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Original Research Article

Effectiveness of Perturbation Based Balance Training in an Older Individuals: A Randomized Clinical Trial

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ABSTRACT

Background: Aging commonly disrupts the balance control and compensatory postural responses that contribute to maintaining balance and preventing falls during perturbation of posture due to the weakness of lower limb muscles. Fall prevention program has to be given to the patients which will mainly focus on the stimulation of primary muscle groups of lower limb.
Aim: To evaluate the effect of perturbation based balance training along with strengthening and balance exercises in improving balance and to reduce risk of falls among older adults.
Methodology: 40 elderly patients aged 65 to 80 years were randomized in two groups by using block randomization. Outcome variables measured were TUG & on force plate are maximum CoP excursion, minimum CoP excursion and stability score. To the group 1 treatment given was standardized OTAGO exercise program and group 2 was given PBBT along with OTAGO exercise program. The results were checked after two months. Treatment effect was checked within the group by using paired t test and between the groups by using unpaired t test.
Results: The results showed significant difference in values of all outcome measures in all the four conditions which are NS EO, NS EC, PS EO & PS EC within the group. There was also a significant reduction in the values of TUG. Between groups analysis also show significant effect between both the groups.
Conclusion: The PBBT is a useful program for fall prevention. It is also inexpensive and compact commercial perturbation-delivery system.

Keywords: Postural control, balance and aging, PBBT, COP.

INTRODUCTION

Aging is a complex process involving many variables such as genetics, lifestyle factors, chronic diseases, that interact with one another, greater influencing the manner in which we age. [1] With Aging there is deterioration of various physiological capacities such as muscle strength, aerobic capacity, neuro-muscular coordination and flexibility which can lead to impaired physical performance. [2] Balance is a highly integrative system that involves the communication among multiple neurological pathways. Balancing is the process by which postural stability is maintained. [3] The overall goals of the postural control system, stability and function, are achieved through integrated CNS systems of control. Reactive postural control occurs in response to external forces acting the body displacing the COM or moving the BOS. Proactive control occurs in anticipation of internally generated, destabilizing forces imposed on the body's own movements. Postural requirements vary depending on the characteristics of the task and the environment. [4] Physiological systems (somatosensory, vestibular and visual) contribute to the maintenance of balance in older adults. [5] Loss of sensitivity

in peripheral sensory systems has been reported so frequently in the elderly without diagnosable disease that these losses are widely regarded as a normal consequence of aging. [6] Adults above 70 years of age have a 40 %reduction in sensory cells within the vestibular system. There is a drop in the proprioceptive function of the elderly, a reduced vibration sense at the ankles and changes in joint sensation. [7] A fall is defined as an event which results in a person coming to rest inadvertently on the ground or floor or other lower level.Aging related deterioration in balance or postural control exerts a significant negative impact on ability to perform everyday activities safely. [8] Force platform systems have advantages in objectively quantifying body sway and measuring the location of an individual's centre-of-pressure related to the base-of-support. [9] Laboratory-based assessment using measures of centre of pressure (COP) recorded from a force platform (FP) considered the gold standard measure of balance. It has been shown that one is able to gather reliable values for balance tasks being measured when assessing balance with the usage of these instruments and parameters. [10] Change-in-support balance reactions, which involve very rapid limb movements, plays critical role in responding to balance perturbations. [11] These postural "reflexes", initiated by external postural perturbations, lead to activation of specific recovery strategies. These recovery strategies are not under volitional control and thus the optimal means for training compensatory responses will involve unexpected external perturbation exercises during standing. [12] The Otago Exercise Program (OEP) is a set of leg muscle strengthening and balance retraining exercises designed specifically to prevent falls. It is individually prescribed and delivered by the physiotherapist. The OEP has been tested in different controlled trials and shown to reduce falls and injuries in older people. The program has been tested in a comprehensive way. The program has been tested beyond a research setting and has proven appropriate and effective in a routine healthcare practice. [13] Treatments that involve perturbing support surfaces (perturbation training) allow altered forces and torques to be applied to the lower extremity in multiple directions and in a controlled manner. These techniques may induce compensatory muscle activation patterns in older individuals. [14] The OEP is a safe, effective, practical, eminently feasible and low-cost falls prevention strategy. But this program doesn't include the exposure of the joint to potentially destabilizing loads during training, which is necessary stimulus to encourage the development of effective neuromuscular compensatory patterns. Whereas PBBT involve perturbing support surfaces which alters forces and torques and allows destabilizing loads to the lower extremity in multiple directions and in a controlled manner. Therefore, in present study comparison between OEP alone and OEP added to PBBT was done to determine which training program was more effective for prevention of fall in older individuals. The aim of the study was to evaluate the effect of perturbation based balance training along with strengthening and balance exercises in improving balance and to reduce risk of falls among older adults. The purpose of the study was to establish the effect of perturbation based balance training added to strengthening and balance exercises in improving balance and to reduce falls among older adults.

