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Number of Steps and Time to Accomplish Turning During Timed Up and Go Test in Community-Dwelling Elderlies With and Without Idiopathic Parkinson Disease

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Abstract

Background: Losing balance during locomotive actions becomes an increasing threat to both the community-dwelling elderly and elderly with Parkinson disease (PD). Those with PD may be at a high risk of fall due to particular characteristics during the turn. Turning around during locomotive actions may be one of problematic factors causing losing balance.

Objects: This study is part of a larger study, which in part aims to identify turning strategies, to compare the strategies in the elderly with and without idiopathic PD aged 51 years and older and to distinguish whether the turning strategies can predict the elderly at risk of falls.

Methods: A total of 22 community-dwelling elderlies (10 elderlies with idiopathic PD and 12 healthy elderlies) were investigated for the turning strategies during the timed up and go test.

Results: There were some significant differences between the two groups during turning ($p<.05$). The idiopathic PD group had a tendency of challenging on taking more number of steps, more time to accomplish and staggering more for the turn relative to the control group.

Conclusion: Taking more number of steps and more time to turn may be useful for distinguishing the characteristics of PD from that of the healthy elderly in turning strategy.

Key Words: Assessment; Elderly; Idiopathic Parkinson disease; Mobility; Postural balance.

Introduction

Losing balance during standing or locomotion becomes an ever increasing threat to the safety and health of the elderly, especially those at advanced ages. Twelve percent of community-dwelling U.S. adults experienced falling, which estimated approximately 80 million falls at a rate of 37.2 falls per 100 person-years and 111 billion dollars of total life time cost in 2010. Of those falls, more than one third of fall-related injuries occurred among the elderly group who are 65 years or older (Verma et al, 2016). The individuals who have a history of fall are therefore at a high risk for falling share particular characteristics. Those are most likely to be people who take more steps to turn 360°, who are unable to stand up from a chair without pushing off, who show high prevalence of antidepressant use, have impaired position sensation and fear of falling (Koller et al, 1989; Lipsitz et al, 1991; Stack and Ashburn, 2008).

The majority of individuals with Parkinson disease (PD) exhibit balance disturbances during the course of the disease predisposing to an increased risk of falling (Moscovich et al, 2013). Difficulties terminating tasks such as walking, turning or speaking task may be occurred during the progression of PD. These functional movements are attributed to sustained discharge in the supplementary motor area (SMA), rather than the rapid drop in neural activity in the SMA that normally allows movements to be terminated (Tan et al, 2011). The difficulty terminating loco-motor task is thought to be one of the ma-

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jor factors that predisposes individuals with PD to slip, trip or fall (Morris, 2000; Tan et al, 2011). Of these functional tasks, little quantitative evidences on the turning task has been documented.

Turning around during locomotion is most problematic for people who experience episodes of freezing or motor instability. When the healthy elderly perform 360° turning during walking, they tend to take fewer than 6 steps to complete the task. In contrast, individuals with PD and motor instability take up to 20 steps to turn, with increasingly shorter step length until an eventual stop. Additionally, they exhibit little movement of the trunk, head, arms on turning, whereas individuals without movement disorders turn by moving the head, shoulders, trunk and legs in a fluid sequence (Bagley, 1991).

An early study looked for the movement characteristics in the elderly aged 65 years and older that served as indicators of difficulty in turning during walking (Thigpen et al, 2000). The study found the absence of a pivoting motion to complete a turning task in an elderly group who had reported difficulty in turning during walking. In addition, the elderly group who had reported no difficulty in turning while walking even demonstrated some characteristics such as staggering, multiple steps (5 or more), hesitation in taking step, pauses or increased time.

The purposes of this study are; 1) to identify turning strategies that occur during the turning task, 2) to compare the movements in the elderly adults between with and without idiopathic PD and 3) to assess whether the turning strategies can predict individuals with idiopathic PD at risk for falling.

Methods

Subjects

This study is part of a larger project to describe movement characteristics and indicators of difficulty in turning while walking in older adults. Twelve community-dwelling healthy elderlies without idiopathic PD who met the study criteria were selected from a group of volunteers recruited from local retirement centers and served as control group. The criteria for the selection were; 1) residing in a community independently, 2) reporting a life style with moderate level of activity and 3) having no difficulties activities such as walking, walking outside, changing directions while walking, mobility, activities of daily living, maintaining balance. The healthy elderly were asked to fill out a form including their demographic information, history of falls within 6 months. The selection criterion was having no difficulty on turning while.

