The discovery of the x-ray was 80 years away when Irish surgeon Abraham Colles published his paper about fractures of the "distal extremity of the radius." He had no idea about the possible intra-articular component of this fracture, but he knew that the fracture was unstable and frequently settled back to the deformity that "will remain undiminished through life." The management of this very common fracture and its dysfunctional sequelae has remained a challenge to surgeons and therapists alike. Improved treatment with better functional results and fewer complications for unstable, intra-articular, displaced, and comminuted distal radius fractures has been more vigorously pursued by modern orthopedic surgeons and hand surgeons.

The more recent literature tends to support a definite correlation between accurate anatomic position and a more positive functional outcome. Heightened awareness of risk factors for instability, shortening, and malunion, coupled with better methods of fixation, has improved functional results.

The references to therapy following distal radius fractures in the literature are mixed. In some sources, there is no mention of therapy. Other sources state that therapy is recommended only if finger and wrist stiffness persist, and that the need for therapy may actually be considered to be a poor prognostic sign. More contemporary sources stress the importance of therapy and rehabilitation following fracture management with external fixation or open reduction and internal fixation (ORIF). Typically, however, these references are brief and general, and provide few specifics about the therapeutic management.

Most hand surgeons and hand therapists agree that therapy does play an important role in the treatment of these fractures, and therapist-authored chapters have outlined treatment techniques. However, there is no study to document the effectiveness of rehabilitation and what impact therapy may have on the final outcomes.

The treatment goals for any distal radius fracture are anatomic reduction, restoration of joint congruency, and upper-extremity function with maximum pain-free wrist and forearm range of motion (ROM) and full movement of the shoulder, elbow, fingers, and thumb.

**IS IT REALLY A "COLLES' FRACTURE"?**

Colles' original description was that of a distal radius fracture with dorsal displacement, generally caused by a fall on the outstretched hand. This is...
one of the most common fractures, and many times is minimally displaced, extra-articular, and stable. Treatment with cast immobilization for these stable fractures is usually adequate and effective. Residual deformity is minimal, complications are unusual, and full function generally returns. This patient population, however, is largely unknown by many hand surgeons and most hand therapists! While the eponym “Colles’ fracture” may be appropriate for a stable fracture, a significant percentage (up to 25%) do not fit this description. An increasing number of reports and the authors’ clinical experience involve treatment of patients with unstable fractures. Often these fractures are complex with intra-articular components and are sustained during “high-energy,” often sports-related, activities by younger patients or a more active elderly population. Fractures of the distal radius are not limited to “little old ladies” anymore!

In higher-impact injuries with the wrist in extension, there is increased tension on the volar surface and increased compression on the dorsal surface, leading to more dorsal comminution. Sometimes a compression force exerted by the lunate on the distal radius produces a depressed fracture of the lunate fossa—the so-called “die punch” fracture. More lateral compressive forces exerted by the scaphoid can cause a scaphoid fossa depression fracture. Ulnar styloid fractures occur commonly with distal radius fractures. The stability of the distal radioulnar joint cannot be reliably predicted from the size or location of the ulnar styloid fracture. This is best determined by examination under anesthesia after stabilizing the radius.

BEYOND COLLES': DISTAL RADIUS FRACTURE CLASSIFICATION SYSTEMS

In an attempt to be more definitive and to assist the surgeon in diagnosis and selection of treatment, fracture classification systems have been developed based on the extent of extra-articular and intra-articular patterns. No one classification system, however, is commonly accepted, since none of them describes all fracture patterns, accounts for the varying degrees of comminution, or has consistent prognostic value. By becoming more familiar with the more commonly used classification systems, hand therapists may be able to communicate more effectively with the referring surgeon. An improved understanding of the functional impact of articular injuries may help better define realistic goals and treatment plans. Although others have been developed, the most commonly used are the Frykman, Melone, and ASIF (or AO) classifications.
Cited most frequently in the literature is that of Frykman, who established 8 categories emphasizing the difference between intra-articular and extra-articular fractures and involvement of the ulnar styloid (Fig. 1). Frykman's system does not specify the extent of articular displacement or comminution, nor does it take into account deforming forces. Melone's classification views intra-articular injury as a separate entity and focuses on fracture patterns (Fig. 2). It defines a 4-part articular fracture consisting of the radial shaft, the radial styloid, the dorsal medial fragment, and the palmar medial fragment.

The Association for Study of Internal Fixation (ASIF) classification system (also known as the AO system) differentiates the simple fractures from.

**FIGURE 3.** The AO distal radius fracture classification. Division of the distal radius fracture into three basic types (A, B, C), each with 9 main groups and 27 subgroups, can, with documentation of ulnar lesions, produce 144 possible combinations of distal radius fractures. Increased severity, difficulty of management, and a worse prognosis occur in the progression from A1 to C3. Adapted with permission from: Fernandez D, Jupiter J. Fractures of the Distal Radius: A Practical Approach to Management. New York: Springer-Verlag, 1995, copyright 1995 by Springer-Verlag New York, Inc.

those with more increasingly complex articular fragmentation and metaphyseal comminution as well as associated ulna fractures (Fig. 3).

