Fracture-Dislocation of the Radiocarpal Joint

A CLINICAL STUDY OF FIVE CASES

BY Z. JOHN BILOS, M.D.*, ARSEN M. PANKOVICH, M.D.*, AND SHARUKIN YELDA, M.D.*, CHICAGO, ILLINOIS

From the Division of Orthopaedic Surgery, Cook County Hospital, and Hektoen Institute for Medical Research, Chicago

ABSTRACT: In five patients with fracture-dislocation of a radiocarpal joint, the wrist injury was severe and associated with injuries to other systems. Typically there was neurovascular impairment and closed reduction was performed as soon as possible to relieve pressure or tension on vessels and nerves. Fracture of the radial and ulnar styloid processes, fracture of the dorsal rim of the radial articular surface, and a multitude of carpal and intercarpal injuries were present in all cases. Early open reduction, internal fixation of the fractures, and repair of all torn ligaments appeared to be the treatment of choice.

Radiocarpal dislocation is an uncommon injury. According to Dobyns and Linscheid, it is often associated with fracture of the dorsal rim of the radial articular surface, rupture of the palmar radiocarpal ligament, and fracture of the radial and ulnar styloid processes. In most cases, therefore, it is a fracture-dislocation. Böhler reported five cases of radiocarpal dislocation. In two of them, the carpus was displaced dorsally; in two, volarly; and in one there was an open dorso-ulnar dislocation. Destot saw one open dorsoradial dislocation without a fracture over an eighteen-year period. Fahey described a case in which the radial styloid process was fractured and dislocated volarly together with the carpus. Weiss and associates recorded an irreducible dorsal dislocation associated with fractures of the radial and ulnar styloid processes and separation of the distal radio-ulnar joint. Dunn, in a review of 112 carpal fracture-dislocations, found six radiocarpal fracture-dislocations: three dorsal, two volar, and one in which all of the carpal bones were crushed and dislocated in various directions. Wagner reported two dorsal dislocations of the carpus: one with a fracture of the radial styloid process and the other with no fracture.

During the last several years we have treated five patients with radiocarpal fracture-dislocations, four of them followed for from sixteen to twenty-six months. Since few injuries of this type have been reported in the literature, the findings and results of treatment in these cases were thought to be worth reporting.

Materials and Methods

From 1974 to 1978, five patients with closed radiocarpal fracture-dislocations were treated in our private practice and at the Cook County Hospital. All were men in their early twenties, and the left wrist was involved in each instance. All the injuries were caused by severe trauma: a motorcycle accident in two cases and a fall from a height, in three. All five patients had other severe injuries.

Two other patients were also seen: one, a sixty-five-year-old woman with an open volar fracture-dislocation of the left wrist caused by an automobile accident, and the other, a thirty-year-old man with a closed dorsal fracture-dislocation of the right wrist, treated by closed reduction. Both of these patients were lost to follow-up after three months and are not included in this series.

Case Reports

Case 1. A twenty-five-year-old right-handed male carpenter fell about 4.6 meters from a scaffold, landing on his left side. He was unconscious briefly and on admission, one hour later, he complained of severe pain and numbness in the left hand and wrist. Examination revealed dorsoradial displacement of the hand and wrist in relation to the forearm. The radial pulse was present and the sensation of the hand was normal. The patient also had contusions about the left orbit and the left knee.

Roentgenograms revealed dorsoradial dislocation of the carpus, a large, comminuted, displaced fracture of the radial styloid process, and multiple smaller fragments from the volar and dorsal rims of the radial articular surface. There was also an undisplaced fracture of the navicular (Figs. 1-A and 1-B). Satisfactory reduction of the dislocation and radial fractures was easily accomplished by traction on the hand under local anesthesia with 1 per cent Xylocaine (lidocaine). The limb was held for nine weeks in a long cast with the forearm in slight pronation and the wrist in slight flexion and ulnar deviation. Numbness of the fingers resolved several days after reduction of the dislocation, but recovery was complicated by dizziness and nausea which were attributed to the head injury. The patient was able to do limited work in six months and returned to regular employment about one year after injury. At that time, he still had pain over the ulnar side of the wrist after heavy labor, but his condition continued to improve during the next year and at follow-up two years after injury he had only mild, intermittent aching in the wrist, requiring no medication. Motions of the left wrist were: extension to 55 degrees, flexion to 45 degrees, supination to 65 degrees, pronation to 70 degrees, radial deviation to 5 degrees, and ulnar deviation to 30 degrees. Grasp of the left hand was 75 per cent of that on the right. Roentgenograms revealed some residual irregularity of the distal articular surface of the radius, but the joint space was still maintained. The fracture of the navicular had healed completely (Figs. 1-C and 1-D).

