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Volar plate versus k-wire fixation of distal radius fractures

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ABSTRACT

The optimal management of distal radius fractures remains controversial. The aim of this study was to compare the radiographic and functional outcomes of 318 patients who underwent k-wire fixation or volar plating for fractures of the distal radius. Patients were aged between 20 and 65 years and followed for a mean of 32 months. The mean values for volar tilt, radial inclination, radial length and ulnar variance were all significantly better in the volar plate group. Malunion occurred in 13.2% of patients undergoing k-wiring and 4% of patients treated with a volar plate ($p < 0.007$). Higher values for radial inclination, radial length and volar tilt correlated with better functional outcome as measured by disabilities of the arm shoulder and hand (DASH) and patient rated wrist evaluation (PRWE) scores. Lower values for ulnar variance correlated with better functional outcome. Although volar plate treatment resulted in a superior radiological outcome, there was no evidence that this translated into a superior functional outcome (DASH 13.12 vs. 11.25, $p = 0.28$) (PRWE 17.56 vs. 16.31, $p = 0.69$). The k-wiring procedure remains a suitable inexpensive option for simple fractures. Volar plating should be reserved for complex fractures that cannot be reduced by closed means.

Introduction

Fractures of the distal radius are the most common fractures of the human skeleton [1]. The optimal management of these common fractures remains controversial. Treatment options include manipulation and casting, Kirschner (k)-wire fixation, volar or dorsal locking plates and external fixation. The use of volar locking plates for distal radial fractures (DRF) has become increasingly popular. One of the advantages of volar locking plates is increased pullout strength in osteoporotic bone [2,3]. In addition to this, the volar plate construct allows for earlier active range of motion.

It has previously been demonstrated that, with increasing age, patients are more tolerant of functional deficits or imperfect radiological outcome [4]. A younger age profile may influence the treating surgeon to choose volar plating over k-wire fixation in an effort to accelerate rehabilitation. There is, however, a paucity of clinical data to endorse its superiority, when examining medium-term functional outcome in younger adults (age 20–65 years). The aim of this study was to determine whether volar plate or k-wire fixation achieved a better radiological outcome and whether this translated to a better functional outcome.

Patients and methods

Institutional review board approval was granted for this retrospective study. Between October 2006 and May 2010, 565 DRFs were treated in our level 2 trauma centre. Indication for fixation included fractures with dorsal angulation of $>10^{\circ}$, an articular step-off of >2 mm, a radial inclination of $<10^{\circ}$ or radial shortening of >5 mm. The method of fixation was based on the surgeon's preference. Inclusion criterion was patients between the ages of 20 and 65 years undergoing k-wire or volar plate fixation for distal radius fracture. The exclusion criteria for this study were those patients undergoing manipulation and casting, external fixation, ipsilateral upper limb injury, prior distal radius fracture and skeletal immaturity. Extrafocal percutaneous fixation using k-wires was performed following closed indirect reduction. Patients were immobilised post-operatively in a below-elbow plaster of

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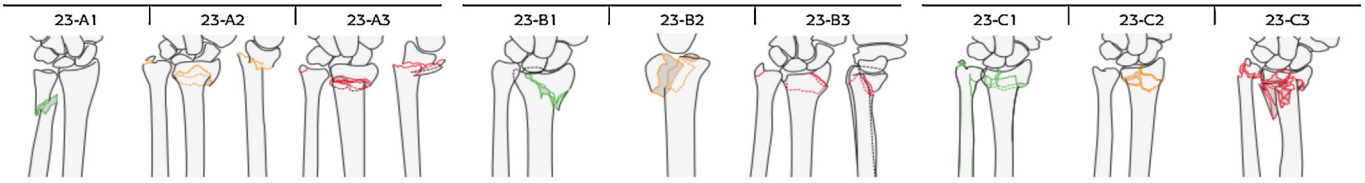

23-A extraarticular fracture
23-A1 ulna fractured, radius intact
23-A2 radius, simple and impacted
23-A3 radius, multifragmentary

23-B partial articular fracture of radius
23-B1 sagittal
23-B2 coronal, dorsal rim
23-B3 coronal, palmar rim

23-C complete articular fracture of radius
23-C1 articular simple, metaphyseal simple
23-C2 articular simple, metaphyseal multifragmentary
23-C3 articular multifragmentary

Fig. 1. Orthopaedic Trauma Association classification of distal radius fractures.

