Effect of Dual Task on Static Postural Stability in Persons with Parkinson's Disease

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ABSTRACT

Background and Purpose of Study: Patients with Parkinson's disease often need physiotherapy for the management of their gait and balance problems. Dual task performance compromises postural stability in Parkinson's disease which can lead to falls and also deterioration in the performance of the simultaneous tasks, when the attention capacity resources are shared amongst different tasks. The purpose of this study was to observe the effects of performance of secondary motor task and secondary cognitive task on postural stability in persons with Parkinson's disease using clinical steady standing tests, and to further clarify whether the type of task was a major determinant of the severity of dual task interference.

Materials & Methods: It is a randomized experimental study with same subject design. 42 subjects were included in the study selected on the basis of inclusion & exclusion criteria. All the subjects were required to maintain 5 steady stance positions (feet apart, feet together, stride stance, tandem stance, single leg stance) without any secondary task and while doing a secondary motor task (thumb and finger opposition) and a secondary cognitive task (reciting the days of the week backwards) separately. Time spent in each of the positions was recorded using a stopwatch, the maximum time being 30 seconds.

The general Linear Model Repeated Measures Analysis of Variance (ANOVA) was used to examine the changes in the outcome variables under 3 different conditions.

Results: The difference between the mean time duration during the performance of secondary motor task and secondary cognitive task was significant (at $p < 0.05$) in the feet together; stride stance, tandem stance and single leg stance position. This indicated that the performance of cognitive task was more detrimental to postural stability than the performance of motor task in the more difficult stance positions.

Conclusion: The performance of even simple motor and cognitive task resulted in deterioration of postural stability in this study. The cognitive task was more demanding task for the subjects and hence resulted in greater dual task interference and postural instability.

Keywords: Dual task performance, Postural stability, Parkinson's disease.

Introduction

Postural instability is a common and serious problem in Parkinson's disease (PD). Postural reactions of up to 96% of all parkinsonian patients diminish during the course of the disease. Koller and colleagues (1) reported that 38 of 100 patients with PD fall- 13% of them more than once a week – 13% experience fractures, 18% hospitalisation, and 3% are confined to a wheel chair. In addition, social isolation occurs because of the fear of falling. Unfortunately, the effect of dopaminergic medication on postural instability is negligible (2). Furthermore, postural instability is not restricted to late stages of the disease, and it can even be the first presenting symptom.

Postural control has traditionally been considered an automatic or reflex controlled task, suggesting that postural control systems use minimal attention resources. However, recent research has provided evidence against this assumption. These studies suggest that there are

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rehearsing action sequences or consciously attending to maintaining balance while movements are performed. These automatic tasks of maintaining posture or walking may become cortically controlled. So when the patients are asked to perform these tasks along with any other motor or cognitive task, there may be deterioration in either of them indicating limited attention resources.

The effect of concurrent performance of motor and cognitive tasks on postural stability has been studied. Morris et al (14) reported that people with PD performed poorly on a series of standing balance tasks when required to direct their attention towards reciting the days of week backwards. Those who were fallers showed greatest dual task interference. Using multiple tasks test, Bloem et al (15) showed that the number of healthy older people and those with PD who made movement errors increased as the secondary tasks became more complex. Those with PD made the most errors. There is a single study (16) that has seen the effects of both the tasks (motor and cognitive task) on postural stability. The cognitive task was more demanding than the motor task for the PD patients. A study performed on the effect of motor and cognitive task on the gait of PD patients, showed no difference in between the tasks ([17]). Different types of tasks were used in different studies.

The type of secondary task has been shown to influence the degree of dual task interference. This may be due to structural interference if the secondary task competes for similar cognitive resources to the postural task, or capacity issues if the task has a greater attention demand. The degree of interference to either the postural or secondary task is influenced by the individual's prioritization of the tasks. Preferential attention may be instructed or may arise out of the tasks themselves. Greater priority may be given to a task that poses a greater threat to stability than to the concomitant secondary task. Whether the type of secondary task (motor or cognitive) or just the level of complexity of the tasks is a major determinant of dual task interference in people with PD is not clear.

