



EVALUATING THE IMPACT OF COGNITIVE TRAINING ON FREEZING EPISODES IN PARKINSON'S DISEASE: A COMPARATIVE ANALYSIS

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Abstract : Cognitive training has been proposed as an intervention to address motor impairments in Parkinson's disease, especially freezing of gait episodes and functional mobility challenges. This study aimed to evaluate the impact of cognitive training on these parameters using pre- and post-intervention data from individuals with Parkinson's disease. Analysis using within-group comparisons was meant to assess the effectiveness of the intervention, while between-group comparisons were aimed at detecting differences in the magnitude of improvements. The statistical analysis provided significant improvements in FOG episodes and functional mobility as quantified by standard tests following intervention. However, no statistically significant differences were found in the extent of improvements among groups. These findings show that cognitive training may be an important tool to reduce motor impairments in Parkinson's disease, since it can be an efficient and accessible therapeutic approach. Further research is necessary to look into its long-term benefits and optimize training strategies.

IndexTerms - Freezing of Gait (FOG), Timed Up and Go (TUG), Wilcoxon Signed-Rank Test

Introduction

Parkinson's disease (PD) is a progressive neurodegenerative disorder that presents with motor symptoms such as bradykinesia, rigidity, and tremors along with significant nonmotor symptoms that negatively affect the quality of life of the patients. Of these motor impairments, freezing of gait (FOG) is particularly disabling and often leads to falls and diminished mobility. Apart from this, functional mobility and agility, as assessed by scales such as the Timed Up and Go (TUG) test, are two important measures of motor function and overall functional capacity of PD.

Recent evidence has shown the potential role of cognitive training as an intervention to be added to the treatment regimen that can enhance motor and functional outcome in PD. Cognitive-motor integration is an important approach toward overcoming gait disturbances and increasing agility and is, therefore, an appealing approach toward rehabilitation.

This study examines the effects of cognitive training interventions on FOG episodes and functional mobility, using FOG and TUG metrics to evaluate changes before and after intervention. We will apply both within-group and between-group analyses to provide insights into the efficacy of cognitive training in enhancing mobility and reducing FOG episodes in individuals with PD.

Review of literature:

Maryam Emadi et al: (2023) Conducted a study on "Effect of Cognitive Rehabilitation by Auditory Stroop Training on Quality of Life of Individuals with Tinnitus" in this study Thirty chronic tinnitus (> 6 months) patients were included in this study. They were distributed into two 15-member groups: intervention and control. Common audiometric, psychometric, and psychoacoustic evaluations of tinnitus were performed for two groups before intervention and after auditory Stroop training of group At the end they conclude that cognitive rehabilitation using tasks such as auditory Stroop can be effective in controlling tinnitus by improving cognitive control.

Rebecca Chow, Bryan P, Daniel Rzondzinski, et al: (2021) conducted a study on "Investigating therapies for freezing of gait targeting the cognitive, limbic, and sensorimotor domains". Their objective was to investigate whether these 3 treatments could improve functional outcome of FOG. Total 15 individuals with PD and FOG, were randomized into different groups and receiving intervention and they conclude that FOG severity significantly improved after cognitive intervention.

Shervin Rahimpour, Amol Yadav, Dennis Turner, et al (2022) conducted a study on "Freezing of gait in Parkinson's disease: invasive and noninvasive neuromodulation". This study aimed to review the neuroanatomy and pathophysiology of gait initiation in the context of FoG, and discuss targets of central nervous system neuromodulation and their outcomes so far and they conclude that the evidence presented in this review suggests FoG to be a heterogeneous phenomenon (akinetic, trembling, responsiveness to environment) without a single unifying pathologic target.

Nirgilandi, Joseph Tal, Tali Azulay, et al (2007) conducted a study on "Validation of the Freezing of Gait Questionnaire in Patients with Parkinson's Disease". Their objective was to revalidate the Freezing of Gait Questionnaire (FOG-Q). Comparisons between FOG-Q item 3 and UPDRS item 14 were also made. Principal component analysis indicated that FOG-Q measures a single dimension. Conclusion of study is that Test-retest reliability and internal reliability of FOG-Q score was high. FOG-Q was best correlated to items of the UPDRS relating to walking, general motor issues, and mobility. Correlations between baseline and endpoint suggested that FOG-Q item 3 is at least as reliable as UPDRS item 14. At baseline, 85.9% of patients were identified as "Freezers" using FOG-Q item 3 (1) and 44.1% using UPDRS item 14 (1) (P 0.001). FOG-Q was a reliable tool for the assessment of treatment intervention. FOG-Q item 3 was effective as a screening question for the presence of FOG patients with Parkinson's disease (PD).

Methodology:

Research Design

A randomized controlled trial design will be used to examine the effectiveness of cognitive training in enhancing freezing of gait (FOG) in patients with Parkinson's disease. This is a study design that enables strong causal inference by the random assignment of participants to either the treatment or control group.