METHODOLOGY

Subjects were recruited from the institute of Mangalore. Type of sampling was Purposive Sampling. It was a randomized clinical trial. Sample size was 40. Block Randomization was used. Materials/ Tools Used in the study were BERTEC Force plate, Columbus, OH 43229, U.S.A, and Perturbation Platform. Materials used were Foam, Pen/pencil, Inch tape, Chair, Stopwatch, Consent form. Inclusion criteria was age group 65-75 years, both males and females, subjects with

no known history of musculoskeletal, neurological, Cardiovascular or pulmonary impairment that may affect their ability to perform the testing procedures were included. Timed up and go test score ≤25 seconds. Exclusion Criteria was Using any sedative of any type having known history of osteoporosis, Mini-Mental State exam score <25 (impaired cognition), Severe focal muscle weakness or paralysis, Total Hip or knee arthroplasty Serious visual impairment, Severe peripheral or compression/entrapment neuropathies, orthostatic hypotension, Cancer, metastatic or under active treatment. Any vestibular disturbance

PROCEDURE

The study was approved by ethical committee of the institute. Informed consent was obtained from all subjects before enrolling them into study. Once informed consent was obtained, subjects who met inclusion criteria were included in the study. The confidentiality of all the subjects was protected. Before intervention subjects were randomized into experimental group 1 and experimental group 2 by block randomization method.

Data Collection Procedures

Force plate details:

It has 2 parts. It has two parts:

1. Monitor – to visualize and record all the information while performing the tasks on plate.
2. Platform – (40cm ×60cm ×10cm) to perform all tasks to measure the COP variables. This BERTEC's force plate (square platform) was used to analyze the dynamic as well as static postures in various conditions. It has six-component load transducer to measure the three orthogonal components of resultant force presented over the force platform.

The Balance-Check software system has been used in this study which is designed to quantify a person's ability to maintain balance while standing or any defined positions. Force plate was designed to record and measure the ground reaction forces exchanged between the patient's feet and the surface of the force platform and shows the ability of a person to maintain balance in form of reports. This system is also has the specificity about the task and feet positions where it takes the information from the digital platform, analyzes it, stores it, and shows the analysis results as a statistical representation of the COP with 95% confidence ellipse. [15]

Initially a demonstration was done by the therapist on Force plate in order to make the patient understand and to avoid fear. Participants were asked to remove their shoes, stand upright on the force plate and remain as still as possible in a relaxed posture. Participants were asked to put their arms to their sides in a comfortable position and to distribute their body weight evenly on both feet while breathing normally. Finally, the participants were instructed to look straight ahead at an "X" on the opposite wall located 2 meters away at eye level. If the patient usually wore glasses, they continued to do so during this procedure.

The measurements were taken in 4 different testing conditions.

I. Normal stability

Eyes open

Eyes closed

II. Perturbated stability

Eyes open

Eyes closed

Outcomes Variables of Force Platform

1. Maximum COP excursion (cm.): The major axis of the ellipse. It indicates the magnitude of the movement in the direction of maximum movement; the smaller value the better.
2. Minimum COP excursion (cm.): The minor axis of the ellipse (A_{min}) which indicates the magnitude of the movement in the direction of minimum movement; the smaller value is better.

3. Stability score (%): A score of subject's ability to maintain balance during the test. The larger value is better.

OTHER OUTCOME VARIABLES

Timed Up & Go Test: [16]

Participants of these 2 groups were measured for timed up and go test. It is a simple and quick functional mobility test that requires a subject to stand up, walk 3m, turn, walk back, and sit down. The time taken to complete the test was recorded by therapist. The smaller the value the better it is.

TREATMENT PROCEDURE

Experimental Group 1:

OTAGO EXERCISE PROGRAMME [17]

The program describes the practical implementation of a strength and balance retraining program.

It is a set of leg muscle strengthening and balance retraining exercises designed specifically to improve balance and to prevent falls.

Exercise duration: 3 times in a week for 8 weeks

STRENGHENING EXERCISES:	BALANCE EXERCISES:
1) Knee extensor (front knee strength) 2) Knee flexor (back knee strength) 3) Hip abductor (side hip strength) 4) Ankle plantarflexors (calf raises) 5) Ankle dorsiflexors (toe raises)	1) Knee bends 2) Backwards walking 3) Walking and turning around 4) Sideways walking 5) Tandem stance (heel toe stand) 6) Tandem walk (heel toe walk) 7) One leg stand 8) Heel walking 9) Toe walk 10) Heal toe walking backwards 11) Sit to stand 12) stair walking

	STRENGTHENING	BALANCE RETRAINING	WALKING
Activities	5 leg muscle strengthening exercises with up to 4 levels of difficulties	12 balance retraining exercises with up to 4 levels of difficulties	Advice about walking
Assessment	The amount of weight in ankle cuff should allow 8-10 repetitions before fatigue	Set each exercise at a level that person can perform unsupervised	Discuss present walking condition
Intensity	Moderate	Moderate	Usual pace with usual walking aids
Progression	Increase to 2 sets of repetitions Increase the weight of ankle cuff	From supported exercise to unsupported exercise	
Duration	Approximately 30 minutes to do the flexibility, strength and balance exercises; Exercises can be divided up over the day	30 minutes; can be broken down to three 10 minutes walks throughout the day	
Frequency	3 times a week with rest day in between	3 times a week	At least 2 times a week

