Winter 2007

First Hand News

Topics in Upper Extremity Care

A publication of the Christine M. Kleinert Institute for Hand and Microsurgery, Inc.

Fractures of the Distal Radius Part 2

Editors note: This is the final installment in the two-part Distal Radius Fractures series

Treatment Options

There are a wide variety of fracture patterns that occur in the distal end of the human radius. This variation is based on the force and direction of the load creating the fracture, the position of the wrist at the time of impact, and the quality of the bone and its surrounding soft tissue supportive structures. No one treatment modality is applicable to all fractures of the distal radius. The fundamental principle of treatment is the restoration of anatomy, to restore congruity to the radio-carpal and distal radio-ulnar joint surfaces, and to restore and maintain the length of the radius, with the hope of producing full, painless motion of the wrist. The initial consideration of treatment options after fracture of the distal radius must be made in the context of the patient's needs and functional requirements. Appropriate management of fractures in the region should also take into account the specific characteristics of the individual fracture pattern.

Fractures of the distal radius require an anatomic reduction, as even minimal step-offs are associated with the development of osteoarthritis. Optimal management requires careful assessment of important fracture characteristics such as displacement, stability, and reducibility. The vast majority of fractures (75% to 80%) at the distal end of the radius are extra-articular. They are effectively treated by closed manipulative reduction and external plaster support. Marked displacement with extensive metaphyseal comminution renders the fracture highly unstable and refractory to successful articular restoration by closed reduction alone. Excessive offset, gapping, impaction, and tilting of key articular components are signs of an injury apt to prove irreducible by all methods of closed management. They should be stabilized by some type of fixation device, whether external, internal, or both.

Fractures that involve the radiocarpal articular surface require individual assessment and a treatment program tailored to the specific nature of the injury pattern to secure fracture reduction and ensure uncomplicated healing. There are many different treatment options that can be utilized in an effort to restore anatomy and congruency of the articular surfaces, including closed reduction and splinting, k-wire fixation, external fixation, augmented external fixation and formal open reduction, and internal fixation through either a dorsal or volar approach. The methods used will depend on many factors, including the surgeon's experience and training and the fixation devices available to them. Not all treatments are appropriate for all fracture patterns, and adequate reduction of the fracture must be accomplished in the first instance. The aggressiveness with which we approach the fracture must be tempered by the patient's age, functional limits, and general medical condition.

Conservative treatment of distal radius fractures in adults is recommended and reliable for nondisplaced extra-articular and intra-articular fractures, for displaced fractures that remain stable following closed reduction, and for certain unstable fractures in elderly patients. The aims of conservative treatment are to obtain and maintain anatomic realignment of the fracture for a period of 6 weeks, the time at which bony union is well advanced, so that the risk for secondary displacement at that stage is minimal. In closed reduction techniques, once the fracture fragments are disimpacted, each component of the fracture displacement should be reduced. This technique utilizes ligamentotaxis (fracture reduction through intact ligaments) to restore anatomic relationships. The position of the distal fragment

Objectives

After reading this issue you should be able to:

- LIST treatment options for fractures of the distal radius
- DISCUSS techniques for internal fixation of distal radius fractures
- LIST complications of fractures of the distal radius
- DISCUSS rehabilitation issues for fractures of the distal radius

is maintained indirectly by external cast contact, by tension on soft tissue structures, and by the hydraulic pressure of the soft tissue envelope. For plaster immobilization one should try to adapt the position of the hand and wrist to a position that is directly opposite to the displacement that occurred in producing the original deformity. Some form of three-point fixation is needed, with a dorsal splint holding the wrist in slight flexion (10 to 20 degrees) and ulnar deviation (15 degrees). However, neither the position of immobilization nor extension above the elbow appear to influence the anatomic outcome. Maintenance of fracture alignment depends mostly on the inherent characteristics of a given fracture (e.g. initial displacement, comminution, bone quality). The length of immobilization varies from 3 to 6 weeks.

