Visual Cues Training on Parkinsonian Gait: 
A Randomized Controlled Study

Hayam M Sayed 1, Eman S Fayez1, Soheir M Abd El Rahman2, Abeer A Yamany3

Physical Therapy Department for Neuromuscular Disorders and its Surgery1, Faculty of Physical Therapy, Cairo University; Physical Therapy Department for Biomechanics2; Faculty of Physical Therapy, Cairo University; 
Physical Therapy Department for Basic Science3, Faculty of Physical Therapy, Cairo University

ABSTRACT

Background: Parkinsonian patients exhibited marked deficits in maintaining equilibrium during transitions between static and dynamic equilibrium. Walking can be initiated from many positions including the seated position and the sit- to-walk is a functional task of daily living activities. Objective: to evaluate the effect of visual cues on parkinsonian gait, and compare it with un-cued gait training. Methods: Twenty eight male Parkinson's patients with level II and III according to modified Hoehn and Yahr classification of disabilities were randomly participated, with duration of illness ranged from 2 to 5 years, and age ranged from 60 to 66 years old. Patients were randomly divided into two equal groups of 14; group I as study group received visual cues gait training and group II as control group received un-cued gait training. Both groups, received designed program of physical therapy for Parkinsonism, 3 times per week for successive 6 weeks. Spatiotemporal gait parameters and lower limb range of motion were evaluated for all patients pre and post treatment during sit to walk movements. Results: our results revealed that group I that received visual cues gait training showed highly significant improvement of spatiotemporal gait parameters, and lower limb range of motion than group II that received un-cued gait training. Conclusion: the study was concluded that visual cues during sit to walk movement are more effective in promoting parkinsonian gait than un-cued gait training. [Egypt J Neurol Psychiat Neurosurg. 2013; 50(3): 331-337]

Keyword: visual cues, Parkinsonism, gait, spatiotemporal data.

INTRODUCTION

Parkinson's disease (PD) is a chronic neurodegenerative movement disorder characterized by the presence of tremor, rigidity, bradykinesia, postural instability and gait disorders7. The incidence of Parkinson's disease is thought to be 0.3% of the population worldwide, and from 1%to 2% of individuals are more than 60 years old2. The progressive nature of Parkinson's disease often causes disruption in the daily functions. 

Gait disorders are one of the most incapacitating signs of PD. The negative impact of gait disorders includes immobility and the risk of falling7. A large number of studies have been performed to measure gait parameters in PD patients. These studies have shown that Parkinsonian gait is characterized by shortened step and stride length and reduced velocity5, decreased arm swing, increased double-limb support, and decreased lower-extremity ranges of motion8. Parkinsonian patient has been also reported to experience difficulties in rising from a seated position, and demonstrate impairments in the ability to control sequential and/ or coordinated movements of the joints9,10.

Walking can be initiated from many positions including the seated position; the sit- to-walk (STW) is a functional task of daily living activities. Better knowledge of the STW components and of their diverse movement strategies, may lead to better rehabilitation approaches11. STW task imposes challenges to both the locomotor and dynamic postural control systems and its biomechanical evaluation may provide valuable insight into postural control deficits in PD12-14.

Visual deficits have been demonstrated to parkinsonian patients with respect to visual evoked potentials and spatiotemporal contrast sensitivity15. The interest in the visual defect is enhanced by the possible relationships between gait disorders and visual perception, in as much as parkinsonian gait problems such as festination and the freezing phenomenon15. 

The earliest detailed analysis of parkinsonian gait and the effectiveness of utilizing vision in gait training were performed and reported a marked facilitation of locomotor activity16-20. So the current study demonstrated the effect of visual cues on parkinsonian gait during sit-to-walk task.
MATERIALS AND METHODS

Subjects:
Twenty eight male Parkinson’s patients with level II & III according to modified Hoehn and Yahr classification of disabilities were randomly recruited from the neurology outpatient clinic at Kasr El Aini Teaching Hospital and the out-patient clinic, Faculty of Physical Therapy, Cairo University. The patients were diagnosed as Parkinsonism by a neurologist and radiological investigations including magnetic resonance imaging (MRI) of the brain. Patients were classified according to Unified Parkinsonism Diseases Rating Scale (UPDRS): Motor part III score will range from 32 to 52 of disabilities, with duration of illness ranged from 2 to 5 years.