Experimental group 2: [14]

Along with the Otago exercise program PBBT was given to the experimental group. The custom build wooden platform 60cm × 60 cm× 5 cm with four rollers was used. The surface of the platform was controlled to move 0.30 m forward and backward. Participants stood barefoot on the moving platform (roller board) with their feet approximately shoulder-width apart, eyes open, and while looking straight ahead. They were instructed to remain relaxed and remain standing still after the perturbation. The first trial began with the platform moving approximately 0.02 m. Once patient matched the perturbated force given by the therapist, progression was made by increasing 0.02m each time. Multidirectional perturbations were given while the subjects were standing with one lower extremity on a roller board and contra lateral lower extremity on a stationary platform. The subject was instructed to maintain a steady position of the roller board when the therapist attempted to move the board. The subject attempted to resist the therapist's force on the board by pushing the lower extremity on the roller-board in the opposite direction while matching the speed and magnitude of the therapist's perturbation force. The therapist perturbed the roller board in varying directions, amplitudes, and speed. The subject's ability to match the therapist's perturbations was monitored by the therapist by observing the movement of the roller board. If the subject matched the therapist's perturbations correctly, there should have

been minimal movement of the roller board as the therapist applied and released forces or changed the direction and speed of forces on the roller board. Training on the roller board was given three times per week for four weeks. Each training session consist of 20 forward and 20 backward platform perturbations presented in a random order. [10]

RESULTS

The data analysis was done by using the statistical software SPSS (version 16) for windows. Among 40 participants, in group 1 there were 20 participants and in group 2 there were 20 participants. Statistical analysis of sex for both the groups were carried out using the chi squared test which shows the x^2 value of 0.902 and p value found was 0.342, which means that both the groups are not statistically significant.

Descriptive statistics were calculated for age for healthy adults. The mean age of the participants in group 1 was 71.95 years with standard deviation of 5.826 years. The mean age of the participants in group 2 was 73.50 years with standard deviation of5.171 years. Standard deviation of 2.74 years. Unpaired t-test was used which showed the t value is 0.849 and p value is 0.401, which means that both the groups are not statistically significant. To examine the difference within the groups after the treatment paired t test was used. To examine the difference between the groups before the treatment unpaired t test was used.

Table 1: Showing group wise analysis of data according to sex using chi squared test.

		Group		
		Group 1	Group 2	Total
Sex	F	12	9	21
		60.0%	45.0%	52.5%
	M	8	11	19
		40.0%	55.0%	47.5%
Total		20	20	40
		100.0%	100.0%	100.0%

X^2= 0.902

P VALUE- 0.342, which is greater than 0.001, meaning that both the groups are not statistically significant according to age criteria.

Table 2: Showing descriptive statistics about age using paired t test.

Group	Mean	Std. Deviation	t value	p value
Group 1	71.95	5.826	.849	.401
Group 2	73.50	5.717		NS

t test value found is 0.849 and p value is 0.401, meaning both the groups are not statistically significant according to age.

Table 3: Showing results of unpaired t-test between the groups before the treatment.

Pre

Parameter	Type	Group	Mean	Std. Deviation	t value	p value
Maximum COP excursion (cm)	NS EC	Group 1	1.48	.40	.040	.968
		Group 2	1.47	.39		NS
	NS EO	Group 1	1.26	.37	.130	.893
		Group 2	1.27	.34		NS
	PS EC	Group 1	2.10	.77	.430	.667
		Group 2	2.00	.61		NS
	PS EO	Group 1	1.77	.72	.220	.825
		Group 2	1.73	.55		NS
Minimum COP excursion (cm)	NS EC	Group 1	.82	.30	.320	.750
		Group 2	.85	.29		NS
	NS EO	Group 1	.71	.24	.140	.893
		Group 2	.70	.23		NS
	PS EC	Group 1	1.31	.69	.030	.980
		Group 2	1.30	.52		NS
	PS EO	Group 1	1.10	.62	.230	.819
		Group 2	1.06	.46		NS
Stability Score (%)	NS EC	Group 1	82.66	6.02	.890	.378
		Group 2	84.15	4.47		NS
	NS EO	Group 1	84.18	5.97	1.120	.271
		Group 2	85.99	4.11		NS
	PS EC	Group 1	78.31	7.26	.360	.724
		Group 2	79.05	5.81		NS
	PS EO	Group 1	80.11	6.84	.770	.447
		Group 2	81.62	5.49		NS

	Group	Mean	Std. Deviation	t value	p
TUG(sec) pre	Group 1	18.915	2.9186	.691	.494
	Group 2	19.465	2.0417		NS

p value for NS EC was 0.968, for NS EO it was 0.893, for PS EC it was 0.667 and for PS EO 0.825. p value for minimum CoP excursion for NS EC was 0.750, for NS EO was 0.893 , for PS EC was 0.980 and for PS EO was 0.819. For stability score the p value found out for NS EC was 0.378, for NS EO was 0.271, for PS EC was 0.724 and for PS EO was 0.447. p value for TUG was 0.447. p value found out for all the parameters mean that before the treatment there is no significant difference between both the groups.

