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Effect of Visual Feedback versus Sensory Integration on Postural Instability in Patients with Idiopathic Parkinson disease

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Among the core symptoms of Parkinson disease (PD), postural instability is probably the most relevant because of reduced mobility, falling and increase morbidity leading to a poor quality of life. The aim of this study was to compare the efficacy of visual feedback versus sensory integration training on postural instability in PD patients. Forty patients with idiopathic Parkinson disease aged from 55 to 75 years participated in this study. They were assigned into two equal groups, group A; received visual feedback training on Biodex balance system and group B; received sensory integration training. The treatment program was conducted three times per week, for four weeks. Assessment postural stability index (overall, ant. /post. And med./ lat.) was done after completion of treatment session. There was a significant reduction in all postural instability indices post treatment in both groups especially group A who received visual feedback training ($p<0.05$) Moreover, the results of this study revealed statistically significant difference between both groups in the group A more than group B. Visual feedback training is a more beneficial modality than sensory integration training improving the postural instability in parkinsonian Patients who have balance problem.

Keywords: Parkinson Disease, Biodex balance system, Visual feedback, Sensory integration, Postural instability.

INTRODUCTION

Parkinson's disease (PD) is a neurodegenerative brain disorder that progresses slowly in most patients. (Parashos et al., 2017). Early symptoms of PD are subtle and occur gradually. The four primary symptoms of PD are tremor (trembling in hands, arms, legs, jaw, and face), rigidity (stiffness of the limbs and trunk), bradykinesia (slowness of movement) and postural instability (impaired balance and coordination). As these symptoms become more pronounced, patients may have difficulty walking, talking, or completing other simple tasks. As the disease progresses, the shaking, or tremor, which affects the majority of PD patients may begin to interfere with daily activities (Voon et al., 2015).

In PD patients, postural instability may be the result of faulty processing of the sensory organization, in which one or more of the orientational senses (visual, vestibular, and somatosensory) are involved and integrated within the basal ganglia (Steno et al., 2015).

Balance impairment by postural instability is the most disabling feature of PD. Parkinson

disease patients exhibit poor orientation to vertical, often assuming a stooped posture with progression of the disease. Patients experiencing postural instability are at increased risk of falls resulting in traumatic injuries and are usually dependent on the use of assistive devices such as walkers (Grimbergen et al., 2009).

The moderate Pearson interclass correlations suggested that Biodex balance postural stability system provided unique information and construct validity and reliability of the Biodex balance system tests (Pickerill and Harter, 2011).

Therefore, this study was designed to compare the efficiency of visual feedback versus sensory integration training on postural instability in parkinsonian patients.

MATERIALS AND METHODS

Design:

Three factorial pre and post study design was used as randomized study with intra- rater reliability and inter-rater agreement.

Setting and timescales:

Study was conducted at Outpatient clinic of Neurology department, Faculty of Physical Therapy and biomechanics lab in MTI University in the period from July 2017 to July 2018.

Participants:

Subjects eligible to participate in this study were fifty patients with idiopathic Parkinson disease, but we excluded ten patients due to hearing or vision problems, previous surgical treatment for PD as stereotactic surgery and unstable cardiovascular disease or other chronic conditions that could interfere with their safety during testing or training procedures. Forty adult patients with idiopathic Parkinson disease were selected from outpatient's Clinic of Neurology, Faculty of Physical Therapy, Cairo University, Modern university for technology and information (MTI), patients randomly selected and all of them completed intervention program divided into two equal groups (group A; n=20, and group B; n=20) detected by power analysis to calculate sample size. All subjects read and signed a consent form before the beginning of the study. The study was approved by the Institutional Ethics Committee of the Faculty of Physical Therapy, Cairo University, Egypt (No: P.T. REC/012/001641). The anonymity and confidentiality were assured, and all the procedures were performed in compliance with relevant laws and institutional guidelines. Patient's age range was 55-75 years with a mean ± SD values in G.(A) and G.(B) were 64.20 ±6.06 and 64.35 ±4.33year respectively and the body mass index (BMI) ranged from 24.5 kg/m2 to 28kg/ m^2 with a mean ± SD values in G.(A) and G.(B) were 26.17 ±1.63and 25.71 ±1.44 kg/m^2 respectively. Duration of illness was 7 to 14 years from affection idiopathic Parkinson disease with mean ± SD values in G.(A) and G.(B) were 10.72 ±3.44 and 10.62 ±2.45year respectively. All patients with idiopathic Parkinson disease were referred from neurologist. The age and BMI of the patients was randomized selected by using closed envelope contains patient's names and selected envelopes randomly for each group. Clinically all the selected patients suffered from postural instability and able to walk with or without assistive device. The selection of patients should include stage 3 according to modified hoehn and yahr staging scale and Mini Mental State Examination score >25 because severe mental and physical disability can affect performance of the patients and our data collection.

