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Functional status and activity participation in patients with distal radius fracture: Approach with ICF framework

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ABSTRACT

Objectives: Distal radius fracture (DRF) affects overall health status. The International Function Classification (ICF) based approach offered a different perspective on DRF management. The aim was to investigate the effectiveness of the rehabilitation program administered in patients with DRF from an ICF perspective.

Methods: In this prospective study, 53 patients were divided into conservative and surgical groups and were admitted to 12-weeks supervised rehabilitation program. Body structure and functions were evaluated with pain assessment, range of motion and muscle strength measurement. Also, radiographic evaluations were done. Activity participation was assessed with Push-Off Test (POT), Michigan Hand Outcomes Questionnaire (MHOQ), Quick Disabilities of Arm-Shoulder and Hand (Q-DASH) and Jebsen-Taylor Hand Function Test (JTHFT). Measurements were made on the 2nd, 6th week and the 3rd, 6th months.

Results: A total of 53 patients, 32 female (60.4%) and 21 male (39.6%) were included in the study. The mean age of the patients was 47,43±12,20 (23-60) years. 35 (66%) patients were treated conservatively and 18 (34%) patients were surgically treated. There was no difference between groups in pain level, range of motion, grip strength, POT, MHOQ, Q-DASH, JTHFT and radiologic measurements (p>0,05).

Conclusion: Creating an ICF-based assessment and intervention plan for the activity participation of patients with DRF guides hand surgeons and hand therapists in achieving their goals.

Key words: *Activity participation, distal radius fracture, hand therapy, ICF*

Introduction

Distal radius fracture (DRF) frequently causes functional loss leading to wrist and forearm limitations and affects overall health status [1]. Studies on DRF in the literature generally dwelled on pain, range of motion, grip strength, bone healing and alignment and include early mobilization and immobilization; focused on supervised hand therapy and home program. The superiority of early mobilization and supervised hand therapy are emphasized [2]. In many studies, although functional results are evaluated with specific scales, few studies have encountered functional tests that help to evaluate activity participation [3]. In a study based on The International Function Classification (ICF), a con-

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sensus was reached for the main evaluation methods of DRFs. According to this study, primary outcome measures include pain, return to daily life and roles / participation, adjustment, fracture healing, position, and range of motion, while secondary outcome measures include performance-based tests and functional status, complications, concomitant conditions and patient satisfaction. The ICF based approach is useful in both the treatment and rehabilitation of DRF from a broad perspective [3-5]. For this reason, a methodological study is required for DRFs.

Purpose

The aim was to investigate the effectiveness of the rehabilitation program administered in patients with DRF based on the ICF framework.

Materials and Methods

Study design

According to ICF, body structure and functions were evaluated with pain assessment, range of motion (ROM) and muscle strength measurement. Activity participation assessed with Push-Off Test (POT), Michigan Hand Outcomes Questionnaire (MHOQ), Quick Form of Disabilities of Arm-Shoulder and Hand Questionnaire (Quick-DASH) and Jebsen-Taylor Hand Function Test (JTHFT). In addition, volar tilt, radial slope and radial length were examined in radiological evaluation.

ROM and pain assessments were made on 2nd, 6th weeks and on the 3rd, 6th months. Grip strength, POT, Q-DASH, MHOQ, JTHFT were performed at 3rd, 6th months. Radiologic assessments were done at pre and post-intervention, 2nd, 6th weeks and on the 3rd, 6th months.

The Non-Interventional Clinical Research Ethics Committee meeting numbered 60116787-020/3518 approved this prospective study. Clinical trials identifier number was NCT04071002. Written informed consent was obtained from all patients included in the study.

Subjects

The criteria for inclusion in this prospective cohort study were; 1) Aged between 18 and 60 years, 2) Diagnosed with DRF, 3) Primary fixation after injury. Exclusion criteria were; 1) Bilateral DRF, 2) Concomitant ulnar styloid fracture, 3) Another orthopaedic, neurological or rheumatologic problem involving the ipsilateral upper limb, 4) Patients who underwent surgery that involved ipsilateral upper extremity, 5) Associated injuries such as nerve or tendon injuries, 6) Secondary procedures at follow-up, 7) Un-cooperated patients.

