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Effect of dual task exercise to develop body balance, movement co-ordination and walking speed among post cervical injury clients

Dayanidhi Hota[1], Sasmita Das[*2], Neethu Maria Joseph[3]

[1]Nurse Educator, Department of Nursing, HCG Panda Cancer Hospital, Cuttack, Odisha, India
[2]Department of Medical and Surgical Nursing, SUM Nursing College, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar 751003, Odisha, India
[3]Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar 751003, Odisha, India

ABSTRACT

To determine the effect of level of body balance, movement coordination and walking speed among patients with a cervical injury. A true experimental design (pre-test and post-test control group) was set up in the physiotherapy unit of Regional Spinal Injury Centre (RSIC), Cuttack, Odisha. A total of 40 post cervical injury patients were selected who were undergoing single task exercises in the setting. Patients were divided randomly with 20 in experimental and 20 in the control group. The experimental group performed dual-task exercises (for hands and legs) for 6 days a week, continuing for 4 weeks. Body balance was measured using 'berg balance scale', movement coordination and walking speed assessed with 'motor assessment scale'. There was a significant improvement in the scores of body balance and movement coordination among the experimental group. The control group showed no significant difference between the pre and post-test scores. There was no significant change in the pre and post-intervention scores of movement coordination and walking speed among the experimental and control group except in body balance. Dual-task exercises were helpful in developing the body balance, movement coordination and walking speed among post cervical injury patients.

*Corresponding Author

Name: Sasmita Das
Phone:
Email: das.sasmita2@gmail.com

INTRODUCTION

World health organization (WHO) records suggests the total incidence of spinal cord injury globally to 40 – 80 cases / million populations (WHO, 2013). An aggregate data on the epidemiology of spinal cord injury in the Indian setup is not available. However, from various epidemiological studies, it can be concluded that, among the spinal cord injury cases, cervical spinal cord injury (CSCI) cases ranges from 33 – 56% (Pandey *et al.*, 2007; Sridharan *et al.*, 2015; Chhabra and Arora, 2012).

CSCI is one of the disabling disorders which can cause multiple physical and psychological challenges for the affected person. The rehabilitation phase can also be eventful with life-threatening complications like urinary tract infections, pressure ulcers, deep vein thrombosis, respiratory difficulties and mobility impairment (WHO, 2013; Rahimi-Movaghar *et al.*, 2013; Flanders *et al.*, 1999). The development of self-care, locomotion, mobility and sphincter control in CSCI patients depends upon the presence of hemorrhage and length and location of edema (Flanders *et al.*, 1999).

Rehabilitation is a long process in spinal cord injury. The goal of early rehabilitation with regard to mobility is to improve the level of functioning. Measures are taken to prevent joint contractures, restore muscle strength and to improve motor task performances (Sezer, 2015). For a patient with the potential for neurological recovery, it is essential to provide task-specific practices as a repetitive activity, as the training will help the patient to function normally (Harvey, 2016). Dual-task exercises (DTE) performed by patients requires them to do two tasks simultaneously, which is opposed to traditional single task exercises. The tasks performed can be cognitive or motor or both maintaining the postural control. Dual-task exercises have been used for elderly patients and those with neurologic impairments like Alzheimer's disease, stroke, brain injuries and Parkinson's disease. The purpose is to improve gait, body balance and control, cognitive and executive functions (Shin and An, 2014; Mendel et al., 2015).

Mendel et al. (2015) conducted a literature review on dual-task exercises on neurologic patients by selecting nine clinical trials after conducting an extensive survey. The studies used cognitive with motor tasks and dual motor tasks as an intervention. Improvements were observed in gait parameters, body balance and cognitive functions (Mendel et al., 2015). A randomized controlled trial among 25 chronic stroke patients revealed that a 4-week dual-task exercise program significantly improved the gait parameters like walking speed, cadence, stride time and stride length (Berg et al., 1989).

Since patients after cervical spinal cord injury develops postural and mobility complications, the researchers wanted to assess the effect of a dual-motor task exercise program on body balance, movement coordination and walking speed among cervical spinal cord injury patients. This exercise program prompted the participants to perform simultaneous upper limb and lower limb exercises.

METHODS

Pre-test post-test control group design was adopted. The study was conducted in a physiotherapy unit of Regional Spinal Injury Centre (RSIC), Cuttack, Odisha, which is a 50 bedded centre providing rehabilitation services to the patients. This particular setting was selected for its accessibility, availability of subjects and equipments required for the study. Patients who were admitted in the setting after cervical injury were performing different single task exercises for 5 days per week. The duration of these sessions varied from one to four hours. 46 patients were randomly selected, among which six participants were unwilling to take part in the study, thus making a total of 40 patients. They were randomly allotted as 20 each into an experimental and control group using the chit method. The sample included hemodynamically stable males or females who were > 30 days post-injury at the time of data collection. Patients who were < 10 years of age, in shock, or with any reported history of psychiatric illness were excluded.