IS IT STABLE? OR UNSTABLE?

It is critical very early in treatment to diagnose patterns of displacement and articular fragmentation, which may be the markers of instability. This principle seems obvious, but it is often overlooked and delays and may compromise ideal treatment. The algorithm detailed by Cooney and Berger illustrates some of the diagnostic and treatment challenges to be considered with distal radius fractures (Fig. 4).

Stable fractures generally have minimal comminution, have less angulation or displacement, and usually have no involvement of the radiocarpal or radioulnar joints. Unstable fractures tend to have significant volar or dorsal comminution, extension of the fracture into the radiocarpal joint with a tendency toward lateral displacement of the radial styloid and depression of the lunate fossa fragment. The fracture may involve the radioulnar joint with or without fracture of the distal ulna.

With unstable fractures, it is usually possible to achieve fracture reduction, but hard to maintain it. This type of fracture necessitates more aggressive treatment—pins and plaster, external fixation, or internal fixation—and cannot be maintained by only a cast. Displacement and loss of position in the majority of distal radius fractures usually occur within the first 2 weeks of immobilization. One complication that is rarely associated with cast treatment of these fractures is a nonunion. If the fracture is unstable and reduction cannot be maintained, the fracture settles into its position of inherent stability and heals quickly. The opportunity for prompt restoration of exemplary function is lost. The stage is set for the cascade of complications well known to the experienced therapist: deformity; stiffness of the fingers, wrist, forearm, and shoulder; and prolonged loss of functional capabilities.

THE SHAPE AND ALIGNMENT OF THE DISTAL RADIUS REALLY DO MATTER

Even though there are reports of some cases of malunion and residual deformity with surprisingly good function, careful studies of large groups of patients have shown that obtaining and maintaining accurate reduction correlate positively with improved outcomes. Restoration of the radial angle, palmar tilt, radial length, and joint congruency definitely impacts final wrist function. Excessive dorsal angulation, radial shortening, and intraarticular joint incongruency are the major factors in poor outcomes.

Radial tilt (normal average 23 degrees) (Fig. 5A) has often been found to have less impact on functional outcome than do some of the other anatomic parameters. However, Jenkins and Mintowt-Czyz found a positive correlation between flattening of the radial angle and a decrease in grip strength.

When there is a fracture with a loss of palmar tilt (normal average 11 degrees) (Fig. 5B) and a resultant dorsal angulation, the wrist may appear deformed and ROM is often limited. Even small losses of palmar tilt may cause midcarpal instability and shift the hand axis out of alignment with the forearm. Dorsal angulation ranging from 10 degrees up to 45 degrees changes the load on the ulna...
Accurate reduction of intra-articular fractures is also very important. In a retrospective analysis, Knirk and Jupiter\cite{28} found that even very small step-offs of 1 mm or more result in a high (nearly 65%) rate of traumatic arthritis. Bradway and colleagues\cite{31} concur that those wrists with 2 mm or more of intra-articular incongruity are at higher risk for development of posttraumatic arthritis.

There is a high incidence of distal radioulnar joint injuries associated with unstable, significantly displaced distal radius fractures. Results of recent biomechanical studies\cite{65} suggest that ulnar styloid fractures alone change the load in the wrist very little. Some studies report that these are not usually significant\cite{24,20} unless associated with instability of the distal radioulnar joint. However, other investigators cite poorer overall outcomes associated with ulnar styloid fractures.\cite{14,16,22,30}

Specific parameters have not been established for just how much deformity can result in an acceptable outcome after the treatment of distal radius fractures. Further biomechanical studies of the wrist and information derived from clinical studies are helping to answer some of these questions and further define treatment guidelines.

