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Effects of Video Games-Based Task-Oriented Activity Training (Xbox 360 Kinect™) on Activity Performance and Participation in Patients with Juvenile Idiopathic Arthritis: A Randomized Clinical Trial

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Abstract

Objective: The aim of the study was to compare the effects of two different task-oriented activity training (TOAT) programs on activity performance and participation in children/adolescents with Juvenile Idiopathic Arthritis (JIA).

Design: Sixty-two patients were randomized into group I and group II for TOAT. In group I, activities of daily living (ADL) were practiced using real materials from daily life and, in group II, ADL were practiced using video-based games (Xbox 360 Kinect^{TM}) for 3 days/a week/8 weeks. Pain by the "Numeric Rating Scale (NRS)", upper extremity muscle, grip, and pinch strengths by a dynamometer, activity performance and participation by the "Childhood Health Assessment Questionnaire (CHAQ)", "Canadian Occupational Performance Measure (COPM)", and "Duruoz Hand Index (DHI)" were evaluated.

Results: After treatment in both groups, significant changes were found in the NRS, muscle strength, grips strength, CHAQ, COPM, and DHI ($p<0.05$). Group II was statistically superior to group I in changes of almost all upper extremity muscle strengths, palmar pinch strength, COPM-satisfaction, and DHI scores ($p<0.05$).

Conclusion: Video games-based TOAT is an alternative and feasible treatment for children/adolescents with JIA. This new method may have widespread applicability in future research, given the rapidly growing interest in virtual reality-based therapy in rehabilitation.

Key Words: Video Games; Task Oriented Training; Upper Extremity; Juvenile Idiopathic Arthritis

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INTRODUCTION

Juvenile idiopathic arthritis (JIA) is the most common chronic rheumatic disease in childhood.[1] Arthritis occurs in one or more joints for at least 6 weeks before the age of 16 years in JIA. Arthritis can affect large joints such as knees, elbows, hands, ankles, and hip joints, as well as small joints such as finger joints.[2] According to a prevalence study conducted by Hoeksma et al.[3], approximately 80% of JIA cases have hand and wrist involvement. Varying degrees of restriction in activities of daily living (ADL) occur due to muscle imbalance, ligament laxity, joint deformation, pain, and stiffness in JIA patients with upper extremity involvement.[3] However, there is very limited information about the prevalence of symptoms (pain and stiffness) due to upper limb involvement, disorders (body structure and function disorders), consequent limitation of activities (e.g. writing), restriction of participation (problems with continuity in school and roles in life), and treatment options in JIA.[2-4]

Traditional rehabilitation practice focuses on improving body structure and function, whereas task-oriented training focuses on activity and participation in accordance with the International Classification of Functioning, Disability, and Health guidelines. In task-oriented training, the patient develops problem-solving skills and effective compensatory strategies by adapting to different conditions to complete the task. Studies report task-oriented training improves upper extremity functions using problem-solving skills and is superior to exercises involving multiple repetitive motion patterns in patients with neurological and musculoskeletal problems.[4-7] Exercise equipment, daily life tools, and, rarely, virtual reality-based applications are preferred to improve functional performance of the individual in task-oriented training.[5,7]

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The use of technology in rehabilitation is increasing rapidly. Therefore, interactive systems are being developed with the intention to engage patients in various therapies. Amid the recent technological advances, Kinect from Microsoft (Redmond, WA) has advanced user interaction technology, which facilitates and complements many clinical applications.[8] Xbox 360 Kinect™, a product of rapidly developing video games technologies that does not require controllers, is a new addtion to rehabilitation programs.[9] In clinical trials, Kinect-based games applied in various disease groups ellicted improvement in upper extremity functions.[10-12] In a pilot study with children with cerebral palsy, Kinect-based rehabilitation systems increase upper extremity functions and exercise performance by enhancing exercise motivation and improving achievement incentives.[13] Tarakci et al.[14] reported that video-game rehabilitation practices allow targeted activities to be performed, increase motivation for exercises, and has superior effects on functions compared with classical practices in children with cerebral palsy. However, in the literature, there were no studies on the effectiveness of video-based games or task-oriented activity training (TOAT) in patients with arthritis.

The aim of the study was to compare the effects of video games-based TOAT and TOAT in daily living on activity performance and participation in children/adolescents who have JIA with upper limb involvement. The hypothesis of our study was that video games-based TOAT improves pain, upper extremity muscle strength, grip strength, and pinch strength and increases activity performance and participation in children/adolescents with JIA.

