

Effect of range of motion and isometric strengthening exercises on grip strength and hand function in rheumatoid arthritis patients

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ABSTRACT

In previous studies, duration of hand exercises in patients with rheumatoid arthritis (RA) had widely varying ranges, from 3 weeks to 4 months. An experimental study was conducted to evaluate the effect of range of motion (ROM) and muscle strengthening exercises for 6 weeks on grip strength and hand function in RA patients. Seventeen patients with chronic RA were randomly assigned to a treatment group and a control group. The treatment group (n=8) was given muscle strengthening exercises and heat therapy using paraffin baths 3 times a week at the hospital and ROM exercises once a day at home for 6 weeks. The control group (n=9) was given only paraffin baths 3 times a week. After 6 weeks, there were significant differences in hand function (p=0.003), right and left grip strength (p=0.000 and p=0.001) and ROM in the interventional group only. ROM and isometric strengthening exercises significantly improved grip strength and hand function in patients with RA, while no impact was found when the patients were given paraffin baths only. In view of the small size of the study population, there is a need for further studies with larger populations.

Keywords: Hand exercise, grip strength, rheumatoid arthritis

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INTRODUCTION

Rheumatoid arthritis (RA) is an inflammatory chronic systemic disease, which is particularly manifested at the synovial membrane of diarthrodial joints and can result

in destruction of the involved joints.⁽¹⁾ It is present in 0.5% to 1% of the general population, twice as often in women, and the age at disease onset is mainly between 45 and 65 years.⁽²⁾ The clinical picture of RA is characterized by pain, fatigue, disability, and reduced quality of life.

The course of the disease is often unpredictable, and the symptoms may vary from day to day. The main goals of treatment for RA are to prevent or control joint damage, prevent loss of function, and decrease pain.⁽³⁾ Despite substantial progress in the pharmacological and surgical interventions over the last decade, many patients with RA will still experience disability, pain, psychological distress, fatigue, and poor quality of life.⁽⁴⁾ Reduced levels of physical performance has been found to be associated with RA. Patients with RA have been shown to have reduced muscle strength and aerobic capacity. Impairments, disabilities, and handicaps associated with RA can be devastating, leading to pain, activity restriction, and diminished quality of life, while placing a strain on the health care system and society.⁽⁵⁾

Besides pharmacological and surgical interventions, conventional therapies such as physical therapy, occupational therapy, and comprehensive rehabilitation and self management programs are commonly and frequently used interventions. Despite different pathophysiological processes, patients suffering from RA experience pain and a gradual decline in muscle strength, eventually resulting in loss of function and quality of life. Increasing evidence shows that physical exercise improves function and prevents loss of function in RA.⁽⁶⁾ Owing to a fear of enhancing joint inflammation and accelerating cartilage destruction, it has been advocated that exercise in active RA should be restricted to gentle assisted range of motion (ROM) exercises. On the contrary, exercise was found to have beneficial effects on function, pain and muscle strength. An intensive exercise program consisting of ROM strengthening and aerobic exercises is more effective than a conservative exercise program, and does not have deleterious effects on disease activity.⁽⁷⁾ In RA patients with active

disease, an inpatient program with frequent exercise therapy was found to be superior to usual care regarding disease activity as well as muscle strength. Long term high impact exercise has been proven to be beneficial regarding function and muscle strength in patients with low disease activity in an outpatient setting. In this study, exercise also did not increase disease activity.⁽⁸⁾

Hand function is recognized as being important to those diagnosed with RA, because reduction in muscle power and grip can lead to increasing difficulties in performing activities of daily living. O'Brien et al gave hand strengthening and stretching exercises as a home program for 6 months and showed significant results compared with stretching and joint protection.⁽⁹⁾ Theoretically, the effect of strengthening exercises can be expected after 2-3 weeks because of neural adaptation, but muscle adaptation itself can be seen after minimally 4 weeks of training.⁽¹⁰⁾

The aim of this study was to examine the effect of ROM isometric strengthening exercises, combined with therapeutic heating using paraffin baths on grip strength and hand function in RA patients.

