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Original Research

Relationship Between Hand Dominance and Treatment Outcomes for Distal Radius Fractures in the Elderly in the Short-Term

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Purpose: Many studies have found no notable long-term differences in functional outcomes between operative and conservative treatments for distal radius fractures (DRFs) in elderly patients. However, those studies have not considered hand dominance. The current study compared outcomes between both treatments in a dominant wrist–injured group (dominant group) and nondominant wrist–injured group (nondominant group).

Methods: A total of 101 patients aged 65 years and older who experienced displaced DRF requiring reduction and who were managed for over 3 months with either operative or conservative treatment were examined. The dominant group included 46 subjects (operative, n = 26; conservative, n = 20), and the nondominant group included 55 subjects (operative, n = 28; conservative, n = 27). All operative treatments were performed with volar locking plate fixation, and all conservative treatments were immobilized with a sugar-tong orthosis or forearm cast. Functional outcomes and radiographic assessments were compared 3 months after treatment. The primary outcome measure was the *Quick*–Disabilities of the Arm, Shoulder, and Hand (*Quick*DASH) score; secondary outcomes were grip strength, range of motion, and Mayo wrist score. We also examined *Quick*DASH scores after at least 1 year.

Results: The *Quick*DASH score showed no significant differences between treatments by dominance at 3 months or more than a year. In the dominant group, operative treatment resulted in significant 7-kg greater grip strength at 3 months, whereas the nondominant group showed no significant differences in functional outcomes between treatments.

Conclusions: Although *Quick*DASH scores were similar at 3 months and 1 year between treatments regardless of hand dominance, surgery for dominant-side DRF resulted in better grip strength than conservative treatment at 3 months.

Clinical relevance: This study will help clarify potential outcomes differences between operative and conservative DRF treatment in patients aged over age 65 years.

Distal radius fractures (DRFs) often occur in young teenagers and elderly people with a bimodal distribution, and the incidence in women increases rapidly from menopause to around age 80 years.[1–4] There is no correlation between hand dominance and fracture side.[5] The rate of operative treatment for DRFs in elderly patients has been increasing; the most common treatment involves the use of volar locking plates (VLPs),[1,2,4] with overall good outcomes reported.[6] However, many studies found that although operative treatment for DRFs in elderly patients improved radiographic outcomes, no major differences were noted in long-term functional outcomes between operative and conservative treatments.[7–15]

Regarding the short-term outcomes, operative treatment has been associated with better functional outcomes than conservative treatment. Arora et al[8] reported that up to 3 months after

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treatment, the Disabilities of the Arm, Shoulder, and Hand (DASH) and Patient-Rated Wrist Evaluation values and grip strength were better in cases of operative treatment, whereas the range of motion (ROM) and pain score did not differ markedly between operative and conservative treatment.[8] In contrast, Egol et al[10] reported that the DASH score, grip strength, ROM, and pain score did not differ markedly at 3 months. Chan et al[11] reported that the ROM and grip strength were better with operative treatment than conservative treatment until 6 months. Thus, short-term outcomes have differed among reports.

However, previous reports have not compared operative and conservative treatment while accounting for the relationship between hand dominance and fracture side. Because the frequency of hand use differs depending on hand dominance, it is possible that DRFs in the dominant versus nondominant wrist should be dealt with differently. One benefit of operative treatment for DRF is the ability for the patient to recover the use of the hand more quickly, which is even more important in cases involving a patient's dominant hand. Therefore, we evaluated patients based on the dominant side.

We hypothesized that operative treatment for the dominant hand would be more effective than that for the nondominant hand in elderly patients in the short term. The current study compared operative and conservative treatments for DRFs in elderly patients and explored the relationship between hand dominance and fracture side. The primary outcome measure was the *Quick*DASH score; secondary outcomes were grip strength, ROM, and Mayo wrist score (MWS).

Materials and Methods

From 2014 to 2018, 675 patients were treated for DRFs at our institution, 261 of whom patients were aged 65 years or older. Among them, 116 patients who experienced DRF and who were managed for over 3 months with either operative or conservative treatment were examined. Patients for whom the fracture was minimally displaced and required no reduction were excluded from this study (n = 3). We also excluded cases involving bilateral DRFs (n = 3), emergently treated open fractures (n = 1), use of an external fixator (n = 2), other fractures of the affected upper limb (n = 2), and existing deformity or paralysis of the affected upper limb (n = 4). The remaining 101 patients were available in the current study.

