Influence of Sensory Integration Training on Postural Instability in Elderly with Parkinsonian Disease Following Stereotactic Surgery

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Abstract

Background: Impaired posture is strongly associated with function particularly in parkinsonian patients.Objective: to detectthe effect of sensory integration training on postural instability in elderly parkinsonian patients following stereotactic surgery.Methods: The study was conducted in out-patients clinic of the Faculty of Physical Therapy, Modern University for Technology and Information, Cairo, Egypt during the period from January 2018 to august 2018. Twenty seven patient's (16 males and11 females) idiopathic Parkinson's disease were included in the study, age 63.07 ± 2.46 years old. The duration of illness ranges from 5 years till 16 years. The patients were assessed before and after twelve weeks by the postural stability test, times up and go test and the unified Parkinson's disease rating scale.Participants were randomly assigned into three groups each group included nine patients, Group I received sensory integration training, Group II underwent stereotactic surgery and Group III received sensory integration training after ten days postoperative to stereotactic surgery.Results:There was significant improvement in group III more than in group I and II concerning the Overall stability Index, Ant./Post. and Med./Lat. Index. Conclusion:combining sensory integration training following stereotactic surgery is effective on postural instability in elderly with parkinsonian disease.

Keywords: Parkinsonian patients, Sensory integration and Stereotactic surgery.

Introduction

Parkinson's disease (PD) is a chronic and progressive neurodegenerative disease characterized by motor and non-motor features. The disease has a significant clinical impact on patients, families, and caregivers through its progressive degenerative effects on mobility and muscle control (1).

Parkinson's disease is characterized clinically by resting tremor, Bradykinesia, rigidity and postural instability (2). Although it is primarily a disease of the elderly, some individuals have developed PD in their 30s and 40s.In the industrialized countries, PD affects about 0.3% of the entire population, more than 1% of those older than 60 years and up to 4% of those older than 80 years (3).Parkinson's disease results primarily from the death of dopaminergic neurons in the substantianigra (4).

Dopaminergic substantianigra pars compacta (SNc) neurons degeneration is a slowly evolving process, therefore PD may take decades to develop. Substantianigra of each human hemisphere are estimated to have 120000 to 220000 dopaminergic neurons and when more than 50% of these cells are lost, patients start to develop signs and symptoms typical of PD (5).

Among the core symptoms of PD, postural instability is probably the most relevant one because reduced mobility and falling increase morbidity, leading to a poor quality of life (6).Postural instability is particularly challenging and difficult to treat as it does not respond well to dopaminergic therapy (7). Previous occurrence of falls being is one of the main predictors and several motor factors including measures assessing postural stability, abnormal posture, freezing of gait, impairment of rapid alternating movement, and dyskinesia identified. Cognitive impairment, including measures of global and executive function have also been associated with falls (8).

Other non-motor features including sleep, particularly rapid eye movement (REM) sleep behavioral disorder (RBD), autonomic symptoms, depression, cardiovascular and musculoskeletal comorbidity, and medication use, such as hypnotics and anti-depressants, have also been implicated in induce falling (9). People with Parkinson's disease have not only motor and cognitive deficits but also difficulties in sensory processing. Pointing to remembered targets is impaired in compared with controls, especially when visual feedback is not present (in dark conditions) (10).

Stereotactic surgery is a minimally invasive form of surgical intervention which makes use of a three-dimensional coordinate system to locate small targets inside the body and to perform on them some action such as radiosurgery, implantation, lesion, injection, stimulation, biopsy and ablation. Most neurosurgery for Parkinson's disease has been done on the thalamus, globuspallidus, pars interna, or sub thalamic nucleus, using either lesion or high frequency deep brain stimulation. In recent years, advances in imaging have increased the precision of surgical interventions; this and advances in the understanding of basal ganglia physiology have meant that deep brain stimulation of the sub thalamic nucleus has been preferred (11).

Study Design:

This was a controlled randomized trial of pretest posttest control group experimental design.

Procedure:

Sample size

The sample size calculations were performed using the G*Power software (version 3.0.10). Overall stability Index was chosen as the primary outcome measure. The effect size of Overall stability Index was estimated to be medium (0.25). Considering a power of 0.95, a _ level of 0.05, 3 groups and response variables of 3, a generated sample size of at least 7 participants per group would be required. Allowing for a 20% dropout rate, it was necessary to reach a total sample level of a minimum of 27 participants.