Need and Significance of Study

It is well established that concurrent motor task or cognitive task performance in PD accentuates movement disorders during upper limb tasks and walking, although whether this applies to postural control has not been examined in detail. Though motor task and cognitive task both deteriorate the balance, there is some difference between them. There is scarcity of literature on the comparison of effects of cognitive and motor task on postural stability in PD patients. A study by Roberta Marchese et al (2003) compared the effects of motor task and cognitive task on postural stability in PD patients, which showed greater interference effects of cognitive task on postural stability ([16]).

The therapists should know that how these motor and cognitive tasks differ in their effects on postural stability in PD patients. If there is difference in the effects of motor and cognitive task on postural stability then these two should be addressed separately during teaching the patient strategies to avoid them and even during dual task training.

Purpose of the Study

The purpose of this study is to observe the effects of performance of secondary motor task and secondary cognitive task on postural stability in patients with Parkinson's disease, using clinical steady standing tests and to further clarify whether the type of task is a major determinant of severity of dual task interference.

Statement of the Question

Do the secondary cognitive task and secondary motor task have different effects on static postural stability in patients with Parkinson's disease?

Experimental Hypothesis

Secondary motor task and secondary cognitive task differ in their effects on static postural stability in patients with Parkinson's disease.

Operational Definitions ([18-19])

Postural Stability or balance is defined as the ability to maintain the projected center of mass within the limits of the base of support. Static Postural Stability is the ability to maintain the body in equilibrium during rest. Postural stability as measured in this study is the ability of the subject to maintain the following steady stance positions, each for a maximum time of 30 seconds.

significant attention requirements for postural control, and that these requirements vary depending on the postural task, the age of the individual and their balance abilities ([3-5]).

The mechanisms of postural instability in Parkinson's disease are still uncertain and probably complex. PD patients start at a disadvantage. Their flexed posture means that the center of gravity is not comfortably over the base of the feet. There are problems with motor adaptation; there is loss of anticipatory postural control; co activation of muscles in trunk and lower limbs and reduced limits of stability ([6-10]).

Performance of more than one task at a time may lead to fall in PD patients. Many activities of daily life involve performing several tasks at once, such as talking and walking, or maintaining standing balance while dressing. Although most people are able to perform several tasks at the same time, some individuals experience difficulty, particularly if one is a 'postural task' that requires them to maintain balance and upright stance. The term 'dual task interference' refers to the deterioration in performance that occurs when two tasks are performed simultaneously. People with basal ganglia dysfunction are particularly at risk of severe dual task interference due to the role of this part of the brain in the regulation of the movement automaticity. Iansek et al (11) and Seitz and Roland (12) have described how the motor cortical regions of the frontal cortices play a key role in enabling a person to perform a motor skill during the early stages of motor learning. Once the skill has been practiced to the level that it is well learned, it is relegated to the basal ganglia for control. Thus while basal ganglia enable the motor skill to be executed 'automatically' with the correct speed, amplitude and force for the context in which it is performed, the frontal cortical regions of the brain are free to control other tasks 'on line', such as speaking, arithmetic or doing any other motor task.

In basal ganglia disease, the ability to perform more than one task at time can become severely compromised due to less capacity for movement automaticity (13). In such situations, patients must resort to the use of attention strategies to maintain stability. Attention strategies are cognitive activities such as planning out and mentally

Feet placed 10cm apart.

Feet placed together.

Stride Stance: Feet placed 10cm apart and with the heel of the front foot in line with the toes of rear foot.

Tandem Stance: One foot directly in front of other and toes of rear foot contacting the heel of front foot.

Single Leg Stance: Non-weight bearing leg held 45 degrees knee flexion and hip in neutral flexion and 5 degrees abduction.

Dual Task performance: It is also known as concurrent performance and involves the execution of a primary task, which is the major focus of attention, and a secondary task performed at the same time.