Paired t test was used to check for the difference within the group after the treatment.

Table 4: Showing results for Maximum CoP Excursion within the group

Parameter: Maximum COP excursion (cm)

Type	Group		N	Minimum	Maximum	Mean	Std. Deviation	Median	Mean difference	S.d of difference	change (%)	t test value	p value
NS EC	Group 1	Pre	20	.9	2.3	1.48	.40	1.50	.250	.231	16.95	4.85	.000
		Post	20	.5	2.1	1.23	.40	1.25					<0.001, HS
	Group 2	Pre	20	.9	2.3	1.47	.39	1.50	.415	.067	28.23	27.67	.000
		Post	20	.4	1.9	1.06	.41	1.00					
NS EO	Group 1	Pre	20	.6	1.9	1.26	.37	1.25	.200	.056	15.94	15.92	.000
		Post	20	.5	1.7	1.06	.35	1.10					<0.001, HS
	Group 2	Pre	20	.8	2.0	1.27	.34	1.25	.410	.091	32.28	20.11	.000
		Post	20	.3	1.5	.86	.32	.80					
PS EC	Group 1	Pre	20	.9	3.8	2.10	.77	1.95	.205	.060	9.79	15.16	.000
		Post	20	.8	3.5	1.89	.73	1.75					<0.001, HS
	Group 2	Pre	20	1.2	3.5	2.00	.61	1.90	.440	.050	22.00	39.15	.000
		Post	20	.7	3.0	1.56	.60	1.50					
PS EO	Group 1	Pre	20	.8	3.5	1.77	.72	1.65	.215	.088	12.15	10.99	.000
		Post	20	.7	3.1	1.56	.67	1.45					<0.001, HS
	Group 2	Pre	20	1.0	2.9	1.73	.55	1.65	.410	.072	23.77	25.53	.000
		Post	20	.6	2.6	1.32	.56	1.30					

The effect of treatment on maximum cop excursion was analyzed within the group by using paired t test. For group 1 the mean of NS EC was 1.23 $\pm$ 0.40 cm. The t test value found was 4.85. For group 2 the mean of NS EC was 1.06 $\pm$ 0.41 cm. The t value found was 27.67. For both the groups the p value found was 0.000(<0.001), which means that after the treatment there is a significant change in both the groups. For group 1 the mean of NS EO was 1.06±0.35 cm. The t value was 15.92. For group 2 the mean of NS EO was 0.86±0.32 cm. The value was 20.11. For both the groups the p value was 0.000, which means that there is a significant change in both the groups after the treatment. For PS EC the mean found in group 1 was 1.89±0.73 and in group 2 was 1.56±0.60 cm. the t value found for group 1 was 15.16 and for group 2 it was 39.15. For PS EO in group 1 the mean was 1.77±0.72 and in group 2 it was 1.73±0.55. The t value found for group 1 was 10.99 and for group 2 it was 25.53. The p value found for both the groups were 0.000 which means that they are highly significant.

Table 5: Showing results for Minimum CoP Excursion within the group

Parameter: Minimum COP excursion (cm)

Type	Group		N	Minimum	Maximum	Mean	Std. Deviation	Median	Mean difference	S.d of difference	change (%)	t test value	p value
NS EC	Group 1	Pre	20	.4	1.5	.82	.30	.80	.140	.060	17.07	10.47	.000
		Post	20	.3	1.4	.68	.27	.65					<0.001, HS
	Group 2	Pre	20	.5	1.5	.85	.29	.80	.400	.056	47.06	31.83	.000
		Post	20	.1	1.1	.45	.28	.35					
NS EO	Group 1	Pre	20	.3	1.1	.71	.24	.70	.145	.051	20.57	12.70	.000
		Post	20	.2	.9	.56	.21	.60					<0.001, HS
	Group 2	Pre	20	.4	1.2	.70	.23	.60	.355	.069	51.08	23.13	.000
		Post	20	.1	.8	.34	.19	.30					
PS EC	Group 1	Pre	20	.4	3.4	1.31	.69	1.30	.185	.081	14.18	10.18	.000
		Post	20	.4	3.1	1.12	.64	1.10					<0.001, HS
	Group 2	Pre	20	.7	2.5	1.30	.52	1.20	.415	.049	31.92	37.93	.000
		Post	20	.3	2.1	.89	.53	.80					
PS EO	Group 1	Pre	20	.3	2.9	1.10	.62	.85	.170	.086	15.53	8.79	.000
		Post	20	.3	2.6	.93	.56	.70					<0.001, HS
	Group 2	Pre	20	.5	2.1	1.06	.46	.90	.380	.062	36.02	27.61	.000
		Post	20	.2	1.8	.68	.46	.50					

Paired t test was carried out to check for the significant difference within the group after the treatment. The mean value found for NS EC in group 1 was 0.68±0.30 and for group 2 it was 0.45±0.28. The t value found for group 1 was 10.47 and for group 2 it was 31.83. for NS EO the mean value obtained for group 1 was 0.71±0.24 and for group 2 it was 0.56±0.21. The t value for group 1 was 12.70 and 23.13 was for group 2. For PS EC the mean value for group 1 was 1.12±0.64 and for group 2 it was 0.89±0.52. The t value found for group 1 was 10.18 and for group 2 it was 37.93. For group 1 the mean value of PS EO was 0.93±0.56 and for group 2 it was 0.68±0.46. The value found for group 1 was 8.79 and for group 2 it was 27.61. The p value found for all the four conditions were 0.000 which means they are highly significant.

