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Original Article

Physiotherapy Section

Comparison Study of Wobble Board and Bosu Ball along with Strength Training on Lower Limb Strength, Dynamic Balance, Agility and Functional Performance of Runners with Lateral Ankle Instability

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ABSTRACT

Introduction: Chronic Ankle Instability (CAI) is characterised by a subjective feeling of recurrent instability, continued episode of giving way and self-reported disability. A wealth of literature is available reporting causes and risk factors related to CAI, still there is a lack of understanding regarding rehabilitation procedures.

Aim: To compare effect of BOSU ball and wobble board along with strength training on muscle strength, dynamic balance, agility and functional performance in recreational runners with CAI.

Materials and Methods: It was an experimental study design conducted at Physiotherapy Outpatient Department (OPD) of SGT Hospital, Gurugram. Data collection was done from July 2019 to October 2019. Analysis and report writing took 2 months i.e from November 2019 to December 2019. Total 60 male runners in the age group of 18-35 years with CAI were randomly divided into two groups i.e. A (Wobble board) and B (BOSU Ball) with 30 players in each group. All subjects were evaluated for ankle muscle strength, agility, dynamic balance and functional performance as measured by Manual muscle tester, T-test, Y balance test and figure of eight hop test respectively on day one and last day of 3rd and 6th week of intervention. Statistical Package for the Social Science (SPSS) software version 20.0 was used to analyse result. Mean and Standard deviations were calculated. Analysis of Variance (ANOVA) and Student t-test was used for analysing inter group differences.

Results: The statistical findings in this study postulate that both groups had significantly improved fitness and skill related variables but BOSU ball group showed highly significant improvement compared to wobble board group ($p<0.05$).

Conclusion: The current results support that sensorimotor training can be progressed in difficulty by systematically reducing the base of support with help of BOSU ball.

Keywords: Athletic rehabilitation, Dynamic exercises, Functional instability, Physical disability

INTRODUCTION

Repetitive ankle sprain can progress to chronic ankle instability, which is characterised by a subjective feeling of recurrent instability, continued episode of giving way, weakness and self-reported disability after physical activity [1]. Literature reports 40-70 percent of people with functional ankle instability which can be defined as a feeling of "giving way" in the ankle joint or can be defined as joint motion beyond volitional control, but not considerable physiological range of motion. The pathological process of functional ankle instability includes mechanical, muscular and sensory motor deficiencies [1,2].

Researchers have noticed the existence of chronic ankle instability through a variety of assessment modalities including impaired balance, decreased joint position sense, slowed peroneal muscle contraction to inversion protuberance, strength deficits and altered functional performance. The Cumberland ankle instability tool consists of nine questions with a total of 30 points possible. Lower scores indicate more severe ankle instability. A score of less than or equal to 27 indicates a subject has ankle instability, where as a score of 28 or higher indicates no functional ankle instability [2].

Health and performance based fitness variables like muscle strength, dynamic balance, agility and functional performance play a crucial role in determining performance in sports that involve dynamic movements like running, jumping etc. Figure of eight test is a test to evaluate functional performance of athletes. The Y balance test is a dependable test for measuring single limb stance outing distances while performing dynamic balance testing in collegiate soccer players [1]. T-test is one of the agility test used to assess speed with direction changes and as forward sprinting left and right side shuffling and back pedaling [3].

The primary aim of rehabilitation is to make the athlete return back to participation as rapidly as possible. Some athletes continue to suffer from the effects of recurrent sprains despite clinical efforts to avoid these injuries from recurring [4]. Strength training is important for players with ankle instability as it helps to further muscular gain during the first three weeks to five weeks because it increases neural factors. It also helps to improve proprioception and balance deficiency [1]. The resistance bands are generally used for strength gain in individuals with chronic ankle instability. In addition, protocols using rubber exercise bands for strength development have been established and are adaptable for many muscle groups. Balance training can be given by wobble board. Wobble board also defined as multi-directional balance board is made up of a round, disk like platform over a partial or half ball affixed to the center, bottom of the platform and allows multi planar movements. The use of the both sides utilised (BOSU) balance trainer has become enhancing popular among fitness and medical personnel [5]. Very few studies have focused on the effect of BOSU ball in sports that require excellent strength, agility and functional performance.

A wealth of literature is available reporting causes and risk factors related to CAI still there is a lack of understanding regarding rehabilitation procedures involving balance and strength training in patients with chronic ankle instability. This work intends to develop novel ways of promoting different training program utilisation that would have the potential to revolutionise the improvement of performance in recreational runners. The purpose of current

study was to compare the effect of two different balance training programs i.e., wobble board and BOSU ball exercises along with strengthening exercise in both the groups on selected fitness and performance variables in runners with chronic ankle instability.

