Research Article

Efficacy of External Cueing on Kinematic Gait Parameters During a Dual Motor Task in Parkinson's Disease

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ABSTRACT

Dual task walking deficits, impact functional mobility, increases disability, increases risk of fall and leads to decreased quality of life. However the therapeutic intervention in dual task walking has been limited and there is uncertainty about whether clinicians should teach people with Parkinson's disease to avoid dual tasking or whether they should encourage them to practice dual tasking. 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 and also to investigate the interference of dual task on the walking performance whereby improving the attention of the dual motor task while walking. A quasi experimental study was conducted in a home and rehabilitation setup. A convenient sampling of 30 subjects who fulfilled the inclusion criteria, were randomly assigned into three groups where the groups will receive auditory, visual and audio-visual cueing respectively and each group will undergo single and dual task. Initially, baseline values were taken and after the 4 weeks session post test values were recorded with a 10 meter walk test. This study will examine the role of Audio-Visual cueing that is the combination strategy which helps in the improvement of the kinematic gait variables and also a significant reduction of the interference of the dual task. The improvements shown in the values from pre test to post test, explains the suspected role of cerebellar pathway as an alternative motor pathway. Thus reflecting the need for including dual task walking with the hope to lead an enhanced quality of life and to reduce the amount of disability.

Keywords: Cueing, dual task, kinematic gait, parkinson's disease.

INTRODUCTION

Parkinson's disease is a progressive neurological disorder due to gradual degeneration of the gray matter within the pars compacta of basal ganglia, resulting in a declining production of the neurotransmitter dopamine by the substantia nigra.[1-3] People with Parkinson's disease typically have hypokinesia, resting tremor, episodes of freezing and stooped posture. With disease progression gait is affected, the characteristic shuffling pattern results in abnormal cadence, stride length and gait velocity.[1,4]

In India the prevalence of Parkinson's disease is approximately 13 to 33% of patients. They present with gait disturbances as their initial motor symptoms[3] and also there were 93% of patients with Parkinson's disease having disturbed gait among the hospitalized neurological patients.[5,6]

Among the kinematic gait variables Parkinson's disease patients exhibit shortened stride length, decreased speed and increased cadence as per the stage of classification by Hoehn and Yahr scale from I to III.[7] The basal ganglia are implicated in two main roles in the control of automatic, well learned movements, primarily through their interaction with supplementary motor area. The second role is its contribution to cortical motor set. Although dysfunctions in both of these roles of basal ganglia have been implicated in stride length deficiencies in Parkinson's disease. While a lowered gait speed is due to bradykinesia and is not intrinsic to the disease.

The cadence may be often elevated in relation to the patient's velocity.[8]

Dual task performance or concurrent performance involves execution of a primary and secondary task at the same time, this dual task interference is particularly noticeable problem of the disruptions of motor functions of basal ganglia.[9-11]

The Parkinson's disease patients show marked deterioration in the kinematic gait variables such as gait speed and stride length walk along with a complex visuomotor task involving the upper limbs.[12,13]

Cueing is defined as temporal or spatial stimuli to facilitate gait initiation and continuation which serve to bypass the dysfunctional movement pathways due to the disrupted internal cueing mechanism in basal ganglia.[14]

External cueing can be delivered using different modalities as visual, auditory and somatosensory.[15]

Aim of the Study

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 and also to investigate the interference of dual task on the walking performance whereby improving the attention of the dual motor task while walking.

Objective of the Study

1) Use this external cueing technique in improving the disturbed kinematic gait parameters.

2) To reduce the interference effect of the dual task during the gait.

MATERIALS AND METHODS

A Quasi experimental study was conducted in a Rehabilitation center and also in a Home based set-up with 30 subjects who were been referred to the physiotherapy department. A Convenient sampling technique is adapted. Eligibility criteria included patients who are 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 are undergoing anti-Parkinson's drug therapy and subjects who were able to walk short distance without assistive device were included.[2,17-20] Whereas unstable vital signs, Parkinson's plus syndromes, auditory and visual disability, other musculoskeletal conditions involving gait problems and other neurological conditions[8,21-24] where excluded. Outcome measure[14,25] 10 meter walk test was been used.

Procedure[1,15,26-32]

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 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 medication cycle (1 hour after medication intake). The participants in each group walked under two different conditions as:

Single task: (walking alone)

Dual task: (walking and carrying a tray on which there were two cups of water). This task was chosen to reflect a functionally ecological valid activity.

Cueing Types

Auditory Cueing

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

Visual Cueing

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

AudioVisual

The patients are asked to walk with 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. The dual task of carrying the tray is seen in the mirror by the patients.

The outcome measures which were taken at the end of 4th week are done without the external cues. In this test the patient covers a distance between two lines, which are at a comfortable pace. The patient begins this test 5 meters before the first line and stops 5 meters after the second line. Time is recorded from the moment that the patient crosses the first line with one foot to the moment that the patient crosses the second line with the other foot. The test is repeated three times, after which the average pace (distance/number of seconds) and the average number of steps of the three walking tests will be determined.