Data collection procedure

The study duration was one month (January 2017 to February 2017). After explaining the purposes of the study and the intervention in detail, informed consent was collected from willing participants. They were given information regarding the intervention – dual-task exercise. To collect the socio-demographic data, a tool was developed by the researchers, which included age, sex, occupation, post days of injury, and any diagnosed co-morbid conditions. This self-structured tool was validated by five experts from the field of nursing and physiotherapy.

The socio-demographic variables along with body balance, movement coordination and walking speed were assessed by the researcher. The patients were asked to perform some tasks as required by the "berg balance scale" and "motor assessment scale" (Carr et al., 1985; Yang et al., 2007). Body balance was measured using "berg balance scale" which included 14 tasks which are as follows: sitting to standing, standing to sitting, standing unsupported, sitting unsupported, transfer from one chair to next, standing with eyes closed, standing with feet together, reaching forward with outstretched arm, retrieving object from floor, turning to look behind, turning 360 degrees, placing alternate foot on stool, standing with one foot in front, standing on one foot. These tasks were scored from a scale of 0 to 4 depending upon the patient's ability to perform each.

Movement coordination was assessed using "motor assessment scale" which again involved performance of certain tasks like supine to side-lying position, supine to sitting over bedside, balance in sitting position, sitting to standing, walking, upper arm functions during sitting and supine positions, hand movements, advanced hand activities and general tonus on affected side. When the walking performance was scored, the walking speed was measured simultaneously using the distance covered/ time formula.

After the pre-intervention measurement, 20 participants in the experimental group were taught dual-

task exercises for upper and lower limbs. The exercise program included catching ball, preparing pyramids, steeping the fingers, low weight lifting for upper limbs. The exercises for lower limbs were walking in marked areas, playing football, stretching, sitting and standing habit with support. These exercises were performed under the supervision of the physiotherapist and the researcher. This set of exercises were carried out 6 days a week and continued for 4 weeks.

RESULTS AND DISCUSSION

Data analysis was done by entering the collected information on Microsoft Excel 2007. Frequency and percentage was used to interpret the socio-demographic data. Unpaired t-test was used to compare the post-test scores of body balance, movement co-ordination and walking speed among the experimental and control group. With the help of a paired t-test, the effect of dual-task exercises on the dependent variables on each of the two groups was examined. Chi-square analysis was employed to calculate any association between body balance, movement coordination and walking speed with socio-demographic data.

Information given in Table 1 highlights the distribution of socio-demographic characteristics of both the experimental and control group. Most of the participants (40%) were in the age group of 11 – 25 years. The majority of the patients were males (90%) in both groups. Patients both in experimental (65%) and control (75%) were diagnosed to have malnutrition.

Before the intervention, 95% of the patients were walking with assistance and remaining used wheelchair. Post-intervention scores showed an improved outcome, with 20% of the patients walking independently, 75% walking with assistance and 5% depending on a wheelchair. On the contrary, no improvement was observed in all the patients enrolled in a control group who were able to walk with assistance.

In experimental group, pre-test and post-test mean scores of body balance were 27 ± 5.14 and 32 ± 7.62 respectively and pre-test and post-test mean scores of movement coordination and walking speed were 25.5 ± 5.24 and 30.1 ± 3.50 as shown in Table 2. To test the effectiveness of dual task exercises, paired t-test was used for statistical analysis. The calculation showed that there was a significant difference between pretest and posttest mean scores of body balance (t-value – 5.23, p – 0.0001) and movement coordination and walking speed (t-value – 4.50, p – 0.0002).In the control group, there was no signifi-

cant difference in the pretest and posttest scores of body balance (t-value – 1, p – 0.32) and movement coordination and walking speed (t-value – 0.32, p – 0.74).

On comparing the post-intervention mean scores of the experimental and control group using unpaired t-test as shown in Table 3, there was a significant difference between the scores of body balance (t - 2.89, p - 0.006), movement coordination and walking speed (t – 2.81, p – 0.007). In Table 4, it is highlighted that there was a significant association between age and gender with body balance. Also, there was found to be a significant association between age and occupation with movement coordination and walking speed.

Our study revealed that there was an improvement in body balance, walking speed and movement coordination after dual task exercises. It was observed that after 4 weeks of the dual-motor task exercise program, the values of body balance improved from 27 ± 5.14 to 32 ± 7.62 and values of movement coordination and walking speed increased from 25.5 ± 5.24 to 30.1 ± 3.50 among patients admitted after cervical spinal cord injury.