Table 6: Showing results for stability score within the group.

Parameter: Stability Score (%)

Type	Group		N	Minimum	Maximum	Mean	Std. Deviation	Median	Mean difference	S.d of difference	change (%)	t test value	p value
NS EC	Group 1	Pre	20	72.2	91.9	82.66	6.02	84.70	-1.725	.558	2.09	13.82	.000
		Post	20	74.3	92.7	84.38	5.91	86.45					<0.001, HS
	Group 2	Pre	20	74.4	91.7	84.15	4.47	84.75	-4.455	.772	5.29	25.80	.000
		Post	20	78.2	96.9	88.61	4.59	89.10					
NS EO	Group 1	Pre	20	74.4	93.0	84.18	5.97	85.85	-1.595	.436	1.89	16.37	.000
		Post	20	76.4	94.3	85.77	5.77	87.45					<0.001, HS
	Group 2	Pre	20	76.8	92.5	85.99	4.11	86.60	-4.190	.636	4.87	29.48	.000
		Post	20	80.5	97.3	90.18	4.24	90.85					
PS EC	Group 1	Pre	20	67.5	93.9	78.31	7.26	78.15	-1.790	1.006	2.29	7.96	.000
		Post	20	69.3	95.6	80.10	7.07	79.85					<0.001, HS
	Group 2	Pre	20	66.6	89.5	79.05	5.81	80.00	-4.230	.746	5.35	25.37	.000
		Post	20	70.9	93.2	83.28	5.70	84.80					
PS EO	Group 1	Pre	20	70.0	91.6	80.11	6.84	80.60	-1.990	.491	2.48	18.13	.000
		Post	20	72.3	92.5	82.10	6.69	82.60					<0.001, HS
	Group 2	Pre	20	70.2	91.1	81.62	5.49	82.20	-4.145	.575	5.08	32.22	.000
		Post	20	74.5	95.7	85.76	5.44	86.95					

Paired t test was used to analyze the difference in the stability score within the group after the treatment. For group 1 the mean value of NS EC was 84.38±5.91, NS EO was 85.77±5.77, PS EC was 80.10±7.07 and for PS EO it was 82.10±6.69. The t test value for group 1 for NS EC was 13.82, for NS EO was 16.37, for PS EC was 7.98 and for PS EO it was 18.13. For group 2 the mean value of NS EC was 88.61±4.59, for NS EO it was 90.18±4.24, for PS EC it was 83.28±5.70 and for PS EO it was 85.78±5.44. The t test value found for group 2 for NS EC was 15.80, for NS EO was 29.48, for PS EC was 25.37 and for PS EO were 32.22. The p values found for all the conditions were 0.000, which means the difference within the group is highly significant.

Table 7: Showing results for TUG score within the group

Group		N	Minimum	Maximum	Mean	Std. Deviation	Median	Mean difference	S.d of difference	change (%)	t test value	p value
Group 1	TUG(sec) pre	20	14.0	24.0	18.92	2.92	19.70	1.38	.32	7.30	19.557	.000
	TUG(sec) post	20	13.2	22.8	17.54	2.72	18.35					<0.001, HS
Group 2	TUG(sec) pre	20	16.8	23.7	19.47	2.04	18.75	3.39	.55	17.39	27.625	.000
	TUG(sec) post	20	13.1	19.8	16.08	1.81	15.95					<0.001, HS

Paired t test was carried out to check for the difference within the group after the treatment. In group 1 the mean change in TUG observed was 17.54±2.72. And in group 2 the observed change in mean of TUG was 16.08±1.81. The t test value for group 1 was 19.557 and for group 2 it was 27.625. The p values found for group 1 and group 2 were 0.000 which means that there are significant changes within the groups after the treatment.

Unpaired t test was carried out to check for the difference between the groups.

Table 8: showing results for Maximum CoP Excursion between the groups

Parameter: Maximum COP excursion (cm)

Type	Group	N	Mean difference	S.d of difference	change (%)	t test value	p value
NS EC	Group 1	20	.250	.231	16.95	3.07	.004
	Group 2	20	.415	.067	28.23		<0.001, HS
NS EO	Group 1	20	.200	.056	15.94	8.77	.000
	Group 2	20	.410	.091	32.28		<0.001, HS
PS EC	Group 1	20	.205	.060	9.79	13.36	.000
	Group 2	20	.440	.050	22.00		<0.001, HS
PS EO	Group 1	20	.215	.088	12.15	7.70	.000
	Group 2	20	.410	.072	23.77		<0.001, HS

For NS EC the difference in the t value was 3.07. p value was 0.004 which means that both the groups are highly significant. For NS EO the t value difference was 8.77 and p value was 0.000. For PS EC the t value difference between the groups were 13.36. p value found was 0.000. For PS EO the t value difference is 7.70 and p value found out was 0.000.