The exclusion criteria were, Patients with other symptom of Parkinson disease, or sever Parkinson disabilities with stage ranging from four to five according to modified HYS and hearing or vision problems that may hinder the ability to hear the feedback sound.

Instrumentation:

Patients underwent pre-treatment and post-treatment assessment using the Biodex balance system (Biodex-medical system. Inc., brook baren R&D plaza, 20 Ramsey road, box 702, Shirley, Newyork 11967-0702), this machine consists of a multiaxial standing platform which adjusted to provide varying degrees of platform tilt or platform instability (level 1 to level 8) (Lapointe et al., 2015).

The Mini–Mental State Examination (MMSE) is a 30-point questionnaire that was used measure cognitive impairment. The MMSE test includes simple questions and problems in a number of areas: the time and place of the test, repeating lists of words, arithmetic such as the serial sevens, language use and comprehension, and basic motor skills (William et al., 2018).

Intervention:

Evaluation protocol to measure the posture stability by Biodex balance system:

Level eight was selected (the most stable level), then postural stability testing mode was

selected and then data of patient was inserted to the device. The patient was instructed to try to achieve a centered position on platform, once platform was set to motion. This is accomplished by shifting the position of patient's feet to a position which was easy to keep the cursor on visual feedback screen in the center of the screen**.** After centering the cursor at the center, the platform was kept leveled beneath the patient's feet while the patient was standing in a comfortable upright position. (Figure 1**).**

Treatment protocol:

Group A**;** received visual feedback training on Biodex balance system for patients with idiopathic Parkinson disease in form of (postural stability training and limits of stability training)**,** While group B**;** received sensory integration training. Treatment duration was about for four weeks (12 sessions; 3 times per week day after day and each session for one hour).

Statistical Analysis:

All statistical calculations were done using computer program IBM SPSS (Statistical Package for the Social Science; IBM corp, USA) release 22 for Microsoft Windows Power analysis revealed that sample size was 20 subjects for each group, Test of normality (Shapiro-Wilk W Test) was used before applying statistical analysis, and it show that data was not normally distributed so we used non-parametric test, Paired t-test was used for comparison within each group, Unpaired (Independent) t-test was used for comparison between groups, P-values less than 0.05 were considered statistically significant and less than 0.01 was considered highly significant. (William and Luis, 1998).

RESULTS

The general characteristic of subjects:

The age, weight, height, BMI and duration of illness of patients in the two groups are represented in table.1

1) Comparing of overall postural stability index within and between groups:

Statistical analysis by paired t-test revealed a significant decrease of overall stability index post treatment in groups A and B (P=0.004, P=0.029) respectively. The percentage of improvement was 52.55% in group (A) and 37.37% in group (B). (figure.2 and Table.2).

Statistical analysis by independent t-test revealed that there was no significant difference between both groups in overall stability index pre-treatment (P=0.393) while, there was a significant difference between both groups in post-treatment overall stability index (P=0.002), being significantly lower in group A. (figure.3 and table.3)

2) Comparing of ant. /post. postural stability index within and between groups:

The statistical analysis by paired t-test revealed that there was a significant decrease of pre- and post-ant. /post. Index post treat in groups A and B (P=0.002, 0.018), respectively. (figure.4 and table.3).

