



Effect of task-oriented training on pain, functionality, and quality of life in rheumatoid arthritis

Ömer Faruk Özcelep¹ , İşıl Üstün² , Z. Candan Algın³ 

¹Department of Physiotherapy and Rehabilitation, Gökçem Rehabilitation Center, Istanbul, Turkey

²Department of Physical Medicine and Rehabilitation, University of Health Sciences, Bakırköy Dr. Sadi Konuk Training and Research Hospital, Istanbul, Turkey

³Department of Physiotherapy and Rehabilitation, İstanbul Medipol University, İstanbul, Turkey

Received: June 03, 2020 Accepted: February 01, 2021 Published online: March 01, 2022

ABSTRACT

Objectives: The aim of this study was to demonstrate additional effects of task-oriented training (TOT) in patients with rheumatoid arthritis (RA) regarding pain, dexterity, muscle strength, and ability to perform activities of daily living (ADLs) within five weeks.

Patients and methods: Between June 2016 and February 2018, a total of 46 female RA patients (mean age: 51.17 ± 7.9 years; range, 29 to 68 years) who were volunteer for participating in the study were randomized into two groups as follows: conventional exercise group (Group 1) and conventional + TOT group (Group 2). The exercises of Group 1 included passive range of motion (PROM), isometric grip strength exercises, and mobilization of metacarpophalangeal, proximal interphalangeal, and distal interphalangeal joints. In Group 2, in addition to conventional exercises, the patients completed an exercise program consisting of washing their faces, using forks, drinking water from a glass, sitting up, and putting on a shirt. Exercises were performed twice a week for a five-week period. Before and after the exercise programs, hand grip strength was assessed with a Jamar hand dynamometer, hand dexterity with Nine Hole Peg Test (NHPT), pain with Visual Analog Scale (VAS), and ADLs with Health Assessment Questionnaire (HAQ) and Duruöz Hand Index (DHI).

Results: There was no significant difference in NHPT and Jamar in both groups ($p > 0.05$). Although a significant decrease was observed within the groups in VAS and HAQ scores before and after the exercise programs in both groups ($p < 0.05$), no significant difference was found between the groups ($p > 0.05$). The DHI showed a significant improvement in Group 2 and a significant difference was observed between the two groups ($p < 0.05$).

Conclusion: This study shows that exercise programs may be beneficial in alleviating pain and performing daily activities. Also, adding task-oriented training to a program may facilitate ADLs in RA patients.

Keywords: Hand therapy, rheumatoid arthritis, task-oriented training.

Rheumatoid arthritis (RA) is a chronic inflammatory autoimmune condition and connective tissue disease that most often leads to significant impairment, morbidity and even mortality.^[1] It causes elbow, metacarpophalangeal (MCP) and proximal interphalangeal (PIP) joint erosion. In addition, the main causes of impairment in RA patients are synovitis, capsular distension, ligament laxity, lack of range of motion (ROM), and functional loss in

the hands due to muscle imbalance.^[2,3] In routine tasks, such as shaving and dressing, preparing a meal, washing, shopping, work and recreational activities, symptoms such as discomfort, exhaustion, weakness and lack of muscle control cause complications.^[4] Most of the hand exercise programs recommended for RA patients usually contain a series of movements aimed at strengthening the ROM of the hand and wrist joints and/or improving/maintaining grip strength.^[5]

Corresponding author: Ömer Faruk Özcelep, MD. Kirazlıdere Mah., Aylıgan Sok., No: 24, 34788 Çekmeköy, İstanbul, Türkiye.

e-mail: omerfarukozcelep@gmail.com

Cite this article as:

Özcelep ÖF, Üstün I, Algın ZC. Effect of task-oriented training on pain, functionality, and quality of life in rheumatoid arthritis. Turk J Phys Med Rehab 2022;68(1):76-83.

©2022 All right reserved by the Turkish Society of Physical Medicine and Rehabilitation

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited and is not used for commercial purposes (<http://creativecommons.org/licenses/by-nc/4.0/>).



