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Original Article

The relationship between surgical treatment results of AO type-C radius distal end fractures in adults and patient age

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Abstract

Aim: To evaluate the results of the locking anatomic plate fixation method with volar intervention according to age groups in the surgical treatment of unstable radius distal end fractures involving the joint.
Materials and Methods: In this study, 72 adult patients with distal radius fractures who were treated with open reduction and locked volar plate fixation due to radius distal end fracture in group C according to AO classification between August 2010 and August 2018 were evaluated retrospectively. All our patients were evaluated for a post-op range of motion. We divided the age ranges into four groups: Group 1 for ages 17-30, Group 2 for ages 30-45, Group 3 for ages 45-60, and Group 4 for ages over 60.
Results: The mean values of joint range of motion and grip strength in all our patients were; flexion 70.95° (Group 1 76.87°, Group 2 74.00°, Group 3 66.96°, and Group 4 64.16°), extension 67.38° (Group 1 71.87°, Group 2 68.33°, Group 3 61.15° and, Group 4 61.16°), radial deviation 27.02° (Group 1 32.50°, Group 2 29.67°, Group 3 23,08° and, Group 4 21.67°), ulnar deviation 32.86° (Group 1 38.75°, Group 2 36.33°, Group 3 28.46°, and Group 4 25.83°), supination 77.74° (Group 1 85.0°, Group 2 79.67°, Group 3 74.62°, and Group 70.0°), pronation 82.50° (Group 1 85.62°, Group 2 84.33°, Group 3 82.69°, and Group 4 73.33°). Analysis of the data revealed a negative correlation between patient age and post-operative joint range of motion. Our findings indicate a statistically significant difference in joint range of motion among Group 4, Group 1, and Group 2 patients.
Conclusion: Volar locking plate surgery in AO type C radius distal fractures is suitable for all age groups thanks to rigid fixation and early mobilization.

Keywords: Radius distal fractures, locked anatomical plate, unlocked plate, internal fixation

INTRODUCTION

Radius distal end fractures constitute approximately 20% of fracture cases and 75% of forearm fractures admitted to the emergency department (1). The majority of distal radius fractures encountered in the emergency department are stable fractures, and the treatment method chosen in 75-80% is closed reduction and fixation with plaster cast. However, approximately 30% of distal radius fractures are unstable and require surgical treatment (2). While distal radius fractures are caused by high-energy injuries such as sports injuries, traffic, and work accidents in the young population, they result from low-energy traumas such as simple falls due to osteoporotic bone structure in the elderly population.

The aim of fracture treatment is to correct the anatomical deformation in bone and soft tissue. The unsuccessful clinical and functional results obtained with conservative methods, especially in complex fractures, have brought up new searches in the treatment of these fractures (3). With surgical treatments performed by applying anatomical plates and screws specially produced for this region, an anatomical reduction can be made on the joint surface and metaphysis, intercarpal pathologies can be treated at the same time, and early mobilization is provided due to tight fixation (4).

The aim of our study was to comparatively evaluate the relationship between the joint range of motion and age groups in the surgical treatment of unstable radius distal end fractures

involving the joint, using volar access and locking anatomic plate fixation methods.

MATERIALS AND METHODS

The study received ethics committee approval from the Clinical Research Ethics of Fırat University (approval no: 2018/14/3). In our study, 72 distal radius end fractures of adults who underwent open reduction and locked anatomical volar plate due to radius distal end fracture in group C according to AO classification in our clinic between August 2010 and August 2018 were evaluated retrospectively. The mean follow-up period was 24 months (13-69 months). All of our patients were evaluated for a post-op range of motion. The 17-30 age range was grouped as Group 1, the 30-45 age range as Group 2, the 45-60 age range as Group 3, and the >60 age range as Group 4. There were 8 patients in Group 1, 15 patients in Group 2, 13 patients in Group 3, and 6 patients in Group 4.

