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Research Article

The Effect of an Intensive Hand Exercise Program on Muscle Strength and Hand Functions in Patients with Rheumatoid Arthritis

Hakki Arslan[1], Ibrahim Halil Erdem[2]

[1]Meram State Hospital, Department of Physical Medicine and Rehabilitation, Konya, Türkiye
[2]Basaksehir Cam and Sakura City Hospital, Department of Physical Medicine and Rehabilitation, İstanbul, Türkiye

Abstract

Aim: This study investigated the effectiveness of classic and intensive exercise programs in patients with rheumatoid arthritis (RA) and their relationship with disease activity and patient functional well-being.

Material and Methods: Sixty patients aged 18 to 65, diagnosed with RA in our clinic, were randomly divided into two groups of 30 each. The first group received an intensive exercise program, while the second group received a classic exercise program. Disease activity was evaluated using erythrocyte sedimentation rate, C-reactive protein, DAS28Sedim, and DAS28Crp. Daily life activities were assessed using the HAQ score and Duruöz hand index. Joint mobility measurements were taken with a goniometer, and muscle strength measurements were taken using a manual dynamometer and pinch meter. Hand and wrist radiographs were taken and evaluated according to Steinbroker stages before exercise therapy.

Results: Improvement was observed in both groups' Visual Analog Scale (VAS) and Health Assessment Questionnaire (HAQ) scores, with a significant improvement in VAS scores favoring the intensive exercise group.

Conclusions: The study concluded that exercise therapy had positive effects on patients' hand functions, and the intensive exercise program was more effective.

Keywords: Rheumatoid arthritis, exercise, disease activity

INTRODUCTION

Rheumatoid arthritis (RA) is a chronic, systemic, inflammatory autoimmune disorder that affects multiple joints. It is characterized by an unknown etiology and primarily affects synovial tissues, leading to joint destruction and other tissue damage (1,2). The hands are often among the joints most affected by RA, resulting in significant changes in hand function (3,4). Hand function disability is a significant component due to the hands' vital role in daily activities such as gripping, lifting, and carrying objects (5,6). Research has indicated that individuals with RA experience a significant 75% reduction in hand strength when compared to their healthy counterparts (7). Impairments and limitations in the upper extremities, particularly hand involvement, negatively impact patients' daily activities. Therefore, identifying deficiencies and limitations in the upper extremities, closely monitoring them, and taking early measures to prevent permanent damage are crucia (7,8).

Deformity prevention and treatment require multidisciplinary approaches, including patient education, physical therapy modalities, assistive devices, occupational therapy, energy conservation principles, rehabilitation focused on preserving daily life activities, as well as medical and exercise therapies (9). Recent research

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Corresponding Author: Ibrahim Halil Erdem, Basaksehir Cam and Sakura City Hospital, Department of Physical Medicine and Rehabilitation, İstanbul, Türkiye
E-mail: iherdem@outlook.com

has shown an increasing interest in intensive exercise programs, contrary to traditional recommendations for gentle exercise therapy. While conventional regimens focus on improving joint mobility and preserving hand strength, intensive exercise programs also strive to augment hand strength (10-12).

The primary objective of this research was to assess and contrast the impacts of an intensive hand exercise program and a traditional hand exercise program on hand strength, joint mobility, pain, and functional ability among individuals diagnosed with RA. Given the lack of similar studies in the literature regarding the applied programs and the diversity of evaluation parameters and follow-up periods, this study aimed to contribute to the existing literature.

MATERIAL AND METHOD

Between January and August 2012, a total of 60 consecutive patients with RA who met the American College of Rheumatology (ACR) diagnostic criteria and were followed up at the Physical Medicine and Rehabilitation Clinic of Istanbul Education and Research Hospital were included in the study. Random selection was employed to include patients within the age range of 18 to 65 years, who had been living with the disease for a minimum of 2 years and a maximum of 10 years. The patients were assigned to groups in a consecutive manner according to their order of admission and then randomized. The classic exercises group (CE) received exercises including squeezing and releasing an object (such as a ball) that could fit in the palm, bringing the fingers closer together and moving them apart while stabilizing the hand on a flat surface (such as a table), performing resistance exercises for 5 seconds while supinating and pronating the hand and forearm, picking up and releasing small objects with index finger and thumb, pressing the hand against a flat surface (such as a table) and resisting for 5 seconds, extension exercises with a water bottle in the palm, and flexion exercises with a water bottle in the palm. The intense exercises (IE) group underwent exercises, including fist clenches and releases, thumb-finger opposition, wrist flexion (bending the wrist downwards), wrist extension (bending the wrist upwards), forearm rotation towards the palm (pronation), and forearm rotation away from the palm (supination). Both exercise programs were performed three times a day, with 30 repetitions for each exercise, five days a week.