Table 1: Demographic characteristics of all Patients.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group 1</th>
<th>Group 2</th>
<th>t-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age(y)</td>
<td>63.45±4.85</td>
<td>61.6±5.08</td>
<td>0.970</td>
<td>0.341</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>170.55±10.12</td>
<td>170.9±7.84</td>
<td>0.925</td>
<td>0.096</td>
</tr>
<tr>
<td>Wight (Kg)</td>
<td>78±17.69</td>
<td>80.67±13.16</td>
<td>0.678</td>
<td>0.296</td>
</tr>
<tr>
<td>BMI</td>
<td>26.56±3.91</td>
<td>27.44±2.85</td>
<td>0.533</td>
<td>0.096</td>
</tr>
<tr>
<td>H&amp;Y</td>
<td>2.45±0.43</td>
<td>2.48±0.47</td>
<td>0.631</td>
<td>0.096</td>
</tr>
<tr>
<td>UPDRS</td>
<td>40.2±5.58</td>
<td>39.9±5.64</td>
<td>0.832</td>
<td>0.231</td>
</tr>
</tbody>
</table>

BMI body mass index, cm centimeter, H&Y Hoehn and Yahr classification of disabilities, Kg kilogram, M mean, p probability level, SD standard deviation, y years, UPDRS Unified Parkinson’s Diseases Rating Scale.

Instrumentation:
1- Opto-electronic motion analysis system: Qualisys Motion Capture System was used in this study to measure joint excursions of the hip, knee, and ankle joints of the right lower limb. The system consists of the following:
   1- ProReflex MCU 120 (motion capture unit): This unit was consisted of three cameras system to perform multi camera measurements. The cameras had a captured capability of 120 frames/sec, type: 170120, 100-240V (50-60 Hz), 20 w (max. 230 mA), 2- wand-kit (type 130440): It consisted of two parts; 1) L-shaped and 2) T-shaped wand was used to provide the cameras system with measurement points for the calibration process. This wand had two markers (one at each end, and the handle). 3- Personal Computer (PC): with the Q (Qualisys) Trac and Q Tools soft ware for data analysis. 4- Skin markers: small silver balls and of eight cm² surface areas. Each marker was capable of reflecting the infrared light sent from the ProReflex Cameras. II- Strips: 1-m blue masking tape strips of 2.5-cm-wide were placed orthogonal to the direction of walking.

Procedures:
All patients had the ability to stand up and ambulate at least ten meters independently. Patients were excluded if there were cognitive disabilities, skeletal deformities of the lower limbs, or uncooperative. Effect of medication was controlled by evaluating and treating all patients after 2 hours of medical administration. The protocol was approved by the ethics committee of Faculty of Physical Therapy, Cairo University. All subjects had signed an informed consent statement prior to participation. Patients were randomly divided through block randomization into two equal groups of 14; group 1(G1) as study group that received visual cues and group 2 (G2) as control group. The randomization procedure consisted of the simple drawing of a card (A or B) which determined whether the patient in study or control group. Demographic characteristics of all Patients were represented at Table (1).
After calibration, the subject preparation was started. Six passive reflective markers were placed and stacked by double face strap to the skin over the specified bony landmarks on the body as the following: 1- One on the anterior superior iliac spine, 2- on greater trochanter (GT), 3- on the lateral aspect of the knee joint line, 4- on the lateral malleolus, 5- over base of 5th metatarsal bone, and on calcaneous (center of the heel)26.

The patient sat, the trunk was erect on a slightly padded stool without armrest with adjustable height and the bare feet was at the same level and fully supported on the ground, the knee angle was in 90°flexion26, 27. The subject stood, instructed to walk on the walkway inside the Lab., with his maximal walking speed (as fast as possible). The right leg that was swing first during walking was identified and was remained consistent across the trial.

