How many clinic visits does it take to treat distal radial fractures?

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Abstract The purpose of this study was to evaluate the changes in alignment during the course of treatment for extra-articular distal radius fracture and the relationship of initial and intermediate radiographs, with the final radiograph taken at fracture union. A cohort of 96 consecutive patients who were conservatively managed for extra-articular distal radius fracture in an 18-month period was undertaken. The radiographs analysed were taken at prereduction, postreduction, a week later and at fracture union. The radiological parameters analysed were radial tilt, radial length, radial inclination, dorsal comminution and ulnar styloid fracture. There was a significant change in radiographic alignment between initial and immediate postreduction radiographs, and between postreduction 1 week later radiographs ($p < 0.05$), but the number of patients in the 1 week later and fracture union groups remained similar ($p > 0.05$). All patients with poor radiological outcome had ulnar styloid fractures. This was also associated with dorsal comminution in 86% of patients. Patients with satisfactory radiological outcome had ulnar styloid fracture and comminution in 34% and 43% of

patients respectively. The final radiological outcome was not found to be influenced by initial unsatisfactory alignment of radial tilt, radial length and radial inclination individually or in combination. We suggest that two clinic visits after initial reduction of the fracture should be sufficient to manage such injuries; the first visit 1 week after manipulation to detect unacceptable displacement and if found satisfactory, the last visit at fracture union for final review, advice and referral to physiotherapy.

Résumé Le but de cette étude est d'évaluer les changements d'axes durant le traitement d'une fracture extra articulaire de l'extrémité distale du radius et la relation entre ces déplacements évalués sur les radiographies initiale et intermédiaire et le résultat final au moment de la consolidation. Une cohorte de 96 patients consécutifs a été évaluée sur une période de 18 mois après traitement orthopédique de la fracture extra articulaire de l'extrémité distale du radius. Les radiographies analysées ont été réalisées avant la réduction, huit jours après la réduction et au moment de la consolidation. Les paramètres radiologiques analysés ont été la bascule radiale, la longueur du radius, l'inclinaison radiale, la comminution postérieure et la fracture de la styloïde radiale. Il y avait un changement d'axe significatif entre les clichés pré et post réduction ainsi qu'entre les post réductions et 8 jours ($p < 0.05$) mais pas entre les radios à 8 jours et les radios à consolidation ($p > 0.05$). Tous les patients ayant un mauvais résultat avaient une fracture de la styloïde cubitale. Ce résultat était également associé à une comminution postérieure chez 86% des patients. Les patients avec un bon résultat radiologique ne présentaient une fracture de la styloïde cubitale que dans 34% des cas et une comminution postérieure dans 43% des cas. Le résultat radiologique final n'est pas influencé par la bascule radiale, la longueur du radius et l'inclinaison radiale initiale. Nous pensons que, dans de tels traumatismes, deux

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examens cliniques après la réduction initiale de la fracture sont suffisants. La première consultation doit s'effectuer une semaine après la réduction de façon à dépister un déplacement secondaire inacceptable, la dernière visite doit être réalisée au moment de la consolidation et de la rééducation.

Introduction

Extra-articular fractures of the distal radius are the most common fracture of the upper extremity and are usually treated by closed reduction and plaster immobilisation for 6–8 weeks [6]. These fractures are usually unstable, comminuted and prone to redisplacement [1–3, 12]. Various treatment options for correction have been suggested [3, 8, 9, 13–15, 21]. Regular clinical assessments are useful to evaluate and treat malunion, which is a recognised cause of suboptimal function in patients of all ages after this common injury [5, 12, 15].

There are few studies based on radiological analysis of such fractures that have debated the role of initial deformity in influencing the final radiological outcome [10, 22]. The purpose of this study was to evaluate the changes in alignment during the course of treatment of extra-articular distal radius fracture and the relationship of the initial and intermediate radiographs with the final radiograph at fracture union. The influence of comminution and ulnar styloid fractures was also taken into account for evaluation of radiological results at fracture union.

Patients and methods

We carried out a retrospective radiographic analysis of a cohort of 96 consecutive, non-operatively managed patients with extra-articular fractures of the distal radius. They were treated conservatively with closed reduction and plaster cast application in the 18-month period from July 2002 to January 2004. There were 15 males and 81 females with ages ranging from 26 to 97 years (average age 66 years). Ninety-one patients (95%) were seen within 24 hours of injury and all patients were seen within 72 hours of injury. All patients underwent closed manipulation of the fracture using haematoma block, Biers' block or intravenous sedation. The dorsal plaster slab was applied and check radiographs were taken. Patients were advised on plaster care, limb elevation and exercises. They were reviewed a week later with check radiographs and a well-moulded plaster cast applied by trained orthopaedic plaster technicians.

