EFFECTIVENESS OF PROGRESSIVE STEPPING PROGRAM ON BALANCE PERFORMANCE IN GERIATRICS: A RANDOMIZED CONTROLLED TRIAL

EFICIENȚA PROGRAMULUI DE MERS PROGRESIV ASUPRA ECHILIBRULUI LA VÂRSTNICI - STUDIU RANDOMIZAT

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Key words: geriatrics, balance, progressive stepping program, electronic balance board

Abstract

Background. Balance is a complex motor skill that describes the dynamics of body posture in preventing fall. Loss of balance is associated with aging. Physical therapy intervention plays restorative and accommodative role in minimizing balance instability and hence decreasing risk of fall.

Objective: The objective of this study was to find out the effectiveness of Progressive stepping program on balance performance (TUG, BBS and EBB.MFT®) in Geriatrics.

Study Design. Randomized Controlled Trial.

Study Setting. Department of Community Physiotherapy, Pravara Rural Hospital, Loni-413736, District- Ahmednagar, Tal- Rahata, Maharashtra State, India. **Participants.** Thirty six male and female participants (age 60 and above) with significant history of fall or imbalance. **Interventions.** Participants were divided into two groups; both the groups received Electronic Balance Board exercises in common and the experimental group received Progressive Stepping Program (PSP) in addition for 12 sessions, 4 days a week for 3 weeks for duration of 30-45 min.. Risk of fall and balance were assessed pre and post intervention. **Outcome Measure.** The outcome measures were Timed up and Go test, Berg Balance Scale and Electronic balance board, manufactured by my fitness trainer (EBB.MFT®).

Result: The data of the present study were analyzed using statistical method of unpaired t-test between both the groups. The result showed highly significant ($p<0.001$) improvement in the experimental group as compared to control group.

Conclusion. Progressive stepping program along with Electronic balance board can be a useful intervention for improving balance performance in older individuals with significant history of fall and imbalance.

Key words: persoane vârstnice, echilibru, program de mers progresiv, placă electronică de echilibru

Rezumat

Introducere. Echilibrul este abilitate motorize complexă care descrie dinamica posturii corpului în precenirea căderii. Pierderea echilibrului este asociată cu înaintarea în vârstă. Kinetoterapia are un rol restaurativ și de acomodare în reducerea instabilității, reducând astfel riscurile de cădere.

Obiective. Obiectivul acestui studiu este de a stabili eficiența programului de mers progresiv în îmbunătățirea echilibrului (TUG, BBS and EBB.MFT®) la vârstnici.

Designul studiului. Studiu randomizat.

Locul de desfășurare. Departamentul de Kinetoterapie al spitalului municipal Pravara, Loni-413736, District-Ahmednagar, Tal- Rahata, Maharashtra State, India. **Participanți.** 36 de subiecți, bărbați și femei (peste 60 de ani) cu antecedente de dezechilibre și cădere. **Intervenție.** Participanții au fost împărțiți în două grupuri; ambele au urmat exerciții cu placa electronică de echilibru, iar grupul experimental a urmat în plus și programul progresiv de mers încă 12 ședințe, 4 zile /săptămână, timp de 3 săptămâni, cu o durată de 30-45 min. Riscul de cădere și echilibrul s-au evaluat pre și post intervenție.

Evaluarea. S-au folosit testul Ridică-te și mergi, scala Berg și placa electronică de echilibru, concepută de un antrenor de fitness (EBB.MFT®).

Rezultate. Datele studiului prezent au fost analizate statistic cu ajutorul testului T pentru eșantioane independente, pentru ambele grupuri. Rezultatele au demonstrat o îmbunătățire semnificativă ($p<0.001$) a echilibrului la grupul experimental comparativ cu grupul de control.

Concluzii. Programul de mers progresiv, alături de exerciții pe placa electronică de echilibru, poate fi utilă în îmbunătățirea echilibrului la vârstnicii cu un istoric semnificativ de dezechilibre și cădere.

