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Study of IM Intervention on Physical Function in Older Adults with Parkinson's Disease

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Abstract

The purpose of this study was to examine the effects of interactive metronome intervention on the physical function of an Older adult individual with Parkinson's disease. The participant of this case study was a 72-year-old male with Parkinson's disease diagnosed 3 years prior. This study was a single-subject research with an A-B-A design. She received IM training during the treatment phase (B phase) for 50 minutes per session. She was assessed pretest and posttest using the Berg balance scale and Wolf motor function test, and at baseline and the treatment phase using the measured box-and-block test and a Tetrax system. After training, the patient's static and dynamic balance, functional activity, and performance time of the upper extremity improved. Interactive metronome therapy improved the manual dexterity of both hands. Interactive metronome therapy also improved the limit of stability of the Parkinson's disease. Though a case study, the results of this study suggest that IM intervention y is effective at restoring the physical function of patients with Parkinson's disease

Keywords: *Older Adult, Parkinson's disease, Physical function*

1. INTRODUCTION

As our society increasingly ages, the health of the elderly has emerged as a significant social issue [1].The incidence of age-related diseases or disorders increases with age and an increasing elderly population [2]. Parkinson's disease is the most common and a progressive neurodegenerative disorder of the central nervous system which affects both motor and cognitive symptoms, next to Alzheimer's disease. In particular, motor symptoms in Parkinson's disease are the principal features of rigidity, bradykinesia, tremor, and postural instability [3]. As the disease progresses, patient demonstrate abnormal postural response when controlling their movements, resulting in a forward stooped posture [3]. Competing attentional demands increase postural instability, such as forward flexed posture of the head, neck, trunk, hip joint, knee joint, and ankle joint, which result in difficulty during dynamic destabilizing activities such as self-initiated movements including functional reaching, walking, turning and poor performance when experiencing perturbed balance [4]. These symptoms are affected by therapies involving the use of pegboards, ring arcs, clothes pin trees, and other equipment and rote activities, and Parkinson's disease has been shown to negatively affect the function of the upper extremities [4]. Patients with early stage Parkinson's disease may experience difficulty with fine motor tasks such as fastening the top or cuff button on a shirt, and complain of changes in handwriting and excessive fatigue [4]. Interactive metronome (IM) is a computer program originally intended for improving musicians

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‘timing. Later, the the creators of IM promoted research on use of the IM as a sports-enhancement modality, and in marketed it widely to occupational and physical therapists [5]. Shank and Harron examined the efficacy of IM training in improving timing skills, hand function, and parental report of self-regulatory behaviors for children with mixed motor and cognitive impairment. They reported a close relationship between cognitive and motor skills that have potential therapeutic value [6]. Nelson and colleagues examined the efficacy of IM therapy for the remediation of cognitive difficulties of soldiers with persisting cognitive complaints after incurring blast-related traumatic brain injury. They suggested the IM therapy has a positive effect on neuropsychological outcomes for solders who have sustained mild-to-moderate traumatic brain injuries [7]. The purpose of this study was to examine the effects of IM training on the postural stability and upper extremity function of individuals with Parkinson’s disease.

2. METHOD

2-1 Subject

The participant of this case study was a 72-year-old male diagnosed with Parkinson’s disease 3 years ago. He was 165 cm high, weighed 68 kg, and had a BMI (body mass index) of 27.68. He was grade 2 on the Hoehn and Yahr Scale. He did not have any visual or auditory impairment, and was able to follow simple comments and communicate with researchers. He was not diagnosed as having any other diseases or disability except Parkinson’s disease, and had not taking any medications that could affect the results of this study, within 6 months prior to this clinical intervention. The researchers explained the purpose and procedure of the study to the participant and her caregivers, and obtained her voluntary consent to participate in this study.

2-2 Procedures

This study was a single-subject research using an A-B-A design to examine the effects of IM therapy on the postural stability and upper extremity of a female with Parkinson’s disease. The Berg balance scale, box-and-block test, Wolf motor function test, and a Tetrax system were used to evaluate the outcome measures. All procedures of the tests and intervention were conducted in five stages as follows: pretest, first baseline phase (A phase), treatment phase (B phase), second baseline phase, and posttest. This study assessed outcome measures at pretest and posttest using the Berg balance scale (BBS) and Wolf motor function test (WMFT), and at baseline and the treatment phase using the box-and-block test (BBT) and a Tetrax (Tetrax Ltd., Ranmat Gan, Israel). He received IM training in the treatment (B) phase for 40 minute per session. The study consisted of three stages with an A-B-A design: 4 sessions in the first baseline phase, sessions in the treatment phase and 4 session in the second baseline phase.