One of the more important problems of the patients who applied to our hospital with the complaint of wrist trauma and were found to have a fracture of the distal radius after the physical examination and radiological evaluation were primarily resolved. Radius distal end fracture occurred as a result of simple fall in 40 (55.5%) patients, falling from a height in 17 (23.6%) patients, traffic accident in 9 (12.5%) patients, work accidents in 4 (5.5%) patients, and impact in 1 (2.7%) patient. There was no open fracture in any of our patients. In addition, 1 patient had an ipsilateral acetabulum fracture, 1 patient had an ipsilateral iliac wing fracture, 1 patient had an ipsilateral intertrochanteric femur fracture, 1 patient had C7 left transverse process fracture, 1 patient had L2 vertebral fracture, 1 patient had T12 vertebral fracture.

Control radiographs were taken after closed reduction and long arm splint application under sedoanalgesia in patients with distal radius fractures involving the joint. Patients who have fractures with poor reduction (less than 15 degrees of radial inclination, more than 20° volar angulation, more than 5 mm of radial shortening, and more than 2 mm separation on the articular surface) and unstable fractures (more than 20 degrees of dorsal angulation, fragmentation of the dorsal cortex, patients aged >60 years, with concomitant ulna fracture, shear fracture and dislocation fractures) and patients who accepted surgical treatment and were followed up for a sufficient period formed study group.

Surgical Method

All of the patients; In the supine position, 60 patients (83.3%) were operated under general anesthesia, 12 patients under axillary block (16.6%) and all patients were operated using a pneumatic tourniquet. Before the application of anesthesia, 1 g of cefazolin sodium for prophylactic purposes and clindamycin 600 mg of antibiotic were applied as I.V. to patients with a history of penicillin allergy. Henry's approach was used for the palmar approach in the distal wrist anterior aspect. The fracture was reached, and the fracture was reduced, and the compatibility of the articular surface and reduction of the fractured fragments were controlled by fluoroscopy. After the reduced position was achieved, the fracture reduction was detected with temporary K-wires sent from the radial styloid. The distal radius volar anatomical plate was placed distal to the radius and stabilized with screws through the appropriate holes on the plate. After the tourniquet was terminated and bleeding was controlled, the FCR tendon sheath was repaired, and the subcutaneous tissues and skin were closed.

Post-Operative Evaluation

A semi-rigid wrist splint was applied to the patient, leaving the metacarpophalangeal joint exposed. For edema control, the forearm was kept above the heart level, and circulation monitoring was described to the patients. Active finger movements were started. After an average of 2-3 weeks, the splint was terminated, and wrist and forearm rotation movements were started.

Exercises to increase muscle strength were allowed after the radiological and clinical union was observed. While the patients were checked in the post-op 2nd and 6th weeks in the early period, other controls were made later in the 2nd, 3rd, and 6th months. In the 2nd-month control evaluation performed in almost all patients, patients who could not achieve adequate ROM were rehabilitated in terms of ROM and grip strength by consulting the physical therapy and rehabilitation department after the adequate union was observed. At the last control of the patients, their complaints were questioned. Forearm rotation and wrist movements were evaluated with a physical examination.

Patients with extra-articular fractures of the distal radius of the radius and patients with additional fractures in the ipsilateral upper extremity were not included in our study. Functional outcomes were evaluated using the Gartland-Werley scoring system (5) and QuickDASH-T questionnaire (6). Gartland-Werley scoring system is based on a "demerit" scoring system involving subjective and objective aspects related to wrist and hand function, residual deformities, range of motion, and nerve complications (5). Quick-DASH is an assessment questionnaire that measures activity and participation limitations in upper extremity disorders (6).

Radiological controls were evaluated with AP and lateral radiographs. Radiological evaluations were made according to the Stewart radiological evaluation system (7). SPSS (Statistic Packages for the Social Sciences) 21.0 in data analysis. package program was used. Categorical measurements were summarized as numbers and percentages, and continuous measurements as mean±standard deviation or median. Chi-square test statistics were used to compare categorical measures between groups. The Mann-Whitney U test was used in the analysis of continuous variables that did not show normal distribution. A p-value of <0.05 was considered significant in all tests.

