TREATMENT OF UNSTABLE FRACTURES OF THE DISTAL RADIUS BY EXTERNAL FIXATION

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The Roger Anderson external fixator was used in the treatment of unstable fractures of the distal radius in 52 patients, and the results evaluated after a follow-up averaging 58 months.

The indications for its use were failure to maintain adequate closed reduction using plaster, and instability of the fracture as determined by the initial radiographs. Our radiological criteria for instability included dorsal angulation of more than 20°, fractures involving the joint, radial shortening of more than 10 mm, and severe dorsal comminution.

Using the Lucas modification of the Sarmiento demerit point-rating system, we found that 46 patients (89%) had good or excellent results and six (11%) were classified as fair. There were no poor results. Seven patients (14%) developed complications. None of these affected the long-term results except in one elderly woman where the pins loosened and had to be removed.

Although the optimum treatment of Colles' fractures remains controversial, functionally good results can be expected in most patients treated by closed reduction and plaster immobilisation. There are some fractures of the distal end of the radius, however, where results are consistently poor. In particular, badly comminuted and/or intra-articular fractures present specific problems in management (Gartland and Werley 1951; Bacorn and Kurtzke 1953; Frykman 1967). It is generally agreed that although reduction of these fractures may be easy to achieve, it is extremely difficult to maintain. Shortening of the radius and reversion to the original dinner-fork deformity after a few days or weeks is a frequent complication. The problem is related to instability of the fracture due to comminution of the dorsal cortex of the radius and intra-articular components.

A variety of methods have been devised to avoid loss of reduction, including pinning the distal fragment percutaneously (DePalma 1952; Dowling and Sawyer 1961; Munson and Gainor 1981), immobilising the wrist and forearm in supination (Sarmiento *et al.* 1975), above-elbow casts, fixing the fracture fragments with

pins incorporated in a plaster cast (Bohler 1932; MacFarlane and Thomas 1937; Scheck 1962; Brady 1963; Cole and Oblatz 1966; Marsh and Teal 1972; Green 1975), using an external fixator (Anderson and O'Neil 1944; Conney, Linscheid and Dobyns 1979; Grana and Kopta 1979; Forgon and Mammel 1981), and the use of longitudinal pins (Rush and Rush 1949; Lucas and Sachtjen 1981). The basic principle in many of these methods is to provide fixed traction which prevents shortening of the radius. All have claimed success, in varying degree.

Anderson devised a technique whereby traction was achieved by inserting a Kirschner wire through the distal third of the shaft of either the first or second metacarpal and two wires proximal to the fracture site (Anderson and O'Neil 1944). Distraction was maintained by connecting the distal and proximal wires to an outrigger. At the Toronto East General and Orthopaedic Hospital a modification of this technique has been employed for the treatment of unstable Colles' fractures, and the follow-up results of 52 patients from 1968 to 1983 have been assessed.

PATIENTS AND METHODS

Between March 1968 and July 1983, 59 patients with unstable fractures of the distal radius were treated with the Roger Anderson external fixator at the Toronto East General and Orthopaedic Hospital. This represents less than 10% of all the Colles' fractures treated at our hospital.

The indications for using the Roger Anderson external fixator were failure to maintain an adequate closed reduction with plaster-cast immobilisation; and instability of the fracture as determined by the initial antero-

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posterior and lateral radiographs, indicating that plaster-cast immobilisation would probably not maintain the reduction.

Our criteria for instability on the initial radiographs included dorsal angulation of more than 20° ; fractures which involved the wrist joint; radial shortening of more than 10 mm; and severe dorsal comminution of the fracture site.

Of the 59 patients treated, follow-up was possible in 52 (88%). The follow-up ranged from 6 months to 8 years with an average of 58 months. There were 14 men and 38 women. The average age was 52 years (60 years for women and 37 for men).

Thirty patients had immediate fixation (within one day of the fracture) and 22 had delayed fixation with the Roger Anderson external fixator; the average delay was 11 days (range 3 to 17 days).

The mechanism of injury in the older women was almost always a fall on the outstretched hand. In the younger men the injury was usually more violent—motor vehicle accidents (4) and falls at work from a height of over four feet (10).

Thirteen patients (25%) had associated injuries, including two fractures of the clavicle, two fractures of the metacarpals in the contralateral limb, two undisplaced scaphoid fractures in the contralateral limb, four fractures of the surgical neck of the humerus in the ipsilateral limb, a fracture of a rib, an undisplaced radial head fracture, and a tibial fracture. In eight patients (15%) the fracture of the radius was compound.

Analysis of the original radiographs showed that there were four Smith's fractures (volar displacement of the distal fragment), one Barton's fracture (proximal displacement of the carpus accompanied by a fragment of the radius, including part of the articular surface) and 47 Colles' fractures (dorsal displacement of the distal fragment). All the fractures showed a moderate to severe amount of comminution.

