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Physical Telerehabilitation Improves Quality of Life in Patients with Multiple Sclerosis

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Abstract. The purpose of this study was to investigate the effect of physical telerehabilitation on the quality of life (QOL) in patients with multiple sclerosis (PwMS) in a randomized controlled trial. PwMS in both groups received home-based individualized exercise plan based on their physical therapy exam. PwMS in the intervention group were guided by a telerehabilitation system in following their exercise program on a daily basis whereas PwMS in the control group received periodic newsletters. Disease-specific QOL was assessed by MSQOL-54 survey at the baseline and the end of 3-month rehabilitation program. Among the MSQOL sub-scales, the mean sub-score values for pain and cognitive function in control and intervention groups were significantly different as demonstrated by one-way ANOVA (pain: $F = 4.301$, $p = 0.044$, cognitive function: $F = 5.053$, $p = 0.030$). Our results demonstrated positive effects of physical telerehabilitation on MS symptoms and QOL. Development of further approaches promoting continuous participation in telerehabilitation in PwMS is warranted.

Keywords. Multiple Sclerosis, quality of life, pain, cognitive function

1. Introduction

Multiple sclerosis (MS) requires life-long management of symptoms because MS is a chronic neurological disorder [1-4]. Pain is an important and frequent symptom that accompanies MS, and about one-third of patients report pain as one of the most debilitating symptoms of MS [5]. The existence of pain can affect the quality of life (QOL) and daily activities [3].

Cognitive disorders occur in about 50% of patients with MS (PwMS) [6]. Neuropsychological studies show cognitive impairment in 40 to 65 percent of MS patients with significant involvement in memory, continuous attention, and information processing speed [7]. Cognitive disorders affect the performance of a role in work and social life independently of physical disabilities and can have a dramatic effect on the QOL of a patient. Physical rehabilitation was shown to slow down neurodegenerative decline in PwMS [8]. Exercise exposure can act as a mechanism to improve stress resistance, promote neural protection, regeneration, and reduce long-term disability.

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Access to regular rehabilitation is frequently limited for PwMS due to multiple barriers including mobility limitation. Telerehabilitation has potential to address these limitations however its impact on QOL was not systematically studied.

The goal of this study was to investigate the effect of physical telerehabilitation on the quality of life in patients with multiple sclerosis (PwMS) in a randomized controlled trial.

2. Methods

2.1. Telerehabilitation

In this study, a home-based telerehabilitation system was used to support personalized, physical therapy exercise program which was prescribed by a licensed physical therapist (PT) to each patient after a comprehensive physical therapy exam [9]. The telerehabilitation system supports patient-specific exercise plan and self-management, comprehensive patient provider communication, and multidisciplinary treatment coordination as previously described [10].

2.2. Study Design

A total of 45 consecutive PwMS (33 females and 12 males) were enrolled into the study and randomly assigned to intervention (I) and controlled (C) groups. Patient disability level varied from 5.5 to 7.5 on the Kurtzke Expanded Disability Status Scale (EDSS). All patients were instructed by PT on how to perform their exercises at home, received necessary exercise equipment, and were followed for 3 months. The study outcomes were assessed at the baseline (BL) and 3-month (3M) by a blinded assessment team.

Patients in the intervention group were assisted by the telerehabilitation system in following their customized exercise plans at home daily. For patients in the control group, MS bulletin was sent every two weeks to address attention bias.

The Multiple Sclerosis Quality of Life-54 (MSQOL-54) [11] was used to evaluate multidimensional health-related quality of life at baseline (BL) and 3-month follow-up (3M). Physical health, role limitations-physical, role limitations-emotional, pain, emotional well-being, energy, health perceptions, social function, cognitive function, health distress, sexual function, change in health, satisfaction with sexual function, overall quality of life, physical health composite, and mental health composite were sub-scaled.

Comparisons were made between the control group and the intervention group. All statistical analyses were performed using IBM SPSS Statistics 26 for Windows.

3. Results

3.1. Sociodemographic Characteristics of Patients

Overall forty-five patients with multiple sclerosis were analyzed. The age ranges of intervention group and the control groups were between 35 and 77 with 57.8 ± 11.9 years (mean ± SD) and between 39 and 74 with 56.0 ± 12.8 years respectively. The MS

duration varied between 1.0 and 50.8 years for the intervention group and between 2.5 and 49.6 years for the control group and the years of education were 14.9 ± 3.3 years for the intervention group and 16.2 ± 3.0 years for the control group. The racial and ethnic composition comprised 62.1% Whites and 13.8% Hispanics in I and 56.2% and 12.5% correspondingly in C group. Self-reported MS severity was categorized as moderate by 50% of control patients and by 58.6% of intervention group patients (Table 1).

