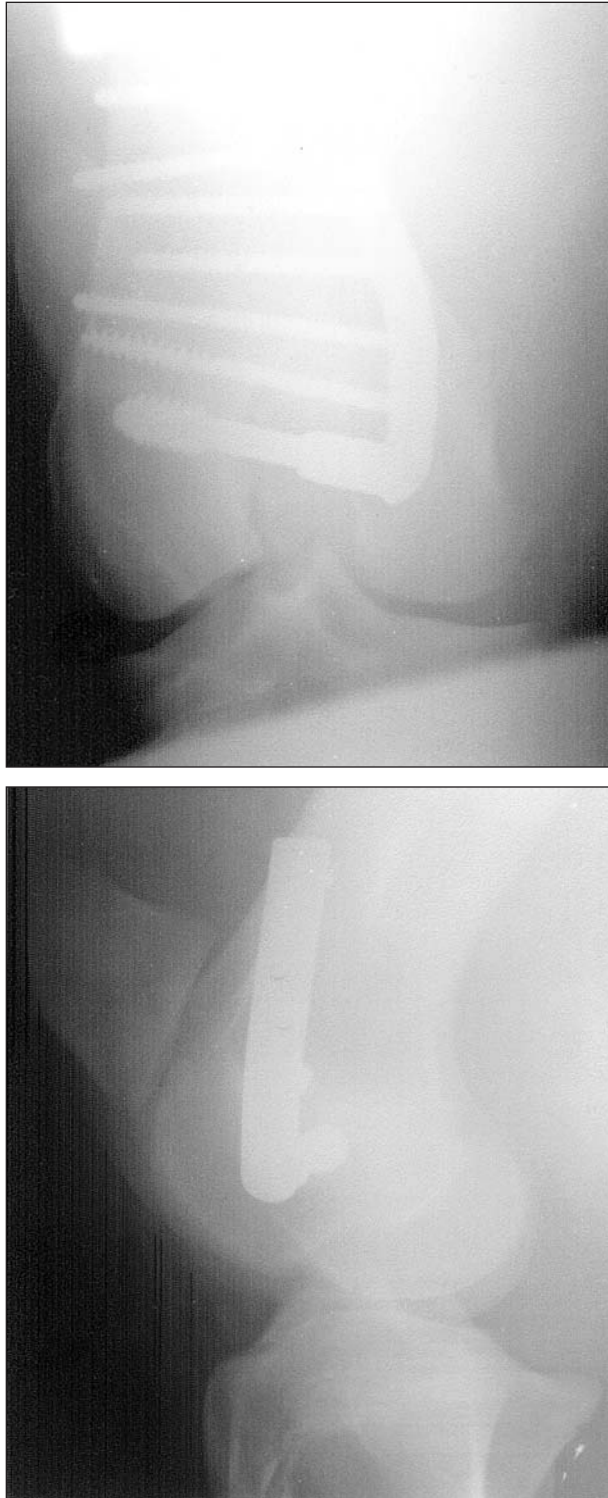


Figure 2—Craniocaudal (top) and lateromedial (bottom) radiographic views of the distal portion of the right femur of the horse in Figure 1 obtained 14 days after fixation of the fracture with a 6-hole condylar screw plate.

The horse was discharged 14 days after surgery. The owner was instructed to confine the horse to a stall for 30 days, followed by an additional 30 days of stall rest with short periods of hand walking and a subsequent gradual return to pasture turnout. Trimethoprim-sulfadiazine (25 mg/kg [11.4 mg/lb], PO, q 12 h) was administered for 14 days after discharge.

The horse was used for natural breeding 2 months after discharge with no complications. Follow-up telephone communications were received from the referring veterinarian 2 months after surgery and from the owner 9 months after surgery. It was reported that the horse was doing well with no noticeable signs of lameness during pasture turnout.