These findings are supported by a similar study done by Yang et al. (2007) among chronic stroke patients. A four-week ball exercise program showed an increase in walking speed (cm/s) from 85.62 ± 19.85 to 115.35 ± 18.14 among ambulatory participants (Berg et al., 1989). A recent pilot clinical trial was conducted by Liu et al. among three groups – cognitive dual-task group, motor dual-task group and conventional physical therapy. The results revealed that the walking speed in the motor dual-task group increased from 62.4 ± 13.8 to 63.8 ± 13.7 (Liu et al., 2017). In a therapeutic aquatic environment, Kim et al. observed that a 6-week aquatic dual-task exercise reduced the time (in seconds) required for a 10-meter walk test from 15.9 ± 1.4 to 12.9 ± 1.9. Also, Berg Balance Scale scores showed that the body balance scores raised from 41.8 ± 1.6 to 44.4 ± 1.4 (Kim et al., 2016). Even though further statistical measures were not applied, it was seen that there was an association between age and gender with body balance. Also, there was a significant association between age and occupation with movement coordination. In a study conducted in Washington School of Medicine among patients with cervical spine problems, it was found that the mean ages of patients with symptoms of dizziness and imbalance was 54.5 ± 11.5 years. It was revealed that there was no significant association between age and gender with symptoms of imbalance (Rieke and Clara, 2008). Another

Table 1: Baseline demographic characteristics of the experimental and control group

	Items	Experimental group (n =20)	Control group (n=20)
Age (in years)	11 – 25	8 (40)	6 (30)
	26 – 40	5 (25)	9 (45)
	41 – 55	5(25)	5 (25)
	56 – 70	2(10)	Nil
Gender	Male	18 (90)	18 (90)
	Female	2 (10)	2 (10)
Occupation	Student	6(30)	6(30)
	Employee	7(35)	11 (55)
	Sportsperson	3(15)	Nil
	Laborer	4(20)	2 (10)
	Farmer	Nil	1 (5)
Co- morbid conditions	Diabetes Mellitus	6(30)	3 (15)
	Malnutrition	13 (65)	15 (75)
	Infectious disease	1(5)	10 (50)

The numbers given are the frequency with a percentage in brackets.

Table 2: Pretest and post-test scores of body balance, movement coordination and walking speed among experimental and control group

Group	Variables		Mean $\pm$ SD	t-value	p-value
Experimental group	Body balance	Pre-test	27 ± 5.14	5.23	0.0001*
		Post-test	32 ± 7.62		
	Movement coordination and walking speed	Pre-test	25.5 ± 5.24	4.50	0.0002*
		Post-test	30.1 ± 3.50		
Control group	Body balance	Pre-test	26.3 ± 4.49	-1	0.32*
		Post-test	26.75 ± 4.52		
	Movement coordination and walking speed	Pre-test	26.82 ± 4.20	-0.32	0.74*
		Post-test	27.6 ± 4.17		

*p $\leq$ 0.05

Table 3: Compare post-intervention scores of body balance, movement coordination and walking speed among experimental and control group

Variable	Research group	Mean $\pm$ SD	t-value	p-value
Body balance	Experimental group	32 ± 7.62	2.89	0.006*
	Control group	23.95 ± 4.10		
Movement coordination and walking speed	Experimental group	30.1 ± 3.05	2.81	0.007*
	Control group			
		1. 26.8		

*p $\leq$ 0.05

Table 4: Association between body balance, movement coordination and walking speed with socio-demographic variables

Socio-demographic variables	Body balance			Movement coordination and walking speed		
	Chi-square value	df	p-value	Chi-square value	df	p-value
Age	10.48	3	0.01*	10.98	3	0.01*
Gender	10.73	1	0.001*	1.12	1	0.28
Occupation	4.36	5	0.49	44.90	5	<0.0001*
Co-morbid disease conditions	7.55	3	0.05	2.29	3	0.39

*$p \leq 0.05$

research in Japan among cervical spinal cord injury arrived at the conclusion that there was a significant correlation between age and ambulation (r = -0.32, P= 0.044) (Hasegawa *et al.*, 2014).

The study had some limitations. A small number of patients were selected as samples, thus limiting the generalizability of the research findings. No follow-up of the participants was conducted. Thus, it is not clear whether the improvement in body balance, movement coordination and walking speed were maintained further. Also, among the different gait parameters like speed, cadence, stride length, this study measured only the walking speed of the patients.

CONCLUSIONS

The results of the study showed that there was a significant improvement in body balance, movement coordination and walking speed after a 4-week dual task exercise program among cervical spinal cord injury patients. This can be practiced in rehabilitation centers among patients in the ambulatory phase as a part of gait training. However, further research studies should be conducted to support the findings.

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