Effectiveness of Three Different Surfaces for Balance Training on Ambulant Stroke Patients - A Comparative Study

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Abstract: *Balance impairment is important to consider after stroke.[2] The firm surface is been routinely used for balance training, but there is inadequate information about the effects of sand, balance pad and wobble board.[6] So this study is mainly focusing on the balance training on SAND, BALANCE PAD and WOBBLE BOARD and to compare the effects of all three surface. Methodology: In the present experimental study, total of 75 patients with 25 patients randomly allocated in each of three groups (sand, balance pad, wobble board) and given a set of six balance exercises along with routine physiotherapy protocol for 6 days a week for 6 weeks. Pre and post intervention assessment was carried out using BBS, TUG and FRT. Results: All the three surfaces are effective for balance training. But sand proved to be significantly better than remaining two with descriptive statistics using ANOVA and post HOC tests. Conclusion: All three surfaces are effective for balance training in ambulant stroke patients, Moreover SAND is the most effective and can be used as an alternative to remaining two for community based rehabilitation.*

Keywords: Balance, Sand, Balance pad, Wobble board

1. Introduction

Stroke, or cerebro-vascular accident (CVA), results in sudden, specific neurological deficit.[1] Balance impairment is important to consider after stroke, Since Two-thirds of the survivors have difficulty in walking immediately after suffering a stroke, and 6 months later over 30% (States et al., 2009).[2] Dimensions for making the exercises complex and difficult describe four different surfaces: Firm surface (wood floor), uneven surface (grass, sand), compliant surface (i.e. balance pad) and wobbly surface (wobble board).[6]

Sand training is a low-impact form of resistance training. Training on sand activates and strengthens underworked areas, such as the ankles and foot muscles, which are used to grip the uneven surface. Since the body must constantly adjust, training on sand is advantageous for improving balance and stability.[7] A balance pad increases the external swing which more effectively encourages postural orientation by forcing faster modifications of the sensory system and motor system. So a balance pad is used as a compliant surface for study.[5] Wobble board exercise program can be used to increase the range of motion in ankle joint complex, strengthen musculature of foot ankle and lower leg. Some study also focused that it improves static balance.[8]

Among the four surfaces the firm surface is been normally used in the physiotherapy setups for balance training, but there is lack of evidence about the effects of remaining three surfaces and especially the SAND. The present study is focusing on the balance training on three remaining surfaces i.e., SAND, BALANCE PAD and WOBBLE BOARD to compare the effects found on all three surfaces and to conclude the most efficient one.

2. Aims and Objectives

1) To find the effectiveness of the specific surfaces on the balance training in ambulant stroke patients.
2) To find which surface is the most effective for balance training in ambulant stroke patients.
3) To find whether sand can be used as an alternative to other surfaces for balance training in ambulant stroke patients.

3. Review of Literature

Ji yeun, jungseo park, daehee lee, hyolyun roh (2011), performed a study on "The Effects of Exercising on Unstable Surfaces on the Balance Ability of Stroke Patients" and found that balancing exercise on an unstable surface (balance pad) was more effective than on a stable surface at improving the balance of stroke patients.[5]

Ayodele teslim onigbinde, taofeek awotidebe, henry awosika (2009), studied on "Effect of 6 weeks wobble board exercises on static and dynamic balance of stroke survivors" The study concluded that wobble board exercise improved both static (eye closed) and dynamic balance of stroke survivor used in this study.[8]

Clarissa Barros de Oliveira, Ítalo Roberto Torres de Medeiros, Norberto AnizioFerreira Frota, et al. (2008) performed a study on "Balance control in hemi-paretic stroke patients: Main tools for evaluation" and concluded that Different tools for balance assessment have been validated and should be chosen according to individual characteristics of patients with stroke. [4]

4. Methodology

4.1 Study Design

An experimental study

4.2 Sample Size

Required minimum sample size for present study is 75 (25 per group). Sample size is obtained using n-Master software.

4.3 Study Population

Post-stroke patients referred to Outdoor Physiotherapy Department of S.S.G. Hospital, Vadodara fulfilling the inclusion and exclusion criteria.

4.4 Inclusion Criteria

Stroke, single episode of unilateral stroke, who will be referred by the physician/ neurologist for physiotherapy and are medically stable[5]; Berg Balance Score of 41 – 56[11] ; Brunnstrom's recovery stage of 3 or above for the lower limb[3] ;Ability to walk independently for 10 m without assistance[5] ;Mini Mental state Examination score of 24 or more.[5]

4.5 Exclusion Criteria

Any associated neurological conditions[8] ; Blind or experience severe visual field deficit affecting balance and gait[9] ;Musculoskeletal ailments of lower extremity leading to instability and pain[8] ;Presence of uncontrolled hypertension and diabetes[5] ;Recent cardiac diseases (less than 2 months)[5].