This study was approved by the institutional review board; informed consent was obtained from all patients.

Treatment

All patients received a radiographic assessment at the first medical examination. The fracture was reduced and immobilized with a sugar-tong orthosis or forearm cast. Additional radiographic assessments were conducted just after reduction and a few days later. Patients were informed that DRFs with considerble shortening, comminuted dorsal cortex, remaining dorsal tilt, and intra-articular fracture were indications for surgery; specifically, patients with a dorsal tilt greater than 10°, ulnar variance greater than 3 mm, and AO/Orthopaedic Trauma Association classification of type B, C2, or C3 were recommended for surgery. However, the final decision regarding operative or conservative treatment was left to the patient. In addition, even when the fracture was within acceptable limits, patients underwent surgery if they desired it.

Operative treatment was performed under general anesthesia or brachial plexus anesthesia. A VLP was fixed with a trans-flexor carpi radialis approach. An ulnar plate was added in 3 cases. The wrist was immobilized with a forearm cast for about 1 week after the operation, and then active exercise was started. In conservative treatment, immobilization was continued for about 4 to 5 weeks, and callus was observed in all conservatively treated patients at that time, so active ROM exercise of the wrist were started. No patients wore a removable orthosis after discontinuation of immobilization. Instructions on finger exercise were given; these exercises were started on the day of injury for both treatments. Patients received standardized rehabilitation from occupational therapists. Bone healing was defined radiographically by the bridging trabeculae across the fracture and was confirmed in all patients within 3 months.

Outcome metrics

We examined the demographic characteristics of the patients (age, sex, affected side and dominance, and fracture type based on AO/Orthopaedic Trauma Association classification) and divided all 101 patients into 4 groups (dominant-operative, dominant-conservative, nondominant-operative, and nondominant-conservative).

Radiographic assessments (radial inclination, palmar tilt, and ulnar variance), functional outcomes of ROM (degree and percent contralateral side; wrist extension and flexion, forearm supination, and pronation), grip strength (kilogram and percent contralateral side, assessed using a Smedley hand dynamometer [Matsumiya Ika Seiki Seisaku-sho, Tokyo, Japan]), MWS (pain, function, ROM, and grip strength), and *Quick*DASH score were compared among 4 groups at 3 months after treatment. Range of motion and grip strength were measured by an experienced hand-surgical specialist or an experienced orthopedic surgical specialist who were not blinded to the study protocol. Grip strength measurements were corrected by handedness based on the report that right-handed subjects were 10% stronger in grip strength on the dominant side; in left-handed subjects, mean grip was the same for both hands.[16]

Complications that occurred within the first 3 months after treatment were also examined. To evaluate longer-term outcomes, we mailed *Quick*DASH forms and questionnaires to patients for whom more than a year had lapsed since treatment. We collected 52 responses; mean time of the survey after treatments was 26 months (range, 15–55 months). An additional questionnaire asked, "If you got the same fracture again, would you choose the same treatment?" Patients could select "yes", "no," or "uncertain."

Statistical analyses

We performed statistical analyses using Shapiro-Wilk test to assess the normality of distributions. Data are reported as mean and SD. An analysis of variance and Tukey's honest significant difference test for parametric samples or Kruskal-Wallis analysis and Bonferroni correction for nonparametric samples were used to compare outcomes among 4 groups. The incidence of complications and answers to the questionnaire were evaluated using chi-square test. $P < .05$ was considered to indicate statistical significance.

We conducted a post hoc power analysis to assess the appropriate sample size, which was n = 25 in each of the 4 groups, based on a mean difference of 16, SD of 20, α error rate of 5%, and power of 80%. The mean difference was based on the reported minimum clinically important difference of the *Quick*DASH,[17] and the assumed SD was based on 3 months of data from the *Quick*DASH form in this study.