METHODS

Research design

This study was a single-blind, randomized controlled trial and conducted between January and May 2006.

Subjects

Subjects were RA patients in the subacute phase who had already been treated, aged 20-70 years, male or female, meeting the criteria of the American College of Rheumatology.⁽¹¹⁾ Additional inclusion criteria were : (i) having joint involvement in the hand, which may be recognized from intrinsic muscle atrophy and/

or a Hand Function Index (HFI) score of 5-35.⁽¹²⁾ (ii) never done structured ROM and hand strengthening exercise before; and (iii) willing to be involved in the study.

Exclusion criteria were: (i) presence of peripheral nerve problems or muscle disease accompanied with atrophy; (ii) hand muscle weakness; (iii) sensory problems in the hand; (iv) finger amputation, open wound, fracture and contracture; (v) memory and cognitive problems. Additional exclusion criteria were: (i) severe hypertension with systolic blood pressure of more than 150 mmHg and diastolic blood pressure of more than 100 mmHg; (ii) hand deformity related to RA, including radioulnar or metacarpophalangeal (MCP) subluxation, *boutonniere* and swan neck; and (iii) doing strenuous grip activities in their activity of daily living, such as washing clothes.

The study protocol was approved by the Committee of Medical Research Ethics of the Faculty of Medicine, University of Indonesia.

Interventions

All subjects meeting the inclusion and exclusion criteria, after having been given an explanation about the study program and the mechanisms of joint protection, were randomly assigned to the intervention group or the control group, using optimal allocation with a simple randomization. Subjects in the intervention group were given heat therapy using paraffin baths 3 times a week at Cipto Mangunkusumo Hospital, followed by isometric strengthening exercises. Strengthening exercises were done by opposing the resistance given by the researcher's hand or by putty, without performing any movement of the joints. Muscle contraction was sustained for 6 seconds and repeated up to 6 times for each joint, alternately for the right and left hands. Every subject in this group also did ROM exercises once a day at home. These were performed over the 6-week

study period. Subjects in the control group only had therapeutic heating using paraffin baths 3 times a week at the hospital and did not do any home exercises. All outcome assessments were undertaken at baseline and 6 weeks following randomization.

Outcome measures

Hand function was assessed using the HFI by giving a score according to the ability of the subject to do some finger activity then totally summed up. The minimum score is 4 and the maximum 42. The lower the score, the better the hand function. ROM was measured using a goniometer, and grip strength (GS) of the right and left hands was measured using a modified sphygmomanometer. The sphygmomanometer was modified by rolling up the cuff and securing it within a bag made of nonstretch material so that when inflated to a specific point, the cuff attains a constant circumference of 6 inches. For each hand, GS was measured 3 times alternately. The best values were taken for each GS. GS measurements were done using a standardized protocol in which the subject had to sit with the shoulder in neutral rotation, the elbow flexed 90°, the forearm in neutral position, the wrist extended 30°, and the ulnar deviated 15°. The pressure of the sphygmomanometer should be adjusted to 20 mmHg before taking any measurements.

Statistical analysis

Descriptive statistics was done to know the distribution of the variables age, gender, education level, job and medication. Changes in outcome measures were examined by calculating 95% confidence intervals of the difference between baseline and endline scores. Between-group differences in score changes were determined by Student's t test for unpaired samples. The significance level was set at 0.05.