Femoral fractures reportedly are common in foals,<sup>1</sup> and several reports<sup>2-14</sup> detailing their repair in foals and young horses have been published. Femoral fracture repair is rarely attempted in adult horses because of their large body mass and subsequent predisposition to severely comminuted fracture configurations.<sup>1</sup> Distal femoral Salter-Harris type fractures have been successfully repaired by use of lag screw fixation,<sup>6,12</sup> condylar buttress plating,<sup>10</sup> cobra-head plating,<sup>9</sup> and intramedullary pinning.<sup>5</sup> Conservative management has also yielded success in cases with minimal displacement.<sup>14</sup> The most common distal femoral physal fractures in horses are reported to be Salter-Harris type-II fractures, followed by Salter-Harris type-IV fractures.<sup>1</sup> A Salter-Harris type-III fracture in a 5-month-old foal has been reported.<sup>14</sup> In this foal, the transverse component of the fracture exited on the lateral aspect of the physis, and the fracture fragment was minimally displaced. The foal was managed conservatively with a good outcome.

Traditional fracture fixation plates are often inadequate for repair of condylar fractures because of the limited space in the distal fragment for placement of bone screws. Solutions to this shortcoming have included use of angled blade plates, condylar buttress plates, cobra-head plates, and the condylar screw plate used in the present report. This plate is 5.4 mm thick, whereas traditional broad fracture fixation plates are only 4.5 mm thick, giving the condylar screw plate a great advantage in strength but making the plate more difficult to contour to the shape of the underlying bone.<sup>13</sup> On the other hand, the single large condylar screw allows some flexibility in positioning of the plate. The condylar screw plate has been shown in *in vitro* testing on human cadaveric femora to be the implant of choice for fixation of condylar fractures, as long as the distal condylar fragment is at least 4 cm long.<sup>16</sup>

Treatment options for this horse included conservative management after closed reduction, lag screw fixation, and plating with one of the special implants that are available (ie, angled blade plate, condylar buttress plate, cobra head plate, and condylar screw plate). The owner intended to use the horse for natural breeding, so good function of the limb was required. Therefore, it was thought that conservative management would be unlikely to yield an acceptable result because of the likelihood that the fracture fragment would be displaced and degenerative joint disease



would develop. We also thought that lag screw fixation alone would be more likely to fail than plating, because of the large size of the horse. The condylar screw plate was chosen on the basis of its advantages in regard to plate strength, purchase in the condylar fragment, and relative ease of application. In the absence of the condylar screw plate, a cobra-head plate likely would have yielded similar results.

The medial approach used in this horse necessitated deep soft tissue dissection. To reduce the chance of seroma formation, dissection was limited to the extent that would allow placement of the 6-hole condylar screw plate. Postoperative seroma formation and incisional drainage did occur and was successfully managed with bandaging and continued antimicrobial treatment.

The condylar screw plate was designed for placement on the lateral aspect of the femur; however, the configuration of the fracture in this horse dictated medial placement. Difficulty was encountered with plate placement on the medial aspect of the femur. Although the plate and drill guide fit well on the lateral aspect of the femur, they do not conform well to the medial aspect. Therefore, the drill guide was not used, and the guide wire was placed freehand, using Kirschner wires for orientation. The guide wire location in this case required contouring of the plate near the plate-barrel junction, which proved difficult because of the inability to properly position the plate in the plate-bending press. The barrel for the lag screw prevented ideal positioning within the press, and contouring was therefore imperfect at this location. To compensate for this, an osteotome was used to remove bone proximal to the plate barrel hole and improve plate-bone contact. Additionally, the plate was dorsally angulated along the femoral shaft because of the curvature of the bone. A 6.5-mm cancellous screw was used in the plate hole immediately adjacent to the lag screw in an effort to achieve greater compression of the fracture in the sagittal plane. The remainder of the screw holes were filled with 5.5-mm cortical screws to take advantage of their greater pull-out strength, compared with 4.5-mm cortical screws.<sup>17</sup>

An alternative method for application of the condylar screw plate has been proposed<sup>18</sup> and may be applicable in cases similar to this one. Currently, the manufacturer recommends insertion of the guide wire parallel to Kirschner wires,<sup>19</sup> as was performed in this case, but an alternative insertion method that does not use Kirschner wires has been described. With this method, the guide wire is inserted perpendicular to the femoral cortex. This decreases the possibility of trauma to articular and periarticular structures associated with insertion of the Kirschner guide wires. However, with this alternative insertion method, there is an increased risk that the condylar screw will protrude into the intercondylar fossa near the cruciate ligament attachments in human patients.<sup>18</sup> This concern is also valid in equine patients, in which a relatively caudal placement of the guide wire together with a caudal insertion angle may predispose to intercondylar fossa penetration. On the other hand, this alternative insertion method may minimize the longitudinal angulation of the plate

attributable to bone curvature that was seen in this horse.<sup>18</sup> Although guidelines for insertion of the condylar screw plate were developed with human cadaveric femora, the principles are relevant to application in horses.

