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PARKINSONS DISEASE- COMPARISION OF GAIT HYPOKINESIA BETWEEN FORWARD, BACKWARD AND SIDEWAYS WALK AMONG FREEZERS AND NON FREEZERS

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Ridhima Daga[1]*, Srihari Sharma K N[2]

Corresponding Author :
*[1]Dr. Ridhima Daga, Assistant Professor, Vemana Institute of Physiotherapy, Bengaluru, Karnataka, India
Email: ridhimadaga5@gmail.com
Co Author:
[2]Dr.Srihari, Associate Professor, College of Physiotherapy, Dayananda Sagar University, Devarakaggalahalli, Harohalli, Kanakapura Road, Bengaluru, Karnataka, India

ABSTRACT

Background: Parkinson's disease (PD) is a chronic degenerative disease. It is characterized by its cardinal symptoms of rigidity, resting tremor, bradykinesia and impaired postural reflexes. Objective of the study was to evaluate the gaits peed in forward, backward and sideways direction to both right and left side in freezers and non-freezers and also to compare the speed of walking in different directions within and between the groups. **Methods:** 30 subjects were included in the study. They were divided into two groups: Group A (N=15) consisted of freezers, Group B (N=15) consisted of non-freezers. All the subjects performed 10 meter walk test in their off state of medication in forward direction, backward direction, sideways to right and sideways to left. Three readings were taken and their average was included for the analysis. Within group comparison and between groups comparison was performed. **Results:** In Group A, there was a significant difference between FW and BW (p=0.001), FW and SW (Rt) (p= 0.007) , FW and SW(Lt) (p=0.009). There was no significant difference between BW and SW (Rt) (p=0.910), BW and SW (Lt) (P= 0.890). No statistical difference was found when SW (Rt) was compared with SW (Lt) with p value of 1. In group B, there was a statistical difference between FW and BW (p=0.002), FW and SW (Rt) (p=0.002), FW and SW (Lt) (p=0.0001). There was no statistical difference in between B Wand SW (Rt) (p=1), BW and SW (Lt) (p=0.957), SW (Rt) and SW(Lt) (p=0.959). In 'between group analysis', there was no statistical difference in FW between the groups (p=0.073). There was a statistical difference in BW (p=0.021), SW (Rt) (p=0.004) and SW (Rt) (p=0.011) between the groups. **Conclusion:** Backward walking and sideways walking to either direction is more affected than forward walking in freezers and non-freezers.

Keywords: Parkinson's disease, hypokineisa, gait, freezing of gait, 10 meter walk test

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INTRODUCTION

Parkinson's disease (PD) is a chronic progressive neurological disorder which is characterized by a large number of motor and non-motor symptoms. The cardinal motor symptoms are rigidity, bradykinesia, tremor and postural instability. Other motor symptoms include hypomimia, dysarthria, dysphagia, sialorrhoea, micrographia, slow activities of daily living, difficulty in arising from chair and turning in bed etc.

Gait abnormalities include decreased arm swing, shuffling gait, and festination. Non-motor symptoms are cognitive impairment, bradyphrenia, tip-of-the-tongue (word finding) phenomenon, depression, apathy, fatigue, and other behavioral and psychiatric problems. Sensory symptoms include anosmia, ageusia, pain (shoulder, back), and paresthesia. Other symptoms are dysautonomia (orthostatic hypotension, constipation, urinary and sexual dysfunction, abnormal sweating and seborrhea), weight loss and sleep disorders (Vivid dreams, daytime drowsiness, sleep fragmentation, restless leg syndrome etc.)[1-5] .

There is no definitive test to diagnose PD. In clinical practice, it is mainly diagnosed based on cardinal motor symptoms i.e., rest tremor, bradykinesia, rigidity, and loss of postural reflexes.(1) United Kingdom(UK) Parkinson's Disease Society Brain Bank and National Institute of Neurological Disorders and Stroke have developed diagnostic criteria for PD, but their reliability and validity have not been established clearly[9-11] .