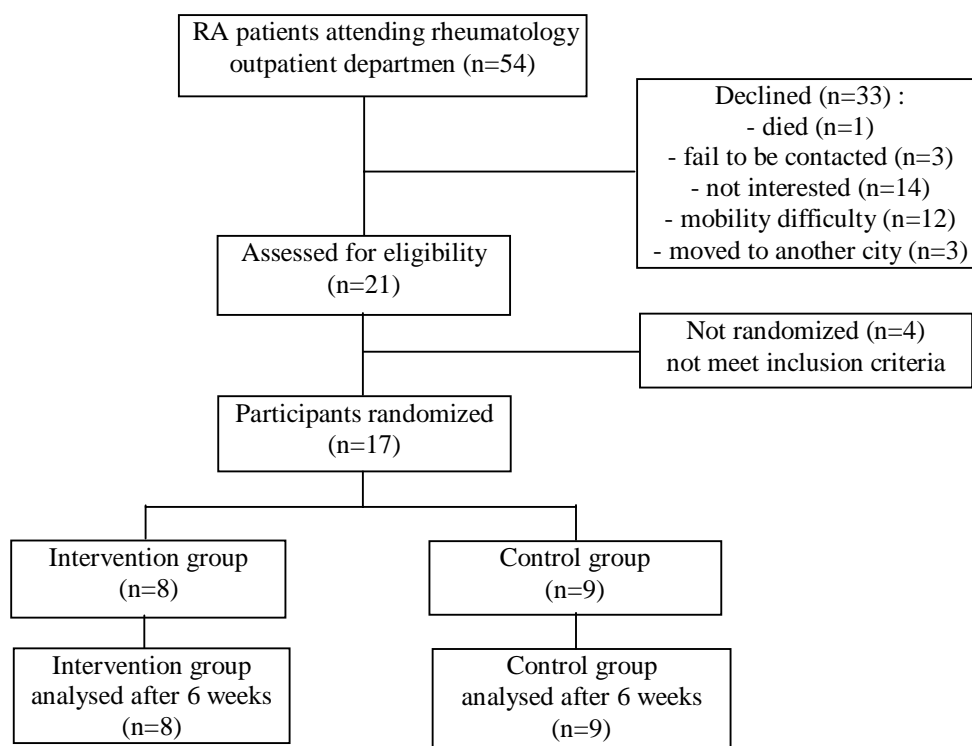


Figure 1. Flowchart of the number of subjects who completed the study

RESULTS

Subjects

Seventeen subjects were involved in this study, with eight subjects in the intervention group and nine in the control group. All subjects successfully followed the study to completion. Subjects' compliance in getting treatment in the hospital in the intervention group was 93%, while that in the control group was 79%. In the interventional group, subjects' compliance to do ROM exercises at home was 96.4%. All subjects were right handed. The age of the subjects ranged from 20 to 70 years (Table 1). The majority of the subjects, totalling 14 patients (82.3%) were female and only 3 patients were male. From the educational perspective, 8 subjects had an educational level

of high school (47%) and 7 subjects had a master degree (41.2%).

Hand Function

Hand function before and after intervention can be seen in Table 2. HFI before and after intervention between the two groups showed non-significant results, in which the p value was more than 0.05.

Grip Strength

Grip strength before and after intervention can be seen in Table 2. GS before and after intervention between interventional and control group showed non-significant results in which the p value for right and left GS was more than 0.05.

Table 1. Demographic and clinical data of 17 patients participating in the study at baseline

Characteristic	Intervention (%) n=8	Control (%) n=9
Age (year)		
20-29	1 (12.5)	1 (11.1)
30-39	2 (25)	2 (22.2)
40-49	-	2 (22.2)
50-59	4 (50)	1 (11.1)
60-70	1 (12.5)	3 (33.3)
Sex		
Female	7 (87.5)	7 (77.8)
Male	1 (12.5)	2 (22.2)
Education		
Junior High School	1 (12.5)	1 (11.1)
High School	4 (50)	4 (44.4)
Master Degree	3 (37.5)	4 (44.4)
Occupation		
House wife	2 (25)	2 (22.2)
Retired	2 (25)	2 (22.2)
Civil servant	-	1 (11.1)
Teacher	3 (37.5)	2 (22.2)
Student	-	1 (11.1)
Unemployed	1 (12.5)	1 (11.1)
Medication		
Methothrexate	8 (100)	6 (66.7)
Steroids	5 (62.5)	3 (33.3)
NSAIDs*	5 (62.5)	5 (55.6)
Others**	2 (25)	4 (44.4)

*NSAIDs = Non steroid anti inflammation drugs; **Others (Sulcolon and Chloroquine)

Range of motion

Range of motion before and after intervention can be seen in Table 3. ROM before and after intervention between the intervention and control group showed non-significant results for all joints. Using the paired t-test, it was found that there was a significant improvement in ROM for 12 areas of joints in the intervention group and 2 areas of joints in the control group.