To our knowledge, use of this particular implant system for fixation of a Salter-Harris type-III fracture on the medial side of the femur in a horse has not been described previously. Use of the condylar screw plate yielded a successful outcome in this case. Future use of this system in horses with distal fractures of the femur may be improved by adopting guidelines recommended in the human literature.

<sup>a</sup>Dynamic condylar screw, Synthes Ltd, Paoli, Pa.

## References

- Hance SR, Bramlage LR. Fractures of the femur and patella. In: Nixon AJ, ed. *Equine fracture repair*. Philadelphia: WB Saunders Co, 1996;284–293.
- Pettit GD, Wheat JD. Distal epiphyseal fracture of the femur in a Shetland pony. *J Am Vet Med Assoc* 1961;138(1):13–14.
- Turner AS. Surgical repair of a fractured femur in a foal: a case report. *J Equine Med Surg* 1977;1:180–185.
- Valdez H, Morris DL, Auer JA. Compression plating of long bone fractures in foals. *J Vet Orthop* 1979;1:10–18.
- Stick JA, Derksen FJ. Intramedullary pinning of a fractured femur in a foal. *J Am Vet Med Assoc* 1980;176:627–629.
- DeBowes RM, Grant BD, Modransky PD. Lag screw stabilization of Salter type IV femoral fracture in a young horse. *J Am Vet Med Assoc* 1983;182:1123–1125.
- Boulton CH, Dallman MJ. Equine femoral fracture repair: a case report. *J Equine Vet Sci* 1983;3:60–64.
- Rose PL, Watkins JP, Auer JA. Femoral fracture repair complicated by vascular injury in a foal. *J Am Vet Med Assoc* 1984;185:795–797.
- Kirker-Head CA, Fackelman GE. Use of the cobra head bone plate for distal long bone fractures in large animals: a report of four cases. *Vet Surg* 1989;18:227–234.
- Orsini JA, Buonanno AM, Richardson DW, et al. Condylar buttress plate fixation of femoral fracture in a colt. *J Am Vet Med Assoc* 1990;197:1184–1186.
- Hunt DA, Snyder JR, Morgan JP, et al. Femoral capital physal fracture in 25 foals. *Vet Surg* 1990;19:41–49.
- Walmsley JP, Summerhays GES. Repair of a Salter-Harris type IV fracture of the distal femur of a yearling Thoroughbred by internal fixation. *Equine Vet Educ* 1990;2:177–179.
- Smyth GB, Taylor EG. Stabilization of a proximal femoral physal fracture in a filly by use of cancellous bone screws. *J Am Vet Med Assoc* 1992;201:895–898.
- Hance SR, Bramlage LR, Schneider RK, et al. Retrospective study of 38 cases of femur fractures in horses less than one year of age. *Equine Vet J* 1992;24:357–363.
- Auer JA. Application of the Dynamic Condylar Screw (DCS) and Dynamic Hip Screw (DHS) implant systems in the horse. *Vet Comp Orthop Traumatol* 1988;1:18–25.
- Harder Y, Martinet O, Barraud GE, et al. The mechanics of internal fixation of fractures of the distal femur: a comparison of the condylar screw (DCS) with the condylar plate (CP). *Injury Int J Care Injured* 1999;30:SA31–SA39.
- Yovich JV, Turner AS, Smith FW. Holding power of orthopedic screws in equine third metacarpal and metatarsal bones: part 1. Foal bone. *Vet Surg* 1985;14:221–229.
- Maier A, Cordey J, Regazzoni P. Prevention of malunions in the rotation of complex fractures of the distal femur treated using the Dynamic Condylar Screw (DCS): an anatomical graphic analysis using computed tomography on cadaveric specimens. *Injury Int J Care Injured* 2000;31:SB63–SB69.
- Muller ME, Allgower M, Schneider R, et al. *Manual of internal fixation. Techniques recommended by the AO-ASIF group*. 3rd ed. Heidelberg, Germany: Springer-Verlag Inc, 1991;1–750.