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Original Research Article

# ASSESSMENT OF GAIT AS OUTCOME MEASURE FOLLOWING SENSORY-ENHANCED THERAPY IN PARKINSON'S DISEASE USING UNIFIED PARKINSON'S DISEASE RATING SCALE (PART III).

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## ABSTRACT

**Background of the study:** Gait and mobility problems causes disability in patients with Parkinson's Disease (PD) which can result in loss of independence, falls and hospitalisation. Cueing is defined as using external temporal or spatial stimuli to facilitate gait. The purpose of the study was to assess the effects of 4 weeks of gait training with sensory-enhanced therapy by using visual and auditory cue on gait score on tool Unified Parkinson's Disease Rating Scale (UPDRS), step length, gait speed and cadence in patients with PD.

**Materials and Methods:** Study Design was experimental study with total sample size of 30 patients with confirmed diagnosis of PD. Patients were divided into experimental group (n=15) and age and disease severity matched control group(n=15). Conventional gait training was commonly administered in both the groups, whereas sensory-enhanced therapy (visual and auditory cue) was given along with gait training in experimental group for 4 weeks. The outcome measures were recorded at the 1st day & at the end of 4th week in both experimental and control group.

**Results:** The data collected was subjected to analysis using Statistical Package for the Social Sciences (SPSS). All data were expressed in mean±sd, paired t-test was used to analyze the variables within the experimental and control group. Unpaired t-test was used for analyzing the variables between the experimental and control group. A significance level of 0.05 was set for all comparisons. There was a significant decrease in gait score on tool UPDRS (p=0.0002) increase in step length (p<0.001), gait speed (p<0.001) and cadence (p=0.005) in experimental group following 4-weeks of sensory-enhanced gait training as compared with the patients in the control group.

**Conclusion and Clinical Significance:** Sensory-enhanced gait training can be a useful rehabilitation strategy for the improvement of gait in PD patients and may prove to be valuable adjunct to traditional pharmacologic treatment of Parkinsonian gait.

**KEY WORDS**: Parkinson's Disease, Gait Training, UPDRS, Visual Cue, Auditory Cue, Sensory-Enhanced Therapy, Basal Ganglia.

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## INTRODUCTION

Parkinson's disease (PD), also known as 'Shaking Palsy' by James Parkinson [1], is a chronic progressive neurological disease in which chemicals specially dopamine which facilitate electrical transmission between nerve cells are depleted [2]. It is characterized by rigidity, slowness of movement, freezing, tremors, postural instability, gait abnormalities as well as other musculoskeletal impairments and functional impairments [3]. According to Gourie-Devi (2014), the estimated prevalence of PD in India is 6-53/100000. Males are more affected than females. Patients with PD have more mortality rate than in age-matched normal individuals [4].

In Parkinson's disease, the gradual degeneration of the grey matter results in decrease production of neurotransmitter dopamine by substiantia nigra. Dopamine plays an important role in movement preparation and execution [5]. Thus, motor control strategies gets impaired in PD resulting in gait and mobility impairments. Gait impairment is an early sign of PD. It is characterised by short shuffling steps, flexed forward posture, decreased arm swing and difficulty in initiating or changing their gait pattern. Patients have difficulty in changing directions while walking [6,7].

Gait disorders are associated with a loss of independence, hospitalization and increased falls [7]. The patient with PD feels hesitant to walk which in turn hampers the patient quality of life. Physiotherapy is considered to be a useful adjunct to the medical treatment of the disease comprising of mainly dopamine substitute such as levodopa [6,7].

Reviewed literature data suggest that sensory cueing can be useful for patients with PD [5-9]. Improvement in gait pattern of PD are possible with the use of appropriate sensory cues i.e verbal, visual and auditory cues. However, fewer studies are being carried out to evaluate the efficacy of sensory cues on gait in patients with PD in Indian population. Therefore, the purpose of the present study was to assess the gait score on UPDRS (part III), step length, gait speed and cadence after the 4-week gait training with sensory cues in patients with PD.

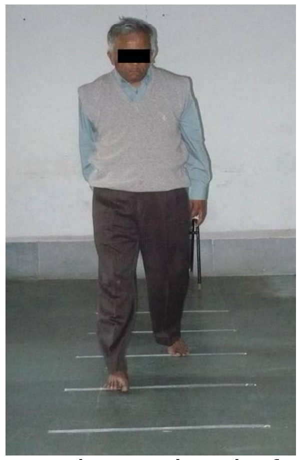
## MATERIAL AND METHODS

Approval to carry out the research work was obtained from the Institutional ethical committee. Study design was experimental study, comprising of total 30 patients (age 51-78 years). The study was carried out in a Physiotherapy clinical setting. After ethical committee approval, the patients who were willing to participate were given detailed information about the research study and written consent was obtained in the language they understood.

