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RESEARCH ARTICLE

IMAGINARY CUES IN FREEZING OF GAIT IN PATIENTS WITH PARKINSON'S DISEASE

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ABSTRACT

Background: Freezing of gait is a disabling core feature of Parkinson's disease. Several studies have proven that implementation of visual, auditory cues have improved freezing of gait, which requires conspicuous horizontal lines, audio instrument such as metronome. ***Objective***: Our aim is to evaluate the effect of imaginary cues in freezing of gait in patients with Parkinson's disease. ***Methodology***: 22 patients who presented with freezing of gait and diagnosis consistent with Parkinson's disease were included in the study. Patients were asked to perform the 50 feet walk test. They have to walk 25 feet, turn around, and walk back 25 feet. Subjects were allowed to perform all tasks at their own speed. The parameters measured were the number of freezing episodes and the time taken to walk 50 feet. In the second part, subjects were asked to imagine themselves that they are riding a bicycle and asked to lift their legs and walk as if riding a bicycle (pedaling a bicycle) for 25 feet, turn around, and walk back 25 feet. The above mentioned parameters were measured again. The effect of test-retest variability was assessed. ***Results***: The mean time taken to walk without cues was 51.45 ± 7.84 seconds and with cues was 45.59 ± 8.51 seconds. The mean value of the number of freezing episodes while walking without cues was 2.32 ± 0.48 and with imaginary cues was 1.5 ± 0.51. There is statistically significant difference ($p<0.05$) in time taken to walk 50 feet and number of freezing episodes between before and after imaginary cues. 10 out of 22 patients showed immediate improvement in freezing of gait. Whereas six patients showed improvement on the repeated attempts. Six patients did not show any improvement. ***Conclusion***: This study reiterates the fact that such a simple measure that requires no special instruments, can improve the mobility and the quality of life in Parkinson's patients. Further studies are required to assess sensitivity/specificity.

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INTRODUCTION

Normal locomotor circuitry consists of central pattern generator in the spinal cord which receives input from the diencephalic and mesencephalic locomotor centers. The GABAergic output from the internal toglobuspallidus of basal ganglia inhibits the mesencephalic locomotor region (Takakusaki, 2008; Grillner *et al.,* 2008). This tonic inhibition gets disinhibited with the integration of sensory, motor and cognitive inputs from the cortical structures in the basal ganglia for that particular desired movement (Takakusaki, 2008; Grillner *et al.,* 2008). Freezing of Gait (FOG) is a severely disabling symptom for the patient with Parkinson's Disease (PD) and it results from the short-lived changes in the locomotor circuitry. The currently proposed definition for freezing of gait by the freezing of gait study group is "brief, episodic absence or marked reduction of forward progression of feet despite the intention to walk" (Giladi and Nieuwboer, 2008). Apart from interruption with the locomotion of the patient, freezing of gait also results in increased falls and thereby affecting the quality of life (Giladi *et al.,* 2001). In Parkinson's disease, freezing of gait is one of the significant causes of morbidity which needs to be addressed promptly (Giladi *et al.,* 2001). Even though freezing of gait is more common in the late stages of Parkinson's disease and with the increase in the duration of levodopa therapy (Macht *et al.,* 2007), it is also known to occur in the early stages and levodopa naïve patients. In addition, it also does not correlate with the cardinal features of Parkinson's disease (Giladi *et al.,* 2001; Macht *et al.,* 2007). There are various mechanisms implicated in the pathophysiology of freezing of gait, of which one needs special mention as it has been proved by physiological experiments. Normal locomotion requires proper coordination of the right and left sides which on impairment results in freezing of gait. This was proved by very simple bedside test which consists of asking the patient to make a 180 degree turn. This manoeuvre worsened freezing of gait because it is known to produce asymmetry in the stepping pattern

