Review

Distal radius fractures: treatment options

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Abstract

Distal radius fractures are one of the commonest injuries worldwide, second only to hip fractures with a substantial social and economic burden. Over the last years treatment of these fractures has passed from the inexpensive means of casting and percutaneous pinning to the use of anatomical locking plates and specific fragment plates.
Current classification systems fail to guide the management of these fractures in a consistent manner and although the parameters of acceptable reduction and the indications for surgical treatment remain clear for younger patients, elderly patients can tolerate small to moderate degrees of displacement and malunion without significant changes in their everyday functionality. Improvement in the design of fixation materials and adequate training of orthopedic surgeons lead to lower complication rates and restoration of functionality with shorter recovery times, but to this day there is not enough scientific evidence to definitively advocate for one method over another despite the number of studies and some meta-analyses in recent years.

Keywords

Distal radius; Distal radius fractures; Wrist fractures; Distal radius fractures treatment options

Introduction

Distal radius fractures are either low energy injuries in middle-aged and elderly population or high-energy injuries in young adults.[1] Historically, the management of these fractures has been based on closed reduction and cast immobilization, while surgical treatment was based on the use of external fixators and/or Kirschner wires.[2] In the last two

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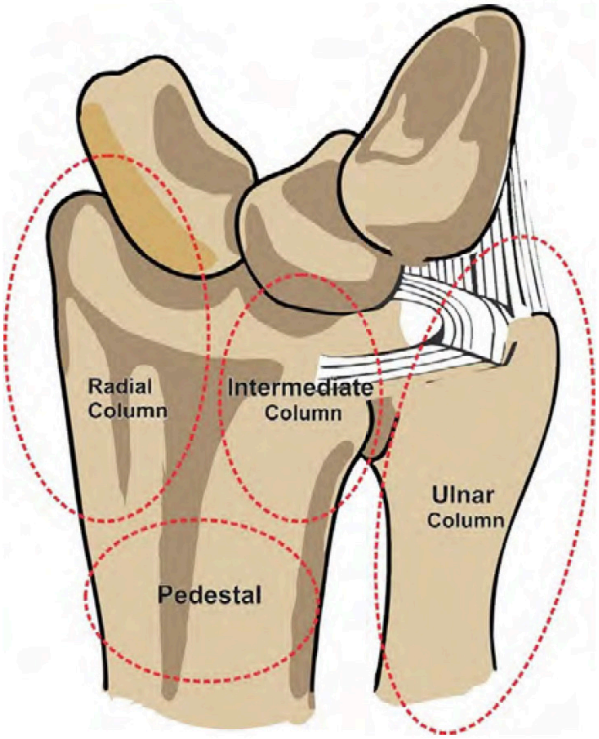

Figure 1. *The columnar concept of the wrist as introduced by Rikli and Regazzoni. (Rachuene PA, Du Toit FJ, Tsolo GK, Khanyile SM, Tiadi MJ, Golele SS. Distal radius fractures: current concepts. SA Orthop J 2021;20(4):231-239.)*

decades the widespread use of palmar anatomic plates has brought changes in prognosis as well as increased economic burden in Health Care Systems around the world.[3] Indicatively, the incidence of distal radius fractures in elderly patients in USA reaches 643,000 per year leading to a cost of 535 million dollars.[4]

Elements of Anatomy

According to the three-column theory, the distal radius, ulna, and distal radioulnar joint are functionally divided into three columns: the radial, middle, and ulnar columns. (Figure 1) The radial and middle columns are supported by the radial metaphysis and bear approximately 80% of the axial loading at the radiocarpal joint.[5,6] The middle column receives most of the axial loading and consists of the lunate fossa and the sigmoid notch. The dorsal wall, volar rim and dorsal ulnar corner fractures are specific types of middle column fractures and are the result of shear forces or axial loading, and are usually associated with instability.[4]

Clinical Evaluation

Neurovascular assessment is of great importance after a fracture of the distal radius. Careful evaluation of the median nerve is crucial, especially when the patient reports numbness of the fingers or paresthesia in order to rule out acute carpal tunnel syndrome. The incidence ranges from 0.2-21.3% of the patients diagnosed with a distal radius fracture requiring immediate surgical decompression.[7,8]

