

## Intraarticular Osteotomy of Distal Radial Malunions

*Robert G. Marx, MD; and Terry S. Axelrod, MD, MSc*

Failure to reduce intraarticular fractures of the distal radius to less than 2 mm of residual articular incongruity often will lead to post-traumatic arthrosis. Intraarticular osteotomy of the distal radius was performed for intraarticular malunions with a step greater than 2 mm in the distal radial articular surface, in the absence of arthrosis. The technique involves careful recreation of the fracture into the joint and rigid internal fixation of the osteotomy site. Four patients were followed up at an average of 23 months postoperatively (range, 12-43 months). All patients treated with this operation were satisfied with their results and their wrists were functioning well at the time of review. All had good or excellent Gartland and Werley functional wrist scores. Further followup is required to document the long term outcome of these patients.

Fracture of the distal radius is a common injury.<sup>1</sup> There are many ways to classify these injuries.<sup>6,8,18,19</sup> The anatomic type of the fracture can be defined as intraarticular or extraarticular,<sup>14</sup> with intraarticular fractures extending into the radiocarpal or distal radioulnar joint. They may involve cartilage

disruption and the subsequent development of degenerative arthrosis. Failure to reduce a displaced intraarticular fracture adequately often will lead to posttraumatic arthrosis.<sup>3,5,15,16,20</sup> Displaced intraarticular fractures with greater than 2 mm of residual articular incongruity will lead to arthrosis in almost all cases.<sup>12</sup> Hastings and Leibovic,<sup>10</sup> in a review of 50 distal radial fractures, found that articular incongruities of 2 mm or greater were associated with poor results. No poor results were seen in the group they evaluated with less than 2 mm of residual incongruity.

Because extraarticular distal radial fractures are so common, extraarticular malunion of the distal radius is not an unusual occurrence. Corrective osteotomy for this problem has been described by several authors.<sup>2,7,11,13</sup> If closed techniques fail to reduce the joint surface with a fresh fracture, appropriate treatment involves open reduction and internal fixation or limited open reduction with external fixation.<sup>3,4</sup> Late reconstructive procedures for an established intraarticular malunion of the distal radius include intraarticular osteotomy, limited or total wrist arthrodesis or simple observation, awaiting the inevitable arthrosis.

The authors describe a technique for correction of intraarticular malunions and the early results of treatment for a retrospective case series.

From the Sunnybrook Health Science Center, Division of Orthopaedic Surgery, North York, Ontario, Canada. Reprint requests to Terry S. Axelrod, MD, MSc, Sunnybrook Health Science Center, Division of Orthopaedic Surgery A315, 2075 Bayview Avenue, North York, Ontario, Canada M4N 3M5.

## MATERIALS AND METHODS

### Indications

Intraarticular osteotomy of the distal radius was performed for intraarticular malunions with a joint surface step of greater than 2 mm in the distal radial articular surface, in the absence of arthrosis. The patients in this study were generally young, active, high demand individuals. This group of patients would be served poorly by observation alone followed by late wrist arthrodesis for arthrosis.

### Patient Demographics

Intraarticular osteotomy of the distal radius was performed on 4 consecutive patients by the senior author. All patients were seen for followup. Their ages ranged from 26 to 67 years with an average of 42 years. Followup time averaged 23 months (range, 12–43 months). Two patients were male and 2, female. Only 1 patient had his or her dominant hand affected. All patients had a healed, intraarticular fracture of the distal radius with at least 2 mm of residual radiocarpal joint incongruity. The osteotomy was performed between 4 weeks and 18 months after fracture. Two individuals had displaced intraarticular fractures of the distal radius in association with a scapholunate dissociation. One was treated with an intraarticular osteotomy and a Blatt tenodesis. The other patient was only 1 month postinjury and thus underwent primary ligament repair in conjunction with osteotomy (Fig 1). Although 4 weeks is a relatively short time for the establishment of a well healed malunion, impacted metaphyseal bone heals quickly and this injury was found to be solidly united at surgery. Another patient had a complex intraarticular fracture treated with external fixation. He presented 18 months after fracture with a painful malunion and ulnocarpal impingement. He underwent corrective osteotomy of the distal radius and an ulnar shortening osteotomy. The other patient had an isolated intraarticular malunion without associated pathology (Fig 2).