Other elements of hand functionality such as dexterity are often not taken into consideration in clinical trials. While planning randomized-controlled trials that include task-oriented exercises, the measurement of the results should be target-oriented.

Task-oriented training (TOT) is easy and feasible approach that provides the opportunity to exercise with real-life objects, including functional movements for daily activities to increase endurance and intensity of practice.^[6] It has been shown to be effective in improving upper extremity function and ability to perform activities of daily living (ADLs) in chronic hemiplegic stroke patients with impaired cognition.^[7] The TOT is mostly offered to stroke patients, thus the number of studies on the effect of TOT on individuals with RA is limited. Srikesavan et al.^[5] demonstrated the first evidence of the acceptability of TOT in RA. Although their studies suggested a computer-based approach, they reported that TOT was acceptable for patients, as it allows the use of many real objects. Brorsson et al.^[8] found that hand training programs reflected real-life conditions, as they similarly affected extensor and flexor muscle groups. Guzelkucuk et al.^[9] showed that the therapeutic activities imitating ADL were more effective in improving functions of the hand. They recommended that the therapeutic activities imitating ADL could have more advantages than standard rehabilitation programs. Lamb et al.^[10] claimed that a significant therapeutic objective should be to optimize the advantages of biological and disease-modifying antirheumatic drug (DMARD) regimens in terms of function, impairment and health-related quality of life.

In the present study, we hypothesized that TOT might be effective in alleviating pain and improving muscle strength in RA cases. Including TOT to the rehabilitation program may be beneficial in terms of ADLs and wellbeing. This study, therefore, aimed to examine the impact of TOT in RA patients on pain, dexterity, strength, and efficiency of ADLs.

PATIENTS AND METHODS

This single-center, parallel-group, randomized-controlled clinical trial was conducted at Bağcilar Treating and Research Hospital, Department of Physical Medicine and Rehabilitation between June 2016 and February 2018. Inclusion criteria were as follows: having a diagnosis of RA according to the American College of Rheumatology (ACR) and European League Against Rheumatism (EULAR) criteria, being monitored for RA diagnosis for at least

one year, being between the ages of 30 and 65 years, not having any restrictions to participate in the study, having the cognitive capacity to understand and follow the instructions provided, having no upper extremity surgeries for orthopedic, neurological or other reasons, and having a functional capacity Class of I-II. Exclusion criteria were as follows: being under severe pain as assessed by the Visual Analog Scale (VAS) >7, stating the intent to withdraw from the study without specifying any reason, having major psychiatric disorders, such as schizophrenia or major depression, and having a cardiovascular disease (i.e., coronary artery disease, history of myocardial infarction, angina), stroke, uncontrolled hypertension, chronic obstructive pulmonary disease (COPD). A written informed consent was obtained from each participant. The study protocol was approved by the Istanbul Medipol University Ethics Committee (No: 10840098-604.01.01-E.5773). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Among 60 patients evaluated, 14 who did not meet the inclusion criteria were excluded. Three patients had carpal tunnel syndrome, two patients had COPD, five patients did not agree to participate, and four patients did not fulfill the age requirements. As a result, 46 female RA patients (mean age: 51.17 ± 7.9 years; range, 29 to 68 years) voluntarily agreeing to take part in the study were randomized into two groups as follows: conventional exercise group (Group 1) and conventional + TOT group (Group 2) (Figure 1). Randomization was carried out by putting 23 pieces of paper with the No. 1 and 23 pieces of paper with the No. 2 in a closed box (56 pieces of paper in total). The participants included in the study were asked to draw a random piece of paper from the box. The participants drawing up the pieces of paper with No. 1 were placed in Group 1, and participants drawing up the pieces of paper with No. 2 were placed in Group 2. During the trial, two patients in Group 1 and four patients in Group 2 decided to withdraw from study and were excluded. Twenty-one patients in Group 1 and 19 patients in Group 2 completed the study.

Treatment program

In Group 1, the patients performed passive range of motion (PROM) exercises, mobilization of MCP, PIP and distal interphalangeal (DIP) joints and isometric exercises. While PROM and isometric exercises were applied in 30 repetitions, joint mobilizations were performed by the therapist with moderate severity in the form of anteroposterior and mediolateral gliding.