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Introduction

A fall is often defined as 'Inadvertently coming to rest on the ground, floor or other lower level'.[1] Falls in elderly are a major cause of morbidity and mortality often extending far beyond minor injuries limiting functional independence or even death. It is estimated that 1.5 to 2 million people are injured and 1 million succumb to death every year due to falls. [2]

Advancing age is accompanied with generalized reduction of visual systems associated with postural instability and increased risk of falls.[3] Increased attention demand for obstacle crossing as compared to walking on even ground has been higher in older subjects than in younger groups whether the obstacle appear suddenly or not.[4]

A step is a fundamental component of walking; it represents the initiation of body weight transfer and basic expression of human mobility. [5, 6, 7] Reduced activities in daily life of an elderly causes greater decrease of sensorimotor function especially motor function. A decrease in function causes instability when walking and causes a greater risk of fall.[8] Research shows that an altered balance is the greatest collaborator towards fall in elderly.[9] Loss of balance is associated with aging. Balance is a complex motor skill that describes the dynamics of body posture in preventing fall. [10] Physical therapy intervention plays restorative and accommodative role in minimizing balance instability and hence decreasing risk of fall.[11]

Currently there are many exercise programs that helps to improve balance in older adults for e.g. unstable surface balance training, progressive stepping program, Swiss ball etc. [12-14] Progressive Stepping Program consists of stepping tasks with movement of upper or lower limb to make a new contact with the support surface while negotiating obstacles around the field.[4] EBB.MFT® is used to provide Centre of pressure (COP) bio-feedback. The weight on each foot is computed and converted into visual feedback. The computer analyses the data and provides relevant biofeedback (sway path and COP position) on the visual monitor. This device was used for training and measuring balance in healthy and older adults.[15,16] There are many studies that aims to improve balance with exercises but there is limited evidence as to which treatment is appropriate and aims to improve balance.

Hence, the present study was aimed to compare the effectiveness of EBB.MFT® and Progressive stepping program (PSP) on balance and risk of fall in geriatrics.

Method

Participants: The study received ethical approval from the Institutional Ethical Committee (Ref no PIMS/CPT/IEC/2013/1374) of Pravara Institute of Medical Sciences, Loni. A total of forty eight participants were screened, out of them thirty six participants (28 males and 8 females) with history of imbalance or significant concern about their balance was included in the study. Participants with any musculoskeletal, neurological diagnosis, auditory impairment, discomfort while stepping, mini mental state examination (MMSE) < 24 were excluded from the study. Participants were randomly allocated into two groups. i.e. experimental group A and control group B. The intervention duration for both the groups was four times a week for three weeks.

Outcome Measures used for the study were:

Risk of fall was with Time up and Go Test (TUG).

The timed "Up and Go" test is measured, in seconds, the time taken by the participant to stand up from a standard arm chair (approximate seat height of 46 cm [18in], arm height 65 cm(25.6 in), walk a distance of 3 meters (118 inches, approximately 10 feet), turn, walk back to the chair, and sit down. The participant was asked to wear their regular footwear and use their customary walking aid; if any (none, cane, walker). No physical assistance was given. They participant started the test with their back against the chair, their arms resting on the armrests, and their walking aid at hand (if any). They were instructed that, on the word "go" they had to get up and walk at a comfortable and safe pace to a line on the floor 3 meters away, turn, return to the chair and sit down again. The participant walked through the test once, before being timed

in order to become familiar with the test. Either a wristwatch with a second hand was used to time the trial.

Interpretation: 13.5 sec or less- Normal mobility.