Table 1. Sociodemographic characteristics of patients.

Characteristics (yrs.)		**Minimum**		**Maximum**		**Mean**		**SD**	
		C	**I**	C	**I**	C	**I**	C	**I**
Age		39	35	74	77	56.0	57.8	12.8	11.9
MS Duration		2.5	1.0	49.6	50.8	19.8	21.4	13.7	13.5
Education		11	8	20	21	16.2	14.9	3.0	3.3
Characteristics	Gender			Race			Hispanic		
		C	**I**		C	**I**		C	**I**
N (%)	female	10(62.5)	23(79.3)	AA	6(37.5)	8(27.6)	yes	2(12.5)	4(13.8)
				Asian		2 (6.9)			
	male	6(37.5)	6(20.7)	White	9(56.2)	18(62.1)	no	14(87.5)	25(86.2)
				other	1 (6.3)	1 (3.4)			

Characteristics	MS severity			Disease status (self-report)		
		C	**I**		C	**I**
N (%)	none		1 (3.4)	progressing	8(50.0)	10(34.5)
	mild	2(12.5)	6(20.7)	stable	8(50.0)	18(62.1)
	moderate	8(50.0)	17(58.6)			
	severe	6(37.5)	5(17.3)	improving		1 (3.4)

C: control group, I: intervention group, yrs.: years, MS: multiple sclerosis, SD: standard deviation, AA: African American

3.2. MSQOL-54

Average differences between baseline (BL) and 3-month follow-up (3M) were investigated for sub-scaled parameters. Increases in mean values of subscales were found in physical health, role limitations-physical, role limitations-emotional, pain, health perceptions, social function, cognitive function, health distress, satisfaction with sexual function, overall quality of life, physical health composite, and mental health composite in the intervention group, while decreases in mean values of sub-scale scores were found in role limitations-physical, role limitations-emotional, pain, cognitive function, health distress, changes in health, satisfaction with sexual function, overall quality of life, and mental health composite in the intervention group. (Table 2)

Table 2. MSQOL-54.

	C			I		
Parameter name	**Mean**	**SD**	**SE**	**Mean**	**SD**	**SE**
Physical health (3M-BL)	1.9	33.2	8.3	6.6	30.7	5.8
Role limitations-physical (3M-BL)	-7.8	31.3	7.8	2.6	43.5	8.1
Role limitations-emotional (3M-BL)	-14.6	53.0	13.3	0.0	43.6	8.1
Pain (3M-BL)	-11.1	23.0	5.7	4.3	24.3	4.5
Emotional well-being (3M-BL)	0.5	24.1	6.0	-3.0	15.0	2.8
Energy (3M-BL)	4.3	18.9	4.7	-1.4	16.6	3.1
Health perceptions (3M-BL)	3.4	17.3	4.3	2.6	15.8	2.9
Social function (3M-BL)	3.7	20.8	5.2	5.5	23.7	4.4
Cognitive function (3M-BL)	-6.6	13.4	3.3	5.5	19.0	3.5
Health distress (3M-BL)	-3.1	22.1	5.5	5.5	17.5	3.2
Sexual function (3M-BL)	4.2	42.2	11.3	-5.7	36.1	7.7
Change in health (3M-BL)	-1.6	17.0	4.3	-4.3	23.2	4.3
Satisfaction with sexual function (3M-BL)	-9.1	43.7	13.2	8.0	29.3	6.2
Overall quality of life (3M-BL)	-4.4	21.8	5.4	2.4	8.8	1.6
Physical health composite (3M-BL)	0.7	10.7	2.9	1.6	12.3	2.6
Mental health composite (3M-BL)	-5.6	23.0	5.7	1.1	15.4	2.9

C: control group (n=16), I: intervention group (n=29), BL: data acquired at commencement of the study, 3M: data acquired at the 3-month follow-up, 3M-BL: difference data between 3M and BL, SD: standard deviation, SE: standard error of the mean

3.3. Pain and Cognitive Function

Total sixteen parameters of MSQOL-54 were investigated to identify the significant difference between the intervention group and the control group by comparing the means of two groups. Among sixteen parameters, the mean scores in control group and intervention group for pain and cognitive function were significantly different as demonstrated by one-way ANOVA (pain: $F = 4.301$, $p = 0.044$, cognitive function: $F = 5.053$, $p = 0.030$). (Figure 1)