In spite of performing a reduction and applying a plaster, and regardless of the position of immobilization, the reduction of some distal radius fractures cannot be predictably maintained with the use of splints or circular plasters alone. For this reason, many have advocated skeletal fixation. Many forms of internal skeletal fixation have been advocated for the maintenance of reduction of distal radius fractures. These include percutaneous pins, compression screws, tension band wires, Rush rods, and plate fixation.

Plates have the advantage of providing secure fixation throughout the entire healing process without protruding wires or pins, and they allow early and intensive forearm, wrist, and digital exercises. These advantages may offset disadvantages that include additional operative trauma, fragment devascularization, and some additional risk for wrist stiffness; occasional tendon rupture; and at times, plate removal. New developments in plate and screw design and operative strategies, fragment specific fixation, and plate strength have improved results with plate fixation. Fixed angle blades as well as locking screws and pegs enhance overall plate stability and support the articular surface of the distal radius. Plates must be matched to the fracture configuration and selected according to the surgeon's judgment and skills.

Technique

Our practice has moved towards the rigid internal fixation of unstable distal radial fractures. We currently favor fixed angle plate screw systems (where the screws or pegs lock into the plate). These devices provide initial fixation and prevent any collapse of the fracture later. These are placed using a volar approach. This is because of superior results when compared to the dorsal plating systems that we have used (Smith et al, 2005). The volar aspect is a better choice for implant application for the following reasons: more space is available, because flexor tendons are located far from the volar radial surface and the pronator quadratus is conveniently interposed, protecting the plate; the concave surface of the distal radius protects flexor tendons from hardware irritation, causing less tendon adherence postoperatively; blood supply is less likely to be disturbed by a volar approach; the volar cortex usually is less comminuted, facilitating volar osteosynthesis; less contouring of the plate is necessary; and finally, volar scars are better tolerated.

Using either general anesthesia or a brachial plexus block and upper arm tourniquet, the surgeon exposes the fracture through a volar longitudinal approach. The approach is immediately over the flexor carpi radialis tendon (FCR) beginning at the palmar flexion crease and coursing proximal for 8cm to 10cm. The tendon is exposed and the sheath of the tendon is opened in a longitudinal manner. The FCR can then be retracted ulnarly. This will reveal fat and, more proximally, the musculotendinous portion of the flexor pollicis longus (FPL) muscle. These structures can be swept ulnarly with a sponge to reveal the pronator quadratus. The pronator quadratus can be released from the radial aspect of the radius and elevated in an ulnar direction to reveal the underlying fracture. If more exposure is required and the radial styloid is not easily reduced, the bracial radialis tendon (BR) can be detatched from the radial styloid. This should have exposed the volar surface of the fracture. The fracture can now be reduced. A periosteal elevator is used to lever the distal fragment back onto the proximal radius while the fracture fragments are being distracted. The reduction should be checked with an image intensifier. Once the reduction has been obtained, a distal radial plate is applied. If desired, temporary fixation can be achieved at this point with a 1.6mm k-wire through the radial styloid. If

Fig 1. shows a common distal radius fracture. Fig 2. is a post operative view with a volar plate.

a radiograph reveals an anatomic reduction, the remainder of the screws are applied.

The exact way that different plating systems are used varies slightly. The key to their use is that each main fracture fragment is stabilized with at least one screw or peg that locks into the plate. The reduction and fixation can than be checked with an image intensifier.

The pronator quadratus should be repaired to cover the plate and the FCR sheath closed. At this point the tourniquet can be released to gain hemostasis and the skin closed. The patient then has a post operative splint applied. At two weeks the patient can start gentle range of movement exercises and use a removable splint for comfort (assuming that the fixation is good). At six weeks, the fracture is usually united and the patient can be managed without further support. Formal physical therapy can then be started.

Complications

Regardless of treatment, distal radius fractures continue to be associated with a high complication rate. Fractures involving the radiocarpal or distal radioulnar articular surface are especially prone to complications. The more widespread use of internal fixation and supplemental bone grafting with external fixation has decreased the incidence of malunions from close-cast treatment and percutaneous pinning, but has increased the risk of the complications specific to surgical intervention.

The complications associated that result in high unsatisfactory results are infection, persistent neuropathy, radiocarpal or radioulnar arthrosis, malposition/ malunion, nonunion, tendon ruptures and/or tendonitis, reflex sympathetic dystrophy, finger stiffness, and Volkmann's ischemia.

