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ORIGINAL STUDY

A comparison of outcomes of K-wire vs plate fixation for distal radial fractures with regard to patients' quality of life

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The objective of the study was a comparison of outcomes of K-wire vs plate fixation for distal radial fractures with regard to patients' quality of life. One hundred and two patients, 79 women and 23 men with displaced distal radial fractures, were non-randomly allocated for either K-wire (n=72) or palmar plate (n=30) fixation. In general, simpler fractures were fixed by pins, while plates were used for those that were more severe. No statistically significant differences were seen at 3- and 6-month follow-up assessment in any of the analyzed variables: wrist range of motion, total grip and key-pinch strength, and the DASH and SF-36 scores. We conclude that being guided by the postulated algorithm in treatment-choice of distal radial fractures is a reasonable balance between clinical- and cost-effectiveness. We also failed to find any advantage in health-related quality of life as an outcome measure in distal radial fractures compared to standard measures

Keywords : Distal radial fractures ; Operative treatment ; Outcome measures ; Quality of life.

INTRODUCTION

There are several options of operative treatment for distal radial fractures, but two methods are most commonly used: palmar plate and percutaneous K-wire fixation. Although the former technique has attracted increasing popularity in recent years, the latter is still useful for selected fractures. A direct comparison of these techniques shows no significant differences in mid-term (6-12 months) clinical outcomes, with K-wire fixation being simpler and cheaper *(1,2,3)*. Obviously, not all fractures are suitable for pinning. Complex, comminuted and multifragmental fractures are difficult to closed reduction and K-wire fixation in anatomical position. Further maintaining the reduction until fracture healing is also problematic. Open reduction and palmar plate fixation is then a better (safer) option *(9)*.

Multiple outcome measures have been described to measure the success of the treatment of distal radius fractures, including general, anatomy-specific, patient-reported subjective scales, objective and radiographic measurements *(10)*. Only single studies have evaluated the impact of the fracture and its treatment on the general health and quality of life of patients. Sustained injury may disturb many aspects of daily life; not only physical, but

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also mental, emotional and economical, therefore it seems reasonable to include this aspect in a complex assessment of outcomes for the treatment. The SF-36 questionnaire has gained popularity as an instrument for measuring the impact of various life events on the general health of patients *(10)*.

The objective of the study was a comparison of outcomes of K-wire vs plate fixation for distal radial fractures with regard to patients' quality of life.

MATERIALS AND METHODS

The study obtained the approval of the Ethics Committee in the local Medical University. Patients referred to the authors' institution with distal radial fractures during the first 6 months of 2013 were recruited. Subjects with bilateral fractures, serious mental disorders and who did not agree to participate in the trial were excluded. Initially the group consisted of 111 patients, but nine (8%) did not attend the final follow-up and were excluded. Eventually the study group comprised 102 persons, 79 women (77%) and 23 men (23%) with a mean age of 54 (range : 36-87) years. Fifty-two patients sustained fracture of the dominant, and 50 of the non-dominant limb. Seventy-two (70%) had isolated distal radial fracture and 30 (30%) had concomitant ulnar styloid fracture (this was not addressed at operative treatment).

Seventy-two patients (70%) were operated on by closed reduction and percutaneous fixation with K-wires, and 30 patients received open reduction and internal fixation with palmar locking palmar plates (Aptus, Medartis). Demographic and clinical data for each group are shown in Table 1. Patients were selected to the operative method according to the algorithm (based on AO classification) that has been used in the authors' institution for about 10 years *(13)*. Fracture configurations A2, A3, B2, C1 and some C2 were operated on by closed reduction and percutaneous K-wire pinning. Fracture configurations B3, C3 and some C2 were given open surgery with locking palmar plate fixation. The mode of treatment for C2 fractures was at the discretion of the operating surgeon. The distribution of particular fracture configurations in treatment group types is provided in Table1. The difference in number of patients assigned to particular treatment method (72 vs 30) resulted from greater number of fractures configurations suitable for pinning identified within a study period frame. This reflects typical proportion of these fractures types seen in our institution.

The closed operative technique consisted of mixed transtyloid and intrafocal fixation, with 5-7 K-wires of 1.4-1.6 mm diameter ("augmented" fixation) (Fig. 1). Open reduction and internal fixation was performed in the standard way. All operations were performed under brachial plexus block anaesthesia. Post-operatively, the patients operated on by pinning had the wrist immobilized with a short palmar plaster splint for four weeks, and those with plate fixation had a plaster splint for only one week. The K-wires were removed as an office procedure at 6-8 weeks post operatively. The patients were not given formal physiotherapy (not commonly available in the authors' country).