Case 2. A twenty-two-year-old right-handed male welder landed on his left hand in a motorcycle accident. Examination of the left wrist revealed marked dorsoradial displacement of the hand and wrist with neurovascular insufficiency in the hand. Roentgenograms (Figs. 2-A and 2-B) showed a dorsoradial dislocation with a displaced fracture of the radial styloid process and a displaced fracture of the navicular, with the proximal fragment completely separated and lying on the dorsal surface of the radius. The dislocation was easily reduced in the emergency room.
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Fig. 1-A through 1-D: Case 1, a twenty-five-year-old male carpenter who fell 4.6 meters from a scaffold, injuring the left wrist.

Figs. 1-A and 1-B: Roentgenograms made on admission, showing a comminuted compression fracture of the radial styloid process, a fracture of the dorsal rim of the radial articular surface, an avulsion fracture of the ulnar styloid process, and an undisplaced fracture of the navicular.

Figs. 1-C and 1-D: Two years after injury, there is some irregularity of the distal end of the radius and the fracture of the navicular has healed.

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roentgenograms revealed that the wrist was still subluxated and the navicular fragments were separated. Four days after admission, the wrist joint was exposed through a dorsolateral incision. The fracture of the navicular was reduced and the two fragments were fixed with a navicular screw. The radial styloid process was also fixed with a navicular screw (Figs. 2-C and 2-D). Postoperatively, a long cast was worn for seven weeks. The patient regained useful wrist motion and strength quickly and returned to his work as a welder one month later. At his last clinic visit, fifteen months after injury, he had point tenderness over the screw heads but no pain in the wrist. The wrist motions were: extension to 45 degrees, flexion to 55 degrees, supination to 90 degrees, pronation to 65 degrees, radial deviation to 12 degrees, and ulnar deviation to 15 degrees. Grip on the left was 10 per cent stronger than on the right, even though he was right-handed. The patient, an Olympic boxing-team aspirant, ascribed this difference to favoring his left hand in boxing and to weight-lifting prior to the accident. Roentgenograms at this time showed the fracture of the radial styloid to be healed in good position, and there was partial resorption of the proximal fragment of the navicular (Figs. 2-E and 2-F).

CASE 3. A twenty-two-year-old right-handed man fell down a flight of stairs and on admission to the emergency room was found to have a compression fracture of the second lumbar vertebra and a grossly deformed left wrist. The left hand was cool and the radial pulse was not palpable. Roentgenograms (Figs. 3-A and 3-B) revealed a severely comminuted compression fracture of the radial styloid process and adjacent metaphysis, which was displaced radially with the carpus; an undisplaced fracture of the volar rim of the radial articular surface; and an avulsion fracture of the ulnar styloid process. There was also a volar dislocation of the lunate. The wrist was manipulated initially to reduce the dislocation and restore the circulation to the hand, and the wrist was immobilized with a volar splint. The following day, the wrist joint was exposed through a dorsolateral approach. The carpal and lunate dislocations were reduced and the radial styloid process was stabilized with a cancellous screw and a Kirschner wire. At operation it was apparent that the naviculolunate ligament was ruptured and that the navicular was subluxated dorsally. The navicular was reduced and stabilized with two Kirschner wires: one was inserted into the lunate and the other, into the capitate (Fig. 3-C). Postoperatively the wrist was immobilized in a long cast for six weeks, and the screw and Kirschner wires were removed eight weeks later.

Thereafter the patient had practically no pain in the wrist, but he was unable to find work because of his inability to stand for long periods.
Figs. 3-A through 3-E: Case 3, a twenty-two-year-old man who fell down a flight of stairs injuring the left wrist and sustaining a compression fracture of the second lumbar vertebra.

Figs. 3-A and 3-B: Original roentgenograms, showing marked radial displacement of the carpus with a large fragment of the radial styloid process, volar dislocation of the lunate, and fractures of the ulnar styloid process and of the volar rim of the radial articular surface.

Fig. 3-C: Postoperative roentgenogram at six weeks, showing the internal fixation.

Figs. 3-D and 3-E: Twenty-two months after injury, the fracture of the radial styloid process has healed in satisfactory position but there is widening and irregularity of the lunate-triquetral joint and moderate extension of the lunate with respect to the adjacent structures.

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and lift heavy objects, a consequence of the spine injury. At his last clinic visit, twenty-two months after injury, the wrist remained asymptomatic and wrist motions were: extension to 45 degrees, flexion to 55 degrees, radial deviation to 20 degrees, ulnar deviation to 30 degrees, and supination and pronation to 90 degrees each. The left and right grip strengths were nearly equal. The roentgenograms at that time showed irregularity and widening of the lunate-triquetral joint, a moderate extension displacement of the lunate, and a healed radial fracture in satisfactory position (Figs. 3-D and 3-E).