Statistical Analysis

Age and gender were the independent variable 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: Comparison Between Pre Test and Post of External Cue Training In Gait Velocity

Group	Tasks	Pre Test		Post Test		t Test	Significance
		Mean	SD	Mean	SD		P < 0.05
Auditory	Single	0.408	0.33	0.451	0.032	8.310	0.000
	Dual	0.363	0.027	0.399	0.022	6.194	0.000
Visual	Single	0.389	0.026	0.450	0.041	8.276	0.000
	Dual	0.350	0.014	0.395	0.021	8.293	0.000
Audio-Visual	Single	0.407	0.032	0.726	0.079	13.85	0.000
	Dual	0.343	0.023	0.431	0.032	10.46	0.000

The above table 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 0.408 to 0.451, for dual task it was 0.363 to 0.399. In visual group single task pre test to post test were 0.389 to 0.450, for dual task it was 0.350 to 0.395 whereas for audiovisual group single task pre test to post test were 0.407 to 0.726, for dual task it 0.343 to 0.431.

Table 2: Comparision 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
	Dual	68.4	6.99	69.2	5.43	1.037	0.327
Visual	Single	57	5.92	58.3	6.21	2.177	0.057
	Dual	53.6	5.79	55.6	5.77	6.708	0.000
Audio-Visual	Single	60.2	4.80	69.3	5.18	6.643	0.000
	Dual	56.8	4.21	64.5	3.95	10.120	0.000

The above table shows the 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, for dual task it was 68.4 to 69.2. In visual group single task pre test to post test were 57 to 58.3, for dual task it was 53.6 to 55.6 whereas for audiovisual group single task pre test to post test were 60.2 to 69.3, for dual task it 56.8 to 64.5.

Table 3: Comparision Between Pre Test and Post of External Cue Training in Cadence.

Group	Tasks	Pre Test		Post Test		T Test	Significance
		Mean	SD	Mean	SD		P < 0.05
Auditory	Single	111.1	8.45	108.8	7.85	2.570	0.030
	Dual	107	7.52	105	7.84	1.285	0.231
Visual	Single	112.7	12.04	110.8	12.50	1.013	0.338
	Dual	109.2	11.13	108.1	10.57	1.019	0.335
Audio-Visual	Single	113.8	11.48	97.6	4.02	8.389	0.000
	Dual	109.3	11.47	101.3	9.78	4.068	0.003

The above table 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, for dual task it was 107to 105. In visual group single task pre test to post test were 112.7 to 110.8, for dual task it was 109.2 to 108.1 whereas for audiovisual group single task pre test to post test were 113.8 to 97.6, for dual task it 109.3 to 101.3.

The data is described as the mean values of each trial type. In addition to it also calculated the interference effect on gait of a dual task. This was expressed as the mean percentage difference between single and dual tasks for each trial type.

Dual task – single task **/**single (pre test) **x** 100

Table 4: Interference of Dual Motor Task in Gait Velocity

Group	Pre Test		Post Test		T Test	Significance
	Mean	SD	Mean	SD		P< 0.05
Auditory	-10.923	3.760	-12.596	4.448	1.706	0.122
Visual	-9.812	4.494	-13.828	7.478	1.940	0.084
Audio-Visual	-15.563	4.427	-72.531	19.520	9.583	0.000

From above, the results can be inferred as, interference in gait velocity, values in auditory group pre test to post test were -10.92 to -12.59. In visual group pre test to post test were -9.81 to -13.82, whereas for audiovisual group pre test to post test were-15.56 to -72.53.

Table 5: Interference of Dual Motor Task in Stride Length

Groups	Pre Test		Post Test		T Test	Significance
	Mean	SD	Mean	SD		P < 0.05
Auditory	-4.459	2.58	-5.706	3.187	1.296	0.227
Visual	-5.914	3.718	-4.676	3.434	1.003	0.342
Audio-Visual	-5.594	1.852	-7.948	8.558	2.20	0.050

From the above, the results can be inferred as, interference in stride length, values in auditory group pre test to post test were-4.45 to -5.70. In visual group pre test to post test were -5.91 to -4.67 whereas for audiovisual group pre test to post test were-5.59 to -7.94.

Table 6: Interference of Dual Motor Task in Cadence

Groups	Pre Test		Post Test		T Test	Significance
	Mean	SD	Mean	SD		P < 0.05
Auditory	-3.642	1.526	-2.786	2.710	-1.091	0.303
Visual	-3.053	1.468	-2.313	4.278	-0.531	0.608
Audio-Visual	-3.988	0.914	-3.253	5.568	-4.062	0.003

From the above the results can be inferred as, interference in cadence, values in auditory group pre test to post test were -3.64 to -2.78. In visual group pre test to post test were-3.05 to -2.31, whereas for audiovisual group pre test to post test were -3.98 to -5.23.