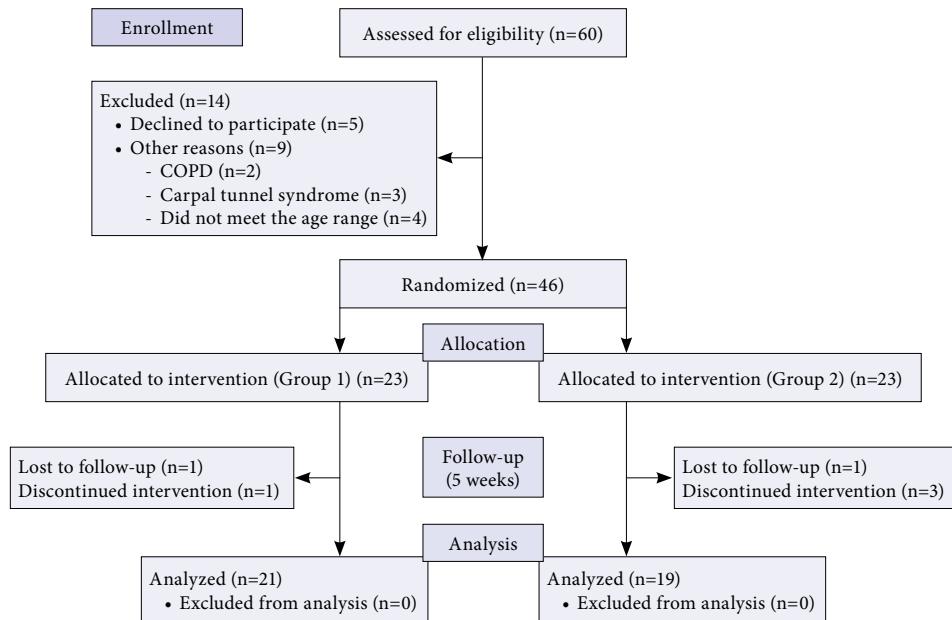


Figure 1. Study flow chart.

COPD: Chronic obstructive pulmonary disease.

Group 2 practiced washing face, using forks, drinking water with glasses, sitting up and wearing t-shirts in 30 repetitions in addition to PROM exercises, mobilization of MCP, PIP, DIP joints and isometric exercises. Sessions were held twice a week for five weeks. The duration of sessions in both groups was an average of 45 min twice a week and the patients were instructed to perform the exercises at home on the other days. One patient in Group 1 and two patients in Group 2 were on anti-tumor necrosis factor-alpha (TNF- α) treatment and others were using conventional synthetic DMARDs.

Outcomes

The level of pain was assessed using the VAS with a scale from 0 to 10. Hand grip strength was assessed with a Jamar® hydraulic hand dynamometer (Sammons Preston, Bolingbrook, Illinois, USA). The assessments were repeated three times and the average value was calculated.^[11] Hand dexterity was assessed with the Nine Hole Peg Test (NHPT).^[12] The ADLs were assessed using the Duruöz Hand Index (DHI) and Health Assessment Questionnaire (HAQ).^[13,14] All assessments were performed by the therapist before and after the treatment.

Statistical analysis

Statistical analysis was performed using the IBM SPSS version 26.0 software (IBM Corp., Armonk,

NY, USA). Descriptive data were expressed in mean \pm standard deviation (SD), median (min-max) or number and frequency. The distribution of variables was confirmed using the Kolmogorov-Smirnov test. Two-way repeated measures analysis of variance (ANOVA) was used to evaluate the scores of variables with normal distribution according to follow-up. Independent samples t-test and Mann-Whitney U test were used for the comparison of quantitative data. The Wilcoxon test was used for the repeated measurement analysis. A *p* value of <0.05 was considered statistically significant.