Materials

Primary Outcome Measures

Pain: Severity of pain was assessed with VAS in sleep, rest, and activity. Localized pain of patients was evaluated using an algometer as an objective method (Algometer Commander™ JTech Medical Industries). Pain points were determined on m. pronator quadratus (MPQ), m. flexor pollicis longus (FPL), ulnar styloid (US), distal radioulnar joint (DRUJ), radial styloid (RS) and triangular fibrocartilage complex (TFCC). The threshold value of the pain was determined by placing the probe on the pain points. Then, it was gradually increased and reduced to apply a pressure of 1kg / 0.5cm^2 with 0.5 cm^2 probe head [6].

Range of Motion: Range of the forearm and wrist joints of patients were measured with a universal goniometer [7].

Michigan Hand Outcome Questionnaire: MHOQ, consisting of six headings, was used for evaluating the participation and functional levels of the patients [8].

Quick-DASH: The Quick-DASH was used to measure physical function and symptoms in people with any or multiple musculoskeletal disorders of the upper limb [9].

Radiographic evaluations: The posteroanterior (PA) and lateral radiographic measurements were assessed by an experienced hand surgeon to determine the type of fracture, geometry, and associated pathology. Radial length, radial inclination and dorsal or volar angulations of the distal fragment were evaluated [10].

Secondary Outcome Measures

Grip strength: Grip strength was measured with a hand dynamometer (Baseline® Evaluation Instruments, 7-piece Hand Evaluation Set 12-0100) according to standard grip strength measurement method suggested by American Society of Hand Therapists [7].

The Push Off Test: POT was performed to determine the weight transfer strength of the patient to the extremities bilaterally [11]. The test was performed bilaterally by reversing the hand parts of the two hand dynamometers (Baseline® Evaluation Instruments, 7-piece Hand Evaluation Set 12-0100).

Jebsen Taylor Hand Function Test: The seven individual subtests of JTHFT (Sammons Preston Ability One, #8063) including writing, card turning, picking up small common objects, stacking checkers, stimulated feeding, moving light objects and moving heavy objects were performed in a standardized procedure [12].

Procedure

Conservative and surgical treatments of the patients were determined according to the indication by the same hand surgeon. Then, patients were collected in two groups, conservative (CG) and surgical (SG). All hand therapy programs and evaluations were by the same physiotherapist managed and radiographic evaluations were made by the same hand surgeon.

Conservative Treatment

Circular short arm plaster was applied. Weekly antero-posterior and lateral radiographs were followed. At 6th weeks according to fracture healing, plaster was removed [13].

Surgical Treatment

All patients in the surgical group were treated with the volar locking plate system (Acu-Loc® 2, Acumed, Hillsboro, OR, USA). Surgery was performed with standard volar approach by the same hand surgeon [14].

Hand Therapy

The patients were admitted to 12-weeks rehabilitation program and were called up once a week for follow-up appointments. Hand therapy continued as home program between 12th week and 6th month (Table 1).

None of the patients was received orthotic devices, mobilization techniques or additional electrotherapy.

Statistical Analysis

The Statistical Package for the Social Sciences (SPSS) version 21.0 was used for statistical analysis. Descriptive statistical data are presented as means ± standard deviation (x ± SD) or percentages (%). The Friedman test was used to determine whether data met parametric test conditions. The paired samples T-test

Table 1. Hand therapy program for conservative and surgical groups.