Secondary Motor Task: is defined as any motor activity a subject is engaged in while performing motor task of maintenance of posture, balance or gait. The secondary motor task used in this study is the sequence of thumb opposition to second, third, fourth and fifth digits of the dominant hand.

Secondary Cognitive Task: is defined as a cognitive task, which diverts ones attention from the regulation of primary motor task. The secondary motor task used in this study is reciting the days of week backwards.

Materials and Methods ([14,16-18,20-22])

Sample

42 subjects with idiopathic Parkinson's disease in stage 3 of Hoehn and Yahr disability scale (diagnosed by a neurologist). The study was done at A.I.I.M.S, New Delhi.

Patients who were in Hoehn and Yahr stage 3 of disability, medically stable, were able to stand or walk unassisted for a distance of 10 meters, were able to understand and follow commands (score of 24 or more on Mini Mental Status Examination (M.M.S.E) were included in the study.

Patients with any other neurological condition affecting balance (Cerebellar Ataxia, Stroke, Traumatic Head Injury etc). any painful musculoskeletal or joint problem affecting lower limb with scores of less than 20 on Mini Mental Status Examination, with visual or hearing impairment (if any, then successful use of corrective lenses/hearing aids), on tranquillizers, with postural hypotension or lower limb dyskinesias were excluded from the study.

Sample of Convenience was taken. A signed informed consent was obtained from the prospective candidates before their participation.

Instrumentation and Tools for Data Collection: Foot Print Templates made on coloured paper to align feet in various positions, Digital stopwatch to record time spent in various positions.

Independent Variables were secondary motor task (Sequence of thumb opposition to second, third, fourth and fifth digits of dominant hand) and secondary cognitive task (reciting the days of week backwards). The outcome measures to assess static postural stability are the clinical steady standing tests: Standing with feet 10cm apart; Standing with feet together; Stride stance; Tandem stance and Single limb stance.

Procedure

A demonstration for each test position was given to the subjects prior to testing. Subjects were given the opportunity to practice each test twice before the actual trials begun. Foot print templates were placed on the floor to align the feet in various positions. Subjects stood bare foot on these foot print templates. All the subjects were asked to perform 5 steady standing tests with their eyes open. These tests were: standing with feet 10cm apart; standing with feet together; stride stance (alternately with right and left foot ahead); tandem stance (alternately with right and left foot ahead) and; single limb stance (alternately on right and left leg). The tests were repeated under 3 different conditions: without any secondary task; with a secondary motor task (thumb opposition to fingers tips) and; with a secondary cognitive task (reciting the days of week backwards).

A standard verbal protocol was followed for all the patients in the beginning of each test. The instructions to the subjects while performing the cognitive task were: 'While you balance yourself in this position I want you to say the days of the week backwards out loud as many times as you can until I say stop'. The instructions to the subject while performing the motor task were: 'While you balance yourself in this position I want you to touch your finger tips with your thumb as many times as you can until I say stop'. Initially the subject took some external support to acquire the test position, but at the moment of recording time he stood without support. During these tests, subjects were instructed to keep their arms by their sides. If they began to move their arms to regain their balance they were instructed to retain them to their sides. A stopwatch recorded the time spent in each of the positions.

Each test was concluded if the subject changed their initial stance position, took some external support, stopped performing the task or maintained the position for maximum testing time of 30 seconds.

3 trials were given for each of the positions if the subject could not maintain it for 30 seconds. The best of three trials was taken for data analysis. Adequate rest periods were given in between the testing as per the patients will. The order of the three conditions was randomised amongst the entire group (by lots system).

Data Acquisition

Data was collected during the 'on phase' of Levodopa treatment i.e. after 45 minutes to 1 hour of drug administration. The room for data collection was quiet, warm and well lit. There was one attendant around the patient to support him if he unbalanced himself. Data was recorded in the data collection form along with the other details of the patient.

Data Analysis

The General Linear Model Repeated Measures Analysis of Variance (ANOVA) was used to examine the changes in the outcome variables under 3 different conditions. If there were any significant changes, Bonferroni post-hoc comparison of the outcome variables was performed. The significance level set for this study was $p<0.05$. The software program used for data analysis was SPSS 11.5 and STATA 8.0.