Treatment procedures: Both groups received the designed program of physical therapy (Maintain regular physical activity; walk at least 3 times a week for 40 minutes; Maintain upright posture; strengthening low back extensors and hip extensor muscles; practice standing up from seats of different heights; turning, walking, and moving from lying supine to sitting up over edge of the bed; muscle stretching and positioning programs 30 minutes per day; Practice strategies for overcoming movement slowness and postural instability) 3 times per week for successive 6 weeks, on the same days of the week and at the same time of day21.

Group I: In addition to the designed program of physical therapy, subjects were required to walk distance of ten meters with cues (1-m strips of 2.5-cm-wide blue masking tape), the subject was instructed at the beginning of each day to step over these visually cues over the walkway; the distance between the strips was 110% of the initial mean step length calculated from the first uncued assessment session24. While, Group II; patients were required to walk un-cued for the same distance. After the period of 6 weeks of training; patients were re-evaluated through the clinical and biomechanical assessment that performed pretreatment.

Data analysis: Q Tools program was used to determine the changes in flexion angles of the lower limb joints during walking. The angles were calculated automatically, by determining reference markers.

**Statistical Analysis:**

Data were statistically analyzed to compare the differences between both groups (GI and GII). The statistical package for social sciences (SPSS) was used for data processing, using the P-value < 0.05 as level of significance. The arithmetic mean was used for describing the central tendency of observations. The standard deviation is a measure of dispersion of results around the mean. Unpaired t-test was used to compare the mean changes in the subject's parameters in between the two groups. Paired t-test was used to compare the mean changes in the subject's parameters within the same group (pre and post treatment).

**RESULTS**

1- **Timed Up and Go (TUG) results, and Spatiotemporal data.**

There were no statistical significant differences between both groups pretreatment, regarding TUG duration of STW phases and spatiotemporal data, P>0.05, Figure 1-3. However, after 6 weeks of treatment, there were highly significant improvement of mean values of TGU, step length, step velocity, of GI when compared to mean values of GII, P<0.05. There was an improvement of time between seats off and heal off mean value of GI when compared to GII mean values after treatment with mean difference of 0.02, however, this improvement was not statistically significant (Table 2).

2- **ROM of Hip, Knee and Ankle joint during STW:**

There were no statistical significant differences between both groups pretreatment, regarding ROM of lower limb during STW movements P>0.05. However, after treatment both groups were improved. There were significant improvement of mean values of ROM of hip flexion, knee flexion and ankle dorsiflexion of GI (that received visual cues during movement) when compared to mean values of GII (un-cued), P<0.05 (Table 3).
Figure 2. Spatiotemporal mean values of group I pre and post treatment

Figure 3. Spatiotemporal mean values of group II pre and post treatment.

Table 2. Comparison between Mean values of spatiotemporal data both groups during STW movement after treatment.

<table>
<thead>
<tr>
<th>Variables</th>
<th>GI Mean±SD</th>
<th>GII Mean±SD</th>
<th>Mean difference</th>
<th>t-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TUG</td>
<td>13.65±2.42</td>
<td>16.15±3.98</td>
<td>2.50</td>
<td>3.51</td>
<td>0.005*</td>
</tr>
<tr>
<td>Step length</td>
<td>0.46±0.2</td>
<td>0.42±0.1</td>
<td>0.04</td>
<td>4.72</td>
<td>0.001*</td>
</tr>
<tr>
<td>Step velocity</td>
<td>0.81±0.12</td>
<td>0.76±0.18</td>
<td>0.05</td>
<td>4.54</td>
<td>0.001*</td>
</tr>
<tr>
<td>Time between seat off and heel off</td>
<td>1.19±0.75</td>
<td>1.21±0.47</td>
<td>0.02</td>
<td>5.09</td>
<td>0.054</td>
</tr>
</tbody>
</table>

GI group 1, GII group 2. TUG Timed Up and Go test.
* Significant at P≤0.01

Table (3): Comparison between Mean values of right lower limb ROM for both groups during STW movement after treatment.

