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Fine Motor Skills in Patients with Parkinsons Disease: Effect of Auditory Cueing

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Abstract

Background and purpose - Parkinson's diseasewith cardinal feature of bradykinesia is a movement disorder. The effect of cueing in disorders like parkinsons patients ,stroke, spinal cord injury for improving motor skills and gait and lower limb functions have long been investigated by the Researchers, but there are dearth of studies evaluating the effect of cueing on fine motor skills in patients with parkinson's disease. Hence this study tries to investigate the effect of auditory cueing on fine motor skills in Parkinson's disease.**Methodology** - 25 diagnosed Parkinson's patients having primary level of education, with mean age 72±5 yrs in Hoehn and Yahr stages 1 to 3 of disease and MMSE score above 24 were included in the study. Two groups were formed; one group performing activities with auditory cueing and other group performing activities without auditory cueing. Scores were calculated using Jebsen Taylor Hand Function Test.**Results** - Mean values of pre and post intervention timings on Jebsen Taylor Hand Function Test werecalculated. Group with auditory cueing showed improvement in total sores of subtests of Jebsen Taylor Hand Function Test with mean and standard deviation (58.51±2.69) seconds in dominant hand and (54.59±2.43) seconds in non-dominant hand, whereas, Group without auditory cueing showed improvement in total sores of subtests of Jebsen Taylor Hand Function Test with mean and standard deviation of (13.39±2.07) seconds in dominant hand and (13.52±1.96) seconds in non-dominant hand.**Conclusion**- Auditory cueing is proved to be an effective method in improving fine motor skillsin patients with Parkinsons disease.

Key Words- 1. Parkinson's disease 2. fine motor skills 3. auditory cue 4. Cueing 5. hand function.

Introduction

Parkinson's disease (PD), is resultant of loss / reduction of dopamine producingneurons of the basal ganglialeading to a progressive neurodegenerative disorder. Patients present with difficulty in initiation as

well as performing well-timed movements. Cardinal features of the disorder include"resting tremor, rigidity ,bradykinesia, and postural instability".[1]
The motor activities are underscaled leading to slowness in performing sequential tasks of feeding, personal care and dressing. It is hypothesized to result from defective "reflex-gain mechanisms" resulting in rigidity. The patient experience increased time taken to lift objects, principallylight load. The speed of reaching and grasping a moving object is maintained at near usual speed ,in contrast to reaching stationary target. It may be that moving object triggers lower-level brainstem or spinal reflex responses while bypassing the defective Basal Ganglia .[2]
Inability to perform tasks such as dressing, fastening buttons, or getting arms into sleeves is worsened by the presence of bradykinesia and akinesia. Impact is greater in tasks such as brushing teeth, shaving, or other repetitive movements if the dominant hand is more affected.[1]The changes in the rhythmic movement of motor performance arealso observed alonwith bradykinesia and hypometria. Precision in reaching a stationary target is attributed to timing - the crucial aspect of any movement . The deficits in the regulation of time parameters was observed by Stelmach and Worringtonas a key feature in patients of PD in addition to changes in the force production.[3]The motor deficits leads to impairments in activities of daily living including dressing and eating thus limiting the independence with poor quality of life.
Various exercise regimes has been looked into to improve the symptoms of the Parkinson's patient. Some exercise programs advocate the application of rhythmic cues in the treatment protocol. Cueing is defined as "using external temporal or spatial stimuli to facilitate movement (gait) initiation and continuation."Recent researchessuggestthe encouraging effects of cueing on gait parameters of Parkinson's patients .But the generalization of positive effects of cueing to improve "Activities of Daily living"of Parkinson's Patients in their own home setting is still to be identified.[4]