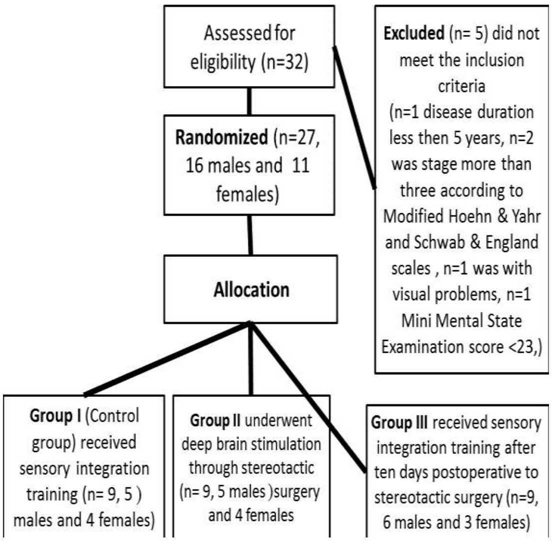

Figure (1): Random Allocation

Randomization

Immediately after the baseline evaluation, participants were randomly allocated and assigned to Group I (Control group) received sensory integration training, Group II underwent deep brain stimulation through stereotactic surgery and Group III received sensory integration training after ten days postoperative to stereotactic surgery.

Randomization was implemented simply by means of a computer-generated randomized table using the SPSS program (IBM, USA) prepared in advance to data collection. A specific identification number was assigned for each participant. These numbers were randomized into three groups. Individual and sequentially numbered index cards were secured in opaque envelopes. Each participant was given a hand-picked envelope and was relocated accordingly to their treatment groups.

Subject, materials and methods

Subjects:

Twenty seven patients diagnosed with idiopathic Parkinson’s disease were included in the study. Their age were ranged from 60 to 70 years old. Both genders were included (16 male’s and11 females). The duration of illness ranges from 5 years till 16 years. All patients were assessed by The Unified Parkinson’s disease rating score (UPDRS) (١٢-١٤). Patients were stage three according to Modified Hoehn&Yahr and Schwab & England scales (١٥) and were with normal or corrected vision (e.g., glasses or contacts) to see screen and get a good visual feedback. The cognition was enough that enables them to understand the requirements of the study. All participants had no other neurological conditions or mental deterioration (١٦). All participants did not require assistance to rise from chairs or beds, had no cardiovascular disease or other chronic conditions that could interfere with their safety during testing or training procedures or had not severe dyskinesia or “on-off” phases. Patients with any orthopedic that affect posture, cannot follow instructions as blindness and deafness, with cognitive and psychiatric disorders or who had participated in balance exercises in last six months were not included.

All participants were instructed to take their Parkinson’s medications regularly and were tested and trained during the on phase (1 to 2.5 hours after taking their morning dose) (17). Participants were randomly allocated and assigned into three groups each group included nine patients:

Group I (Control group): received sensory integration training.

Group II: underwent deep brain stimulation through stereotactic surgery.

Group III: received sensory integration training after ten days postoperative to stereotactic surgery.

Postural stability was estimated by measuring the overall stability Index, Ant./post. Index and Med./ Lat. Index (18) before and after twelve weeks using Biodex balance System. Inc., brook baren R&D plaza, 20 Ramsey road, box 702, Shirley, Newyork 11967-0702 USA.

Procedure:

A- Testing Procedures:

The Postural Stability Test: emphasizes patient’s ability to maintain center of balance. On this test the patient’s score assesses deviations from center, thus a lower score is more desirable than a higher score. Platform stability can be varied during the test by selecting from the Postural Stability Testing screen. Clinicians can also set trial time, number of trials, starting and ending platform stability, rest countdowns or bilateral test (18). It consists of six conditions:

- First conditionthrougheyesopenfirmsurface :baseline:incorporatesvisual,vestibular andsomatosensoryinputs.
- Second conditionthrough eyesclosedfirmsurface:eliminatevisual inputtoevaluatevestibularandsomatosensoryinputs.
- Third conditionthrough visualconflictonfirmsurface:somevisionpresentbutinformationconflictswithvestibularinformation.Thisconditionbringsinmoresomatosensoryandvestibular inputs.
- Fourth conditionthrough eyesopenonadynamicsurfaceusedtoevaluatesomatosensoryinteractionwithvisuallyinput.
- Fifth conditionthrough eyesclosedondynamicsurface:usedtoevaluatesomatosensoryinteractionwithvestibularinput.
- Six condition through visual conflict on dynamic surface: used to evaluate the mediation of visual with

and vestibular and somatosensory inputs.

A. Overall Stability Index (SI) represents the volatility of the position of the platform from the horizontal plane, expressed in degrees, during all movements in the test. Its high value indicates a high amount of movements in the test.