Using Frykman's (1967) classification (Table I), 40% of the fractures were Type VIII, 40% were Type VII, and the remaining 20% were distributed equally between Types IV, V, and VI.

The initial mean dorsal angulation was 27° (range 10° to 53°), the initial mean shortening of the radius was 10 mm (range 3 to 20 mm), and the initial mean radial angulation was 6° (range -16° to $+24^\circ$). In the normal wrist there is 10° of volar and 22° of radial angulation (van der Linden and Ericson 1981).

Technique (Figs 1 and 2). The external fixator is applied in the operating room under sterile conditions. We use general anaesthesia for most patients, but we have also used regional lidocaine block or axillary block with good results. The pins are of 2.3 mm diameter. Anderson's technique has been slightly modified in that two pins are inserted at 90° to one another and at 45° to the second metacarpal shaft. This is done only after flexing the metacarpophalangeal joints to 90° to prevent tethering

Table I. Frykman's (1967) classification of fractures

Type	Fracture
I	Extra-articular, no fracture of ulna
II	Extra-articular, fracture of ulna
III	Intra-articular radiocarpal, no fracture of ulna
IV	Intra-articular radiocarpal, fracture of ulna
V	Intra-articular radio-ulnar, no fracture of ulna
VI	Intra-articular radio-ulnar, fracture of ulna
VII	Intra-articular radiocarpal and radio-ulnar, no fracture of ulna
VIII	Intra-articular radiocarpal and radio-ulnar, fracture of ulna

of the intrinsic muscles, which may occur if the fingers are extended at the time of pin insertion. Pins are then inserted in a similar fashion proximally (in the distal third of the radius). All four pins are connected to an outrigger after reduction of the fracture. The clamps holding the interconnecting rods are then tightened and sterile dressings are applied to the pin sites.

Fig. 1

Fig. 2

Figure 1—Equipment used for application of the external fixator: hand drill, Crowe pins, connecting rods, clamps, wrench, and screwdriver. Figure 2—External fixator applied to the wrist with two pins in the second metacarpal connected to two pins in the radius via two connecting rods.

Postoperatively the hand is elevated, the neurovascular status is closely monitored, and the patient is instructed in exercises for the fingers, elbow and shoulder.

The average stay in hospital after operation was four days (range 1 to 14 days). The apparatus was left on for approximately eight weeks.

RESULTS

Fifty-two patients with an average follow-up of 58 months were evaluated with the Lucas modification of the Sarmiento demerit point-rating system (Table II; Sarmiento *et al.* 1975; Lucas and Sachtjen 1981). Using this scale, 15 patients (29%) were found to have excellent results, 31 (60%) good results, and six patients (11%) were classified as fair. There were no poor results.

Subjectively, 44 patients (85%) were fully satisfied, three patients (6%) were partially satisfied, and five patients (9%) were unsatisfied with their final result. Of the three patients who were only partially satisfied, one had occasional wrist pain in damp weather or with over-exertion, one had pain at the site of insertion of the pin in the second metacarpal, and one had pain over the distal radio-ulnar joint. No patient had a significant decrease in functional capacity. All five unsatisfied patients had severe almost continuous pain in the wrist; but their rating in the non-subjective categories raised them above the "poor" results. All patients who were working returned to their usual work.

Table II. Demerit point-rating system*

Results	Demerit points
<i>Residual deformity</i>	
Prominent ulnar styloid	1
Residual dorsal tilt	2
Radial deviation	2-3
<i>Subjective</i>	
Excellent (no pain)	0
Good (rare pain)	2
Fair (occasional pain)	4
Poor (frequent or constant pain)	6
<i>Objective</i>	
Loss of dorsiflexion	5
Loss of ulnar deviation	3
Loss of supination	2
Loss of volar flexion	1
Loss of radial deviation	1
Pain in distal radio-ulnar joint	1
Loss of pronation	2
<i>Complications</i>	
Minimal arthritis	1
Minimal arthritis with pain	3
Moderate arthritis	2
Moderate arthritis with pain	4
Severe arthritis	3
Severe arthritis with pain	5
Median nerve impairment	1-6
Finger stiffness	1-6
Reflex sympathetic dystrophy	1-6
<i>End-result</i>	
Excellent	0-2
Good	3-6
Fair	7-18
Poor	19 and more

* From Sarmiento *et al.* (1975), modified by Lucas and Sachtjen (1981)

Fig. 3

Fig. 4

Fig. 5

Fig. 6

Figures 3 and 4—Initial anteroposterior and lateral radiographs of an unstable Colles' fracture (Frykman VIII) in a 72-year-old woman; this injury was caused by a fall at home. Figures 5 and 6—Radiographs after reduction, with the fracture held securely by the Roger Anderson device.