Before the exercise therapy, wrist radiographs were taken and evaluated according to the Steinbrocker stages. The disease activity of the patients was evaluated through measurements of C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), and Disease Activity Score 28 (DAS28) based on both ESR and CRP, and daily life activities were evaluated using the Health Assessment Questionnaire (HAQ) score and Duruöz hand index. During the assessment of the DAS28 score, the following criteria were used to categorize disease activity: remission (≤2.4), low disease activity (2.4-3.6), moderate disease activity (3.6-5.5), and high disease activity (>5.5) (13). The Duruöz hand index is a scale that evaluates activity limitations related to hand function in RA patients. The scale consists of 18 items assessing hand abilities in dressing, kitchen activities, personal hygiene, work, and other daily movements. An increase in the score indicates greater difficulty and more activity limitations. The scoring system ranged from 0 (lowest score) to 90 (highest score) (14). Goniometry was utilized to measure joint range of motion (ROM), while muscle strength assessments were conducted employing a manual dynamometer and a pinch gauge. The assessments of disease activity, daily life activities, muscle strength, and goniometric measurements were conducted at the beginning of the exercise program, and at the end of 8th weeks. Pain intensity was evaluated using the Visual Analog Scale (VAS), where patients were asked to indicate their level of pain by marking along a 10-cm line. One end of the line represented the absence of pain, while the other end represented the most severe pain. The patients were asked to mark the point on the line that represented their current pain level, and the marked section was measured in millimeters (0-100 mm).

Patients with mental, cognitive, or any other neurological diseases, heart failure, tumor, osteomyelitis or any other infectious diseases, spinal deformity or congenital anomalies of the hand, injury or fracture of the forearm and hand, previous hand surgery, vertebral, pelvic or shoulder surgery, nerve laceration, compression or peripheral neuropathy, motor deficits, inflammatory diseases other than RA, contracture deformities and sequelae in the wrist and fingers secondary to RA, RA activation, and participants outside the age range of 18 to 65 years were excluded.

Following comprehensive explanations of the research objectives and study procedures to the participants, formal written consent was acquired from all individuals. The study was conducted in accordance with the ethical principles set forth in the Helsinki Declaration and was duly approved by the institutional ethics committee of the hospital.

Statistical Analysis

The data were analyzed using various statistical methods. Descriptive statistics, such as standard deviation (SD), ratio, mean, and frequency values, were used to summarize the data. To assess the distribution of the data, the Kolmogorov-Smirnov test was employed. Parametric data were subjected to analysis using the t-test, while non-parametric data were analyzed using the Mann-Whitney U test. The chi-square test was applied to analyze proportional data. In cases where the conditions for the chi-square test were not met, the Fischer test was utilized as an alternative. A significance level of $p<0.05$ was considered to determine statistical significance. All statistical analyses were conducted using the SPSS Statistics Standard Concurrent User V 26 (IBM) statistical package program.

RESULTS

The study included patients aged between 18 and 65 years. The mean age was 49.5±8.4 years in the CE group and 47.6±8.6 years in the IE group. The female-to-male ratio was 24/6 in the CE group and 27/3 in the IE group. The proportion of housewives was high in both groups. There were no statistically significant differences in terms of employment status,gender and age between the groups (p>0.05).

Both groups had a dominant right hand, with equal proportions of 28/30. When patients' hand X-rays were evaluated according to the Steinbroker stages, both groups were predominantly classified as stage 1, with a ratio of 28/30. There was no history of trauma in the patients' medical records. There were no statistically significant disparities observed between the CE and IE groups in terms of disease duration, dominant hand side, Steinbroker stages, trauma, presence of other diseases besides RA, and medical treatments (p>0.05) (Table 1).