B. Ant./Post. Index (AP) reflects the volatility of the position of the platform for movements in the sagittal plane, expressed in degrees.

C. Med./Lat. Index (M/L) reflects the volatility of the position of the platform for movements in the frontal plane, expressed in degrees.

B- Training Procedures: Sensory Integration Training: this programme was designed according to American Society of Neurorehabilitation (19-20). Balance training consisted of exercises to improve both feedback and feed forward postural reactions. Patients were asked to repeat exercises belonging to 3 different predetermined groups of exercises.

The patients performed exercises of self-destabilization of the center-of-body mass consisted of voluntary motor actions in static or dynamic conditions (e.g., transferring their body weight onto the tips of the toes and onto the heels as in get to stand from sitting on stool; alternating stand on the right leg then the leg; stand with step forward or lateral direction. These tasks mainly involved feed forward postural control.

In addition to tasks that externally induced destabilization of the centre-of-body mass. The patient was required to maintain balance while standing on foam support bases of different consistency, on moveable balance board, or while the therapist was disturbing the patient's stability by sternal or dorsal pulling in order to induce perturbations in the anterior and posterior direction. These tasks mainly involved feedback postural control.

Also exercises emphasized coordination between leg and arm movements during walkingas well as locomotor dexterity over an obstacle courseand other potentially destabilizing activities

Results

The statistical analysis was conducted by using statistical SPSS Package program version 20 for Windows (SPSS, Inc., Chicago, IL). Additionally, testing for the homogeneity of variance revealed that there was significant difference ($P > 0.05$). Descriptive statistics included the mean and standard deviation for variables. Wilcoxon test used to compare between pre- and post-treatment within each group. Friedman test was used to compare among three groups. All statistical analyses were significant at level of probability ($P \leq 0.05$). The following statistical procedures were conducted:

- ***Descriptive statistics*** including the mean and standard deviation for demographic data (age, weight, height, BMI, duration of disease, times up and go test, UPDRS and Postural Stability Test (Overall Stability Index, Ant./Post. Index, and Med./Lat. Index) variables.
- ***Wilcoxon test*** to compare within

groups for Postural Stability Test (Overall Stability Index, Ant./Post. Index, and Med./Lat. Index).

- ***Friedman test***to compare among groups for Postural Stability Test (Overall Stability Index, Ant./Post. Index, and Med./Lat. Index).

- ***Significant level:*** all statistical analyses were significant at 0.05 level of probability (P ≤ 0.05).

1. Demographic data

Mean age values were 62.20 ± 1.14, 62.78 ± 1.42 and 64.22 ± 5.09 years respectively. Mean body mass values were 71.47 ± 5.89, 69.22 ± 3.27 and 69.58 ± 4.90 Kg respectively. Mean height values were 165.44 ± 8.33, 167.44 ± 8.53 and 162.44 ± 6.36 cm respectively. Mean BMI values were 26.25 ± 2.59, 24.82 ± 3.64 and 26.51 ± 3.37 Kg/m^2 respectively. Mean duration of disease values were 11.22 ± 2.53 11.60 ±3.26 and12.78 ± 3.34 years respectively. Mean times up and go test values were 7.14 ± 0.24, 7.05 ± 0.25 and 7.04 ± 0.21 seconds respectively. Mean UPDRS (Part III score) values were 45.38 ± 4.9644.57 ± 3.51 and 45.64 ± 4.63, respectively. Mean Hoehn and Yahr staging scale values were 3.00 ±0.56, 3.00 ± 0.50 and 3.00 ± 0.52 a.u. respectively. The sex distribution of male patients numbers (percentage) were 6 (66.67%), 5 (55.56%) and 5 (55.56%) respectively, and the female patients number (percentage) 3 (33.33%), 4 (44.44%) and 4 (44.44%) respectively. The statistical analysis revealed that no significant differences (P > 0.05) among groups in values of demographic data (age, weight, height, BMI, duration of disease, times up and go test, UPDRS and sex) **(Table 1 and Figure 2)**.

Table (1): Demographic data mean values among groups

Items	Group I	Group II	Group III	χ^2-value	P-value	Significance
Age (year)	62.20 ±1.14	62.78 ±1.42	64.22 ±5.09	0.182	0.913	NS
Body mass (kg)	71.47 ±5.89	69.22 ±3.27	69.58 ±4.90	1.647	0.438	NS
Height (cm)	165.44 ±8.33	167.44 ±8.53	162.44 ±6.36	0.667	0.639	NS
BMI (kg/m^2)	26.25 ±2.59	24.82 ±3.64	26.51 ±3.37	0.437	0.804	NS
Duration of disease (years)	11.22 ±2.53	11.60 ±3.26	12.78 ±3.34	0.667	0.717	NS
Time's up and go test (seconds)	7.14 ±0.24	7.05 ±0.25	7.04 ±0.21	1.471	0.479	NS
UPDRS (Part III score)	45.38 ±4.96	44.57 ±3.51	45.64 ±4.63	1.556	0.459	NS

SD: standard deviation P-value: probability value NS: non-significant.