Imaging studies and radiographic parameters

Basic imaging of a distal radius fracture includes anteroposterior and lateral radiographs as well as oblique views.[2] Five radiographic parameters of the distal radius are evaluated: radial height; radial inclination; ulnar variance; volar tilt and articular step-off. [9] Furthermore, the distal radioulnar joint (DRUJ) and the ulnar styloid process are also evaluated.[2,10] Computed tomography is a useful tool for evaluation of the articular surface and provides valuable information for the surgical planning. CT scan can detect more complex injuries including distal radioulnar joint and scaphoid fractures. Finally, studies show that 3D-CT scans offer important information for the management of these fractures.[1,2,5]

Classification

Many classification systems have attempted to emphasize key parameters to better understand the fracture mechanism. The Frykman classification focuses on the intra-articular extension of the fracture and the involvement of the ulnar styloid process.[11] The Melone classification refers specifically to intra-articular fractures,[12] whereas the AO classification is the most comprehensive, with 27 subcategories,[13] while the Fernandez and Jupiter classification considers the injury mechanism.[14] (Figure 2)

Treatment

The goal of treatment of the distal radius fractures is the anatomical and functional restoration of the ra-

Fracture type (adults) based on the mechanism of injury	Children fracture equivalent	Stability/ instability: high risk of secondary displacement after initial adequate reduction	Displacement pattern	No. of fragments	Associated lesions: carpal ligament, fractures, median, ulnar nerve, tendons, ipsilateral upper extremity, compartment syndrome	Recommended treatment
Type I: bending fracture of the metaphysis	Distal forearm fracture: Salter II	Stable, unstable	Nondisplaced Dorsal (Colles-Pouteau) Volar (Smith) Proximal Combined	Always two main fragments + varying degree of metaphyseal comminution (instability)	Uncommon	Conservative (stable fractures) Percutaneous pinning (extra- or intrafocal) External fixation Exceptionally: bone graft
Type II: shearing fracture of the joint surface	Salter IV	Unstable	Dorsal Radial Volar Proximal Combined	Two-part Three-part Comminuted	Less uncommon	Open reduction Screwplate fixation
Type III: compression fracture of the joint surface	Salter III, IV, V	Stable, unstable	Nondisplaced Dorsal Radial Volar Proximal Combined	Two-part Three-part Four-part Comminuted	Common	Conservative closed, limited, arthroscopic assisted, or extensile open reduction Percutaneous pins combined external and internal fixation Bone Graft
Type IV: avulsion fractures, radiocarpal fracture, dislocation	Rare	Unstable	Dorsal Radial Volar Proximal Combined	Two-part (radial styloid ulnar styloid) Three-part (volar, dorsal margin) Comminuted	Frequent	Closed or open reduction Pin or screw fixation Tension wiring
Type V: combined fractures (I, II, III, IV); high-velocity injury	Rare	Unstable	Dorsal Radial Volar Proximal Combined	Comminuted and/or bone loss (frequently intraarticular, open, seldom extraarticular)	Always present	Combined method

Figure 2. *Fernandez Classification (Ilyas AM, Jupiter JB. Distal radius fractures – Classification of treatment and indications for surgery. Hand Clin 26 (2010) 37-42. doi:10.1016/j.hcl.2009.08.003)*

diocarpal joint. Important factors in decision-making include the type and the stability of the fracture, the patient's age, the functional demands, the hand dominance, and other individualized factors.[15]

Radiographic criteria have been established for acceptable alignment such as radial shortening of less than 2mm, radial inclination no less than 10°, 10° dorsal to 20° volar tilt and intrarticular step-off less than 2mm.[2,9]

Furthermore, instability is defined as the inability of a fracture to resist displacement after being manipulated into an anatomic position. Dorsal angulation > 20°, dorsal comminution, metaphyseal comminution, loss of radial height > 5 mm, intra-articular fractures, concomitant ulnar fracture and age > 60 years are considered factors of instability.[1] According to a meta-analysis by Walenkamp et al., the most important factors of instability are dorsal comminution, female gender and age over 60.[16]