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METHODS

Study Design and Participants

All patients attending the outpatient clinic of the Division of Physiotherapy and Rehabilitation, Faculty of Health Science, Istanbul University between April 2015 and October 2016 were recruited to participate in this study. All guardians of children and adolescents signed informed consent forms. Patients 18 years old signed the form on their own. Approval for this study was obtained from the ethical committee (the Research Ethics Committee of Cerrahpasa Medical Faculty in Istanbul University) (No: 02/41260 03.Feb.2015) and conducted in accordance with the Declaration of Helsinki. This study was registered with ClinicalTrials.gov, Clinical Trial Number: NCT02954718. Inclusion criteria consisted of a diagnosis of JIA according to the International League of Associations for Rheumatology (ILAR) criteria[15], aged between 6 and 18 years, having at least one affected upper extremity joint (shoulder, elbow, wrist, or finger joints), and being able to read and write in the Turkish language. Patients were excluded from the study if they had a second rheumatic or another chronic disease, a history of mental deficit or psychological problem, or no familial consent for participation in the study. Patients who regularly receive medical treatment planned by the doctor were included. Medical treatments were stable during the study period for all patients.

Between 45 and 64 patients were required in order to detect a statistically significant difference between group I and group II at the 10% level with a power of 90% within the trial. A 4% reduction (change of 0.13 in the total score of 3) on the Childhood Health Assessment Questionnaire (CHAQ) was estimated as the minimal clinically important improvement score needed using data from Dempster et al.[16] for patients with JIA. All patients attending our clinic

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during the study duration were assessed, and 62 were suitable for inclusion and consented to participate in the study. Patients' characteristics (sex and age) and disease characteristics (disease duration and disease activity) were collected by the physiotherapists. The randomization was done with Microsoft Excel "RAND (USA)" function using a simple number table. A participant flow diagram is presented in Supplemental Figure 1 (Supplemental Digital Content 1, http://links.lww.com/PHM/A641). Patients in group I (n = 25) and group II (n = 25) completed 8-week TOAT programs. All measurements were performed before and after 8 weeks. The selector (OK) was aware of the randomization scheme but did not perform any assessments. The assessor (ET) was blind to the groups to which the participants had been allocated and conducted standard procedures in both groups. The physical therapist (NA) was blind to the assessments but was aware of the nature of the intervention and the physical findings of JIA and treated the participants. The supervisor (DT) determined therapeutic purposes and characteristics of the games and grouped the games according to the problems, but was unaware of which game was used by which patient.

Primary Outcome Measures: Activity performance and participation were evaluated using the CHAQ, Duruoz Hand Index (DHI), and Canadian Occupational Performance Measure (COPM) as primary outcome measures. The CHAQ and DHI were selected as primary outcome measures because they measure upper extremity functions using the patients' ability to perform ADL and participation. COPM was selected as a primary outcome measure because it is a client-centered activity-focused outcome measure for the detection of change in perceived activity performance over time.

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CHAQ is a reliable and valid tool for the assessment of functional ability in patients with JIA.[17] In 8 activities (dressing/grooming, arising, eating, walking, hygiene, reach, grip, and activities), a number of questions were answered and scored on a scale of 0–3, where 0 = able to do with no difficulty, 1 = able to do with some difficulty, 2 = able to do with much difficulty, and 3 = unable to do. Total score identified the CHAQ score (range, 0–3). The CHAQ also provided an assessment of discomfort using a 100-mm visual analogical scale (VAS) for the evaluation of pain and a 100-mm VAS for the evaluation of overall well-being. A score of 0 indicates "no pain" and 100 "extreme pain" for VAS pain, and a score of 0 indicates "very well" and 100 "very bad" for VAS overall well-being. A higher score indicates more problems in both pain and overall well-being.[18]

DHI is a self-reported questionnaire developed to assess hand ability in the kitchen, during dressing, while performing personal hygiene and office tasks, and other general items. DHI is derived from 18 validated questions to assess functional disability and handicap of the hand. Each answer is scored on a scale of 0 (no difficulty) to 5 (impossible to do) with a maximum score of 90. A higher score indicates a worse disability or handicap.[19]

COPM is a client-centered, occupation-focused outcome measure for the detection of change in perceived occupational performance over time. It is a generic measure suitable for all clients with perceived problems in daily activities (self-care, work, and/or leisure activities). The COPM results in two scores (Performance and Satisfaction) each out of 10. The patient prioritizes up to 5 problems she/he deems are the most urgent or important and rates the problems on an ordinary 10-point scale regarding performance (1 = not able to do at all and 10 = able to do extremely

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well) and satisfaction (1 = not satisfied at all and 10 = extremely satisfied).[20,21] Performance and satisfaction scores for the top 5 activities were summed and divided by the number of activities, resulting in total performance and satisfaction scores. COPM is a reliable, valid, and responsive instrument and a score change of 1.4 for performance and 1.9 for satisfaction are considered clinically important.[21]

Secondary Outcome Measures: Secondary outcomes included pain, upper extremity muscle strengths, grip and pinch strengths, and activity performance based on time in both groups.

Pain severity was assessed according to an 11-point Numeric Rating Scale (NRS). The NRS is considered a valid and reliable pain assessment tool.[22] The pain intensity was graded from 0 (no pain) to 10 (the most intense level of pain). Participants reported their pain level during daily living activities self-determined as the 5 most important activities according to COPM.

