Fracture repair of the distal portion of the radius by use of a condylar screw implant in an adult horse

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An 8-year-old American Quarter Horse gelding weighing 1,212 lb (550 kg) was evaluated at the Veterinary Medical Teaching Hospital because of a fracture involving the left radius. The horse had fallen during training and become immediately non-weight-bearing in the left forelimb. There was swelling and a small 4-cm laceration over the dorsolateral aspect of the distal portion of the antebrachium. Radiography was performed by the referring veterinarian and revealed a fracture of the distal metaphysis of the radius. The horse was immediately placed in a full-limb support bandage with a lateral splint extending proximally to the top of the shoulders (withers) and referred for surgical repair of the fracture.

On initial evaluation, the horse was unable to bear weight on the left forelimb, and radiographs of the left radius were obtained without removing the full-limb support bandage. Radiography revealed a long oblique fracture of the distal metaphysis of the radius, with minimal displacement of the fracture fragments (Fig 1A). The distal-most extent of the proximal fragment involved the distal medial metaphysis. Because of the configuration of the fracture, we recommended surgical intervention with internal fixation of the fracture fragments. We elected to use a condylar screw (CS) implant to provide the most stable fixation based on the strength of the fracture repair.

Prior to induction of anesthesia, the horse received potassium penicillin (22,000 U/kg [10,000 U/lb] of body weight, IV, q 6 h), gentamicin sulfate (2.2 mg/kg [1.0 mg/lb], IV, q 8 h), and phenylbutazone (4.4 mg/kg [2.0 mg/lb], IV, q 12 h). The PCV and total protein concentration were within reference ranges. The limb was kept wrapped with a lateral splint extending to the withers. The horse was anesthetized and positioned in dorsal recumbency; with the limb supported from the ceiling of the surgical suite. The full-limb bandage was removed, and manipulation of the limb caused blood and serum to drain from the wound over the dorsolateral aspect of the distal antebrachium. On the basis of this finding, the fracture was considered open. Sterile petroleum jelly was placed in the wound and the limb was shaved from the withers to the distal aspect of the third metacarpus. Using a teat cannula, the wound was lavaged thoroughly with saline (0.9% NaCl) solution. The limb was prepared for surgery, using a povidone-iodine scrub. The limb was draped accordingly to allow exposure of the medial and dorsolateral aspect of the radius. An impermeable iodine-impregnated drape was then applied around the antebrachium. A medial approach was performed first, with a 30-cm skin incision extending from the level of the distal radial epiphysis to the level of the proximal radial metaphysis. Dissection was continued through the antebrachial fascia to expose the periosteum of the radius. The fracture line was located exiting the distal medial metaphysis 1 to 2 cm proximal to the level of the physis. The fracture was minimally displaced, and manipulation of the proximal fragment (with bone-holding forceps) allowed full reduction of the fracture. An incision was made on the dorsolateral aspect of the radius from the level of the distal epiphysis to the proximal portion of the antebrachium. The fascia between the common digital extensor and extensor carpi radialis muscles was bluntly separated to expose the dorsolateral surface of the radius. The lateral extent of the fracture line was identified to ensure adequate reduction prior to the placement of lag screws. Using the forceps, the fracture was maintained in reduction, and two 5.5-mm cortical bone screws were placed in lag fashion through the proximal portion of the antebrachium. The radius was incised longitudinally and elevated 1 to 2 cm cranially and caudally from the distal metaphysis to the proximal diaphysis.

With the aid of fluoroscopy, a 2.5-mm drill bit was placed through the 95° CS drill guide to penetrate the distal radial epiphysis in a medial to lateral direction. The drill bit was inserted across the midline of the distal epiphysis. The drill bit was removed, and the 2.5-mm CS guide pin was inserted through the angled drill guide and into the drilled hole. The guide pin was inserted to approximate the lateral cortex of the distal epiphysis. The guide pin was left engaged in the epiphysis, and the angled drill guide was removed. Using the CS direct measuring device, the depth of the guide pin was determined to be 70 mm. According to the principles of application of the CS system, 5 mm was subtracted from this measured distance. The assembled CS triple reamer (8-mm cannulated drill bit and CS reaming head) was set to a depth of 65 mm. The hole