4.6 Procedure

A written and informed consent about enrolment in the study was taken from all patients included in the study. 6 weeks intervention program with 6 days a week was given.

Patients were randomly allotted into group A, B, and C.GROUP A: Balance training exercises over the sand; GROUP B: Balance training exercises over balance pad; and GROUP C: Balance training exercises over wobble board. In addition to this all the participants continued with the conventional physiotherapy intervention (mat exercises, PNF and massage).[8]

Balance exercises included a set of 6 exercises: Exercise 1: Weight shifting exercise.[12] ; Exercise 2: The subjects stood up and walked in the same place[5] ; Exercise 3: The subjects repeatedly raised their heels in the standing position.[5]; Exercise 4: The subjects laced their fingers in standing position and stretched their arms up, down, left and right[5]; Exercise 5: The subjects maintaining balance on both feet will perform small knee bends to challenge balance. Gradually were asked to bend the knees further into squat.[12]; Exercise 6: The subject threw a ball against a wall and catches it on its return. They also perform this with a partner.[12]

Patient's outcome measures were taken before and at the end of 6 weeks of intervention/treatment. The assessments focused on the BERG BALANCE SCALE, TIMED UP AND GO TEST and FUNCTIONAL REACH TEST. Differences in the scores are assessed by appropriate statistical methods.

5. Results

All the tests and calculations were performed using StataIC 13.

5.1 Gender and Age Distribution

The study included 75 post stroke patients, of which 58 were males (77.3%) and 17 were females (22.7%), when compared using chi-square tests it was found that gender distribution is homogenous. The Mean age of all 75 Post-Stoke Patients was 49.84 years with SD 12.482 and was homogenous.