The duration of immobilisation varied between 5 and 6 weeks, final patient review with check radiographs took place after 6 weeks followed by referral for physiotherapy. The radiological parameters measured were radial height (length), radial angle (inclination), radial tilt, ulnar styloid fracture and presence of dorsal comminution (Fig. 1). The inclusion criteria in the study were extra-articular fractures in mature skeleton, single closed manipulation, no surgical fixation of fractures, and a complete set of radiographs and medical records. The criteria for satisfactory alignment of distal radius fractures described by Graham [7] were used. Statistical analysis was performed using McNemar's test and paired Student's *t* test.

Fig. 1 Radiographs of the distal radius showing the measurements taken in the anteroposterior and lateral views where *a* is radial height/length, *b* is radial angle/inclination and *c* is radial tilt

Table 1 Satisfactory radiological results of 96 patients evaluated at different hospital visits

	Prereduction (1)	Postreduction (2)	At 1 week (3)	Fracture union (4)	Comparing 1 with 2 (<i>p</i> value)	Comparing 2 with 3 (<i>p</i> value)	Comparing 3 with 4 (<i>p</i> value)
Radial height	54	89	74	73	<0.005	<0.005	>1.00
Radial angle	54	86	74	76	<0.005	<0.05	>0.50
Radial tilt	23	85	78	82	<0.005	>0.05	>0.50
All combined	14	77	60	61	<0.005	<0.005	=0.804

Results

The radiological parameters analysed individually were radial height, radial angle and radial tilt, comminution and presence of an ulnar styloid fracture (Tables 1, 2). The radiological parameters used in combination were radial height, radial angle and radial tilt (Table 1). The changes in these parameters measured during the course of treatment are shown in Fig. 2.

It was seen that there was a significant improvement in the individual and combined radiological parameters from their prereduction (1) position to the postreduction (2) position ($p<0.05$). However, there was a significant loss of this satisfactory alignment after a week (3) in plaster compared with radiographs taken immediately postreduction (2). The only radiological parameter that did not show a significant loss of satisfactory alignment 1 week after immediate postmanipulation was radial tilt. It was noted that there was no further change between 1 week postmanipulation and fracture union, in the radiological parameters individually or in combination ($p>0.05$).

The radial height, radial angle and radial tilt were analysed individually for the presence of satisfactory (a) or unsatisfactory (b) alignment with the combined radiological parameters (4) at fracture union. This comparison of individual parameters with the final radiological result (4) was done for the prereduction (1), immediate postreduction (2) and 1 week (3) stages of the treatment (Tables 3, 4, 5).

Table 2 Comparison of final radiological results with the presence of comminution and an ulnar styloid fracture

	No ulnar styloid fracture	Ulnar styloid fracture	No comminution present	Comminution present
Satisfactory fracture union	40	21	35	26
Unsatisfactory fracture union	0	35	5	30

The final radiological result at fracture union was not found to be influenced by any individual radiological parameter at any stage of treatment ($p>0.05$). The satisfactory and unsatisfactory results for the combined three radiological parameters (radial height, radial angle and radial tilt) at prereduction, immediate postreduction and 1 week later were compared with the final radiological outcome at fracture union (Fig. 2). There was no relationship between an initial unsatisfactory alignment and unsatisfactory radiological outcome ($p>0.05$). The two patient groups, a week later and at fracture union, appeared statistically similar, having similar satisfactory or unsatisfactory radiological outcomes.

The combined radiological parameters showed significant improvement in results after manipulation of the fracture. A week later, there was a statistically significant fall in the number of patients with satisfactory radiological alignment. All patients with an unsatisfactory radiological result had an ulnar styloid fracture. There was an ulnar styloid fracture in 34% of patients with satisfactory radiological outcome (Table 2). Extra-articular dorsal comminution at the fracture site was seen in 86% of patients with an unsatisfactory outcome, whereas 43% patients with a satisfactory outcome had dorsal comminution.

Discussion

The background to our study was to address the growing concern with regard to repeated clinic visits in patients with extra-articular distal radius fractures, which is not only troublesome for the patients, but also leads to an increased clinic load and appointment waiting times. Extra-articular fractures of the distal radius with comminution and ulnar styloid fractures may result in malunion [14]. These fractures should be followed up repeatedly in the clinics and remanipulated in the presence of malalignment for optimal function [5, 8, 12, 14]. The relationship between the radiographic and functional outcomes of treatment for such fractures, especially in the elderly, remains controversial [12, 14, 15].