Table 1. Comparison of the groups based on disease duration, hand dominance, radiological stage, comorbidities, and medication usage before treatment

	Classic exercise group (CE)		Intense exercise group (IE)		P
Disease Duration (years)	5.5±2.3 (Mean±SD)		5.1±2.5 (Mean±SD)		0.520
	N	**%**	**N**	**%**	
Dominant hand					
Right	28	93.3	28	93.3	
Left	2	6.7	2	6.7	>0.05
Steinbrocker					
Class 1	28	93.3	28	93.3	
Class 2	2	6.7	2	6.7	
Co-morbidity	11	36.7	5	16.7	0.08
Methotrexate	22	73.3	16	53.3	0.108
Hydroxychloroquine	5	16.7	5	16.7	>0.05
Leflunomide	6	20	8	26.7	0.542
Steroid	12	40	14	46.7	0.602
NSAID	15	50	11	36.7	0.297
Sulfasalazine	6	20	5	16.7	0.739
Anti TNF	1	3.3	0	0	>0.05
RF +	26	86.6	25	83.3	>0.05
Anti CCP +	27	90	27	90	>0.05

Mean±SD: mean±standard deviation, NSAID: non-steroidal anti-inflammatory drug, RF: rheumatoid factor, Anti CCP: anti-cyclic citrulline peptide, Mean: mean, Chi-square test/ Fischer exact 95% confidence interval

When comparing the pre-exercise and 8th week evaluations of the patients, improvements were observed in terms of HAQ scores and Duruöz scores in both groups. However, no significant difference was found between the two groups (p>0.05) (Table 2).

No statistically significant differences were found between the CE and IE groups in terms of morning stiffness duration, sedimentation, CRP, DAS28Sedim, DAS28CRP, RF, degrees of forearm supination and pronation in the right and left sides, degrees of PIP flexion, degrees of MCP extension, degrees of abduction and flexion of the thumb, degrees of radial and ulnar deviation of the wrist, and degrees of wrist flexion and extension before treatment and at the 8th week (p>0.05).

When examining the VAS scores of the groups before treatment (CE: 6.9, IE: 7.3) and at the 8th week (CE: 6.7, IE: 5.2) a significant decrease was observed in the VAS scores of the IE group after treatment (p<0.05), while there was no significant change in the scores of the CE group (p>0.05). The VAS scores of the CE group (6.7±1.01) were notably greater compared to the intensive exercise group (5.2±0.81) after the treatment (p<0.05) (Table 2).

Table 2. Comparison of the clinical parameters of the groups before and after treatment

		Classic exercise group (CE) (Mean±SD)	Intense exercise group (IE) (Mean±SD)	p
VAS (centimeter)	BT	6.9±8.3	7.3±9.8	0.325
	AT	6.7±10.1	5.2±8.1	0.004
HAQ	BT	1.0±0.6	0.9±0.7	0.327
	AT	0.7±0.5	0.7±0.6	0.446
Duruöz hand index	BT	10.7±6.2	7.1±6.9	0.037
	AT	7.9±5.3	5.3±5.8	0.078
Right-side pinch strength (pound)	BT	14.5±3.4	13.7±4.5	0.439
	AT	16.0±4.1	20.6±5.6	0.001
Left-side pinch strength (pound)	BT	13.4±3.4	13.3±4.9	0.903
	AT	14.8±3.9	20.8±5.8	0.000
Right-side grip strength (pound)	BT	53.4±14.2	47.8±15.0	0.143
	AT	56.0±12.8	56.0±17.2	0.993
Left-side grip strength (pound)	BT	51.7±13.5	45.2±15.0	0.083
	AT	52.8±13.9	53.7±16.4	0.820
Right wrist flexion (degrees)	BT	74.5±4.7	76.6±4.6	0.084
	AT	74.6±4.7	76.9±4.0	0.079
Left wrist flexion (degrees)	BT	74.7±4.7	76.4±4.8	0.064
	AT	74.7±4.7	76.8±4.3	0.054
Right wrist extension (degrees)	BT	65.1±3.3	65.8±4.0	0.464
	AT	65.2±3.3	65.9±4.1	0.387
Left wrist extension (degrees)	BT	64.7±3.4	65.4±4.6	0.468
	AT	64.6±3.5	65.8±4.2	0.270
PIP flexion right (degrees)	BT	91.3±2.9	93.7±4.1	0.754
	AT	91.3±2.9	93.8±4.2	0.668
PIP flexion left (degrees)	BT	90.3±2.5	93.7±4.1	0.856
	AT	90.4±2.6	93.9±4.2	0.835
MCF flexion right (degrees)	BT	84.0±3.5	86.5±3.1	0.877
	AT	84.2±3.7	86.7±2.9	0.829
MCF flexion left (degrees)	BT	83.1±3.5	86.4±3.2	0.454
	AT	83.3±3.8	86.8±2.9	0.466
MCF extension right (degrees)	BT	25.1±4.2	25.3±4.1	0.897
	AT	25.1±4.3	25.3±4.2	0.897
MCF extension left (degrees)	BT	25.2±4.2	25.0±4.2	0.878
	AT	25.2±4.2	25.2±4.1	1.000
Sedimantation mean (mm/hr)	BT	28.4±12.6	31.2±15.9	0.453
	AT	29.1±14.0	37.5±19.2	0.165
CRP mean	BT	0.8±0.7	0.7±0.6	0.542
	AT	1.0±1.0	0.7±0.5	0.532
DAS 28 sedim	BT	2.6±0.3	2.5±0.5	0.383
	AT	2.6±0.2	2.6±0.3	0.138
DAS 28 CRP	BT	1.4±0.2	1.4±0.3	0.126
	AT	1.5±0.2	1.4±0.2	0.236