IM therapy is a dynamic behavioral system, in which a participant performs various repeated movements in time to a beat, while a computer provides precision feedback on performance [5]. The IM hardware consists of a master control unit with a USB cord, headphones, a button switch, a tap mat, and in-motion insole triggers. The IM software consists of an objective assessment and training tool, engaging and fun reports and graphs, and adjustable settings 4). This study used IM pro 8.0 (Interactive metronome Inc., FL, USA) and 13 movement exercises that require timing and sequencing in relation to the auditory input used the computerized metronome beat to which the patient was asked to tap her hand, foot, or both at the same time as the beat. Computerized guide sounds were provided via headphones to assist the patient to fine-tune her movements [6].

Outcome measures were assessed using the BBS, WMFT, BBT, and a Tetrax system. BBS is a 14-item objective measure designed to assess the static balance and fall risk of adult populations. It measures static and dynamic activities of varying difficulty, and item-level scores range from 0 (unable) to 4 (able), and are determined by the participant's ability to perform the assessed activity. The maximum score is 56. BBT measures manual dexterity [7]. A test box with 150 blocks and a partition in the middle is placed lengthwise along the edge of a standard-height table, and the participant sits on a standard-height chair facing the box. A total of 150 blocks are placed in the compartment of the test box on the side of the participant's dominant hand. The test last for one minute, during which the participant picks up the blocks one at a time with the hand, transports the block over the partition, and releases it into the opposite compartment. The score is the number of blocks carried, by each hand separately, from one compartment to the other in one minute [8]. WMFT is a quantitative measure of upper extremity motor ability assessed through timed and functional tasks. The original version consists of 21 items, and the modified version consists of 17 items. The maximum score is 75, and lower scores are indicative of lower functioning levels [9].

The Tetrax interactive balance system measures balance at four different reference points, each yielding separate signals of pressure fluctuations. This enables the evaluation of sway patterns of each four-foot parts and assessment of the interaction between them, and traditional measures of stability of postural stability. The Tetrax score measures eight different conditions with different head positions with the eyes open or closed: the 'neutral head position with the eyes opened (NO)', the neutral head position with the eyes closed (NC), the neutral head position with the eyes opened and standing on pillows (PO), the neutral head position with the eyes closed and standing on pillows (PC), a position with the head tuned to the right and the eyes closed (HR), a position with the head turned to the left and the eyes closed (HL), a position with the head tilted backward by 30 degrees and the eyes closed (HB), and a position with the head tilted forward about 30 degrees and the eyes closed (HF). This study measured the limit of stability using the Tetrax balance system.

Descriptive statistics were used to calculate means and standard deviations. Analysis was performed with the aid of PASW version 22.0 for Windows (SPSS Inc., Chicago, IL, USA) and a statistical significance level of 0.05

3. RESULT

Table 1 shows the pre-test and post-test BBS and WMFT scores. The BBS was 46 at pre-test and 52 at post-test, a change in value of 6. The WMFT score for functional ability was 4.73 at pre-test and 4.93 at post-test for the right hand, and 4.66 at pre-test and 4.93 at post-test in left hand. The performance time of WMFT was 3.61 seconds at pre-test and 3.28 seconds at post-test for the right hand, and was 4.02 seconds at pre-test and 3.43 seconds at post-test for left hand. This study also measured BBT and Tetrax at the baseline and treatment phases.

■ **Table 1. Berg balance scale and Wolf motor function test scores at pre- and post-test of an elderly female with Parkinson's disease**

Variable			Pretest	Posttes
Berg balance scale			46	56
(scores)		Right	4.73	4.93
	Functional ability (scores)	Left	4.66	4.93

Wolf motor function test				
	Performancetime (seconds)	Right	3.61	3.28
		Left	4.02	3.43

The BBT scores were 54.0, 66.0, and 71.5 at the first baseline, treatment, and second baseline phases, respectively, for the right hand, and 50.3, 65.5, and 74.8 scores at the first baseline, treatment, and second baseline phases, respectively, for left hand (Table 2).