In participants with a neurological disorder, such as stroke or PD, the additional rhythm can improve motor control and timing. The immediate effects of rhythm on a simple upper extremity movement have been studied in post-stroke patients. An external cue of a metronome provides a template for when to begin the movement, an end point for the movement, as well as guidance for the whole trajectory of the movement . [5] The auditory cue can attract the motor system to entrain immediately .Ma Trombly, Tickle-Degnen, and Wagenaar found that a single, auditory cue of a bell immediately improved a movement.
According to Marsden, Parkinson's patients find it difficult to execute automatic learned motor plans but can complete simple motor programs. This in turn leads to inability to propagate sequential motor actions due topoor initiation of movement alongwith slowness in finishing. Visual and auditory cues can act as triggers to assist initiation and maintain tempo of movement. Visual cues can range from observing and following movement's of fellow group member or restructuring the movements by seeing the self in mirror to follow the therapist's movements. Auditory cues utilizeseither a metronome to regular rhythmic music or verbal instructionsand reinforcement from the therapist.[6]
The present research aims to provide justification for the use of cueing for physical therapists and occupational therapists who work in the rehabilitation of Parkinson's patients. Depending upon the outcome of the study as assessed by Jebsen Taylor Hand Function Test in which time taken to complete each of the tasks isrecorded during test administration, therapists will be able to use external cue alone, to improve timing of hand movements.[7]
The objective of present study is to evaluate the effect of cueing training on the hand functions, in Parkinson's patients when monitored in their own residenceatmosphere.

Method

Subjects

Pre test-post test study was conducted A total of 45 subjects sampled according to convenient sampling were included in the "on Phase " of Parkinson's Disease according to Hoehn and Yahr scale, stages of disability (1 to 3).The PD patients having age more than 45 years of age with MMSE score above or equal to 24, Independent sitting upto 10 minutes and primary level of education and exhibiting the ability to perform upper limb homework task including reaching, grasping and manipulation were invited to be part of the study. Patients with history of fractures of upper limb within past 6 months, visual or auditory disturbance, upper limb deformity, patients with Deep Brain Stimulation were excluded from the study.

Procedure

A detailed assessment of each subject was done according to an assessment Performa. Prior to intervention, all procedures were explained to the subjects.

Pilot Study

A pilot study was conducted on 5 patients to see the effect of auditory cueing and the reliability was calculated using the cronbach's alpha with good reliability of 0.08. The subjects were made to perform the chosen activities at their preferred frequency and which was adjusted weekly.

Intervention

Subjects were randomly allocated to either of Two Groups: Group A -peforming activities with auditory cue (metronome beats) or Group B- without auditory cue .During the experiment, the subjects sat comfortably on chair with their elbows and forearm resting on the table in front of them. The experimental task consisted of five activities including, 1. Buttoning with buttons of different sizes , 2. Pouring water from onepolystyrene cup to another, 3. Picking up 5 rice grains between thumb and forefinger and placing it in a bowl, 4. Folding paper and keeping it in envelope and 5. Opening and closing a jar with contents inside.
Subjects of Group A were instructed " Start the movement when you hear the the beat." Whereas for Group B subjects as there were no metronome beats they were instructed to "start the movement when you are ready." No stress was laid on the pace of movement. The participants performed repetitions of each and every activity according to their preferred frequency for five days in a week for three weeks. Every week number of repetitions for activities was increased according to the comfort of the individual patient. The training session lasted for about 25- 45 minutes including the rest period of about 2-3 minutes in between the training session as required by the patient.

Statistical analysis

The Mean and standard deviation of demographic details of the subjects (age, MMSE score) and each sub component of Jebsen Taylor Hand function test was calculated in the both the groups. Independent t-test to compare dependent variables between two groups and Paired t-test to compare dependent variables within the group was calculated. Data analysis was done using Stastical Package for Social Science (SPSS), Windows Version 17.0. In this study p value <0.05 has been considered significant.

Result

Table 1. Comparison of characteristic of patients between 2 groups

	Group A Mean±SD	Group B Mean±SD	t value	p value
Age	70.42 ± 6.84	69.25 ± 5.71	0.45	0.66 NS
MMSE	26.92 ± 1.51	27.08 ± 1.08	0.31	0.75NS

Table 2. Comparison of pre post difference time taken in subtets of Jebsen Taylor Hand Function Test between two groups for dominant hand

S.No.	Subtests of Jebsen Taylor Hand Function Test	Mean ± SD (sec) Group A	Group B	t value	p value
1	Writing	8.64±4.06	2.42±3.11	4.32	.00*
2	Simulated page turning	3.04±1.99	2.92±2.39	.13	.90 NS
3	Lifting small common objects	2.48±1.42	1.64±0.65	1.93	.07 NS
4	Simulated feeding	4.16±3.01	2.09±1.39	2.32	.04*
5	Stacking checkers	1.68±1.27	1.56±1.64	.19	.85 NS
6	Lifting light cans	2.88±2.40	1.20±1.50	2.12	.05*
7	Lifting heavy cans	1.48±1.03	2.11±2.28	-.88	.39 NS

