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Research Article

Distal radius fractures: What are the effects of ulnar styloid fracture and face-to-face rehabilitation on the functional outcome?

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ABSTRACT

Objective: This study aimed to investigate the effects of the accompanying ulnar styloid fracture and 2 different postoperative rehabilitation protocols on the final outcomes following surgical treatment of distal radius fractures.

Methods: In this retrospective study, 47 patients (11 male, 35 female; mean age = 52.6 years, age range = 24-85) who underwent plate fixation for distal radius fractures were divided into 4 groups based on the presence of an ulnar styloid fracture and type of rehabilitation. To evaluate clinical outcomes, wrist range of motion (ROM), grip strength, lateral pinch strength, disabilities of the arm, shoulder, and hand (DASH) questionnaire scores and visual analog scale (VAS) scores were obtained at the final follow-up. The rehabilitation exercises of the patients in groups 1 and 2 were carried out in the physical therapy room by the hand therapist during the postoperative 2 months. Patients in groups 3 and 4 were supplied with videos of the exercises of each phase and instructed to carry out those exercises at home routinely.

Results: Patients who received home rehabilitation programs demonstrated greater grip strength loss. Patients without accompanying ulnar styloid fractures had better DASH and VAS scores. Final wrist ROM and the duration for return to preinjury activity level did not differ among groups.

Conclusion: This study has suggested that accompanying ulnar styloid fractures may worsen the functional outcomes after plate fixation of distal radius fractures. Home-based programs may provide patients with adequate overall wrist function with certain drawbacks compared to rehabilitation under direct supervision.

Level of Evidence: Level III, Therapeutic Study.

Introduction

The treatment of distal radius fractures (DRF), which are among the most common fractures, has evolved through time with experience, technological improvements, and gathered evidence. Restoration and rigid fixation of the original anatomy and stabilization of the articular surface is the prerequisite for a good outcome. Open reduction and internal fixation has been the method of choice for instable DRF during the last decade.[1] It is also known that postoperative rehabilitation is a key component of DRF treatment.[2] However, not all patients can receive a supervised physical treatment after surgery.[3] Moreover, utilization of different physical therapy modalities like early mobilization, splinting, and manual therapy varies among different treatment centers. It is still unclear which kind of physical therapy improves the functional outcome best after DRF. The necessity of physiotherapist-supervised therapy is also being questioned by different studies.[2-5]

Other determinants of a good functional recovery after DRF are the accompanying injuries like carpal ligament injuries, distal radioulnar joint instabilities, and concomitant carpal bone fractures.[6-8] Ulnar styloid fractures, particularly, are frequently seen with DRF with an incidence of 44-65%.[9-12] Since the ulnar styloid is important for the stability of the triangular fibrocartilage complex, which is critical for the distal radioulnar joint stability, ulnar styloid fractures have the potential to ultimately affect the clinical outcome of DRF by causing instability, pain, and limited range of motion (ROM).[10,13] Contrary to general belief, published data has been inadequate to show a clear correlation with accompanying ulnar styloid fractures and adverse outcomes after DRF treatment, and there is also increasing evidence showing that the ulnar styloid injury may not affect the overall results.[9,10,13-19]

In the current study, we investigated the effects of 2 physical therapy methods and the presence of an ulnar styloid fracture on the final results after instable DRF surgical treatment to test the null hypothesis that the presence of an ulnar styloid fracture is not associated with worse outcomes and home-based physical therapy is as effective as physical therapy under direct hand therapist supervision for achieving good wrist function. To our knowledge, this study is the first to report the effects of physical therapy method together with the presence of an ulnar styloid fracture on the results after surgical treatment of DRF.

Materials and methods

The study protocol was approved by the Koç University Ethical Committee (Approval No: 2020.

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409.IRB2.109). Written informed consent was obtained from all subjects before the study.

Patients with DRF who had been treated with open reduction and internal fixation using a volar locking plate by 2 experienced surgeons between April 2010 and February 2019 and had been followed at least 2 years were consecutively enrolled in this retrospective study. Intra-articular fractures presenting with dorsal angulation >5˚, radial inclination <20˚, radial shortening >5 mm and intra-articular step off >1 mm were included in the study. Extra-articular fractures that also exhibited dorsal angulation >5˚, radial inclination <20˚, radial shortening >5 mm were also included. Patients with ipsilateral upper extremity trauma or ulna fracture other than ulnar styloid fracture and multi-trauma patients were excluded. Fractures that required a dorsal approach or any other secondary approach for the reduction were excluded. Patients operated on more than 10 days after the trauma were also excluded.