DISCUSSION

The greatest prevalence of RA is in the 50-59 year subgroup and 82.3% are female. This reconfirms the literature stating that RA is

frequently found in the fourth and fifth decades and the incidence of RA is higher in females.⁽²⁾

HFI was used in this study to measure hand function before and after intervention, because it has been proved to be a simple and fast tool for evaluating function and disease activity in RA.⁽¹²⁾ Between the two groups, there was no significant difference before and after intervention. In the interventional group, there was a significant difference in hand function before and after intervention (Table 2), but there was none in the control group. This indicated that there were significant differences of hand function after intervention in both groups, but the difference was higher in the interventional group. HFI showed better improvement

Table 2. Hand function and grip strength before and after intervention

Parameter	Intervention Group				Control Group				
	Base line	End line	Mean difference within group	p	Base line	End line	Mean difference within group	p	Mean difference between group
HFI	16.88 ± 9.46	14.63 ± 10.16	2.25 ± 0.7	0.003	17.11 ± 5.75	15.44 ± 4.82	1.67 ± 0.93	0.153	0.58 ± 0.23
RGS	89.50 ± 18.45	98.00 ± 18.73	8.5 ± 0.28	0.000	89.11 ± 15.33	87.56 ± 12.72	1.55 ± 2.61	0.725	6.95 ± 2.33
LGS	82.75 ± 30.63	91.25 ± 29.95	8.5 ± 0.68	0.001	85.33 ± 18.19	88.00 ± 13.27	2.67 ± 4.92	0.316	5.83 ± 4.24

HFI = Hand Function Index; RGS= right grip strength; LGS= left grip strength; ns= not significant (p>0.05)

Table 3. Joint range of motion before and after intervention

Parameter	Interventional Group				Control Group				
	Base line	End line	Mean difference within group	p	Base line	End line	Mean difference within group	p	Mean difference between group
RWE	53.75 ± 13.82	60.63 ± 15.68	6.88 ± 1.86	0.001	55.00 ± 13.92	52.50 ± 10.00	2.5 ± 3.92	0.347	4.38 ± 2.06
RMCP1F	61.50 ± 14.92	67.50 ± 14.53	6.00 ± 0.39	0.013	58.67 ± 15.13	60.33 ± 13.96	1.66 ± 1.17	0.605	4.34 ± 0.78
LMCP2F	85.00 ± 8.42	90.25 ± 5.39	5.25 ± 3.03	0.027	86.00 ± 5.57	88.11 ± 4.14	2.11 ± 1.43	0.100	3.14 ± 1.6
LMCP2E	20.00 ± 9.26	24.25 ± 6.45	4.25 ± 2.81	0.085	20.67 ± 8.89	25.33 ± 10.05	4.66 ± 1.16	0.019	0.41 ± 1.65
LMCP3E	20.00 ± 9.26	24.25 ± 6.45	4.25 ± 2.81	0.085	20.89 ± 9.06	24.67 ± 9.90	3.78 ± 0.84	0.033	0.47 ± 1.97
LMCP4F	84.50 ± 8.80	88.25 ± 5.90	3.75 ± 2.9	0.035	83.78 ± 9.46	87.22 ± 7.14	3.44 ± 2.32	0.060	0.31 ± 0.58
LMCP5F	82.50 ± 10.99	88.25 ± 4.95	5.75 ± 6.04	0.040	86.44 ± 7.67	86.67 ± 8.00	0.23 ± 0.33	0.892	5.52 ± 5.71
RMCP4E	84.50 ± 8.99	84.75 ± 9.07	0.25 ± 0.08	0.044	20.00 ± 8.66	21.78 ± 9.08	1.78 ± 0.42	0.086	1.53 ± 0.34
LMCP4E	18.75 ± 9.91	24.25 ± 6.45	5.5 ± 3.46	0.036	22.00 ± 9.54	24.78 ± 10.02	2.78 ± 0.48	0.085	2.72 ± 2.98
RPIP3F	99.25 ± 10.79	104.00 ± 9.72	4.75 ± 1.07	0.032	102.67 ± 8.31	104.56 ± 6.91	1.89 ± 1.4	0.176	2.86 ± 0.33
RPIP4F	101.00 ± 11.95	106.63 ± 11.55	5.63 ± 0.4	0.021	102.67 ± 10.10	107.33 ± 5.41	4.66 ± 4.69	0.071	0.97 ± 4.29
RPIP5F	99.00 ± 8.35	105.00 ± 9.44	6.00 ± 1.09	0.012	102.33 ± 10.37	102.44 ± 7.45	0.11 ± 2.92	0.969	5.89 ± 1.83
LPIP3F	100.25 ± 15.51	104.88 ± 14.52	4.63 ± 0.99	0.026	105.67 ± 7.28	108.33 ± 4.74	2.66 ± 2.54	0.055	1.97 ± 1.55
LPIP4F	100.75 ± 13.39	106.75 ± 10.31	6.75 ± 3.08	0.002	105.33 ± 7.35	107.44 ± 5.50	2.11 ± 1.85	0.130	4.64 ± 1.23