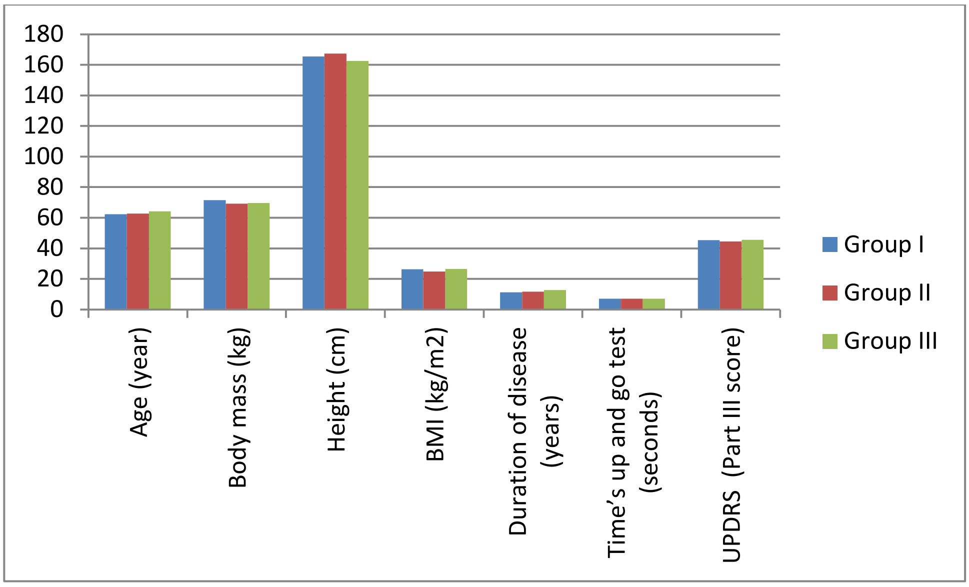

Figure (2): The demographic data of all groups

2. Postural Stability Tests

A. Overall Stability Index: The mean values of overall stability index Were 1.54 ± 0.47 in pre-result and became 2.21 ± 0.07 in post-result, with improvement percentage 30.32%, in group I (control group of sensory integration training only), 1.78 ± 0.44 and became 2.30 ± 0.23, with improvement percentages 22.61%, in group II (underwent deep brain stimulation through stereotactic surgery) and 1.12 ± 0.07 and became 2.19 ± 0.44, with improvement percentages 48.86%, in group III (received sensory integration training after ten days postoperative to stereotactic surgery).

The statistical analysis by Wilcoxon test revealed that there were significant differences within groups in overall stability index with Z- values = 2.554, 2.192 and 2.677 and P-values = 0.011, 0.028 and 0.007 for the three groups respectively ($P < 0.05$).

Also, the statistical analysis by Friedman test revealed that there was insignificant difference among groups in pre-results of overall stability index while there was significant difference among groups in post-results with X^2-value = 12.667 and 1.556 and P-value= 0.459 and 0.002 respectively (Table 2 and Figures 3).

Table (2): Overall stability Index within and among groups

Variables	Items	Pre-treatment Mean ±SD	Post-treatment Mean ±SD	Improvement %	Z-value	P-value	Significant
Overall stability Index	Group I	1.54 ±0.47	2.21 ±0.07	30.32%	2.554	0.011*	S
	Group II	1.78 ±0.44	2.30 ±0.23	22.61%	2.192	0.028*	S
	Group III	1.12 ±0.07	2.19 ±0.44	48.86%	2.677	0.007*	S
	χ^2-value	12.667	1.556				
	P-value	0.459	0.002*				
	Significant	NS	S				

SD:standarddeviationS: significant NS: no significant *Significant level (P ≤ 0.05) P-value: probabilityvalue