5.2 Intra Group Comparision of Three Outcome Measures
Paired sample T-test was used to compare the values of three outcomes BBS, TUG and FRT, pre intervention and post intervention in all three groups.
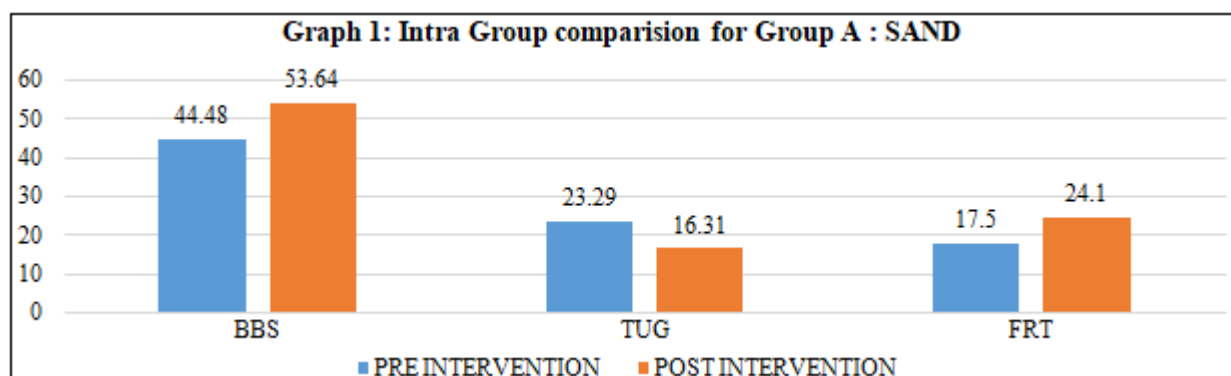
Graph 1: Graph shows Mean difference ± SD values for BBS (9.160±1.95); TUG (6.983 ± 1.38) and FRT (6.608 ± 1.28) for Group A, which are highly significant at 99% confidence interval.
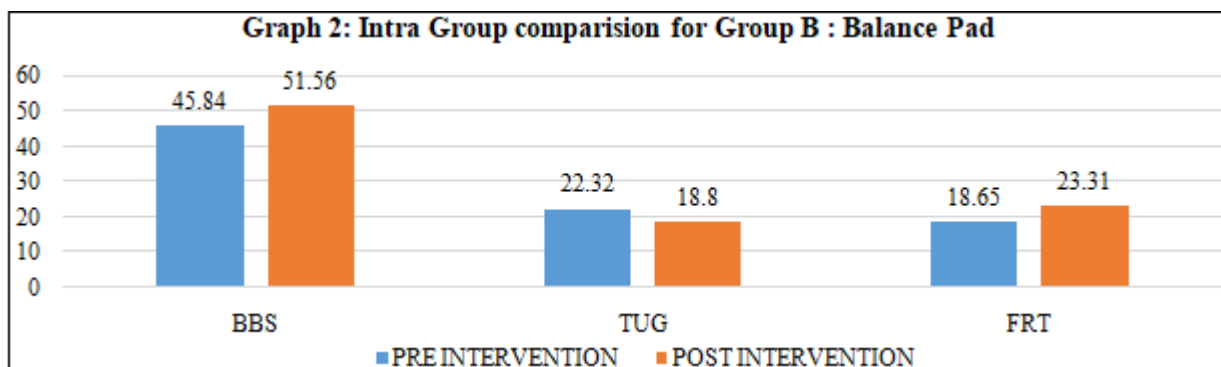
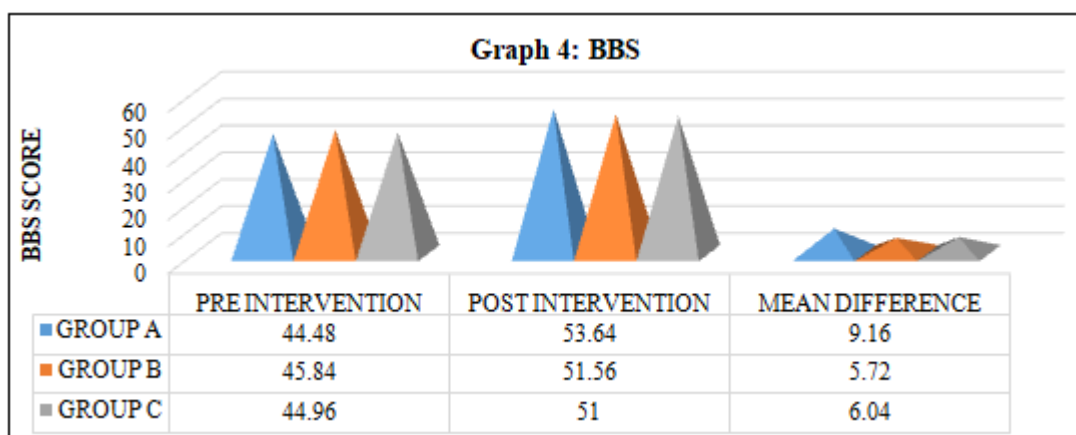**Graph 2:** Graph shows Mean difference ± SD values for BBS (5.720 ± 1.51); TUG (3.516 ± 1.56) and FRT (4.664 ± 1.42) for Group B, which are highly significant at 99% confidence interval.
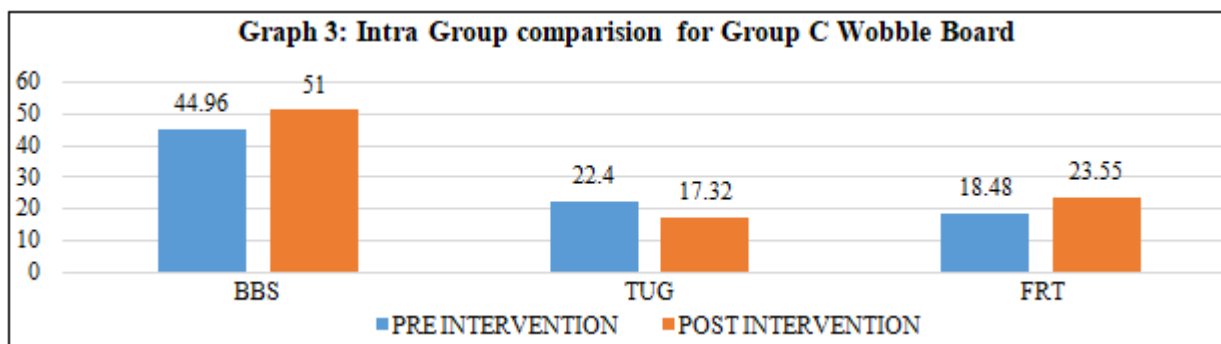
Graph 3: graph shows Mean difference ± SD values for BBS (6.040 ± 1.64); TUG (5.080 ± 1.11) and FRT (5.072 ± 1.17) which are highly significant at 99% confidence interval.