Prevalence of PD worldwide and in India: In 2016, 6·1 million individuals had Parkinson's disease globally, compared with 2·5 million in 1990. Over the past, the global burden of PD has increased, more than doubled as a result of increasing numbers of older people, with contributions from longer disease duration and environment al factors[3]. Population-based surveys from different regions of India (excluding Parsis) have shown a crude prevalence rate (CPR) of PD varying from 6-53/100000. In a survey in Bangalore, in rural region the rate of PD was three times higher as compared to the urban region (Rural41and urban 14/100000). In the elderly homes in Bangalore prevalence of PD was three times higher in Indians compared to Anglo-Indians. This suggests genetic background to the disorder since both the groups were from shared environment. The low prevalence of PD in India (except the Parsi population) is due to 40% lower number of melanized neurons in substantia nigra in normal human brains of Indians as compared to that in UK[12-14].

Pathophysiology of PD: The basal gangliais a network of parallel loops that integrate cerebral regions which include associative, oculomotor, limbic and motor areas. Motor circuit is directly related to pathophysiology of motor disorder. Cortical motor area is connected to postero-lateral putamen where they establish excitatory and glutamatergic synaptic connections with neurons containing GABA. These neurons lead to two pathways i.e., direct and indirect pathways, which connect the striatum to globus pallidus interna (GPi) and substantia nigra pars, reticulate (SNr) (output nuclei of basal ganglia). Neurons in the 'direct pathway' run directly from putamen to GPi/SNr and provide an inhibitory effect on GPi/SNr neurons [15-17].

Striatal neurons in 'indirect pathway' connect the putamen to GPi/SNr through the globus pallidus pars externa (GPe)and sub thalamic nucleus (STN).Projections from putamen to

GPe and from GPe to STN are GABAergic and inhibitory. Neurons from STN use glutamate and activate neurons in the GPi/SNr. Stimulation of neurons in 'indirect pathway' leads to inhibition of GPe, disinhibition of STN and excitation of GPi/SNr. Hence it is clear that output activity of basal ganglia is influenced by the opposingeffectsofinhibitoryinputsfromthedirectpathwayandexcitatoryinputsfrom the indirect pathway. Thus, this provides an inhibitory effect on brainstem and thalamocortical neurons involved in motor activity [18-21].

Need of the study: Gait is the major concern of PD patients. Patients commonly complain of difficulty in gait either in terms of slowing of gait speed or FOG. FOG has found to affect the quality of life of the patients beyond the motor aspect. Also FOG is very disabling as there are unsatisfactory results of FOG alleviation with drugs and DBS. Physiotherapy has found to show positive results to reduce FOG in 'on state of medication'. Almost one third of the patients affected with PD would be freezers in the later stage of the disease. Patients with less severe PD are physically active and have a high activity level. For many of the patients the gait difficulty poses a big problem in community walking.

Aim and Objective Of the study: This study aims to compare gait hyperkinesias between forward, backward and sideways walk among freezers and nonfreezers in subjects with Parkinson Disease.

Objectives of the study Primary objective:

To assess the gait speed in forward, backward and sideways (both right and left) walk among freezers in subjects with Parkinson Disease.

To assess the gait speed in forward, backward and sideways (both right and left) walk among non freezers in subjects with Parkinson Disease.

To compare the gait speed between forward, backward and sideways (both right and left) walk among freezers in subjects with Parkinson Disease.

To compare the gait speed between forward, backward and sideways (both right and left) walk among non freezers in subjects with Parkinson Disease.

Secondary objective:

To compare the gait speed in forward, backward and sideways (both right and left) walk between freezers and nonfreezer in subjects with Parkinson Disease.

METHODOLOGY

Source of Data: Sagar Hospitals, Jayanagar, Bengaluru, Sagar Hospitals, Banashankari, Bengaluru, Out Patient Department, Collegeof Physiotherapy, DSU, Bangalore.

Method of collection of data: Study population was Parkinson disease subjects and Study setting Out at Patient Department, Sagar Hospitals, Jayanagar. Sample design was Purposive sampling. Sample size 30 and Study design was Cross-sectional, observational study. Duration of the study was 6months.

Inclusion criteria: Subjects diagnosed with Idiopathic Parkinson's Disease by a neurologist, HoehnandYahrscalestage2and3, Male and female subjects aged between50-79 years, Mini Mental Status Examination (MMSE) score between 25 and 30, Subjects who can walk independently without external support, Subjects willing to participate in the study.

