Carpal Arthrodesis—Indications and Techniques

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Severe injuries involving the carpus are often characterized by multiple fractures of the various carpal bones with accompanying joint instability. Most such injuries can be managed successfully utilizing aggressive internal fixation techniques, with reasonably good prognosis for a pasture sound animal, satisfactory for breeding purposes. Author's address: Elgin Veterinary Hospital, Inc., PO Box 629, Elgin, TX 78621. © 2001 AAEP.

1. Introduction

Severe breakdown of the carpus is an infrequent, but life-threatening, injury encountered in racehorses. Most cases will be affected by complete fracture of one or more carpal bones, often with comminution or “crushing” of the injured bone(s). The hallmark of these injuries is significant destabilization of the carpus. Such injuries are devastating in nature, and reports in the literature regarding management of these cases is sparse. Historically, management has most often consisted of external coaptation with either casts or splints. Often, when surgical intervention has been utilized it has been conservative, involving lag screw reconstruction of fractured carpal bones in combination with external coaptation, with autologous cancellous bone grafting in select cases.¹ Such cases are extremely susceptible to laminitis, or other overload complications, in the contralateral limb. Cases that initially survive are often left with painful degenerative joint disease and varying degrees of angular limb deformity. More aggressive attempts at surgical management have been reported, but dealt with a limited number of cases.²,³ The purpose of this presentation is to describe techniques developed and utilized by the author in a significant number of cases during the past 18 years, which have resulted in reduced mortality early in the course of management, and much improved overall soundness for longer durations of time.

2. Materials and Methods

Records for 28 horses that underwent surgical procedures to affect arthrodesis of either the middle carpal and carpometacarpal joints, or the antebrachio-carpal, middle carpal, and carpometacarpal joints, were reviewed. Review of surgical logs revealed an additional eight cases for which records were no longer available, representing some of the earliest cases managed with these procedures. All cases were operated between January 1983 and December 2000. This presentation describes the nature of the injuries, procedures used, and outcomes for the 28 cases for which records were reviewed.

The breed distribution included 20 Quarter Horses and 8 Thoroughbreds. There were 27 females and one male. All 28 cases were unilateral surgical procedures. The left carpus was affected in 16 cases, and the right carpus in 12 cases. Descriptions of the injuries were divided into three categories:

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Category 1. Acutely injured cases treated with arthrodesis of the carpometacarpal and middle carpal joint (middle carpal joint arthrodesis).

Category 2. Acutely injured cases treated with arthrodesis of the carpometacarpal, middle carpal, and antebrachiocarpal joints (pancarpal arthrodesis).

Category 3. Chronic cases that had sustained prior destabilizing injuries of the carpus resulting in presentation with painful degenerative joint disease and significant angular limb deformity.

These cases were all treated with panchpal arthrodesis.

Fourteen cases were classified as category 1, seven cases as category 2, and seven cases as category 3. All category 1 and category 2 cases were presented within 8 days of the injury. The duration of injury could not be accurately determined in most category 3 cases, but all cases had sustained the original injury several years prior to presentation. Five of the seven category 3 cases had undergone surgical procedures previously, as evidenced by presence of one or more lag screws on radiographs made at presentation. All category 1 and category 2 cases were horses of racing age, ranging from two to five years of age, and all sustained the injury during their last race. As best it could be determined, all category 3 cases had sustained their initial injuries as a result of racing. Ages of category 3 cases ranged from four to nine years. The single male patient was classified as category 2.

Category 1
Category 1 cases all presented with a dehisced fracture of the third carpal bone (C3), and most cases exhibited medial displacement, with or without comminution, of the second carpal bone (C2). All cases presented severely lame in the affected limb, and nearly all displayed some degree of hyperextension with minimal load on the limb. Hyperextension is often enhanced as a result of gouging of the distal surface of the radial carpal bone by the intact caudal portion of C3. Some varus angular deformity is typical in such cases, and is relative to the degree of comminution of the radial facet of C3 and medial extrusion or comminution of C2.