Patients with confirmed diagnosis of PD with steady drug treatment, those who rated grade II-IV on Hoehn and Yahr disease rating scale and those who were having mild to severe gait disturbances (score ≥ on UPDRS) were included in the study. Whereas, patients with intellectual, communication, visual, cognitive, hearing impairments and those who had undergone deep brain stimulation and other stereotactic neurosurgery were excluded from the study.

The patient included were divided into 2 groups, experimental (n=15 )and age and disease severity matched control group (n=15) with mean age 66.7±7.2 and 65.7±7.3 yrs, mean height 167.4±7.4 and 165.9±6.3cms, mean Hoehn and Yahr rating 2.9±0.74 and 2.8±0.83 respectively.

Before the treatment session, the patients were evaluated barefooted on 1st day. They were made to walk on a 10m walkway at their preferred speed. Boric powder was spread over the floor in the middle 2m of the walkway to obtain the footprints [10,11]. After the familiarization walk trial, then in next walk, gait score on tool UPDRS (part III), step length, (distance between the heel of one leg to the heel of other leg), gait speed (time required to complete the 10m distance), cadence (number of steps per minute) were noted. The data was also collected for same at the end of the 4th week



**Exercise protocol:** The study consisted of 3 sessions per week, each consisted approximately 30 minutes, for 4 weeks. Patients were allowed to take breaks as they needed.

The conventional gait training was administered commonly for both the groups. It consisted of marching at place (2 sets for minimum 30sec each), high stepping at place (2 sets for minimum 30sec each), walking forward, backward, side-stepping (minimum 2 sets of each exercise on 10m walkway).

**Sensory-enhanced therapy**: The sensory-enhanced therapy was administered in experimental group along with conventional gait training for 4 weeks. It consisted of visual and auditory cues administered simultaneously when walking on a 10m walkway.

**Visual cue**:- 2.5cm wide and 90cm long parallel lines were drawn on the floor across a 10m walkway using white chalk. The distance between 2 lines initially was 110% of the baseline step and was increased to 120%, 130%, 140% at the start of 2nd, 3rd and 4th week respectively [12].

**Auditory cue**: Rhythmic counting of numbers 1,2,3....with the interval matching the patient preferred step time [13] dictated by the therapist loudly while the patients steps on the white lines. The frequency of walk for patients with mild PD, moderate PD and severe PD was 15 repetitions, 10 repetitions and 5 repetitions respectively.

## RESULTS

The data collected was analysed using SPSS and was expressed in mean±sd. Paired t-test and unpaired t-test was used to analyze gait score on UPDRS (part III), step length, gait speed and cadence within the experimental and control group, and between the experimental and control group respectively. A significance level of 0.05 was set for all comparisons.

**Table 1**: Mean scores in experimental and control group.

| | Experimental group | Control group |
|---|---|---|
| **Age (yrs)** | 66.7±7.2 | 65.7±7.3 |
| **Height (cms)** | 167.4±7.4 | 165.9±6.3 |
| **Hoehn & Yahr stage** | 2.9±0.74 | 2.8±0.83 |

Table 1 shows the mean±sd for age, height and disease severity in experimental and control group. It suggested that the two groups were comparable for age, height and disease severity.

**Table 2**: Comparison of mean scores of variables on 1st day and end of 4th week.

| Variable | Experimental group | | | Control group | | |
|---|---|---|---|---|---|---|
| | 1st day | End of 4th week | p value | 1st day | End of the 4th week | p value |
| **Gait score on UPDRS** | 1.8±0.75 | 1±1.09 | 0.016 | 1.93±0.77 | 1.73±0.85 | 0.26 |
| **Step length(m)** | 0.39±0.12 | 0.48±0.14 | 0.041 | 0.4±0.11 | 0.42±0.11 | 0.318 |
| **Gait speed (m/s)** | 0.54±0.21 | 0.69±0.24 | 0.046 | 0.55±0.19 | 0.57±0.19 | 0.372 |
| **Cadence (step/min)** | 81.6±7.84 | 84.6±9.91 | 0.142 | 80.93±6.56 | 80.73±6.20 | 0.467 |

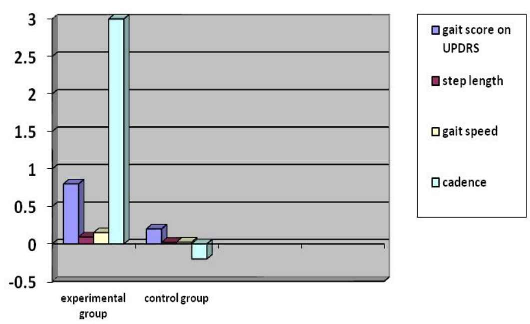
Table 2 shows the mean scores of gait score on UPDRS, step length, gait speed, and cadence in both experimental and control group on 1st day and end of 4th week. In experimental group, there was significant improvement in gait score on UPDRS (part III), step length, gait speed after 4 weeks of sensory-enhanced therapy whereas cadence did showed small improvement. In control group, the result was non-significant.