Muscular strength was measured at maximal isometric force for the muscles of the upper extremities using a portable handheld dynamometer (MicroFET 2, Hoggan Health Industries, Salt Lake City, 83 UT). Twelve major upper extremity muscle groups were tested bilaterally. Subjects were asked to exert maximum effort and then straighten (for the triceps) or curl (the biceps) their elbow as forcefully as possible. The maximum force realized during a 3- to 5-sec effort was recorded in lb. The test was performed three times with a 30-sec interval between tests, and the mean value was recorded.[23]

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Grip strength was measured using a standard adjustable handle Jamar® Plus+Hand Dynamometer (Irvington NY, USA) in the sitting position with the shoulder adducted and neutrally rotated and the elbow flexed at 90°.

Pinch strengths (tip, key, and palmar pinch) were measured using a hydraulic pinch gauge (Irvington NY, USA) in the sitting position with the shoulder adducted and neutrally rotated and the elbow flexed at 90°. Pinch positions were defined using the American Society for Hand Therapists guidelines.[24] Each grip and pinch strength test was performed three times with a 30-sec interval between tests, and the mean value was recorded.

Task-Oriented Activity Training (TOAT) Protocol

TOAT is a highly individualized, client-centered rehabilitation approach including intensive training, variable practices, and intermittent feedback. Baseline COPM results were used to generate individualized intervention goals for each participant. COPM top-priority functional activities (self-care, work, and/or leisure activities) were intensively practiced in-clinic and at the client's home for 70% of the therapy time. Focusing on top-priority functional activities enabled the client to determine the optimal motor strategies to fulfill functional needs. Our study was based on the patient-centered COPM role model. Training programs were established by considering the evaluation results as well as the patient's personality, roles, activity level, and self-meaningful activities. After identifying the 5 most important problems following the assessments and activity analysis, a customized training program was created.

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The two different patient-centered TOAT programs were TOAT in daily living conditions (Group I) and video games-based TOAT (Group II). TOAT was conducted with an average of one hour sessions three times a week for 8 weeks in both groups. In the program of TOAT in daily living, the target activities involved training with the materials (clothes, spoons, pencils, buttons, rope, etc.) needed for the activity as well as Velcro cylinders, skill cubes, exercise bands, screw sets, therapeutic putty, and tripled coordination tools. In the activity training, progression occurred by increasing/decreasing the activity performance time, increasing the complexity of activities, and changing the material used (e.g., soft/hard for therapeutic putty, big/small buttons for buttoning, soft/hard for resistive bands, grasping different size objects with Velcro cylinders, and increasing the number of repetitions).

The Xbox 360 Kinect™ games were analyzed to determine the technical and fictional characteristics of the games and the motion patterns needed during the games to compose a program of video games-based TOAT. For this purpose, potential motion patterns during the games, difficulty levels of games, transitions between levels of difficulty, and accordance of priority problems with the games were defined. Therapeutic purposes and fictional characteristics of Xbox 360 Kinect games were determined by our team. Games related to 5 target activities determined according to the person-centered analysis results were chosen for each patient. Warm-up (10 minutes) to minimize joint stiffness was provided with the "Macarena" dance, a dance consisting of upper extremity joint movements in "Dance Central 3" from Xbox 360 Kinect™ games for the TOAT with video-based games program. During the practice, it was requested that the act of the avatar displayed on the screen should be copied by the person like a mirror image. The more the person's movements were analogous to the actions

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of the avatar for angle, speed, and fluency, the higher the person's score. Then, the other Xbox 360 Kinect games were selected according to the activity performance level of the person and the activity training program created under physiotherapist supervision. In all games, progression occurred through game-specific changes such as increasing/decreasing game performance time, adding more levels with increased complexity, or continuing with endurance-oriented games. Two different TOAT programs for a sample patient are detailed in Table 1.

Statistical analysis

The statistical package "Statistical Package for Social Sciences" (version 21; SPSS Inc., Chicago, IL) was used for data analysis. The level of significance was set at 0.05 (2-tailed). Power was calculated using the Raosoft website (http://www.raosoft.com/samplesize.html).

Normality of baseline data was verified using the Shaphiro-Wilks Test ($P > 0.05$). Therefore, parametric testing was applied for both groups. Descriptive statistics were reported as mean ± SD. Between-group differences in demographic and baseline variables were tested using a chi-square test for categorical variables and an independent *t*-test for continuous variables. The independent *t*-test was used to compare the score changes between the groups. The paired *t*-test was used to examine within-group changes from baseline to 8 weeks.

Results

Baseline characteristics

Out of 71 patients with JIA eligible after the screening, 9 were excluded because of inclusion criteria and 7 eligible patients refused to participate in the treatment. All patients were diagnosed

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with JIA at least 6 months prior to the study. Sixty-two patients were randomly assigned to two groups as group I (TOAT in daily living) and group II (video games-based TOAT). Twelve patients left the treatment for various reasons (Fig. 1). Table 2 displays the patients' demographic characteristics. There were no statistically significant differences in age, weight, height, body mass index, duration of disease, number of involved joints, sex, dominant side, unilateral/bilateral involvement, and JIA subtype between the two groups ($p>0.05$).