RESULTS

The mean age of the patients was 53.6 ± 9.1 years in Group 1 and 48.5 ± 10.3 years in Group 2 (*p*=0.109). The mean height was 1.6 ± 0.1 in Group 1 and Group 2 (*p*=0.952). The mean weight was 76.8 ± 14.4 in Group 1 and 69.8 ± 11.8 in Group 2 (*p*=0.102). The mean body mass index (BMI) was 30.7 ± 5.0 in Group 1 and 28.0 ± 5.0 in Group 2 (*p*=0.094). The mean Disease Activity Score in 28 joints (DAS28) was 3.6 ± 0.6 in Group 1 and 3.8 ± 0.8 in Group 2 (*p*=0.364). There were no statistically significant differences between the groups in terms of descriptive characteristics, namely age, height, weight, BMI, and DAS28 (*p*>0.05). Statistical comparison of hand dexterity and strength between the groups is presented in Tables 1-3.

TABLE 1 Nine Hole Peg Test results					
	Group 1		Group 2		<i>p</i> *
	Mean±SD	Median	Mean±SD	Median	
Nine Hole Peg Test (right hand)					
Before treatment	22.9±4.3	22.3	21.5±2.8	21.1	0.303
After treatment	21.6±3.5	21.0	20.4±2.2	20.1	0.233
Before/after difference	-1.3±3.5	-0.1	-1.1±2.6	-1.3	1.000
Intra-group difference <i>p</i>	0.217†		0.085†		
Nine Hole Peg Test (left hand)					
Before treatment	23.8±3.8	24.6	22.8±4.1	21.2	0.323
After treatment	23.5±5.9	23.2	21.6±3.0	21.3	0.249
Before/after difference	-0.4±6.0	-1.2	-1.2±4.2	-0.8	0.860
Intra-group difference <i>p</i>	0.181†		0.240†		

SD: Standard deviation; * Mann-Whitney U test; † Wilcoxon test.

Table 2 Nine Hole Peg Test repeated measures results					
	Type III sum of squares	df	Mean square	F	<i>p</i> *
Right hand					
Follow ups	4.616	1	4.616	0.954	0.335
Groups	35.691	1	35.691	2.048	0.161
Follow ups groups	0.152	1	0.152	0.031	0.860
Left hand					
Follow ups	0.491	1	0.491	0.036	0.851
Groups	40.112	1	40.112	1.667	0.205
Follow ups groups	3.756	1	3.756	0.274	0.604

* Two-way repeated measures analysis of variance.

TABLE 3 JAMAR results					
	Group 1		Group 2		<i>p</i> *
	Mean±SD	Median	Mean±SD	Median	
JAMAR (right hand)					
Before treatment	39.4±13.4	45.0	43.6±13.5	44.0	0.532
After treatment	38.1±13.8	36.0	46.1±19.8	46.0	0.112
Before/after difference	-1.3±13.2	0.0	2.5±14.3	5.0	0.136
Intra-group difference <i>p</i>	0.481†		0.274†		
JAMAR (left hand)					
Before treatment	34.2±13.4		39.1±13.5	39.0	0.302
After treatment	37.2±11.1		41.8±17.3	40.0	0.606
Before/after difference	3.0±10.1		2.8±14.7	5.0	0.989
Intra-group difference <i>p</i>	0.159†		0.513†		

SD: Standard deviation; * Mann-Whitney U test; † Wilcoxon test.

Table 4
JAMAR repeated measures results

	Type III sum of squares	df	Mean square	F	<i>p</i> *
Right hand					
Follow ups	55.463	1	55.463	0.585	0.449
Groups	737.528	1	737.528	1.986	0.167
Follow ups groups	74.298	1	74.298	0.783	0.382
Left hand					
Follow ups	19.960	1	19.960	0.256	0.616
Groups	446.921	1	446.921	1.447	0.236
Follow ups groups	0.132	1	0.132	0.002	0.967

* Two-way repeated measures analysis of variance.