Table 1
Demographic Characteristics

	Dominant Group		Nondominant Group	
	Operative (n = 26)	Conservative (n = 20)	Operative (n = 28)	Conservative (n = 27)
Age, y (mean [SD])	73.2 ± 4.9	75.8 ± 8.0	73.0 ± 6.1	76.7 ± 8.0
M/F, n	8/18	3/17	1/27	5/22
R/L, n	24/2	16/4	1/27	1/26
AO/OTA classification, n (%)				
A2	4 (15.4)	9 (45.0)	5 (17.9)	11 (40.7)
A3	6 (23.1)	8 (40.0)	6 (21.4)	9 (33.3)
B2	1 (3.8)	0	0	0
B3	2 (7.7)	0	2 (7.1)	0
C1	1 (3.8)	2 (10)	3 (10.7)	4 (14.8)
C2	8 (30.8)	1 (5)	7 (25.0)	2 (7.4)
C3	4 (15.4)	0	5 (17.9)	1 (3.7)

Results

Table 1 lists patients' demographic data. The dominant group included 46 subjects (dominant-operative, n = 26; and dominant-conservative, n = 20) and the nondominant group included 55 subjects (nondominant-operative, n = 28; and nondominant-conservative, n = 27).

Table 2 lists radiographic outcomes. Palmar tilt after reduction and all parameters at 3 months showed significant differences. Functional outcomes at 3 months are shown in Table 3. There were significant differences in grip strength (kilogram and percent contralateral side). Although the MWS did not differ significantly, the grip strength of MWS showed a significant difference. The *Quick*DASH responses did not differ significantly at 3 months or at more than a year after treatment.

Questionnaire: "If you got the same fracture again, would you choose the same treatment?"

In the dominant group, the rate of answering "yes" was 64.3% in operative cases and 42.9% in conservative cases. In the nondominant group, the rate of answering "yes" was 64.7% in operative cases and 77.8% in conservative cases. There were no significant differences among the 4 groups ($P = .55$). All patients who did not answer "yes" answered "uncertain"; no patients answered "no."

Complications that occurred within the first 3 months are listed in Table 4. There were no significant differences in the incidence of complications among the 4 groups ($P = .83$). Three of 6 operatively treated patients who developed carpal tunnel syndrome (CTS) underwent surgery for carpal tunnel release and VLP removal: 2 patients (1/group) underwent them at 4 months after the operation and 1 in the dominant group did so at 14 months. Three of 5 conservatively treated patients (1 in the dominant group and 2 in the nondominant group) who developed CTS underwent carpal release soon after the 3-month evaluation, which relieved the symptoms. Two conservatively treated patients in the nondominant group who developed extensor pollicis longus tendon rupture did not wish to undergo repair surgery.

Four operatively treated patients (3 in the dominant group and 1 in the nondominant group) showed asymptomatic friction of the flexor pollicis longus (FPL) tendon with the plate within 6 to 9 months after surgery. Friction was judged by crepitus, feeling with the clinician's finger, and ultrasound examination. One dominant group patient who desired VLP removal underwent additional surgery at 8 months. The other 3 patients did not develop FPL tendon rupture.

Discussion

In the dominant group in the current study, grip strength (in kilograms) was significantly better in the operatively treated patients than in the conservatively treated ones at 3 months. However, there was no significant difference between treatments in the nondominant group. Therefore, operative treatment for the dominant wrist may lead to better grip strength in the short term.

Beumer and Lundu[18] reported strong correlations between the grip strength ratio and the DASH score in different hand and wrist conditions, including DRFs. Swart et al[19] analyzed patients undergoing operative fixation of DRFs and found that pain, grip strength, and supination were significantly correlated with DASH scores. Kim et al[20] examined patients treated by VLP fixation for DRF and reported the minimum clinically important difference of grip strength to be 6.5 kg. The 7-kg difference in grip strength observed between dominant-operative and dominant-conservative groups in the current study was thus suspected to be clinically important. Although there was no significant difference in the *Quick*DASH score between treatments in the dominant group, this difference in grip strength (in kilograms) may have been more helpful for daily functioning among operatively treated patients than among conservatively treated ones.