**TABLE 1. Demerit Point System Used To Evaluate End Results of Healed Colles' Fracture**

<table>
<thead>
<tr>
<th>Residual deformity</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prominent ulnar styloid</td>
<td>1</td>
</tr>
<tr>
<td>Residual dorsal tilt</td>
<td>2</td>
</tr>
<tr>
<td>Radial elevation of hand</td>
<td>2–3</td>
</tr>
<tr>
<td>Point range</td>
<td>0–6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subjective evaluation</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent: no pain, disability, or limitation of motion</td>
<td>0</td>
</tr>
<tr>
<td>Good: occasional pain; slight limitation of motion; no disability</td>
<td>2</td>
</tr>
<tr>
<td>Fair: occasional pain; limitation of motion; feeling of weakness; activities slightly restricted</td>
<td>4</td>
</tr>
<tr>
<td>Poor: pain; limitation of motion; disability; activities more or less restricted</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Objective evaluation†</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss of dorsiflexion</td>
<td>5</td>
</tr>
<tr>
<td>Loss of ulnar deviation</td>
<td>3</td>
</tr>
<tr>
<td>Loss of supination</td>
<td>2</td>
</tr>
<tr>
<td>Loss of pronation</td>
<td>2</td>
</tr>
<tr>
<td>Loss of palmar flexion</td>
<td>1</td>
</tr>
<tr>
<td>Loss of radial deviation</td>
<td>1</td>
</tr>
<tr>
<td>Loss of circumduction</td>
<td>1</td>
</tr>
<tr>
<td>Pain in distal radioulnar joint</td>
<td>1</td>
</tr>
<tr>
<td>Grip strength 60% or less of opposite side</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Complications</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arthritic change</td>
<td>1</td>
</tr>
<tr>
<td>Minimum with pain</td>
<td>2</td>
</tr>
<tr>
<td>Moderate</td>
<td>3</td>
</tr>
<tr>
<td>Moderate with pain</td>
<td>4</td>
</tr>
<tr>
<td>Severe</td>
<td>4</td>
</tr>
<tr>
<td>Severe with pain</td>
<td>5</td>
</tr>
<tr>
<td>Nerve complications</td>
<td>1–3</td>
</tr>
<tr>
<td>Loss of finger motion</td>
<td>1–3</td>
</tr>
<tr>
<td>Point range</td>
<td>0–10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>End result point range</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>0–2</td>
</tr>
<tr>
<td>Good</td>
<td>3–8</td>
</tr>
<tr>
<td>Fair</td>
<td>9–20</td>
</tr>
<tr>
<td>Poor</td>
<td>21+</td>
</tr>
</tbody>
</table>

*Reprinted with permission from: Sarmiento A, Pratt GW, Berry NC, Sinclair WF: Colles’ fractures—functional bracing in supination. J Bone Joint Surg Am 57:311–317, 1975.†Objective evaluation is based on range of motion. The minimum required for normal function: dorsiflexion, 45 degrees; palmar flexion, 30 degrees; radial deviation, 15 degrees; ulnar deviation, 15 degrees; pronation, 50 degrees; supination, 50 degrees.*

**REPORTING OUTCOMES: DISTAL RADIUS FRACTURE OUTCOME SCORING SYSTEMS**

As with the fracture classification systems, no one particular outcome scoring system is universally accepted. The most commonly used are the Gartland and Werley and the modified Green and O'Brien scoring systems.\cite{66}

The rating system of Gartland and Werley,\cite{2,37} less stringent in regard to motion and strength required to achieve a good or excellent result. Residual deformity, subjective complaints, and arthritic changes all factor into the final score (Table 1).

The system of Green and O'Brien, as modified by Cooney and coworkers,\cite{47} does not take radiographic changes into consideration, but requires higher levels of function and better ROM and strength for an excellent result (Table 2).

**THE STABLE FRACTURE: CONSIDERATIONS FOR REDUCTION AND IMMobilIZATION**

Extra-articular, stable, minimally displaced fractures with no comminution are usually treated effectively with close reduction and immobilization. Care should be taken with cast application to ensure that the cast is comfortable and well-padded over the distal ulna, and that full movement of the metacarpophalangeal (MP) joints is possible. The x-ray may look fine, but when the patient says that the cast doesn't feel fine, prompt attention to this complaint is required. Many of the well-known complications of finger stiffness, carpal tunnel syn-

*TABLE 1. Demerit Point System Used To Evaluate End Results of Healed Colles' Fracture*
drome, and reflex sympathetic dystrophy start with an improperly applied or too tight cast, particularly when the patient’s complaints are not promptly addressed.2,5,6

The usual position of immobilization is with the wrist moderately flexed and in ulnar deviation. Theoretically, the flexed position of the wrist uses the dorsal soft tissues and the intact dorsal periosteum of the radius as a hinge to maintain the reduction the fracture. Unfortunately, prolonged wrist flexion can have a most deleterious effect on hand and finger function.68 Gelberman et al.69 measured carpal tunnel pressures in relationship to wrist position in patients with Colles’-type fractures. They concluded that neutral was the safest position for the median nerve. Forty degrees of flexion was found to increase the carpal tunnel pressure on the median nerve to dangerous levels.

The traditional position of immobilization has been challenged by Gupta,68 who found a lower incidence of loss of anatomic reduction and improved hand function with the wrist immobilized in 20 degrees of extension.