The patients were followed up twice; at 3 and 6 months after fracture and surgery, according

Table 1. — Comparison of demographics of patients in the study

Variable	K-wire n= 72	Palmar plate n= 30	Statistical significance
Age (mean and range)	56 (22-87)	49 (24-71)	p=0.07
Sex F/M	61/11	18/12	p<0.01
Hand involved right/left	35/37	13/17	p=0.63
Fracture configuration in AO classification	A2-6 A3-25 B2-5 C1-26 C2-10	B3-5 C2-18 C3-7	

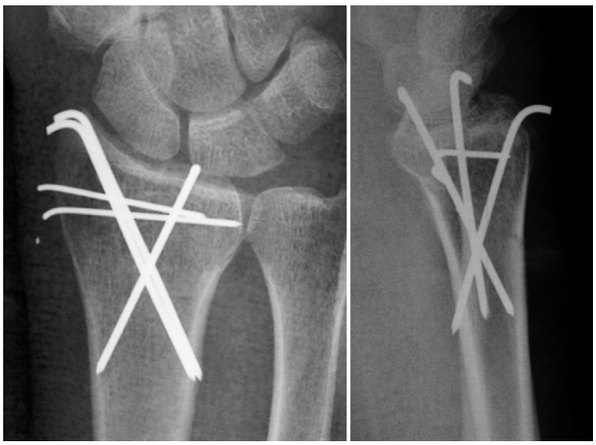

Fig 1. — C1 type distal radial fracture fixed by „augmented" K-wire technique

to the same protocol: objective measurements, including wrist range of motion, total grip and key-pinch strength, subjective hand function (DASH) and health-related quality of life (SF-36). The outcomes obtained in both groups were compared and statistical analysis has been made using the U Mann-Whitney test.

RAND SF-36 questionnaire

The SF-36 is a generic health-related quality of life questionnaire consisting of 36 items grouped in 8 scales (domains): PF - Physical Functioning, RP - Role Physical (role limitations because of physical health problems), BP - Bodily Pain, GH - General Health, VT-Vitality, SF-Social Functioning, RE-Role Emotional (role limitations because of emotional problems) and MH-Mental Health. The first four domains consist of physical, and the latter four domains of mental components. Raw scores from each item are next translated into a final score ranging from 0 (poor health) to 100 (optimal health). The questionnaire also comprises one separate question not related to any scale. This concerns the patient's feeling of his/her actual health status, compared to their status from one year before. This outcome was recorded using a three-grade scale: better, the same or worse than a year before.

Table 2. — Comparison of physical outcomes at 3 and 6 months

Variable	K -wire n=72		Palmar plate n=30		Stat. sign.
	Meanz	Range	Mean	Range	
At 3 months assesment					
Palmar flexion	38°	14-75	40°	10-72	p=0.68
Dorsal flexion	33°	2-60	36°	10-74	p=0.30
Ulnar deviation	24°	3-48	24°	9-50	p=0.81
Radial deviation	15°	0-34	16°	2-28	p=0.54
Total grip strength	38%	3-88	39%	0-97	p=0.94
Key pinch strength	67%	17-115	63%	2-96	p=0.81
DASH score	41	7-82	37	0-82	p=0.23
At 6 months assessment					
Palmar flexion	66°	32-95	68°	42-90	p=0.44
Dorsal flexion	56°	20-90	59°	29-84	p=0.26
Ulnar deviation	36°	15-55	37°	24-52	p=0.55
Radial deviation	25°	11-41	24°	8-48	p=0.49
Total grip strength	69%	19-122	70%	31-110	p=0.82
Key pinch strength	86%	41-134	83%	41-145	p=0.55
DASH score	14	0-51	12	0-77	p=0.30

RESULTS

The outcomes of operative treatment of distal radial fractures at 3 and 6 months in 102 patients, 77 operated on by K-wire, and 30 by locking palmar plate fixation were compared.

a. Comparison of physical parameters (Table 2)

An assessment at 3 months showed no statistically significant differences between the groups in any of the considered variables. Almost all variables were better in the palmar plate group, but the differences were minimal and clinically not meaningful. Likewise, at 6 months the outcomes for this group were superior in five out of seven parameters, but the differences were minimal and statistically insignificant.

b. Comparison of the health-related quality of life (Table 3)

An assessment at 3 months showed no statistically significant differences between the groups in any of the SF-36 domains. The lowest scores in both groups were seen in domain Role Physical (29 and 27 points), indicating role limitations due to physical health problems (sustained wrist fracture). This correlated well with physical parameters - relatively weak grip strength and high DASH scores (Table 2). Answering the question concerning their actual health perception, a statistically significantly greater percentage of patients who were operated by locking plate regarded their health to be poorer than from one year before (n=19; 63% vs n=29; 41% for K-wire, p=0.05).