**Table 3**: Mean difference in variables between experimental and control group and p value.

| Variable | Experimental group | Control group | P value |
|---|---|---|---|
| **Gait score on UPDRS** | 0.8±0.4 | 0.2±0.4 | 0.0002 |
| **Step length (m)** | 0.09±0.02 | 0.02±0.00 | 0 |
| **Gait speed (m/s)** | 0.15±0.04 | 0.02±0.01 | 0 |
| **Cadence (steps/min)** | 3±4.11 | -0.2±1.51 | 0.005 |

Table 3 shows the mean difference of variables between the two groups, and p value suggests the result for gait score on UPDRS (part III), step length, gait speed and cadence are highly significant (p<0.001).

**Graph 1:** Graph showing mean difference between experimental and control group.




## DISCUSSION

In the present study, patients with PD in the experimental group, all of whom were capable of independent gait, showed statistically significant improvement in gait score on UPDRS (part III), step length, gait speed and cadence after 4 weeks of sensory-enhanced gait training when compared with control group. Control group underwent gait training without sensory cues for 4 weeks did not showed significant improvements. The small increase in gait performance in control group was probably the result of practice effects.

In the present study, sensory-enhanced therapy used visual (white stripes) and auditory cues (rhythmic counting of numbers) in gait training. Visual cues helps to provide visual feedback on appropriate step length [9,14]. When patients are told to step over each markers, they are forced to take properly sized steps, normalizing their step length. Also, visual and auditory cues can help, as they focus attention on gait [9]. Once the patient is concentrating on walking, it is no longer an automatic task that is being processed through the basal ganglia thus bypassing it [14]. Basal ganglia acts as an internal cue or trigger to carry out smooth coordinated movements without attention [8]. In patients with PD, this internal cue is deficit, so the external cues incorporated in the treatment might have compensated for this internal motor trigger.

Morris et al suggested that PD patients increase the velocity of walking by increasing both cadence and stride length [15]. However, study done by Ferrarin et al in 2008 suggested that mild PD subjects responds to the forward oriented optic flow which produces an increase in cadence and gait speed while subjects with severe PD tends to be more responsive to the attentional strategy, through an increase in step length and compensatory decrease in cadence [16].

Azulay et al suggested that visual cues activates the cerebellar-visual-motor pathway as they act as moving target [17]. Thus, the use of visual cues can cause a change in the control of gait from the cortical-motor pathway to the cerebellar-visual-motor pathway [8,17]. Rhythmic counting of numbers which acted as a auditory cue in the present study, focuses attention of patient on gait which can facilitate a normal gait pattern by activating motor set for the entire gait sequence [18,19]. According to Paltsev and Elner, sometimes rhythmic sound patterns can increase the excitability of spinal motor neurons via the reticulospinal pathway reducing the time for the muscle to respond to the given motor command [18]. Auditory stimuli can reduce reaction time in a voluntary motor task which in turn can improve slowness of movement and gait [20].

In the present study, it was felt that sensory cues were chiefly responsible for significant improvement in gait variables in experimental group. Other possible influences that could have affected the outcome of the study were the effect of medication, stimulation parameters and subject themselves. To minimize these biases, 10m walkway was selected such that the patient can walk unencumbered and as natural as possible. The patient included were on a steady drug regime and treatment was given within 2 hours of taking medication. The use of a standardized protocol and commands by same therapist while patient were undergoing treatment decreased the likelihood of bias. Also, the patients varied in age (51-78 years). Such broad variation of age and disease severity may account for some of the differences in the walk. This variation was minimized by including age and disease severity matched patients in control group, and minimum sets of exercise for mild, moderate and severe PD were inducted for patients

The improvements in gait in patients with PD observed in this study are encouraging for the physiotherapy practice. The sensory-enhanced therapy is likely to be a novel and inexpensive tool which can be used easily in the clinical setting for improving gait parameters and gait rehabilitation in patients with Parkinson's Disease.

## CONCLUSION

4 weeks of sensory-enhanced therapy with gait training established a significant improvement in gait score on UPDRS (part III), step length, gait speed and cadence. Therefore, sensory-enhanced therapy can be a useful, easy to administer treatment strategy in gait training in patients with Parkinson's disease in clinical setting.

## ABBREVATIONS

**PD -** Parkinson's Disease
**UPDRS -** Unified Parkinson Disease Rating Scale

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**Conflicts of interest: None**

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