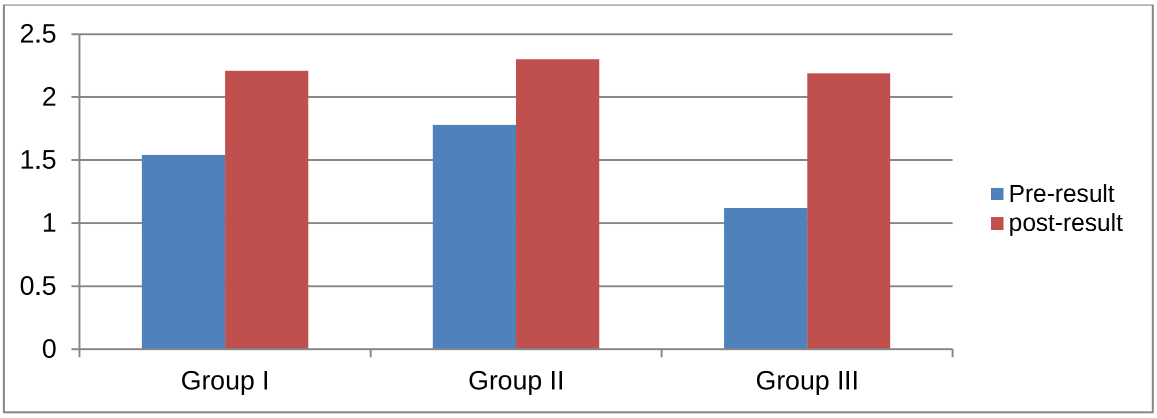

Figure (3): Overall stability Index of pre and post treatment within groups

B. Ant./Post. Index: The mean values of Ant. /Post. Index were 0.60 ± 0.11 and became 1.69 ± 0.42, with improvement percentage 64.50%, in group I, 0.77 ± 0.13 and became 1.79 ± 0.58, with improvement percentage 56.98%, in group II and 0.49 ± 0.09 and became 1.93 ± 0.13, with improvement percentage 74.61%, in group III.

The statistical analysis by Wilcoxon test revealed that there were significant differences within groups in Ant./ post. Index with Z- values = 2.665, 2.658 and 3.273 and P-values = 0.006, 0.008 and 0.003 for the three groups respectively (P <0.05).

Also, the statistical analysis by Friedman test revealed that there was insignificant difference among groups in pre-results of Ant./ post. Index while there was significant difference among groups in post-results with X^2-value = 7.600 and 0.222 and P-value= 0.895 and 0.022 respectively (Table 3 and Figures 4).

Table (3): Ant./Post. Index within and among groups

Variables	Items	Pre-treatment	Post-treatment	Improvement %	Z-value	P-value	Significant
		Mean ±SD	Mean ±SD				
Ant./ post Index	Group I	0.60 ±0.11	1.69 ±0.42	64.50%	2.665	0.006*	S
	Group II	0.77 ±0.13	1.79 ±0.58	56.98%	2.658	0.008*	S
	Group III	0.49 ±0.09	1.93 ±0.13	74.61%	3.273	0.003*	S
	χ^2-value	7.600	0.222				
	P-value	0.895	0.022*				
	Significant	NS	S				

SD:standarddeviation S: significant NS: no significant *Significant level (P ≤ 0.05) P-value: probabilityvalue

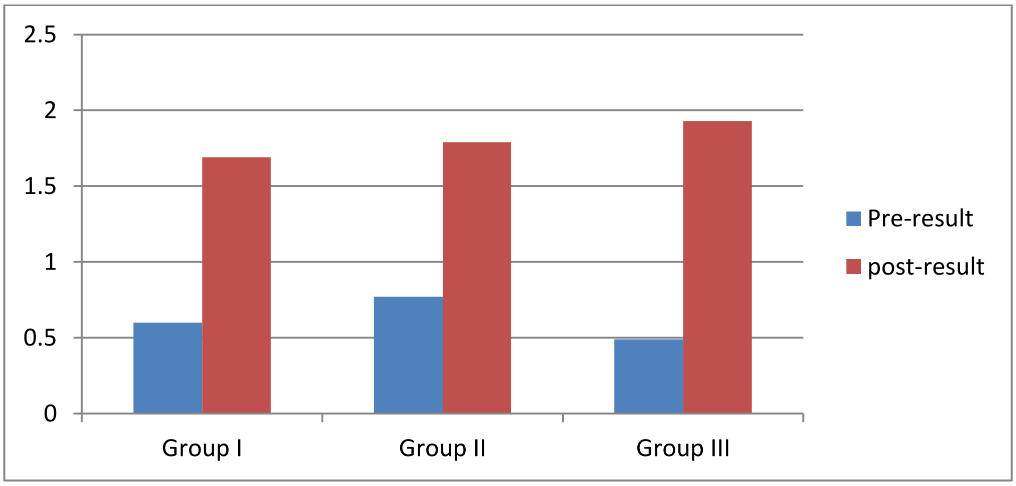

Figure (4): Ant./ post. Index of pre and post treatment within groups

C. Med./Lat. Index: The mean values of Med./Lat. Index were 0.45 ±0.14 and became 0.74 ±0.16, with improvement percentage 39.19%, 0.43 ±0.05 and became 0.56 ±0.07, with improvement percentage 23.21% and 0.38 ±0.04 and became 0.86 ±0.07, with improvement percentage 55.81% in the three groups respectively.

