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Review

Stabilisation of distal radius fractures: Lessons learned and future directions

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ABSTRACT

Our understanding of the diagnosis and management of distal radius fractures has been a long developed over centuries. There has been a shift in treatment of these very common injuries from closed reduction and casting to internal fixation. The answer to the best method of treatment has yet to be found. Today, we have a multitude of treatment options available with varying degrees of evidence to support their use. This review helps to illustrate the lessons we have learned and future directions for treatment.

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Introduction

Our knowledge of distal radius fractures has grown greatly since J.L. Petit first noted in the 18th century that what was once thought to be a dislocation of the carpus might indeed be a fracture at the distal aspect of the radius. Dupuytren, Voillemier, Barton, Smith, and most notably Colles all helped recognise, define, and establish early treatments for what is now accepted as one of the most common musculoskeletal fractures in the human body. Over the years, treatment of these fractures has evolved. Whilst there is no clear "best" treatment for distal radius fractures, our armamentarium is ever expanding with new and old techniques alike, thus providing us with a way to treat these notorious fractures.

Anatomy and stability

Early knowledge of distal radius fractures was centred on appropriate reduction of the fracture. In their historic article Gartland and Werley noted that dorsal tilt, radial deviation and

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shortening were key components of the fracture and important aspects of the reduction to address [1]. They noted that there was a worse functional outcome in those fractures that tended to settle. McQueen and colleagues later went on to further show that patients with fractures having residual dorsal angulation after reduction greater than 12° demonstrated significantly worse grip strength, range of motion, and ability to perform activities of daily living ($p < 0.05$) [2]. The early treatment goals for distal radius fractures were thus focused on extra-articular reduction, with restoration of radial length and maintenance of volar tilt [1,3–6].

As understanding of this injury progressed it became clear there was an importance in acknowledging the relationship between the distal radius and the carpus. The column theory developed, indicating the importance that the medial, intermediate, and lateral columns of the distal radius play in the carpus [7]. The medial, or ulnar column, serves as an axis for forearm and wrist rotation as well as a platform for secondary load transmission. The intermediate column acts in primary load transmissions and the lateral, or radial, column is a bony buttress for the carpus and serves as an attachment point for the intracapsular ligaments.

Intra-articular incongruity after treatment of distal radius fractures has been found to correlate with the development of arthritis [8–10]. What may be more interesting, however, is that even with the development of arthritis, function has been well preserved. Catalano et al.'s study looking at long term results in young adults after open reduction and internal fixation found that at an average of 7 years development of osteoarthritis of the radiocarpal joint correlated with residual displacement of articular fragments at the time of osseous union [9]. However, the functional status at time of follow up did not correlate with the magnitude of the residual step and gap displacement at the time of healing. They found that all patients had a good or excellent functional outcome regardless of radiographic evidence of osteoarthrosis of the radiocarpal or the distal radio-ulnar joint or non-union of the ulnar styloid process [9].

Similarly, Goldfarb et al. used Musculoskeletal Functional Assessment and the Hand Function Sort questionnaires to assess function at 15 year follow up. Despite worsening arthritis, patients maintained a high level of function at their long-term follow-up evaluation [10]. What may be a more important predictor of function is the loss of radiocarpal alignment. McQueen et al. performed a prospective randomised trial of 120 patients who were unable to maintain closed reduction in a plaster cast. What was found to be statistically significant in the final outcome was that carpal malalignment had a negative effect on function [11].

In addition to better understanding the anatomic importance and impact reduction may have on function, the stability of the fracture is also important when considering a method of stabilisation. Lafontaine published five predictors of instability in the fracture: (1) Initial dorsal angulation greater than 20°, (2) the presence of dorsal comminution, (3) intra-articular radiocarpal fracture, (4) presence of an ulnar fractures, and (5) patient age older than 60 years. He noted that one may want to consider early surgical fixation if three or more the above criteria are present given the increased propensity for fracture displacement [12]. This knowledge, together with the understanding of how the articular surface of the distal radius interacts with the carpus and its kinematics, has shifted the trend from historically treating these fractures with closed reduction and plaster cast treatment to the more widely used surgical treatment.

Closed treatment and casting

Closed reduction and immobilisation is an acceptable and practiced treatment today in distal radius fractures that are stable. It is important to monitor for loss of reduction, however. Lafontaine's criteria can help guide decision-making regarding treatment and risk for loss of reduction. In addition to the above listed criteria, bone mineral density can play a role in distal radius fracture instability. Poor bone mineral density can result in a 30–50% risk for secondary displacement after reduction and splinting [13]. In those fractures where closed treatment is deemed acceptable, a splint is usually used for the first few days to allow subsidence of swelling, followed by a cast or removable wrist splint. It is the opinion of the AAOS that distal radius fractures treated nonoperatively be followed with weekly radiographs for the first 3 weeks and at the conclusion of immobilisation in order to monitor fracture alignment [14]. Still, not all distal radius fractures are amenable to nonoperative treatment and thus our toolbox of possibilities for surgical intervention must be explored.

Closed reduction and percutaneous pinning

Knowing that some fractures are inherently unstable and at risk for displacement, augmentation of the closed reduction with percutaneous pinning has been a good option for years (Fig. 1). Cross-pinning with two radial styloid pins and placement of a pin from the ulnar corner of the radius has been shown to be the most rigid construct in both torsion and cantilever bending. Adding a fourth pin to the construct required at least a .062-inch pin to be used for any significant changes in rigidity of the four pin configurations tested to be discerned [15]. Long-term outcomes of patients treated with closed reduction and percutaneous pinning have been promising. Whilst retrospective, a review of 54 patients with 55 AO type A2, A3, C1, or C2 distal radius fractures treated with closed reduction and percutaneous pinning were found to have excellent range of motion, normal Disabilities of the Arm, Shoulder, and Hand (DASH) scores, and no significant differences in the radiographic parameters between fracture fixation and fracture healing [16].

What we learned from percutaneous pinning is that it is not appropriate for all patients with similar fractures. As pins are not load bearing devices they are limited in their ability to maintain support in fractures with metaphyseal comminution, especially in the osteoporotic bone of the elderly [17]. In a prospective randomised study of 57 patients older than 60 years of age with unstable, extra-articular distal radius fractures percutaneous fixation has been found to provide only marginal improvement in radiological parameters compared to a cast alone and did not correlate with an improved function outcome [18]. McFadyen et al. showed in their prospective randomised controlled trial that patients with unstable extra-articular distal radius fractures had

Fig. 1. Postoperative radiographs showing the utilisation of percutaneous pinning.