Beaulé et al[21] described self-reported disability levels among patients treated for DRFs using either a cast or an external fixator. Patients who sustained a dominant wrist injury were likely to report greater functional impairment, such as in opening doors, cutting meat and vegetables, pouring liquid from a pitcher, lifting pots and pans, wiping the buttocks, turning a key, arising from a chair using support, washing floors and walls, opening and closing a faucet, and experiencing morning and evening stiffness, than those who sustained a nondominant wrist injury. They stated that outcome studies for the treatment of DRF should consider hand dominance.

In this study, at more than a year after treatment, *Quick*DASH scores did not differ significantly between operative and conservative treatments, regardless of hand dominance, which was in line with past reports.[7–14]

Radiographic outcomes were better with operative treatment than conservative treatment, which was also in line with past reports.[7–14] In particular, palmar tilt in conservative treatment was often inadequately reduced and was smaller than in the surgery group even just after reduction, which may have affected outcomes at 3 months. Hohmann et al[22] investigated elderly people aged greater than 60 years with DRFs and found that the radial height and ulnar variance were closely related to the grip strength, and palmar tilt had a weak relationship with the DASH and Patient-Rated Wrist Evaluation. However, they concluded that minor deformities in DRFs are unlikely to be clinically relevant and have no

Table 2
Comparisons of Radiographic Outcomes*

	Dominant Group		Nondominant Group		*P* Value
	Operative (n = 26)	Conservative (n = 20)	Operative (n = 28)	Conservative (n = 27)	
Radial inclination (degrees)					
Before reduction	15.2 ± 6.8	19.3 ± 9.5	15.8 ± 9.7	17.9 ± 5.9	.27
After reduction	21.7 ± 3.2	20.5 ± 3.7	22.3 ± 4.2	21.0 ± 4.7	.47
3 mo	22.3 ± 3.8†	17.0 ± 5.2‡	22.1 ± 4.1	18.7 ± 7.7	<.05
Palmar tilt (degrees)					
Before reduction	−11.0 ± 20.0	−8.1 ± 12.5	−10.2 ± 16.6	−14.0 ± 16.6	.65
After reduction	7.3 ± 6.6†	2.3 ± 6.3‡	8.6 ± 5.6	3.7 ± 7.2	<.05
3 mo	6.3 ± 6.9†,§	−4.1 ± 9.0‡	7.5 ± 7.2§	−2.8 ± 11.4	<.05
Ulnar variance (mm)					
Before reduction	3.6 ± 1.8	3.1 ± 1.8	3.0 ± 2.5	3.0 ± 1.7	.61
After reduction	1.6 ± 1.7	2.4 ± 1.8	1.3 ± 2.0	2.0 ± 1.2	.20
3 mo	2.3 ± 1.6†	3.8 ± 1.9‡	2.1 ± 1.6	3.1 ± 1.7	<.05

* Values are given as mean ± SD.
† Significantly different ($P < .05$) from values of dominant-conservative patients.
‡ Significantly different ($P < .05$) from values of nondominant-operative patients.
§ Significantly different ($P < .05$) from values of nondominant-conservative patients.

Table 3
Comparisons of Functional Outcomes*

	Dominant Group		Nondominant Group		*P* Value
	Operative (n = 26)	Conservative (n = 20)	Operative (n = 28)	Conservative (n = 27)	
At 3 mo					
ROM (degrees)					
Extension	59 ± 13	59 ± 18	59 ± 13	61 ± 12	.98
Flexion	47 ± 13	40 ± 12	43 ± 13	41 ± 15	.09
Supination	83 ± 12	80 ± 15	80 ± 13	82 ± 12	.94
Pronation	78 ± 13	75 ± 10	79 ± 11	77 ± 12	.29
ROM (%)					
Extension	86 ± 11	85 ± 18	85 ± 13	88 ± 10	.80
Flexion	76 ± 15	65 ± 16	70 ± 18	70 ± 25	.35
Supination	93 ± 14	96 ± 8	90 ± 14	91 ± 11	.39
Pronation	94 ± 17	90 ± 9	93 ± 12	94 ± 16	.15
Grip strength (kg)†	17 ± 7‡,‖	10 ± 4	12 ± 5	11 ± 6	<.01
Grip strength (%)†	70 ± 15‖	56 ± 20	61 ± 21	49 ± 23	<.01
MWS (points)	71.2 ± 13.1	68.5 ± 10.7	65.5 ± 11.7	63.0 ± 12.3	.07
Pain	21.0 ± 3.2	20.5 ± 3.6	20.2 ± 2.9	19.4 ± 2.9	.34
Function	20.6 ± 6.8	22.3 ± 3.8	21.1 ± 5.3	21.5 ± 5.2	.96
Rom	16.4 ± 5.2	15.5 ± 4.6	15.9 ± 5.3	15.6 ± 5.1	.94
Grip strength	13.3 ± 4.9§,‖	10.3 ± 5.0	8.4 ± 3.9	6.5 ± 4.3	<.01
*Quick*DASH score	20.8 ± 20.5	24.7 ± 19.0	22.7 ± 21.4	27.0 ± 17.4	.35
At > 1 y	n = 15	n = 7	n = 18	n = 12	
*Quick*DASH score	9.3 ± 12.0	9.1 ± 12.7	7.3 ± 12.7	12.9 ± 14.3	.292
Elapsed time after treatment (mo)	21.9 ± 11.5	33.7 ± 14.2	30.7 ± 13.4	22.2 ± 13.6	.124