After cast removal or post operative 1-4. Weeks	• 3 M ™ Coban and tube grip bandage treatment for edema • Contrast bath • Retrograde massage • Active and active assistive exercises [Pronation, supination, wrist flexion and extension, thumb extension, abduction, adduction, opposition and reposition, active blocking, tendon gliding exercises for other fingers, shoulder and elbow range of motion exercises (if there is a limitation)] • Light activities of daily living
6.Week	• Additional exercises for the wrist joint [radial and ulnar deviation exercise]
8.Week	• Starting to progressive resistive exercises [Theraputty, digiflex, hand-master, 0,5-2 kg dumbbells] • Dart Throwing Motion (DTM)
12.Week	• Control and advices. The patient continues home based program. • Moderate activities of daily living
6. Month	• Performing the assessments and tests. • Heavy activities of daily living, sports and recreational activities

and Mann-Whitney U test were applied in dependent groups to determine the effectiveness of the methods used in the study. The independent samples T-test and Wilcoxon Test were used to determine the superiority of applications in independent groups. The general linear model was performed for repeated measures. Z value was used as the effect size and fragility index. Statistical significance level was accepted as p<0, 05.

Results

Fifty-three patients, 32 female (60.4%) and 21 male (39.6%) were included in the study. The mean age of the patients was 47,43±12,20 (23-60) years. There was no difference between groups in terms of age, gender and affected extremity. Thirty-five patients (66%) were conservatively treated and 18 (34%) were surgically treated (Figure 1). The duration of immobilization in conservative treatment was 43,17±7,38 days.

There was no difference between groups in pain levels, ROM, grip strength, POT, MHOQ, Q-DASH, JTHFT and radiologic measurements (p>0,05).

All patients have had minimal pain levels at sleep, rest and activity. In both groups, the number of people