Patients were divided into 4 groups according to the presence of an ulnar styloid fracture and postoperative rehabilitation program. Patients in "group 1" did not have ulnar styloid fracture and underwent rehabilitation under direct hand therapist supervision. Patients in "group 2" had accompanying ulnar styloid fracture and underwent rehabilitation under direct hand therapist supervision. Patients in "group 3" did not have ulnar styloid fracture and underwent a home rehabilitation program. Patients in "group 4" had accompanying ulnar styloid fracture and underwent a home rehabilitation program.

All the patients were asked and invited to undergo rehabilitation at the hospital under supervision. The physical therapies of those who agreed, were conducted at the hospital for 2 months. These patients were assigned to groups 1 and 2 accordingly. The patients who were not able to come to hospital regularly for rehabilitation or afford hospital rehabilitation expenses were assigned to groups 3 and 4.

Surgical technique and postoperative rehabilitation

All fractures were internally fixed with an anatomic distal radius locking plate and screws (Aptus Distal Radius System 2.5 Medartis®, Basel, Switzerland) through a standard Henry volar–radial approach. The stability of distal radioulnar joint was assessed intraoperatively after the placement of the last screw by checking ulnar head displacement with anteroposterior stress under fluoroscopic control.

All operated wrists were placed in a soft, below-the-elbow dressing for 10 days. All patients were evaluated by the same physiatrist and phase 1 exercises were taught by the same hand therapist on the postoperative first day. After the removal of the bulky dressing on postoperative day 10, patients were reexamined by the physiatrist and a rehabilitation program was planned. After the removal of the bulky dressing, all patients were asked to use custom-made hand splints at night until the end of 6 weeks and were encouraged to use their hands during light daily activities. The rehabilitation exercises of the patients in groups 1 and 2 were carried out in the physical therapy room by the hand therapist during the postoperative 2 months. Patients in groups 3 and 4 were supplied with videos of the exercises of each phase and instructed to carry out those exercises at home routinely. Patients in groups 3 and 4 were also asked to come for the control visit on the starting day of each rehabilitation phase.

Rehabilitation following distal radius fractures

Phase 1 (Exercises in bulky dressing) (days 0-10):

- Active isolated ROM exercises for finger joints
- Thumb opposition exercises
- Flexor tendon gliding exercises

Phase 2 (day 10-week 4) (After removal of the dressing):

- Phase 1 exercises
- Composite fist exercises
- Tenodesis exercises
- Intrinsic muscle stretching exercises (if needed)
- Active assistive wrist ROM exercises
- Scar tissue mobilization

Phase 3 (weeks 5-8):

- Phase 2 exercises
- Active dart-throwing motion exercises
- Stretching
- Strengthening exercises
- Proprioceptive exercises

Phase 4 (>week 9)

- Progressive strengthening exercises
- If wrist ROM is restricted following exercises added;
- Midcarpal mobilization
- Distal radioulnar translation exercises

Clinical evaluation

The clinical parameters evaluated in the study included wrist ROM, grip strength, lateral pinch strength, and disabilities of the arm, shoulder, and hand (DASH) questionnaire scores and visual analog scale (VAS) scores that were recorded during the last follow-up visit. Wrist ROM values of both wrists were measured using a standard goniometer and inclinometer. Grip and lateral pinch strengths were measured using a Jamar hand dynamometer with 3 repeated attempts for both hands. The highest value of the strength measurements was recorded. Patients were asked to grade wrist pain, if any, during daily activities for VAS assessment. Patients were also asked how long it took to return to their preinjury daily activity level, if ever.

Any complication related to surgery and the need for hardware removal was also recorded.

Statistical analysis

Statistical analyses were performed with Statistical Package for Social Sciences (SPSS) version 17.0 program (SPSS Inc.; Chicago, IL, USA). Continuous variables were checked for normal distribution by the Kolmogorov–Smirnov test and presented as mean ± standard deviation while categorical variables were expressed as numbers or percentages. Chi-square test was used to compare categorical variables.

HIGHLIGHTS

- Distal radius fractures accompanied by ulnar styloid fractures are associated with worse functional and pain scores.
- The presence of an ulnar styloid fracture does not have any negative impact on the final wrist motion and does not delay return to the preinjury activity level after distal radius fractures.
- Home-based exercise programs are an effective way of rehabilitation to obtain satisfactory wrist function after the surgical treatment of distal radius fractures.

Student *t*-test and analysis of variance test were used to compare continuous variables with normal distribution while Mann–Whitney *U*-test or Kruskal–Wallis test were used to compare the continuous parameters without normal distribution. Correlation analysis was performed by Spearman's correlation tests. $P < .05$ was considered statistically significant.