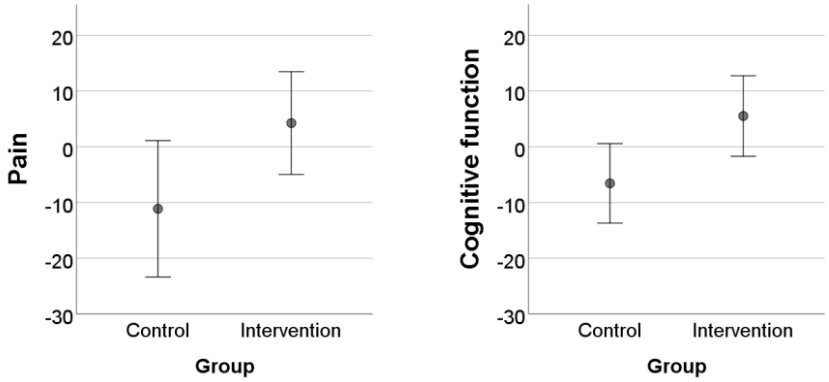

Figure 1. Comparisons between the control group and the intervention group (error bar: 95% confidential interval).

4. Discussion

In this study, we investigated impact of physical rehabilitation on composite sub-scale scores of disease-specific QOL resulting from 3-month home-based personalized exercise program. We found that physical telerehabilitation in the intervention group resulted in more prominent improvements in QOL and symptom reduction as compared to a usual care control group. More than 70% of the patients in the intervention group showed improvements in sub-scales reflecting physical health, role limitations-emotional, health perceptions, cognitive function, change in health and satisfaction with sexual function, and more than 60% of this patients improved in scores of role limitations-physical, social function, health distress, sexual function, and overall quality of life. In particular, the use of the physical telerehabilitation system showed statistical differences in major MS symptoms including pain and cognitive function (Figure 1) with significant changes in the corresponding sub-scale scores (pain: 27.3%, cognitive function: 35.3%).

Caregivers were shown to play a significant role in PwMS support. Previous studies demonstrated enhanced use of remote patient assessment and monitoring by caregiver participation. Future telerehabilitation systems should include functionality supporting caregiver engagement in PwMS self-management.

5. Discussion

Based our results, physical telerehabilitation supporting individualized exercise programs in PwMS demonstrated a significant potential. Development of further approaches promoting continuous participation in telerehabilitation in PwMS is warranted.

References

[1] Clifford DB, Trotter JL. Pain in multiple sclerosis. Arch Neurol. 1984 Dec;41(12):1270-2.
[2] Vermote R, Ketelaer P, Carton H. Pain in multiple sclerosis patients. A prospective study using the McGill Pain Questionnaire. Clin Neurol Neurosurg. 1986;88(2):87-93.
[3] Svendsen KB, Jensen TS, Overvad K, Hansen HJ, Koch-Henriksen N, Bach FW. Pain in patients with multiple sclerosis: A population-based study. Arch Neurol. 2003 Aug;60(8):1089-94.
[4] Svendsen KB, Jensen TS, Hansen HJ, Bach FW. Sensory function and quality of life in patients with multiple sclerosis and pain. Pain. 2005 Apr;114(3):473-481.
[5] Stenager E, Knudsen L, Jensen K. Acute and chronic pain syndromes in multiple sclerosis. Acta Neurol Scand. 1991 Sep;84(3):197-200.
[6] Benedict RH, Cookfair D, Gavett R et al. Validity of the minimal assessment of cognitive function in multiple sclerosis (MACFIMS). J Int Neuropsychol Soc. 2006 Jul;12(4):549-58.
[7] Bobholz JA, Rao SM. Cognitive dysfunction in multiple sclerosis: A review of recent developments. Curr Opin Neurol. 2003 Jun;16(3):283-8.
[8] White LJ, Castellano V. Exercise and brain health–implications for multiple sclerosis: Part 1–neuronal growth factors. Sports Med. 2008;38(2):91-100.
[9] Finkelstein J, Liu J. Usability of telerehabilitation system supporting multipronged exercise in patients with multiple sclerosis. Stud Health Technol Inform. 2018;251:281-284.
[10] Finkelstein J, Wood J, Cha E. Impact of physical telerehabilitation on functional outcomes in seniors with mobility limitations. Annu Int Conf IEEE Eng Med Biol Soc. 2012;2012:5827-32.
[11] Vickrey BG, Hays RD, Harooni R, Myers LW, Ellison GW. A health-related quality of life measure for multiple sclerosis. Qual Life Res. 1995 Jun;4(3):187-206.