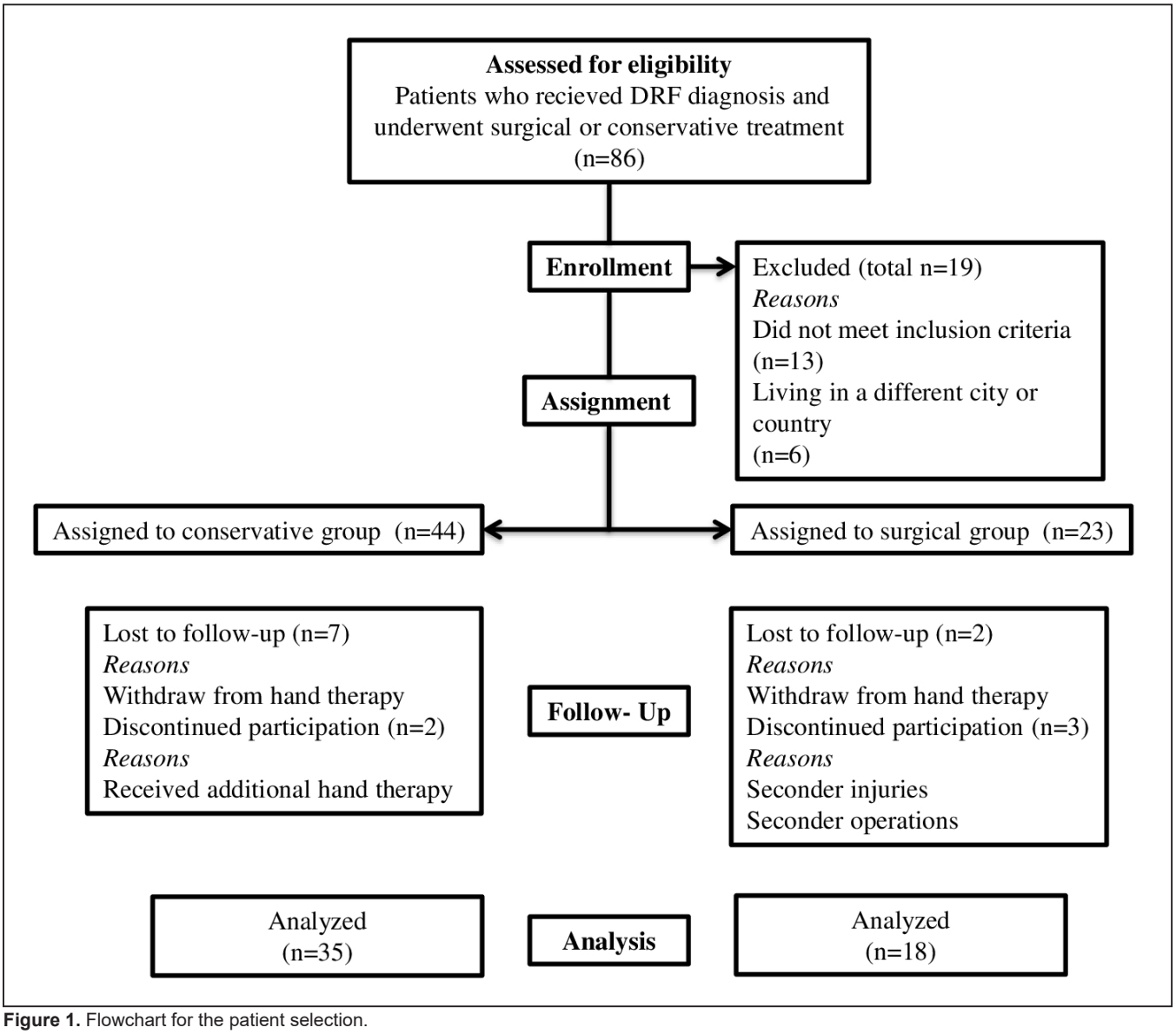

Figure 1. Flowchart for the patient selection.

who felt pain during the follow-ups decreased. Statistical analysis was not performed for the threshold assessments because of a few numbers of patients who felt pain.

Statistically significant differences were found between all intermediate measurements for ROM, grip strength and POT (Table 2), MHOQ and Quick-DASH (Table 3) and JTHFT (Table 4) within the groups (p<0,05).

Significant differences were observed in all radiographic measurements after intervention in both groups compared to previous results (p<0,05). No statistically significant differences were found between repeated measurements (p>0,05).

Discussion

In this study, the conservative group have better results than the surgical group, but the functional status and activity participation showed a similar improvement regardless of the type of intervention. It has been reported that the lack of studies about in body structures and activity participation on late-term follow-ups in the rehabilitation of DRF [3-5]. This study is an example of ICF-based study and presents extensive results regarding biopsychosocial model with supervised hand therapy methodology and the use of different appropriate assessment methods (such as JTHT, POT, and MHOQ). In terms of early intervention, the timing and progression of exercises, as well as the advancement in activity participation, supervised hand therapy program was found successful in both groups.

Table 2. Inter and intra group comparisons of the grip strength and POT results.

Variables	CG Mean±SD	SG Mean±SD	p value
Grip Strength			
3. Month	12,70±8,07	16,79±12,38	0,25(z^1=1,13)
6. Month	20,62±9,31	22,16±12,55	0,98(z^1=0,01)
p value	0,00(z^2=5,12)	0,00(z^2=3,57)	
Push Off Test			
3.Month	6,69±8,62	8,73±9,38	0,30(z^1=1,02)
6.Month	10,54±9,20	13,64±9,41	0,21(z^1=1,25)
p value	0,00(z^2=3,19)	0,00(z^2=3,72)	

z^1 Mann Whitney U Test, z^2 Wilcoxon Test

Table 3. Inter and intra group comparisons of the Q-DASH and MHOQ results.

Variables	CG Mean±SD	SG Mean±SD	p value
Q-DASH			
ADL			
3.Month	32,91±20,78	30,67±18,76	0,84(z^1=0,19)
6.Month	12,36±11,19	10,09±10,69	0,62(z^1=0,48)
p value	0,00(z^2=5,08)	0,00(z^2=3,72)	
Work			
3.Month	49,68±30,17	37,98±35,67	0,21(z^1=1,24)
6.Month	17,18±17,54	16,82±24,52	0,59(z^1=0,53)
p value	0,00(z^2=3,84)	0,00(z^2=2,94)	
Sport/Music			
3.Month	68,75±54,12	16,66±14,43	0,26(z^1=1,12)
6.Month	33,33±57,73	4,16±7,21	0,79(z^1=0,25)
p value	0,18(z^2=1,34)	0,18(z^2=1,34)	
MHOQ			
Total ADL			
3.Month	77,67±20,57	91,20±9,05	0,52(z^1=0,63)
6.Month	79,60±19,99	92,55±9,56	0,29(z^1=1,05)
p value	0,00(z^2=5,16)	0,00(z^2=3,51)	
Total Score			
3.Month	63,63±16,48	74,68±12,72	0,90(z^1=0,12)
6.Month	64,78±14,36	78,80±13,26	0,15(z^1=1,42)
p value	0,00(z^2=5,01)	0,00(z^2=3,72)	