W= wrist; R=right; L=left; F=Flexion; E=Extension; MCP= metacarpophalangeal; PIP= proximal interphalangeal; ns= not significant (p > 0.05)

especially by a combination of therapeutic exercises and heating. It is important to note that HFI measures the ability of the wrist and fingers to move in their ROM, thus improvement in ROM is indicated by a higher HFI.

There was no significant improvement in right and left grip strengths between the two groups. There was a significant difference in right and left grip strengths in the interventional group (Table 2), but not in the control group. It is known from the literature that strengthening exercises can have effect after a minimum of 4 weeks.⁽¹⁰⁾ This was proved in the isometric strengthening of quadriceps muscle in patients with osteoarthritis of the knee.⁽¹³⁾ Other studies showed that exercise in RA patients needed a longer time to take effect, such as in the study by Hakkinen for 2 years.^(14,15)

Myositis in RA patients can result in muscle weakness, and can be confirmed by muscle biopsy, in which there is type II muscle atrophy, acute myositis and focal necrosis. Medications such as steroid agents also can result in myopathy.⁽¹⁶⁾ Table 1 indicates that 62.5% of subjects in the interventional group and 33.3% of subjects in the control group took steroid agents.

In the control group, right GS decreased after intervention, while left GS increased. This may be due to the great variability in clinical manifestations, joint involvement, disease course and response to treatment. There was no significant difference between the two groups. ROM before and after intervention in the interventional group showed significant differences in 12 joints (Table 3), while in the control group there were differences in only 2 joints. This may be due to the variability in baseline characteristics between the two groups. In the interventional group, ROM improvement may have been the result of the heating and ROM exercises that were done at home. In the control

group, ROM improvement could have been the result of therapeutic heating. As has been commonly recognized, the effect of heating is to improve tissue extensibility, decrease joint stiffness and pain, and help reduce infiltrate resolution in the inflammation.⁽¹⁷⁾

There were no significant differences between the 2 groups in HFI, GS and ROM, possibly as a result of the limited number of subjects in this study. The duration of this study which was only 6 weeks may have been one of the factors resulting in a non-significant difference in GS and ROM between the two groups. Moreover, ROM exercises in this study were done only once a day.

In this study, joint pain was not assessed. It is well-known that pain can stimulate reflex inhibition of muscular contraction, but the investigators attempted to reduce pain by giving the patient education about joint protection and by measuring the GS using a modified sphygmomanometer.^(18,19)

CONCLUSION

ROM and isometric strengthening exercises combined with therapeutic heating using paraffin baths for 6 weeks in RA patients can increase hand function. GS and ROM better than therapeutic heating using paraffin baths alone.

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