Table 3. Comparison of pre post difference time taken in subtests of Jebsen Taylor Hand Function Test between two groups for non-dominant hand

S.No.	Subtests of Jebsen Taylor Hand Function Test	Mean ± SD (sec) Group A	Group B	t value	p value
1	Writing	6.40±4.37	3.73±3.68	1.67	.11 NS
2	Simulated page turning	2.78±1.53	2.23±1.51	.91	.37 NS
3	Lifting small common objects	1.94±3.61	0.89±2.33	.87	.39 NS
4	Simulated feeding	6.14±3.72	2.34±1.92	3.25	.00*
5	Stacking checkers	1.48±0.42	1.71±1.40	-.55	.59 NS
6	Lifting light cans	2.25±0.98	1.25±1.24	2.22	.04*
7	Lifting heavy cans	1.89±1.15	1.12±0.93	1.86	.08 NS

Discussion

Parkinson's Disease have an effect on upper limb movement impairing the ability to reach ,grasp and individual finger control. Although dopamine replacement medication results in improvement in reaching but has limitedcontrol on grasp or fine finger movements.[8,9]

The purpose of the study was to test the hypothesis that auditory cueing will be effective in improving fine motor skills in Parkinson patients as evaluated by Jebsen Taylor Hand Function Test. The study compared the use of external auditory cue given with activities and the activities performed without cueing condition. Twenty seven subjects participated in the study, however only twenty five participants completed the study and the data was analysed. Data was analyzed to determine the impact of external cueing on movement timing for hand activities.

The results of the study revealed considerable improvement in performance timings for both dominant as well as non-dominant hand in both the groups. But the improvement for Group A timing was more as compared to the Group B timing.

Ringenbach et al,observed improvement in timing, scaling and synchronization with auditory pacing during a drawing task and Robert C et al also supported his findings. They observed that even a single auditory cue exaggerated movement kinematics in sequential movements of upper extremity activities of patients. [10,11]Nieuwboer A et al further found that scaling and timing of the activities can be improved. It can be translated to augmentedpurposeful performance after guidance period.[4] Thus according to the available evidence it has been noted that external cues superimposed with instruction can recover movement and speed of hand functions but they do not entirelyeradicate bradykinesia in Parkinson's Patients.

Valarie et al, 2002 commented "levodopa improves the speed of movements in individuals with PD but it may not fully restore movements to normal". Although levodopa has found to improve non-cued and precise reaches to a much greater extent than cued and fast reaches.[12,13] Similarly in the present study the improvement in timing of hand functions for both dominant and non-dominant hand has improved significantly. The implication could be due to combined effects of levodopa and external cueing as patients in both the groups practiced the task activities in on-phase medication.
Wegen E et al in 2005 proposed the neurophysiological basis for the use of sensory reminder as an competent therapy tool in Parkinsons disease. The cues bypasses the incompetent straitofrontal system in support of cerebello-parietal-premotor pathways. So. it help the patients to compensate for their movement generation deficit.[14]
Patients with PD have a disturbed functioning of the basal ganglia-thalamo-cortical circuit, causing specific difficulties in self-driven behavior, such as slowness of movement and loss of movement amplitude. Providing them with peripheral cues can overcome these troubles.Cueing activates the lateral system, together with the premotor and parietal cortex and the cerebellum, and as such bypasses the deficient medial system, including the basal ganglia.[14,15]
The benefit of auditory cue ia also related to the "modality appropriateness hypothesis" (Welch et al, 1986), which suggests that "timing tasks benefitfrom auditory information." Auditory cues allows kinesthetic focus which is thought to increase brain activation in PD patients (Lim et al,2006).