Ten eligible elderlies with idiopathic PD were selected from 43 volunteers who had been diagnosed with idiopathic PD and remained on their regular PD medication schedule recruited from local retirement centers and community civic organizations. The same selection criteria were used to select the community-dwelling elderly with idiopathic PD for this study. In addition, the subjects for idiopathic PD group were also evaluated with Hoehn and Yahr disability scale and not included for the study if they scored stage V on the scale, indicating wheelchair bound or bedridden unless aided for functional activities (Hoehn and Yahr 1967; Goetz et al, 2004). Seventeen percent (2/12) were rated 1 and 83% (10/12) were rated 2 by the disability scale for the PD group. These elderlies were then asked if they experienced one or more falls in the past 6 months.

A fall in this study was defined as an accident resulted in the person unexpectedly coming to the ground. Prior to the evaluation, all elderlies reviewed and signed an informed consent form approved by the institutional review board. This experiment was performed in compliance with the relevant laws and/or institutional guidelines. To be included in the study for both groups, all elderly subjects were required to be medically stable without any other neurologic or orthopedic disorders and cognitively normal with a score 24 or greater out of 30 on the Folstein Mini-Mental State Exam (Folstein et al, 1975).

Procedure

The timed up and go (TUG) test, a most widely used for evaluating basic mobility maneuvers, was originally developed for providing valuable information on fall risk of frail elderlies (Mathias et al, 1986). The instrument has widely been accepted for measuring functional mobility in various populations with arthritis, spinal cord injury and vertigo for groups apart from the frail elderly (Arnold and Faulkner, 2007; Freter and Fruchter, 2000; Herman et al, 2011; Hollands et al, 2010; Norén et al, 2001; Siggeirsdóttir et al, 2002; van Hedel et al, 2005). A version of the TUG test used in this study was adapted by Podsiadlo and Richardson (1991) and measured time in seconds for completing the test; 1) standing up from a chair with a 48 centimeter seat height, 2) walking a distance of 3 meters to a line on the floor, 3) turning with the way the elderly prefer, 4) walking back to the chair and 5) sitting down in the chair (Figure 1). The turning strategies in this study were classified into three categories; 1) pivoting on one foot or both feet simultaneously, 2) multiple steps for wide turning and 3) mixed with pivoting and steps.

Each subject was given one practice test followed by 3 test trials. The average value of 3 test trial measurements was used for the analysis. To address the turning strategies while walking using a standardized format of the TUG test components, turning activity in this study was defined as, when the elderlies completed the movement of the beginning and the end of 180-degree reversal in direction at the turning line on the floor. The last heel-strike prior to initiation of the reversal of direction was designated to the beginning of the turn, and the heel-strike of the first step initiating in a direct line back to the chair was designated the end of the turn. In addition, three components of the body segment (i.e., one of both feet) observed included: 1) heel-strike when the elderly started anticipating the turn, 2) mid-turn, and 3) heel-strike progressing walking back toward the chair. For this study, the whole procedure of the TUG test for each elderly were videotaped while performing the TUG test, including few practice trials followed by three successful trials. The videotapes were viewed with a video player with a stop-action function key and frame by frame slow motion capability. The each trial of the test was set to .01 second for timing of the entire test and each turn. Close observations were made to count the number of steps and strategies in the sagittal plane of movement for turning and was performed by a physical therapist who had 15 years of clinical experiences.

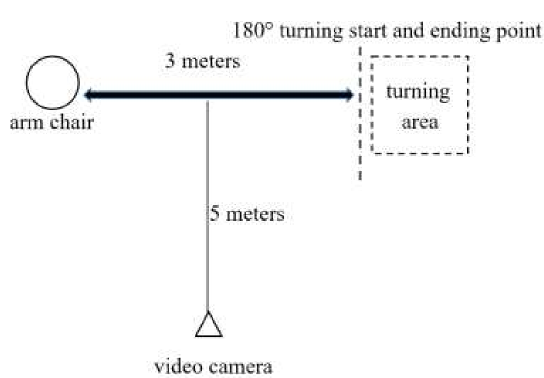

Figure 1. Schematic presentation of the videotaping set-up for turning task during timed up and go (TUG) test.

