Initial shortening and internal fixation in combination with a Sauvé-Kapandji procedure for severely comminuted fractures of the distal radius in elderly patients

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We identified 11 women with a mean age of 74 years (65 to 81) who sustained comminuted distal radial and ulnar fractures and were treated by volar plating and slight shortening of the radius combined with a primary Sauvé-Kapandji procedure.

At a mean of 46 months (16 to 58), union of distal radial fractures and arthrodesis of the distal radioulnar joint was seen in all patients. The mean shortening of the radius was 12 mm (5 to 18) compared to the contralateral side. Flexion and extension of the wrist was a mean of 54° and 50°, respectively, and the mean pronation and supination of the forearm was 82° and 86°, respectively. The final mean disabilities of the arm, shoulder and hand score was 26 points. According to the Green and O’Brien rating system, eight patients had an excellent, two a good and one a fair result.

The good clinical and radiological results, and the minor complications without the need for further operations related to late ulnar-sided wrist pain, justify this procedure in the elderly patient.

Severely comminuted unstable distal radial fractures (DRF) often occur in association with comminuted fractures of the distal ulna (DUF) at the level of the ulnar neck or head. In the case of an open fracture, the wound is usually at the ulnar side of the distal forearm, adjacent to the ulnar head. These injury patterns are accompanied by large metaphyseal defects in the radius and the ulna and involving the distal radio-ulnar joint (DRUJ).

A common difficulty in maintaining reduction is the large metaphyseal defect after restoration of the length of the radius and ulna. In order to overcome this, corticocancellous iliac bone graft may be used to restore length and prevent metaphyseal collapse. If bone graft is to be avoided, resection of the fracture fragments is undertaken with slight shortening of the radius.

A further difficulty is reduction and fixation of the small fragments of the distal ulna. Although after reduction and fixation of a distal radial fracture the associated ulnar fracture is usually stable, some remain displaced or unstable. Failure to achieve stable anatomical reduction and congruity of the DRUJ compromises the ability to re-establish ulnar variance and stability of the DRUJ, which may cause local dysfunction, nonunion of the distal ulna, ulnar-sided wrist pain and post-traumatic arthritis. Although options of internal and external fixation have been described to treat these fractures, poor functional results, high complication rates, problems at the DRUJ and limited movement of the wrist and rotation of the forearm are predicted, requiring secondary salvage operations such as the Darrach or Sauvé-Kapandji procedure.

Despite emphasising the complications and disability of the forearm after inadequate treatment of patients with unstable comminuted distal radial and ulnar fractures, some authors have reported satisfactory results using salvage procedures undertaken primarily.

The purpose of this study was to evaluate the radiological and functional results of the treatment of comminuted distal radial and ulnar fractures by volar plating of the former combined with a primary Sauvé-Kapandji procedure.

Patients and Methods

Following institutional review board approval, a retrospective review of the radiological and clinical records between 1991 and 2000 identified 11 women with a mean age of 74 years (65 to 81) who sustained an unstable radial fracture in association with comminuted distal ulnar fracture and were treated by volar plating of the radial fracture and a primary Sauvé-Kapandji procedure. The indication for operation was severely comminuted fractures...
of the distal radius and ulna with involvement of the DRUJ and where, intra-operatively, the radial fracture had been fixed with shortening without the use of bone graft, and where the associated ulnar fracture could not be reconstructed to achieve neutral ulnar variance and satisfactory congruity of the DRUJ (Figs 1a and 1b). In ten patients the operation was performed on the day of injury. One was referred late and operated on 20 days after injury.

The cause of injury in all cases was a fall. The left wrist was involved in five patients and the right wrist in six. The dominant wrist was affected in seven patients. There were no associated injuries, and no patient had previous injuries to the wrist.