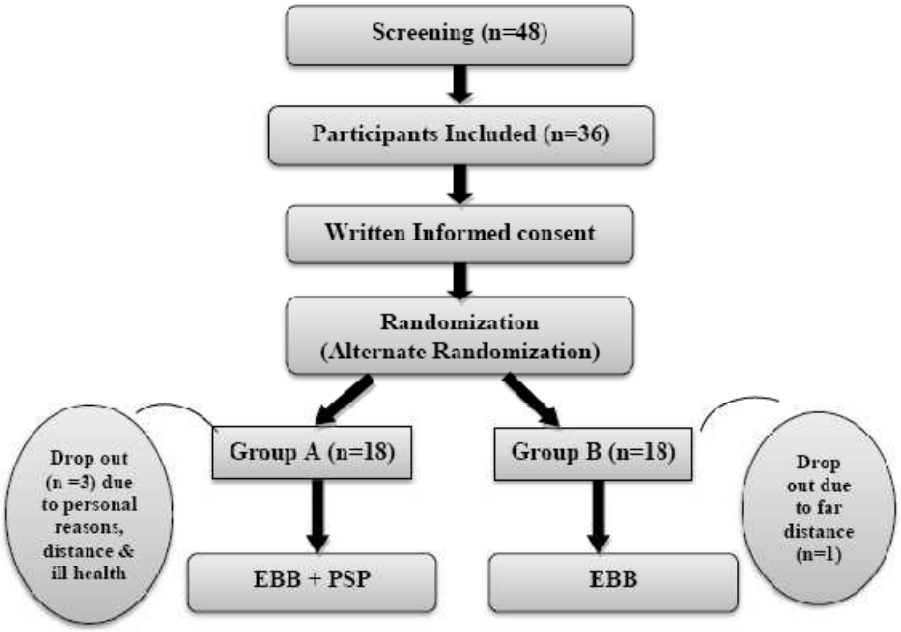
> 13.5 sec- Person may be prone to fall/risk of fall.[24,25]

Balance was assessed using Berg Balance Scale (BBS).

It is a 14-item scale designed to measure balance of the older adult in a clinical setting, Completion Time: 15-20 minutes. Scoring : A five-point scale, ranging from 0-4. "0" indicates the lowest level of function and "4" the highest level of function. Total Score = 56(Appendix F)
Interpretation: 41-56 = low fall risk.
21-40 = medium fall risk.
0 –20 = high fall risk.[26]

Dynamic balance was assessed using Electronic Balance Board (EBB.MFT®).

The Electronic Balance Board. MFT® (www.myfitnesstrainer.net), manufactured by my fitness trainer. MFT Software Balance Test 1.7.
Scoring: 1= Excellent Stability, 2= Good Stability, 3= Improvable Stability, 4= Disappointing Stability, 5= Bad Stability.[27,28]



Flow Chart Representing the Procedure of Selection of Participants

Thirty six participants were divided by using alternate method into control (n=18) and experimental group (n=18) based on inclusion and exclusion criteria. Participants in control group received Electronic balance board (EBB.MFT®) training for a duration of 15min and Experimental group received Progressive Stepping Program (PSP) along with EBB.MFT® for a duration of 30-40 min; both groups performed exercises 4 times a week for 3 weeks. The outcome measures were assessed before the study and reassessed at the end of study for risk of fall with TUG and balance with BBS and EBB.MFT®

Progressive Stepping Program: Participants in the experimental group were trained for three major components of which involved, (a) A 3-person team relay stepping exercise;(b) A step on line exercise; (c) A grand stepping tour exercise. The 3-person team relay stepping exercise (fig 1)required the participant to carry a baton and to walk the length of the room (approximately 6 m), step over a low obstacle placed in the middle of the course (3 m point) and

then to pass the baton to the other person on the team. The duration of this exercise was for 3 minutes.

Fig1:3 person team relay exercise

The Step on the line exercise (fig 2) required the participant to walk the distance of 6 m while stepping on two coloured lines which were taped on the ground and veering apart at a tangent so that eventually the person had to spread out their legs to beyond shoulder width in order to place their feet on the line. As the participant arrived at the end of the course, they were asked to return to the start point to repeat the course again. The duration of this exercise was for 3 minutes.

Fig 2: Step on line exercise ***Fig 3:Grand stepping tour exercise***

The Grand stepping tour exercise (fig 3) is a stepping course marked out by coloured squares, soft rubber cushions, and low obstacles. The purpose was to create a course whereby the person is required to step on and off the coloured squares, over low obstacles, and on and off soft rubber cushions. The course is set in such a way that the participants need to move in a non-stop circuit-like manner. The entire grand stepping exercise duration was for 6 minutes.