**TABLE 2. Modified Clinical Scoring System***

<table>
<thead>
<tr>
<th>Category</th>
<th>Score (Points)</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain (25 points)</td>
<td>25</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>Mild, occasional</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>Moderate, tolerable</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>Severe or intolerable</td>
</tr>
<tr>
<td>Functional status</td>
<td>25</td>
<td>Returned to regular employment</td>
</tr>
<tr>
<td>(25 points)</td>
<td>20</td>
<td>Restricted employment</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>Able to work but unemployed</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>Unable to work because of pain</td>
</tr>
<tr>
<td>Range of motion</td>
<td>25</td>
<td>Percentage of normal</td>
</tr>
<tr>
<td>(25 points)</td>
<td>15</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>75–99</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>50–74</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>25–24</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dorsiflexion–plantar flexion arc (injured hand only)</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>120° or more</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>91°–119°</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>61°–90°</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>31°–60°</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>30° or less</td>
</tr>
<tr>
<td>Grip strength</td>
<td>25</td>
<td>Percentage of normal</td>
</tr>
<tr>
<td>(25 points)</td>
<td>15</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>75–99</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>50–74</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>25–49</td>
</tr>
<tr>
<td>Final result</td>
<td></td>
<td>Percentage of normal</td>
</tr>
<tr>
<td>Excellent</td>
<td>90–100</td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>80–89</td>
<td></td>
</tr>
<tr>
<td>Fair</td>
<td>65–79</td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td>&lt;65</td>
<td></td>
</tr>
</tbody>
</table>


The merits of immobilizing the elbow either in pronation or supination, and different types of casts and braces, have been the subject of studies.37,40,70 There is no consensus among orthopedists for any one method. Even the time of immobilization is controversial. Various authors have recommended from as little as 3 weeks to 8 weeks of immobilization.5,65,68,70

What is the “bottom line?” The quality and stability of the reduction would seem to be the most important factor.71 Immobilization with the wrist in more than 20 degrees of flexion should be avoided, and problems with casts must be addressed immediately and rectified.

**THE UNSTABLE FRACTURE: TREATMENT OPTIONS**

The unstable fracture necessitates more than plaster to maintain reduction. Unfortunately, many surgeons determine fracture stability by loss of reduction in the cast. This is frequently insidious and may occur gradually over a period of 10–14 days or later. At 3 weeks, many of these fractures have slipped to their position of inherent stability and have begun to heal in a malunion. Stewart et al.72 identified a means of scoring the fracture prior to treatment to help estimate the risk of collapse in plaster. These factors include dorsal comminution, radial shortening, dorsal tilt, and intra-articular displacement. The risk of collapse increases directly in proportion to the number of risk factors present.72 Early recognition of potential instability using the pre-reduction x-ray is the key to proper treatment of these distal radius fractures.

In the 1970s, especially following Green’s work, pins and plaster were used to provide traction to augment closed reduction with cast immobilization; Melone has continued to use and recommend this method. For the most part, the favored technique of the 1980s has been the use of a wide variety of external fixators. More recently, improved techniques of ORIF have begun to show improved outcomes especially in severely comminuted, displaced, intra-articular distal radius fractures.

**Pins and Plaster**

Popularized by Green5 in the 1970s, incorporating pins into a plaster cast is indicated when anatomic reduction can be obtained by traction. However, pin tract infections, loosening of the pins, problems associated with circumferential plaster, and lack of adjustability are the disadvantages with this treatment. Restoration of adequate palmar tilt is often not achieved with this treatment.3,44,52 The pins are usually removed at 8 weeks postsurgery. Wrist motion is difficult to regain, especially if an intra-articular fracture was present.
External Fixation

External fixation of unstable distal radius fractures is the method that has largely superseded treatment with pins and plaster. The array of external fixation devices in use have their own strengths and weaknesses as well as cost differences.\textsuperscript{77,71–76} Like pins and plaster, external fixation is based on the principle of ligamentotaxis, in which fracture fragments are brought into alignment by traction applied across the fracture through the capsuloligamentous structures.\textsuperscript{77,78} Rarely does this traction completely reduce the dorsal angulation of the distal fragment back to normal volar tilt.\textsuperscript{76,79} Often reduction and supplemental percutaneous pinning of this fragment are required.\textsuperscript{26,80}

Treatment of unstable, displaced distal radius fractures with external fixation has yielded more satisfactory final radiographs, but also has been associated with complication rates—as high as 62% in the studies reviewed.\textsuperscript{14,15,27,41,43,80–82} Complications include a high rate of pin tract infections, iatrogenic fractures of the metacarpals, and even nonunion of the distal radius fracture. Other complications encountered include: median neuropathies, irritation of the dorsal sensory branch of the radial nerve, reflex sympathetic dystrophy, finger stiffness, and damage to the finger and wrist tendons as well as the intrinsic muscles of the hand.

Recommendations for periods of immobilization with the external fixator average about 8 weeks. If traction is discontinued before this, the fracture often re-displaces, since healing times are prolonged with traction. Because many of these fractures are intra-articular, the wisdom of 8–10 weeks of traction is questionable.

Open Reduction and Internal Fixation

Complex articular fractures in which the fragments are rotated, displaced, or impacted may be impossible to reduce by traction or other closed means.\textsuperscript{79–83} Those fractures with persistent articular stepoff necessitate ORIF.\textsuperscript{17,18,30} In most other areas of the skeleton, accurate stable reduction of intra-articular fractures with bone grafting and rigid fixation followed by early motion has been shown to hasten healing and improve functional outcomes.