All the radial fractures were unstable with dorsal angulation > 20°, extensive dorsal comminution, lack of cortical support and an intra-articular step-off > 2 mm. All were classified pre-operatively by CT and conventional radiographs. According to the AO/ASIF classification, three fractures were A3, four C2 and four C3. According to the classification of ulnar fractures of Biyani et al there were two B1, two B2, four B3 and three B4 fractures. Seven patients had closed fractures and four a second-degree open fracture. All patients were available for assessment at a minimum of one year post-operatively, with a mean follow-up of 46 months (16 to 58).

The assessor of the radiological outcome was not a member of the surgical team and was blinded to the functional outcome. Standard anteroposterior (AP) and lateral radiographs were taken, and assessment included measurement of palmar tilt, radial inclination, radial length and ulnar variance, immediately post-operatively and at two and six weeks, three and six months, one year, and at the final follow-up. The values for the uninjured contralateral side were measured from AP and lateral radiographs at the final follow-up examination. Palmar tilt was expressed as the number of degrees from the neutral position. Union of the fracture was defined as bone bridging at the fracture site of the distal radius and arthrodesis at the DRUJ as seen in AP and lateral projections within three months of surgery.

Post-traumatic arthritis was classified using the radiological system of Knirk and Jupiter. Functional outcome was assessed by an orthopaedic specialist physiotherapist who was not blinded to the method of treatment, as the surgical scars could easily be seen. The assessment included measurement with a goniometer of the active range of extension and flexion of the wrist and pronation and supination of the forearm. The power of grip was measured with a dynamometer (Jamar; Therapeutic Equipment, Clifton, New Jersey). All clinical data were compared with the uninvolved side. Pain in the wrist was evaluated using the visual analogue scale (VAS) between zero (no pain) and 10 (severe pain). Care was taken to record discomfort in the proximal ulnar stump. The subjective functional outcome was measured using the disability of the arm, shoulder and hand (DASH) questionnaire (range 0 to 100, with 0 for the best result).

Subjective and objective data were summarised using the modified Green and O’Brien score (range 0 to 100, with 100 for the best result). All procedures were undertaken or supervised by one of the senior authors (SP, ML). The operations were performed under regional anaesthesia in six patients and general anaesthesia in five. The distal radius was exposed...
by a palmar approach along the flexor carpi radialis tendon. After release of the pronator quadratus from its radial insertion, the fracture site and the palmar surface of the distal radius were exposed. The proximal fragment was impacted into the distal fragment to neutralise the metaphyseal defect and avoid secondary axial dislocating forces. Fixation was obtained using a Volar Distal Radius Plate (KLS Martin, Mühlheim, Germany) in six cases and a 2.4 mm LCP (Synthes, Salzburg, Austria) in five. The distal screws were placed subchondrally under image intensifier control. When possible, the pronator quadratus was repaired to protect the flexor tendons. No bone graft or bone substitute was used. The arthrodesis of the DRUJ was performed via a dorso-ulnar incision. The head of the ulna was preserved and part of its distal shaft resected to match the radial shortening. The cartilage of the DRUJ was removed and arthrodesis achieved by screw fixation of the fractured ulna to the sigmoid notch in a position of neutral or slightly negative ulnar variance. The mean radial shortening was 12 mm (5 to 18) compared to the contralateral side on final radiographs (Fig. 2). Six patients (55%) had stage 1 and two (18%) had stage 2 arthritis at the radiocarpal joint, as classified by Knirk and Jupiter.18

Clinical outcome. The mean active extension of the wrist was 53.7° (30° to 70°, 87% of the uninjured side) and the mean flexion was 49.6° (25° to 65°, 79% of the uninjured side). The mean pronation of the forearm was 81.7° (40° to 90°, 94% of the uninjured side), and the mean supination was 86.3° (35° to 90°, 95% of the uninjured side). The mean grip strength was 89.0% (35% to 100%) of the uninjured side.

Seven patients (64%) were pain-free, two (18%) had mild and two (18%) had moderate pain. No patient had clinical evidence of instability of the ulnar stump. The modified Green and O’Brien score showed eight excellent results, two good and one fair. The mean DASH score at final follow-up was 22.6 points (0 to 41). There was no correlation between forearm shortening and the active ROM, grip strength, pain level, DASH or Green and O’Brien score (t-test; p = 0.07).