Results

A total of 47 patients were included in the study. There were 11 males and 36 female patients with a mean age of 52.6 years (24 years-85 years). The right wrist was involved in 19 patients and the left wrist in 28. The mean follow-up time was 30.3 months (24 months-120 months). There were 11 patients in group 1, 13 in group 2, 10 in group 3, and 13 in group 4 (Table 1). The groups did not differ significantly in terms of age and follow-up period ($P=.194$, $P=.842$). For groups 1 and 2, the mean number of physical therapy sessions per patient was 14 (4-34). Therapy session numbers did not demonstrate a significant difference between groups 1 and 2 ($P=.939$).

None of the patients demonstrated distal radioulnar instability at the end of surgery.

The losses in wrist motion degrees among the 4 groups were not found to be statistically significant (Table 2).

Statistical analyses of the grip strength and lateral pinch strength losses between the affected and unaffected hands revealed significant differences among the 4 groups ($P=.001$, $P=.004$ respectively) (Table 3). Grip strength loss of the patients in group 3 and group 4 was significantly higher compared to group 1 and group 2, while there were no significant differences in grip strength loss between group 3 and group 4 and between group 1 and group 2. Group 3 patients showed significant loss in lateral pinch strengths compared to group 1, group 2, and group 4 patients, while no difference was observed in loss of lateral pinch strengths among group 1, group 2, and group 4 patients.

Disabilities of the arm, shoulder, and hand scores and VAS showed a significant difference between groups ($P=.001$ and $P=.017$, respectively) (Table 4). Group 1 patients had significantly lower DASH scores than the patients in groups 2 and 4. Similarly, DASH scores of group 3 patients were also significantly lower than the DASH scores of groups 2 and group 4.

Group 3 patients had significantly lower VAS compared to Groups 2 and 4. Although Group 4 had relatively higher mean VAS, its comparison with groups 1 and 2 failed to show statistical significance. The comparison of group 1 patients with either group 2 or group 3 also did not also show statistical significance for VAS.

No statistical significance was found between the time needed to return to their preinjury level of daily activity among the 4 groups ($P=.669$) (Table 5).

Complex regional pain syndrome was seen in 1 patient from group 1, in 2 patients from group 2. Implants were removed due to local irritation and pain in 2 patients from group 1, in 1 patient from group 2, and in 2 patients from group 3. No other complications were observed.

Discussion

In this study, we recruited patients with unstable DFR with or without ulnar styloid fracture, who underwent open reduction and internal fixation through a volar approach and a postoperative rehabilitation of 2 different methods to see if the presence of an ulnar styloid fracture worsened the final results and if rehabilitation under direct supervision had improved the final outcome. The results of the current study suggest that the presence of an ulnar styloid fracture and the type of physical therapy did not affect the final wrist motion loss after DRF fixation with plate and screws via a volar approach. This finding in our study was in accordance with findings of previous studies.[11-15,17,19,20] Zyluk et al[2] reported similar final wrist ROM in DRF cases with or without ulnar styloid fracture. Belloti et al[14] stated that the presence of an ulnar styloid fracture did not bring out any difference in wrist motion. The meta-analysis performed by Wijffels et al[12] showed that the ulnar styloid fracture did not affect the final wrist motion. However, Souer et al[21] and Wakefield et al[5] found that the patients, who did independent home exercises, had better flexion–extension arc than those who underwent occupational therapy (118° vs. 129°) at the end of the sixth month. Krischak et al[2] also showed better improvement in wrist motion with home-based therapy at the sixth week controls.[2] Our interpretation of their results is that, even if there is a significant difference between 2 therapy methods in these studies, both groups had good wrist ROM and the statistical difference may have disappeared with longer follow-up, which would then be similar to our findings.

Table 1. Mean age and mean follow-up values of groups

	Group 1 (n=11)	Group 2 (n=13)	Group 3 (n=10)	Group 4 (n=13)	*P*
Mean age (years)	49.2	47.2	53.4	60.3	.194
Male sex n (%)	2 (18%)	2 (15%)	2 (20%)	5 (38%)	.552
Follow-up (months)	34.6	29.8	25.2	31.4	.842

Table 2. The mean loss of wrist motion in degrees between the affected and unaffected wrists

	Group 1	Group 2	Group 3	Group 4	*P*
Flexion	5.6	8.5	9.5	6.2	.427
Extension	3.6	4.5	9	5.2	.361
Pronation	1.4	2.7	3	1.9	.797
Supination	1	2.7	2.2	1	.128

Table 3. The mean loss of grip and lateral pinch strengths between the affected and unaffected hands

	Group 1	Group 2	Group 3	Group 4	*P*
Grip strength difference (kg)	1	1.6	6.8*,+	4.2*,+	.001
Lateral pinch strength difference (kg)	0.5	0.7	2.75*,+	1.14&	.004

*Denotes significant difference compared to group 1 (post hoc analysis). +Denotes significant difference compared to group 2 (post hoc analysis). &Denotes significant difference compared to group 3 (post hoc analysis).