Non-Surgical Treatment

Management of distal radius fractures with closed reduction and immobilization with a splint/cast remains the mainstay of treatment for non-displaced or stable fractures after reduction. Several methods of anesthesia, reduction and immobilization have been described without, however, showing that one method is superior to the other, based on the existing literature.[17] After closed reduction and splinting patients are monitored radiologically for the first three weeks for the possible loss of reduction and finally after splint removal.[2]

Closed reduction and percutaneous pin fixation

Stable extra-articular fractures of the distal radius can be treated with closed reduction and percutaneous pinning.[1] Several fixation methods have been described in the literature aiming in fracture stability and early mobilization, and their common feature is the use of at least three Kirschner-wires (K/W) to en-

Figure 3. Comminuted distal radius and ulna fracture treated with an external fixator

Figure 4. Distal radius fracture treated with volar anatomical locking plate

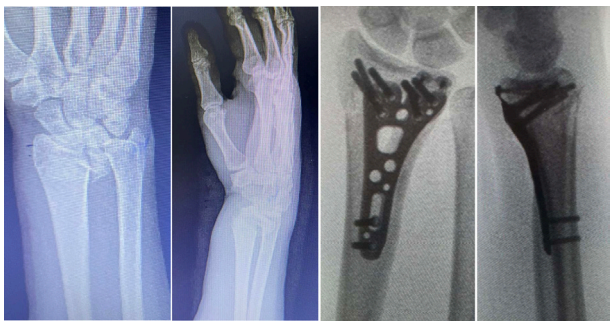

Figure 5. Distal radius fracture with a volar rim fragment treated with an anatomical rim plate

sure stability.[18] In the Kapandji technique, the K/Ws are placed at the fracture site thereby leveraging the reduction.[19] However, percutaneous K/W fixation provides relative stability and often requires additional immobilization with a splint or with external fixators. Several studies showed good long-term results,[20,21] however in a meta-analysis by Handoll et al. the use of K/Ws is supported, but the occurrence of complications such tendon rupture, nerve damage and pin site infections should be taken into account.[22]

External fixation

External fixation is still a viable option for complex intra-articular or open fractures of the distal radius, however the indications for use have decreased due to improved internal fixation techniques and materials.[2] External fixation is based on ligamentotaxis to maintain fracture reduction[23] and is a useful tool for temporary fracture stabilization in polytrauma patient or open fractures with severe soft tissue damage, as well as an adjunctive tool in cases of relative instability with internal osteosynthesis methods.[24] (Figure 3) There are non-bridging external fixation devices, where the device does not cross the carpal joint, and bridging devices, with the latter being the most common. It must be underlined that external fixators must be combined with augmentation methods (K/Ws and/or bone grafting) in cases of metaphyseal comminution.[25] In a prospective randomized study Egol et al. compared external fixation with adjunctive K-wire fixation and internal fixation with locking palmar plates for unstable fractures of the distal radius found similar functional outcomes and complication rates at the first year of follow-up.[26] Similarly, Roh et al. reported comparable functional outcomes between external and internal fixation methods with a palmar plate in a prospective randomized study of 92 patients with minimal follow-up at 12 months.[27]

Internal fixation

The main goal of internal fixation is to restore the anatomy of the distal radius and the function of the wrist. Fixation with volar fixed-angle plates offers anatomic reduction of the volar cortex and enables restoration of radial length, radial inclination, and volar tilt.[1,2]