Infection can be minimized through judicious use of antibiotics, postoperative rehabilitation and education, and meticulous pin site care when external fixation is used. Should the fracture site itself become infected, thorough debridement and irrigation are warranted in combination with appropriate intravenous antibiotic therapy. Internal fixed devices should be removed.

Acute nerve compression or injury should be dealt with by an immediate reduction of the fracture. Median nerve damage may occur in the form of acute and late carpal tunnel syndrome, contusion, or stretch. Ulnar nerve damage has also been reported. Avoidance of injury to nerves by careful dissection through "safe planes" and visualization of nerves and their branches minimizes iatrogenic injury.

Tendon ruptures are rare, most commonly occurring within 8 weeks after the traumatic event and can be seen late after fracture healing. It is probably caused by a combination of mechanical and ischemic mechanisms. Although direct end-to-end repair is usually not possible because of tendon attrition and retraction, transfer of the extensor indicis propius or an interposed graft can reliably restore thumb extensor function after rupture. Tendonitis of the first dorsal compartment and of the extensor carpi ulnaris (ECU) can be seen. First dorsal compartment tendonitis can usually be treated with steroid injection.

Early splinting or immobilization to alleviate pain, removal or splitting of a dressing or cast to relieve pressure, elevation of an edematous hand, and/or intensive hand therapy are frequently very helpful in preventing the development of full sympathetic dystrophy. For the patient who does not respond to early local measures, sympathetic blocks, even while the cast is in place, should be considered.

Malunions of distal radius fractures may be extra-articular in the metaphyseal region or intra-articular with residual joint surface incongruity. Malunions of the distal radius may be associated with decreased range of motion, wrist pain (radiocarpal, radioulnar, and/or ulnocarpal), subluxation of the distal radioulnar joint, midcarpal instability, and post-traumatic arthritis. Of the many complications associated with distal radial fractures, post-traumatic arthritis is perhaps the most serious and disabling to the patient. Restoration of precise articular congruity and minimized disruption and "devitalization" of articular fragments through limited dissection can restore anatomy and minimize further articular damage.

Nonunion of distal radius fractures is extremely rare. Physiologic tension combined with careful assessment for need of supportive bone grating should greatly minimize the occurrence of nonunion. If the fracture fails to unite by 3 to 6 months after initial treatment, open debridement, cancellous bone grafting, and internal fixation are warranted. If the nonunion involves the radiocarpal articulation and a nonsalvageable joint results, arthrodesis of the radiocarpal joint may be warranted as a salvage procedure.

Late collapse of distal radius fractures with secondary malalignment of the carpus should be reconstituted by anatomical realignment of the distal radius. Osteotomy, plating, and bone grafting are often necessary to realign the carpus and distal radius. Rigid internal fixation and iliac crest bone grafting is used for nonunions as well. Late arthritic deformities of midcarpal instability, secondary to malunion or proximal carpal malalignment with pain, are managed surgically by proximal row carpectomy, interpositional fascial or silastic arthroplasty, or wrist arthrodesis.

Rehabilitation

In the initial stage of fracture healing there is low fracture site stiffness. The wrist splints used at this stage are static and are used for immobilization to limit unwanted motion, to prevent displacement at the fracture site, and to prevent or correct joint contractures. Protected wrist motion is initiated in this phase. In the next stage of fracture healing, increasing fracture site stiffness should be able to withstand the forces generated with light strengthening and dynamic/static progressive wrist splinting. In the last stage of fracture healing there is sufficient fracture site stability to tolerate the loads generated during gripping and lifting. Dynamic/static progressive wrist splinting continues until motion plateaus.