Table 3 shows the comparison between the groups for activity performance, pain severity, and hand and pinch grip strengths. Table 4 shows the comparison between the groups for upper extremity muscle strength in patients with JIA before and after treatment. There was no statistically significant difference in outcome measures between the two groups except for scores of DHI-Total, COPM-Satisfaction, Palmar Pinch, and some muscle strengths at the start of the study ($p<0.05$).

Intragroup comparison

The change after treatment in all outcome measures was statistically significant for group I and group II ($p<0.05$). The change after treatment in all grip scores was statistically significant for group I and group II ($p<0.05$). While almost all muscle strength scores in group II were lower than in group I, the majority in group II were statistically less than group I's before the treatment ($p<0.05$). The change in almost all muscle strength scores after treatment was statistically significant for both groups ($p\leq0.001$).

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Intergroup comparison

Differences in DHI-Total, COPM-satisfaction, and right palmar pinch scores after the treatment were statistically significant in favor of group II ($p<0.05$). After the treatment, all differences in muscle strength scores were greater in group II than group I except for the right SUP score. There were also statistically significant differences in the majority of muscle strength scores between the groups after the treatment in favor of group II, except for right shoulder extension, left shoulder adduction, right wrist flexion, and right and left wrist extension ($p<0.05$).

Discussion

This study is the first randomized trial to compare the effects of two different TOAT programs on activity performance and participation in children/adolescents with JIA. According to the results, both TOAT programs were effective for patients with JIA. However, the video games-based TOAT was statistically superior to the ADL TOAT for several outcomes, including changes in upper extremity muscle strength, palmar pinch strength, activity performance, participation, and satisfaction.

Task-oriented training studies focus on patients with stroke and cerebral palsy.[5,25,26] A study examining task-focused upper extremity training in 17 children with hemiparesis was conducted in a family-supervised training program consisting of 5 tasks: eating, carrying, tooth brushing, combing, and picking up a small object. As a result of the study, the TOAT provided a significant improvement in using the arm and functionality in daily life in children with hemiparesis.[25] Almhdawi et al.[26] reported that the task-focused approach is significantly superior to functional outcome measures in a study that investigated task-focused upper limb ergotherapy

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versus upper extremity rehabilitation in 20 patients with stroke. They achieved an increase of 2.83 and 3.46 points in COPM-performance and -satisfaction scores, respectively, used as a function measurement in the task-oriented ergotherapy group. The present study is the first study for JIA using COPM as a (primary) outcome. We suppose that determining the 5 most important problems in ADL as a treatment goal by COPM positively affected the success of the treatment. Eyssen et al.[21] reported that a change score in COPM of at least 1.4 for performance and 1.9 for satisfaction was needed to evaluate clinical relevance. In the present study, 96% of the patients with JIA in both groups showed clinically relevant changes in COPM-performance scores after the treatment. In addition, COPM-satisfaction scores for all patients increased in both groups. However, a difference of COPM-satisfaction scores after the treatment was statistically significant in favor of the video games-based TOAT group.

Based on the results of our study, the pre-treatment DHI score in the video games-based TOAT group was higher than in the TOAT in daily living group. After treatment, the DHI scores in both groups decreased to 0 for all patients. This may be related to the personalized task-based treatment using target difficult activities according to DHI in both groups. We believe that the higher post-treatment difference in the TOAT with video-based games group may be related to the motiviational effect of video-based games for children.

Similar to our study, Srikesavan et al.[27] reported that six weeks of task-oriented training with interactive computer games improved hand function outcomes and exercise compliance in patients with rheumatoid arthritis or hand osteoarthritis and the enjoyable, engaging, and motivating aspect of task-oriented training was emphasized. In addition, using video games for

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rehabilitation makes the physical therapy routines more interesting and engaging for patients and provides them with real-time feedback on their progress.

In the literature, there is only one study using Kinect-based games for the rehabilitation of patients with arthritis.[14] This study emphasized that Kinect-based games should be included in rehabilitation programs because of the benefits of monitoring movement and controlling activity level. Kinect-based games were similarly superior for treatment of chronic diseases other than arthritis. Zoccolillo et al.[13] reported that video-based game activity training with an Xbox 360 Kinect™ System provided a significant increase in upper extremity functions compared to conventional therapy in children with cerebral palsy. Sevick et al.[28] also confirmed that kinetic games have a high potential for improving upper limb functions and providing motivation in children with cerebral palsy. Similar to these studies, our patients preferred to use Kinect-based games in therapy and improved their upper extremity functions. However, our two treatment programs focused on specific activities, were person-centered, and the patient had an active role in treatment, unlike classical treatments. We suggest the similarities in improvements in many of the parameters for both groups may be based on these superior aspects in the present study.