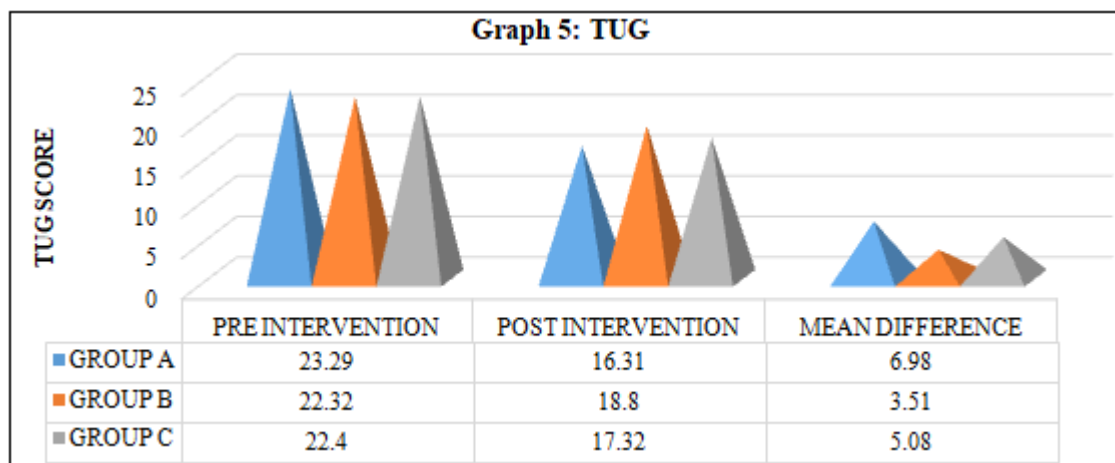**5.3 Inter Group Comparision of Outcomes Using ANOVA**

	PRE INTERVENTION	POST INTERVENTION	MEAN DIFFERENCE
GROUP A	44.48	53.64	9.16
GROUP B	45.84	51.56	5.72
GROUP C	44.96	51	6.04

Graph 4: Shows Comparison of pre intervention, post intervention and mean difference values of BBS of three groups using ANOVA and post HOC test

Using ANOVA there was no significant difference in the pre intervention BBS values of all three groups but there was significant difference in the post intervention BBS values of all three groups. Post HOC test when used for multiple comparisons showed that the post intervention level mean values of BBS are significantly higher in GROUP A as compared to GROUP B and GROUP C. But there is no significant difference in the values of GROUP B and GROUP C.

Using ANOVA there is significant difference in the mean difference values of BBS of all three groups. Post HOC test when used for multiple comparison showed that the mean difference values of BBS is significantly higher in GROUP A as compared to GROUP B and GROUP C. But there is no significant difference in the values of GROUP B and GROUP C.

Graph 5: TUG

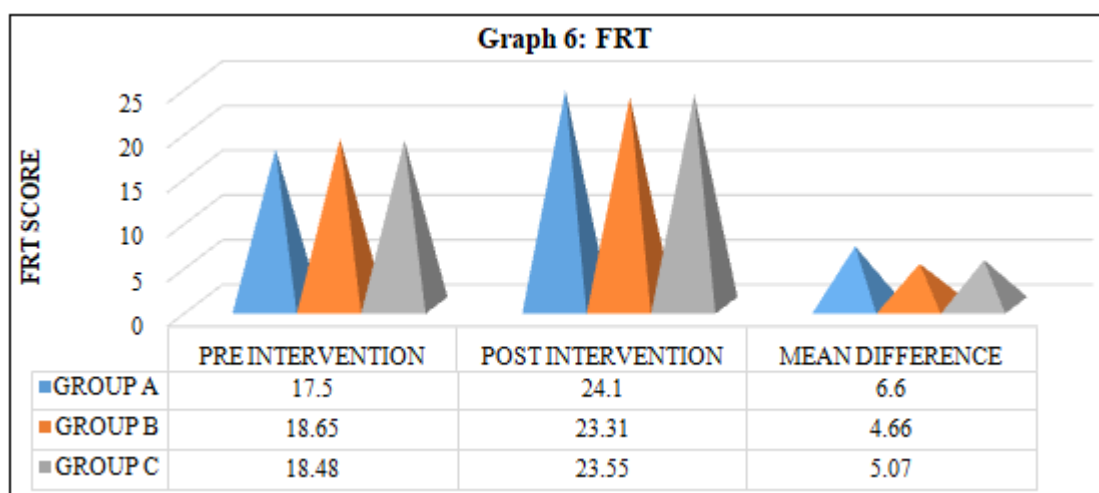|	PRE INTERVENTION	POST INTERVENTION	MEAN DIFFERENCE
■GROUP A	23.29	16.31	6.98
■GROUP B	22.32	18.8	3.51
■GROUP C	22.4	17.32	5.08