Treat the thumb and fingers first. To salvage thumb mobility work to maintain motor control and tissue gliding for IP motion with active motion exercises, passive motion exercises, IP mobilization, and place and hold exercises as needed. If the thumb is completely immobilized (meaning that IP is not able to move), you will just have to wait till stability of the healing fracture allows for the cast to be trimmed to allow IP motion or for the cast to be removed altogether. The fingers have the same problem as the thumb but they will have been able to move a little more. As you make gains with thumb mobility, begin employing similar treatments for the fingers. Treat the palm third. Once the cast is removed, the hand will typically be stiff and weak and will lack some intrinsic control. Opposition of the digits will usually be a challenge. Place and hold exercises, along with light putty (utilized to facilitate motor control then strength) exercises, are commonly combined with Moberg's 25 fist exercises. While all this is going on, the wrist remains in a neutral position. As the digits are moved, tendons glide across the wrist, indirectly loosening soft tissues and inhibiting adhesions. Only when the cast comes off or the external fixator is removed does the therapist allow any gentle active motion at the wrist. No direct mobilization or aggressive treatment is engaged.

Just before the cast or fixator is removed, the therapist should talk to the physician to find out how stable the healing fracture is and what the expected outcome for this patient is. The therapist should communicate to the surgeon any important information he has learned in the course of treating the patient thus far. Important information includes patient compliance and risk behavior by the patient.

At 3-6 weeks the cast or fixator will typically be removed. The physician will occasionally request an over-the-counter wrist support to be worn for an additional period of time (except when in therapy). Active and active-assistive range of motion is key at the 4-6 week period. Progression of treatment should be determined by the condition of the wrist and the amount of protection appropriate for that patient. At 6-8 weeks the therapist engages in more direct treatment to help restore motion including therapeutic exercise, mobilization, and modalities as needed. This is near the end of the primary rehabilitation phase, and progress will come slower than it did at 3-4 weeks. It is common to follow a patient in this phase of rehabilitation up to the 12-week point. By 12 weeks, soft tissue remodeling continues but most of the scar is mature. It is now a slow and subtle process. Most patients now have as much motion and motor control as they are likely to get. However, some more complex fractures will improve slowly over the next several months. Patients should now be put on a reduced home program of exercises that will maintain mobility and motor control. If they fail to comply they could experience stiffening of their hand, mild stubborn swelling, and subtle reductions in fine motor control as the remodeling process continues. At this point, you are in the conditioning phase of rehabilitation. This is the appropriate time to initiate conditioning or work hardening. The wrist and hand have good motion, no pain (or very little), grossly normal strength, and no restrictions to activities. The patient will profess to be "doing great" but when pressed will admit to frequent stiffness and occasional pain and soreness with certain stresses. Sedentary patients require very little conditioning and may need just a home program and occasional follow-up with the therapist.

The laborer should undergo work conditioning beginning with 2 hours progressing up to 4 hours. The balance of the day provides appropriate recovery time for the soft tissue structures in the still remodeling wrist that has not experienced high energy stress for months.

While the body is laying down scar in response to the injury, the intact, underlying, non-injured ligaments go for months doing nothing. These become weak from disuse and must become conditioned with progressive exercise (stress). If this is not done the weakened soft tissue can be easily strained as the patient returns to preinjury loads too quickly and overloads the tissue. Gradual conditioning with appropriate recovery time strengthens the ligaments and muscles so the patient can return to work without risking reinjury.

Rehabilitation takes substantial time. The initial inflammatory phase is significant for protecting the repair and preserving function in the noninjured parts. The primary rehabilitation phase is significant for the removal of the cast or fixator and for restoration of normal function. Because of the trauma involved, this takes longer than one might think. The conditioning phase should not begin before the patient is ready and should be tailored to meet the needs of each patient.

Work hardening/conditioning programs were originally designed to take the patient through the conditioning phase of treatment prior to returning to work. The idea was to build the worker up to their preinjury strength and conditioning level so as to reduce the risk of reinjury when they returned to work. This was very effective but could involve 8 to 10 additional weeks of treatment before the worker could return to the job site. Today's return to work programs are based on the knowledge that the faster a worker returns to the work environment, the more likely they will return to full duty and their normal job. It is the responsibility of the therapist to communicate with the employer and balance the activities in work hardening/ conditioning with the modified duty being performed. Adequate recovery time after periods of activity should be tailored to meet the needs of each patient. In the end, our treatment should be tailored to achieve the patient's maximum rehab potential.