MATERIALS AND METHODS

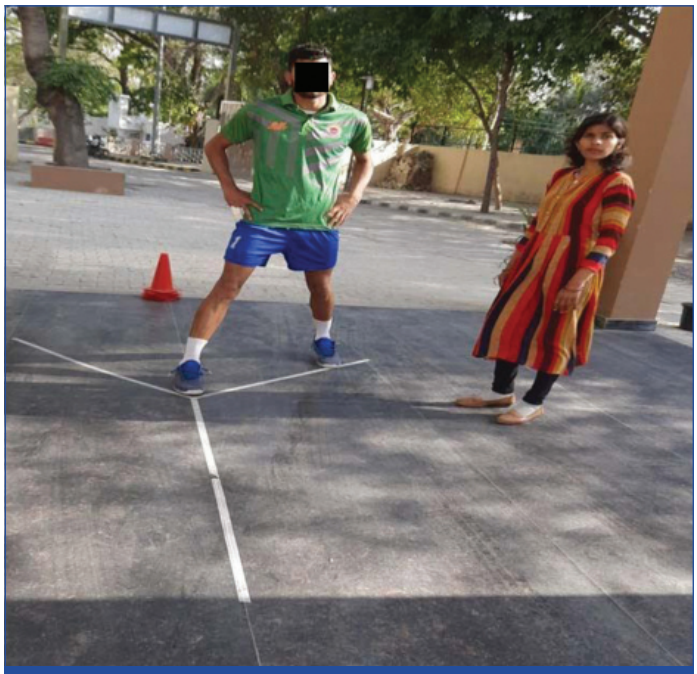
It was an experimental study design conducted at Physiotherapy OPD of SGT Hospital, Gurugram, from July 2019 to October 2019. The study was approved by the Ethical Research Committee of Faculty of Physiotherapy, SGT University Ref. No. SGT/FOP/2019/25. A sample size of 60 was calculated using G power. Players who fulfilled the inclusion and exclusion criteria participated in the study.

Inclusion and Exclusion criteria: The inclusion criteria for the study were male recreational runners in the age group of 18-35 years with lateral ankle instability score less than 27 as measured by Cumberland ankle instability Index and with no history of any injury in past six months. Subjects having recent injury of ankle, a history of recent ankle surgery or fracture and not willing to participate were excluded from the study.

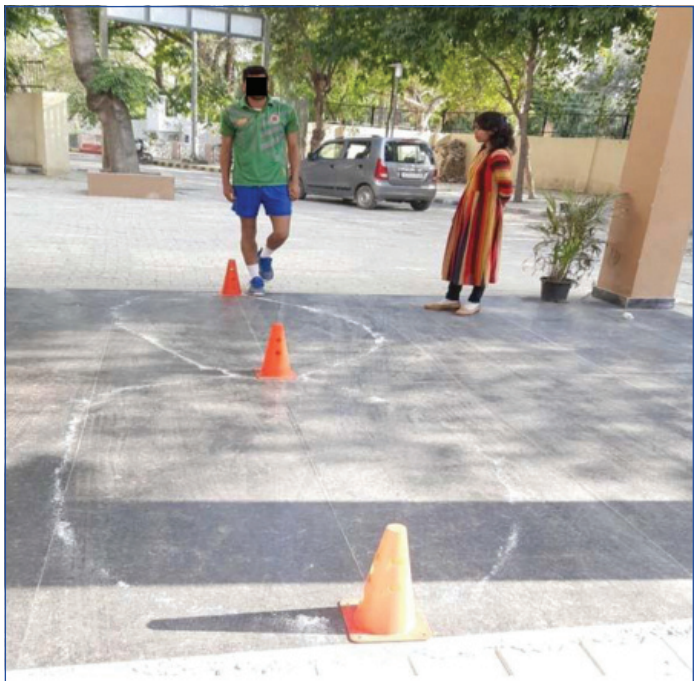
The whole procedure of the training program was explained to the subject and written informed consent was taken from them. Subjects who fulfilled the inclusion and exclusion criteria were divided into two groups by simple random sampling method i.e., Group A included 30 athletes which received Wobble board training along with strengthening exercises and Group B included 30 athletes that received BOSU ball training along with strengthening exercises. Both groups received training 4 times a week for 6 weeks. Measurements were taken for age, height, weight and Body Mass Index (BMI) for all subjects. All players underwent baseline assessment for agility, ankle muscle strength, dynamic balance and functional performance.