Category 1 cases were treated by middle carpal joint arthrodesis, using two ASIF bone plates. This procedure is approached through a skin incision, approximately 25 cm in length, made on the cranial aspect of the carpus, beginning 5 cm proximal to the antebrachiocarpal joint, extending distally. The middle carpal joint capsule is incised in two locations, one dorsomedial and one dorsolateral. These incisions are extended proximally to the level of, but not into, the antebrachiocarpal joint. The incisions are extended distally onto the dorsomedial and dorsolateral metacarpus, through the periosteum. Periosteum is reflected to accommodate the bone plates selected. Typical bone plates used are ASIF 7 hole narrow plates. With the limb in flexion, all remaining articular cartilage in the middle carpal joint is removed. The proximal ends of the plates are anchored to the radial carpal and intermediate carpal bones, respectively, taking care not to place the dorsal ends of the plates over the synovial portion of the antebrachiocarpal joint capsule. Either 6.5-mm ASIF cancellous or 5.5-mm ASIF cortical bone screws are used in the proximal holes of the plates. Major fracture fragments of C3 are reconstructed with lag screw technique, either through the respective plate, or independently, depending on the configuration of the fracture. Care is taken to achieve normal limb alignment prior to attaching the plates to the metacarpus. In some cases, bone loss is to the extent that the medial plate serves as a buttress.

In three of the category 1 cases reviewed, comminution of the second and third carpal bones was to the extent that the fragments were removed, and a bone allograft was used. Grafts used were in the form of 1-in. diameter bone dowels, harvested previously from the shaft of the ilium of a donor horse and stored in sterile containers at −70°C. Proper graft lengths were determined intra-operatively, and the dowels were prepared to proper length with a motorized bone burr. The graft was fitted into place with the limb flexed, and extrusion dorsally is prevented by the overlying bone plate. This graft produces excellent mechanical stability. In addition, similar grafts were used in two category 2 cases. No evidence of rejection has been observed or reported in any of these cases.

All cases were maintained in a full-length fiberglass cast, incorporating the foot, and extending proximally to the elbow. The typical convalescence included approximately six weeks in a cast, followed by approximately six weeks of additional stall confinement. Records indicate three category 1 cases were maintained in full length casts for longer periods (9 to 11 weeks). These were cases with extensive fragmentartion and bone loss, creating probable added stress on the fixation.

Recovery of horses from general anesthesia, which have been fitted with a full length fiberglass cast on the forelimb, is usually unassisted. While shorter duration elective orthopedic surgery cases are usually allowed to recover unassisted without benefit of additional cushioning beyond the recovery stall floor, carpal arthrodesis cases are placed on an upholstered 8-in. thick foam-filled cushion to recover. Occasionally, cases with full forelimb casts are assisted when they attempt to stand, but not routinely. The decision to assist is based on observation during recovery.

Category 2
Category 2 cases presented with a somewhat greater variety of fracture configurations, and all seven cases had sustained injuries to C3. In addition, all cases had fractures of the radial carpal bone and/or
the intermediate carpal bone. Degree of comminution varied, and degree of vertical collapse varied from minimal to extreme. All cases presented extremely lame on the affected limb. Those with fracture and total dehiscence of the radial and/or intermediate carpal bones demonstrated marked joint instability.

Category 2 cases were treated with pancarpal arthrodesis, using two ASIF bone plates. This procedure is approached through a skin incision, approximately 45 cm in length, made on the dorsal aspect of the forelimb, the center of the incision located approximately at the level of the upper row of carpal bones. Both antebrachio carpal and middle carpal joint capsules are incised in two locations, one dorso medial and one dorsolateral. Incisions are extended proximally and distally through the periosteum of the radius and metacarpus, respectively. Periosteum is reflected to accommodate the selected bone plates. Typical bone plates used are ASIF 18-hole broad DC plates. After removal of all remaining cartilage in the antebrachio carpal and middle carpal joints, fractured fragments of the radial and intermediate carpal bones are reconstructed using lag screw technique. Large fragments present in the lower row of carpal bones, usually of C3, are reconstructed in like fashion. Bone plates are then applied, taking care to achieve normal limb alignment. Allografts, as described earlier, were used in two category 2 cases to replace comminuted bone and enhance stability of the fixation.

All cases were maintained in a full length fiberglass cast, incorporating the foot, and extending proximally to the elbow. The typical convalescence included approximately six weeks in a cast, followed by approximately six weeks of additional stall confinement. Varying degrees of bone removal was required to achieve acceptable limb alignment. All cases were maintained in full length fiberglass cast, incorporating the foot, and extending proximally to the elbow. The typical convalescence included approximately six weeks in a cast, followed by approximately six weeks of additional stall confinement.

