Distal Radius Fractures in Adults

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Although distal radius fractures are a common injury in the elderly and young adult population, the classification, treatment options, and assessment of outcomes of these fractures remain controversial. Since there is no uniform fracture classification system, it is difficult to compare studies. An evidence-based model of management needs to be developed.

Distal radius fracture, first described by Abraham Colles in 1814, is a common injury seen in most emergency rooms. The fracture was defined as a displaced fracture of the lower end of the radius within 1.5 inches of the joint. More than 180 years have passed since this initial description by Colles, and yet this common fracture still attracts discussion and controversy in the areas of descriptive classification, treatment options, and assessment of clinical outcomes.

INCIDENCE

Distal radius fractures are common injuries and account for one sixth of all fractures seen and treated in emergency rooms. The incidence of articular damage in association with distal radius fractures varies among reports but has been reported to be as high as 90%.

Distal radius fractures occur in patients who can be categorized in two broad groups: 1) an elderly group which sustains these fractures from relatively low-energy trauma to osteoporotic bone, and 2) a young adult group which has high-energy trauma to normal healthy bone. In the young adult group, trauma originates from motor vehicle accidents, occupational injuries, and sporting activities.

The major critical factor in association with an aging population is the dramatic increase in the incidence of osteoporotic-related fractures. The incidence of distal radius fractures is estimated to double in the next 25 years according to demographics provided by the Australian Bureau of Statistics and the projected rates of fractures in the United States.

ANATOMY

The anatomic features of the distal radius need to be restored to improve outcome. These features include the palmar slope or tilt. The normal range of volar tilt is 11°-12°. Radial inclination and radial length are the anatomic features critical to the assessment of reduction (Figure 1). Apart from some of the bony anatomical landmarks of the distal radius, the soft-tissue anatomy also has an impact on the outcomes following injury of the distal radius. The triangular fibrocartilage complex needs to be considered as it is commonly involved in distal radius fractures (Figure 2). Other soft-tissue components of the wrist joint that need to be considered in association with injuries of the distal radius are the scapholunate and lunotriquetral ligaments.

CLASSIFICATION

The problems with classification systems have been related to confusion due to the use of eponyms and also the problems with interobserver reliability and intraobserver reproducibility. Some of the earlier classifications of distal radius fractures were eponymous. The use of eponyms (eg, Smith, Colles, and Barton fractures) created much confusion and also resulted in conflicting outcome measures reported in the literature.

In 1951, the Gartland and Werley classification was described in the first attempt to move away from the use of eponyms in classifications. The Gart-
The Welfley classification was based on the presence of fragment displacement not the extent of displacements and also used the presence of intra-articular involvement. The next classification was described by Older in 1965. Older's classification was based on the extent of displacement, dorsal angulation, and shortening. It also took into consideration the extent of dorsal comminution. Dorsal comminution and the degree of initial deformity were the best predictors for the loss of initial reduction.

The Frykman classification described in 1967 is based on the distinction between extra- and intra-articular fractures in the presence of distal ulna fracture involvement. The essentials of this classification are shown in the Table. The problem with the Frykman classification apart from the fact that it is cumbersome for routine clinical use, is that it considers displaced and non-displaced fractures as equally important and, therefore, has no practical use in predicting outcome of treatment modalities in the management of distal radius fractures.

The Melone classification was introduced in 1984. This classification system was one of the first to provide a description that most fractures propagate through the articular surface of the radius (Figure 3). This classification is most appropriate and relevant for fractures of the intra-articular distal radius. One of the more recently developed classifications is the AO classification system. This is a complex classification system in which there are approximately 27 categories. This level of complexity makes it difficult in daily clinical use, however, it does serve as a useful guide particularly in research and comparative studies. The problem with this classification system is that there is a low degree of inter- and intraobserver agreement. The AO classification has been modified by both Jupiter and Fernandez and considers the mechanism of injury resulting in the fracture. The mechanisms include bending, shear, compression, and avulsion. This modification involves 25 subtypes and
adds to further complexity in its daily use.

In summary, the problems with the various classification systems have been related to the difficulty of their use in daily clinical practice. Some of these classifications are descriptive of fracture patterns and are not directly related to management or outcomes. A further problem with the classification systems is the low degree of inter- and intraobserver error that has been demonstrated in several studies.

**TREATMENT, METHODS, AND OUTCOMES**

In evaluating the treatment options available for the management of distal radius fractures, the outcome following nonoperative treatment of displaced distal radius fractures in low-demand elderly patients does result in satisfactory outcomes.1 The key, however, is the fact that high-demand and younger individuals require restoration of the anatomical parameters mentioned earlier for a better outcome. The parameters that result in better outcomes are associated with a restoration of the radiographic parameters of radial inclination, radial height, and correction of the dorsal angulation. It also has been demonstrated that an intra-articular step >1 mm significantly alters the outcome in terms of a predisposition to the development of distal radial carpal arthritis and, therefore, the anatomic reduction and maintenance of the reduction has been a key approach targeted by most new techniques in the management of these fractures.