We found statistically significant increases in scores for upper extremity muscle strength in both groups after treatment. These children have general muscle weakness due to inflammation. We achieved a positive change in muscle strength due to the activities in both groups and the anti-inflammatory effect of the exercise. However, changes in almost all shoulder and elbow muscle strength scores in the video games-based TOAT group were superior to the other group in the present study. A possible explanation is that video-based games do not focus solely on the hand

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but contain very repetitive movements intended for the proximal muscles, and stabilization of the proximal muscles is needed for high gameplay performance. Furthermore, the changes of palmar pinch strength and activity satisfaction were statistically superior in the video games-based TOAT than the TOAT in daily living group, which may be explained by increased proximal muscle strengths.

Omar et al.[29] compared a treatment program with range of motion exercises versus a treatment program consisting of game-based and purposeful activities in 30 children with restricted ADL due to burns on the hand and wrist and found that game-based activities were superior to range of motion exercises in terms of decreased pain and increased function. They suggested that these results can be based on moving away from pain and fear in the movement of children during the game and instead focusing on winning the game. Similarly, in our study, activities in both groups were interesting to the children and they focused on gaming because it was fun, thus reducing pain and fear avoidance, resulting in increased activity performance. In both groups, despite performing repetitive activities to increase their endurance, only children in the TOAT in daily living group requested small resting periods during a session because of fatigue. Although children in the video games-based TOAT group were frequently asked their fatigue level by the physiotherapist, they did not complain of fatigue and tried to keep their activity performances high. We think the children focused on the fun of games rather than their perception of being treated, because video-based games are interactive, providing visual and verbal feedback, are stimulating, and increase motivation and incentive of achievement.

Although our results are promising, some limitations should be considered. First, participants

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needed to visit the center three times. In seven cases, it was difficult for children and their parents to continue the treatment for various reasons and these patients were not included. Another limitation was lack of intention to treat analysis. Monitoring the patients at home may be easy for a physiotherapist, but the cost may not be suitable for every patient and parent. Secondly, we think that video games-based TOAT using Xbox 360 Kinect ™ can increase the motivation of patients and decrease fear avoidance, but we did not evaluate kinesiophobia or motivation of patients, which could influence treatment adherence. Further research is necessary to determine if video games-based TOAT using Xbox 360 Kinect ™ will be effective for at home monitoring of patients with chronic diseases.

In conclusion, this study has quantitatively shown that physiotherapists can design an effective activity training program from low-cost video games and video games-based TOAT is a feasible and alternative treatment for children/adolescents with JIA. In addition, no adverse effects of video games-based TOAT were observed. Xbox 360 Kinect™ is a video game playing device that may be suitable as an intervention for functional recovery in other patients with chronic diseases.

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Conflicts of interest

There are no conflicts of interest.

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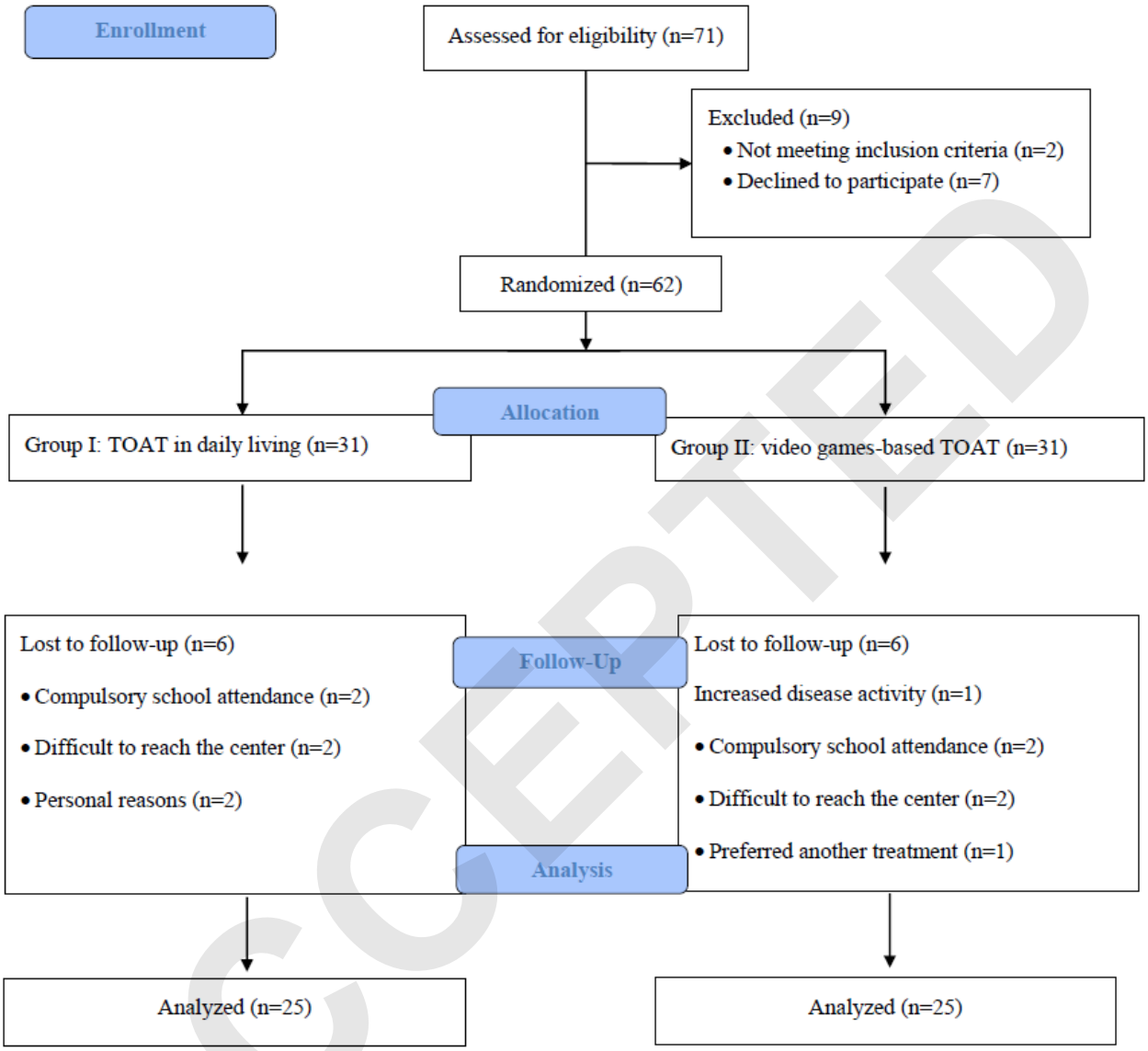