Fig. 2 Comparison of intermediate radiological parameters with final result. 1 indicates combined radiological parameters premanipulation. 2 indicates combined radiological parameters postmanipulation. 3 indicates combined radiological parameters 1 week later. 4 indicates combined radiological parameters at fracture union

There are several reports in the literature identifying individual radiological parameters such as radial length [2, 3, 9, 22], radial tilt [16, 22] and radial angle influencing the functional outcome of the hand [11]. There are only a few studies based on radiographs, most of which have debated the role of the initial deformity in influencing the final radiological outcome [7, 11, 14, 22]. Stewart et al. [19] used an anatomical scoring system that combined radial tilt, radial angle and radial shortening to show that the severity of the initial displacement had a direct effect on the final outcome. Villar et al. [23] in their study disagree with the initial deformity influencing the final radiological outcome.

Some studies reported that late displacement of a Colles' fracture in the second week of injury and initial radial shortening, age of the patient influenced this redisplacement [1, 3]. We found that the individual radiological parameters or their combination in the initial deformity did not influence the final radiological outcome. A combination of radial shortening over 5 mm, a radial angle of less than 15° and dorsal tilt of over 15° are associated with poor results [9]. Our study showed that the radiographs showing satisfactory alignment 1 week after manipulation did not change significantly at fracture union and therefore, additional clinic visits are avoidable in such patients.

Table 3 Relationship between initial individual radiological parameters and final result

	Radial height 1a	Radial height 1b	Radial tilt 1a	Radial tilt 1b	Radial inclination 1a	Radial inclination 1b
Satisfactory 4	41	20	17	44	41	20
Unsatisfactory 4	10	25	6	29	10	25

1a indicates premanipulation satisfactory radiological parameter

1a indicates premanipulation unsatisfactory radiological parameter

4 indicates combined radiological parameters at fracture union

Table 4 Relationship between individual radiological parameters postmanipulation and final result

	Radial height 2a	Radial height 2b	Radial tilt 2a	Radial tilt 2b	Radial inclination 2a	Radial inclination 2b
All satisfactory 4	58	3	57	4	55	6
All unsatisfactory 4	31	4	28	7	31	4

2a indicates postmanipulation satisfactory radiological parameter

2b indicates postmanipulation unsatisfactory radiological parameter

4 indicates combined radiological parameters at fracture union

Table 5 Relationship between individual radiological parameters after 1 week and final result

	Radial height 3a	Radial height 3b	Radial tilt 3a	Radial tilt 3b	Radial inclination 3a	Radial inclination 3b
All satisfactory 4	57	4	57	4	59	2
All unsatisfactory 4	17	18	21	14	17	18

3a indicates satisfactory radiological parameter 1 week later

3b indicates unsatisfactory radiological parameter 1 week later

4 indicates combined radiological parameters at fracture union

The integrity of the distal radio-ulnar joint, ulnar styloid and fibrocartilage has been shown to influence final results [11, 13]. A few studies show the incidence of associated ulnar styloid fractures to be 51% [23]. We had 58% patients with an ulnar styloid fracture. Villar et al. showed that fractures of the ulnar styloid did not affect stability [21, 23]. Although in our study all patients with unsatisfactory results had an ulnar styloid fracture, there was no significant correlation between the satisfactory radiological result and absence of an ulnar styloid fracture. We found comminution present in 86% of patients with unsatisfactory results. Extra-articular fractures have much more inherent stability than intra-articular fractures [4].

Immobilisation in plaster in the presence of comminution is an inferior method of preserving radial length and palmar tilt because of the lack of stability in such fractures [4, 5, 10, 11, 15, 20]. Soren demonstrated the usefulness of well-moulded plasters to maintain reduction [17]. Charnley advocated the use of a plaster cast adequately covering the dorso-radial aspects and well moulded rather than just a dorsal slab [5]. We found no significant change in radial tilt between fracture reduction and fracture union. This could be explained on the basis of plaster cast application dorsally preventing further dorsal tilting (Table 1). However, we found a significant loss of satisfactory alignment following reduction of these fractures after 1 week. There was no significant loss of alignment between a week of treatment and final radiographic union. The presence of early callus and the application of a well-moulded plaster after a week would resist further loss of alignment. Some authors suggest application of a moulded but split plaster cast following manipulation would have the benefit of not only maintaining alignment, but also avoiding potential plaster complications [17, 18]. A further study to look into the significant benefits and risks of a well-moulded cast from the beginning would prevent significant malunion.

We suggest that two clinic visits after initial reduction of a fracture should be sufficient to manage such injuries; the first visit 1 week after manipulation to detect unacceptable displacement, and if found satisfactory, the last visit at fracture union for a final review and referral for physiotherapy. We conclude that there was a significant loss of alignment 1 week after manipulation, but no significant

change in the deformity thereafter. The radiographs performed after 1 week are a reliable predictor of outcome and no single radiological parameter on its own influenced the final radiological outcome.

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