This has been clinically demonstrated even in some fractures of the distal radius such as the volar Barton’s anterior lip fracture dislocation.\textsuperscript{83} Anterior plate fixation of these fractures has been the standard of care for over a decade. Until recently, orthopedic surgeons have avoided the dorsally displaced, unstable distal radius fracture. However, improved techniques and new tools such as low-profile plate designs and sterile traction operating tables are making ORIF more predictable. The authors’ early experience with these devices suggest that even severe dorsally displaced fractures of the Frykman types VII and VIII and the AO types C2 and C3 can be stabilized. The stability achieved in many cases is adequate to initiate motion of the wrist and hand within the first week postoperatively.\textsuperscript{48}

The incorporation of early movement of the wrist in patients undergoing ORIF requires specific therapeutic management with close communication between surgeon, therapist, and patient. The patient’s progress and activity level require careful monitoring and a very specific exercise program. At first, the wrist is protected in a splint except for removal for skin care and performance of exercises. Weaning from the splint begins at approximately 3–6 weeks postsurgery when the first sign of clinical union appears as the clinical tenderness at the fracture site subsides. Efforts to reduce edema, control pain, and quickly maximize finger and thumb ROM are the same as those for fractures treated by other methods.

REHABILITATION FOLLOWING DISTAL RADIUS FRACTURES

It is a sign of the times that a discussion about rehabilitation of distal radius fractures begins not with therapeutic and anatomic considerations but instead with factors related to the delivery of hand therapy services in a “managed care” environment.

The trend in managed care is limitation of the actual number of treatments (6.7 visits per referral for upper-extremity problems, according to one source)\textsuperscript{85} or the length of treatment time—30–60 days maximum “per condition” in many cases. A problem arises in the management of distal radius fractures in that maximum functional improvement often does not occur for many months. Stable fractures with minimal or no complications usually reach maximum improvement at about 6 months postinjury.\textsuperscript{20,33} Some sources indicate continued improvement from 1 year\textsuperscript{39,46} to approximately 2 years\textsuperscript{43} postfracture. In some cases, benefits for therapy may expire even before the wrist is ready to be mobilized!

Therapist, surgeon, and patient are now challenged with the task of completing distal radius fracture rehabilitation in a time frame not compatible with healing and functional recovery. The issues of patient compliance and the therapist’s role as an educator\textsuperscript{86} are especially pivotal in the treatment of distal radius fractures. Patient education and participation in a home program must have increased focus. Our challenge is to forge a collaborative rehabilitation effort with a paradigm shift from what we can do “to” the patient to what the patient can do “for” himself or herself to achieve a satisfactory end result.

Acute Intervention

The optimum situation is to initiate therapy while the wrist is still immobilized.\textsuperscript{53} The goals are to maintain full shoulder and elbow ROM and to achieve full finger and thumb ROM by the time the wrist is ready to be mobilized.
Early control of edema and pain are of paramount importance in eliminating and preventing joint stiffness and dysfunction, which can quickly become chronic problems. Active ROM of the shoulder and elbow needs to be maintained and full movement of the fingers and thumb must be re-established as soon as possible. It is important to encourage functional use of the affected extremity but always within the limits of pain, swelling, and tissue reactivity.

Edema Control

Rapid resolution of edema is critical because swelling decreases mobility, impedes the blood supply, and can lead to the formation of scar tissue. The primary method of combating edema is elevation. The therapist must insist on it! To be properly elevated, the hand needs to be above the elbow and the elbow above the heart regardless of whether the patient is lying, sitting, or standing. Be very explicit in these instructions and provide examples of proper as well as improper elevation. Commercially available foam positioning devices make it easier to keep the arm elevated while sleeping.

Shoulder ROM is important not only for prevention of stiffness but for edema reduction as well. The patient should be instructed to "salute" the ceiling hourly. Immobility blocks the outflow of the veins and lymphatic system in the axilla, thus increasing edema in the hand. As the edema in the hand increases, the motion decreases; a vicious circle of edema and shoulder and hand stiffness can occur. Early recognition and prompt treatment of symptoms of edema, pain, stiffness, and vasomotor disturbances are needed to alter the dysfunctional cycle that can result in one of the worst complications of a distal radius fracture—reflex sympathetic dystrophy.

The use of a sling should be avoided because it promotes shoulder and elbow stiffness, does not properly elevate the hand, and discourages functional use of the upper extremity. The patient should be allowed to wear a sling only for short periods when protection is needed in crowded, public situations.

Prolonged flexion of the elbow in positions of arm elevation may result in symptoms of ulnar nerve irritation such as increased pain and tingling in the small finger. Make the patient aware of this potential problem and suggest positions of arm elevation that minimize elbow flexion.