Summary

Fractures of the distal radius are common. The clinician must carefully diagnose and treat these injuries. These injuries have a significant complication profile so they should be approached with respect. They also have a critical rehabilitation period to return to proper pain-free functionality. This concludes our two-part presentation on fractures of the distal radius.

FHN

Suggested Readings

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Volar fixation for dorsally displaced fractures of the distal radius: a preliminary report. J Hand Surg 2002;27A: 205-215

Green's Operative Hand Surgery, 3rd edition.
Green, Hotchkiss, Penderson, Wolf editors, 2005.

Fractures of the Distal Radius (Chapter 39)
Skeletal Trauma (2nd edition).
Browner, Jupiter, Levine, Trafton
Pgs. 1383-1416

Operative Techniques in Upper Extremity Sports Injuries.
Frank W. Jobe. Pgs. 673-680

Fractures of the Distal Radius (Chapter 90): Robert M. Szabo
Operative Orthopaedics (2nd edition). Michael W. Chapman

Rockwood & Green's Fractures in Adults (Volume 1)
Charles A. Rockwood, David Green, Robert W. Bucholz, James A. Heckman
Pgs. 769-791

Fractures of the Distal Radius (Chapter 26). Surgery of the Hand and Upper Extremity. Clayton A. Peimer. Volume 1

Fractures of the Distal radius. (Chapter 23). Andrew K. Palmer.
Pgs. 929-965

Complex Articular Fracture of the Distal Radius: Classification and Management: Jesse B. Jupiter. J Am Acad Orthop Surg 1997;5:119-129

Methods and Concepts in Hand Surgery. Neil Watson, Richard J. Smith.
pgs. 256-260

The Upper Extremity in Sports Medicine. James A Nicholas, Elliot B Helsman
Pgs. 434-445

The Frequency and Epidemiology of Hand and Forearm Fractures in the United States. J Hand Surg 2001; 26A:908-915.

Avoidance and Treatment of Complications of Distal Radius Fractures.
Andrew P. Gutow. Hand Clin 21 (2005) 295-305.

Closed Manipulation and Casting of Distal Radius Fractures.
Diego L. Fernandez. Hand Clin 21 (2005) 307-316

Biomechanics and Biology of Plate Fixation of Distal Radius Fractures
Alan E. Freeland, Kurre T. Luber. Hand Clin 21 (2005) 329-339

Volar Plate Fixation of Distal Radius
Jorge Orbay. Hand Clin 21 (2005) 347-354

Rehabilitation of Distal Radius Fractures: A Biomechanical Guide
David J. Slutsky, Mojca Herman. Hand Clin 21 (2005) 455-468

About First Hand News

First Hand News is the education journal of the Christine M. Kleinert Institute (CMKI). CMKI is a center for hand care research and education. CMKI encompasses research and education in the areas of hand care, hand and microsurgery, physical therapy, rehabilitation, and injury prevention.

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If you have any patient care questions, Kleinert Kutz can be contacted 24 hours a day, seven days a week at the following number: (502) 561-4263 or toll free 1 (800) 477-4263.

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To earn credit, read First Hand News carefully, answer the questions below, submit your completed quiz to The Christine M.

QUESTIONS

True or False

1. Almost all fractures involving the distal radius are intra-articular.

True False

2. Conservative treatment of distal radius fractures in adults is recommended and reliable for nondisplaced extra-articular and intra-articular fractures, for displaced fractures that remain stable following closed reduction, and certain unstable fractures in elderly patients.

True False

3. Rigid internal fixation is a reasonable choice for unstable distal radius fractures.

True False

4. Distal radius fractures have few if any complications.

True False

OBJECTIVES

After reading this issue you should be able to:

- LIST treatment options for fractures of the distal radius
- DISCUSS techniques for internal fixation of distal radius fractures
- LIST complications of fractures of the distal radius
- DISCUSS rehabilitation issues for fractures of the distal radius

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Fractures of the Distal Radius

Winter 2007

First Hand News

Topics in Upper Extremity Care

A publication of the Christine M. Kleinert Institute for Hand and Microsurgery, Inc.

Fractures of the Distal Radius - Part II

Editors note: This is the final installment in the two-part series

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