### Technique

Adequate imaging of the malunion is an important first step in the planning of a corrective intraarticular osteotomy of the distal radius. Tomograms or computed tomography (CT) scans

with sagittal reconstruction (1 mm cuts) are useful. Jupiter et al<sup>11</sup> has described the use of computer generated bone models for preoperative planning in complex osteotomies. The internal fixation should be planned before surgery aided by a drawing of the fracture.<sup>17</sup> If there is uncertainty regarding the condition of the articular cartilage, arthroscopy of the wrist may be indicated.

The distal radius usually is approached dorsally with a longitudinal incision between the third and fourth extensor compartments. The dissection is continued through the third compartment, and the extensor tendons are reflected ulnarly without violating the fourth compartment. The exposure of the distal radius is continued distally into the dorsal wrist capsule. The wrist is opened with a T shaped incision to expose the distal radial articular surface. A palmar approach using the interval between flexor carpi radialis and the radial artery is preferable in selected cases, such as a malunited volar Barton's fracture.

A dull instrument is used to distinguish between hyaline cartilage and fibrocartilage. The fibrocartilage, which feels softer, should be removed with care to appreciate the articular step. The metaphyseal fracture scar is identified to recreate the primary extraarticular fracture. It is useful to pass 2 or 3 small (1.1 mm) Kirschner wires (K wires) along the plane of the fracture at 2 or 3 sites, beginning at the extraarticular component and exiting within the joint, to ensure that the correct plane is identified. After radiographic confirmation of the K wire placement, the osteotomy is performed. It is done through the old fracture site into the joint using a 3- or 4-mm wide osteotome. Reduction is monitored by direct vision and radiographs. The use of intraoperative fluoroscopy is useful. Provisional fixation of the osteotomy is with K wires. Definitive fixation follows AO/Association for the Study of Internal Fixation principles using lag screws or a dorsal buttress plate wherever possible. The smaller 2-mm and 2.7-mm plate designs can be very useful.

If the osteotomy creates a large metaphyseal defect, bone graft from the iliac crest is used to act as an additional buttress. This is usually not required because the osteotomy created is usually of the oblique variety, leaving broad cancellous surfaces in contact after reduction. If scapholunate instability is present, it should be addressed with a ligament repair if the injury is recent, or a reconstructive procedure if the injury is old.



**Fig 1A-C.** Patient 1 is a 67-year-old housewife referred to the senior author at 1-month postinjury. (A) The radiographs demonstrate a 6 to 7 mm articular step with proximal migration of the scaphoid facet (B and C). The patient was treated with open reduction, internal fixation, and a scapholunate ligament repair.

#### Followup and Patient Evaluation

Followup consisted of a history, a physical examination, and a patient administered questionnaire. The questionnaire incorporated visual analog scales for severity of pain and weakness and

asked the patients about the frequency of the pain, the duration of the pain, and the use of analgesia. The questionnaire also asked whether the patients had difficulty with leisure activities, socializing, sports, work duties, or working their usual amount. Gartland and Werley scores<sup>9</sup> were



**Fig 2A-C.** Patient 2 is a 29-year-old female computer operator referred to the senior author at 1-year postinjury. (A) She had 2-mm articular step and eroded cartilage on the ulnar side of the scaphoid facet noted at operation. (B) The patient underwent open reduction and internal fixation with a single screw supplemented by a K wire. (C) She had her hardware removed because of soft tissue irritation.

calculated for each patient. All patients had radiographs of the affected wrist taken at the time of followup to assess union, development of arthrosis, and position of fixation.