* Values are given as mean ± SD.
† Grip strength measurements were corrected by handedness.
‡ Significantly different ($P < .05$) from values of dominant-conservative patients.
§ Significantly different ($P < .05$) from values of nondominant-operative patients.
‖ Significantly different ($P < .05$) from values of nondominant-conservative patients.

Table 4
Complications That Occurred Within First 3 Mo

	Dominant Group		Nondominant Group	
	Operative (n = 26)	Conservative (n = 20)	Operative (n = 28)	Conservative (n = 27)
CTS	2 (7.7%)	2 (10.0%)	4 (14.3%)	3 (11.1%)
Median nerve palmar branch injury	1 (3.8%)			
Extensor pollicis longus rupture				2 (7.4%)
Total (incidence)	3 (11.5%)	2 (10.0%)	4 (14.3%)	5 (18.5%)

impact on patient-reported outcomes for elderly people. Anzarut et al[23] found that acceptable radiographic reduction was not associated with better patient-reported outcomes (Short Form−12, DASH, or a patient satisfaction survey) or increased satisfaction at 6 months in elderly patients with conservatively treated DRFs. In addition, our radiographic outcomes also seemed to not be associated with the patient-reported outcomes of *Quick*DASH at 3 months, a finding similar to that of previous reports.[10,13]

Regarding complications, similar previous studies reported the incidence of complications (operative, 8.3% to 36.1%; and

conservative, 7.5% to 17.1%).[7,8,10–12,14,15] Several previous studies reported that operative treatment was associated with a higher incidence of complications than conservative treatment.[7,8,10,14,15] In those reports, CTS or complex regional pain syndrome type 1 occurred in both groups, and tenosynovitis or tendon rupture resulting from a prominent screw or plate occurred in operatively treated cases. Orbay and Touhami[24] stated that most of these complications were related to the surgical technique and could be prevented with adequate VLP fixation. In the current study, although friction of the FPL tendon with the plate was observed within 6 to 9 months after treatment, no tendon rupture related to the implant was reported.

Evidence supporting the notion that operative treatment results in better functional outcomes for DRFs in elderly patients has been lacking,[25] so elderly patients tend to be treated conservatively.[5,26] However, elderly patients who sustained DRF on the dominant side and underwent operative treatment had significantly better grip strength at 3 months. If patients desire early recovery after DRFs, surgeons should consider taking hand dominance into account when deciding to perform operative treatment, even if the patient is elderly.

Some limitations associated with the current study warrant mention. First, both operative and conservative treatments were performed by several clinicians, which might have influenced the treatment outcomes. Second, there was selection bias because treatment information was given by several clinicians, and the decision regarding operative or conservative treatment was made by the patient. Finally, the group sizes may have been underpowered for some of the analyses reported, although we were sufficiently powered for the primary outcomes.

Based on these findings, although we saw no difference in *Quick*DASH scores at 3 months or 1 year, operative treatment for patients with injury to the dominant wrist was associated with an earlier recovery of grip strength (in kilograms). The 7-kg greater grip strength for the dominant hand achieved with operative treatment was suspected to be clinically important. Operative treatment for DRF on the dominant side in elderly patients may aid in their functional recovery.

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