Statistical analysis by independent t-test revealed that there was no significant difference between both groups in ant. /post. index pre-treatment (P=0.849) while, there was a significant difference between both groups in ant. /post. index post-treatment overall stability index (P=0.026), being significantly lower in group A. (figure.5 and table.3).

3) Comparing of the med./lat. postural stability index within and between groups:

Statistical analysis by paired t-test revealed a significant decrease of overall stability index post treatment in groups A and B (P=0.019, 0.037) respectively. (figure.6 and table.4).

Statistical analysis by independent t-test revealed that there was no significant difference between both groups in med. lat. index pre-treatment (P=0.504) while, there was a significant difference between both groups in med. lat. index post-treatment (P=0.021), being significantly lower in group A. (figure.7 and table.4).

This study aimed to spotlight on comparing the effect of visual feedback versus sensory integration training on postural instability in PD patients. The data (postural stability indices) were collected were from forty adult patients divided into two equal groups.

A single trained investigator evaluated all patients and collected the data and patients were tested at the same place as well as in the same sequence and by the same assessor to eliminate inter-investigator error. This agreed with Horak et al., (2003) who mentioned in their study which evaluated postural control in PD that elimination of inter-investigator error helps to maintain consistency during testing in the baseline and treatment phase.

Table (1): Demographic and clinical data mean values between Group (A) and Group (B).

Items	Group (A)	Group (B)	t-value	P-value	Significance
Age (year)	64.20 ±6.06	64.35 ±4.33	0.090	0.929	NS
Weight (kg)	67.49 ±3.90	70.00 ±5.69	0.330	0.743	NS
Height (cm)	169.00 ±8.70	168.00 ±7.58	0.388	0.701	NS
BMI (kg/m^2)	26.17 ±1.63	25.71 ±1.44	0.939	0.354	NS
Duration of disease (year)	10.72 ±3.44	10.62 ±2.45	0.111	0.912	NS

Table (2): Comparison between mean values of pre- and post-overall stability index within each group and between groups.

Items	Overall stability index (Within groups)				Overall stability index (between groups)			
	Group (A)		Group (B)		Pre-treatment		Post-treatment	
	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment	Group (A)	Group (B)	Group (A)	Group (B)
Mean ±SD	1.96 ± 0.26	0.93 ± 0.18	1.90 ± 0.16	1.19 ± 0.12	1.96 ±0.26	1.90 ±0.16	0.93 ±0.18	1.19 ±0.12
Difference	-1.03		-0.71		0.06		-0.26	
Improvement %	52.55%		37.37%					
t-value	11.215		3.993		0.864		5.138	
P-value (P<0.05)	0.004		0.029		0.393		0.002	
Significance	S		S		NS		S	

Table (3): Comparison between mean values of pre- and post- Ant. /post. stability index within each group and between groups.

Items	Ant. /post. index (Within groups)				Ant./post. index (between groups)			
	Group (A)		Group (B)		Pre-treatment		Post-treatment	
	Pre-treatment	Post-Treatment	Group (A)	Group (B)	Group (A)	Group (B)	Group (A)	Group (B)
Mean ±SD	1.69 ±0.15	0.82 ±0.09	1.69 ±0.15	1.70 ±0.07	1.69 ±0.15	1.70 ±0.07	0.93 ±0.18	1.19 ± 0.12
Difference	-0.87		-0.59		0.01		-0.29	
Improvement %	51.48%		34.71%					
t-value	6.344		2.565		0.191		7.965	
P-value (P<0.05)	0.002		0.018		0.849		0.026	
Significance	S		S		NS		S	

Table (4): Comparison between mean values of pre- and post- Med. lat. stability index within each group and between groups.