Data Analysis

Kolmogorov-Smirnov test was performed in order to determine whether the variables of the number of steps and the time taken to accomplish the turn for 2 groups (elderly with and without idiopathic PD) were normally distributed. Bivariate chi-square analysis of idiopathic PD versus control groups by demographic and turning-related characteristics was used to identify variables distinguishing those 2 elderly groups. Intra-rater reliability on two variables of the turning strategies was calculated by the use of Pearson's correlation coefficient. To determine the difference between the 2 groups in the turning strategies, t-test was performed with p-value less than .05.

Results

There was a total of 22 elderlies (10 elderlies with idiopathic PD and 12 elderlies for control group), aged 50 years and older, that participated in this study. Their mean age was 65 years with a standard deviation (SD) of 8.7 for the elderly with idiopathic PD and 67.1 years with a SD of 6.8 for the control group. Chi-square test revealed that the healthy elderly group without idiopathic PD (i.e., control group) was statistically less staggering than the elderly with idiopathic PD ($p<.05$). Both groups were not statistically different in the variables of age, sex, fall history and strategy while turning (Table 1). For inspecting any staggering signs while turning, none of elderlies for both group exhibited loss balance, while 5 out of 10 elderlies with idiopathic PD and 2 out of 12 elderlies of the control group showed loss balance but immediately self-corrected it.

As shown in Table 2, the Pearson's correlation coefficient were calculated to determine intra-rater reliability on the measurements of the number of steps and the time taken to accomplish the turning while walking.

Kolmogorov-Smirnov test confirmed that the distributions of both groups were not statistically different from a normal distribution. Thus, two-sample student t-test was performed to examine the difference between the groups in mean values of the number of steps and the time taken while turning. The t-test revealed statistically significant differences between the groups while turning ($t=-3.929$, $p=.001$ versus $t=-2.554$, $p=.019$). This comparison showed that number of steps while turning and the time taken to accomplish the turn was more in the elderly with idiopathic PD (Table 3).

Table 1. Bivariate chi-square analysis of PD versus control groups by various demographic and turning-related characteristics (N=22)

Characteristic	PD[a] group (n_1=10)	Rate (%)	Control group (n_2=12)	Rate (%)	Significance (p<.05)
Sex					
Male	4	40%	8	67%	
Female	6	60%	4	33%	
Age					
50≤Age≤59	3	30%	2	17%	
60≤Age≤69	3	30%	3	25%	
70≤Age≤79	4	40%	7	58%	
Fall history					
Yes	9	90%	0	0%	
No	1	10%	12	100%	
Staggering while turning					†
No loss balance	5	50%	10	83%	
Loss but self-correct	5	50%	2	17%	
Loss balance	0	0%	0	0%	
Turning Strategy					
Pivot	0	0%	4	33%	
Steps	6	60%	3	25%	
Mixed	4	40%	5	42%	

[a]Parkinson disease, †p<.05 significant difference.

Table 2. Correlation coefficients for intra-rater reliability in measurements of number of steps while turning and time taken to accomplish turning

	PD[a] group	Control group	p
Number of steps taken while turning	1.00	1.00	<.001
Time taken while turning	.99	.99	<.001

[a]Parkinson disease.

Table 3. Student t-test in comparison of both groups on the number of steps taken while turning and the time taken to accomplish the turn

Characteristics of turning		PD[a] group	Control group	p
Number of steps taken while turning	Mean±SD[b]	7.70±3.52	3.30±1.43	<.001[†]
	SE[c]	1.11	.41	
	Max steps[d]	14	7	
	Min steps[e]	4	2	
Time taken to accomplish the turn (seconds)	Mean±SD	5.34±4.50	1.98±.71	.019[*]
	SE	1.42	.20	
	Max time[f]	16.75	3.37	

[a]Parkinson disease, [b]standard deviation, [c]standard error, [d]maximum number of steps taken, [e]minimum number of steps taken, [f]maximum time taken to accomplish turn, [†] statistically significant at p=.001, [*]statistically significant at p=.05.

Discussion

This study represents an attempt in comparisons of turning strategies with clinically distinguished two groups, the elderly with idiopathic PD and community-dwelling healthy elderly without PD, in sagittal plane of motion during the TUG test by the use of videotaped images. The measurement quality of counting the number of steps and time taken during turning by viewing videotape image was an excellent way to measure the turning strategies. The primary findings of this study revealed that the elderly with idiopathic PD had a tendency of challenging relative to the healthy elderly without PD (i.e., control group), particularly shown in: 1) more steps required and 2) more time to accomplish turning task. Staggering and the complete absence of a pivoting strategy during turning was the distinguishing characteristics the elderlies with idiopathic PD.