Palmar plating

Regardless of palmar or dorsal displacement of the distal radius, the use of a palmar anatomic plate is a good option for both intra- and extra-articular fractures while minimizing some of the soft tissue complications.[28] The Henry and the FCR (and the extended FCR) approaches are the most frequently used approaches for internal fixation of the distal radius fractures.[1] The choice of plate is individualized according to the fracture, patient characteristics and

surgeon experience.[29] Locking anatomic plates added greater fracture stability. Most locking palmar plates allow for multiaxial screw fixation while retaining reduction of small fragments through a multihole design.[4] (Figure 4) All the above make these plates very useful in cases of fracture comminution in elderly patients with coexisting osteoporosis. Most studies support the use of palmar plates as superior to dorsal plates as the surgical approach is less harmful to soft tissues and it is believed that the metaphyseal blood supply of the bone is preserved.[1] Most retrospective and comparative studies have shown good results with the use of palmar anatomical plates in the treatment of unstable and comminuted fractures of the distal radius. In particular, comparative studies between fixation with palmar plates and percutaneous fixation showed better functional outcomes for patients treated with internal fixation.[18] However, the superiority of internal fixation over external fixation has not been demonstrated.[27] Finally, the use of palmar plates is accompanied by some complications, mainly loss of reduction and complex regional pain syndrome.[2] A study by Johnson et al. showed a complication rate of up to 9.7%, which is lower than other methods of treating distal radius fractures. Other complications include tendon tears, with the flexor pollicis longus being the most commonly involved tendon, as well as irritation and extensor tendon tear from palmar screws that penetrate the dorsal cortex.[28]

Dorsal plating

In general, dorsal plates are used in cases with an extensive dorsal comminution.[30] Historically, this approach has been associated with higher complication rates and a risk of extensor tendon irritation and rupture despite the fact that newer material design has been shown to reduce the risk of tendon abrasion.[2,30] Spiteri et al. reported no tendon rupture in 46 patients using low-profile plates at five-year follow-up, while 8.7% of patients reported irritation and underwent material removal. A different technique, which is useful in high-energy comminuted fractures, uses a bridging plate between the metacarpal and radial diaphysis (Joint Spanning Distraction Plating), with a 3.5 mm limited contact dynamic compression plate (LC-DCP) with 12 to 16 holes. These plates must be removed relatively early, approximately at 12 weeks postoperatively.[32]

Fragment specific fixation

Some complex, high-energy fractures require a combination of small special low-profile plates and techniques. These techniques rely on the experience of the surgeon and the specially designed material for the individual fracture fragments.[2] (Figure 5) A comparative biomechanical study by Dodds et al. in four-part compound fractures showed good results in relation to the use of external fixation.[25] In addition, retrospective clinical studies report good functional outcomes with a low rate of complications, however a comparative prospective study by Sammer et al. showed that the use of palmar anatomical plates is superior in terms of functional results and complication rate compared to the use of special plates.[33]

Arthroscopically assisted fixation

Arthroscopically assisted fixation is a distinct method applied to intra-articular fractures in the last three decades.[1] Nevertheless, it has not managed to gain popularity among surgeons as it is a time-consuming and technically demanding method with risk of postoperative compartment syndrome.[34] Until now, the intraoperative evaluation of the articular surface of the radius in the majority of cases is done fluoroscopically, however, it was shown that arthroscopy is superior in the evaluation of intra-articular fractures and the potential wrist ligament and TFCC ruptures.[35]

Osteoporosis

According to recent literature, distal radius fractures represent an atypical precursor of osteoporotic spine and hip fractures.[1] It is imperative to recognize risk factors in patients with distal radius fractures and to treat them adequately for osteoporosis, so as to avoid future fragility fractures.[36]

Conclusion

The treatment of the distal radius fractures remains a difficult problem that depends primarily on the clinical experience of the surgeon. Unfortunately, there is not enough scientific evidence to definitive-

ly advocate for one method over another despite the number of studies and some meta-analyses in recent years.[2] Regarding younger patients, the parameters of acceptable reduction and the indications for surgical treatment remain clear as any deviation can lead to unacceptable functional results. In contrast, elderly patients can tolerate small to moderate degrees of displacement and malunion without significant changes in their function.[1] However, it seems that the trend in recent years leads to the surgical treatment of fractures in these age groups as well.[1] In conclusion, non-surgical management of distal radius fractures is the ideal option for most of cases leading to good functional outcomes. Improvement in the design of fixation materials and adequate training of orthopedic surgeons lead to lower complication rates and restoration of functionality with shorter recovery times.

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