Procedure: A total of 43 subjects diagnosed with Idiopathic Parkinson's Disease by the neurologist were screened for the onset of disease, disease duration and gait difficulty such as freezing of gait, medical history, other conditions like knee pain, back pain, history of vestibular disorder, cognition level, lower limb dominance and history regarding physiotherapy treatment .After applying the inclusion criteria, a total of 30 subjects were eligible for the study. Informed consent was obtained from all the participants. Stage of PD was assessed using H and Y Scale.

Level of cognition was assessed using MMSE scale. Disease severity was measured in off state of medication using Unified Parkinson's Disease Rating Scale Motor Section (UPDRS - III).There are13 questions in the motor section with a total of 52 scores. Higher is the score, more is the disease severity. For each sign, there are 5 grades, with 0 representing absence and 4 representing maximum severity of that sign.

Lower limb dominance was assessed using WFQ which has total 10 items. The subjects were asked to imagine each task in turn. For each item, respondents had to answer: always the left (-2); usually left (-1); both (0); usually right (1) and always the right (2). The items are then scored from -2 to 2. The total score ranges from -20 to 20, according to the given answers. From the sum of the items, the footedness can be classified as: Left, if the scores obtained are between-20to-7; mixed, if the scores obtained are between-6 to 6 and, Right, if the scores obtained are between 7and20.

Depending on the FOG, the subjects were divided in to two groups. 'Freezers' in group A(n=15)and' non freezers' in group B(n=15).Freezers were those who have positive History of FOG in past one month prior to participation and scored>1markinquestion 3 in FOG-Q and non freezers were those who have no history of FOG in past one month prior to participation and scored 0 in question 3 in the FOG-Q. For the participants who could not understand the meaning of freezing , the therapist demonstrated the phenomenon of freezing .The participants were examined for gait hypokinesiausing10meter walk test, in their off-state of medication (after12hours of taking last medication) .(43)

Patientswerefollowedupbytelephonicconversationonthefollowingday.Theywere advised for the Do's and Don'ts for their queries.

Intervention: Ethical clearance was obtained from the Institutional Ethical Review Board, College of Physiotherapy, DSU, Bangalore. Informed consent was taken from all subjects after giving due consideration to inclusion criteria. Each participant was asked to walk on a 10 meter imaginary straight path on an even surface with their regular footwear. The start and end of the distance was marked by the micropore tape. Each subject was asked to perform forward, backward and sideways walk"as fast as possible". The same series of walk was performed in both the groups. All subjects started to walk towards the right side followed by left side during sideways walk. The subjects were asked to initiate their walk at the command 'Start' and stopped on completing the 10 m distance**.**

No external cue or command was provided to subject once they started to walk. If the subjects stopped during the walk, he/she was advised once to complete the distance with the command "kindly complete your walk" and time was recorded for the same. Subjects were

free to discontinue the experiment at any point of time. Time taken to cover initial two meters and last two meters distance was not considered for analysis. Only the time taken to cover the middle 6 meters was taken into consideration. However, the patient was unaware as from what distance time was recorded. Three trials of each direction of walk were taken. Time taken was measured in seconds. Adequate rest time was given to each participant in between the walk. Outcome measures were Gait hypokinesia was quantified using the10-meter walk test, the procedure of which is described above.

RESULT

Statistics: Data analysis was performed by SPSS (version17) for windows. Alpha value was set as 0.05. Descriptive statistics was performed to find out mean, standard deviation (SD) for the demographic variable and outcome variables. Chi square test was performed to find out gender distribution and H and Y stages among both groups. Unpaired t test was used to find out significant differences among demographic variable such as age and Years of disease onset.

Mann Whitney U test was used to find out difference in scores, between the groups for demographic variables such as UPDRS, FOG-Q, WFQ and MMSE. Unpaired t-test was used to find out difference between groups for FW, BW, SW to right (Rt) and SW to left (Lt).

One way ANOVA was used to analyze 'within group' data f or FW, BW, SW (Rt) and SW (Lt). Post hoc analysis was performed by Scheffe test. Microsoft excels and Microsoft word was used to generate graph and tables.