In the present study the major changes in timing and performance was seen in writing, simulated feeding and lifting light can subtest of Jebsen Taylor Hand Function. Writing as well as feeding are automatic skills. It does not requirecommon subjects to pay concern to the amplitude of the requisite of movements. Whereas, PD patients whilewriting routinely fall short to reach normal amplitude. Their presentation is aided by external cues that detail the particular amplitude. Oliveira et al,1997 also demonstrated improvement in micrographia in the existence of both visual as well as auditory cues. The external cues were also effective in improving the speed of initiation of movement in Parkinson's patients. [16] Ondo and Satija,2007, also found better peformance of handwriting in subjects when they performed the handwriting task with eyes closed. [16]
On the basis of the available evidences and the findings of the current study it can be concluded that auditory cue is beneficial for improving the timing for hand activities over dominant and non dominant hand. The benefit is also observed in irradiation and carry over effect of one activity over the other in Parkinsons patients.

Conclusion

Study suggests that supplementation of auditory cue in training of fine motor skills leads to appreciably potential and durable functional gains. Various activities includingsimulated feeding , lifting light weighted cans and writingexhibited considerable improvement in both dominant and non-dominant hand. The intervention being not complex can be easily carried out in home settings. Although there is

still a dilemma in precise determination ofmost efficient parameters of training. Aprospective goal to systematicallyestablish the most efficient and patient friendly protocol for each user can be planned. We can only contemplate that activities performed in the presence of auditory cue are more useful than the activities performed without auditory cue.

References

1. Nicholas F. Movement Disorders. In: Michael D. Brain's Diseases of NervousSystem.12th ed. Pg(1233-1323).
2. Meg E Morris. Movement Disorders in people with Parkinson's disease: A Model forPhysical Therapy. Phys Ther. 2000; 80:578-597.
3. Fernandez et al. Evaluation of the effect of training using auditory stimulation onrhythmic movement in Parkinsonian patients- a combined motor and (^{18} F)- FDG PET study. Parkinsonism and Related Disorders . 2006;155-164.
4. Nieuwboer, et al. Cueing training in home improves gait related mobility in Parkinson's Disease: the Rescue trial. Journal of Neurol Neurosurg Psychiatry. 2007; 78:134-140.
5. Jill Whitall,et al. Repetitive Bilateral Arm Training With Rhythmic Auditory Cueing Improves Motor Function in Chronic Hemiparetic Stroke. American Heart Association. stroke.ahajournals.org
6. P. Praamstra et al. Reliance on external cues for movement initiation in Parkinson's disease.Evidence from movement-related potential. Brain. 1988;121, pg 167-177.
7. Jebsen ,Taylor, Treischmann, Trotter and Howard. Jebsen test of hand function. Jebsen summary prepared by Occupational Therapy Program, University of Western Sydney. 2006; pg 13-16.
8. Teulings, et al.Parkinsonism Reduces Coordination of Fingers, Wrist, and Arm in Fine Motor Control, Experimental Neutology. 1997 ;146, 159-170.
9. Ponsen, et al.Bimanual coordination dysfunction in early, untreated Parkinson's disease,;Parkinsonism and Related Disorders. 2006; 12,246-252.
10. A.W.AVan G., C H Adler, G E Stelmach. Parkinson's disease patients undershoot target size in handwriting and similar tasks. J. Neurol Neurosurg Psychiatry. 2003; 74: 1502-1508.
11. Hui-Ing, et al. Effect of One Single Auditory Cue on Movement Kinematics in Patients with Parkinson's Disease. American Journal of Physical Medicine and rehabilitation.2004 ;pg 530-536.
12. Valerie E. Kelly, et al. Inteaction of Levodopa and Cues on Voluntary Reaching in Parkinson's disease. Movement Disorder. 2001; pg. 38-44.
13. Agnes Floel ,et al. Levodopa improves skilled hand functipns in the elderly. European Journal of Neuroscience.2008; pg.1301-1307.
14. Sarah V. et al. Abnormalities and Cue Dependence of Rhythmical Upper- Limb Movements In Parkinson Patients With Freezing of Gait. J. of Neurorehabilitation and Neural Repair. 2012; 26:636.
15. E Heremans, et al. External cueing improves motor imagery quality in patients with Parkinson's disease. J. of Neurorehabilitation and Neural Repair, in press.
16. Rosinda M Oliveira et al. Micrographia in Parkinson's disease: the effect of providing external cues. Journal of Neurology, Neurosurgery and Psychiatry.1997; 63:429-43