One patient developed carpal tunnel syndrome, which resolved with physiotherapy. Another developed a complex regional pain syndrome and calcification between the ulnar stumps. Because treatment of the fracture was delayed, the pronator quadratus muscle could not be identified and the ulnar stump was not covered. Following resection of the calcification and removal of the radial plate, full forearm rotation was achieved.

Discussion
In a complex distal radial fracture associated with a comminuted fracture of the ulna the restoration of articular anatomy, neutral ulnar variance and congruity of the distal radio-ulnar joint are critical to obtaining a good functional result and preventing post-traumatic arthritis.20

The wound in open fractures is usually close to the ulnar fracture. There is thus poor soft-tissue cover at the fracture site. The principles of open fracture management recommend sufficient soft-tissue cover of implants and preservation of the blood supply to bone. Whereas adjunctive corticocancellous iliac bone grafting is recommended in isolated closed distal radial fractures,3 this is not the case with open fractures, because of the need for an additional incision, a longer operation and the limited amount of bone...
leaving the ulnar fracture untreated would cause the late pain, DRUJ instability and limited rotation of the forearm.25

Instances. Ruchelsman et al11 described 11 patients with a mean age of 62 years at an average follow-up of 42 months who were treated by a Darrach procedure undertaken at the time of fixation of a distal radial fracture. The distal ulna was resected and extensor carpi ulnaris tenodesis was performed to prevent instability of the distal ulna. The mean ROM of the wrist was 53° of flexion and 52° of extension. The mean range of movement of the forearm was 81° of pronation and about 77° of supination. The mean grip strength was 90% of the contralateral side. There was no case of distal ulnar instability or ulnar carpal translation.

Because unsatisfactory anatomical restoration of the DRUJ was inevitable, we performed the Sauvé-Kapandji procedure primarily to avoid complications and the need for a secondary operation. In contrast to a primary Darrach resection, the retained ulnar head provided ulnar-sided abutment to aid stability of the fixed radial fractures.

Hori et al10 undertook a primary Sauvé-Kapandji procedure for treatment of comminuted combined distal radial and ulnar fractures in four patients with a mean age of 69 years. They used bone substitute in one patient and autogenous iliac bone graft in two to fill the metaphyseal void of the radius. The mean flexion/extension arc of the wrist was 76°, the mean pronation/supination was 135° and the mean grip strength was 64% of the contralateral side.

The functional and radiological outcomes in our study compare favourably with these studies. Of our 11 patients, ten had good or excellent results.

Instability and pain at the proximal ulnar stump might also be of concern following the Sauvé-Kapandji26 or Darrach procedure.12 By keeping the proximal ulnar stump as long as possible and covering it with pronator quadratus, instability of the ulnar stump was not observed in our study. Symptoms of ulnar impingement are more relevant in manual workers than in elderly patients.

The operation should be performed within ten days, as deterioration of pronator quadratus may prevent its use as cover for the proximal ulnar stump, and identification of the periosteum becomes more difficult.

We recognise that our study has limitations. First, it is retrospective, and second, the small cohort reflects the rarity of these injuries. Our findings do not suggest that all unstable distal radial with concomitant distal ulnar fractures should be treated by radial shortening without bone graft and in combination with a primary Sauvé-Kapandji procedure. Primary radial shortening is, however, a reliable alternative to iliac bone grafting of the radial void. The primary Sauvé-Kapandji procedure is an alternative to K-wire fixation, internal fixation using locked plates, acute Darrach resection or non-operative treatment of the comminuted unreconstructable distal ulnar fracture. As some loss of grip strength is inevitable after a Sauvé-Kapandji procedure we do not use this technique as a primary operation in young active patients.

Because of the good clinical and radiological results, and minor complications without the need for revision surgery, we believe that plating with shortening of the radius, combined with a primary Sauvé-Kapandji procedure, is a reasonable option for elderly patients with this complex injury.
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References