RESULT

Table 1: Descriptive statistics for demographic variables

Sl.No:	Variables	GroupA	GroupB	Þ-value(0.05)
1	Age	67.07±8.62	64.20±7.25	0.333
2	Gender(M/F)	14/1	10/5	0.169
3	Hoehn and Yahr stage(II/III)	5/10	9/6	0.143
4	Years of Disease Onset	4.07±2.76	2.87±1.80	0.170
5	UPDRS	25.53±4.34	23.13±6.51	0.270
6	FOG-Q	12.73±2.05	3.60±1.72	0.0001
7	WFQ	13.20±6.90	17.00±3.02	0.100
8	MMSE	27.40±1.84	28.53±1.68	0.065

The table above shows the statistical value of demographic data of both the groups i.e., group A (Freezers) and group B (Non freezers) which includes age, gender, Hoehn and Yahr scale, years of disease onset, UPDRS scale, FOG-Q, WFQ and MMSE.

The mean and SD of age for Group A was found to be 67.07±8.62, and for Group B was found to be 64.20±7.25, which is not statistically significant.Therewere 14 males and 1 female in Group A , whereas in Group B there were 10 males and 5 females. There was no statistical significance in gender between the groups. The mean and SD of years of disease onset in Group A was found to be 4.07±2.76, whereas in Group B the mean and SD was 2.87±1.80, which is found to have no statistical significance.

The mean and SD of UPDRS was 25.53±4.34 in Group A, Where as in Group B it had mean and SD of 23.13±6.51, which was found to have no statistical significance. Regarding FOG-Q, the mean and SD in Group A was 12.73±2.05 and the mean and SD of FOG-Q in Group B was 3.60±1.72 which shows there was a statistical significance between the groups. The mean and SD of WFQ in Group A was 13.20±6.90, whereas in Group B, the mean and SD was 17.00±3.02 which shows there is no statistical significance between the group. Regarding the MMSE score, the mean and SD in Group A was 27.40±1.84, whereas in Group B the meanandSDwas28.53±1.68 which shows there is no statistical difference between the groups.

Table 2: Within the group analysis for both the groups

Sl.No:	Variables	FW	BW	SW(Rt)	SW(Lt)	Þ-value(0.05)
1	GroupA	8.9±3.47	28.75±20.42	25.38±11.07	25.02±10.77	0.0001
2	GroupB	6.31±1.76	15.07±7.28	15.09±6.04	16.25±6.33	0.0001

Table 2 compares within group analysis. Within group A, FW took less time than BW, SW (Rt), SW (Lt).Within group B, FW took less time than BW, SW (Rt), SW (Lt).

Table 3: Comparison between groups

Sl.No:	Variables	GroupA	GroupB	Þ-value(0.05)
1	FW	8.9±3.47	6.31±1.76	0.073
2	BW	28.75±20.42	15.07±7.28	0.021
3	SW(Rt)	25.38±11.07	15.09±6.04	0.004
4	SW(Lt)	25.02±10.77	16.25±6.33	0.011

The table 3 compares the gait speed between the groups in the forward walking, backward walking, sideways walk to left and sideways walk to right.

When forward walking speed was compared between Group A and Group B, there was no statistical significance. In forward walking speed, Group A had a mean and SD value 8.9±3.47, whereas Group B had a mean and SD6.31±1.76. When backward walking speed

was compared between two groups, there was a statistically significant difference. In backward walking Group A had a mean and SD 28.75±20.42 as compared to Group BwhichhadameanandSD15.07±7.28. When sideways walking speed to right was compared between the groups, there was a statistically significant difference.

In sideways walking to right, Group A had a mean and SD25.38 ± 11.07, whereas Group B had a mean and SD 15.09±6.04. When sideways walking to left speed was compared between the two groups, there was a statistically significant difference. In sideways walking to left, Group A had a mean and SD 25.02±10.77, whereas Group B had a mean and SD 16.25±6.33.