Case 4. A twenty-one-year-old right-handed man was thrown from his motorcycle when it was hit by an automobile. After he was brought to the hospital he complained of severe pain in the abdomen and left flank, pain in the left wrist, and numbness of the left hand. There was marked dorsoradial displacement of the hand, the fingers were cold, and the radial pulse was very weak. Anesthesia in the distribution of the ulnar nerve was also noted. Roentgenograms (Figs. 4-A and 4-B) of the left wrist showed a dorsoradial fracture-dislocation of the carpus with a comminuted compression fracture of the radial styloid process, a fracture of the dorsal rim of the radial articular surface, an avulsion fracture of the ulnar styloid process, and a coronal fracture of the lunate. One fragment of the lunate remained in place in the wrist joint.

Immediate closed manipulation was performed to reduce the fracture-dislocation and restore the circulation. Roentgenograms (Fig. 4-C) then showed satisfactory reduction of the radial styloid and carpus. However, the fragments of the lunate remained separated, and seven days after injury the wrist was exposed through a volar approach. The volar capsule was found to be widely lacerated, with part of it displaced into the joint between the fragments of the lunate. The proximal fragment of the lunate was attached on its ulnar surface to an unusually thick ulnar palmar carpal ligament. This fragment was secured to the rest of
the lunate by two Kirschner wires, and the radial styloid was reduced and fixed with another Kirschner wire (Fig. 4-D). The volar capsule was then repaired, and a long cast was applied and worn for eight weeks.

The patient returned to full-time construction work in four months, despite some discomfort in the wrist. At his last follow-up visit, twenty-six months after injury, he had no wrist discomfort and the motions of the left wrist were: flexion to 60 degrees, extension to 75 degrees, supination to 90 degrees, pronation to 75 degrees, no radial deviation, and ulnar deviation to 22 degrees. Roentgenograms (Figs. 4-E and 4-F) showed that the fractures of the lunate and radial styloid were healed in satisfactory position, but there was some narrowing of the radiocarpal and naviculolunate cartilage spaces.

Six weeks after injury, fusion of the radius to the proximal carpal row was performed using iliac cancellous bone grafts along with partial excision of the distal end of the ulna. Only the proximal fragment of the navicular was included in the fusion. The wrist was immobilized in a long cast for six weeks and in a short cast for four more weeks. The patient then had persistent pain in the region of the ulnar styloid process, and five and one-half months after injury the head and styloid process of the ulna were resected. Eight months after injury, at the last follow-up examination, he had mild pain in the wrist. At that time there was a 5-degree flexion contracture of the wrist and flexion to 45 degrees, supination to 70 degrees, pronation to 70 degrees, and fixed radial deviation of 10 degrees, with further radial deviation to 20 degrees. The grip strength of the left hand was 80 per cent of that on the right. Roentgenograms (Figs. 5-E and 5-F) showed a solid fusion between the proximal carpal row and the distal end of the radius.

Twenty-six months after the injury, the fractures of the lunate and radial styloid process have healed in satisfactory position, but there is some narrowing of the radiocarpal and naviculolunate cartilage spaces.

Roentgenograms (Figs. 5-E and 5-F) showed six months after fusion of the radius to the proximal carpal row, bone including the distal fragment of the navicular in the fusion.

**Treatment**

Radiocarpal dislocations and fracture-dislocations are severe, complicated lesions, usually associated with injuries of other parts of the body. Before any treatment of the wrist is attempted, it is imperative that the entire patient be carefully examined to identify other injuries which may be more serious and have priority in treatment.

Immediate manipulation of the wrist is necessary in all cases because of the marked deformity and the circulatory embarrassment that is often present. After manipulation, improvement of vascular status of the hand was prompt in all of our patients, and further vascular em-
barrassment, ischemic phenomena, and subsequent nerve damage were not observed. However, satisfactory reduction was not achieved by manipulation in four of our five patients. Open reduction was not done at the time of the initial manipulation because other injuries had priority in treatment.

Open procedures were required in four patients. The goal of these operations was firm internal fixation of the fractures of the carpal bones and radius as well as stable reduction of the dislocation. In three patients this goal was achieved and the results so far have been excellent. In the fourth patient, failure of the original manipulation and a delay of six weeks from the time of injury made open reduction impossible, and wrist arthrodesis was required.