RESULTS

Of our patients, 47 (65.2%) were male and 25 (34.7%) were female. The mean age of men was 41.29 (17-63), while the mean age of women was 49.13 (31-73), and the mean age was 44.11 (17-73). Looking at the distribution by age groups, 14 patients (19.4%) were 17-30 years old, 25 patients (34.7%) were 31-45 years old, 20 patients (27.7%) were 46-60 years old, and 13 patients (18%) were 61 years or older. 34 (47.2%) of the distal radius fractures were seen in the right wrist, and 38 (52.8%) were in the left wrist. Since all of our patients were right dominant, the fracture rate in the dominant wrist was 47.6% and the fracture rate in the non-dominant wrist was 52.4%.

The mean wrist and forearm rotation range of motion values were measured as a result of the clinical examination performed at the last follow-up of the patients (Table 1). Group 1 range of motion was found to be higher than all other groups. As the age of the patients increased, a decrease was found in the post-op joint range of motion. According to these results, there is a significant difference between the age of the patients and the range of motion of the post-op joint, and our source of difference is between Group 4, Group 1, and Group 2.

Table 1. The relationship between the joint range of motion and age groups after RDEF (Radius Distal End Fractures)

		N	Mean	Std. Deviation	Min	Max	F	p	Difference
Flexion (degree)	Group 1	14	76.8750	7.52970	65.00	90.00	5.097	0.005	61 and above >17-30;3145
	Group 2	25	74.0000	5.73212	65.00	80.00			
	Group 3	20	66.9231	6.30425	55.00	80.00			
	Group 4	13	64.1667	13.57080	50.00	90.00			
	Total	72	70.9524	8.78178	50.00	90.00			
Extension (degree)	Group 1	14	71.8750	4.58063	65.00	75.00	3.389	0.044	61 and above >17-30;3145
	Group 2	25	68.3333	8.16497	45.00	75.00			
	Group 3	20	66.1538	7.94613	50.00	75.00			
	Group 4	13	61.6667	6.83130	50.00	70.00			
	Total	72	67.3810	7.74896	45.00	75.00			
Radial deviation (degree)	Group 1	14	32.50	5.976	25	40	7.699	0.000	61 and above >17-30;3145
	Group 2	25	29.67	6.114	20	40			
	Group 3	20	23.08	5.220	15	35			
	Group 4	13	21.67	4.082	20	30			
	Total	72	27.02	6.813	15	40			
Ulnar deviation (degree)	Group 1	14	38.75	3.536	35	45	5.922	0.002	61 and above >17-30;3145
	Group 2	25	36.33	5.815	25	40			
	Group 3	20	28.46	10.485	0	40			
	Group 4	13	25.83	7.360	20	40			
	Total	72	32.86	8.775	0	45			
Supination (degree)	Group 1	14	85.00	4.629	80	90	1.745	0.174	
	Group 2	25	79.67	13.819	40	90			
	Group 3	20	74.62	15.202	30	90			
	Group 4	13	70.00	16.733	40	90			
	Total	72	77.74	13.934	30	90			
Pronation (degree)	Group 1	14	85.62	4.955	80	90	3.110	0.038	61 and above >17-30
	Group 2	25	84.33	8.209	60	90			
	Group 3	20	82.69	6.651	70	90			
	Group 4	13	73.33	13.663	50	90			
	Total	72	82.50	8.852	50	90			

Gartland-Werley score, Stewart score, and Quick-Dash scores were evaluated individually with age groups (Table 2). Gartland and Werley's clinical evaluation results were given as excellent, good, and moderate (Table 3). None of our patients had a bad outcome. Accordingly, excellent results were obtained in 12 (85.7%) patients in Group 1 and good results were obtained in 2 (14.3%) patients. In group 2, excellent results were obtained in 7 (28%) patients, good results in 16 (64.0%), and moderate results in 2 (8%) patients. In group 3, excellent results were obtained in 8 (40%) patients, good results in 9 (45%) patients, and moderate results in 3 (15%) patients. In group 4, good results were obtained in 8 (61.5%) patients, and moderate results were obtained in 5 (38.5%) patients. According to these results, a significant difference was observed between the age of the patients and the Gartland-Werley score. Our source of difference is between Group 4 and Group 1 (F:4.523- P:0.008).