Results

42 patients in Stage 3 of Hoehn and Yahr Scale were included in this study. The subject characteristics are as following (also Refer Table 1). There were 33 male and 9 female patients.

Age (Mean ± S.D = 65.23 yrs ± 4.88 yrs)

Body Weight (Mean ± S.D = 64.14 kg ± 5.47kg)

Disease Duration (Mean ± S.D = 4.88 yrs ± 2.52 yrs) Feet Apart

The difference between motor task (29.8 ± 0.63) and cognitive task (29.45 ± 1.34) was non significant in the 'Feet Apart' position (at $p > 0.05$). (Refer Table 2).

Feet Together

The performance of motor task (27.88 ± 3.01) and cognitive task (27.42 ± 3.29) showed significant differences in the 'Feet Together' position (at $p < 0.05$). (Refer Table 3).

Stride Stance

The performance of motor task and cognitive task showed significant differences in the Left and Right 'Stride Stance' positions (at $p<0.05$). The Mean and S.D values for motor task in 'Right Stride Stance' are 28.21 ± 3.31 and for 'Left Stride Stance' are 28.59 ± 3.48. The Mean and S.D values for cognitive task in 'Right Stride Stance' are 27.73 ± 4.13 and for 'Left Stride Stance' are 28.14 ± 4.35. (Refer Table 4 and 5).

Tandem Stance

The performance of motor task and cognitive task showed highly significant differences in the 'Tandem Stance' position (at $p<0.05$). The Mean and S.D values for motor task and cognitive task in 'Right Tandem Stance' are 11.14 ± 5.94 and 9.35 ± 5.77 respectively. The Mean and S.D values for motor and cognitive task in 'Left Tandem Stance' are 11.26 ± 5.25 and 9.3 ± 5.16 respectively. (Refer Table 6 and 7).

Single Limb Stance

The performance of motor task and cognitive task showed highly significant differences in the single limb stance position (at $p<0.05$). The mean and S.D values for motor task and cognitive task in right single limb stance are 3.09 ± 3.85 and 1.61 ± 2.52 respectively. The mean and S.D values for motor and cognitive task in left single limb stance are 2.73 ± 3.66 and 1.14 ± 2.5 respectively. (Refer table 8 and 9).

Looking at the mean values of tasks, it is evident that cognitive task is affecting postural stability more than the motor task. This supports our experimental hypothesis that motor task and cognitive task differ in their effects on postural stability and cognitive task is affecting balance more than the motor task.

Discussion and Conclusion

This is one of the few studies observing the effects of motor and cognitive task on postural stability. For ease of clarity and understanding, we shall consider and discuss these findings individually.

Concurrent performance of motor task resulted in interference with postural stability in the steady stance positions, except the 'Feet Apart' position. Also, the concurrent performance of cognitive task (reciting the days of week backwards) resulted in interference with postural stability in all the steady stance positions.

In PD, the control of posture becomes a conscious process controlled by motor cortex because of the defective basal ganglia pathways. On the other hand, the sequential finger movement (motor task in this study) also involves the supplementary motor area activation. Similarly reciting the days of week backwards (cognitive task in this study) also requires processing involving the cortex. Therefore, when the primary task of maintaining posture is done along with any secondary task, the performance in either of them deteriorates. This view is supported by other studies also. The dual task interference occurs because of the sharing of attention resources between the two simultaneous tasks (Capacity sharing model of dual task interference). The attention capacity is said to be limited and so when two tasks are performed simultaneously the attention is divided between them. The allocation of attention is dependent on many factors; nature of secondary task and postural task, goal of subject and the instructions given to the subject ([22]).

In this study the subjects were given in instructions to concentrate on continuing the secondary task and therefore more attention was given by them to these secondary tasks, hence the postural stability deteriorated. It was seen that some patients were not at all able to continue with the secondary task, especially during difficult test positions (single limb stance) because at that time maintaining stability might have become their primary goal. This is known as the "posture first" hypothesis.