Table 9: showing results for Minimum COP Excursion between the groups

Parameter: Minimum COP excursion (cm)

Type	Group	N	Mean difference	S.d of difference	change (%)	t test value	p value
NS EC	Group 1	20	.140	.060	17.07	14.17	.000
	Group 2	20	.400	.056	47.06		<0.001, HS
NS EO	Group 1	20	.145	.051	20.57	10.98	.000
	Group 2	20	.355	.069	51.08		<0.001, HS
PS EC	Group 1	20	.185	.081	14.18	10.84	.000
	Group 2	20	.415	.049	31.92		<0.001, HS
PS EO	Group 1	20	.170	.086	15.53	8.85	.000
	Group 2	20	.380	.062	36.02		<0.001, HS

The t test value found for NS EC was 14.17. For NS EO t test value was 10.98. The t test value for group PS EC was 10.84 and t test value for PS EO 8.85. The p value found for all the conditions was 0.000 which means that they are highly significant after the treatment.

Table 10: Showing results for stability score between the groups

Parameter: Stability Score (%)

Type	Group	N	Mean difference	S.d of difference	change (%)	t test value	p value
NS EC	Group 1	20	-1.725	.558	2.09	12.81	.000
	Group 2	20	-4.455	.772	5.29		<0.001, HS
NS EO	Group 1	20	-1.595	.436	1.89	15.06	.000
	Group 2	20	-4.190	.636	4.87		<0.001, HS
PS EC	Group 1	20	-1.790	1.006	2.29	8.72	.000
	Group 2	20	-4.230	.746	5.35		<0.001, HS
PS EO	Group 1	20	-1.990	.491	2.48	12.74	.000
	Group 2	20	-4.145	.575	5.08		<0.001, HS

The t test value for NS EC was 12.81, for NS EO it was 15.06. For PS EC it was 8.72 and for PS EO it was 12.74. The p values for all the conditions are 0.000 which means that after the treatment there is a significant change between the groups.

Table 11: Showing results for TUG between the groups

Group	N	Mean difference	S.d of difference	change(%)	t test value	p value
Group 1	20	1.38	.32	7.30	14.180	.000
Group 2	20	3.39	.55	17.39		<0.001, HS

The t test value observed was 14.180. The value was 0.000 meaning there is significant change between the groups after the treatment.

DISCUSSION

Falls are a serious problem for older adults. The seriousness of the problem increases with age as 50% of adults aged 80 years and older experience a fall every year. Falls can lead to a decreased quality of life, fear of falling, serious injury, or death.

A substantial number of studies have investigated different types of exercise programs designed to reduce functional decline and prevent falls. [18] However, these

programs have had considerable diversity in the mode of delivery and exercise prescription, including the setting, type of exercise, levels of supervision, duration and intensity of the program. Recently, it has been determined which components of these exercise programs are important to reduce falls. A Cochrane review of falls prevention strategies concluded that exercise programs that target two or more components of strength, balance, flexibility or endurance reduce rate of falls and number of people falling. This can be achieved via a supervised program.

The present study was conducted to investigate the effectiveness of perturbation-based balance training (PBBT) added to strength training in order to improve balance in older adults.

In present study total 40 subjects were taken and they were divided into 2 groups by using block randomization. The mean age of participants in group 1 was 71.95±5.826 years and in group 2 the mean age was 73.50±5.717 years. There is no significant difference among baseline parameters such as Age and sex. Group 1 was given OEP and group 2 was given PBBT along with OEP.

Strength and balance deficits are associated with the risk for falling in older adults. The OEP is a muscle strengthening and balance retraining program. The rationale behind it is that muscle strength, flexibility, balance and reaction time are the risk factors for falls considered the most readily modified. Both leg muscle strength and balance must be maintained above the threshold level required to achieve stability. The gains in strength and balance in trials testing the OEP were achieved by individually prescribing exercises. [19] OEP is mainly characterized by sensory motor training. Afferent information includes signals from sensory receptors in peripheral joints. These receptors provide information from muscular receptors (muscle spindles and golgi tendon organs), joint capsule and ligamentous mechanoreceptors, and other receptors for touch, pressure, temperature, and pain sensation. Cumulatively, this afferent information is known as "proprioception". Maintenance of posture relies on proprioceptive input from three important regions: the sole of the foot, the sacroiliac joint, and the cervical spine. These three areas have been identified as postural regulators due to their density of mechanoreceptors and influence on movement and postural stability. The efferent signals travel through alpha and gamma motor neurons to coordinate motor responses through both facilitatory and inhibitory signals. The proper coordination of these signals between agonists and antagonists is the key to coordinated movement. Increasing strength may offset some of the contraction speed-associated deficits observed in older adults, and further modify other factors (e.g., postural control, proprioceptive input, range of motion, joint destruction, and fear) that would reduce the risk for falling. [20]

Balance reactions can be combined into higher level "strategies" to maintain postural stability in response to larger perturbations, which is lacking in OEP because it only focuses on balance and strength training exercises. The benefit of increased strength from strength training is not fully realized without some sort of task-related training to allow the neural control of the musculoskeletal system to modify to the increased strength. In other words, the optimal muscle recruitment strategy to recover balance from a postural perturbation, such as a slip or trip, changes as lower extremity muscle strength increases, and practice is needed to reacquire a new optimal recruitment strategy. In the present study a similar theory has been put forward for understanding the effects of increased strength dynamic stability (the ability to maintain balance following a postural perturbation) as a potentially important aspect of defining and modifying fall risk. Older adults can, with appropriate training, quickly adapt to a large postural perturbation by changing the biomechanics

of their recovery. To overcome the certain limitations of only balance and strengthening exercises there was a need to check for the effectiveness of PBBT along with balance and strengthening exercises.