z^1 Mann Whitney U Test, z^2 Wilcoxon Test

Within the frame of body structures and function, patients had low pain levels in early and late terms. The patients in the SG were more painful in the early period than the patients in the CG, but the difference was not significant. None of the patients received any additional medication or an application for pain modulation. This study conforms to the literature [15, 16]. Pain is the primary reason for the late return to previous activity and work [17]. So initially, we focused to reduce pain in the hand therapy program. The fact that the patients in the CG reported pain on the DRUJ and the US points in pain threshold measurements. It may suggest

Table 4. Inter and intra group comparisons of the JTHFT results.

Jebsen Taylor Hand Function Test	CG Mean±SD	SG Mean±SD	p value
Writing			
3.Month	42,42±32,88	33,40±16,25	0,52(z^1=0,63)
6.Month	38,52±33,08	30,94±17,36	0,54(z^1=0,60)
p value	0,00(z^2=3,27)	0,03(z^2=2,10)	
Card Turning			
3.Month	9,84±3,96	7,61±1,88	0,06(z^1=1,86)
6.Month	7,36±2,35	6,35±1,46	0,14(z^1=1,45)
p value	0,00(z^2=3,75)	0,00(z^2=2,85)	
Picking up small common objects			
3.Month	10,33±3,11	9,19±1,66	0,47(z^1=0,72)
6.Month	8,78±2,56	7,98±1,71	0,59(z^1=0,52)
p value	0,00(z^2=3,57)	0,00(z^2=3,28)	
Stimulated feeding			
3.Month	12,21±3,06	11,97±2,25	0,82(z^1=0,22)
6.Month	10,49±2,07	10,49±2,20	0,64(z^1=0,46)
p value	0,00(z^2=4,18)	0,00(z^2=2,70)	
Stacking checkers			
3.Month	3,06±1,33	2,44±1,27	0,07(z^1=1,75)
6.Month	2,21±1,07	2,48±2,04	0,89(z^1=0,13)
p value	0,00(z^2=3,98)	0,05(z^2=1,93)	
Moving light objects			
3.Month	6,16±1,39	5,70±1,18	0,37(z^1=0,89)
6.Month	5,32±1,39	5,13±0,82	0,98(z^1=0,01)
p value	0,00(z^2=4,39)	0,00(z^2=3,04)	
Moving heavy objects			
3.Month	6,51±1,77	6,07±1,47	0,38(z^1=0,86)
6.Month	5,61±1,40	5,24±0,93	0,43(z^1=0,78)
p value	0,00(z^2=3,88)	0,00(z^2=3,54)	

z^1 Mann Whitney U Test, z^2 Wilcoxon Test

instability or ulnar variance. The pain felt on the FPL point by the patients in the SG may indicate tendon irritation that occurred after the surgical procedure. Pain threshold measurements may provide insight into the affected structures after surgery or reduction. Nevertheless, the number of patients who felt pain in all points was reduced in accordance with VAS results. In a randomized study closest property to this study, algometer measurements have been taken on the areas where the pain is felt postoperatively. But the results are not yet published for lack of evidence [6,17]. Therefore, this study presents preliminary results in terms of determining structures that can be affected by injury in both soft and skeletal tissues, with measurements at standardised and regular intervals.

In this study, range of motion showed similar improvement in both groups. Most of the studies reported that there was no difference in ROM between the conservative and surgical groups [15,18]. In a randomized multicentre study, it was shown that the volar plate group gave more significant results than the conservative group at 3rd and 12th months [19]. Improvement in ROM is continuing up to 6th month and 1 year follow up with the use of extremity in daily and occupational activities. Even in the third month, the majority of ROM was achieved with early hand therapy in both groups. We believe that the standard and therapist-supervised program is effective in increasing joint range of motion in both groups.

