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

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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 γ-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 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
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 5.5-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

![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.](image-url)
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.

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, and several reports 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. Distal femoral Salter-Harris type fractures have been successfully repaired by use of lag screw fixation, condylar buttress plating, cobra-head plate, and intramedullary pinning. Conservative management has also yielded success in cases with minimal displacement. The most common distal femoral physeal fractures in horses are reported to be Salter-Harris type-II fractures, followed by Salter-Harris type-IV fractures. A Salter-Harris type-III fracture in a 5-month-old foal has been reported. 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. 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.

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.17

An alternative method for application of the condylar screw plate has been proposed18 and may be applicable in cases similar to this one. Currently, the manufacturer recommends insertion of the guide wire parallel to Kirschner wires,19 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 Kirchner 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.18 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.19 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.

Dynamic condylar screw, Synthes Ltd, Paoli, Pa.

References