The statistical analysis by Wilcoxon test revealed that there were significant differences within groups in Ant./ post.

Index with Z- values = 2.673, 2.075 and 3.629 and P-values = 0.008, 0.038 and 0.005 for the three groups respectively (P <0.05).

Also, the statistical analysis by Friedman test revealed that there was insignificant difference among groups in pre-results of Med./Lat. Index while there was significant difference among groups in post-results with X^2-value = 10.237 and 4.667 and P-value= 0.079 and 0.037 respectively(Table 4 and Figures 5).

Table (4): Med. /Lat. Index within and among groups

Variables	Items	Pre-treatment	Post-treatment	Improvement %	Z-value	P-value	Significant
		Mean ±SD	Mean ±SD				
Med./ Lat Index	Group I	0.45 ±0.14	0.74 ±0.16	39.19%	2.673	0.008*	S
	Group II	0.43 ±0.05	0.56 ±0.07	23.21%	2.075	0.038*	S
	Group III	0.38 ±0.04	0.86 ±0.07	55.81%	3.629	0.005*	S
	χ^2-value	10.237	4.667				
	P-value	0.079	0.037*				
	Significant	NS	S				

SD:standarddeviation S: significant NS: no significant *Significant level (P ≤ 0.05) P-value: probabilityvalue

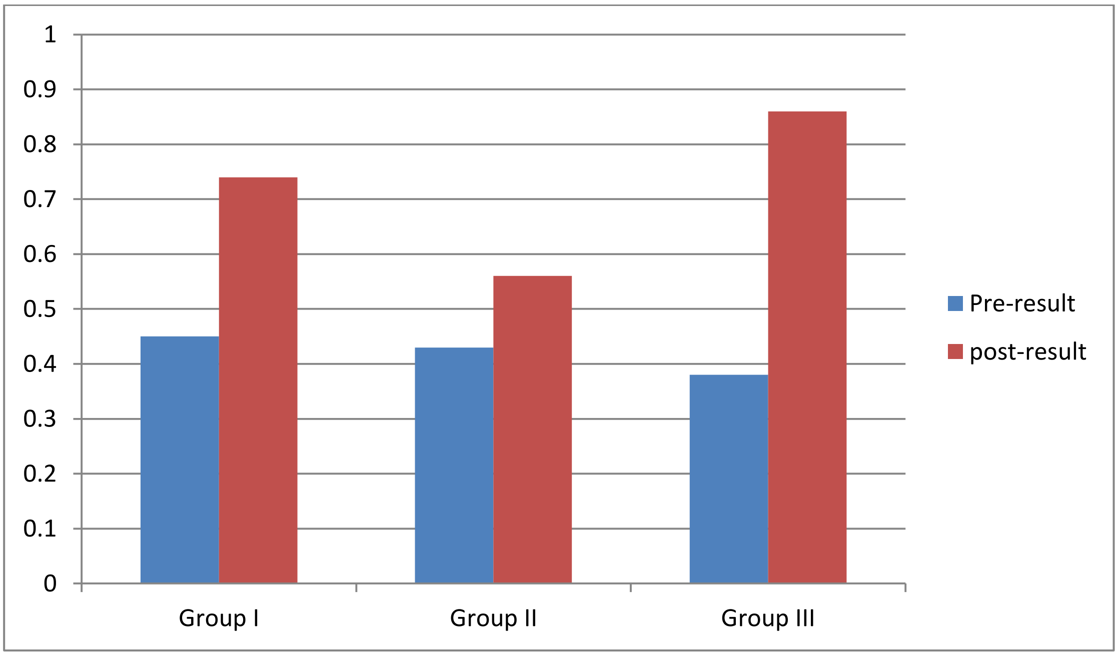

Figure (5): Med. / Lat. Index of pre and post treatment within groups

3. Percentage of improvement of Postural Stability among groups:

A. Percentage of improvement of Overall stability Index among groups:

There was a significant improvement in group III more than in group I and II. The percentof improvement was 30.32%, 22.61% and 48.86% of the three groups respectively (Z- value = 2.554, 2.192 and 2.677 respectively).