Table 4. The mean disabilities of the arm, shoulder, and hand scores and visual analog scale

	Group 1	Group 2	Group 3	Group 4	*P*
DASH	0.9	13.4*	2.8+	12.7*,&	.001
VAS	0.4	0.8	0.3+	1.9&	.017

DASH, disabilities of the arm, shoulder, and hand; VAS, visual analog scale.
*Denotes a significant difference compared to group 1 (post hoc analysis). +Denotes significant difference compared to group 2 (post hoc analysis). &Denotes significant difference compared to group 3 (post hoc analysis).

Table 5. The mean return to preinjury daily activity level (months)

Group 1	Group 2	Group 3	Group 4	*P*
4.1	4.4	3.9	3.6	.669

We found that the final grip strength was not affected by the presence or absence of an accompanying ulnar styloid fracture. This finding was also in accordance with the previous studies.[11,15,17,19,20] On the other hand, we saw that the patients who underwent supervised physical therapy had better grip and lateral pinch strengths. This was again an opposite finding to those found in the studies comparing home and occupational therapy methods after DRF fixation.[2,4,5,21] We have 2 interpretations on this matter. First, our follow-up period was relatively short and the differences in strength measurements may diminish as more time passes since the surgery. Second, the instructions and the motivation given by an experienced physical therapy team and exercises performed at the pain tolerance limit and not under, might have encouraged the patients to gain strength more quickly. However, insurance bureaucracy, therapy costs, workforce cost, and time-consuming modality could all be speculated as drawbacks in direct hand therapist supervision approach.

The results of our study revealed that DASH and VAS scores of patients without ulnar styloid fracture were superior to those with ulnar styloid fracture. Belotti et al[14] and Mulders et al[17] also found worse wrist pain scores and DASH score with concomitant ulnar styloid fracture.[14,17] However, opposite findings were shown by the studies of Zyluk et al,[20] Buijze et al,[15] Kim et al,[13] and Zenke et al,[19] who did not find any difference in DASH and pain scores of patients with or without ulnar styloid fracture. We believe that these conflicting results are due to the involvement of different types of ulnar styloid fractures. Another interesting finding in our study is that patients who did home therapy had better VAS values. Our results were partially in accordance with the studies of Souer et al,[21] Krischak et al,[2] and Wakefield et al,[5] who demonstrated that home-based therapy is more effective in improving wrist function and pain scores.[2,5,21] Souer et al[21] interpreted that physiotherapists may unintentionally prevent patients from pushing their limits, prolonging the recovery period, and patients may benefit from a more active and self-reliant program.[21] We again believe that an experienced physiotherapist could be helpful for encouraging patients to regain their wrist functions by helping the patient to perform the exercises at the pain limit without creating an exacerbated pain response.

In our patient population, we did not observe DRUJ instability after fixation of DRF. Actually, DRUJ instability incidence after DRF fixation is relatively low.[9,12,13,18,20] Zyluk et al[20] reported 2 DRUJ instabilities in 70 patients.[1] Kwang Kim et al[13] found 1 DRUJ instability in 91 patients. Kwang Kim et al[9] found 2 DRUJ instabilities in 138 patients. We believe that a stable wrist with satisfactory ROM enables all our patients to return to their preinjury level of daily activity without any significant delay.

This paper should be interpreted in the light of some shortcomings. First, we did not investigate the effects of different ulnar styloid fracture patterns, nor its union versus nonunion. Our aim was only to only delineate the effects of the presence of the ulnar styloid fracture at the time of presentation. Secondly, we did not investigate the same parameters after other DRF fixation methods like pinning and external fixation. Thirdly, our patient population was relatively small due to the inclusion criteria. The last limitation is the lack of randomization for patient assignment into rehabilitation groups. However, the choice of rehabilitation type was made solely by the patients and this produced real-life data. We don't believe this has caused bias of any type.

Distal radius fractures associated with ulnar styloid fractures may be associated with worse functional and pain scores, while ulnar styloid fracture is not shown to have any deleterious effect on final wrist motion and return to preinjury daily activity level. Home-based therapy is shown to be effective for regaining wrist function, and the specific group of patients that will benefit more from occupational therapy remains to be determined by further studies.

Ethics Committee Approval: This study was approved by the Ethics committee of KoçUniversity (Approval No.: 2020.409.IRB2.109, Date: November 13, 2020).

Informed Consent: Written informed consent was obtained from the patients who agreed to take part in the study.

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