Distal-to-proximal massage assists in reduction of edema and also provides tactile input. If the edema is not controlled by elevation and massage, elasticized wraps such as Coban (3M, St. Paul, MN) or elasticized finger sleeves can be used to help reduce digital edema. Massage should be performed before the application of any compressive wrap and before exercises.

Range of Motion

Range of motion of the uninvolved joints assists in edema reduction by transporting fluid proximally via the pumping action of the muscles, prevents tendon adherence, and maintains joint mobility. Full active flexion and extension of the fingers and the thumb are encouraged and should be sustained for 10 seconds and repeated 5–10 times hourly. Nonspecific, fluttering movements aren’t good enough!

The flexed position of the wrist in the cast or external fixator may prohibit full excursion of the finger flexor tendons. Full digital flexion may also be limited by extensor tendon adherence. The patient should be instructed in individual tendon gliding exercises for the superficialis and profundus tendons as well as hook fisting for isolation of the digital extensors and interphalangeal (IP) joint flexion. Abduction and adduction of the fingers and isolated movements of the hypothenar and thenar muscles should be stressed as well. The intrinsic muscles should be stretched because dorsal edema resulting from a distal radius fracture can cause intrinsic contracture.

If joint stiffness persists, gentle passive ROM exercises are initiated. There should be no painful passive manipulation! The most needed areas of emphasis are usually MP joint flexion, proximal IP joint extension, and stretching of the first web space.

Shoulder ROM should emphasize abduction, flexion, and external rotation. If the patient is initially in a long arm cast, elbow exercises with the focus on reestablishing extension begin when the immobilization is changed to a short arm cast.

Therapist and patient need to work together to design a home program taking into consideration individual needs in relationship to the injury and lifestyle demands of the patient. The instructions should contain explicit details regarding number of repetitions, frequency, and how to alter it if pain and swelling increase. This serves a dual purpose. First of all, it helps the patient accept his or her role in this rehabilitation partnership. Second, it is easier to exercise clinical judgment about changes needed in the rehabilitation program if progress exhibited on reevaluation is based on some known quantity of performance.

Pain Management

The therapist should be a vigilant observer for the causes of increased pain. For instance, edema may have increased, the cast may be too tight, or signs of nerve compression may become evident. When identified as a factor in the patient’s pain, it needs to be treated promptly.

It is also necessary to watch for signs of increased sympathetic reactivity such as redness over the dorsum of the joints, a shiny, wax-like character of the skin, and swelling and stiffness of the fingers that don’t seem to be resolving. Even if the patient’s
pain does not seem out of proportion to the injury, these symptoms could signal impending reflex sympathetic dystrophy. Be alert for descriptive adjectives such as "burning" or comments that the hand "feels like it's running a fever," because these can be warning signs of reflex sympathetic dystrophy. Treatment of these symptoms in the early stages results in a better chance to reverse them and avoid their well-known dysfunctional consequences.91,92

Pay particular attention to changes in sensibility and pain related to the median nerve distribution, which may indicate development of carpal tunnel syndrome. A baseline sensory evaluation should be done to measure changes that might occur early or late in treatment. The Semmes-Weinstein monofilaments have demonstrated better reliability than 2-point discrimination testing in assessment of nerve compression syndromes.93

There are other important subjective and psychological components of pain that physicians and therapists can't control, but can at least influence with a positive, supportive approach.94 Pain can be difficult to assess, measure, and describe. It is important to acknowledge that the pain is real and to reassure the patient that it will get better. These reassurances must be reinforced by instructions in elevation, massage, and exercises that will empower the patient to alleviate the pain.

Troubleshooting: Problems Inherent with Immobilizing Devices

If the wrist is immobilized in a cast, most of the problems encountered are due to fit problems with the cast itself. The cast should allow full movement of the thumb and MP joints of the fingers, especially on the ulnar half of the hand. There should be no circumferential constriction or undue pressure on the distal ulna. Any rough edges that might irritate the skin should be smoothed.

There is a high rate of complications with external fixators, many of which are related to the pins. Regardless of the cleansing agents used, the importance of meticulous pin tract care throughout immobilization must be reinforced for the patient. The percutaneous pin fixation of the external fixator usually transfixes the second and third metacarpals and the distal radius. This provides distraction of the fracture and allows visual observation of any open wounds. Because it is situated along the longitudinal or fixed arch of the hand, it does not give support to the mobile transverse arch. To improve patient comfort and provide support to the transverse arch, a support splint can be helpful (Fig. 6). It is usually fabricated as an ulnar gutter, closely conformed in the palm, yet allowing full motion of the thumb and digits. The length can vary from short to above the elbow depending on the involvement of the injury or the surgeon's desire to limit forearm rotation.