In the 'Feet Apart' position no significant difference was seen between the 'No Task' and the 'Motor Task' condition because this was an easy position to maintain and so the subjects would have used their attention resources to continue with the secondary task performance.

The second main finding of this study was that the balance deteriorated less while performing the motor task than while performing the cognitive task. Cognitive task was more demanding than the motor task and hence the postural stability deteriorated more during the performance of cognitive task.

The cognitive task of reciting the days of week backwards was a more novel task for the patients than the motor task of thumb and finger opposition; therefore, the cognitive task was difficult to perform and required more attention. The motor task after few repetitions might have become an automatic task for the patient, whereas, the cognitive task performed each time might have required mental processing and thinking and so remained an attention-demanding task. Also that each task was repeated many times by the subjects and so motor learning might have occurred. As the motor task was easy so more learning occurred for it as compared to the cognitive task and this could also be one of the reasons that why balance deteriorated less during the motor task performance. Learning made the task easier to perform.

The cognitive task used in this study was not a pure cognitive task but a verbal-cognitive task because the subjects were asked to say aloud the days of the week. A silent mental task might have showed less significant differences but it is difficult to confirm whether the patient is actually doing or not a silent cognitive task.

Also acknowledging the fact that cognitive decline is present even in early stages of PD, we can say that cognitive task was more difficult. Although the patient's inclusion criteria required MMSE score of equal to more than 24, it can still be argued that Mini Mental Status Examination cannot rule out minor deficits in cognition and especially those that may become evident during dual task performance.

Again the difference in between these two tasks was non significant during the 'Feet Apart' position because it might be an easy position for the patients and so they were able to complete both the tasks.

According to the 'Cross Talk Model' of dual task interference, the motor task and the postural task required the same input and output resources and thus increasing the efficiency of these pathways (22). This might have led to less deterioration in balance along with the motor task performance than along with the cognitive task. Mainly the frontal and temporal cortices of the brain control human speech; posture is regulated by brainstem, spinal, cerebellar and basal ganglia nuclei, with a small amount of cortical input.

The 'Tandem Stance' and 'Single Limb Stance' positions are more sensitive tests to identify dual task interference and are also significant in identifying the differences between motor task and cognitive task. Melzer et al (2001) (24) explained that alterations in base of support and cognitive task had an impact on postural sway in older subjects. Adaptation of postural control to a varying BOS diminishes proprioceptive information from ankle musculature. It has also been shown that amongst the Berg Balance Scale items, the most difficult are the maintenance of standing position with a narrow base of support, turning 360 degrees and standing on one foot ([25-27]).

The results of 'Feet Apart', 'Feet Together' and 'Stride Stance' positions were confounded by the ceiling effects i.e. most of the subjects were able to maintain these positions close to 30 seconds.

The differences in data between the right and left sides of stride stance, tandem stance and single limb stance indicate that PD is an asymmetrical disease.

Discussion of Methodology

There is a single study in PD (16), which has compared the effect of motor and cognitive task on postural stability. That was a posturographic study. Posturography is not commonly used in clinical settings. Therefore the need to correlate this difference in effect with some clinical tests of balance was necessary. Hence, these steady standing tests were used in our study.

Secondly these tests are based on the

assumption that as base of support decreases, the stability demands increase. Therefore, it will help us in still better understanding of the dual task interference and how it depends on the increasing demands of postural and task complexities.

Stage 3 patients on Hoehn and Yahr Scale were included in the study because at this stage the postural instability becomes clinically evident.

Data was collected during the 'on phase' of levodopa treatment in order to diminish or remove the symptoms of rigidity, bradykinesia and tremors that can make the testing procedure difficult.

Patients with lower limb dyskinesia were not included in the study because it might be difficult for such patients to maintain stance.

Patients were ruled out for any significant cognitive deficits, using MMSE, to ensure that they were to understand and follow commands.

The speed of secondary task performance was not taken into account because under normal circumstances, PD patients are likely to trade off velocity for safety and adopt a slower performance.