As at 3 months, the 6-month assessment did not demonstrate any statistically significant difference

Table 3. — Comparison of SF-36 outcomes at 3 and 6 months (quality of life)

Variable	K-wire n= 72		Palmar plate n= 30		Stat. sign.
	Mean	Range	Mean	Range	p
RAND SF-36 domains, baseline assessment					
PF - Physical Functioning	71	15-100	73	30-100	p=0.54
RP - Role Physical	29	10-100	27	12-100	p=0.89
BP - Bodily Pain	50	14-100	50	18-100	p=0.97
GH - General Health	48	15-75	47	20-70	p=0.54
VT - Vitality	62	5-100	59	20-100	p=0.55
SF - Social Functioning	83	25-100	75	21-100	p=0.44
RE - Role Emotional	70	24-100	63	11-100	p=0.55
MH - Mental Health	65	8-96	63	20-100	p=0.54
RAND 36 domains, at 6 months assessment					
PF - Physical Functioning	83	15-100	83	30-100	p=0.30
RP - Role Physical	73	23-100	68	15-100	p=0.77
BP - Bodily Pain	63	17-100	64	15-100	p=0.79
GH - General Health	49	20-75	51	20-72	p=0.53
VT - Vitality	62	30-100	63	20-90	p=0.39
SF - Social Functioning	87	13-100	82	25-100	p=0.28
RE - Role Emotional	84	34-100	79	27-100	p=0.55
MH - Mental Health	69	40-100	68	24-92	p=0.72

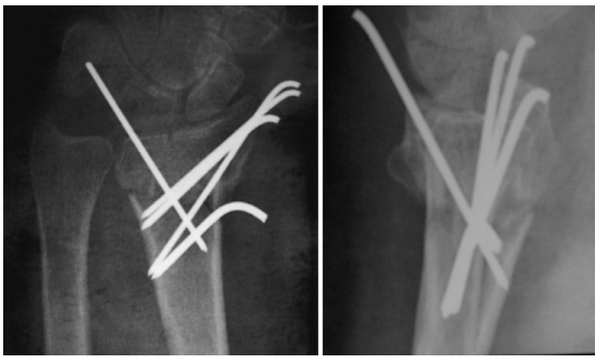

Fig 2. — C2 type distal radial fracture fixed by „augmented" K-wire technique.

between the two groups in any of the SF-36 domains. The lowest scores in both groups were seen in the domain General Health (49 and 51 points), suggesting suboptimal perception of actual health status, but due to general conditions (i.e. systemic comorbidities) rather than sustained wrist fracture. Compared to the previous assessment, the Role Physical scores increased significantly (73 and 68 points) indicating mild limitations due to physical health problems. This also reflected functional improvement - stronger grip and lower DASH scores (Table 2). The difference seen at 3 months in actual health status perception compared to one year before - disappeared. The same proportion of patients in both groups regarded their health to be poorer than before (n=10; 33% vs n=21; 30% for K-wire, p=0.60).

c. Complications

No serious complications were seen. In the K-wire group, an irritation (but no infection) around one of the K-wires was noted in five patients (7%) due to superficially buried pins. In three patients (4%) the pins were buried too deeply and had to be removed in the theatre with fluoroscopic assistance. Two patients presented with tenderness at the site of the retrieved pins at 3 months, but this disappeared by next follow-up visit. Two patients developed mild CRPS, diagnosed at 2 months and treated successfully with intramuscular calcitonin injections for one, and with intravenous mannitol/dexamethasone infusions for the other one *(14)*. Regardless of the resolution of the CRPS episode,

Fig 3. — „Pylon radial" fracture fixed by a palmar plate.

these patients demonstrated the worst scores in all measures at 3 months assessment. In the plate fixation group, one early wound infection was seen, requiring stitches removal, antibiotic therapy and healing by secondary intention. One patient demonstrated finger and wrist stiffness at 3 months, which persisted until the final assessment.

DISCUSSION

The results of this study did not demonstrate any difference in the outcomes of patients treated with K-wires compared to locking plate fixation for distal radial fractures. We intentionally did not focus on anatomical/radiological outcomes, but used patient-derived functional outcome measures and health-related quality of life. We are aware, however, that radiographic assessment of the quality of the reduction and final bone healing may have a bearing on the longer-term functional results.

In our study we intended to investigate to what degree the fracture and its treatment (the event) deteriorates patients' health-related quality of life and would it be valuable use of this variable as an outcome measure. Results at 3 months demonstrated a moderately negative impact of the event on overall quality of life, except for the Role Physical domain, which showed significant impairment. At final assessment the effect of the event on patients' quality of life was minimal. The SF-36 questionnaire is relatively complicated and its scores reflect overall health status rather than disease-specific impairment of life segment. The SF-36 has been used in the outcome analysis of distal radial fractures either using an entire score or as a specific subgroup. Results of the two studies showed good correlation of selected SF-36 scores with DASH scores and physical measurements *(6,7)*. Kreder *et al.*, used the Bodily Pain subscore and found significant differences at 1.5 and 3 months favouring the plate vs K-wire fixation group (less pain), but these disappeared over a longer perspective *(3)*. Like these authors, we failed to find any advantage for health-related quality of life as an outcome measure in distal radial fractures, comparing to standard measures.