The position of many external fixators often blocks radial abduction and extension of the thumb and flexion of the index finger. A contracture of the first web space may not improve adequately with exercises alone. A thermoplastic web spacer can be fabricated and fit over the cast or around the external fixator (Fig. 7). Care should be taken to avoid stressing the ulnar collateral ligament of the MP joint of the thumb. When edema is a bigger prob-

FIGURE 8. If the hand is quite edematous or not tolerant of hard thermoplastic, a foam web spacer can be used. A piece of foam 2" x 1" x 6" is tied in the center with length of Surgitube. Insert into the web and wrap the remaining Surgitube around the wrist in a "figure 8" and tie with a bow. Reprinted with permission from: Colditz J: Practice forum: Soft splinting technique for maintaining thumb abduction. J Hand Ther 4:22, 1991.
must be done to regain maximum movement. Performance of specific active and passive ROM exercises is essential. Point out that sons begin here. Measure and record the active ROMs of the injured wrist. Point out that there is usually more movement in ulnar deviation than in radial deviation. Use a skeletal model to demonstrate the movement of the radius around the ulna in forearm rotation. Also, have the patient feel the movement of the distal radioulnar joint by placing the uninjured hand on the therapist's radius and ulna as supination and pronation are demonstrated. Seeing and feeling this movement can help alleviate the apprehension in some patients that something is "loose" on the ulnar side of the wrist during forearm rotation. Finally, demonstrate the normal synergistic relationship of wrist extension/finger flexion and wrist flexion/finger extension. Emphasize the importance of being able to stabilize the wrist in extension and the impact this has on power grip.

The most important single principle in distal radius fracture rehabilitation is re-establishment of independent wrist extension. The extensor carpi radialis brevis (ECRB), the extensor carpi radialis longus (ECRL), and the extensor carpi ulnaris (ECU) possess different masses, moment arms, fiber lengths, and cross-sectional areas, but the "different anatomic endowments are cerebrally integrated to balance wrist extension, flexion, and ulnar and radial deviation." The ECRB is the strongest wrist extensor, and the ECRL helps extend and radially deviate the wrist. The ECU is more effective as an ulnar deviator when the forearm is in pronation, but it becomes a more efficient wrist extensor when the forearm is supinated. Because the wrist has usually been immobilized in some flexion for several weeks, a centrally mediated substitution pattern of digital extension to implement wrist extension occurs. First and foremost in therapy, the patient must overcome this substitution pattern. Finger flexion, grip strength, and overall hand function cannot improve so long as the digital extensors "fire" when the wrist is extended (Fig. 9).

Splinting of the wrist in slight extension until independent control of the wrist extensors can be reestablished is needed while re-training is carried...
However, the patient should be weaned from the splint as rapidly as possible. Prolonged dependency on the wrist splint is counterproductive to redevelopment of wrist ROM and grip strength.

Commercially available wrist supports do not fit most distal radius fracture patients comfortably and can block full finger and thumb ROM (Fig. 10). Preferable is a custom-made thermoplastic dorsal wrist splint with a slender palmar bar (Fig. 11). Care should be taken to alleviate pressure over the ulnar styloid. Since the ulna is more prominent dorsally when the forearm is in pronation, fabricate the splint with the patient's forearm pronated. A thin piece of foam padding placed over this area before the splint is molded can then be removed and positioned in the splint. The palmar bar should be carefully contoured so that it does not interfere with full finger movement. It is difficult to prevent a volar-based splint from migrating distally and blocking finger movement when the wrist is already stiff in flexion. Compared with its volar-based alternative, the dorsal splint is cooler, allows unrestricted finger and thumb ROMs, and, via its open design, encourages functional use of the hand while wearing the splint.

An almost totally circumferential splint (Fig. 12) can be fabricated if additional support is needed because of the distal radioulnar joint or difficulty in getting the wrist out of its flexed position. Special attention in fitting is required to prevent pressure over the ulnar styloid and to ensure full ROMs of the MP joints (particularly on the ulnar border of the hand) and the carpometacarpal joint of the thumb. This splint is cooler to wear if a perforated thermoplastic is used. Both splints can be stripped of their straps and remolded as needed to coax the wrist into better position.

Mobilization of the wrist begins with active ROM exercises first emphasizing wrist extension with finger flexion. The initial amount of wrist extension is not important so long as it occurs without help from the finger extensors. Teach the patient to monitor that the ring and small finger MP joints do not extend when the wrist is in maximum extension; this means that the wrist extensors are working independently! For some patients, it is necessary to reduce the cognitive level of this activity with some light resistance by squeezing something such as a sponge and then concentrating only on extending the wrist. Neuromuscular electrical stimulation isolated to the wrist extensors may be helpful, but most patients are able to accomplish the retraining of independent wrist extension without it.

Wrist flexion should be performed with the fingers relaxed or extended. Radial and ulnar deviation of the wrist should be done with the forearm pronated and the wrist in neutral position. To prevent shoulder substitution for movements at the distal radioulnar joint, the patient should be instructed to keep the elbow at the side during forearm supination and pronation. These exercises should be done for a sustained effort of 10 seconds at end range and repeated a certain number of repetitions (usually 5–10) several times per day.
The application of heat has been shown to have short-term effects on decreasing pain and improving elasticity of tissue. Some patients respond to the application of cold packs for reduction of pain and inflammation. The use of these thermal agents does seem to help some patients follow their exercise program with less discomfort. These modalities can be quickly and easily incorporated into a home program. It should be made clear to the patient that these are adjuncts—not substitutes—for active, passive, and resistive exercises.