Mean±SD: mean±standard deviation, BT: before treatment, AT: after treatment, VAS: visual analogue scale, HAQ: health assessment questionnaire score, t-Test 95% confidence interval, Mann-whitney u test, 95% confidence range

The muscle strength values of pinch and grip were compared before and after treatment for the patients. Improvement in muscle strength values of pinch and grip was observed in both groups compared to before treatment. When comparing the CE and IE groups, the right-side pinch strength values were significantly lower in the CE group (16.0±4.1) than in the IE group (20.6±5.6) ($p<0.01$). Similarly, the left-side pinch strength values were significantly lower in the CE group (14.8±3.9) than in the IE group (20.8±5.8) ($p<0.01$). Although both groups showed an increase in grip strength values on the right and left sides compared to before treatment, no statistically significant difference was observed between the groups ($p>0.05$). Correlation analysis between muscle strength and disease duration showed a decrease in pinch and grip strength values as disease duration increased, but his difference was not statistically significant both between and within the groups ($p>0.05$).

DISCUSSION

Rheumatoid arthritis (RA) is a chronic autoimmune and inflammatory disease with a wide range of multi-system involvement and an unclear etiology (15). The course of the disease varies from short-term oligoarticular involvement with minimal joint damage to severe polyarticular involvement leading to significant functional impairment (16). The goal of treatment in RA is to reduce pain, control inflammation, preserve joint function and structure, and ultimately manage systemic involvement in order to maintain the patient's quality of life (17). The hand has a wide range of functions and tasks, including writing, gripping, touching, holding, physical defense, and feeding, among others. In RA patients, hand function deteriorates over time, negatively affecting daily life activities (12). Therefore, early diagnosis should be made whenever possible, and diagnosed patients should be regularly monitored and treated.

Muscle weakness is also a common problem in RA patients. Weakness becomes more pronounced due to disuse, muscle inhibition secondary to joint effusion, or myositis (18). Suomi et al. (19) reported the positive effects of exercise on quality of life. Traditionally, the primary goal of exercise therapy for RA has been to preserve joint ROM and enhance muscle strength.

In our study, it was observed that patients receiving the intensive exercise program showed greater improvement in hand function compared to patients receiving the classic exercise program. At the end of 8 weeks, the pinch values of the CE group improved by 10.6% (from 14.5 to 16) on the right side and 10.4% (from 13.4 to 14.8) on the left side, while the pinch values of the IE group improved by 51% (from 13.7 to 20.6) on the right side and 57% (from 13.3 to 20.8) on the left side (Table 2). At the end of 8 weeks, the grip values of the CE group improved by 4.8% (from 53.4 to 55.3) on the right side and 2.1% (from 51.7 to 52.8) on the left side, while the grip values of the IE group improved by 17% (from 47.8 to 56.0) on the right side and 18.7% (from 45.2 to 53.7) on the left side (Table 2). Similarly, Ronningen et al.(12) reported significant improvements in pinch and grip values in the intensive exercise group compared to the classic exercise group in their study involving 30 patients in each group after 14 weeks. Brorsson et al. (20) provided a 6-week hand exercise program to RA patients and evaluated their muscle strengths. They reported a 40% improvement in grip strength in their study. In the same study, hand muscles were evaluated in cross-section using ultrasound, and significantly increased hypertrophy was observed in patients who received exercise compared to the control group. Hakinken et al. (21) reported an increase in muscle strength in patients who performed home exercises 2-3 times a week in their study.