Kihara et al9 demonstrated that incongruency of the distal radial joint occurred with increasing dorsal tilt of the radius and was particularly dramatic when there was >20° of dorsal angulation of the distal radius. Porter and Tillman10 also demonstrated that patients who had >2 mm of intra-articular step had a higher incidence of progression onto symptomatic arthritis of the joint.

In a study by Wagner et al,11 the contact characteristics were significantly altered with a 1-mm depression of the scaphoid side of the joint, which led to significant changes on the lunate side of the joint. Hove et al,12 in their study reviewing malunions or secondary displacements of Colles' fractures, reported the critical factors that predisposed to secondary displacement were the initial degree of dorsal angulation, the patient's age, and the initial radial length. It was noted that those patients in an elderly age group with significant radial shortening, particularly with radial axial shortening, at initial presentation had the greatest risk of secondary displacement.12

In 1907, Lambotte was the first to recognize that comminuted fractures of the distal radius required surgical intervention. His fixation technique used nails and screws to stabilize these fractures. In 1929, Ombredanne was the first to introduce the concept of external fixation for distal radius fractures in adolescence. His technique did not bridge the wrist joint.13

Immobilization of the wrist with either plaster of Paris or external fixation together with the injury to the joint has been demonstrated to lead to functional difficulties persisting in the wrist for as long as 2 years after initial injury.14 These functional difficulties are most commonly related to joint stiffness and pain. Early mobilization of the joint may minimize stiffness and reduce pain.15 Therefore, many techniques that maintain fracture reduction yet allow early mobilization have been developed to overcome this long-term problem. These various techniques can be classified in terms of open reduction and various plating techniques, the use of supplementary pin fixation with or without cast immobilization, the use of dynamic external fixators, and the use of nonbridging external fixators.

**EXTERNAL FIXATION**

In 1929, Ombredanne introduced external fixation for distal radius fractures. His external fixation technique did not bridge the wrist joint. Until recently, all external fixators applied to the forearm for distal radius fractures crossed the wrist joint.16-18

External fixation allows maintenance of the length and provides a rigid scaffold to ensure that fracture reduction is not lost. However, traditional means of external fixation of the distal radius have rendered the wrist joint totally immobile for 6-10 weeks and may have a significant traction force or ligamentotaxis applied across it. This may lead to stretching and tightening of the wrist joint capsule with subsequent scarring and delayed return to full motion. This has been recognized by other researchers who have endeavored to minimize wrist stiffness associated with external fixation by using dynamic external fixation or applying rigid external fixation of a nonbridging fashion.13,18

The Clyburn fixator was the first fixator to allow movement after fixation.13 This was achieved using a ball joint and pistoning device. Clyburn found in this initial study that full flex-

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<th>Fractures</th>
<th>Distal Ulnar Fractures</th>
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<td>Extra-articular</td>
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<tr>
<td>Intra-articular involving the radiocarpal joint</td>
<td>II</td>
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<td>Intra-articular involving the distal radioulnar joint</td>
<td>IV</td>
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<td>Intra-articular involving the radiocarpal and distal radioulnar joints</td>
<td>VI</td>
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<td>Absent</td>
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ion/extension from the day of surgery resulted in loss of volar tilt and also allowed some loss of radial length. In a randomized, comparative study of the Clyburn device and the rigid AO fixation device, the Clyburn fixator allowed a significant loss of radial length when compared to the AO fixator. The Clyburn device in itself suffered from failure due to breakage of the ball joint.

Bishay used the AO mini fixation device, inserting the distal pins into the distal radial fracture fragments, which had not been reported since the work of Ombredanne. This series showed excellent outcomes in 78.5% of patients and a good outcome in 21.5% of patients. The surgical technique used involved the insertion of two pins in the fracture fragments, which led to complications with slipping and loosening of the pins when compared to fragment fixation using four pins.14

Numerous studies cited in the literature demonstrate that external fixation does result in satisfactory outcome. External fixation is particularly recommended for comminuted unstable intra-articular fractures of the distal radius.19-21 The use of external fixation can be supplemented with cancellous allograft to enhance stability and has shown good outcomes, stable fixation, and no recurrence of deformity or late collapse.22

Traditionally, an external wrist fixator is applied in such a way that the device immobilizes both the fracture and the wrist joint. These devices have been associated with complications such as finger and hand stiffness, median nerve neuropathy, reflex sympathetic dystrophy, tendon damage, and iatrogenic metacarpal fractures. Some of these complications may be due to prolonged immobilization of the wrist and hand. As a result, attempts have been made to modify these devices to allow for some movement of the wrist joint during the fixation period. Early wrist movement has been advocated by some authors to reduce the incidence of joint stiffness often with the calculated risk of some reduction loss.