**3. Results**

All category 1 cases reviewed demonstrated a favorable result with middle carpal joint arthrodesis and experienced no complications related to the surgery within the first 3 months. Follow-up was maintained for this length of time in all 14 cases. Two cases were still experiencing lameness in the opposite limb due to laminitis. One of these cases recovered successfully and was pasture sound as a broodmare 39 months later. The other case did produce one foal 24 months after surgery, but was still experiencing lameness from the foot. The operated limb was pain-free. This case was lost to follow-up after that. Of the 12 cases that experienced no complications, long-term follow-up (22 months to five years) was available for 8. All were reportedly relatively sound and none reported as requiring any medication or special considerations for maintenance. One was lost to colic. The author has experienced complications related to implant failure in three cases of middle carpal joint arthrodesis, but these cases were represented in the eight cases for which records had been discarded. The first two cases of middle carpal joint arthrodesis performed utilized ASIF T-plates, and in one case both plates eventually fractured due to fatigue. This case was eventually euthanized. In another case, the proximal screws in each narrow plate failed, but this case was salvaged after a prolonged recovery. The outcome was reasonably acceptable. The failed screws were both ASIF 4.5-mm cortical bone screws. In the third case, the proximal screw in the medial plate failed (also a 4.5-mm cortical bone screw), but this case was salvaged with a very acceptable outcome.

Five of the seven category 2 cases experienced no complications during the first 3 months. One case developed diarrhea during the first week following surgery, and was eventually euthanized due to medical complications. This case was operated in another hospital, but reportedly the operated limb was experiencing no detectable complications. The
other case developed significant laminitis immediately after surgery, but eventually recovered reasonably well after extensive management of the foot. Long-term follow-up (16 months to seven years) was available for five cases. Four were functioning satisfactorily as broodmares, and the stallion was being used for breeding 25 months after surgery. The one mare that experienced laminitis produced two foals at the time of last contact, but experienced significant lameness periodically attributable to the foot. There were no reports of pain attributable to the operated limbs.

A greater rate of complications were encountered with the category 3 cases. Four of the seven cases survived for 3 months. Of the three that did not survive 3 months, one died from colic 2 months postsurgically, one was euthanized due to complications from laminitis in the contralateral limb, and the third was euthanized immediately following surgery due to injuries incurred during recovery from anesthesia. Of the four cases that survived greater than 3 months, survival for 28 months, 42 months, and six years could be documented on three cases, and they all were reported as functioning satisfactorily as broodmares. One case was experiencing pain in the fetlock of the operated limb, and followup examination led the author to believe this was secondary to shortening of the bone column as a result of wedge osteotomy. The fourth case was reported as doing well 9 months after surgery, but was lost to follow-up.

4. Discussion

Previous literature gave a poor prognosis for untreated carpal fracture cases which result in significant destabilization, and a still-unfavorable prognosis in spite of surgical intervention, using lag screw fixation and autologous cancellous bone grafting.¹ The author’s experience and personal communications with colleagues supports these opinions. Later reports of more aggressive attempts at surgical management have been reported,² but case numbers were limited. This study reports on the outcome of a relatively large number of cases, and indicates that the surgical techniques described, when applied to cases of acute injury, produced a favorable outcome (81%) on a short-term basis, and an equally favorable outcome (81% of cases) on a long-term basis as a means of salvage for breeding purposes. The outcome for surgical intervention in category 3 cases was less favorable (57% short term and 43% long term). However, it is very doubtful that any of the category 3 cases in this study would have survived for a significant period of time had surgical intervention not been attempted.

While failures of internal fixation in carpal arthrodesis cases have been experienced by the author, they resulted from faulty technique. None of the cases for which records were available experienced implant complications. No complications directly attributable to the surgical procedure were encountered. Autologous cancellous bone grafting was not used in any of the reported cases, but frozen bone allografts were utilized in five cases with no known complications as a result.

A significant experience of the author is that a large majority of cases operated were very comfortable in the injured limb within a short period of time, and practically all would bear full weight on that limb without objection. Full-length forelimb casts are cumbersome, and using appliances that lengthen the contralateral limb aid in horses ambulating and encourage full use of the casted limb. While laminitis in the contralateral limb was encountered in only 4 of 28 cases, it nonetheless remains a very significant potential complication in horses that sustain carpal breakdowns. The author has elected not to attempt such repairs on numerous cases due to the presence of pre-existing laminitis at the time of admission. It is imperative that early surgical intervention on these injuries be undertaken to reduce the risk of this complication. The methods of repair described produce very stable fixations and rapid arthrodesis. Convalescence is fairly free of pain. If adequate attention is devoted to achieving proper limb alignment, the long term prognosis for pasture soundness is very good. These techniques are not intended to return horses to athletic use. While this study is limited to repairs of profound injuries, the author has used carpal arthrodesis effectively in cases of degenerative joint disease without a history of profound prior injury, as well as in salvage of cases of septic arthritis of the carpus.

References