Congruently to the literature, patients in this study regained 70% of grip strength of contralateral extremity [20] and there was no significant difference between groups [18]. Grip strength is an important factor in returning to activity and occupation. Although most of the patients were housewives, we found that early onset of adequate grip strength contributed to their performance at household chores. It is evident that the intervention program we have implemented has enabled the patients to use their extremities in their daily activities from the early period and contributed positively to the activity participation performances with the effective strengthening program.

Radiographic parameters were in the normal range in both groups. No complications related to healed bone and peripheral joints developed in both groups. Functional loss due to the reduction of volar tilt and decreased grip strength because of the loss of radial inclination and radial length has been reported [21]. Involvement of the

joint in the fracture, recovery of articular congruity and alignment are the factors that affect radiographic and functional results. In this study, it was concluded that the lack of any skeletal complications or deformities supports the functional results at a good level.

POT is an effective method for evaluating weight transfer capacity on the limb and participating to the activity [11]. For example, weight transfer to the upper limb is carried out when pushing the door or getting up from the chair. At this point, upper extremity stability is necessary for functional activities. This study is the first study to present POT results as an outcome measurement of activity participation in the patients with DRF.

There were no differences in MHOQ and Q-DASH between the groups and both improved significantly in early and late terms. However, literature is controversial; some studies report no significant difference between groups [22], some studies show superior functional results in favour of the volar locking plate application [19]. It has been shown that patients are restricted in their household chore, cooking, mobility and transport, eating, dressing and hygiene activities [23]. For this purpose, the early hand therapy program should focus on the independence of the patients in self-care activities.

The use of multiple outcomes assessment modalities has been suggested [24]. Hence, we included two patient-rated outcome measurements to make a subjectively comprehensive assessment. MHOQ, ADL and work sub-sections, were effective in assessing activity participation [5]. Also, we think that MHOQ may be superior for DRF patients compared to Quick-DASH since it is recommended that choices focused on trauma region should be made in the evaluation [25]. Because of the fact that MHOQ allows evaluation of activity participation and ADL, the presence of different subdivisions also ensures that comprehensive functional results are obtained for injury and it is more focused on the hand and wrist.

In studies about JTHFT, no statistically significant difference was reported comparing conservative and surgical treatment [26] and improvements in patients' JTHFT scores have been reported in a study [27]. Also, a group of researchers investigated patient, injury factors and associated the concepts of pain, disorder, and disability with skill [28] and reported that job loss after DRF is very important and that the risk of job loss increases with the increase of pain, disorder and occupational needs [17]. Another researcher found a positive relationship between attendance to therapy and early functional outcomes [29]. The performance tests that provide the evaluation of observed function assist the therapists in commenting on the patients' involvement in either work or ADL with full attendance in supervised regular therapy.

Strengths of this study; it includes ICF based, systematic, valid and reliable evaluation methods that provide important findings in terms of participation and functional status. The compliance of the selected patients, the homogeneity of the groups, the standardized patient follow-up and evaluation are positive aspects. Less mentioned measurements are performed in this study so it makes a significant contribution to the literature.

The greatest limitation is the lack of patients in the SG. We were not able to assess the return to work, which is an important parameter of participation in the activity. Since the majority of patients were housewives, we could not consider the time to return as an outcome measurement. Therefore, patients could only evaluate in terms of returning to ADL. The fact that the radiographic evaluations were performed on unilateral radiographs prevented bilateral comparisons and caused inadequacy in terms of radiographic measurement diversity.

We also think that there is a need for studies on activity participation and hand skills in DRFs. Besides, algometer measurements can be taken in the consideration to examine the effected structures and to direct the hand therapy but there is a need for further evidence. This study not only provides comparative clinical re-

sults of conservative and surgical groups but also presents functional results of early, regular and supervised hand therapy.

Conflict of interest statement

The authors have no conflicts of interest to declare.

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