There have been only a few reports of the use of dynamic external fixators with the distal pins inserted into the fracture fragments, thus avoiding immobilization of the wrist joint. There have been a significant number of recent reports of nonbridging external fixators, including Krishnan et al23 and McQueen et al.24

Numerous pinning and pin and plaster techniques have been described to help stabilize some of these common unstable distal radius fractures. The most popular technique is described by Kapandji, in which the pins are placed dorsally through the fracture site and help stabilize the fracture and prevent further dorsal dislocation.25

The buttress pinning technique described by Kapandji has resulted in good outcomes and has been demonstrated in several studies.24-26 Some studies compared this pinning technique to external fixators and have shown no significant statistical difference in the outcomes. However, it has been noted that external fixators have been more effective in maintaining radial length particularly for those patients followed for >2 years. It also has been noted that a higher initial cost and a greater number of minor complications are associated with external fixation.27

New techniques have been developed including injectable calcium phosphate paste in the treatment of distal radius fractures. Some of the initial biomechanical studies report fracture stability is comparable to the stability achieved with pin fixation.28,29

**OPEN REDUCTION AND INTERNAL FIXATION**

The management of distal radius fractures by internal fixation and early function has resulted in improved clinical outcomes. There are several techniques and plates that have been developed including the Pi plate developed by Jupiter,30 the AO titanium plates for the distal radius,31 and the low-profile distal radial plate.32 These plating techniques have demonstrated good to excellent results in >80% of patients. The anatomical parameters are restored and maintained satisfactorily with a relatively low complication rate.

In a randomized study comparing the methods of closed reduction, external fixation, and open reduction with internal fixation, Kapoor et al.33 demonstrated a significant advantage in terms of the final outcome in the management of patients with an external fixator. This management resulted in 80% good and excellent results compared to 63% good and excellent results in the group treated with open reduction and internal fixation and 43% good and excellent results in those patients managed with plaster.

More recent developments, particularly with improved arthroscopic surgical techniques of the wrist, have reported management of distal radius fractures with arthroscopic-assisted reduction. The value of this technique has been in improving the degree of anatomical reduction, but it also highlighted the presence of other soft-tissue lesions in conjunction with distal radius fractures. The most common lesion associated with distal radius fractures is a tear in the triangular fibrocartilage complex. This was noted in 35% of patients with intra-articular fractures and 53% of patients with extra-articular fractures. Scapholunate ligament injuries with instability in patients with intra-articular fractures have a 21.5% incidence rate and 6.7% in extra-articular fractures.34

Although wrist arthroscopy has been of additional diagnostic value, the clinical outcome following arthroscopic-assisted reduction is not significantly better than reported outcomes following open reduction and internal fixation.

**SUMMARY**

Distal radius fractures are the most common fractures that present in emergency rooms. There is a high association of coexisting soft-tissue injury to the wrist, which is detected with the introduction of wrist arthroscopy in the management of this injury.

The numerous treatment modalities...
described for these fractures and the general outcomes reported at 12-month follow-up show no significant difference in the outcome when comparing most methodologies. However, the problem in comparing such studies is that there has been no uniform fracture classification system reported and there is no significant similarity in the clinical outcome measures used. There also is a paucity of randomized controlled trials comparing these various techniques.

It has been >180 years since Colles described fractures of the distal radius, and the management options are still not clearly defined. Therefore, an evidence-based model of management needs to be developed.

REFERENCES

EDITORIAL COMMENT
ORTHOPEDICS: A unanimously accepted distal radius fracture classification would standardize fracture configurations as a constant, allowing methods of treatment to be treated as independent variables. As the author points out in this article, this would substantially improve scientific comparison when analyzing outcome parameters and in seeking evidence-based guidance in treatment methodology. Such a classification might serve as a discriminator for both treatment and expectations.

The search for a single unifying distal radius fracture classification has, however, proven elusive. The relative unanimity seen with uncomplicated extra-articular fractures progressively evaporates as comminution and complexity increase. Intra- and extraobserver reliability suffers a similar fate. Articular, soft-tissue, ulnar, and carpal injuries as well as variations in bone density further cloud the issue. Patient motivation may influence outcome. It may be a quixotic dream to think that we can apply a truly statistical significant scientific method with a single independent variable in a prospective, double-blind, randomized setting with sufficient follow-up, but we should try. Cooperation among multiple investigators may be needed.

There also is the matter of treatment. Differences in training, instrument and implant availability, intraoperative radiograph capability, and the perception of future patient compliance are among the parameters that may influence treatment selection. We are