TABLE 5
VAS, HAQ, DHI results

	Group 1		Group 2		<i>p</i> *
	Mean±SD	Median	Mean±SD	Median	
VAS					
Before treatment	5.2±1.6		5.0±1.8	5.0	0.989
After treatment	4.3±2.1		3.5±1.9	4.0	0.143
Before/after difference	-1.0±2.0		-1.5±2.3	-1.0	0.537
Intra-group difference <i>p</i>	0.049†		0.005†		
HAQ					
Before treatment	15.1±11.4		10.9±6.3	10.0	0.363
After treatment	11.2±10.7		5.9±4.6	5.0	0.148
Before/after difference	-3.9±5.6		-5.0±5.6	-5.0	0.447
Intra-group difference <i>p</i>	0.008†		0.001†		
Duruöz					
Before treatment	12.9±14.6		11.6±8.0	11.0	0.635
After treatment	12.0±13.6		4.7±2.8	5.0	0.088
Before/after difference	-0.9±5.9		-6.9±7.5	-8.0	0.012
Intra-group difference <i>p</i>	0.400†		0.012†		

SD: Standard deviation; * Mann-Whitney U test; † Wilcoxon test; VAS: Visual Analog Scale; HAQ: Health Assessment Questionnaire; DHI: Duruöz Hand Index.

No significant increase was observed in muscle strength and manual dexterity ($p<0.05$). Two-way repeated measures ANOVA was applied for hand dexterity and strength, no significant difference was found ($p>0.05$). Interaction effects can be seen in Tables 2 and 4.

The VAS and HAQ scores significantly improved in both groups ($p<0.05$). However, there was no significant difference between the groups ($p>0.05$). Both programs alleviated pain and improved the quality of life; however, the programs were not superior to each

other (Table 5). Although no significant changes were observed in Group 1 ($p>0.05$) in DHI, significant improvements were observed in Group 2 ($p<0.05$). The TOT group showed more improvement in ADL compared to the exercise group (Table 5).

DISCUSSION

In the present study, we compared the effects of TOT and conventional exercise programs on pain, dexterity, strength and performance of ADL in RA patients. Our main findings can be listed as follows:

(i) conventional exercise with TOT did not improve hand muscle strength and dexterity, (ii) pain was alleviated and the quality of life was improved in both groups with no significant difference between the groups, (iii) an improvement in the ADL was only observed in the TOT group. The final finding is the key to prove that TOT is superior to the conventional exercise program.

There are controversial opinions in the literature regarding exercise in RA. According to a study conducted by Smidt et al.,^[15] there are inadequate data to endorse the usefulness of specialized exercises for patients with RA. In addition, Wessel^[16] reported that the evidence based on research for or against the effectiveness of hand exercises in the treatment of individuals with RA was not sound. Bergsta et al.^[17] reported in a review that there was no consensus on the efficacy of various types of exercises, but hand exercises could have beneficial effects on strength without aggravating the disease activity. In this study, pain was alleviated, but no improvement was observed on muscle strength after the exercise programs. This may be due to the limited duration of the exercise program. Ellegaard et al.^[18] showed that, although including hand exercises to a compensatory intervention (joint protection, assistive devices, and alternative ways of performing ADLs) increased the muscle strength and ROM, it did not provide additional benefits with regard to ADLs.

Due to the lack of consensus on the effectiveness of TOT in RA, it is difficult to plan an exercise program by referring to the literature. Timmermans et al.^[19] emphasized the necessity to standardize TOT to define its key characteristics. Despite the controversial statements, Dogu et al.^[20] suggested that, in RA, isometric and isotonic hand exercises alleviated pain, limited the activity of the disease, and enhanced hand functions, dexterity and quality of life with a slight improvement in the muscle strength. Similar to the results obtained by Dogu et al.,^[20] in this study, after the exercise program, the level of pain decreased, hand functions and quality of life improved. We did not observe any improvement in the hand dexterity. Another difference was observed in the muscle strength. Although the muscle strength mildly increased in the aforementioned study,^[20] it did not reach statistical significance after the exercise program in this study. The discrepancy can be attributed to the fact that only isometric exercises were applied to the patients in this study. Since

DAS28 scores were not evaluated after the exercise programs, we were unable to observe the exact effect on disease activity.

