Original Article

Comparison of Balance during Dual-Task in-between Cognitively Impaired and Nonimpaired Individuals with Parkinson's Disease

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Abstract

Introduction: Parkinson's disease manifests as bradykinesia, stiffness, tremors, and abnormalities in gait and balance. When performing dual activities, people with cognitive impairments exhibit noticeable alterations in mobility. The purpose of this study was to determine whether balance during dual tasking is related to cognitive deterioration. The aim was to compare balance during dual-task in-between cognitively impaired (CI) and nonimpaired individuals with Parkinson's disease. The objective was to evaluate balance using timed up and go test (TUG), TUG-manual (TUG-m), and TUG-cognitive (TUG-c) and to compare its scores in both the groups. **Materials and Methods:** It was a cross-sectional observational study carried out at outpatient department and Parkinson's societies. The sampling technique was purposive sampling, and the sample size was 22. Subjects were divided into two groups (by stratification method) according to Montreal Cognitive Assessment (MOCA) scores as CI and nonimpaired group. Both groups performed TUG with manual task and cognitive task. The time taken to complete all TUG tests was measured. **Results:** Comparison of TUG between the groups showed a highly significant difference in TUG and TUG-m tests ($P < 0.001$) and a significant difference in TUG-c ($P = 0.028$). **Conclusion:** The study found a significant difference in balance scores, assessed by the TUG test during dual-task conditions, between CI and nonimpaired individuals with Parkinson's disease. This highlights the important role cognition plays in balance regulation in Parkinson's disease.

Keywords: Balance, cognition, dual-task, Montreal cognitive assessment, Parkinson's disease, timed up and go test

Introduction

All Parkinson's disease patients eventually experience balance issues, but the severity may vary.[1-4] When dealing with dual-task settings, cognitive techniques are necessary for optimal performance.[5-7] The idea of including a cognitive component in balance tests is supported by prior research that suggested a link between cognitive function and gait regulation.[8] That being said, it is still unknown exactly how cognitive impairment affects balance, especially while doing dual-task activities. Cognitive impairments in Parkinson's disease often include deficits in executive function, attention and visuospatial processing, all of which are crucial for maintaining balance. In order to determine whether cognitive impairment can independently determine Timed up and go test (TUG) score under dual-task performance utilizing TUG, the current study was designed to evaluate the precise function of cognition on balance in completing the dual task in Parkinson's disease. This research is necessary to enhance our understanding of how cognitive deficits impact motor functions and to improve diagnostic and therapeutic approaches for balance issues in Parkinson's disease.

The primary aim of this study was to compare balance during dual task in-between cognitively impaired (CI) and nonimpaired individuals with Parkinson's disease. The objectives of the study were to assess balance using the TUG test, TUG-manual (TUG-m), TUG-cognitive (TUG-c) and to compare different scores of the TUG test in both the groups.

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Materials and Methods

Approval was obtained from the institutional ethical committee, and the number was EC/NEW/INST/2019/377/116. The design of the study was cross-sectional observational study. The study setting was outpatient department and Parkinson's societies. The sampling technique was purposive sampling and the sample size was 22 (11 in each group). The formula used for calculation was $n = \frac{\left(\sigma_1^2 + \sigma_2^2\right)(Z_{\alpha/2} + Z_{\beta})^2}{\epsilon^2}$ where,

$Z_{\alpha/2}$ is the *z* variate of alpha error, i. e., a constant with a value of 2.5758 (for 95% confidence)

$Z_{\beta,}$ i. e., a constant with a value of 1.6448

α = Type I error = 1%

ε = True difference of at least 5

σ = Standard deviation = 2.4 and 2.9.[9]

Patients diagnosed with Parkinson's disease and on regular medication, patients able to walk independently for at least 9 m (30 ft), with or without a gait aid and those who were able to carry a cup in one hand were included in the study. Patients with Hoehn and Yahr scale stage 4 and above were excluded from the study.[10] The entire procedure was explained to the participants. Informed consent was obtained from participants. Outcome measures used in the study were Montreal Cognitive Assessment (MoCA)[11,12] and TUG (manual and cognitive).

Participants were divided into two groups according to MoCA scores, with more than 27 into cognitively nonimpaired (non-CI) and with less than 27 into CI group. The three types of TUG, TUG-c, and TUG-m were timed with a stopwatch. All the tests were assessed in the ON phase of Parkinson's disease medication. The three tests were completed in random order, and each was repeated three times, with the average of the three scores being used for data analysis. The original TUG evaluated balance by measuring the time taken to stand from a chair, walk 3 m, turn around, return to the chair, and sit down. TUG-m: A manual task of carrying a glass of water was combined with the TUG, creating a dual-task condition TUG-c: Involved counting backward in threes while completing the TUG.