Fig 4: Electronic Balance Board.MFT®

The participant's name, age, gender, height (cm) and weight (kg) was entered in the data form provided in the EBB software. Initially forward backward and then progressing to side to side training was selected for the participant; time was set for the current session. A walker was placed just in front of the balance Board for safety purpose to avoid sudden fall by the participant. For Side to Side(S2S) balance the participant was asked to stand on both his feet facing the computer screen for visual feedback, they were asked to shift the COP in form of an arrow as per displayed on the monitor as a green colour circular target. For Forward Backward

Balance (FB) the Electronic Balance Board was placed 45 degree from 90 degree position. The participant was asked to place both the feet in the centre of the Electronic Balance Board (EBB.MFT®) by facing the computer screen for visual feedback, they were asked to shift the COP in form of arrow as per displayed on the monitor as a green colour circular target. At the end of training, the test was repeated and the displayed score on the computer screen was noted.

Results

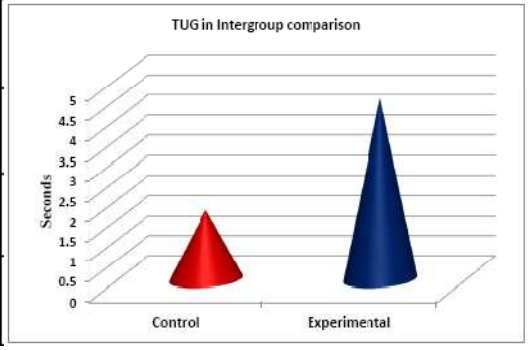
Data were analyzed with Graph pad Instat Trial version 13.3. The data was entered into an excel spread sheet, tabulated and subjected to Statistical Analysis.

Paired 't' test was used to compare the difference in scores between the pre intervention and post intervention values within a single group. Unpaired 't' test was used to compare the difference in scores between the two groups. Thirty six older individuals had participated in the study and out of them 3 participants from experimental and 1 from control group did not complete the study.

No adverse event was noted during the study period. Intra group comparison on Risk of fall had highly significant ($p<0.01$) difference in both the groups while in inter group comparison there was highly significant ($p<0.001$) difference in Experimental Group as compared to Control Group. EBB was equally effective for both the groups while PSP & EBB was more effective in experimental group as compared to control group (table 1), (graph 1)

Table 1: TUG in Intra and Inter group Comparison

TUG	mean± SD		't' value	'p' value	Result
	Pre	Post			
Control group	15.402±1.689	13.674±2.078	6.125	p<0.01	Highly significant
Experimental Group	14.874±1.524	10.37±1.346	13.359	p<0.0001	Highly significant
Control v/s experimental	Control	experimental	6.311	p<0.0001	Highly significant
	1.732±1.165	4.504±1.301			

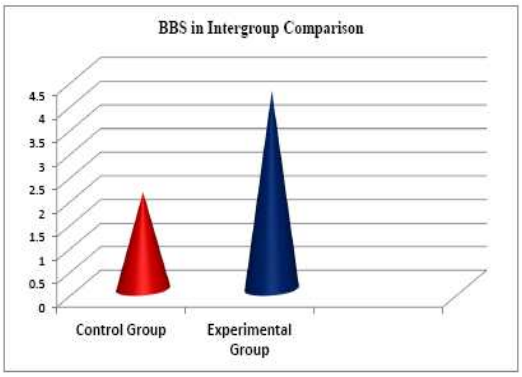


Graph 1:TUG in Intergroup comparison

Statistical Significant and highly significant difference on intra group comparison in both the groups and there was highly significant (p<0.01) difference in intergroup comparison for BBS.PSP was more effective treatment given to improve static balance (table 2) (graph 2)

Table 2: BBS in Intra and Intra group comparison

BBS	mean± SD		't' value	'p' value	Result
	Pre	post			
Control group	48.52±3.145	50.823±1.380	3.719	p<0.01	Highly significant
Experimental Group	49.66±2.475	53.66±1.759	11.039	p<0.0001	Highly significant
Control v/s experimental	Control	experimental	3.542	p<0.01	Highly significant
	2.058±1.886	4.2±1.474			