Items	Med. lat. index (Within groups)				Med. lat. index (between groups)			
	Group (A)		Group (B)		Pre-treatment		Post-treatment	
	Pre-treatment	Post-Treatment	Group (A)	Group (B)	Group (A)	Group (B)	Group (A)	Group (B)
Mean ±SD	0.86 ±0.07	0.46 ±0.07	0.86 ±0.07	0.84 ±0.05	0.86 ±0.07	0.84 ±0.05	0.93 ±0.18	1.19 ±0.12
Difference	-0.40		-0.24		0.02		-0.14	
Improvement %	46.51%		28.57%					
t-value	4.907		2.614		0.674		4.118	
P-value (P<0.05)	0.019		0.037		0.504		0.021	
Significance	S		S		NS		S	

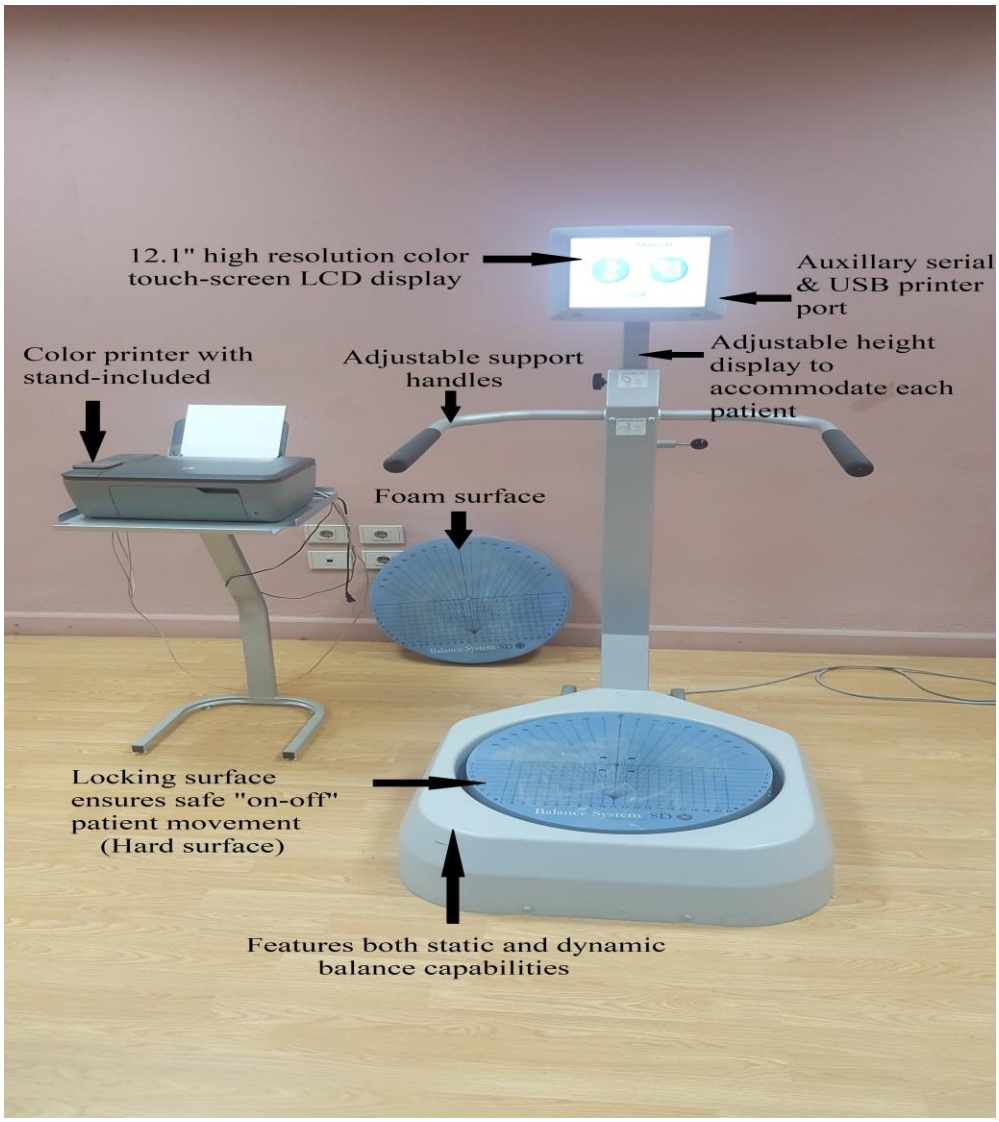

Fig. (1): Biodex balance system (Biomechanics lab, Faculty of Physical Therapy, MTI University)