Fig 1. Trial flowchart

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Table 1. Two Task-Oriented Activity Training programs for a sample patient

Description of patient		
Canadian Occupational Performance Measure (COPM)	Difficulties in 14 different activities in daily life Five most important activities**:** Dressing: Performance: 7 Satisfaction: 1 Writing: Performance: 1 Satisfaction: 1 Hair combing : Performance: 5 Satisfaction: 1 Eating: Performance: 7 Satisfaction: 1 Opening a bottle cap: Performance: 1 Satisfaction: 1	
Pain/Muscular strength /Grip/Pinch strengths	• Moderate severity pain during activities (NRS-activity 5/10 points) • Decrease in muscular strength of all upper extremity muscles and grip/pinch strengths (bilaterally) • Significant decrease in muscle strengths on the left side compared to the right side	
Requirements	The patient needs muscle strength and grip strength to counteract static loading with painless range of motion for the wrists, fingers, and shoulder in order to perform the target activities. In addition, the endurance must be sufficient for the activity to be sustained.	
Goals	Targeted activities: Dressing, writing, hair combing, eating, opening a bottle cap Actions required for target activities: • Shoulder flexion / abduction • Elbow flexion / extension • Supination • Wrist flexion / extension • Wrist radial / ulnar deviation • Finger flexion / opposition	
	Task-Oriented Activity Training in Daily Living	**Task-Oriented Activity Training with Video-Based Games**
Materials	• Upper body ergometer • Cylinders with velcro • Skill cube • Therapeutic putty	• Dance Central 3: Macarena • Kinect Sports I: Beach Volleyball, Table Tennis, Boxing, Darts, Bowling • Fruit Ninja
Practice	• Upper body ergometer-10 min (not resistive, for warm-up) • Moving different sized cylinders on Velcro-10 min (right-left side) • Dressing training with skill cube-10 min (bilateral) • Forming therapeutic putty into different shapes-10 min (bilateral) • Increasing the number of repetitions and hardness of therapeutic putty (after 4 weeks)	• Dance Central 3- Macarena 10 min (Warm-up) • Beach Volleyball-10 min (right-left side, bilateral) • Table tennis-10 min (right-left side) • Darts-10 min (right-left side) • Bowling-10 min (right-left side) • Boxing-10 min (bilateral) (after 4 weeks) • Fruit Ninja-10 min (bilateral) (after 4 weeks)

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Table 2. Comparison of demographic characteristics of the groups

	Group I n=25 Mean (SD)/n	**Group II n=25 Mean (SD)/n**	**p**
Age (years)	13.16 (3.35)	12.36 (2.98)	0.37
Height (m)	1.48 (1.42)	1.43 (1.29)	0.27
Weight (kg)	42.04 (13.95)	38.67 (13.67)	0.39
BMI (kg\m^2)	18.65 (3.90)	18.20 (4.64)	0.71
Duration of disease (years)	5.20 (3.51)	6.64 (4.06)	0.18
Number of involved joint	7.04 (5.33)	10.24 (7.51)	0.08
Female/Male	21/4	21/4	1
Dominant side R/L	24/1	22/3	0.29
Involvement Unilateral/Bilateral	5/20	4/21	0.71
Oligo/poli JIA	13/12	9/16	0.25

JIA: Juvenile Idiopathic Arthritis, BMI: Body Mass Index, R: Right, L: Left, Oligo: Oligoarticular, Poli: Polyarticular