Moreover, Manning et al.^[21] showed that 12-week, resistance exercises improved hand function and grip strength in addition to improved self-efficacy and extremity disability with no adverse effects on disease activity. In the current study, hand function improved, but no improvements were observed in the hand grip strength. This may be due to the exercise program in this study being carried out for only a few weeks. Self-efficacy and extremity disability were unable to be evaluated in this study.

Additionally, Buljina et al.^[22] reported a decrease in pain and tenderness, and an increase in ROM, ADLs, and hand strength with a three-week physical therapy and exercise program. Similar results were obtained in this study in terms of improvement in ADL and decrease in pain levels. Contrary to the study carried out by Buljina et al.,^[22] tenderness and ROM were unable to be evaluated in our study. Furthermore, Cima et al.^[23] reported that, for RA patients with hand deformities, strength exercises were beneficial in improving handgrip and pinch strength, as well as functionality. While the study carried out by Cima et al.^[23] projected that functionality would increase with the increase of muscle and grip strength, an improvement in functionality was achieved in this study without an increase in muscle strength. Speed and Campbell^[24] explained the strength gain mechanism in RA as neural adaptation, without an increase in muscle mass. This could possibly explain the differences in regard to muscle strength.

Nonetheless, there are some limitations to this study. First, this study does not present long-term results of TOT findings. In long-term exercise programs, providing patient compliance is challenging. Since RA is a progressive chronic condition, rehabilitation plans should be long-term and programs should include resistive resistance exercises. Second, although the number of patients in the present study was sufficient to perform a power analysis, a larger sample size would provide more precise results. Third, in this study, the study group consisted of female patients. The lack of male patients and a control group are the other limitations. Disease activity level was measured using DAS28 before the intervention, while this parameter was not assessed after the completion of the exercise program. Measuring the disease

activity level at regular intervals may allow us to correct the potential flaws of exercise programs in RA patients.

In conclusion, our goal was to improve the ADLs in RA patients. These results suggest that including TOT to rehabilitation may improve ADL performance in RA patients within five weeks. Further randomized-controlled studies with larger number of patients with longer periods and with standardized exercise programs are needed to demonstrate the effect of TOT in RA.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding

The authors received no financial support for the research and/or authorship of this article.