Graph 5: Shows Comparison of pre intervention, post intervention and mean difference values of TUG of three groups using ANOVA and post HOC test

Using ANOVA there was no significant difference in the pre intervention TUG values of all three groups. Using ANOVA there no is significant difference in the post intervention TUG values of all three groups.

Using ANOVA there is significant difference in the mean difference values of TUG of all three groups. Post HOC test when used for multiple comparisons showed that the mean difference values of TUG are significantly higher in GROUP A as compared to GROUP B and GROUP C. Also there is significant difference in the values of GROUP B and GROUP C.

Graph 6: FRT

	PRE INTERVENTION	POST INTERVENTION	MEAN DIFFERENCE
■GROUP A	17.5	24.1	6.6
■GROUP B	18.65	23.31	4.66
■GROUP C	18.48	23.55	5.07

Graph 6: Shows Comparison of pre intervention, post intervention and mean difference values of FRT of three groups using ANOVA and post HOC test

Using ANOVA there was no significant difference in the pre intervention FRT values of all three groups.Using ANOVA there was no significant difference in the post intervention FRT values of all three groups.

Using ANOVA there is significant difference in the mean difference values of FRT of all three groups.Post HOC test when used for multiple comparison showed that the mean difference values of FRT is significantly higher in GROUP A as compared to GROUP B and GROUP C. but there is no significant difference in the values of GROUP B and GROUP C.

6. Discussion

The aim of the present study was to find the effectiveness of the specific surfaces on the balance training and find out the most effective surface for balance training in ambulant stroke patients. The results obtained showed that all the three surfaces SAND, BALANCE PAD and WOBBLE BOARD are effective to improve balance in ambulant stroke patients, with the sand to be most effective one.

In the patients exercising on SAND (group A) the p value of paired t test for all the three outcomes BBS, TUG and FRT was obtained < 0.001 which is highly significant and suggesting that there is a noticeable improvement in balance in this group. Sarah gearhart quoted that Sand training is a low-impact form of resistance training. Training on sand activates and strengthens underworked areas, such as the ankles and foot muscles, which are used to grip the uneven surface. Since the body must constantly adjust, training on sand is advantageous for improving balance and stability.[10]

In the patients exercising on BALANCE PAD (group B) the p value of paired t test for all the three outcomes BBS, TUG and FRT was obtained < 0.001 which is highly significant

and suggesting that there is noticeable improvement in balance in this group. Jiyeun et al. demonstrated that the patients exercising on balance pad showed a significant improvement in Berg balance scale (BBS) and parameters of sway of the center of pressure (COP) suggesting a significant improvement of balance as compared to those exercising on a stable surface.[8] This finding is in agreement with a study, which reported that balancing exercises on an unstable surface had a greater effect on sensory motor function than exercises on a stable surface, and a report that postural reactions were faster.[75]

In the patients exercising on WOBBLE BOARD (group C) the p value of paired t test all the three outcomes BBS, TUG and FRT was obtained < 0.001 which is highly significant and suggesting that there is noticeable improvement in balance in this group. Onigbinde A Tet. al. concluded that wobble board exercise improved both static and dynamic balance of stroke survivor,[11] Justifying the results of the present study showing improvement in static balance (FRT), dynamic balance (TUG) and overall balance (BBS).

The statistical analysis carried out using ANOVA and Post HOC tests for inter group comparison between the three groups SAND, BALANCE PAD and WOBBLE BOARD demonstrated that the balance improvement of all the three outcomes i.e. BBS, TUG, and FRT is significantly higher in group A (SAND) as compared to group B (BALANCE PAD) and group C (WOBBLE BOARD), whereas there is no significant difference in the results of group B (BALANCE PAD) and group C (WOBBLE BOARD). Thus shows that the SAND is the most effective from all the three surfaces for balance training. Rather than the modern physiotherapy equipment's like balance pad and wobble board, sand proved to be an effective one.