Analysis of these five cases indicates considerable variability of the lesions. A large or small displaced fragment of the radial styloid process was always present and contributed considerably to the instability of the wrist. Anatomical reduction and fixation of this fragment appeared to be essential, not only for the stability of the radiocarpal joint but also for the restoration of the articular surface of the radius. Once the fracture was reduced, fixation was easily accomplished in these cases using a separate small incision over the tip of the styloid process to insert either a Kirschner wire or a navicular screw (Cases 2, 3, and 4). Small fragments of the dorsal rim of the radial articular surface were excised or removed from the joint or adjacent soft tissue. Radio-ulnar separation was seen in only one wrist (Case 5). Partial resection of the distal end of the ulna done at the time of the wrist arthrodesis was followed by persistent pain. Complete resection had to be done subsequently to relieve pain and improve rotation of the forearm.

Fracture of the navicular was present in three wrists. In one (Case 1), the fracture was undisplaced and healed after closed reduction of the radiocarpal dislocation. In the second (Case 2), the proximal fragment was widely separated and displaced dorsally. It was reduced and fixed with a navicular screw four days after the injury, but two years after surgery there was partial resorption of the proximal fragment although the fracture had united. The functional result at that time, however, was excellent. In this wrist, an initial open reduction was indicated with fixation of the navicular to the lunate because the naviculolunate ligament was ruptured. In the third instance (Case 5), open reduction had to be delayed because of the patient's general condition, and the wrist was subsequently fused.

Dislocation of the lunate was present in Case 3. Early open reduction was done, placing the naviculolunate complex in the reduced position. However, the latest roentgenograms showed changes suggesting disruption of the lunate-triquetral joint, even though the clinical result was excellent. It would have been better to stabilize the carpus with Kirschner wires inserted in the lunate and capitate and to repair the lunate-triquetral ligament if feasible.

Coronal fracture of the lunate was seen in Case 4. At surgery, a larger than usual ulnar palmar carpal ligament was attached to the fragment of the lunate retained in the joint. It is possible that necrosis of this fragment did not develop because there was an adequate blood supply through the attached ligament. Careful dissection and preservation of soft-tissue attachments to such fragments is essential.

Either a volar or a dorsal approach to the wrist may be used, depending on the type of injury and the location of fracture fragments. When necessary, both approaches should be used to facilitate reduction and fixation of the injured structures.

Discussion

Radiocarpal dislocations and fracture-dislocations are infrequent and are not even mentioned in some standard textbooks. From the analysis of the cases in the present series and of those described in the literature, it is evident that these injuries of the radiocarpal joint can be classified into four general types — dorsal, volar, radial, and ulnar — depending on the direction in which the carpus is displaced.

The mechanisms of these injuries are not established. Weiss and associates produced dorsal fracture-dislocations in cadaveria by applying a compressive and torsional force to the hyperextended and pronated wrist. In Böhler's case, an open dorso-ulnar dislocation was produced when the patient's hyperextended wrist was hit by a car while the elbow was fixed against a wall. Our patients were not able to describe the mechanism of their injuries. Large forces must be applied to the wrist to produce these injuries, and the lesions usually are the result of falls from a height or motor-vehicle accidents. Major injuries of other systems are often present and should be identified and treated if need be before treatment of the wrist is undertaken.

The wrist injury should be carefully assessed, since it often involves many components of the wrist joint: the distal ends of the radius and ulna, the distal radio-ulnar joint, and the individual carpal bones, particularly the proximal carpal row. Not infrequently there are dislocations or fracture-dislocations of multiple carpal bones and joints. In our five cases there were nine carpal lesions: three fractures of the navicular, one fracture of the lunate, one dislocation of the lunate, three naviculolunate dissociations, and one lunate-triquetral dissociation.

Conclusions

From this small series, it appears that open anatomical reduction with stabilization of all injured structures, followed by six to eight weeks of immobilization in a long cast, is probably optimum treatment. The operative procedure should be done as early after injury as possible, especially if fragments of the carpal bones are displaced far from their anatomical position, thus jeopardizing their vascular supply. Any patient whose general condition precludes a long operation on the wrist should have a closed reduction and probably percutaneous fixation of major
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fragments with Kirschner wires, particularly when emergency procedures on other vital structures are being done. Late reconstructive procedures on the wrist will thus be facilitated.

Since there was only one nerve injury in our five patients, a neurapraxia of the ulnar nerve, it seems that traction or compression of the nerves at the wrist does not occur readily despite the severity of the injury.

Prognosis after a radiocarpal fracture-dislocation must be guarded. Presumably it depends on the type and extent of the injury, the accuracy of reduction of all lesions, maintenance of the reduction during the period of postoperative immobilization, and the vigor and motivation of the patient during the rehabilitation phase. Although the results in our four patients whose wrists could be treated early were good, it seems possible that with longer follow-up wrist pain due to post-traumatic arthritis may develop.

References