B. Percentage of improvement of Ant. /Post. Index among groups:

The results revealed a significant improvement in group III with a percentage of improvement of 74.61% (Z- value = 3.273) more than in group I and II with the percent of improvement were 64.50% and 56.98% respectively (Z- value = 2.665 and 2.658 respectively).

C. Percentage of improvement of Med. /Lat. Index among groups:

Friedman test revealed a significant improvement in group III (percentage of improvement = 55.81% and Z- value = 3.629) more than in group I and II (the percent of improvement were 39.19% and 23.21% with Z-value = 2.673and 2.075 respectively) (Figure 5).

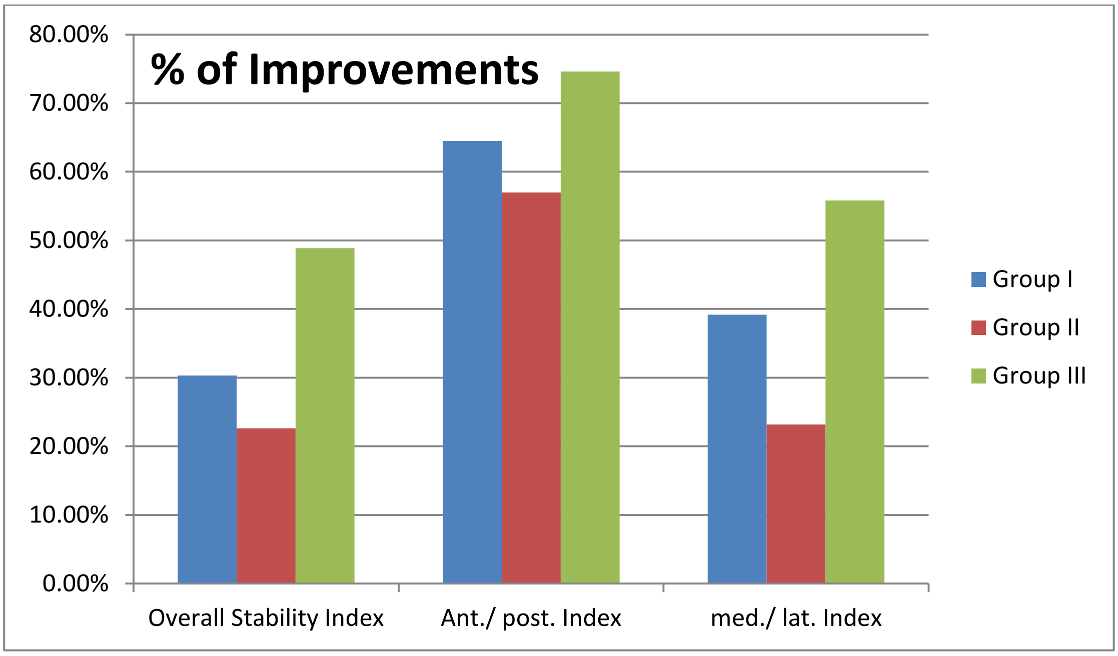

Figure (5): Percentage of improvement of Postural Stability among groups

Discussion

Result of the present study significant revealed improvement in overall stability index. Positive effects of exercise on improving postural stability have been documented in patients with PD (21-23). For example, intensive and challenging task-specific and functional mobility training may increase neuroplasticity in the basal ganglia system, which is responsible for active motor control in PD patients

(24 and 25). Neuroprotective and neurorestorative capacities after intensive exercise have also been reported (26-28).

Furthermore, the exercise-induced benefits on overall brain health, including increased blood flow and trophic factors and a stronger immune system, may help address the environmental need for neuroplasticity in the damaged brain (٢٩-٣١). That, in turn, results in significantlyimproving the mean values of Ant. /Post. Index.Therefore, the improvements in turning performance after training in our study may also be attributed to the mechanisms mentioned above.

However, effective sensory integration training protocols to improve postural stability have not yet been established. A previous study found that exercise training improved postural stability and also led to documented neurochemical and neuroplastic changes that occurred after the exercise intervention (32) so the concurrent study found a significantincrease inthe mean values of Med. /Lat. Index. But this improvement was not enough to prevent falling (33) and did not exert beneficial effects on balance performance (34). Previously, we found that balance ability and lower extremity muscle strength, especially of the extensors and abductors, influenced turning performance in individuals with PD (35). A review study indicated that progressive resistance training can improve functional mobility in PD patients (36). It has also been reported that balance and lower extremity strengthening exercises can result in positive effects on gait performance (37 and 38).

Furthermore, stereotactic surgery aimed at internal globuspallidus (GPi) or subthalamic nucleus (STN) might be more effective (39-42). Studies that used quantified gait analysis or dynamic posturography also confirmed our findings that unilateral pallidotomy, bilateral GPi stimulation, and bilateral STN can improve PIGD (43and44).