The tasks used in this study were non-functional; therefore more real world tasks can be used in future.

The variations in the age and weight of the patients do not affect our results because we are comparing the difference between the tasks against the "no task" condition that serves as a baseline data.

The deterioration occurring in the secondary tasks was not recorded in this study.

Comparison With Other Studies

Another study (16) on effect of motor task and cognitive task on balance in PD patients also supports our result. The difference between the two tasks was significant at p = 0.023. This difference was seen when the patients stood with their feet apart. The significance value is more than that seen in our study because they measured postural sway using posturography technique, which is more sensitive than any clinical test of balance.

A study (17) observing the results of both the tasks on the gait of PD patients showed no difference between the two tasks. Both the cognitive (digit subtraction) and the motor (coin transference) tasks used in this study were novel and so might be equally attention demanding. They explained their results using the capacity sharing model of attention and concluded that type of task is not a major determinant of dual task interference.

Thus, in dual task context when postural demands on attention resources are low, secondary tasks that are similarly low in attention demands may not affect postural stability but more demanding secondary tasks might. However, when postural demands are high, even relatively non demanding secondary tasks might adversely affect postural stability.

We would like to conclude our discussion by writing that it is still not clear that whether there is any difference between the two types of tasks or its just that the tasks are arranged in a hierarchy. In order to understand this paradigm in a better way, more clinical research should be done.

Limitations of the Study

The generalisation of the results of this study can be made to the group of patients with moderate to severe degree of Parkinson's disease (stage 3 of Hoehn and Yahr disability scale) and during the "on-phase" of dopaminergic medications and double blinding would have improved the reliability of the measurements further.

Future Research

A wide array of research can be done in this regard. To fully understand the effect of motor task and cognitive task on postural stability and how they differ, we need to study the effects of various types of skilled, non-skilled, complex and simple tasks. Also effect of more real life activities on balance should be studied. Changes in the brain through biochemical or electrophysiological studies might make it clearer that how do different tasks act at brain level. The effect of dual task interference can be studied in brain injured, stroke, cerebral palsy and other patients. Dual task training can be administered to the patients and results be seen.

Relevance to Clinical Practice

Clinical interventions to reduce dual task interference can be divided into rehabilitation to improve the ability to perform multiple tasks, or compensatory strategies, if the underlying difficulty cannot be overcome. For both of these approaches, raising awareness about the problem of dual task interference with the person, their caregiver and other team members is an initial step. Easy changes can make a difference, including altering the environment (ensure good lighting, reduce obstacles) and simplifying the way in which daily activities are performed (sit down to talk on telephone, avoid thinking while taking bath, avoid talking while walking). This approach is important for safety, to reduce the chance of a trip or fall resulting from inability to perform multi-task.

There is very little published for dual task training in balance or gait. In amputees (28) initially dual task interference was seen but after they were given balance re education the interference reduced because the task of maintaining balance gradually became less demanding. It has been suggested in many studies in psychology that dual task interference can be reduced or almost eliminated when both tasks become quasi automatic following a series of practice sessions. However research work is still needed to confirm this in PD patients.

This increased understanding could serve as a basis for the development of new balance retraining programs that focus on training under the context of multiple tasks. The therapist in order to challenge and improve balance could exploit the concept of multiple hierarchies in both postural and secondary tasks. Dual task interference increases with increasing complexity of both the postural task and the second task. So increasing the difficulty of both tasks could be a logical way to progress treatment. Similarly, intervention could progress from performing dual tasks to multiple tasks. The type of secondary task can vary from a cognitive one to a motor task.

Prioritisation is also important in maintaining safety when performing more than one task. This may be asserted initially with conscious control, where attention is diverted away from the postural task for short and then increasing lengths of time, or during more critical phases of balance recovery. Alternatively, changing the prioritisation toward the postural task is required when compensating for dual task interference that is not improving or when safety is the primary concern. Thus it suggests that in persons where postural ability has potential to improve, so can their dual task ability.