DISCUSSION

The results of the data obtained from 30 Parkinson's disease subjects who were divided into 3 groups as Auditory group, Visual group and the Audio-visual group of the local population, showed respective significant difference in the performance of kinematic gait variables of cadence, gait velocity and stride length in the 10 meter walk test. There was an increase in the performance of the kinematic variables and also reduction of interference of the dual motor task while walking in the 10 meter walk test after training with the combination of the Audio-visual cues.

In Parkinson's disease group dynamic visual perception and cognitive strategies are required predominantly when the patients are walking which was been proposed by Jean – Philippe Azulay and Anrea L Behrman. External stimuli employ different pathways, where the cerebellum may be used in idiopathic Parkinson's disease to compensate for the basal ganglia pathways as an alternative motor pathway, was confirmed by Rasol in another motor task.

The auditory cues can be verbal instructions or a metronome beat and they are the strategies that deliberate attention to specific elements of normal walking that bypass the basal ganglia circuitry and activate the frontal and pre frontal areas of brain to prepare the motor cortex for locomotion Morris. Frenandez Del Olmo in a study using the auditory stimuli showed improvement in movement of Parkinson's disease. There is some evidence in the literature that rhythmic sound patterns can increase the excitability of the spinal motor neurons via the reticulospinal pathway reducing the time required for the muscle to respond to a given motor command by Paltsev and Elner.

The information concerning the motion of white strips while walking on a ten meter walkway which is made up of white parallel lines interspaced with the transverse lines, may use a specific visuomotor pathway, relaying through the cerebellum and thus by passing the damaged basal ganglia, this was been hypothesized by Glickstein and Steinb. A study done by Jean – Philippe Azulay have concluded in their study that the visual control of locomotion in Parkinson's disease as they found the overall significant effects of the stripes in Parkinson's disease group on the stride length as on the velocity. Thus the auditory group improved but not so much as compared to audio-visual group.

However the lateral premotor system involved in externally triggered movements seems not to be impaired in Parkinson's disease as proposed by Jahanshahi. This cortical zone, center receives its main input from the parietal cortex and the cerebellum Golberg.

Thus it is suggested that external stimulation works as a trigger, operating through the intact lateral pre motor system, which is able to overcome the motor programme deficits due to SMA malfunctioning, was in detailed explained by Fernandez del olmo. A study was done to evaluate the effect of external rhythmic cues (Auditory and Visual) on walking during a functional task in homes of people with Parkinson's disease where these external cues reduced the interference effect and maintained gait performance. Which is supporting the results that the Audio-visual group improved significantly where, p value was less than 0.05.

A range of secondary tasks have been used in a dual- task that includes secondary cognitive or motor tasks. The dual motor task choose in this study was both functional and familiar to the participants and thus had a greater ecologic validity as suggested by Katherine Baker. So interference in gait occurs when the central nervous systems processing mechanisms were being challenged whereas the gait is to be controlled by impaired basal ganglia thus reduction in stride length and gait velocity occurs. There is a critical level of task complexity that must be met for interference to occur, which was shown in the study done by Ms O' Shea.

From the above results it can be stated that the Audio-Visual group that is the combination group strategy, helps in reduction of the interference of the dual task which is significant at 95% level with the p value less than 0.05%. Thus from the base line values of the dual motor task in each of the cueing group compared to the single task baseline values we can see the critical task complexity and the interference occurrence and the improvements in the values from pre test to post test which explains the suspected role of cerebellar pathway as an alternative motor pathway that was confirmed by Rascol in another motor task.

The frequency and duration of the treatment of 4 weeks which is performed contributed to the significant changes made in the kinematic gait variables following external cueing techniques during single and dual motor task which is supported by a study on the effect of long term gait training using visual cues by Ben Sidaway.

The interference effect which was to be the problem in the Parkinson's disease patient the external cueing training with the combination of the audio visual cues have also been showed to reduce significantly thus explaining the concept of using the cues in training the patients walking with and without a dual task training provides a beneficial effect in improving the quality of life in Parkinson's disease. The following are recommended for longer study duration which can be done to find out the persistence of changes produced due to Audio-visual cueing in patients with Parkinson's disease. A more complex task would have been made it possible to fully evaluate the cost of cueing strategies.

CONCLUSION

From this study it shows that the external Auditory and visual cueing combination improves the kinematic gait variables as cadence, gait velocity and stride length and also reduces the interference effect of the dual motor tasks during the gait activity in people with Parkinson's disease patients, thus improving the attention while carrying out the dual motor task during the gait activity. From the statistical *analysis* a highly significant difference between the pre test and post test were seen after applying the combined external cues on the kinematic gait variables in Parkinson's disease during single and dual task and a significant improvement in the attention during dual task was reported.

Hence, it can be concluded that the combined audio-visual external cues enhances the altered kinematic gait variables and also attention on dual task. Limitations for the study are difficulties in using the 10 meter walk way as many houses could not provide the 10 meter space and open space was been chosen outside the house.

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