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External cueing on gait parameters in Parkinson's Disease

Deepa S*[1], Ramana K[2]

[1]School of Physiotherapy, VISTAS, Chennai, Tamil Nadu, India
[2]Department of Physiotherapy, Sree Balaji College of Physiotherapy, Chennai, Tamil Nadu, India

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ABSTRACT

Parkinson's disease which is characterized by a paucity of movement, leading to the abnormal gait parameters. The gait pattern is characterized by shuffling as festinant gait. Freezing is an incapacitating motor symptom is also one of the leading causes of gait abnormality leading to falls. Cueing strategy evokes a more goal-directed type of motor control results in improved gait parameters. The purpose of this study to find the effectiveness of external cueing on the gait parameters as cadence, step length and stride length. 30 subjects diagnosed as Parkinson's disease were randomly assigned to three groups, the walking ability was assessed using a 10 meter walk test, and pre-test score was recorded. The external cueing technique was applied for a session of 4 days per week for 4 weeks; each session lasted for about 30 minutes, at the end for 4 weeks, the post-test scores were recorded. External cueing with a combination of audio-visual showed significant improvement in the gait parameters. The improvement showed in the pre-test to post-test reflected the need for introducing the external cueing in improving gait and attention during a motor task.

*Corresponding Author

Name: Deepa S
Phone:
Email: deepasranganathan@gmail.com

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INTRODUCTION

Parkinson's disease is the second Neuro degenerative disorder developing between the age group of 55 to 65 years (Rizek *et al.*, 2016). The prevalence of Parkinson's disease among the population aged ≥45 years is 572 /100,000. In the US the prevalence is estimated 680,000 aged ≥45 years with PD in 2010. By 2020 the number will rise to approximately 930,000 and 1,238,000 in 2030 based on the US Census Bureau population projections (Marras *et al.*, 2018). The prevalence is higher among men than women, with a ratio of 1.5 to 1.0 (Lau *et al.*, 2004). The prevalence rate over the age of 60 years was 247/100,000.] A low prevalence rate of 27/100,000 was reported from Bangalore, in the southern part of India, and 16.1/100,000 from rural Bengal, in the eastern part of India. There is a high prevalence rate of 328.3/100,000 among a population of 14,010 Parsis living in colonies in Mumbai, Western India (Radhakrishnan and Goyal, 2018).

The steady progressive loss of postural reflexes in patients with PD, leads to gait and balance impairments.7% of people suffer with early disease and 60% of people with advanced disease, leading to impairment of quality of life, mobility, and independence (Chen *et al.*, 2013). The slow, short stepped, shuffling, forward-stooped gait with asymmetrical arm swing varies according to the timing of assessment in the PD medication cycle are a hallmark of the Parkinson's disease. The rehabilitation management of gait disorders in people with PD has 3 key elements as strategy training second is the management of secondary sequelae affecting the musculoskeletal and cardiorespiratory systems that occur as a result of dysfunctional conditioning and the third to be promote the physical activities (Morris *et al.*, 2010).

The basal ganglia are implicated in two major roles one is an execution of automatic, well-learned movements by their interaction with supplementary motor area. The first role is the internal cue triggering movement sequences which is carried out without attention during motor sequelae, basal ganglia inhibits the thalamus which projects the supplementary motor area triggering the release and completion of the forthcoming sequence. This results in a well-learned movement sequence to be internally regulated and automated (Lewis, 2000).

The second role in contributing to the cortical motor set allows the basal ganglia in the preparation and maintenance of motor plans. Deregulated basal ganglion triggers deficiencies in stride length. While lowered gait speed are due to bradykinesia and not to the disease and cadence may often elevate in relation to velocity.

Strategy training evidence was first provided with Morris and colleagues, which as assist people with longer steps at a more normal cadence. The trials suggested external cues enabled people to walk faster and compensate the movement disorder as hypokinesia (Morris, 2000). Cueing is defines as the temporal and spatial stimuli, which facilitates gait initiation and continuation. These external cueing bypass the dysfunctional movement pathways due to disrupted internal cueing mechanism. The external cueing can be applied by different modalities as visual, auditory and combination of the both (Morris, 2006)

Growing evidence have implicated towards learning of new motor skills in early stages of PD (Spaulding *et al.*, 2013). Thus, the purpose of this study is to report the effectiveness of Audio-visual cues that are applied individually in improving the abnormal kinematic gait parameters of the patients with Parkinson's disease.