### RESULTS

All osteotomies healed both clinically and radiographically. There were no infections or neurovascular complications. One patient had her hardware removed at 1 year postoperatively because of soft tissue irritation.

The average grip strength was 86% compared with the strength of the uninvolved hand (range, 79%–94%). Thumb and key pinch strength averaged 88% of the uninvolved hand (range, 73%–98%). The Gartland and Werley scores were excellent (score of 1) for 1 patient and good (scores of 3, 4, and 4) for the remaining 3 patients (Table 1). Radiographs showed restoration of intraarticular anatomy in all patients (Figs 1,2). No patient had evidence of advanced arthrosis.

### Pain

The average visual analog score for severity of pain (range, no pain = 0 to worst pain ever = 100) was 25 (range, 0–86). The average visual analog score for weakness (range, no weakness = 0 to extreme weakness = 100) was 17 (range, 2–31). Two of the patients reported no pain. The other 2 patients stated that they had pain 2 to 3 times per day for less than 10 minutes at a time. Three of the patients stated that they used no analgesics, whereas the fourth patient reported using acetaminophen once or twice daily for her wrist discomfort (Table 1).

### Activities

Two patients had a little difficulty participating in their usual activities, whereas the other 2 had no difficulty. All patients stated that they had no difficulty socializing with friends and family. One patient had no difficulty participating in his or her usual sporting activities, 1 had a little difficulty, and a

TABLE 1. Patient Outcomes

Outcome Variable	Patient 1	Patient 2	Patient 3	Patient 4
Grip strength (compared with other hand)	94%	81%	79%	91%
Average of tip and key pinch strength (as compared with other hand)	73%	83%	97%	98%
Gartland and Werley score	4 (good)	3 (good)	1 (excellent)	4 (good)
Visual analog pain score	9/100	86/100	0/100	3/100
Visual analog weakness score	9/100	31/100	2/100	25/100
Analgesia use	acetaminophen	no	no	no
Pain frequency	2 to 3 times per day	2 to 3 times per day	no	no
Pain duration	<10 minutes	<10 minutes	no pain	no pain
Usual activities	no difficulty	mild difficulty	no difficulty	no difficulty
Social activities	no difficulty	no difficulty	no difficulty	no difficulty
Sporting activities	not applicable	moderate difficulty	no difficulty	mild difficulty
Return to work	yes	yes	yes	changed job because of brain tumor
Difficulty completing usual duties at work or home	no difficulty	mild difficulty	no difficulty	no difficulty
Difficulty working usual amount of hours	moderate difficulty	not applicable	no difficulty	mild difficulty

third had moderate difficulty. The fourth patient did not participate in sporting activities before injury (Table 1).

### Work

All patients were able to return to their usual work except 1 individual who had a brain tumor diagnosed and resected 3 months post-operatively and was left with right sided weakness. He was a carpenter and subsequently gained employment as a graphic designer. Three of the patients had no difficulties completing their usual duties at work (including work as a homemaker) and 1 had a little bit of difficulty. One patient had no difficulty working his usual amount of hours, 1 had a little difficulty, and a third had moderate difficulty. The fourth patient indicated that this question was not applicable because she recently had been laid off work for reasons unrelated to her wrist (Table 1).

### DISCUSSION

Intraarticular malunions of the distal radius with a step of 2 mm or more predisposes the patient to the development of posttraumatic arthrosis.<sup>12</sup> The patient's chances for a satisfactory outcome are maximized by prompt recognition and appropriate early treatment of the original injury.<sup>3,4</sup>

The intraarticular malunion is corrected by careful recreation of the fracture with an osteotome. Bone graft from the iliac crest is used if necessary. Internal fixation is with a buttress plate, screws, and K wires as required. The procedure is technically demanding and requires meticulous preoperative planning.

Contraindications include evidence of arthrosis, documented either by radiography or arthroscopy, elderly patients with low demand, and anatomic factors that would complicate the reconstruction, such as poor bone stock or a mutilating soft tissue injury.