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for a 65-mm screw was then prepared and tapped as previously described. The barrel of a 16-hole 95° CS plate was placed over the shaft of the lag screw. The compression screw was placed to engage both the CS plate and lag screw. After placement of the lag screw, the plate was brought into contact with the medial cortex of the radius, using predominantly 5.5-mm cortical bone screws inserted in a distal-to-proximal direction. Working through the dorsolateral incision, an 18-hole 4.5-mm broad dynamic compression plate (DCP) was contoured to approximate the dorsolateral surface of the radius. The second plate was applied to the radius, using 5.5-mm cortical bone screws staggered between the screws placed in the CS plate. Both incisions were lavaged thoroughly with sterile saline solution. A continuous suction drain was inserted along each plate, and each drain exited the skin through a separate incision distal to each incision. Prior to closure of the dorsal incision, amikacin-impregnated polymethyl methacrylate (PMMA) beads were placed along the lateral aspect of the DCP. For both incisions, the underlying fascia was apposed, using No. 0 polydixone in a simple continuous suture pattern. The skin was apposed with No. 1 polypropylene in a continuous interlocking suture pattern. A stent bandage was then placed over each incision, and the limb was wrapped in a full-limb Robert Jones bandage. A support bandage was applied to the right forelimb. The horse was assisted during recovery by use of a sling and recovered without complications. The horse was able to bear an appreciable amount of weight on the left forelimb. Following recovery, the horse was moved to a bedded stall and was cross-tied. After surgery, the horse received potassium penicillin (22,000 U/kg, IV, q 6 h) and gentamicin sulfate (6.6 mg/kg [3.0 mg/lb], IV, q 24 h). Phenylbutazone (4.4 mg/kg, IV, q 12 h) and butorphanol (20 mg, IV) were administered after surgery to provide analgesia. The horse was kept cross-tied and maintained on acepromazine (0.04 mg/kg [2.0 mg/lb], IV, q 6 h) to minimize its activity in the stall. The Robert Jones bandage was changed daily to allow for evaluation of the incisions. The support bandage on the right forelimb was changed every other day. The continuous suction drains from both incisions were evaluated every 6 to 8 hours. The fluid collected during the first 24 hours was predominately bloody, but in the ensuing days, the fluid became more serosanguineous in appearance, and
Radiography of the left radius revealed severe osteolysis involving the diaphysis and distal metaphysis. The hole was lavaged with sterile saline solution, and the incision was closed in a routine fashion. The horse recovered from anesthesia without complications. Sixteen months after the initial fracture repair, the horse had returned to light training without signs of lameness. Future removal of the dorsal plate may be indicated if the horse is to return to aggressive training or becomes lame in the left forelimb.

Fractures of the radius can occur in all breeds and ages of horses. Radial fractures usually occur secondary to direct trauma, such as a kick or fall, or atypical stresses placed on the radius during exercise. Following the injury, horses are non-weight-bearing, and swelling and signs of pain are often observed in association with the affected radius. Because of the minimal soft tissue coverage over the medial aspect of the radius, fractures of the diaphysis and distal metaphysis can often propagate to type-I or type-II open fractures. In foals, transverse or short oblique fractures involving the diaphysis are common, but other configurations can also occur. Radial fractures in foals usually do not result in multiple fragments, whereas radial fractures in adult horses often have more comminution and soft tissue trauma and are subsequently classified as high energy fractures. In young horses, repair of displaced closed radial fractures by use of internal fixation can be successful. However, the successful surgical repair of radial fractures in adult horses has rarely been reported. In a retrospective study, none of the adult horses that underwent internal fixation survived. In a second investigation in which radial fractures in adult horses were evaluated, it was reported that only 2 of 9 horses survived long-term (at least 2 years) following internal fixation. One report described the successful repair of an open radial fracture in a 4-year-old 990-lb (450-kg) Arabian gelding, using two 18-hole 4.5-mm broad DCP and 5.5- and 4.5-mm bone screws. In select instances of radial fractures in adult horses, conservative management may potentially be a successful method of treatment if internal fixation is not an option.