The ankle strategy is more effective at keeping the trunk in a vertical position during small perturbations while standing. Hence in the balance training given on all three surfaces SAND, BALANCE PAD and WOBBLE BOARD, ankle strategy is the major to improve. Moreover the ankle strategy depends more on accurate somato-sensory information.[56] And sarah gearhart quoted for sand "Since the surface is constantly shifting, you're always a little off balance,".[10] Sand is constantly shifting and providing somatosensory information to the soles of feet and thus improving ankle strategy to maximum and giving results significantly better than the remaining two surfaces.

Various body mechanics are at an advantage when exercising on SAND.[10]Singh Amrinder et al. proposed that exercises on sand causes lower reuse of elastic energy and energy loss due to feet slipping during the concentric action (Miyama & Nosaka, 2004; Giatsis et al., 2004). Moreover sand induce different training effects compared to training on a firm surface and the lower impact on the musculoskeletal system induced by training on sand might be useful during rehabilitation programs.[77]Fertig says. "It's a totally different use of the body."[10]
Using SAND as a surface for balance training can be a very helpful factor for community based rehabilitation. Many ambulant stroke patients fails to receive the services of a modern physiotherapy setup due to multiple reason and in turn suffers the recovery, for all such patients this can prove as an best alternative for balance training. All the patients undergoing home physiotherapy can also practice balance training exercises over sand which gives them a greater recovery in balance providing less fall risk and in addition providing a continuous sensory awareness and feedback through the surface of sole of feet. So SAND which was a traditional approach used in physiotherapy that has been almost forgotten since the last decade needs to be incorporated back to its maximum for rehabilitation of balance and balance training strategies in various patients including the patients with neurological insult i.e. stroke.

7. Conclusion

All the three surfaces used in the present study SAND, BALANCE PAD and WOBBLE BOARD are effective for providing balance training in ambulant stroke patients. However SAND is the most effective and best surface for balance training on ambulant stroke patients, and it can be used an alternative to other standard equipment's for balance training in ambulant stroke patients.

8. Limitations

Results of males and females cannot be compared because of fewer female patients as compared to male patients; Division of patients according to age group was not done in the study; Follow up of patients was not done after completion of intervention duration; hence long term benefits of the intervention are unknown.

9. Future Scope

- Same study can be done involving equal number of male and female patients comparing results of males and females.
- A Comparative study including different age groups can be done.
- A further study can be carried out to know the long-term benefits of the intervention.

References

[1] Darcy A. Umphred, "Neurological Rehabilitation", 4th Ed.; 2001: Mosby: 741-786
[2] NikaGoljar, Helena Burger, Marko Rudolf and Irena Stanonik. Improving balance in subacute stroke patients: a randomized controlled study.international journal of rehabilitation research. 2010.
[3] SnehalBhupendra Shah, SmitaJayavant.Study of balance training in ambulatory hemiplegics. Indian journal of occupational therapy. 2006.
[4] Clarissa Barros de Oliveira,Ítalo Roberto Torres de Medeiros, Norberto Anizio Ferreira Frota, MárioEdvinGreters, Adriana B. Confort.Balance control in hemiparetic stroke patients: Main tools for evaluation. Journal of rehabilitation, research and development. 2008.
[5] jiyeun, jungseo park, daehee lee, hyolyunroh. the effects of exercising on unstable surfaces on balance ability of stroke patients. Journelphysther science. 2011.

[6] Timothy c. hain. Balance exercises. March 1 2009, dizziness-and-balance.com.

[7] Sarah gearhart. USA TODAY HIGH SCHOOL. sand training improves balance, strength and speed. IndiaTrampoline.com. 2012.

[8] Ayodeleteslimonigbinde, taofeekawotidebe, henry awosika. Effect of 6 weeks wobble board exercises on static and dynamic balance of stroke survivors. Technology and health care 2009.

[9] Rohit G Shirsat.Comparison of balance training and balance training with obstacle ambulation on dynamic balance in ambulant stroke patients- A Randomized Control Trial. 2009.

[10] Horak FB, Henry SM, Shumway-Cook A. Postural perturbations: New insights for treatment of balance disorders. Phys Ther. 1997;77(5):517–33.

[11] Badke MB, Shea TA, Miedaner JA, Grove CR. Outcomes after Rehabilitation for Adults with Balance Dysfunction. Arch Phys Med Rehabil 2004;88: 227-33.

[12] Wobble board exercises, rehabilitation and exercises, Sportsinjuryclinic.net. 2014.

[13] Fabio RP. Sensitivity and Specificity of platform posturography for identifying patients with vestibular dysfunction. Phys Ther. 1995, 75: 190-305.