Radiocarpal fracture-dislocation is a complex injury characterized by dislocation of the radiocarpal joint, associated with avulsion of the dorsal or palmar cortical margin of the distal radius. Fractures of the radial and ulnar styloids are common. This injury must, however, be differentiated from a shearing or rim fracture of the distal radius, in which the articular fracture is substantial and remains in contact with the carpus (Fernandez and Ghillani, 1996).

Due to the rarity of this injury, most reports have described relatively small numbers of patients (Blilos et al., 1977; Moneim et al., 1985; Schoenecker et al., 1985), or have been isolated case reports (Fernandez, 1981; Freund and Ovesen, 1977; Matthews, 1987; Moore and McMahon, 1988; Thomsen and Falstie-Jensen, 1989). To-date, two reports have included ten or more cases (Dumontier et al., 1995; Nyquist and Stern, 1984).

We describe our operative technique, and report our results using open reduction and internal fixation to restore anatomy, especially of the radial styloid. Open reduction and internal fixation is often necessary to restore the relationship of the end of the radius to the carpus and distal ulna. We present a retrospective review of 12 patients treated over a 10-year period and review the literature.

**PATIENTS AND METHODS**

Twelve patients presenting with radiocarpal fracture-dislocations were treated between 1986 and 1996. There were 11 men and one woman. The mean age was 33 years (range, 19–54). Four patients were involved in a motor vehicle accident, and six injuries were from a fall. Radiocarpal fracture-dislocations without intercarpal injuries were classified as type I and those with intercarpal injuries were classified as type II (Moneim et al., 1985). Using this classification, there were ten type I injuries and two type II injuries (Cases 1, 9). In 11 patients, the carpus was displaced dorsally. The twelfth patient had palmar displacement of the carpus. A large radial styloid fragment was noted in nine cases, and the ulnar styloid was fractured in eight cases.

Four patients had open injuries. In all of these, the dislocation was dorsal and the wound was palmar. Sensory impairment was noted in seven patients. In three, it involved the distribution of both the median and ulnar nerves, and in four patients the median nerve alone was affected. Associated injuries were seen in five patients (Table 1).

On presentation, all injuries were treated by closed reduction in the emergency room. Eight patients underwent operative treatment on the same day. Another two patients (Cases 4, 11) were treated operatively 3 and 6 days after injury respectively. In addition, two patients (Cases 1, 3), were referred to our institution after being operated on elsewhere, and underwent a second procedure 25 and 17 days after injury, respectively.

**Operative method**

The operative technique outlined here, has evolved in the experience of the senior author (JBJ), and what follows is a description of the technique used at the present time. After the initial closed reduction, additional anteroposterior, lateral and oblique radiographs are obtained. These help to assess the fracture and plan subsequent surgery. In the operating room, an external fixator is applied to restore length and obtain control of an unstable extremity. When there are neurological signs, an extended palmar approach is used to decompress the median and ulnar nerves and release the flexor retinaculum.

The radiocarpal joint is examined through the rent in the palmar capsule and the extent of capsular injury is noted. The joint is irrigated and any entrapped soft tissue or osteochondral fragments are extracted. The intercarpal relationships are examined next, both under direct vision and with the use of an image intensifier. If there is injury to the intercarpal ligaments, the affected carpal bones are reduced and fixed with Kirschner wires. Next, sutures are placed in the palmar capsule, using nonabsorbable material. These are not tied at this point. The radial styloid is then accurately repositioned and fixed securely, using screws or Kirschner wires. The sutures in the palmar capsule are then tied. If the capsular avulsion involves bony fragments, these are fixed with wire sutures or nonabsorbable suture material, through drill holes made in the palmar aspect of the distal radius. When the dorsal rim of the distal radius is involved, a second incision is made dorsally and the radiocarpal joint is approached through the bed of the third dorsal compartment.

Impacted articular rim fragments of the distal radius are elevated and bone grafted as necessary, using cancellous bone graft harvested from the iliac crest. If necessary, dorsal buttress plating is carried out.

The ulnar styloid is then reduced through a separate incision and fixed with Kirschner wires or a screw. The
stability of the distal radioulnar joint is tested. The external fixator is then either removed or maintained as an additional form of immobilization to protect the repair (Fig 1).

All the dorsal dislocations in this series had a capsular avulsion from the palmar lip of the radius. The two patients with type II injuries also had tears through the scapholunate interosseous ligament. In the nine patients with a large radial styloid fragment, the exit of the fracture line was either on the scapholunate crest of the distal radius, or very close to it. Impaction of the dorsal aspect of the radius, requiring elevation and bone grafting and buttress plating, was seen in three patients (Cases 1–3), and in all three the impaction was restricted to the lunate fossa. An external fixator was used in four cases. All other patients were immobilized in a Munster splint, with the forearm in mid-supination.