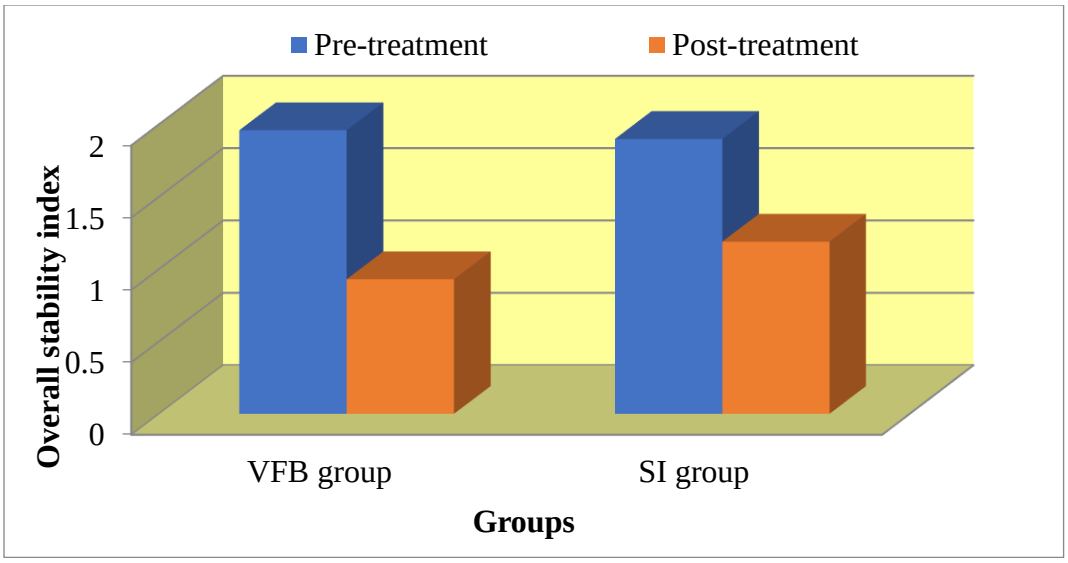

Figure (2): Mean values of pre- and post-overall stability index within each group.

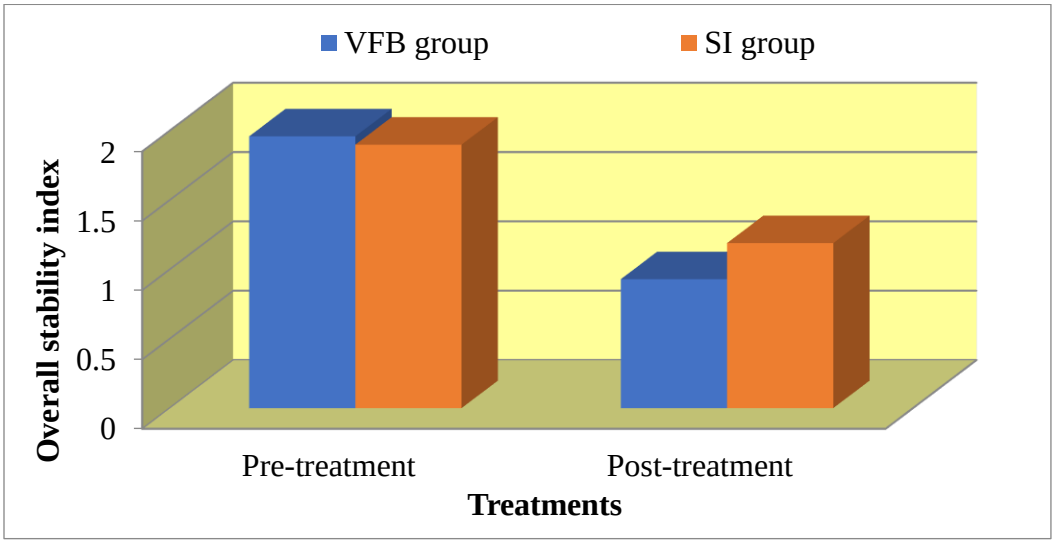

Figure (3): Mean values of pre- and post-overall stability index between both groups.