(Hausdorff *et al.,* 2003; Plotnik *et al.,* 2008; Chee *et al.,* 2009; Snijders *et al.,* 2008). Procedural learning and memory are dependent on the integrity of the basal ganglia. The connections involving supplementary motor area and the structures of basal ganglia are involved in automatic walking, and impairment of this pathway could be another mechanism of freezing of gait. When basal ganglia is confronted with too much information from the various cortical structure, the net inhibition on the brainstem locomotor region increases, and thereby freezing of gait appears. Hence, a goal-directed behavior helps to reset the basal ganglia output to the optimum (Hallett *et al.,* 2008). During the initiation of walking, the preparation for posture is done by the supplementary motor area and the preparation for step is done by the primary motor cortex and they get coupled at pontomedullary reticular formation for normal locomotion to occur. The basal ganglia has to work ahead of the step initiating motor programs from the motor cortices for smooth and effective initiation of gait when the above-said mechanisms are at fault, freezing of gait occurs (Schepens *et al.,* 2008; Cohen *et al.,* 2011). Freezing of gait can also be a consequence of frontal executive dysfunction as the basal ganglia has to work quickly for the appropriate motor programming when it is flooded with too much information rather than the salient ones (Lewis *et al.,* 2009). A review of literature on interventions for the management of freezing of gait has been recently published (Nonnekes *et al.,* 2015). The best example is the improvement in gait parameters with the use of external or internal cues. The automaticity of the walking is primarily basal ganglia dependent and hence internally generated resulting in impaired automatic walking in Parkinson's disease patients (Hallett, 2008; Rahman *et al.,* 2008). Whereas the external cues including the visual and auditory cues, bypasses the basal ganglia and depends on the cerebellum- dorsal premotor circuits, thereby help to improve walking (Rahman *et al.,* 2008; Snijders *et al.,* 2011). External cues also increase activity in the mesencephalic reticular formation and thereby help to compensate for the freezing (Snijders *et al.,* 2011). Marking horizontal lines on the walking surface of the patient activates the lateral premotor cortex and helps to improve freezing of gait (Hanakawa *et al.,* 1999). Attentional strategies and cueing are also equally effective in improving freezing of gait (Nieuwboer *et al.,* 2007; Nieuwboer, 2008). A limited number of studies have evaluated a simple, alternative to external cueing techniques, which can be easily concealed and adopted into routine day to day practice (Rahman *et al.,* 2008). One such technique is imaginary cueing.

During normal locomotion the primary motor area, premotor area, and supplementary motor area also gets activated (Drew *et al.,* 2004) and a direct excitatory influence on the mesencephalic locomotor neurons and thereby overcoming the inhibitory influences of the basal ganglia on mesencephalic locomotor neurons (Drew *et al.,* 2004; Jacobs *et al.,* 2007). Imaging studies have shown evidence for activation of left supplementary motor cortices during bicycling simulation and activation of pre-supplementary motor areas during imagery complex motor activities (Christensen *et al.,* 2000; Sanes *et al.,* 1994; Tyszka *et al.,* 1994; Decety, 1995; Thobois *et al.,* 2000). The Pre- supplementary motor area also helps to properly sequence and time the movement appropriately (Chen *et al.,* 1995; Tanji *et al.,* 1996; Rao *et al.,* 1993; Shima *et al.,* 1996). With these, we hypothesize that during simulation of bicycling, activation of the supplementary motor area helps to excite the mesencephalic locomotor neurons and thereby circumventing the problem of freezing of gait. Our aim is to evaluate the effect of imaginary cues in the freezing of gait in patients with Parkinson's disease.

MATERIALS AND METHODS

Patients presenting with Parkinson disease with FOG and presented to the Institute of Neurology, Madras Medical College, Chennai were recruited after informed consent. The study was conducted from February 2017 to February 2019. Freezing of gait was defined as at least a score of 2 (occasional freezing) on item 14 (freezing when walking) of the Unified Parkinson's Disease Rating Scale (UPDRS) (Fahn *et al.,* 1987). The diagnosis of PD was established and 50 feet walk test was performed in all subjects. Subjects were asked to walk 25 feet, turn around, and walk back 25 feet. Subjects were allowed to perform all tasks at their own speed. The parameters measured were the number of episodes of freezing and the time taken to walk 50 feet. In the second part, subjects were asked to imagine themselves that they are riding a bicycle and were asked to lift their leg and walk as if riding a bicycle (pedaling a bicycle) for 25 feet, turn around, and walk back 25 feet. Patients were trained repeatedly and allowed to make repeated attempts. The above-mentioned parameters were measured again. The effect of pre-test and post-test variability was measured.