Therapists should train newly diagnosed patients of PD for dual task performance with the hope that intensive practice in the early stages might enable them to learn new ways of performing more than one task at a time; however, this is still to be investigated.

These results suggest that dual task interference on postural control occurs in PD patients even during simple motor (sequence of opposition movements of thumb to the second, third, fourth and fifth fingers) or cognitive task (reciting backwards the days of the week). Postural stability was more affected during the cognitive task performance because it was more difficult task for the patients and demanded more attention.

Table 1 Subject Characteristics

	Mean ± S.D
Age	65.23 ± 4.88
Weight	64.14 ± 5.47
Disease Duration	4.88 ± 2.52

Table 2 Comparison Of Tasks In 'Feet Apart' Position

	Mean ± S.D	F value	P value
No Task (NT)	30 ± 0	6.213 (For Repeated ANOVA)	0.003
Cognitive Task (CT)	29.45 ± 1.34		
Motor Task (MT)	29.8 ± 0.63		

NT vs CT = 0.036	NT vs MT = 0.175	MT vs CT = 0.061

Table 3 Comparison Of Tasks In 'Feet Together' Position

	Mean ± S.D	F value	P value
No Task (NT)	28.47 ± 2.36	22.210 (For Repeated ANOVA)	0.001
Cognitive Task (CT)	27.42 ± 3.29		
Motor Task (MT)	27.88 ± 3.01		

NT vs CT = 0.001	NT vs MT = 0.001	MT vs CT = 0.04

Table 4 Comparisons Of Tasks In 'Right Stride Stance' Position

	Mean ± S.D	F value	P value
No Task (NT)	28.5 ± 3.07	11.2 (For Repeated ANOVA)	0.001
Cognitive Task (CT)	27.73 ± 4.13		
Motor Task (MT)	28.21 ± 3.31		

NT vs CT = 0.03	NT vs MT = 0.01	MT vs CT = 0.01

Table 5 Comparisons Of Tasks In 'Left Stride Stance' Position

	Mean ± S.D	F value	P value
No Task (NT)	28.97 ± 2.96	9.872 (For Repeated ANOVA)	0.001
Cognitive Task (CT)	28.14 ± 4.35		
Motor Task (MT)	28.59 ± 3.48		

NT vs CT = 0.005	NT vs MT = 0.01	MT vs CT = 0.039

Table 6 Comparisons Of Tasks In 'Right Tandem Stance' Position

	Mean ± S.D	F value	P value
No Task (NT)	12.71 ± 6.05	89.69 (For Repeated ANOVA)	0.001
Cognitive Task (CT)	9.35 ± 5.77		
Motor Task (MT)	11.14 ± 5.94		

NT vs CT = 0.001	NT vs MT = 0.001	MT vs CT = 0.001

Table 7 Comparisons Of Tasks In 'Left Tandem Stance' Position

	Mean ± S.D	F value	P value
No Task (NT)	12.76 ± 5.63	96.515 (For Repeated ANOVA)	0.001
Cognitive Task (CT)	9.3 ± 5.16		
Motor Task (MT)	11.26 ± 5.25		

NT vs CT = 0.001	NT vs MT = 0.001	MT vs CT = 0.001

Table 8 Comparisons Of Tasks In 'Right Single Limb Stance' Position

	Mean ± S.D	F value	P value
No Task (NT)	4.95 ± 4.2	50.842 (For Repeated ANOVA)	0.001
Cognitive Task (CT)	1.61 ± 2.52		
Motor Task (MT)	3.09 ± 3.85		

NT vs CT = 0.001	NT vs MT = 0.001	MT vs CT = 0.001

Table 9 Comparisons Of Tasks In 'Left Single Limb Stance' Position

	Mean ± S.D	F value	P value
No Task (NT)	4.61 ± 4.17	47.327 (For Repeated ANOVA)	0.001
Cognitive Task (CT)	1.14 ± 2.5		
Motor Task (MT)	2.73 ± 3.66		

NT vs CT = 0.001	NT vs MT = 0.001	MT vs CT = 0.001

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