The average age in our study was 49.5±8.4 in the control group and 47.6±8.6 in the study group. The female-to-male ratio favored women, with 24/6 in the control group and 27/3 in the study group. As the majority of the participants were middle-aged women, housewives ranked first in terms of occupation, and there was homogeneity between the groups. No statistically significant differences were observed between the groups concerning age, gender, dominant hand, radiological stage, presence of additional diseases, and employment status ($p>0.05$) (Table 1).

Goniometric measurements of the participants were performed actively before exercise therapy, and at the end of the 8th week. Measurements were taken for supination, pronation, wrist flexion, wrist extension, MCP flexion, MCP extension, PIP flexion, thumb flexion, thumb abduction, ulnar and radial deviation of the wrist. Except for the left-hand MCP extension degrees of the IE group, all initial measurement values were higher in the intensive exercise group compared to the CE group. The difference in initial ROM values between the groups was not statistically significant. At the end of 8 weeks of exercise, no significant increase was observed in the measurement values of both groups. Hoenig et al. (22) also reported no increase in joint ROM in their study on RA patients who followed a home exercise program for 12 weeks, similar to our results. O'Brien et al. (23) reported no significant difference in upper extremity joint ROM in their study where they followed 67 patients with a home program for 6 months.

When examining the VAS scores of the groups before treatment and 8 week after treatment, a significant decrease was observed in the VAS scores of the IE group after treatment ($p<0.05$), while there was no significant change in the scores of the CE group ($p>0.05$). At the conclusion of the 8th week, the Visual Analog Scale (VAS) scores of the CE group (6.7±1.01) were significantly higher compared to those of the IE group (5.2±8.1). Buljina et al. (7) also reported a more substantial improvement in hand pain scores compared to joint ROM in their study. Hall et al. (24) similarly reported lower pain levels after exercise in their study on RA patients. Hakkinen et al. (25) stated that pain and joint limitations are the most influential symptoms on functional status. Encouraging RA patients to exercise, the physical relief brought by exercise, and individualized attention to the patient's problems have

been reported to reduce chronic patient behavior and alleviate pain (26). In addition to medical treatments, patient education, psychological support, social support, and physical therapy modalities are extremely important in alleviating pain. Various education programs have been developed for this purpose, and their positive effects on pain and limitations have been demonstrated (27,28).

Taştekin et al. (8) reported that hand function, disability level measured by HAQ, hand grip strengths, and joint ROM of the fingers are closely related. In our study, although improvement was observed in HAQ scores in both groups, No statistically significant difference was found between the CE and IE groups regarding HAQ scores ($p>0.05$). Ronningen et al. (12) reported a significant improvement in HAQ scores after exercise in RA patients who received the IE program in their study. Significant improvement was observed in both groups regarding Duruöz hand scale values. However, there was no statistically significant difference between the classic and intensive exercise groups. Our results suggest that both classic and intensive exercises contribute positively to the daily physical activities of the patients.

Morning stiffness, another symptom associated with RA, is particularly associated with synovitis in the joints (29). Yazıcı et al. (30) reported morning stiffness as the most important symptom affecting functionality in their study with 337 RA patients. In the present study, we observed that there was no statistically significant difference in the duration of morning stiffness between the two groups before and after exercise. The results of other studies evaluating morning stiffness with exercise in the literature were also similar to our study (22,31). Although morning stiffness can be expressed to the patient in the best possible way, its evaluation is subjective and dependent on the patient's expression (32). The lack of a significant change in the duration of morning stiffness between the two groups before and after exercise in our study may be related to this subjectivity.

Our study has several limitations that need to be considered. Firstly, the research was conducted in a restricted geographical area, and the population size was relatively small. The higher female-to-male ratio in favor of women is also attributed to the small population. Although efforts were made to ensure compliance of the patients with the program through phone calls and frequent hospital visits, controlling and monitoring home exercise programs is more challenging for physicians compared to treatments provided in the hospital, which is another limitation of our study.

CONCLUSION

In conclusion, our study supports the notion that exercise therapy plays a significant role in improving hand function in RA patients. The implementation of an intensive exercise program may offer better outcomes compared to the classic exercise program. These findings highlight the importance of integrating exercise therapy with medical treatment in the management of RA, contributing to enhanced patient outcomes and overall quality of life. However, further research with larger sample sizes and longer follow-up periods is warranted to corroborate and expand upon our findings.

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