Avril Mansfield et al (2010) concluded that there is a need to determine how best to implement Perturbation- based training programs in a clinical setting. There is a need for development of an inexpensive and compact commercial perturbation-delivery system which would promote widespread clinical application. [21] In this study to overcome limitation of previous study the PBBT was given with the use of roller board and stationary platform.

Nichols proposed a "force-feedback" hypothesis that may explain the coordinated response from muscles to perturbing forces applied to a joint. When a perturbing force is applied to a joint, muscles that would resist the perturbation are stretched and become activated to resist the perturbation. Simultaneously, there is a reflex inhibitory influence on muscles that would have a tendency to pull in the same direction as the perturbation. The inhibitory influence reduces, but does not entirely eliminate, the unwanted stretch reflex from muscles antagonistic to those that would resist the perturbing force. The net result is a coordinated co activation of extremity muscles affected by the perturbation to stiffen the joint and maintain stability. The proposed mechanisms for neuromuscular control of joint stability have several implications for design of treatment programs. The force-dependent nature of the mechanisms suggests that exposing the joint to potentially destabilizing loads during training may be the necessary stimulus to encourage the development of effective neuromuscular compensatory patterns. Treatment techniques that attempt to promote the development of these protective compensatory patterns could be designed to encourage involuntary muscular responses to destabilizing forces.

Treatments that involve perturbing support surfaces (perturbation training) allow altered forces and torques to be applied to the lower extremity in multiple directions and in a controlled manner. These techniques may induce compensatory muscle activation patterns in older individuals. [14]

G Kelley Fitzgerald (2010) demonstrated the method of application of the perturbation training techniques. As individuals acquire new motor skills, muscle activity responses will progress from strong co-contraction patterns to more selective muscle activity and movement patterns. During the roller board and stationary platform perturbation, most subjects appeared to respond with strong co-contractions of lower-extremity muscles during early treatment sessions. It may allow subjects to return to high-level physical activity and it allows subjects to maintain their functional status for longer periods. [14]

Several clinical assessment tools are already established to identify older adults who have an increased risk of falling. They are mainly TUG score, CoP displacement, berg balance scale, etc. In the present study the main outcome measures taken for static stability were maximum CoP excursion, minimum CoP excursion and stability score, which were checked in four different types of conditions they were NS EO, NS EC, PS EO & PS EC. For dynamic stability the tool used was TUG.

L.P. Rossi (2013) et al observed that CoP displacement was reduced following the balance training program. This suggests an improvement in balance control as it would help prevent excessive horizontal displacement of center-of-mass (CM). The reduction of CoP displacement was the main goal of postural response immediately after perturbation so as to avoid a fall. This was also confirmed in that study by the decreased temporal muscle activity after completing the balance training program, which may have prevented excessive CoP displacement through quick and appropriate muscle activation. [22] In present study also the Cop displacement was measured with

the help of minimum CoP excursion and maximum CoP excursion. The reduction in both the values was measured within and between the groups. The significant reduction was found between the groups in both the values. Group 2 which were given PBBT along with OEP shows more significant result compared to group 1 which was given only OEP. With the reduction in the displacement of maximum and minimum CoP excursion there is a significant increase found in the stability score in the present study.

Heike A. Bischoff (2003) et al found that TUG-test duration increased in a stepwise fashion with decreasing mobility. They suggested that the TUG-test is useful in detecting mobility impairments in elderly persons. TUG-test is well suited to assess disability. It is easy to conduct, requires little equipment and has been shown to be reliable and valid. They said in daily clinical practice, community-dwelling elders who perform the TUG-test >12 seconds should receive early evaluation and intervention. The similar score (>12) was observed in present study and there was a significant reduction in TUG score after the perturbation based balance training exercise. [23] The present study was attempted to check for the effectiveness of perturbation based balance training added to balance and strength training program. All the parameters taken into consideration are showing significant improvements in their values. The study has shown better improvement in the participants who has received perturbation based balance training along with balance and strength training exercises. The reason behind that is OEP only focuses on the sensory motor training. Whereas combination of OEP and PBBT is effective in sensory motor training as well as it encourages involuntary muscular responses to destabilizing forces applied to the peripheral joints. This might be the reason for the better improvement in group 2. Thus, the present study supports the experimental hypothesis that group 2 has significantly improved compared to group1. Hence, it rejects the null hypothesis that there is no significant difference between group 1 and group 2. Limited Treatment sessions were given and Training effect was not checked outside the laboratory set up were the limitations of this study.