Graph 2: BBS on Intergroup comparison

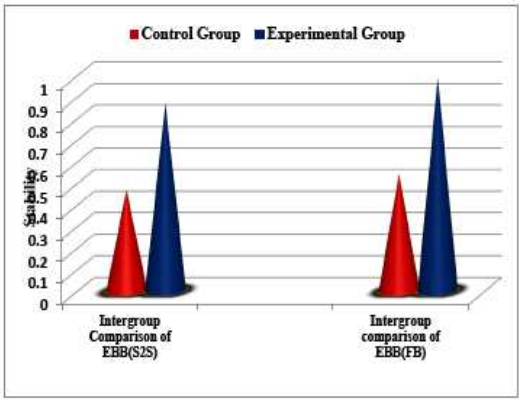
On intragroup comparison for Side to Side (S2S) balance there was highly significant difference between both the groups i.e. control group (p<0.01) and experimental group (p<0.0001), while in intergroup comparison there wasn't much of significant difference. EBB.MFT® was equally effective for both the groups in improving S2S balance whereas; on intragroup comparison for Forward backward (FB) balance there was highly significant difference in both the groups (p<0.0001) while on intergroup comparison there was Highly significant difference (p<0.01) in experimental group as compared to control group.EBB was significantly effective in experimental group as compared to control group (table 3, 4) (graph 3)

Table 3:EBB(S2S)Intra and Inter group Comparison

EBB(S2S)	mean± SD		't' value	'p' value	Result
	Pre	post			
Control group	3.768±0.3316	3.3017±0.4810	3.959	p<0.01	Highly significant
Experimental Group	3.710±0.4499	2.824±0.3808	8.129	p<0.0001	Highly significant
Control v/s experimental	Control	experimental	0.3777	p<0.05	Significant
	0.4711±0.4810	0.8733±0.4377			

Table 4: EBB(FB)in Intra and Inter group Comparison

EBB(FB)	mean± SD		't' value	'p' value	Result
	Pre	Post			
Control group	3.7517±0.3276	3.1806±0.3090	7.074	p<0.0001	Highly significant
Experimental Group	3.564±0.3565	2.750±0.3490	7.770	p<0.0001	Highly significant
Control v/s experimental	Control	experimental	3.582	p<0.01	Highly Significant
	0.5464±0.3185	0.9906±0.3829			



Graph 4: EBB(S2S & FB)on Intergroup comparison

Discussion

The present study showed that the intervention given to both the groups was effective irrespective in terms of balance and reduction in risk of fall, irrespective of the treatment received which was EBB.MFT® or Progressive stepping program(PSP).However, PSP group showed more significant improvement as compared to the control group in overall outcomes.

In this study both the groups showed significant improvement balance and reduction in risk of fall this could be because of the Electronic Balance Board (EBB.MFT®) training. This is in accordance with the work of previous investigators as EBB. MFT® was common for both the groups.[17,18] In the present study EBB.MFT® Balance board is a unique modular design that is used to develop balance, motor coordination skills, weight distribution and core strength.

As the age advances, rehabilitation after injuries to several parts of the body is of prime importance to avoid injurious falls .It gradually helps to expand neural networks that enable the left and right hemispheres of the brain to communicate with each other, thereby increasing its efficiency to develop sensory integration and cognitive skills.[19,20] In addition by giving the individual visual feedback they become more aware of body displacement and orientation in space; they are able to integrate somatosensory and visual information in relation to stance and movement, which may recalibrate deficient proprioceptive information and compensate the sensorimotor deficit.[21,22]

Experimental group received balance exercises by PSP while control group received balance exercises by EBB.MFT®. Stepping strategy is the ability to recover from a forward fall that relies on rapid translation of the stepping foot to a position anterior to the whole body centre of mass (COM) and subsequent generation sufficient recovery limb joint movements.[23] Lower limb strength is an independent predictor of future fall in older adult. Studies on PSP have proved that there is improved lower limb strength that has an ability to recover from a fall in older adults.PSP is performed in older adults with high risk of falling because it can be performed in a small indoor space, walking can be substituted with PSP if there is a possibility of environmental barriers. It requires minimum investment as it involves the use of low tech equipment. As seen in the present study, Progressive stepping program along with Electronic balance board can be a useful intervention for improving balance performance in older individuals with significant history of fall, imbalance or concern about their balance. The study supporting this result, was done by Fung L et al, who concluded that Progressive Stepping Program (PSP) is an useful exercise intervention in improving balance and lower limb function in older adults.[4] The limitation of this study was small sample size, no long term follow up.

Conclusion

Progressive stepping program along with Electronic balance board can be a useful intervention for improving balance performance in older individuals with significant history of fall, imbalance or concern about their balance.

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