Early correction of the malunion is preferable because it is technically easier to work with more compliant soft tissues and there is

less cartilage wear. The surgeon should plan to experience difficulty reestablishing the fracture plane as early as 4 weeks after the injury because of the rapid healing of impacted cancellous bone.

The early results of treatment by this technique are encouraging. The patients were satisfied with the results of the operation and their wrists were functioning well at an average followup time of 23 months. The intraarticular anatomy of the distal radius was restored in all cases. Extended followup is required to document the long term outcome of these patients. The authors think that this is the procedure of choice for individuals with an intraarticular malunion of the distal radius.

### References

1. Alffram P, Bauer GCH: Epidemiology of fractures of the forearm. *J Bone Joint Surg* 44A:104-114, 1962.
2. Amadio PC, Botte MJ: Treatment of malunion of the distal radius. *Hand Clin* 3:541-559, 1987.
3. Axelrod T, Paley D, Green J, McMurtry RY: Limited open reduction of the lunate facet in comminuted intra-articular fractures of the distal radius. *J Hand Surg* 13A:372-377, 1988.
4. Axelrod TS, McMurtry RY: Open reduction and internal fixation of comminuted, intraarticular fractures of the distal radius. *J Hand Surg* 15A:1-11, 1990.
5. Bradway JK, Amadio PC, Cooney WP: Open reduction and internal fixation of displaced, comminuted intra-articular fractures of the distal end of the radius. *J Bone Joint Surg* 71A:839-847, 1989.
6. Cooney WP, Linscheid RL, Dobyns JH: External pin fixation for unstable Colles' fractures. *J Bone Joint Surg* 61A:840-845, 1979.
7. Fernandez DL: Reconstructive procedures for malunion and traumatic arthritis. *Orthop Clin North Am* 24:341-363, 1993.
8. Frykman G: Fracture of the distal radius including sequelae-shoulder hand finger syndrome, disturbance in the distal radio-ulnar joint and impairment of nerve function. *Acta Orthop Scand* 108 (Suppl): 1-155, 1967.
9. Gartland JJ, Werley CW: Evaluation of healed Colles' fractures. *J Bone Joint Surg* 33A:895-907, 1951.
10. Hastings H, Leibovic SJ: Indications and techniques of open reduction. *Orthop Clin North Am* 24:309-326, 1993.
11. Jupiter JB, Ruder J, Roth DA: Computer-generated bone models in the planning of osteotomy of multi-directional distal radius malunions. *J Hand Surg* 17A:406-415, 1992.

2. Knirk JL, Jupiter JB: Intra-articular fractures of the distal end of the radius in young adults. *J Bone Joint Surg* 68A:647-659, 1986.
3. McMurtry RY, Axelrod TS, Paley D: Distal radius osteotomy. *Orthopedics* 12:149-155, 1989.
4. McMurtry RY, Jupiter JB: Fractures of the Distal Radius. In Browner BD, Jupiter JB, Levine AM, Trafton PG (eds). *Skeletal Trauma*. Philadelphia, WB Saunders 1063-1094, 1992.
5. Melone CP: Articular fractures of the distal radius. *Orthop Clin North Am* 15:217-236, 1984.
6. Melone CP: Open treatment for displaced articular fractures of the distal end of the radius. *Clin Orthop* 202:103-111, 1986.
17. Muller ME, Allgower M, Schneider R, Willenegger H: Preoperative, Operative and Postoperative Guideline Manual of Internal Fixation. New York, Springer 134-136, 1979.
18. Muller ME, Nazarian S, Koch P, Schatzker J: Distal Segment of the Radius and Ulna. *The Comprehensive Classification of Fractures of Long Bones*. Berlin, Springer 106-115, 1990.
19. Older TM, Stabler EV, Cassebaum WH: Colles fracture: Evaluation and selection of therapy. *J Trauma* 5:469-476, 1965.
20. Szabo RM: Comminuted intraarticular fractures of the distal radius. *Clin Orthop* 230:39-48, 1988.