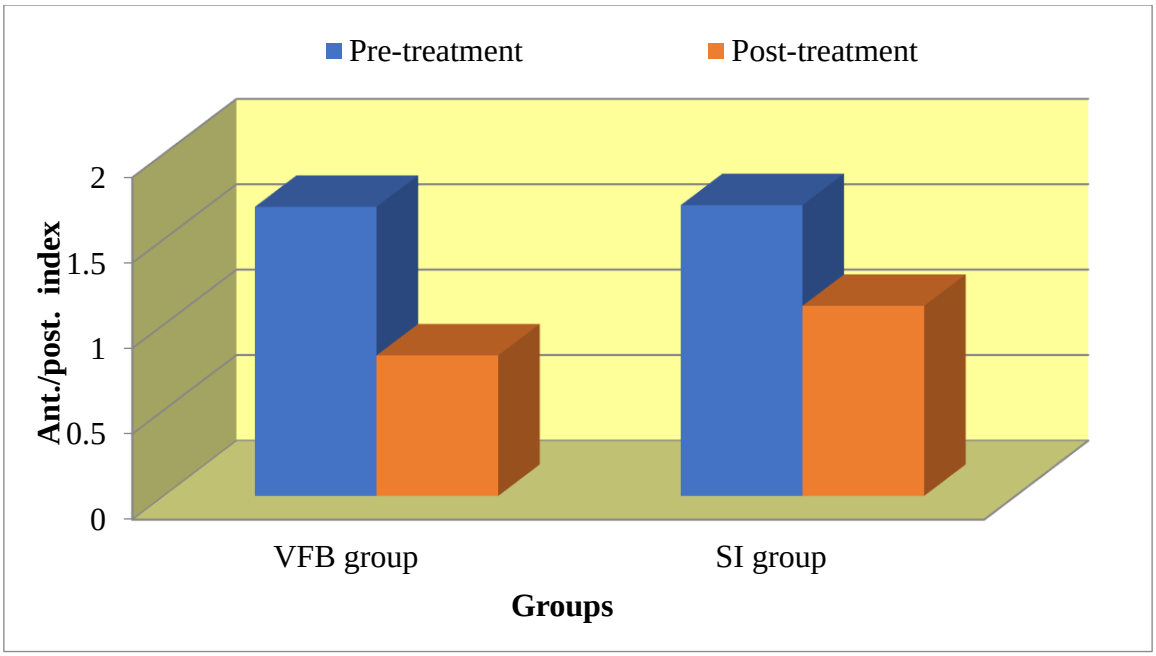

Figure (4): Mean values of pre- and post-ant. / post. index within each group.