REFERENCES

- Christie A, Jamtvedt G, Dahm KT, Moe RH, Haavardsholm EA, Hagen KB. Effectiveness of nonpharmacological and nonsurgical interventions for patients with rheumatoid arthritis: An overview of systematic reviews. *Phys Ther* 2007;87:1697-715.
- Akil M, Amos RS. ABC of rheumatology. Rheumatoid arthritis-I: Clinical features and diagnosis. *BMJ* 1995;310:587-90.
- Erol AM, Ceceli E, Uysal Ramadan S, Borman P. Effect of rheumatoid arthritis on strength, dexterity, coordination and functional status of the hand: The relationship with magnetic resonance imaging findings. *Acta Reumatol Port* 2016;41:328-37.
- Horsten NC, Ursum J, Roorda LD, van Schaardenburg D, Dekker J, Hoeksma AF. Prevalence of hand symptoms, impairments and activity limitations in rheumatoid arthritis in relation to disease duration. *J Rehabil Med* 2010;42:916-21.
- Srikesavan CS, Shay B, Robinson DB, Szturm T. Task-oriented training with computer gaming in people with rheumatoid arthritis or osteoarthritis of the hand: Study protocol of a randomized controlled pilot trial. *Trials* 2013;14:69.
- Steultjens EM, Dekker J, Bouter LM, van Schaardenburg D, van Kuyk MA, van den Ende CH. Occupational therapy for rheumatoid arthritis. *Cochrane Database Syst Rev* 2004;2004:CD003114.
- Park J. Effects of task-oriented training on upper extremity function and performance of daily activities in chronic stroke patients with impaired cognition. *J Phys Ther Sci* 2016;28:316-8.
- Brorsson S, Nilsdotter A, Thorstensson C, Bremander A. Differences in muscle activity during hand-dexterity tasks between women with arthritis and a healthy reference group. *BMC Musculoskelet Disord* 2014;15:154.
- Guzelkucuk U, Duman I, Taskaynatan MA, Dincer K. Comparison of therapeutic activities with therapeutic exercises in the rehabilitation of young adult patients with hand injuries. *J Hand Surg Am* 2007;32:1429-35.
- Lamb SE, Williamson EM, Heine PJ, Adams J, Dosanjh S, Dritsaki M, et al. Exercises to improve function of the rheumatoid hand (SARAH): A randomised controlled trial. *Lancet* 2015;385:421-9.
- Mathiowetz V, Rennells C, Donahoe L. Effect of elbow position on grip and key pinch strength. *J Hand Surg Am* 1985;10:694-7.
- Oxford Grice K, Vogel KA, Le V, Mitchell A, Muniz S, Vollmer MA. Adult norms for a commercially available Nine Hole Peg Test for finger dexterity. *Am J Occup Ther* 2003;57:570-3.
- Duruöz MT, Poiraudeau S, Fermanian J, Menkes CJ, Amor B, Dougados M, et al. Development and validation of a rheumatoid hand functional disability scale that assesses functional handicap. *J Rheumatol* 1996;23:1167-72.
- Maska L, Anderson J, Michaud K. Measures of functional status and quality of life in rheumatoid arthritis: Health Assessment Questionnaire Disability Index (HAQ), Modified Health Assessment Questionnaire (MHAQ), Multidimensional Health Assessment Questionnaire (MDHAQ), Health Assessment Questionnaire II (HAQ-II), Improved Health Assessment Questionnaire (Improved HAQ), and Rheumatoid Arthritis Quality of Life (RAQoL). *Arthritis Care Res (Hoboken)* 2011;63 Suppl 11:S4-13.
- Smidt N, de Vet HC, Bouter LM, Dekker J, Arendzen JH, de Bie RA, et al. Effectiveness of exercise therapy: A best-evidence summary of systematic reviews. *Aust J Physiother* 2005;51:71-85.
- Wessel J. The effectiveness of hand exercises for persons with rheumatoid arthritis: A systematic review. *J Hand Ther* 2004;17:174-80.
- Bergstra SA, Murgia A, Te Velde AF, Caljouw SR. A systematic review into the effectiveness of hand exercise therapy in the treatment of rheumatoid arthritis. *Clin Rheumatol* 2014;33:1539-48.
- Ellegaard K, von Bülow C, Røpke A, Bartholdy C, Hansen IS, Rifbjerg-Madsen S, et al. Hand exercise for women with rheumatoid arthritis and decreased hand function: An exploratory randomized controlled trial. *Arthritis Res Ther* 2019;21:158.
- Timmermans AA, Spooren AI, Kingma H, Seelen HA. Influence of task-oriented training content on skilled arm-hand performance in stroke: A systematic review. *Neurorehabil Neural Repair* 2010;24:858-70.
- Dogu B, Sirzai H, Yilmaz F, Polat B, Kuran B. Effects of isotonic and isometric hand exercises on pain, hand functions, dexterity and quality of life in women with rheumatoid arthritis. *Rheumatol Int* 2013;33:2625-30.
- Manning VL, Hurley MV, Scott DL, Coker B, Choy E, Bearne LM. Education, self-management, and upper extremity exercise training in people with rheumatoid arthritis: A randomized controlled trial. *Arthritis Care Res (Hoboken)* 2014;66:217-27.

22. Buljina AI, Taljanovic MS, Avdic DM, Hunter TB. Physical and exercise therapy for treatment of the rheumatoid hand. *Arthritis Rheum* 2001;45:392-7.
23. Cima SR, Barone A, Porto JM, de Abreu DC. Strengthening exercises to improve hand strength and functionality in rheumatoid arthritis with hand deformities: A randomized, controlled trial. *Rheumatol Int* 2013;33:725-32.
24. Speed CA, Campbell R. Mechanisms of strength gain in a handgrip exercise programme in rheumatoid arthritis. *Rheumatol Int* 2012;32:159-63.