Table 4: Posthoc analysis

Sl.No:	Variables	GroupA	GroupB
1	1vs.2	0.001	0.002
2	1vs.3	0.007	0.002
3	1vs.4	0.009	0.0001
4	2vs.3	0.910	1
5	2vs.4	0.890	0.957
6	3vs.4	1	0.959

P value was set at 0.05. 1: FW, 2:BW, 3:SW(Rt), 4:SW(Lt)

RESULT

Within group analysis of group A:

Analysis showed that there was a statistically significant difference between FW and BW (p-value= 0.001). When FW was compared with SW (Rt), again there was a statistically significant difference (p-value=0.007). When FW was compared with SW (Lt), there was a statistically significant difference (p-value=0.009). When BW was compare dto SW (Rt), there was no statistically significant difference (p-value=0.910). When BW was compared with SW (Lt), there was no statistically significant difference (p-value=0.890). When SW (Rt) was compared to SW (Lt), there was no statistically significant difference (p-value =1).

Within group analysis of group B:

Analysis showed that there was a statistical significant difference between FW and BW (p-value=0.002). When FW was compared to SW (Rt), there was a statistically significant difference (p-value=0.002).When FW was compared to SW (Lt.), there was a statistically significant difference (p-value=0.0001). When

BW was compared to SW (Rt), there was no statistical difference (p-value=1). When BW was compared to SW (Lt), there was no statistical difference (p-value=0.957). When SW (Rt) was compared to SW (Lt), there was no statistical difference (p-value=0.959).

DISCUSSION

The purpose of the study was to assess the gait speed in FW, BW, SW in subjects with PD. 30 subjects were included in the study, of which 15 were freezers (Group A) and 15 were non freezers (Group B). All the 30 patients completed the study without any adverse events. The outcome measure used in our study was 10 MWT and subjects were assessed in off state of medication i.e., 12 hours after taking the last medication. A previous study was conducted by Hackney ME which compared FW and BW between freezers and non freezers in subjects with PD.

They used 5 meter instrumented, computerized GAIT Rite walkway to measure the gait speed and the subjects were assessed in 'on state 'of medication. In our study we found that, within Group A, subjects could walk faster in FW with mean and SD 8.9±3.47 than BW (28.75±20.42), SW(Rt) (25.38±11.07) and SW(Lt)(25.38±11.07).There was a statistical difference when FW was compared to BW and also SW to either side. There was no statistical difference when BW was compared to SW to either side.

There was no statistical difference when SW was compared to right and left. In our study we found that within Group B subjects could walk at a faster speed in FW with mean and SD6.31±1.76 as compared to BW (15.07±7.28), SW (Rt)(15.09±6.04) and SW(Lt) (16.25±6.33). There was a statistical difference when FW was compared to BW and also when FW was compared to SW to either side. There was no statistical difference when BW was compared to SW to either side. There was no statistical difference when SW was compared to either side. Between the group analyses, when FW was compared between the groups, we didn't find any significant difference in their speeds.

The mean and SD of group A was 8.9±3.47where as for group B was 6.31±1.76. This was in agreement with the previous study by Hackney ME. When BW was compared between the groups, there was a statistical difference. The freezers took more time (28.75±20.42) than non freezers (15.07±7.28) to complete the 10MWT.Thiswasnot in agreement with the previous study. The previous study found that there was no statistical difference between the group and both freezers and non freezers walked at similar velocities. This could be due to the testing effect on the participants as well as the fact that they were assessed in 'on state' of medication.

When SW (Rt) was compared, group A had a mean and SD 25.38±11.07 and group B had a mean and SD 15.09±6.04, there was a statistical difference in speed. When SW (Lt) was compared between the groups, group A had a mean and SD 25.02±10.77 whereas group B had a mean and SD 16.25±6.33. There was a statistical difference in speed while walking towards the left. Hence, this study is going to accept the Experimental hypothesis which states that there will be a significant difference between FW, BW and SW among freezers and non freezers.