Paris cast. k-Wires were removed in the outpatient department at 6 weeks.

A distal Henry approach was used to perform volar plating through the bed of flexor carpi radialis under tourniquet control. The implants inserted were the Acu-Loc volar distal radius plate (Accumed Ltd., Hampshire, UK) or the AO distal radius plate (Synthes, Zuchwil, Switzerland). In an effort to avoid penetration of the dorsal cortex and attritional extensor tendon rupture, 2 mm was routinely subtracted from the measured length of the distal locking screws prior to insertion. A routine repair of the pronator quadratus was completed. Patients were immobilised post-operatively in a cast or Futura splint for 4 weeks. Patients in both groups followed a rehabilitation protocol under the supervision of a physiotherapist.

Patients could access the final follow-up radiographs on the Picture Archiving and Communication system (PACS). These were analysed for radiological parameters including radial inclination, volar tilt, radial length and ulnar variance. Unacceptable radiological outcome was defined as radial inclination $> 16^{\circ}$, volar tilt $< -10^{\circ}$, radial length < 7 mm and ulnar variance $> +5$ mm or > -4 mm. Fractures were classified according to the Orthopaedic Trauma Association (OTA) classification system (Fig. 1) [5].

Patients completed the upper-limb DASH questionnaire. This contains 30 items querying symptoms and function related to arm pathology. It is scored from 0 to 100 with a higher score indicating greater disability. The minimum clinically important difference for this instrument is about 10 points [6]. Patients also completed the patient-rated wrist evaluation (PRWE) questionnaire. This consists of 15 questions; five questions are pain specific and 10 relate to function. The PRWE is scored from 0 to 100 with a higher score indicating more disability. Patient age, sex, hand dominance, length of follow-up and complications including further surgery were documented.

Statistical analysis

Each of the continuous variables in the data set was tested to see if they were normally distributed. Normally distributed data were compared using Student's *t*-test. Data deemed to be not normally distributed were compared using a Wilcoxon Rank Sum test. Chi-squared test was used to compare categorical variables. Risk factors for unacceptable radiological and functional outcome were then examined using logistic regression.

Results

A total of 318 patients were found to be eligible including 112 males and 206 females. Mean length of follow-up was 32.2 months (range: 12–60). Table 1 shows the age, sex and OTA classification. Patients were more likely to receive volar plate fixation if the dominant hand was injured ($p = 0.01$).

Radiological outcome

Radiological outcomes were significantly better for all four variables in the volar plate group (Fig. 2 and Table 2). The probability of an unacceptable radiological outcome was significantly greater if the patient was treated with k-wire fixation ($p = 0.007$).

The logistic regression model had a negative parameter of -1.51 for volar plate treatment and a positive parameter of 0.09 for age, both highly significant ($p = 0.002$, $p = 0.0001$). This indicated that volar plate treatment significantly reduced the probability of unacceptable radiological outcome, whilst increasing age significantly increased the probability of unacceptable radiological outcome (Fig. 3 and Table 3).

Functional outcome

Functional scores were collected on 244 (77%) patients. PRWE and DASH scores were negatively correlated with each of radial inclination, radial length and volar tilt. Conversely, each score was positively correlated with ulnar variance. Neither of the two functional scores differed significantly by treatment type ($p = 0.84$ for DASH and $p = 0.69$ for PRWE) (Fig. 4, Table 4). Depending on whether the dominant hand was injured, no significant difference was found in either functional score (DASH score, $p = 0.23$; PRWE score, $p = 0.41$).

Discussion

The aim of this study was to compare the radiographic and functional outcomes of patients undergoing volar plate and k-wire fixation for distal radius fractures (Fig. 5). The key finding was that although superior radiological results were achieved with volar plating, these results did not correlate with a better functional outcome compared to k-wiring at 32 months' follow-up. Treatment of distal radius fracture with a volar plate was shown to significantly reduce the probability of unacceptable radiological outcome; malunion occurred in 4% of patients treated with a volar plate compared to 13.2% of patients treated with k-wire. Notably, increasing age also significantly increased the probability of unacceptable radiological outcome.

Table 1
Patient demographics and OTA classification for treatment groups.

	Volar plate	k-Wire
Age	47.9	45.5
Sex		
Male	61	51
Female	90	116
OTA type		
A	66	91
B	56	61
C	29	15