MATERIALS AND METHODS

A Quasi-experimental study was conducted in a Rehabilitation center and in a Home-based set-up with 30 subjects who had been referred to the physiotherapy department. Sampling was done with convenient sampling technique. Eligibility criteria included patients who were clinically diagnosed as Parkinson's disease in Stage I to III according to the Hoehn Yahr scale, age group of 45 to 65 years of male and female who were undergoing anti-Parkinson's drug therapy and subjects who were able to walk a short distance without assistive device were included. Whereas unstable vital signs, Parkinson's plus syndromes, auditory and visual disability, and other neurological conditions were excluded. Outcome measure as 10 meter walk test was used.

Procedure

An informed consent was taken from 30 subjects who were assigned to their respective groups as visual (n=10), auditory (n=10) and the combination of these two as an audiovisual group (n=10). The subjects prior to the treatment session were assessed for their walking ability using the 10 meter walk test, and the pre-test score were recorded after this the subjects in the respective groups were given the external cueing technique for 4 days a week for 4 weeks, each session to be performed for 30 minutes. After the session, the subjects were evaluated for their walking ability, and the values were recorded as the post-test values. The treatment protocol lasted approximately 30 minutes during which the Parkinson's disease groups were on the phase of the medication cycle (1 hour after medication intake).

Cueing Types

Auditory Cueing

Auditory Cueing were external rhythm (click tone) given at a fixed frequency of 100 click/min.

Visual Cueing

The 10 meter walkway was made of white parallel lines of 2.5 centimeters width and transverse lines that were spaced at 45 centimeters away distance on which the patients were made to walk.

Audio-Visual

The patients were asked to walk with a verbal and auditory command to sequence the gait components along with the white lines drawn on the floor leading to dynamic visual stimuli that may improve motor performance.

Statistical analysis

Age and gender were the independent variables and the performance on the 10 meter walk test measuring the kinematic gait variables as the cadence, stride length and gait velocity was the outcome measure or the dependent variable for this study. Statistical package of the SPSS version 11.5 was used for Data analysis. The tools used are done using paired (dependent) t-test.

Table 1 shows the results of gait velocity, a component of ten-meter walk test values in auditory group single task pre-test to post-test were 0.406 to 0.458. In a visual group, single task pre-test to post-test

Table 1: Comparison between pre-test and post of externalcue training in gait velocity

Group	Tasks	Pre test		Post test		t test	Significance
		Mean	SD	Mean	SD		P < 0.05
Auditory	Single	0.406	0.33	0.458	0.032	8.310	0.000
Visual	Single	0.388	0.026	0.456	0.041	8.276	0.000
Audio-visual	Single	0.404	0.032	0.725	0.079	13.85	0.000

Table 2: Comparison between pre-test and post of external cue training in stride length

Group	Tasks	Pre test		Post test		T test	Significance
		Mean	SD	Mean	SD		P < 0.05
Auditory	Single	71.5	6.05	73.2	4.68	2.762	0.020
Visual	Single	57	5.92	58.3	6.21	2.177	0.057
Audio-visual	Single	60.2	4.80	69.3	5.18	6.643	0.000

Table 3: Comparison between pre-test and post of external cue training in cadence

Group	Tasks	Pre test		Post test		T test	Significance
		Mean	SD	Mean	SD		
Auditory	Single	111.1	8.45	108.8	7.85	2.570	0.030
Visual	Single	112.7	12.04	110.8	12.50	1.013	0.338
Audio-visual	Single	113.8	11.48	97.6	4.02	8.389	0.000

were 0.388 to 0.456, whereas for audiovisual group single task pre-test to post-test were 0.404 to 0.725.