Fig. 7

Fig. 8

Fig. 9

Fig. 10

Fig. 11

Fig. 12

Figures 7 and 8—Initial anteroposterior and lateral radiographs of an unstable Colles' fracture with articular involvement in a 29-year-old man; the injury was caused by a 12-foot fall at work. Figures 9 and 10—Anteroposterior and lateral views after reduction, with the Roger Anderson external fixator applied. Figures 11 and 12—Follow-up radiographs eight weeks after removal of the fixator device.

Wrist movements were measured and as compared with the uninjured side (in brackets) showed an average dorsiflexion of 54° (64°), palmarflexion 48° (60°), radial deviation 19° (22°), ulnar deviation 32° (40°), pronation 80° (85°), and supination 73° (80°). There was restriction of flexion of the metacarpophalangeal and proximal interphalangeal joints of the index and middle fingers in seven patients and limited extension of the same fingers in two patients.

We were able to obtain serial radiographs of 34 patients (65%) and found that, after reduction, 16

patients (47%) had a Grade I fracture (no deformity, no dorsal angulation beyond neutral and shortening of 3 mm or less). Sixteen patients (47%) had a Grade II fracture with slight deformity or none (dorsal angulation of 1° to 11° and shortening of 6 to 12 mm), one patient had a Grade III with mild to moderate deformity (dorsal angulation of 11° to 15° and shortening of 6 to 12 mm), and one patient had a severe deformity (more than 15° of dorsal angulation or more than 12 mm of shortening). The final volar angulation averaged 2° (range 12° volar to 28° dorsal); the normal volar tilt is 10° but these patients initially had an average of 27° dorsal angulation. The final radial angulation averaged 20.5° (range 0° to 30°); the normal radial angulation is 22° but these patients initially had an average of 6°. The average final amount of shortening was 1.8 mm (range from 0 to 10 mm) compared with an average initial shortening of 10 mm (Figs 3 to 6, and 7 to 12).

Complications. Seven patients (14%) developed complications. Two patients experienced irritation of the dorsal sensory branch of the radial nerve; in one symptoms sub-

sided spontaneously, but the other continues to have paraesthesia over the dorsum of the thumb. One patient had a secondary undisplaced fracture of the radius through the site of a radial pin one year after operation; this fracture healed uneventfully. One patient developed a superficial pin-track infection which responded to antibiotics; the Roger Anderson device did not need to be removed. In two patients a pin broke in the medullary canal of the radius during insertion but there have been no problems from this as yet. One 82-year-old woman, who was very osteoporotic, suffered loosening of her pins and at two weeks the Roger Anderson device had to be removed; she was treated by immobilisation in a plaster cast but was left with 10 mm of shortening of the distal radius and significant deformity of the wrist. None of the patients developed median nerve compression or reflex dystrophy.

DISCUSSION

Unstable comminuted fractures of the distal radius present a major problem in terms of stability and methods of immobilisation. The overall results of treatment by our modification of Roger Anderson fixation have been good in nearly 90% of cases. Although the Roger Anderson apparatus was designed to allow early movement of the elbow, forearm and fingers, restricted movement of the wrist and fingers may occur; the restriction of finger movement is perhaps the more disabling and occurred in seven patients (13%).

The cause of this restricted movement is not obvious, but we believe it may be due to two factors. If, when the metacarpal pins are inserted, the fingers are extended, tethering of the intrinsic muscles may occur, thereby limiting finger flexion; secondly, attempts to secure better fixation by inserting the pins across the second web space into the shaft of the third metacarpal may tether and cause subsequent scarring of the dorsal interossei, restricting movement of the index and middle fingers—insertion of the distal pins should probably be confined to the cortices of the second metacarpal. It should be noted, however, that restriction of movement involving primarily the index and middle fingers has been observed as a complication of Colles' fractures treated by casting techniques, so that the case for incriminating the pins is by no means complete.

We found an excellent cosmetic result in all but two of our patients. In one of these the external fixator had to be removed because of pin loosening in osteoporotic bone at two weeks.

Although wrist movement was not always restored to normal, we found that, compared with the uninjured wrist, our patients regained between 80% and 90% of movement. This good functional result reflects the maintenance of the original anatomical reduction afforded by the external fixator. We agree with Conney *et al.* (1979) that unstable Colles' fractures require firm fixation to prevent shortening and deformity.

It has been suggested in the literature (Grana and Kopta 1979) that the external fixator is only warranted in younger patients with strong bony cortices. Our experience does not substantiate this, as we found only one instance of pin loosening out of 25 patients over the age of sixty.

Finally, we would recommend that the Roger Anderson external fixator be left in for eight weeks rather than four to six weeks as some advocate, because of the severe amount of comminution found in these patients. In our series, 80% of the fractures were classified as Frykman's Types VII and VIII, indicating instability.

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