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Table 3. Comparison between the groups for activity performance, pain severity, and hand and pinch grip strengths

		BT			AT		BT-AT		Difference between groups		
		Group I	Group II		Group I	Group II	Group I	Group II	Group I	Group II	
		Mean (SD)	Mean (SD)	p	Mean (SD)	Mean (SD)	p	p	Mean (SD)	Mean (SD)	p
Primary outcome measures	CHAQ-Pain	43.60 (28.52)	31.00 (28.68)	0.12	9.20 (17.54)	8.68 (15.60)	0.00	0.00	34.40 (24.03)	22.32 (21.41)	0.06
	CHAQ-Well-being	57.00 (26.51)	55.80 (21.53)	0.86	29.28 (18.69)	24.20 (16.81)	0.00	0.00	27.72 (18.49)	31.60 (17.60)	0.45
	CHAQ-Total	0.99 (0.62)	1.27 (0.64)	0.12	0.21 (0.34)	0.29 (0.30)	0.00	0.00	0.78 (0.47)	0.98 (0.44)	0.13
	DHI-Total	12.56 (10.67)	19.32 (11.94)	0.04	0 (0)	0 (0)	0.00	0.00	12.56 (10.67)	19.32 (11.94)	0.04
	COPM-Performance	4.38 (1.72)	3.59 (1.66)	0.10	8.69 81.21)	8.57 (1.11)	0.00	0.00	4.30 (1.66)	4.97 (1.78)	0.17
	COPM-Satisfaction	3.46 (1.88)	1.54 (0.68)	0.00	9.08 (1.13)	9.28 (0.98)	0.00	0.00	5.61 (1.89)	7.74 (1.20)	0.00
Secondary outcome measures	NRS-Activity	4.56 (2.53)	3.96 (2.52)	0.40	0.64 (1.31)	1.04 (1.62)	0.00	0.00	3.92 (2.10)	2.92 (1.97)	0.08
	Hand Grip (R) (lb)	17.75 (11.83)	16.35 10.57)	0.66	25.37 (13.35)	23.91 (10.72)	0.00	0.00	7.61 (6.17)	7.56 (5.23)	0.97
	Hand Grip (L) (lb)	15.51 (11.56)	11.91 (9.70)	0.24	23.47 (13.78)	21.23 (10.60)	0.00	0.00	7.96 (5.97)	9.31 (6.08)	0.43
	Tip Pinch (R) (lb)	3.15 (2.67)	2.20 (2.26)	0.18	5.22 (2.42)	3.92 (2.06)	0.00	0.00	2.07 (1.57)	1.72 (2.32)	0.53
	Tip Pinch (L) (lb)	2.39 (2.43)	1.43 (1.34)	0.09	4.32 (2.52)	3.24 (1.83)	0.00	0.00	1.92 (1.15)	1.80 (1.79)	0.53
	Key Pinch (R) (lb)	7.46 (3.29)	6.34 (3.04)	0.22	8.89 (3.37)	8.43 (3.49)	0.01	0.00	1.43 (2.38)	2.08 (2.36)	0.33
	Key Pinch (L) (Ib)	6.71 (2.86)	5.52 (3.07)	0.16	8.19 (2.63)	7.44 (3.18)	0.00	0.00	1.48 (1.96)	1.91 (2.09)	0.45
	Palmar Pinch (R) (lb)	5.54 (3.00)	3.54 (2.33)	0.01	7.19 (3.21)	6.49 (3.13)	0.00	0.00	1.66 (1.78)	2.95 (2.28)	0.03

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	Palmar Pinch (L) (lb)	5.28 (3.24)	3.24 (3.05)	0.02	6.98 (2.97)	6.12 (3.06)	0.00	0.00	1.70 (1.96)	2.87 (2.21)	0.05

BT: Before Task-Oriented Activity Training, AT: After Task-Oriented Activity Training, R: Right, L: Left, lb: Pound, CHAQ: Childhood Health Assessment Questionnaire, DHI: Duruoz Hand Index, COPM: Canadian Occupational Performance Measure

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Table 4. Comparison between the groups for upper extremity muscle strength