Based on the findings of the current study, The mean values of overall stability index was significantly improved. Deep brain stimulation (DBS) in the subthalamic nucleus (STN) and globuspallidusinterna (GPi) alleviates the cardinal Parkinson disease (PD) symptoms of tremor, rigidity, and bradikinesia.

However, its effects on postural instability and gait disability (PIGD) are uncertain (45 and 46). However, in cases where a reduction in dopaminergic medication has been the postsurgical goal, due to medication intolerance or compulsive behaviours, STN has remained the target of choice. The relative effects of DBS in the STN and GPi on postural stability and gait are unclear because experimental studies almost always report only one or the other DBS target (47). Therefore, there was an improvement in Ant. /Post. Index values in the current study. DBS may slow functional progression because patients are more active and exercising more after surgery. In rodent models of PD, exercise has been shown to have neuroprotective benefits, preventing dopaminergic neuronal loss in regions of the basal ganglia (48).

In addition, there also is evidence that exercise may improve function without preserving dopaminergic neurons presumably through compensatory mechanisms. In human subjects with PD postural stability training has produced improvements in gait, quality of life, and levodopa efficacy (49). So, although the precise mechanisms remain to be determined, there is growing evidence that physical activity can curb the rate of motor function decline. This noticed by the present study by the mean values of Med./Lat. Index in the current study. Despite improvements in clinical ratings of postural instability and gait disability (PIGD) immediately after DBS surgery, patients tend to fall more (47).

However, the improvements in groups I and II, patients tend to fall, so it was the idea of adding group III who received sensory integration training after ten days postoperative to stereotactic surgery. Based on these findings, the mean values of overall stability index were significantly improved. These seemingly contradictory findings are not altogether surprising given that balance and gait are complex behaviours consisting of many sensorimotor subsystems other sensorimotor systems underlying posture and gait, such as dependent flexibility (50), sensory integration (51), and postural synergies (52), do not show the same responsiveness to levodopa. Based on the recent results, the mean values of Ant. /Post. Index were significantly improved, in addition to the mean values of Med. /Lat. Index. Therefore, each subsystem underlying control of posture and gait may be related to different neural circuits with varying sensitivities to levodopa or deep brain stimulation (DBS) (53-65). However, the significant improvements in groups I and II, the results from group III was the superior in different aspects of Postural Stability (Overall stability Index, Ant./Post. Index and Med. / Lat. Index) among groups.

Conclusion

Accordingly, combining sensory integration training following stereotactic surgery is effective on postural instability in elderly with parkinsonian disease.

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تأثير التدريب التكامل الحسى على عدم الاستقرار الوضعي لدى كبار السن مع مرض باركنسون بعد الجراحة التجسيمية

الملخص

الهدف: دراسة تأثير التدريب التكامل الحسي على عدم الاستقرار الوضعي لدى مرضى باركنسون المسنين بعد الجراحة التجسيمية.

الطريقة: أجريت دراسة الحالات في العيادة الخارجيه بكلية العلاج الطبيعي ، الجامعة الحديثة للتكنولوجيا والمعلومات ، القاهرة ، مصر خلال الفترة من يناير ٢٠١٨ حتى أغسطس ٢٠١٨. سبعة وعشرون مريضا باركنسون (١٦ ذكور و ١١ أنثى) أدرج في الدراسة ، وتراوحت أعمارهم من ٦٠ إلى ٧٠ سنة. مدة المرض تتراوح بين ٥ سنوات و ١٦ سنة. تم تقييم المرضى من خلال اختبار الثبات الوضعي. تم تقسيم المرضى عشوائيا الى ثلاث مجموعات كل مجموعة شملت تسعة مرضى ، تلقت المجموعة الأولى تدريب التكامل الحسي ، خضع المجموعة الثانية تحفيز الدماغ العميق من خلال جراحة المجسم ، وتلقت المجموعة الثالثة تدريب التكامل الحسي بعد عشرة أيام بعد الجراحة الجراحية التجسيمية.
النتائج: كان هناك تحسن كبير في المجموعة الثالثة أكثر من المجموعة الأولى والثانية.

الخلاصة: يجب على اخصائيين العلاج الطبيعى الجمع بين التدريب على التكامل الحسي على عدم الاستقرار الوضعي في كبار السن مع مرض الشلل الرعاشي بعد الجراحة التجسيمية.

الكلمات الدالة: مرضى باركنسون ، التكامل الحسي ،الجراحة التجسيمية.