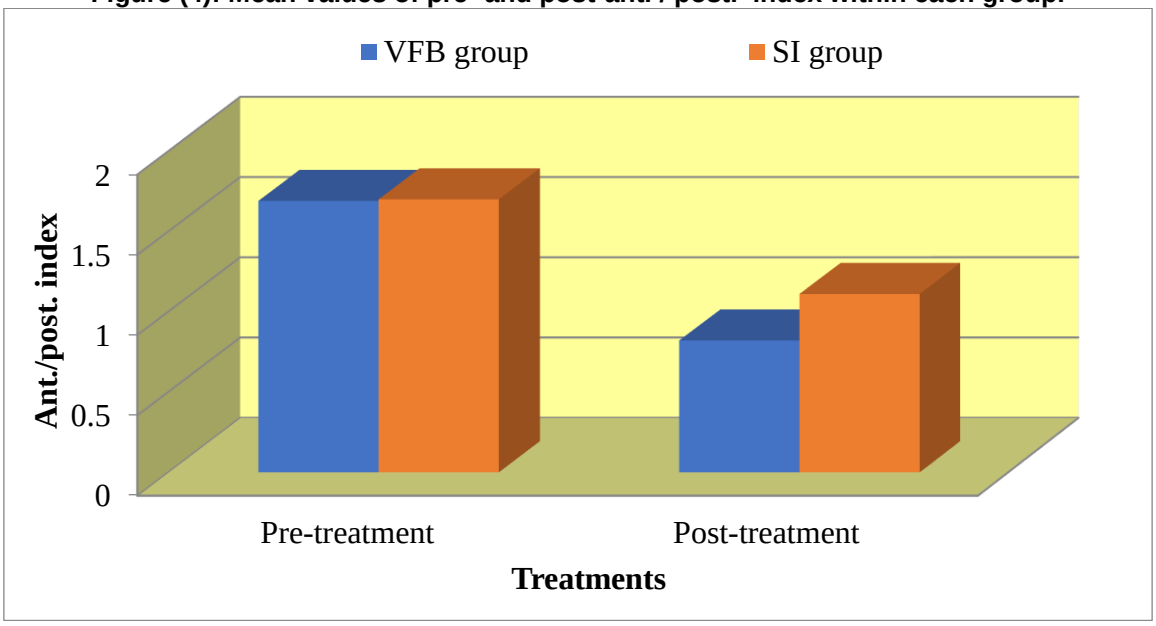

Figure (5): Mean values of pre- and post- ant. / post. index between both groups.

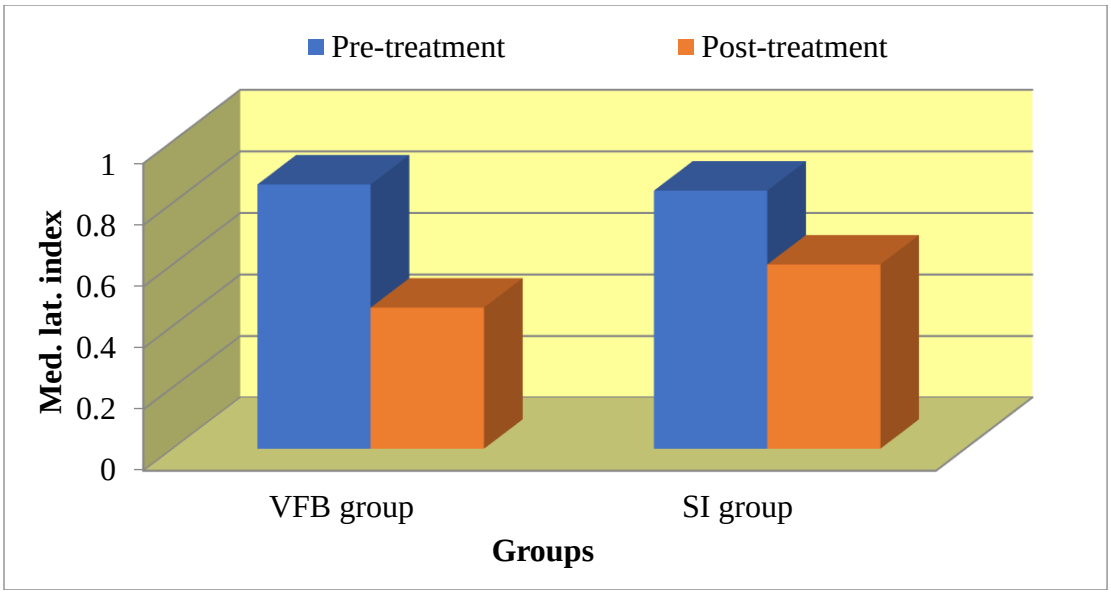

Figure (6): Mean values of pre- and post-med. lat. index within each group.