Stewart Score results in which post-op radiological findings were evaluated were excellent, good, and moderate (Table 4). None of our patients had a bad outcome. Accordingly, excellent results were obtained in 10 (71.5%) patients, and good results were obtained in 4 (28.5%) patients in Group 1. In Group 2, excellent results were obtained in 10 (40.0%) patients, good results in 13 (52 %) patients, and moderate results in 2 (8%) patients. In group 3, excellent results were obtained in 9 (45%) patients, good results in 8 (40 %) patients, and moderate results in 3 (15%) patients. In group 4, excellent results were obtained in 5 (38.4%) patients, good results in 4 (30.7%) patients, and moderate results in 4 (30.7%) patients. There was no significant difference between Stewart's score and age groups (F: 0.795- P:0.504). No significant difference was found between the age groups with the Quick-Dash Questionnaire Score, which was evaluated by considering the subjective findings of the patients (F: 1.347- P: 0.274).

Table 2. Distribution of Gartland-Werley score, Stewart score, and Quick-Dash Survey score by age groups

		N	Mean	Std. Deviation	Min	Max			Difference
Gartland-Werley score	Group 1	14	3.8750	.35355	3.00	4.00			61 and above >17-30
	Group 2	25	3.1333	.63994	2.00	4.00			
	Group 3	20	3.3077	.63043	2.00	4.00			
	Group 4	13	2.8333	.40825	2.00	3.00			
	Total	72	3.2857	.63575	2.00	4.00			
Stewart score	Group 1	14	3.6250	.51755	3.00	4.00			
	Group 2	25	3.4667	.51640	3.00	4.00			
	Group 3	20	3.4615	.51887	3.00	4.00	0.795	0.504	
	Group 4	13	3.1667	.75277	2.00	4.00			
	Total	72	3.4524	.55005	2.00	4.00			
Quick-Dash score	Group 1	14	12.38	2.722	11	19			
	Group 2	25	13.53	2.588	11	19			
	Group 3	20	13.46	1.808	11	17	1.347	0.274	
	Group 4	13	14.83	1.472	13	17			
		72	13.48	2.298	11	19			

Table 3. Distribution of Gartland-Werley score by age groups

	Group 1	Group 2	Group 3	Group 4	Total
Perfect	12 (85.7%)	7 (28%)	8 (40%)	0	27
Good	2 (14.3%)	16 (64%)	9 (45%)	8 (61.5%)	35
Moderate		2 (8%)	3 (15%)	5 (38.5%)	10

Table 4. Distribution of Stewart Score by age groups

	Group 1	Group 2	Group 3	Group 4	Total
Perfect	10 (71.5%)	10 (40.0%)	9 (45%)	5 (38.5%)	34
Good	4 (28.5%)	13 (52%)	8 (40%)	4 (30.7%)	29
Moderate		2 (8%)	3 (15%)	4 (30.7%)	9

No significant complication was encountered in any of the patients in the early post-operative stage. Carpal tunnel syndrome findings occurred in the late period in two patients in Group 3 and one patient in Group 4. Carpal tunnel release was performed in one patient in Group 3 and one patient in Group 4, and the distal radius endplate was removed in the same session. The other patient in group 3 did not accept the operation. Stage 2 arthritis was detected in three patients, one of whom was in group 2 and the other two were in group 3. Stage 3 arthritis was observed in two patients in group 4. Complications such as tendon rupture and tenosynovitis were not observed in any of the patients. In addition, none of our patients developed a complication requiring implant removal due to plate or screw irritation.

DISCUSSION

Radius distal end fractures occur mostly as a result of simple falls in daily life. However, the incidence of these fractures increased after in-vehicle and out-of-vehicle traffic accidents and sports injuries, as well as increasing life expectancy and widespread use of motor vehicles. Successful results can be obtained with closed reduction and casting in non-displaced and extra-articular fractures (8). In unstable fractures that are not under these conditions, plaster treatment may result in poor union. When the literature is examined, it is seen that the success of cases with closed reduction and plaster fixation in intraarticular fractures is very low. In particular, the aim of the surgical treatment of intra-articular radius distal end fractures is stated as restoring function, initiating early movement, preserving motor power, and preventing the development of posttraumatic arthritis and complications (9).