Master chart was prepared for coding the data using Microsoft Excel, $P < 0.05$ was used as level of significance. Normality was checked using Shapiro–Wilk test. While justifying non-parametric test, the normality is mentioned otherwise, data are normal. Statistical analysis was performed using nonparametric Mann–Whitney *U*-test. SPSS version 25 and Minitab software version 19 are used for statistical analysis. The study was carried out in Pune, Maharashtra, India.

Results

P value for TUG and TUG-m is <0.001, which is highly significant and *P* value for TUG-c is 0.028, which is significant, indicating CI individuals were slower in mobility as compared to non-CI individuals.

Discussion

This study was undertaken to compare the balance during dual task in-between CI and nonimpaired (non-CI) individuals with Parkinson's disease. This study observed a mean difference in all TUG scores between CI and non-CI individuals. Non-CI individuals completed the TUG tests in lesser time as compared to CI individuals.

P value for TUG and TUG-m is <0.001, which is highly significant and *P* value for TUG-c is 0.028, which is significant, indicating CI individuals were slower in mobility as compared to non-CI individuals. Roisin C. Vance *et al.* in their study have found cutoff values for fallers in Parkinson's disease as 12s, 13.2s, and 14.7s for the TUG, TUG-m and TUG-c, respectively.[13-15] There was a decrease in mobility while performing cognitive dual-task as compared to manual dual task in non-CI individuals. Van Uem *et al*. also have found that patients with Parkinson's disease require more time to complete TUG compared to controls. They suggest that cognitive disabilities associated with Parkinson's disease can potentially be detected by TUG. In our study, the time taken for the completion of the cognitive task (TUG-c) was slightly more than the manual task (TUG-m) in non-CI individuals with Parkinson's disease, whereas the time taken for completion of TUG-c was slightly less than TUG-m in CI individuals.[16]

The current study has shown increased time for completion of TUG with the addition of manual and cognitive tasks in non-CI individuals where the time required for completion of cognitive task was more than the time required for manual task. On the other hand, CI individuals took more time for the completion of TUG when the manual task was added. This may indicate that not all the secondary tasks performed simultaneously affect the mobility in Parkinson's disease. These results are in accordance with similar results found by Curt M Campbell. in a study comparing effect of cognitive task on TUG in older adults with and without Parkinson's disease. This consistency across studies underscores significant impact of cognitive function on balance and mobility in Parkinson's disease. When comparing the TUG under cognitive task conditions between the two groups, the cognitive task was more difficult compared to the manual task for non-CI individuals, whereas it was less difficult compared to the manual task for CI individuals.[17]

The capacity-sharing model suggests that limited capacity is available for using available information processing resources. Thus, a finite amount of attention needs to be divided into multiple tasks.[18] This preference must be different in CI and nonimpaired individuals. This is confirmed by multiple researchers. A study done by Zirek *et al*. said that patients with Parkinson's disease use attentional resources more while performing two tasks simultaneously. Insufficient attentional resources lead to deterioration of mobility during dual tasks. This study also showed similar results that cognitive tasks

created dual-task cost time for completion of gait. Other contributing factors can be cognitive status, cognitive load, and environmental factors for the affection of dual-task performance.[19-24]

A study done by Sousa and Macedo said that there is significant association between cognitive skills and motor parameters. The ability to allocate attention to multiple tasks at once is substantially connected with balance ability. They found that patients who performed worse in terms of functional mobility were those who had more cognitive dysfunction, indicating a link between these motor symptoms and increasing cognitive dysfunction.[9,25]

A study done by Chen and Tang and Tang *et al*. has hypothesized that the TUG manual may subject a person to more motor load than cognitive load. This can explain why CI individuals had more difficulty in manual tasks despite the presence of cognitive impairment.[26-28]

Alfaro-Acha *et al*. have found the relationship between cognition and handgrip strength. The requirement for sustained grip strength in the TUG-m could be another difficulty-related element. Thus, there is a possibility of affected hand grip strength due to cognitive impairment in CI group, leading to the highest required time for completing manual task in that group.[29-31]

The present study highlights the usefulness of balance evaluation using dual-task TUG while focusing simultaneously on cognitive evaluation as well as the importance of formation of a rehabilitation framework to provide appropriate interventions according to the need of each individual to get better improvement in their performance rather than giving generalized rehabilitation program. This study indicates the need to work on motor training and cognitive training with activities involving dividing attention like dual-task training with two complex motor activities or a combination of different motor and cognitive activities being more beneficial for the particular individual.

The study found a significant difference in balance scores, assessed by the Timed Up and Go (TUG) test during dual-task conditions, between CI and nonimpaired individuals with Parkinson's disease. This highlights the important role cognition plays in balance regulation in Parkinson's disease.[32,33] Specifically, CI individuals take longer to complete TUG under dual-task conditions as compared to those without cognitive impairments. Identifying TUG-c and TUG-m scores can be instrumental in developing effective therapeutic interventions.

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Conflicts of interest
There are no conflicts of interest.

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