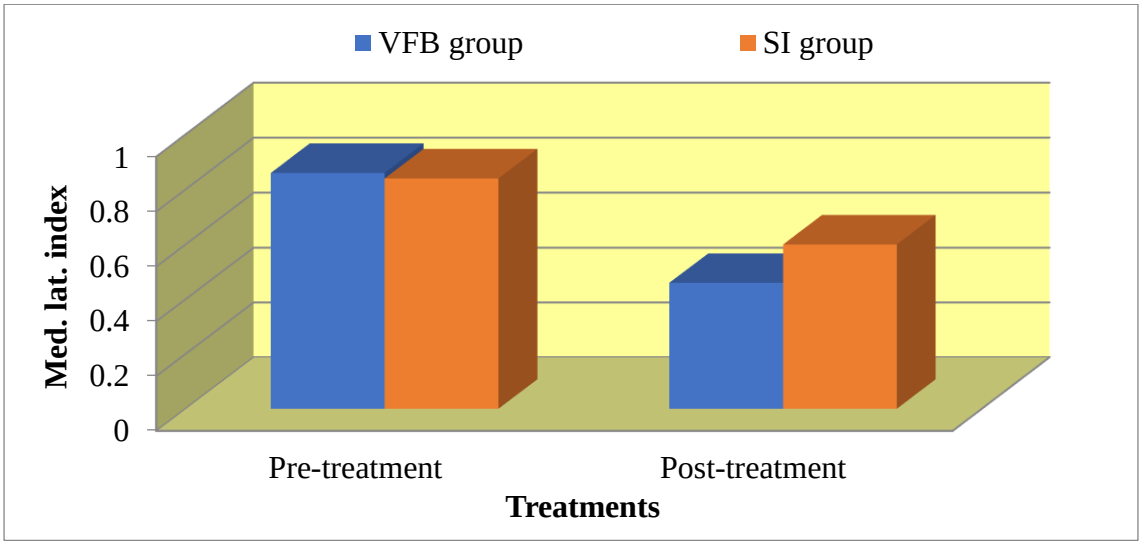

Figure (7): Mean values of pre- and post-med. lat. index between both groups

DISCUSSION

In the current study, there was a significant decrease of overall, ant. /post. and med. lat. stability indices post treatment in both groups, especially group A who received visual feedback training.

Moreover, there was a significant decrease of overall, forward, backward, left and Right LOS indices post treatment in both groups, especially group A.

The findings regarding visual feedback training (group A) were in agreement with Ghoseiri et al., (2007**)** who assured that visual feedback training has been offered to improve functional balance, gait speed and mobility in parkinson patients than sensory integration of balance training (SIBT).

Gwyn et al., (2011), also found that effective balance trainings by Biodex Balance System treat context-specific instabilities of postural control of patients with Parkinson disease by placing more emphasis on somatosensory information in balance training. By means of these trainings, the balance training methods borrowed from reactive movement strategies and sensory strategies for evoking somatosensory information regarding the

guiding contributions of external visual biofeedback.

Chaikeeree et al., (2015) reported that Visual feedback improves balance of Parkinson's patients in the indices of overall stability, anterior-posterior balance and medial-lateral balance is obvious absolutely.

The result of Schenkman et al., (2018) confirmed the result of this study of being visual feedback training lead to more decrease in postural instability than sensory integration training, where they conclude that patients with Parkinson's disease showed a significantly increased the dependence upon visual information both perceptually and motorically.

The findings regarding Sensory integration training (group B) were in agreement with Obeso et al., (2008), also concluded that in PD the SIBT improved an individual's ability to shift their sensory control between the visual, vestibular and somatosensory system, also helped the individuals to override faulty proprioceptive feedback and rather focus on reliable vestibular cues to maintain Postural control; and has the potential to improve an individual's ability to integrate sensory information and thus enable individuals to utilize more of the sensory information available.

Revilla et al., (2013) indicated that individuals with PD have impaired proprioception, causing them to rely predominantly on visual information for postural stability, but with aging, the visual system becomes impaired, leading to reliance on impaired proprioceptive information. Results from this study support previous findings of this study that PD individuals are visual dependent.

The results of Allen et al., (2013) lead to similar conclusion where somatosensory training may be a cost-effective and simple way to improve postural control in individuals with PD.

Wright et al., (2017), also reported that balance improvements is that SIBT as a form of "destabilization training." might play a role for reinforcing the neuronal circuits that contribute to postural control.

CONCLUSION

Within the limitation of this study, it could be concluded that visual feedback training program on Biodex Balance System has a more beneficial effect than sensory integration training in improving the postural instability in parkinsonian patient.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

All authors contributed equally in all parts of this study.

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