Our study was also not a randomized one, as we selected the treatment for the fractures according to an institutionally-fixed algorithm. This guideline has been derived from our clinical experience in the use of different operative techniques for various configurations of distal radial fractures. It was also influenced by economic calculations, as the department has been operating on about 300 fractures a year. Subsequent development of this concept resulted in the establishment of the final guidelines, which have proven correct in our further – over a decade – clinical practice *(13)*. A noteworthy advantage of this algorithm is a reasonable balance between clinical- and cost-effectiveness, as K-wire fixation is much cheaper than the use of modern plates. When dealing with numerous patients, being guided by these rules translates directly into substantially lower expenses for the department and does not diminish the quality of the treatment.

Several reports are available comparing outcomes of K-wire vs palmar plate fixation for distal radial fractures. Most of them show no significant differences between groups treated with the two techniques in terms of radiological and functional results.

Kreder et al. reported outcomes of a randomized trial on 179 patients (88 K-wire vs 91 plate) with a mean age of 40 years. There were no statistically significant differences between the groups at 2 years' follow-up assessment for pain level, wrist range of movement, grip strength and radiological features of the distal radius. The authors suggest that if displaced distal radial fracture can be treated by indirect reduction and percutaneous fixation, a more rapid return to function and a superior functional outcome within two years will be obtained than by plate fixation. Therefore, they recommend in most fractures an attempt at minimally invasive percutaneous reduction *(3)*.

Hollevoet *et al.*, reported outcomes of a randomized trial on 40 patients (20 K-wire/20 palmar plate) aged over 50 years. There were no statistically significant differences between the groups in radiological and functional outcomes at one year, except for better correction in ulnar variance (a mean of 2 mm) in the palmar plate group. Other, non-significant differences included loss of reduction in dorsal tilt $>9^{o}$ in two patients treated with plates and five with K-wires. Likewise, loss of reduction was seen in three patients with palmarly displaced fractures fixed by pins. The authors conclude that both percutaneous K-wires and locking palmar plates can be effective in treating distal radial fractures in patients over 50 years age *(1)*.

Hull *et al*., reported outcomes of a retrospective comparative study on 71 patients with dorsally displaced distal radial fractures (35 K-wire/36 palmar plate) aged a mean of 61 years. There were no statistically significant differences between the groups in functional outcomes (DASH and PRWE scores) at a mean of 21 months follow-up. As with ours, this study did not consider radiological outcomes *(2)*.

Conclusions from other studies are mixed. Some authors show a distinct superiority of palmar plate over K-wire fixation, due to better early post-operative functional and late radiological outcomes

(4,5,8). Others show no differences in function both from a short and long term perspective *(3,9)*. Zong *et al*. reported results of a meta-analysis comparing clinical outcomes of K-wire vs plate fixation. After reviewing seven RCTs with a total of 875 patients, the authors concluded that fixation with palmar plates provided significantly lower DASH scores and reduced the rate of superficial infections when compared to K-wire fixation *(12)*. However, superficial pin track infections were not a problem in the vast majority of cases.

The economical aspect is rarely considered in outcome analysis, although, to our minds, it should be as these fractures are very common and their treatment charges substantially impact departmental, hospital and national financial budgets. Schyamalan et al. reported a difference of 1550 GBP per case between K-wire and palmar plate fixation of distal radial fractures, considering only costs of the implant (plate and 10 screws*) (11)*. Although K-wire fixation provides suboptimal stability and does not guarantee maintaining of the reduction, it can be effective for selected fracture configurations, which constitute at least 2/3 of their total number. We are aware of possible disadvantages and shortcomings with this method, reported in the literature, such as:

- Higher risk of secondary displacement
- Loss of radial height in osteoporotic distal radius over a longer perspective
- Need for additional immobilization of the wrist in a plaster splint

These questions, however, may not be a problem in elderly patients in whom a correlation between anatomical and functional results is less pronounced. In active, younger patients the use of more stable fixation may be superior in terms of faster return to full professional and daily living activity *(9)*. The results of our study show that being guided by the institutional algorithm results in satisfactory clinical outcomes, relatively rare complications and is cost-effective.

Declaration of conflicting interest

All forms of financial support relating to the submission, including pharmaceutical company support.

Any commercial or financial involvements that might present an appearance of a conflict of interest related to the submission. Any agreement with any sponsor of the research reported in the Contribution that prevents the authors publishing both positive and negative results or forbids the authors from publishing this research without the prior approval of the sponsor.

All named authors hereby declare that they have no conflicts of interest to disclose.

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