■ Table 2. Main Box and block test scores at the first baseline, treatment, second baseline phases of an elderly female with Parkinson's disease

Box-and-block test	First baseline Treatment		Second baseline
Right hand	54	66	71.5
Left hand	50.25	65.53	74.75

Table 3 shows the limit of stability scores of the eight different conditions of the Tetrax test. The scores at the first baseline phase were 46.27, 59.02, 50.10, 68.15, 76.17, 67.69, 59.87, and 56.18 under the eight different conditions. The scores at the treatment phase were 33.34, 35.84, 31.00, 40.37, 43.82, 44.21, 42.42, and 47.86 respectively, for the eight different conditions. The scores at the second baseline phase were 44.87, 40.33, 39.66, 38.95, 45.41, 43.03, 42.86, and 43.06, respective

■ Table 3. Main Limits of stability determined by a Tetrax system of an elderly female with Parkinson's disease

Limit of stability	First baseline	Treatment	Second baselin
Neutral head position with eyes open	46.57	33.34	44.87
Neutral head position with eyes closed	59.02	35.84	40.33
Neutral head position with eyes open and standing on pillows	50.10	31.00	39.66
Neutral head position with eyes closed and standing on pillows	68.15	40.37	38.95
Position with head turned to the right and eyes closed	76.17	43.82	45.41
Position with head turned to the left and eyes closed	67.69	44.21	43.03
Position with head tilted backward by 30 degrees and eyes closed	59.78	42.42	42.86
Position with head tilted forward about 30 degrees and eyes closed	56.18	47.86	43.06

4. Discussion

This study examined the effects of IM therapy on the postural stability and upper extremity function of an elderly female with Parkinson's disease. The BBS and WMFT scores were measured at pre-test and post-test, and BBT and limit of stability at the baseline and treatment phases. The main findings were that static and dynamic balance, functional activity and performance time of the upper extremity, the manual dexterity of both hands, and the limit of stability of a Parkinson's disease patient were improved.

IM therapy was developed by Greenspan in 1992 to facilitate the efficiency and performance of central nervous system functions such as attention, motor control, language processing, reading, and parental reports of improvements in the regulation of aggressive behavior [4] . A previous study reported the effectiveness of IM therapy for upper motor neuron dysfunction 4–6, 10, [10] . Cosper and colleagues conducted IM training with a group of children with mixed attentional and motor coordination disorders to further investigate the effects of IM training on the subcomponents of "attentional control" and "motor functioning." They reported that IM training addressed deficits in visuomotor control and speed, but appeared to have little effect on sustained attention or motor inhibition [11]. Hill and colleagues studied the feasibility of adding IM to an occupational therapy program by assessing the changes in upper extremity impairments, function, quality of life, and perceived physical performance ability and satisfaction by using IM training combined with occupational therapy for adults with chronic stroke. They reported that IM training combined with occupational therapy improved the impairments and quality of life of chronic stroke patients. They suggested that rhythm and timing training using the IM is a feasible intervention which should be considered as part of rehabilitation, and that IM training can be considered as a pre- and post-treatment supplement in order to maximize rehabilitation potential [12]. Johansson and colleagues examined the potential effects of synchronized metronome training on the movement kinematics of two children diagnosed as having spastic hemiplegic cerebral palsy. They suggested that synchronized metronome training include smoother and shorter movement trajectories in the bimanual condition and in the unimanual condition of the non-affected side [13]. The IM treatment has been reported to have several beneficial therapeutic effects on cognitive function [e.g., attention, visuomotor control, motor control, perceived physical ability] and physical function, e.g., regulating aggressive behavior. The results of this study show that after IM therapy, there was improvement in static and dynamic balance, limit of stability, and upper extremity function after IM therapy in woman with Parkinson's disease. These therapeutic advantages would improve the static and postural stability, limit of stability, manual dexterity of the upper extremity, and functional activity and performance time of the upper extremity. Our results suggest that IM therapy is effective at restoring the postural stability and upper extremity function of Parkinson's disease patients. However, it should be noted that this study was a case study and previous studies have reported that IM therapy for patients with Parkinson's disease has insufficient effect.

5. CONCLUSION

The results of this study cannot be generalized to all stages of Parkinson's disease because this study used a single-subject design with only one elderly male with Parkinson's disease as participant. In future, the effect of IM therapy on the motor and cognitive functions of patients with mild to severe Parkinson's disease should be investigated in a group treatment program. Future study is also needed to compare the effectiveness of IM therapy with the results of other therapeutic programs for Parkinson's disease

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