Passive ROM exercises should be incorporated into the patient’s program when tolerated. Each stretch is held for 10 seconds and repeated a certain number of repetitions. The differences between active and passive ROMs and their expected therapeutic benefits should be explained so that the patient will understand that one is not a substitute for the other.

The concept of joint mobilization is to assist restoration of normal joint play where ROM is limited. Joint mobilization has been used as an adjunct in helping relieve pain and stiffness. As well as being skilled in joint mobilization, therapists using these techniques need to be aware of intra-articular or joint congruency contraindications for treatment.

As pain-free motion improves, the splinting is decreased, and resistive exercises are added as tolerated by the patient. Resistive exercises that can be carried out easily in a home program should be emphasized.

The well-known therapeutic techniques of heat and stretch, cryokinetics, electrical stimulation, and joint mobilization have been demonstrated to have short-term mechanical effects on changes in ROM. Prolonged gentle stress produced by continuous passive motion, splinting, or serial casting on tissues altered by scarring is more effective in producing permanent changes in tissue length. However, there is no study documenting the effectiveness of these techniques in the treatment of wrist stiffness caused by distal radius fractures. Therapeutic intervention continues to be guided by input from the surgeon, the therapist’s clinical judgment, and the patient’s response to treatment.

When the Wrist Won’t Move—In Spite of Our Best Efforts

It has been theorized that joint tightness is improved by controlled physical stress over significant periods rather than by intensity. In other words, low-load, prolonged stretch/stress (LLPS) is more effective than high-load, brief stretch-stress (HLBS). Therapists’ knowledge of the response of scar tissue and the biomechanics of the hand and wrist have led to advances in splinting technology. Static–progressive splinting applies LLPS to scar tissue through adjustable force application.

An articulated splint using the Phoenix wrist hinge (Human Factors Engineering, Phoenix, AZ)
and the MERIT component (Upper Extremity Technology, Glenwood Springs, CO) can be fabricated for either flexion or extension (Fig. 13). The hinge allows positioning that approximates the anatomic axis of motion, and the progressive tension is adjusted by turning the thumb screw on the MERIT component.

Dynamic supination and pronation splints of the Colello-Abraham type (Fig. 14A) or with a commercially available dynamic supination/pronation kit (Smith & Nephew Rolyan, Inc., Germantown, WI) (Fig. 14B) can be fabricated and worn to improve forearm rotation.

If pain seems to be a bigger problem than stiffness, treatment of the pain is given priority. Try to evaluate whether pain is related to the restriction in joint movement, is sympathetically mediated, or possibly stems from nerve compression problems such as carpal tunnel syndrome. It will be difficult to use treatment techniques to overcome stiffness if pain can’t be controlled.

Identify and correct as soon as possible substitution patterns that contribute to stiffness and dysfunction such as using the trapezius to elevate the shoulder and the digital extensors to extend the wrist.

Emphasize the importance of patient compliance in improving the functional outcome. Establish a realistic time frame. Improvement measurable by the therapist and some functional gains appreciated by the patient should occur by the end of the first month. If not, it’s time to consider the next step—and that may be discharge from treatment. Clinical judgment includes realization of our limitations.

The “Why Weren’t You Referred Last Month?” Dilemma

In therapy utopia, all patients with distal radius fractures have excellent reductions and are referred for rehabilitation early to a clinic in which the therapist and surgeon have excellent communication. Unfortunately, this is not always the case.

Probably very few therapists reading this article have not been faced with the situation of a patient who is 2–3 months post–distal radius fracture and arrives in therapy for the very first time with a definite “failure to thrive” wrist situation. Lamenting the fact that the patient was not referred a few weeks earlier is not going to be helpful at this point. Therapist and patient alike must start this relationship not by thinking “what if” but by focusing instead on “what now.”

Since the diagnosis on the referral is probably listed as “Colles’ fx,” the therapist’s first job is to seek more information. Is this really a well-healed, nondisplaced extra-articular fracture? Or is it a dorsally displaced distal radius fracture—healed—but with some intra-articular involvement, displacement, malunion, radial shortening, dorsal angulation, or a combination of these? Assessment of the residual deformities is the first step in planning realistic goals for wrist ROM and reestablishment of hand function.

Within this decade, surgeons may be finally able to apply the established principles of other metaphyseal fractures to achieve more predictable treatment of unstable, intra-articular distal radius fractures. Accurate ORIF and early motion may improve function with fewer complications within a few weeks. This approach may make treatment of these fractures a more pleasant experience instead of a nightmare for the surgeon, therapist, and patient alike.

REFERENCES


