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Efficacy of Balance and Gait Re-Education under Single and Dual Task Conditions in Post Stroke Hemiparetic Patients

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Abstract:
The primary concern of all the patients suffered from post- stroke hemiparesis is to regain the ability to balance and walk independently. Gait correction and re-education, therefore, is an important physical therapy intervention for patients following stroke. The purpose of the study was to investigate the effect of dual task balance and gait training compared to single task balance and gait training in post stroke hemiparetic patients. 45 post stroke hemiparetic patients aged 40- 70 years, both males and females and within one year of stroke, were included in the study. The patients were conveniently divided into 3 groups, namely, group A, B and C. The patients were assessed for quantitative gait parameters such as step length, cadence, Comfortable Walking Speed (CWS), and Berg Balance Scale (BBS).Group A received balance and gait training under single task condition; whereas the patients in Group B were given balance and gait training under dual task conditions. All the patients received a total intervention of 6 weeks. After statistical analysis, a statistical significant difference was observed in non-paretic step length, stride length, cadence, CWS and BBS score along (p< 0.05) in the groups A and B. The present study shows that both single task as well as dual task training provides better gait rehabilitation but the results are less evident than dual task training in terms of quantitative gait analysis.

Keywords: *Stroke, hemiparesis, gait, single task, dual task*

1. Introduction

The World Health Organization (WHO) defines stroke as 'the rapidly developing clinical symptoms and/or signs of focal (or global) disturbance of cerebral function, with symptoms lasting more than 24 hours or leading to death with no apparent cause other than that of vascular origin'.[i] Stroke is caused by the interruption of the blood supply to the brain, usually because of blood vessel bursts or is blocked by a clot. This cuts off the supply of oxygen and nutrients, causing damage to the brain tissue.[iii] Stroke is the leading cause of adult disability and inpatient rehabilitation admissions [iv-v].It is the most important single cause of disability in people living in their own home.[vi] Dependence in mobility is one of the primary reasons of admission for inpatient rehabilitation after stroke. Approximately 35% of survivors with initial paralysis of the leg do not regain useful walking function, and 25% of all survivors are unable to walk without full assistance.[vii]

Stroke often leads to motor, sensory, language, cognitive and perceptual deficits. Among these deficits the most common deficit is motor impairment, which includes hemiparesis, in co-ordination, and spasticity. The primary concern of all the patients suffered from post stroke hemiparesis is to regain the ability to walk again independently. This concern is important not only for patients but is equally important for clinicians and physiotherapists because the ability to walk is the main deciding factor that determines whether the post stroke hemiparetic patient will return to his or her previous level of efficiency and activity or not. Therefore as soon as the patient starts weight bearing the focus shifts to ambulation and correction of gait pattern occupies a large proportion of time spent in post stroke hemiparetic rehabilitation.

The dysfunction leads to various musculoskeletal complications multiplying the rehabilitation challenges.[viii-ix] In stroke, the exact mechanism underlying balance impairment is ambiguous.[x] The factors such as cognition, perception, and biomechanical alterations were found to be responsible for the impairment .[xi] A subject with hemiparesis bears more weight on the non-paretic lower extremity leading to asymmetry and impaired erect posture. The inability of the non-affected lower extremity to compensate for the paretic limb also contributes to the postural imbalance .[xii]

But still with so many advanced techniques and tools for stroke rehabilitation, the most effective treatment strategies to use in gait re-education following stroke remains unknown. [xiii] Therefore, there is a need to investigate the efficacy of different treatment approaches with special reference to balance and gait re-education of post stroke hemiplegic patients. Nevertheless, prior to the administration of correction measures, it is essential to analysis the gait pattern of these patients.

2. Methodology

The research design of present study is quasi-experimental in nature. The study was performed at the Out Patient department (OPD) of University College of Physiotherapy, Faridkot, In Patient department (IPD) of Guru Gobind Singh Medical College and Hospital Faridkot as well as home based. Total 45 patients were made to participate in the study using convenient sampling method. The participants included in the study had age ranging from 40-70 years with a diagnosis of stroke consistent with the world health organization definition and where possible confirmed by CT and MRI within the 12 months of stroke onset. All the patients included in the study were able to walk without assistance of another person and had a score of Score >23 on the Montreal Cognitive Assessment (MOCA. The patients with any other neurological conditions other than stroke, any orthopaedic or cardiopulmonary problems limiting gait or physical activity were excluded from the study. The patients with previous stroke with residual motor deficit, Uncontrolled hearing impairment, Severe uncontrolled visual impairment, Speech language impairment affecting ability to respond verbally to auditory stimuli, Lower extremity amputation, Not living in the community prior to stroke were also excluded from the study.