Assessment method

At the time of latest follow-up, a detailed history was taken from each patient and clinical and X-ray assessments were done. Patients were asked to describe any symptoms of pain, stiffness and weakness of grip, and their relationship to the time of the day and to the patient’s employment was noted.

Pain was classified as mild, moderate or severe and also whether it was associated with activities of daily living, light work or heavy labour. Patients were also questioned about the protracted use of pain medication, if any. Any change in employment as a direct consequence of the injury was also noted.

The clinical examinations were carried out by two of us (JBJ and JP). Any deformity, swelling or tenderness of the radiocarpal joint, the distal radioulnar joint and intercarpal joints was assessed. The range of motion of the wrist and the rotary motion of the forearm was assessed. Grip and pinch strengths were recorded using commercially available devices (Jamar dynamometer, Clifton, NJ). Finally, the neurological status of the hand was assessed by static two-point discrimination and monofilament tests.

All patients underwent standard posteroanterior (PA), and zero-rotation lateral radiographic views of the wrist (Taleisnik, 1987). Radiographs of the uninjured wrist were not obtained routinely. The PA view was used to assess carpal relationships (Bellinghausen et al., 1983; Gilula and Weeks, 1978; Gilula et al., 1984), radial length (Mann et al., 1992), radial inclination (Friberg and Lundström, 1976), ulnar translocation (Taleisnik, 1985) and articular congruity (Knirk and Jupiter, 1986). In addition, the scapholunate distance and carpal height ratio (McMurtry et al., 1978) were measured.

The lateral view was used to measure any change in the palmar inclination of the radial articular surface (Friberg and Lundström, 1976). In addition, scapholunate and capitohamate angles (Gilula and Weeks, 1978), were measured.

Analysis of outcome

Clinical and functional outcomes were assessed using the clinical scoring system of Green and O’Brien (1978), as modified by Cooney et al. (1987). This scoring system allot 25 points each for pain, functional status, range of motion and grip strength. Results are then graded as excellent (90–100 points), good (80–89 points), fair (65–79 points), and poor (less than 65 points). All patients with scores greater than 65 are considered to have a satisfactory result.

RESULTS

The patients were immobilized for a mean period of 5 weeks (range, 4–8 weeks). The mean follow-up was 36 months (range, 7–96 months). At the time of follow-up examination, the sensory examination was within normal limits in all 12 patients. In six of the seven who had
Fig 1 (a,b,c) Radiographs in Case 3 showing a complex radiocarpal fracture-dislocation of the right wrist with a large radial styloid fragment. Progressive pain developed, after initial closed reduction and application of an external fixator with the wrist in flexion, at another hospital. The exit of the radial styloid fracture is on the scapholunate crest of the distal radius. An ulnar styloid fracture is also seen.
Fig 1  (d,e) Following anterior nerve decompression and ligament repair, dorsal buttress plating and bone grafting was done. (Reproduced by the kind permission of Springer-Verlag from Fernandez D L and Jupiter J B [Eds]: Fractures of the distal radius: A practical approach to management, p231).  

(f,g) Clinical function at 14 months was satisfactory.
Table 2—Follow-up data and outcome

<table>
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<tr>
<th>No.</th>
<th>F/u</th>
<th>Extension</th>
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<th>Pronation</th>
<th>Supination</th>
<th>Grip strength</th>
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F/u = follow-up (in months).
All ranges of motion are expressed in degrees.
Grip strength expressed as percentage of the opposite side.
Case 8 has been excluded as the patient was lost to follow-up.

associated sensory dysfunction, improvement was noted after a closed reduction of the dislocation had been performed. In the seventh patient (Case 9) hypoesthesia in the ulnar nerve distribution persisted for 3 months following injury. One patient (Case 8) was lost to follow-up after 3 months, and has not been included in the analysis of the results. Data from follow-up is summarized in Table 2.

Eight patients returned to their original jobs. Subjectively, complaints were surprisingly few and minor. Four patients (Cases 1, 6, 9, 12) complained of mild pain with heavy labour. Six patients (Cases 1, 3, 4, 6, 9, 12) noted wrist stiffness in the morning, and four patients (Cases 1, 3, 4, 6) complained of a weak grip. Objectively, mean ranges of wrist motion in patients with type I injuries were as follows: extension, 53° (range, 25–85°); flexion, 59° (range, 25–80°); pronation, 82° (range, 70–85°); and supination, 74° (range 40–85°) (Fig 1). The mean grip strength for patients with type I injuries was 83% (range, 55–100%). The two patients with type II injuries (Cases 1, 9), displayed substantially lesser ranges of motion and grip strengths (Table 2), perhaps reflecting the greater severity of injury.