Table 2 results of stride length, a component of ten-meter walk test values in auditory group single task pre-test to post-test were 71.5 to 73.2. In a visual group, single task pre-test to post-test were 57 to 58.3, whereas for audiovisual group single task pre-test to post-test were 60.2 to 69.3.

Table 3 shows the results of cadence, a component of ten-meter walk test values in auditory group single task pre-test to post-test were 111.1 to 108.8. In a visual group, single task pre-test to post-test were 112.7 to 110.8, whereas for audiovisual group single task pre-test to post-test were 113.8 to 97.6.

The findings of this study show that both auditory and visual forms of cueing are effective in improving important kinematic gait parameters in Parkinson's Disease. (Spaulding *et al.*, 2013). In their study had shown that the strategy training involving the combination of audiovisual cueing improved the cadence among the gait parameters, which shows and increase in cadence when used the combination of audiovisual cueing. The results in this study also point towards the difference between auditory and visual cueing. Although the audio visual showed significant improvement in all the three gait parameters as cadence (Table 1) stride length (Table 2) and gait velocity (Table 3) auditory cues also showed positive improvement in all the three parameters.

Nieuwboer *et al.* (2007). In his study done suggested that the auditory cueing improved the gait parameters, which supports the results of this study of improved gait velocity, stride length and cadence using auditory cueing. The improved gait velocity is showed to be the most positive outcome of the gait rehabilitation where the individuals with Parkinson's disease have greater mobility, increased independence and improved quality of life.

Peterson and Smulders (2015), In their study explained the importance of auditory cueing in the clinic, used to improve consistency and rhythmicity of steps. In individuals with PD who freeze, visual and auditory cues can be used in a transient manner to break freezing events, which support this study of using external cueing techniques in gait training among individuals with Parkinson's disease.

In Parkinson's disease group dynamic visual perception and cognitive strategies are required predominantly when the patients are walking which was been proposed by (Azulay *et al.*, 1999). External stimuli uses the cerebellum as an alternative pathway to by pass the basal ganglia was confirmed by (Bostan *et al.*, 2010).

However, the lateral premotor system involved in externally triggered movements seems to be functioning in Parkinson's disease, as suggested in the study by (Jahanshahi *et al.*, 1995). This cortical zone receives its input from the parietal cortex and the cerebellum as proposed by Goldman-Rakic (2011). Thus external stimulation works as a trigger, operating through the intact lateral premotor system, was explained by (Fernández-Del-Olmo and Mazaira, 2003). Studies were done to evaluate the effect of external cues (Auditory and Visual) on walking during a motor task in home-based set up of people with Parkinson's disease. The results showed improved gait performance, and this supports the results of the Audio-visual group improved significantly where p-value was less than 0.05 (Tables 1, 2 and 3).

The frequency and duration of the treatment of 4 weeks is performed. It contributes to the significant changes made in the kinematic gait variables following external cueing techniques during single and dual motor task; it is supported by a study on the effect of long term gait training using visual cues (Sidaway *et al.*, 2006).

Hence the data from the results (Tables 1, 2 and 3) showed a more rhythmic gait performance due to external cueing using the combination of audio and visual as a training strategy, thus bypassing the disruptive internal cueing mechanism and cues are able to access rhythmic mechanisms also in the absence of dopaminergic stimulation. There have been limited studies showing the combined effects of audio visual cueing on the gait performance.

CONCLUSION

Thus the study showed there is a significant improvement in the gait parameters as gait velocity, stride length and cadence. The pronounced improvement in gait velocity has shown to be a remarkable marker in gait rehabilitation, thus leading to a greater level of mobility and independence, leading to a better quality of life. Gait abnormalities which worsen as the disease progress it is suggested to include gait training strategies in the initial stages of the disease diagnosis. This study suggests the purposeful usage of the cueing techniques carefully by effectively evaluating the gait abnormalities, thus showing a marked improvement in those disturbed parameters. The limitations of this study was no long term follow up of the effects of cueing on the gait parameters were done; a larger sample could have been used. The study further suggests the possibility and future investigations are needed to verify its impact and feasibility.

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