<table>
<thead>
<tr>
<th>Variables</th>
<th>GI Mean±SD</th>
<th>GII Mean±SD</th>
<th>Mean difference</th>
<th>t-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angle of Hip flexion</td>
<td>32.1±4.12</td>
<td>28.19±5.41</td>
<td>3.91</td>
<td>5.60</td>
<td>0.0001**</td>
</tr>
<tr>
<td>Angle of Knee flexion</td>
<td>36.87±5.97</td>
<td>32.4±5.63</td>
<td>4.47</td>
<td>5.36</td>
<td>0.0023*</td>
</tr>
<tr>
<td>Angle of Ankle dorsi flexion</td>
<td>11.99±5.26</td>
<td>9.07±2.01</td>
<td>2.92</td>
<td>3.41</td>
<td>0.0020*</td>
</tr>
</tbody>
</table>

GI group 1, GII group 2. * Significant at P≤0.05
** Significant at P≤0.01
DISCUSSION

Results of this study showed that visual cues gait training improve gait performance in parkinsonian patients. However, both groups were improved after treatment, with significant improvement of GI that received visual cues during gait training than GI that received un-cued gait training. Such cues have included instructional28, auditory29, visual30, and cutaneous stimuli31.

During normal movement, it is believed that the basal ganglia, in conjunction with the supplementary motor area, trigger the performance of sequential movement components32. This internal cueing mechanism, however, is disrupted in PD by the basal ganglion pathology33, therefore, it has been hypothesized that the improvement seen with the use of external cues is attributable to such cues serving to bypass dysfunctional movement pathways in the basal ganglia34.

One suggestion is that stripes on the floor improve gait by drawing attention to the stepping process. Another is that each stripe may trigger a step during locomotion. A third is that, when patients walk, the stripes move downward in the visual field and induce specific dynamic visual stimuli that may improve motor performance35. Other study has shown that optic flow modulates walking velocity in normal subjects and that this effect was related to a modulation of stride & step length, the author used an artificial optic flow which resulted in a mismatch between the leg proprioceptive and the visual velocity information. Their results suggest that the adjustment of the gait velocity is the result of a summation of visual and leg proprioceptive velocity information36. Other previous studies coincided with the results of current study37-41.

Kinematic results of the current study revealed an increased step length primarily by increasing both flexion range of motion at the hip & knee that enabled an increase in the angular velocity of the whole limb. The increased angular velocity of the hip and knee joints shown during visual cues, along with the increased step length, contributed to the increased gait speed15,20, this could explain the decrease of time during TUG test post treatment for GI in the current study.

Conclusion

Visual cues training during sit to walk movement are more effective in promoting parkinsonian gait than un-cued gait training.

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التدريب بالإشارات البصرية على مشية الشلل الرعاش: دراسة عشوائية

الملخص

الخليفة: يظهر مرضى الشلل الرعاش عجز ملحوظ في حفاظ الأذن أثناء الانتقال من السكون إلى الحركة. المشي يمكن أن يبدأ من العديد من المواضع بما في ذلك وضع الجمود والجمود إلى المشي والتمرين مشاركة مع الإشارات البصرية، هيئة: إشارات وحولت من Yahr وHoehn الذكور مرضى الشلل الرعاش من مستوى الثاني وفقا لتعديل Hoehn Yahr، إشارة مشيدة: الإلكترون: 88 من 88 سنة. تم تقسيم المرضى عشوائيا إلى مجموعتين متساويتين من 44 المجموعة الأولى: برنامج مصمم من العلاج الطبيعي لحلات الشلل الرعاشية، 3 مرات في الأسبوع لمدة 6 أسابيع متتالية. وجرى تقييم المعاملات المشيئة الزمنية المكانية والمدى المحركي للإشارات من وضع الجمود للمشي، النتائج: تأثر تقييم المجموعة الأولى في تقييم المرضى أثناء المشي في ثلاثة من الإشارات البصرية. الخلاصة: تفيد الدراسة إلى أن التدريب بالإشارات البصرية أثناء الانتقال من وضع الجمود للمشي أكثر فعالية في تعزيز المشي لمرضى الشلل الرعاشية.