Radiographic analysis revealed satisfactory results. Radial length had been restored in all patients. There was no evidence of ulnar translocation in any case. Using the criteria of Knirk and Jupiter (1986), grade 1 arthritic changes (defined as a slight narrowing of joint space), and grade 1 incongruity (defined as a 1–2 mm step-off), were seen in three patients (Cases 1, 9, 10), after 96, 26 and 63 months respectively. Measurements of scapholunate distance, scapholunate angle, capitulate angle and carpal height ratio, showed no evidence of carpal instability.

Complications were few. Four patients had pain from internal fixation devices necessitating removal, which alleviated symptoms completely. Early in the series one patient (Case 10) developed a nonunion of the ulnar styloid. This was treated with tension band fixation and the patient had an excellent outcome. One patient (Case 9) required a split-thickness skin graft, as the operative wound could not be closed primarily due to swelling.

Using the modified scoring system there were four excellent, one good, two fair and two poor results in the patients with type I injuries. In the patients with type II injuries, there was one fair and one poor result. There were two fair and two poor results in the four patients with open injuries. Eight of the 11 patients had a score greater than 65, and were considered to have a satisfactory outcome.

DISCUSSION

Radiocarpal fracture-dislocation is an uncommon injury that according to Dunn (1972), accounts for 0.2% of all dislocations.

In our series, five patients had associated injuries (Table 1), occurring in other organ systems, and also at different levels in the same limb as reported by others (Bilos et al., 1977; Dodd, 1987; Moneim et al., 1985; Mullan and Lloyd, 1980; Nyquist and Stern, 1984; Schoenecker et al., 1985). It is therefore important that a thorough general examination is carried out in patients with this injury.

Neurological deficits in the hand, are noted frequently and can be associated with vascular insufficiency of the hand (Bilos et al., 1977; Fernandez, 1981; Matthews, 1987; Moneim et al., 1985; Nyquist and Stern, 1984; Schoenecker et al., 1985; Varodompun et al., 1985; Weiss et al., 1970). The median nerve appears to be involved more frequently than the ulnar nerve, as was the case in this series.

In our series, sensory impairment was noted in seven patients, and there were no cases of vascular compromise (Table 1). In six of these, the deficits resolved very shortly after closed reduction of the dislocation and correction of the deformity. This suggests a mechanical cause for the sensory impairment with a traction neurapraxia ensuing as the nerve or nerves are tented over a deformed wrist.
In addition to relieving any neurocirculatory embarrassment, prompt closed reduction also helps to restore the soft tissues to length, reduces subsequent soft tissue swelling, and facilitates X-ray examination that provides a better idea of the fracture geometry and therefore helps in planning subsequent surgery.

Open injuries are not uncommon and were present in four of our patients. All four cases demonstrated a palmar wound and a dorsal dislocation. This combination in planning subsequent surgery.

We believe that the restoration of the radial and ulnar styloids is critical in restoring stability to the wrist. By restoring the anatomy of the styloid processes, the attached ligaments are also restored to length, and are mechanically competent to confer stability on the radiocarpal joint.

As an initial step to achieve bony stability, we have found the external fixator to be extremely useful. Not only does it help to reduce and hold the fracture-dislocation, while internal fixation and ligament repair is being carried out, but it also helps in the care of open injuries, serves as a definitive form of immobilization postoperatively, permits free access to the wrist for any secondary procedures and facilitates early elbow and forearm motion if so desired (Fernandez and Ghillani, 1987).

Although Bilos et al. (1977) and Schoenecker et al. (1985) have used a radiodorsal approach, we prefer an extensile palmar approach. This facilitates nerve decompression, fasciotomy if required, inspection and repair of the radiocarpal ligaments, accurate repositioning and fixation of the radial styloid, and in open injuries the palmar wound may be extended to allow irrigation and debridement.

A dorsal incision may be necessary sometimes and we have no hesitation in making a second incision. In our series, a second dorsal incision was needed in three cases, all of whom required dorsal buttress plating and elevation and bone grafting of impacted fragments. The dorsal incision can also be useful when faced with a type II injury, as it can aid adequate exposure and accurate reduction of the carpus.

The four patients with open injuries had an average arc of motion and scores that were less than those in patients with closed injuries. Two patients had poor and two had fair results. This concurs with the findings of Nyquist and Stern (1984), whose study of open radiocarpal fracture-dislocations suggested poor outcomes for these injuries. However, none of our four patients with open wounds has changed occupation and all have very limited disability.

After anatomical repair and stable fixation, a satisfactory clinical outcome can be achieved. Open injuries and type II injuries do not display results that are as good as those in closed injuries or type I injuries. Clinical scores and degenerative changes do not appear to be related to functional outcomes.

REFERENCES