The general practice in a patient with a distal radius fracture is to diagnose early instability by following up between 7-14 days after closed reduction and casting. Instead, if the fracture is evaluated with instability criteria at the first admission, surgical treatment can be planned without waiting for reduction loss in the cast (10). Cooney et al. evaluated the primary instability criteria as dorsal angulation greater than 20 degrees at the beginning, presence of dorsal cortical fragmentation or defect, radial shortness of more than 10 mm, intra-articular fracture, and metaphyseal fragmentation (11). Secondary instability criteria are dorsal angulation of more than 5 degrees and radial shortness of more than 5 mm after closed reduction and casting.

One of the controversial issues related to the treatment of distal radius fractures is the approach to be applied to such injuries in the elderly (12). It is clear that the best results are obtained with anatomical restoration in displaced and unstable distal radius fractures in young patients. However, in patients over 65 years of age with distal radius fracture and treated with non-surgical methods, good functional results could be obtained even if they healed with malalignment. Many studies have been conducted to determine which is more important for long-term results in the restoration of anatomical and radiographic parameters in distal radius fractures. It has been observed that radial shortness causes deterioration in wrist kinematics and adverse changes in the triangular fibrocartilage complex. Current studies focus on the importance of appropriate reduction of the palmar tilt and distal radioulnar joint. In addition, many studies showing that increased dorsal inclination reduces wrist grip strength (13). It has been determined that permanent deformity affects the distal radioulnar joint, causing pain and loss of forearm rotation in some cases. In our study, the radiological and, accordingly, functional results of the patients were satisfactory. We attribute this to both anatomical reduction and early movement exercises.

The mean pre-op radial height of the patients who underwent locking plate was measured as 6 mm and post-op 9.5 mm by Gallacher et al. (14). Pre-op palmar tilt was measured as mean -20º and postoperative 9.2º. They also stated that volar locking plates prevent collapse in radiological follow-ups and have good long-term results, as well as good early-term results. Gerald et al. found postoperative palmar tilt to be 6.2º±5.8° and radial inclination 19.8°±2° in a prospective study in which they applied a volar locking plate (15). Studies on post-op wrist range of motion give more satisfactory results as the year progress. Murakami et al. determined the mean wrist movements after treatment in distal radius fractures treated with a volar locking plate as flexion 65°, extension 67°, pronation 87°, and supination 87° (16). On the other hand, Kostanitinidis et al. examined the clinical results after treatment in a series of 40 patients and found excellent results in 26 patients and good results in 11 patients (17).

In a study by Bentohami et al. in which they included 33 studies that met the study criteria, and examined the complications that occur after surgical treatment of distal radius fractures with a volar locking plate, they found the overall complication rate to be 16.5% in a group of 1817 patients (18). When they divided these complications into major and minor complications, they found that the most common minor complications were tendon irritation at 3.8%, CTS at 2.8% among major complications, and tendon rupture at 1.7% immediately after.

In our study, fixation material failure, deep infection, tendon rupture, any condition that required removal of fixation material, and malunion were not observed as major complications. Conditions such as tendon irritation, neuritis, superficial infection, and reduction loss, which were stated as minor complications, were not observed, but CTS was observed in 3 patients. In addition, stage 2 arthritis developed in three patients and stage 3 arthritis in two patients.

It has been stated that the most important reason for the increasing popularity of open reduction and locking volar plate fixation as a treatment option for distal radius fractures is the prevention of collapse in radiological follow-ups (19). It has been determined that volar locking anatomical plates provide volar inclination better than unlocked plates. Locked anatomical plates allow early movement as they contain many low-profile locking screws distally and allow for tighter fixation because they allow the

fixation of more parts, allowing early movement and providing ease of early rehabilitation for the patient. This leads to good results, especially in patients with poor bone quality and a high probability of reduction loss during follow-up.

CONCLUSION

The treatment of distal radius fractures involving the joint with locked anatomical volar plates provides good functional results in all age groups. However, our results in this population are better than the elderly population, due to better intra-operative reduction due to better bone quality in the adult population, better cooperation of patients with physicians, and greater benefit from physical therapy.

Conflict of Interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
The authors declare that they have received no financial support for the study.

Ethical Approval
The study received ethics committee approval from the Clinical Research Ethics of Fırat University (approval no: 2018/14/3).

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