The result of intra-rater reliability on the number of steps and the time taken while walking on both groups was exceptionally consistent (Pearson's r=.99 ~1.00 at p=.001) compared to several studies using the TUG test (Morris et al, 2001; Smithson et al, 1998). Overall, the reported correlations of the TUG test in those studies were ranging from .80 to .98 for the different phases. For the exceptionally high correlations, one may hypothesize that the measurements of this study was more focused on turning task only of the TUG test and thus less varied rather than performed on the test as a whole. Also, multiple reviews on the videotaped images were performed when the videotaped picture frames did not exhibit any sharp images. This would have been attributed to such high correlations. One concern of our measurement plan was measuring the number of steps from analogue picture frames. Future studies should measure the similar variables by using digitized images for enhancing the internal validity of study.

Bivariate chi-square analysis revealed that demographic and turning-related characteristics did not demonstrated the discrepancy between groups. However, the staggering during turning demonstrate difference between the idiopathic PD and healthy elderly groups. For the variable of staggering motion, seventeen percent of 12 healthy elderlies even showed that loss balance despite immediate recovering motions, while fifty percent of 10 elderlies with idiopathic PD reported the same challenge while turning. That is, the healthy elderly without idiopathic PD experienced less staggering relevant to the elderly with PD. This finding has been confirmed by many studies and introduced into the field of Parkinson's disease as reported here and elsewhere (Bagley, 1991; Bond and Morris, 2000; Hoehn and Yahr, 1967; Morris, 2000; Morris et al, 1996a; Morris et al, 1996b; Tan et al, 2011; Thigpen et al, 2000). Likewise, we have identified that 2 of 12 healthy elderlies without PD had loss balance while turning. This was a somewhat unexpected finding because all of the healthy elderlies had already reported no history of falls and lived independently in community prior to this study participation. However, that was not of our concern due to the ability to recover their balance. This may justify the necessity of intervening community health promotion programs for enhancing safe living in communities regardless of whether or not they are at risk of falling.

The most important finding of the study was that the elderly with idiopathic PD exhibited more steps and more time to accomplish the turn than the healthy elderly did. That is, the elderly with idiopathic PD had a tendency to take more and shortened steps (i.e., hypokinesia) and to slow down in their gait speed (i.e., bradykinesia) than the healthy elderly did. Whether the increased number of steps was attributed to the slower gait speed or vice versa, those two findings have traditionally been reported as major challenges to individuals with PD. These variables have consistently been presented as one of great predictors distinguishing persons with idiopathic PD from other parkinsonian syndromes or populations (Crenna et al, 2007; Morris et al, 1996b; Podsiadlo and Richardson, 1991; Tan et al, 2011; Thigpen et al, 2000), while counting steps during real life turning has been proved to be a poor indicator for fall prediction in few studies (Stack et al, 2004). The present study supports the studies in demonstrating that analyzing turning tasks can be interpreted in light of the need for predicting a complex functional deficit such as difficulties in walking.

In addition, none of the elderly with idiopathic PD in this study showed pivoting strategy while turning. A presumable reason may be postulated for the absence of pivoting strategy. Since the turning task analyzed in this study is a part of the TUG test incorporating several tasks such as standing up from a chair, walking 3 meters, turning around, walking back to the chair and sitting down, the elderly with idiopathic PD may have challenges with an inability to initiate or cease movement (i.e., akinesia) in the continuation of those tasks. Those elderly with idiopathic PD may have more of a difficulty to terminate locomotor action for preparing the turning than did the healthy elderly. That is, the difficulty in terminating walking to prepare for the turn, also known as "freezing", may cause the absence of pivoting strategy while turning.

Conclusion

The present study demonstrated that number of step and time taken while turning can be useful for distinguishing the chracteristic of PD from that of the healthy elderly without PD. Staggering and absence of pivoting strategy while tuning were the typical challenges in the elderly with idiopathic PD. Finally, analyzing the turning task only from TUG test can be a useful measure to predict potential fallers in the elderly with PD as well as healthy elderly.

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