RESULTS

22 patients with Parkinson's disease with freezing of gait were recruited in our study. Out of which 17 were male and 5 patients were female. The median age of the study sample was 66 (48-78) years. The mean of the UPDRS motor score was 25.57 (7.89). The average Hoehn and Yahr stage was 2.59 (0.43). The pre-test and post-test results of the 50 feet walk test, with and without imaginary cues are shown in the Table. The mean time taken to walk without cues was 51.45 ± 7.84 seconds and with cues was reduced to 45.59 ± 8.51 seconds. The mean number of freezing episodes while walking without cues was 2.32 ± 0.48 and with imaginary cues was 1.5 ± 0.51. There is a statistically significant difference ($p<.05$) in the time taken to walk 50 feet and the number of freezing episodes between before and after imaginary cues. 10 out of 22 patients showed immediate improvement in FOG. Whereas six patients showed improvement in the repeated attempts. Six patients did not show improvement.

Table 1. Time taken for 50 feet walk test and number of freezing episodes while walking, before and after imaginary cues

50 feet walk test			
	Without cues (mean±SD)	With cues (mean±SD)	p-value
Time (s)	51.45 ± 7.84	45.59 ± 8.51	p < .05
No. of Freezing Episodes	2.32 ± 0.48	1.5 ± 0.51	p < .05

DISCUSSION

Freezing of gait in Parkinson's disease has been proposed to be due to the disruption of the basal ganglia to supplementary motor area circuit. Previous studies have shown that both visual and auditory cues help improve freezing of gait by directly activating the brainstem locomotor system. Prokop *et al.* initially showed an increase in gait velocity by using dynamic visual cues in normal subjects (Prokop *et al.,* 1997). Whereas Azulay et al. showed similar results with improvement in freezing of gait in subjects with Parkinson's disease using dynamic visual cues (Azulay *et al.,* 1999). Mon S. Bryant *et al.* demonstrated significant improvement in freezing of gait when using green light beam than with red light beam (Mon *et al.,* 2010). In a study, done by Thaut et al. it was found that three weeks of home-based training using auditory cues improved freezing of gait in Parkinson's disease compared to controls (Thaut *et al.,* 1996). Cubo *et al.* were not able to demonstrate any improvement in freezing of gait in Parkinson's disease using auditory cues with a metronome (Cubo *et al.,* 2004). Elinor *et al.* found that internal cues like singing were more effective than external cues in improving gait parameters in healthy adults as well as in patients with Parkinson's disease (Elinor *et al.,* 2018). Riding a bicycle has been found to be easy even in patients with severe freezing of gait probably due to external cues provided by the pedals which reduce limb incoordination (Snijders and Bloem, 2010; Snijders *et al.,* 2010; Snijders *et al.,* 2012). In our study we found that imaginary cues improve the number of freezing episodes in patient with Parkinson's disease. In conclusion, different external stimuli (acoustic, visual, and somatosensory) have been found to modulate the motor pattern in PD and help patients initiate and maintain a rhythmic motor activity (Nonnekes *et al.,* 2015; Nieuwboer *et al.,* 2007 and 2008; Mon *et al.,* 2010; Thaut *et al.,* 1996; Cubo *et al.,* 2004; Elinor *et al.,* 2018). Cued gait training is a very important tool in the treatment of subjects with Parkinson's disease who are no longer respond to dopaminergic stimulation. Based on the significant results obtained in our study, it is evident that imaginary cues are a simple, cost-effective alternative for improving Freezing of gait in Parkinson's disease.

Conclusion

This study reiterates the fact that simple measures like imaginary cues require no special instruments, are free of cost and can improve the mobility and the quality of life in patients with Parkinson's disease. Further studies are required to assess the sensitivity and specificity of imaginary cues in Parkinson's disease.

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