Participants

Target Population: The target population is patients who have been diagnosed with Parkinson's disease and are manifesting FOG.

Total of 30 participants will be involved: 15 participants for each group.

Control Group

Standard care shall be provided to the control group which may include medications and physiotherapy.

Outcome Measures

Primary Outcome Measure: The main outcome measure will be Freezing of Gait Questionnaire, that is a valid self-reported measure of severity of FOG.

Secondary Outcome Measures:

TUG: A measure of functional mobility.

Data Collection Procedures

Before the intervention, baseline measurements will be conducted. After the period of intervention, post-intervention measurements will be carried out.

Statistical Analysis:

Exploratory Data Analysis

Group 1:

- **FOG:** The pre-intervention FOG scores ranged from 8 to 19, with a mean of 15. Post-intervention, the range decreased to 8-17, and the mean decreased to 12.4667. This suggests a potential reduction in FOG severity after the intervention.
- **TUG:** The pre-intervention TUG scores ranged from 28.58 to 39.58, with a mean of 21.7587. Post-intervention, the range decreased slightly, and the mean decreased to 18.5370. This indicates a potential improvement in functional mobility after the intervention.

Group 2:

- **FOG:** The pre-intervention FOG scores ranged from 8 to 19, with a mean of 13.33. Post-intervention, the range remained similar, but the mean increased to 14.1333. This suggests a slight increase in FOG severity, which is unexpected.
- **TUG:** The pre-intervention TUG scores ranged from 11.09 to 41.58, with a mean of 27.2857. Post-intervention, the range remained similar, but the mean decreased to 25.7393. This suggests a slight improvement in functional mobility, which is consistent with expectations.

Overall, the results for Group 1 suggest a potential positive effect of the intervention on both FOG and functional mobility. However, the results for Group 2 are less clear-cut and may require further investigation.

Normality Check

To assess the normality of the data, the Shapiro-Wilk test was employed. This test indicated that FOG pre from group 1 and TUG pre and TUG post for group 2 did not significantly deviate from a normal distribution ($p > 0.05$). However, remaining variable

showed significant departures from normality ($p < 0.05$). Given these findings, non-parametric statistical tests were deemed appropriate for analysing these variables.

To further assess the normality of the data, histograms and Q-Q plots were generated. The result showed significant skewness and kurtosis, reinforcing the decision to use non-parametric tests.

Within-Group Comparison for Group 1 and Group 2

The Wilcoxon Signed-Rank Test was conducted to assess the pre- and post-intervention differences within each group for both measures.

Group 1

1. FOG Pre vs. Post

- $Z = -3.462, p < 0.001$
- Significant reduction in FOG scores post-intervention.
- Suggests improved movement control and reduction in freezing episodes.

2. TUG Pre vs. Post

- $Z = -3.413, p < 0.001$
- Significant improvement in TUG scores, indicating enhanced mobility.

Group 2

1. FOG Pre vs. Post

- $Z = -3.035, p = 0.002$
- Significant decrease in FOG scores post-intervention, suggesting reduced freezing episodes.

2. TUG Pre vs. Post

- $p = 0.006$
- Significant reduction in TUG times, reflecting better functional mobility.

Conclusion

Both groups exhibited significant improvements in FOG and TUG scores post-intervention. These results indicate that cognitive training effectively enhanced mobility and reduced freezing episodes in both groups.

Between-Group Comparison

The Wilcoxon Signed-Ranks Test was conducted to compare the differences in improvement (pre-post change) between mobility (TUG) and freezing of gait (FOG) within each group.

Group 1 (TUG_Diff vs. FOG_Diff)

- $Z = -1.535, p = 0.125$
- The p-value is greater than 0.05, indicating no statistically significant difference between the improvement in TUG and FOG scores.
- This suggests that both mobility and freezing of gait improved similarly post-intervention.

Group 2 (TUG_Diff vs. FOG_Diff)

- $Z = -1.079, p = 0.280$
- The p-value is greater than 0.05, indicating no significant difference between the improvement in TUG and FOG scores.
- This suggests that the intervention had a comparable effect on both measures in Group 2 as well.

Result

For both groups, the improvements in mobility (TUG) and freezing of gait (FOG) were statistically similar. This implies that the intervention had a balanced impact on both aspects, without one showing significantly greater improvement than the other.

Conclusion:

The research assessed the impact of cognitive training on mobility (Timed Up and Go - TUG) and freezing of gait (FOG) episode occurrence in patients with Parkinson's disease. Descriptive statistics showed improvement in both outcome measures following the intervention, with more variability in Group 1. Normality testing suggested non-normal distribution for the majority of the variables, especially FOG scores. Intragroup comparisons exhibited significant gains on both TUG and FOG for both groups. Yet the gains in mobility and freezing of gait episodes were similar for each group. Between-group comparisons revealed no between-group difference for improvement on either measure. Collectively, results indicate that cognitive training improves mobility and decreases freezing episodes in patients with Parkinson's, with benefits being similar in different groups.

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