CONCLUSION

The study concluded that OEP given along with PBBT is more effective treatment which will help in prevention of fall in elderly individuals.

ABBREVATIONS

AP: Anterior Posterior
ML: Medial Lateral
BOS: Base of Support
COG: Center of Gravity
COP: Center of Pressure
NS EO: Normal Stability Eyes Open
NS EC: Normal Stability Eyes Closed
PS EO: Perturbation Stability Eyes Open
PS EC: Perturbation Stability Eyes closed
NS EO 1: Normal Stability Eyes Open Post Treatment
NS EC 1: Normal Stability Eyes Closed Post Treatment
PS EO 1: Perturbation Stability Eyes Open Post Treatment
PS EC 1: Perturbation Stability Eyes closed Post Treatment
TUG: Timed Up & Go Test
TUG 1: Timed Up & Go Test Post Treatment
PBBT: Perturbation Based Balance Training
OET: Otago Exercise Training
SMT: Sensory Motor Training

REFERENCES

1. Robert S Mazzeo. Exercise and physical activity for older adults. Medicine & science in sports & exercise 1998 June; 30**;** 992-1008.
2. Elisabeth Rydwik. Effects of physical training on physical performance in frail elderly people. Neurobiology, caring sciences and society, Division of physiotherapy.
3. Franjoine MR, GuntherJS, Taylor MJ. Pediatric Balance Scale: A Modified Version of the Berg Balance Scale for the School-Age Child with Mild to Moderate Motor Impairment. Pediatric Phys Ther. 2003; 15:114-28.

4. Sarah Westcott, Linda Pax, P Richardson. Evaluation of Postural Stability in Children: Current Theories and Assessment Tools. Phys Ther.1997; 77(6):629-45.
5. Susan B O'Sullivan, Thomas J Schmitz (ed), physical rehabilitation, 5th edition. Philadelphia, F.A. Davis Company; 2007:249.
6. Carrie A. Laughton, Mary Slavin, Kunal Katdare. Aging, muscle activity, and balance control: physiologic changes associated with balance impairment. Gait and Posture. 2003; 18: 101- 08.
7. Woollacott MH. Age- related changes in posture and movement. J Gerontol. 1993; 48:56-60.
8. Tenetti ME, Speechley M, Gintel SF. Risk factors for falls among elderly persons living in the community. N Eng J med. 1988; 319:1701-7.
9. Hageman PA, Leibowitz JM, Blanke D.Age and Gender Effects on Postural Control Measures. ArchPhys Med Rehabil 1995; 76:961-5.
10. Sabrina Mae Deans, Determining the validity of the Nintendo with balance board as an assessment tool for balance. 2012. UNLV Theses/Dissertations/Professional Papers/Capstones. Paper 1238.
11. Avril Mansfield, Amy L Peters, Barbara A Liu, Brian E Maki. A perturbation-based balance training program for older adults: study protocol for a randomized controlled trial.BMC Geriatrics 2007; 7:12.
12. Amir Shapiro and Itshak Melzer. Balance perturbation system to improve balance compensatory responses during walking in old persons. J neuro eng rehab 2010; 7:32.
13. Steve Iliffe, et al. Multicentre cluster randomized trial comparing a community group exercise programme and home-based exercise with usual care for people aged 65 years and over in primary care. NHC 2014; 18(49).
14. G Kelley Fitzgerald et al. The Efficacy of Perturbation Training in Nonoperative Anterior Cruciate Ligament Rehabilitation Programs for Physically Active Individuals. Phys Ther.2000 Nov- Feb; 80: 180-200.
15. Bertec Corporation Balance Check and Balance Check Screener User Manual, Version 3.3.2.
16. Yi-Chung (Clive) Pai. Motor Training for Fall Prevention. 2012 June. http://clinicaltrials.gov/show/NCT01621958
17. A John Campbell MD, M Clare Robertson. Otago exercise program to prevent falls among elder adults.2003 March.
18. Horak FB, Shupert CL, Mirka A. Components of postural dyscontrol in the elderly: A review. Neurobiol Aging. 1989; 10:727-38.
19. Susie Thomas, Shylie Mackintosh, Julie Hakbert. Does the 'Otago exercise programme' reduce mortality and falls in older adults? : A systematic review and meta- analysis: Age and aging. 2010; 39 (6): 681-87.
20. Michael E. RogersInt. Balance Training for older athlete. J Sports PhysTher. 2013; 8(4): 517–30.
21. Bieryla KA, Madigan ML. Proof of concept for perturbation-based balance training in older adults at a high risk for falls. Arch Phys Med Rehabil. 2011 May; 92(5):841-3.
22. Luciano Pavan Rossi et al. The effects of perturbation-based balance training on the reactive neuromuscular control in community-dwelling older women: a randomized controlled trial. Human movement. 2013; 14(3): 238-46.
23. Hieke A. Bischoff et al. Identifying a cut-off point for normal mobility: a comparison of the timed 'up and go' test in community-dwelling and institutionalised elderly women. Age and aging. 2003; 32: 315–20.

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