Muscle Strength (lb)	BT			AT		BT-AT		Difference between groups		
	Group I	Group II	p	Group I	Group II	Group I	Group II	Group I	Group II	p
	Mean (SD)	Mean (SD)		Mean (SD)	Mean (SD)	p	p	Mean (SD)	Mean (SD)	
Shoulder FLEX (R)	9.40 (2.56)	7.67 (2.45)	0.02	10.56 (2.94)	11.27 (2.56)	0.01	0.00	1.15 (1.84)	3.59 (1.90)	0.00
Shoulder FLEX (L)	8.64 (1.95)	7.50 (2.38)	0.07	10.15 (2.61)	11.14 (2.82)	0.00	0.00	1.51 (1.52)	3.63 (2.88)	0.00
Shoulder EXT (R)	6.29 (1.40)	5.90 (2.03)	0.43	7.63 (1.99)	7.91 (2.16)	0.00	0.00	1.34 (1.36)	2.01 (1.31)	0.08
Shoulder EXT (L)	6.57 (1.45)	5.65 (2.04)	0.08	7.40 (1.51)	7.63 (2.19)	0.00	0.00	0.83 (0.77)	1.98 (1.79)	0.01
Shoulder ABD (R)	7.71 (1.59)	7.01 (2.06)	0.19	8.90 (2.38)	9.71 (2.32)	0.00	0.00	1.18 (1.45)	2.70 (1.81)	0.00
Shoulder ABD (L)	7.11 (1.47)	6.38 (1.78)	0.12	8.32 (2.23)	9.52 (2.46)	0.00	0.00	1.21 (1.66)	3.14 (1.76)	0.00
Shoulder ADD (R)	7.96 (2.33)	6.44 (2.35)	0.03	9.46 (3.16)	9.23 (2.69)	0.00	0.00	1.50 (1.90)	2.78 (2.28)	0.04
Shoulder ADD (L)	7.01 (1.67)	6.13 (1.74)	0.07	8.29 (2.55)	8.43 (2.24)	0.00	0.00	1.27 (1.78)	2.30 (2.01)	0.06
Shoulder IR (R)	5.54 (1.46)	4.34 (1.58)	0.01	6.59 (1.93)	6.60 (1.82)	0.00	0.00	1.05 (1.17)	2.25 (1.42)	0.00
Shoulder IR (L)	5.30 (1.49)	4.25 (1.51)	0.02	5.99 (1.53)	6.20 (1.50)	0.00	0.00	0.68 (1.01)	1.95 (1.41)	0.00
Shoulder ER (R)	6.80 (2.13)	4.76 (1.91)	0.00	8.33 (3.10)	7.61 (2.03)	0.00	0.00	1.52 (2.07)	2.84 (2.06)	0.03
Shoulder ER (L)	5.95 (1.57)	4.63 (1.53)	0.00	7.27 (1.87)	7.25 (1.68)	0.00	0.00	1.31 (1.39)	2.61 (1.67)	0.01
Elbow FLEX (R)	8.58 (1.79)	7.08 (2.24)	0.01	10.19 (2.09)	10.76 (2.59)	0.00	0.00	1.60 (1.60)	3.67 (1.50)	0.00
Elbow FLEX (L)	8.56 (1.85)	7.39 (2.45)	0.06	10.34 (2.20)	11.8 (2.90)	0.00	0.00	1.78 (1.69)	3.69 (2.12)	0.00
Elbow EXT (R)	7.11 (2.10)	5.49 (1.99)	0.01	8.52 (2.62)	9.08 (2.26)	0.00	0.00	1.40 (1.48)	3.58 (1.86)	0.00
Elbow EXT (L)	6.93 (1.97)	6.08 (2.38)	0.17	8.54 (2.07)	8.79 (2.24)	0.00	0.00	1.60 (1.15)	2.71 (1.80)	0.00
SUP (R)	5.67 (1.62)	4.25 (1.45)	0.00	6.96 (1.85)	6.77 (1.47)	0.00	0.00	1.29 (2.52)	1.05 (1.19)	0.00
SUP (L)	5.40 (1.82)	3.97 (1.63)	0.01	6.59 (1.50)	6.88 (1.31)	0.00	0.00	1.18 (2.90)	1.42 (1.66)	0.00
PRO (R)	5.65 (1.56)	4.24 (1.26)	0.00	6.15 (1.60)	6.58 (1.53)	0.06	0.00	0.50 (1.25)	2.34 (1.13)	0.00
PRO (L)	5.86 (1.43)	4.40 (1.41)	0.00	6.96 (1.59)	6.80 (1.43)	0.00	0.00	1.10 (1.48)	2.40 (1.50)	0.00

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Wrist FLEX (R)	4.19 (1.80)	4.07 (1.39)	0.35	5.42 (1.67)	5.99 (1.62)	0.00	0.00	1.23 (1.18)	1.91 (1.40)	0.07
Wrist FLEX (L)	4.46 (1.51)	4.08 (1.33)	0.80	5.57 (1.58)	5.90 (1.47)	0.00	0.00	1.10 (0.73)	1.81 (1.16)	0.01
Wrist EXT (R)	4.88 (1.74)	4.98 (1.50)	0.84	6.42 (1.90)	6.78 (1.51)	0.00	0.00	1.53 (1.10)	1.80 (0.76)	0.32
Wrist EXT (L)	4.47 (1.73)	4.29 (1.40)	0.69	6.41 (1.80)	6.30 (1.80)	0.00	0.00	1.93 (1.17)	2.00 (1.19)	0.83

BT: Before Task-Oriented Activity Training, AT: After Task-Oriented Activity Training, lb: Pound. R: Right. L: Left. FLEX: Flexion. EXT: Extension. ABD: Abduction. ADD: Adduction. IR: Internal Rotation. ER: External Rotation. SUP: Supination. PRO: Pronation

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