In adult horses, internal fixation of radial fractures has commonly been performed, using 1 broad DCP applied dorsally and a second broad DCP placed laterally whenever possible. Fractures involving the distal metaphysis of the radius may limit the ability of the surgeon to gain adequate bone fixation using traditional broad DCP. The application of the CS implant has been suggested as a means of enhancing the stability of radial fractures in adult horses. The CS implant is used in human orthopedics for fractures involving the ends of certain long bones. The large screw enables the surgeon to achieve greater purchase within the bone of the smaller fracture fragment, thereby greatly enhancing the stability of the final repair. Although the dorsolateral-
al side of the radius is the greatest area of tension, we placed our implants on the dorsal and medial aspects of the radius. The CS implant was placed on the medial surface of the radius to wedge the distal tip of the proximal fragment between the plate and distal fragment.

Postoperative complications that have been reported following surgical repair of radial fractures in adult horses include breakdown of the internal fixation, osteomyelitis, and laminitis. Breakdown of the internal fixation can occur because of cyclic failure of the implants, configuration of the fracture, postoperative osteomyelitis, or technical errors during the repair. The successful outcome of the horse of this report may be attributable to a number of variables. The nondisplaced long oblique configuration of the fracture enabled good bone-to-bone contact after reduction of the fracture. We believe the combination of the CS implant, 4.5-mm broad DCP implant, and 5.5-mm cortical screws provided the greatest stability of this fracture. Plate luting was not used in this horse but could have been used to enhance the postoperative stability of the surgical repair. The ability to gain stable fixation of this fracture allowed immediate weight-bearing after surgery and during the immediate postoperative period. The ability to provide weight distribution between the forelimbs helps prevent the development of weight-bearing laminitis. Another possible important factor was that the horse’s temperament was amenable to a prolonged period of being cross-tied.

The open wound over the dorsolateral aspect of the antebrachium was a major concern before surgery because of the potential for development of osteomyelitis. Osteomyelitis can weaken a stable fixation and result in an infectious nonunion. Administration of antibiotics before surgery and aggressive lavage of the wound may have helped decrease the number of microorganisms in the wound prior to surgery. Intraoperative placement of amikacin-impregnated PMMA beads over the dorsal plate was performed to prevent development of sepsis after surgery. Antibiotics were administered after surgery for a prolonged period because of the open wound and the continued serous yellow drainage from this wound. In this instance, we believe that the administration of antibiotics combined with the placement of antibiotic-impregnated PMMA beads into the wound helped prevent development of osteomyelitis.

Culture of the yeast *C. albicans* from the tip of the dorsally placed drain may have been associated with either a contaminant or a true local fungal infection involving the soft tissues. We concluded that this was most likely a true soft-tissue infection, because the tip of the drain was collected aseptically, and no evidence of a contaminant was found to explain the strong growth of this microorganism. In horses, infections with *Candida* spp have been associated with infectious arthritis. To minimize the possible overgrowth of *Candida* spp within the soft tissues and within the common digital extensor tendon sheath, we elected to use PMMA beads impregnated with an antifungal agent.

Amphotericin B was chosen because *C. albicans* is reportedly susceptible to this antifungal agent; also, because this antifungal is in powdered form, it was easier to incorporate into the PMMA beads. No adverse effects were noticed after the impregnated PMMA beads were placed within the soft tissue.

The long-term postoperative complication in this horse that necessitated removal of the bone plate was quite interesting. Six months after surgery, the horse was lame at the walk and had signs of pain on palpation over the distal medial aspect of the radius. Because of the clinical signs and radiographic evidence of bone lysis, we elected to remove the CS implant. Bone lysis around a plate or screw can develop as a result of local infection, bone avascularity, or a restriction placed on the normal physiologic elastic motion present within bone. In the horse of this report, bone avascularity beneath the plate combined with a possible restriction of the normal elastic motion within the bone may have resulted in the osteolysis. This report also reveals the potential difficulty that may be encountered in removing the lag screw. The barrel of the CS plate and the shaft of the lag screw interconnect in a way similar to a socket wrench over a bolt. Removal of the lag screw was accomplished by using the plate shaft as a lever arm to back the lag screw out of the epiphysis. Implications of leaving the dorsal plate in situ indefinitely could result in implant or screw breakage, continued lameness, or potential secondary fractures, because the normal elastic motion within the bone is disrupted. Although the dorsolateral DCP was not removed, future removal of the plate may be required prior to this horse returning to increased levels of training or if this horse develops lameness or signs of pain on palpation of the left forelimb.

**References**