Majority of the Freezers had freezing episodes while initiating the walk and also while approaching the target. There were few subjects who had freezing episodes in middle of the walk. They were not able to voluntarily

take a step further. Freezing episodes were noted in all three directions. Subjects also experienced more difficulty in walking side ways to wards right as compared to walking sideways towards left, this is attributed to the fear of fall. There were only 2 subjects in freezers who didn't demonstrate any freezing episode during the procedure. All the non freezers had shuffling gait pattern. Shuffling was commonly noted during the start of the walk. Even this group reported more difficulty in walking side ways to right as compared that on the left due to fear of fall and tremors. Shuffling was more common in FW and SW than in BW. Majority (N=22) of the PD subjects of both the groups topped once during BW and were advised to complete the walk as per the procedure. All the 30 subjects were able to walk in an imaginary straight line without much deviation[22-23].

FW is normally used in daily activities than BW and SW to either direction. This could be one of the explanation as to why Group A subjects took less time to complete the FW. Moreover BW relies more on proprioception information as there are no visual clues. In addition, BW has higher energy expenditure, which requires active concentric muscle contraction. This active contraction propels the COG on the line of progression. Sideways walking has high energy expenditure. Individuals without neurological deficit also, try to walk in an attempt to reduce the energy expenditure as much as possible [24].

Hence this may support the reason for slow speed in sideways walk. Studies have found that PDs have more postural instability in backward and lateral perturbances. Similarly, in Group B which consisted of non freezers, subjects exhibited faster gaits peed in FW as compared to BW and SW to either side. This could be because FW is used in everyday activities; BW and SW are very rarely used. BW and SW have high energy expenditure and in addition to it BW relies heavily on neuro muscular control and proprioception abilities. Postural instability affects the gait of the PD, hence they are more unstable in backward and sideways direction perturbation [25-27].

Between group analyses there was no significant difference for FW speed, this may be because FW is always preferred for majority the task and hence both the groups have gained optimum gait speed to accomplish the task given. It is known that subjects with PD have smaller than normal anticipatory postural adjustments. Hence they are bradykinesia and take more time to initiate the steps [28].

These postural adjustments May be necessary for backward and sideways walk as well. This slow postural adjustment may be further aggravated by the de synchronization of activation of leg muscles and co activation of antagonist muscle which is seen in freezers. Also BW is more unstable and requires active contraction of the muscles. Because of the abnormal synchronization of the leg muscles, the freezers may be more impaired compared to non freezers. Also, it is worth noting that the lateral body equilibrium needs fine motor lateral trunk motion which may be required for SW [29-31].

Due to the axial rigidity in PD subjects, it is difficult to control the lateral equilibrium as they require more trunk and hip muscle control than the ankle. Whereas gait in Group B may be affected due to abnormal timing mechanisms of the sequential motor acts or may be due to decrement in generation of muscle forces in the lower limbs while walking at constant speed. Due to possible difference in

the gait mechanism of freezers and non freezers, might have lead to a difference in their gait speeds [32].

The exact pathophysiology of FOG is not yet known. Moreover it is difficult to elicit the freezing episodes in clinical set ups and in 'on state'. It is more common in crowded areas, while taking turns, while doing dual tasking and during the 'off state'. Because of this lack of understanding of the freezing episodes, there is no definite treatment for FOG. Medications have not found to have satisfactory effect on the episodes of FOG. Physiotherapy interventions have shown some positive results.

CONCLUSION

The study demonstrates that there is a difference in walking speed in PD subjects in different directions .Backward walking and sideways walking are more affected than forward walking. Training freezers and non freezers is essential in all three directions of walking. Backward walking performance is predictive of walking difficulty in high functioning older adults. Assessment of BW could be an important clinical tool as BW impairment might be associated to BW falls.(30) In our study there wasn't significant difference in time taken to walk backward and sideways in either directions. Hence backwards and sideways walking can also be includedinrehabilitationprotocolforgaitspeedtraining.AsPDpatientsareproneto fall even sideways, incorporating sideways walking can improve their gait as well as reduce the fall risk. Gait training in sideways walk can contribute to improvement in the strategies which is found to be abnormal. As axial rigidity is one of the components affecting the structural stability inside ways perturbation, treatment of axial rigidity can also contribute further in improving sideways walk. Although sideways walk is not as common as forward walk, but the research on the postural instability and falls in sideways direction directs the need to improve the sideways walking. This will help the subject to improve the quality of life and reduce the fear of fall.

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