The subjects in group A were administered conventional therapy along with the balance and gait training program under single task conditions as mentioned. The subjects in groupB were administered conventional therapy along with the balance and gait training program under dual task conditions as mentioned. All the subjects were instructed to walk along 10 m along walkway at a comfortable speed. All the gait parameters step length (cm) for both paretic and non – paretic leg, stride length, cadence, comfortable walking speed, fastest walking speed, time up and go test, berg balance scale and Wisconsin gait scale were assessed for the patients. After the above assessment all the subjects were given specific interventions depending upon their respective group. All the subjects were received a total intervention of 3 times per week for 6 weeks. The subjects were reassessed after 3 and 6 weeks of initial assessment. The Statistical Analysis was done using SPSS (version 16). The various statistical tests applied for data analysis were unpaired t-test, one way ANOVA.

Parameter	Mean ± S.D Group A (Single task training)	Mean ± S.D Group B (Dual task training)
Age (Years)	53.2 ± 8.3	53.6 ± 8.3

Table 1: Comparison of the mean of the age (in years) of post stroke hemiparetic patients in the interventional groups:

Variable	Mean ± S.D 0 weeks	Mean ± S.D 3 weeks	Mean ± S.D 6 weeks	F - value	p - value
Step length (paretic) (cms)	46.4 ± 14	46.9 ± 13.8	57.4 ± 13.4	3.02	0.059 (NS)
Step length (Non - paretic) (cms)	44 ± 13.7	44.1 ± 14	55.2 ± 12.7	3.41	0.042 (S)
Cadence (steps/min)	59.1 ± 10.7	60.6 ± 10.9	71.9 ± 11.5	5.933	0.005 (S)
CWS (cm/s)	25 ± 9.7	25.3 ± 9.3	39.6 ± 13.9	8.37	0.001(S)
BBS	45 ± 3.3	46.4 ± 3.4	52.7 ± 2.7	24.8	0.000(S)

Table 2: Comparison of the mean of the gait parameters of post stroke hemiparetic patients: 0 weeks, 3 weeks and 6 weeks post training within the group A (Single Task Training):

Variable	Mean ± S.D 0 weeks	Mean ± S.D 3 weeks	Mean ± S.D 6 weeks	F - value	p - value
Step length (paretic) (cms)	43.1 ± 14.6	43.5 ± 14.6	57.5 ± 12.8	5.10	0.010 (S)
Step length (Non -paretic) (cms)	39.9 ± 14.3	43.6 ± 15.1	54.7 ± 14	4.2	0.021 (S)
Cadence (steps/min)	56.5 ± 13.6	57.7 ± 13.4	72.9 ± 13.4	6.88	0.003 (S)
CWS (cm/s)	23.5 ± 6.8	23.8 ± 6.9	34.2 ± 7.3	11.3	0.000 (S)
BBS	45.5 ± 3.4	47 ± 3.3	50.5 ± 2.4	10.3	0.000(S)

Table 3: Comparison of the mean of gait parameters of post stroke hemiparetic patients: 0 weeks, 3 weeks and 6 weeks post training within the group B (Dual Task Training):

Variable	Mean ± S.D Group A	Mean ± S.D Group B	t	p - value
Step length (paretic) (cms)	11 ± 3.4	14.3 ± 3.7	-2.56	.016 (S)
Step length (Non - paretic) (cms)	11.2±2.9	14.8±2.1	-3.75	0.001 (S)
Cadence (steps/min)	12.8 ± 4.2	16.4 ± 1.9	-3.002	0.006(S)
CWS (cm/s)	18.03 ± 10.5	10.7 ± 1.8	2.66	0.013(S)
BBS	7.7 ± 2.9	5 ± 1.8	2.98	0.006(S)

Table 4: Comparison of the mean score of gait parameters of post stroke hemiparetic patients: between the groups using independent sample t test:

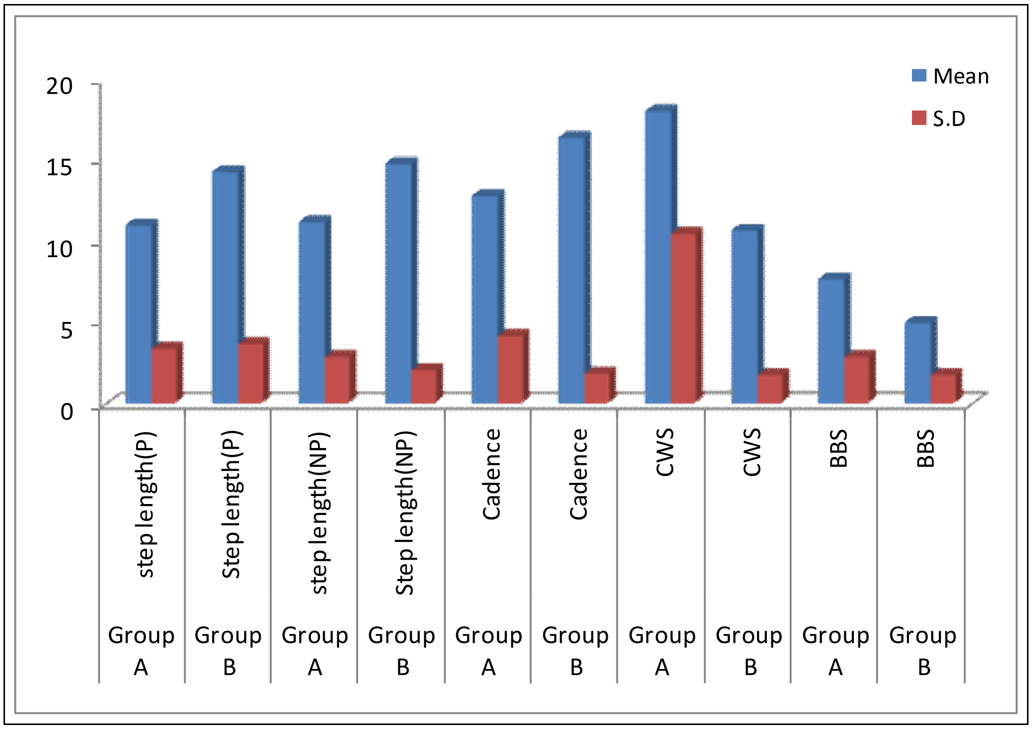

Figure 1: Graphical representation of the mean score of the Step length gait parameters of post stroke hemiparetic patients: between the groups using independent sample t test.

3. Discussion

When the patients with hemiparesis were provided with a rehabilitation protocol consisting of single task paradigm, a significant difference was found in the gait parameters including gait mobility and stability before the single task training and after single task training. The significant improvement in gait parameters with single task training is attributed to the fact that single task training is a part of sustained attention, which is further an important part and is basis to develop cognition of person with cognitive perceptual disorder. Kerrigan et al. also stated that attention is a broad term which covers the number of different processes which are related to each other and integrate the receptive stimuli and process it into an action. He stated that attention is sub classified into sustained, selective, alternative and divided attention. All the types of attentions play a vital role in walking.[xiv] Changes in the gait parameters due to dual task and single task performance are due to the interference between gait and attention splitting task the participant performs (Marjorie Woollacott and Anne Shumway-Cook (2001).[xv] Maintaining a sustained attention depends upon the person's cerebral capacity to accommodate both attention demanding task and walking (Verhaeghen and Cerella, 2002). Executive functions are mainly responsible to control attention.[16]Thus, performing a single task training improves the cerebral capacity of a patient post stroke, thus it improves the gait mobility and stability in the course of rehabilitation. All the parameters showed a significant improvement during this type of training expect step length of paretic side. Because step length largely depends upon the motor control of lower extremity as well as weight shift to the unaffected side.

When a dual task training protocol was assigned to the patients with hemiparesis a significant improvement in all the gait parameters including mobility and stability was found. It is because along with others factors responsible for normal gait cycle two important aspects of higher level cognition i.e. executive function and attention plays an important role in the performance of normal walking.

Executive function is an important basis of higher cognitive processes, which receives the information from the various cortical sensory systems in the brain, modulates them and produces behavior. [xvii - xviii] This function, occurs as an integration of both cognitive and behavioral components, which is necessary for the goal directed action and for controlling the attentional resources. These both aspects are the basis of independently managing the activities of daily living.[xix-xx] our results co incised other studies also with Duncan et alobserved an average gain of 25cm/s after an 8-week, home-based exercise program that was designed to improve strength, balance, and endurance in subjects at an average of 66 dayspoststroke.[xxi] Dean et alfound that a 4-week training program on the performance of locomotor-related tasks led to an averagegain of 12.6cm/s in subjects at a mean of 2.3 years post stroke. [xxii] Furthermore, Ada et alintroduced a concurrent cognitive task and designed a 4-week treadmill and overgroundwalking program. They found that this 4-week treadmill and over ground walking program was associated with an averagegain of 18 cm/s in subjects with chronic stroke. [xxiii]

When a comparison was made between single task and dual task training a significant improvement was observed in patients post stroke in all the parameters expect fastest comfortable speed, TUG test and WGS. Thus it is clear from the study that dual task training has more carry over effect over the single task training. Although both the trainings provided significant improvements but the dual task protocol showed better results in many of the parameters. The results of our study coincides with yang et al (2007) [xxiv]. Cognitive motor interference in the form of dual task training is of great importance in rehabilitation of a patient. Every regime of physical therapy requires both cognitive as well as motor performance. While mostly the emphasis is put more on the motor part and cognitive part is neglected. But poor cognitive performance leads to poor dual task performance which may be the major reason of success of a management plan. Thus assessment of cognition and its implication in the management plan is an important aspect of neuro as well as musculoskeletal physical therapy. Finally our activities of daily living also demands dual task performance and inability to cope up with dual task performance leads to falls as well as immobility.

4. Conclusion

The data obtained from the study showed that dual task training had improved the gait mobility and stability of patients with hemiparesis. It was also found that single task training also provides better gait rehabilitation, but the results are less evident than dual task training in terms of quantitative gait analysis. So cognitive training is an important aspect of gait rehabilitation post stroke. Thus the alternate hypothesis stated in the study holds true.

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