Outcome Measures

1. **Agility was measured by T-test**: 4 Cones were placed to form alphabet T. The participants started at cone A. On the command of the timer, the participants sprinted to cone B and touch the base of the cone with their right hand. They then turned left and shuffle sideways to cone C, and also touched its base, this time with their left hand. Then they shuffled sideways to the right to cone D and touching the base of cone with the right hand and again shuffled back to cone B touching the base of cone with the left hand, and ran backwards to cone A. The stopwatch was stopped as they passed cone A. Time was recorded with the help of a stopwatch.
2. **Ankle muscle strength:** The instrument was calibrated before each participant was tested. Four directions were tested-dorsiflexion, plantar flexion, inversion and eversion. Participants were placed in subtalar neutral position for all testing. Foot was neither supinated nor pronated and examiner palpated the prominent position of the medial and lateral aspects of the talus. The manual muscle tester (Make-Biomed) was placed at the superior aspect of the metatarsal heads, participants were instructed to pull or push against the device as hard as they could for each direction for five seconds per trial. The test was conducted three times. Manual muscle tester is a reliable and valid instrument to assess isometric muscle strength at different joint angles [6].
3. **Dynamic balance was measured by Y balance test:** It incorporates a single-leg stance on one leg with greatest reach of the opposite leg. The test was performed with the subject standing at the center of a grid placed on the floor, with three lines extending at 458 increments from the center of the grid. The three lines positioned on the grid were labeled according to the direction of excursion relative to the stance leg: Anterior (A), Posteromedial (PM), Posterolateral (PL). The subject lightly touched the furthest point possible on the line with the most distal part of the reach foot. The subject then returned to a bilateral stance while maintaining their balance. The examiner measured the distance from the center of the grid to the touch point with a tape measure in centimeters. All trials were performed in sequential order in either the clockwise or anticlockwise directions. Trials were discarded and repeated if the subject: 1) does not touch the line with the reach foot while maintaining weight bearing on the stance leg; 2) lifts the stance foot from the center grid; 3) loses balance at any point in the trial. Average of three scores was taken as final reading [Table/Fig-1].
4. **Functional performance was measured by figure of eight hop test:** Participants hopped in a 5-m course around the cones in an "8" design on the involve ankle. The participants were instructed to hop as quickly as possible thrice through the course. Speed was measured in second with stopwatch. Average of three readings was taken [Table/Fig-2].



[Table/Fig-1]: Subject performing Y Balance test.



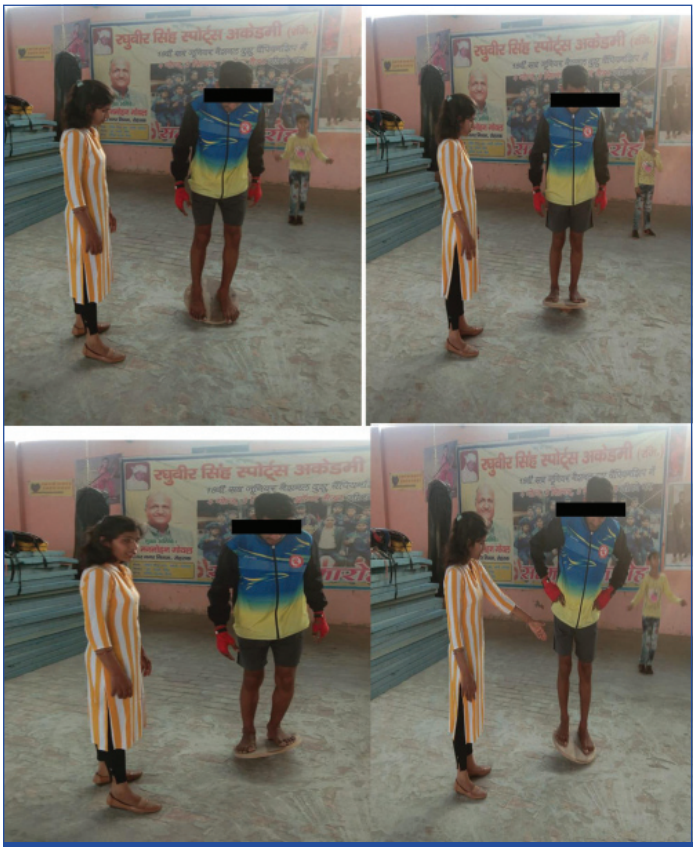
[Table/Fig-2]: Subject performing figure of eight Hop test.

Procedure Group A: Wobble board training along with strength exercise program [Table/Fig-3,4]. Group B: BOSU ball training along with strength exercise program [Table/Fig-5,6]. Both the groups started with warm up for five to ten minutes which included exercise

like walking, running, jogging, stretching and other free exercises. Both groups received intervention for 45 minutes thrice a week for six weeks under the supervision of the therapist.

S. No.	Exercises	Repetitions×Sets
1.	Maintain forward position	10×3
2.	Maintain backward position	10×3
3.	Maintain right lateral position	10×3
4.	Maintain left lateral position	10×3
Rest between exercises-10-20 seconds Rest between set of exercises-40-60 seconds		

[Table/Fig-3]: Group A: Wobble board exercise.



[Table/Fig-4]: Maintaining balance in Forward, backward, right and left lateral positions on balance board.

S. No.	Exercises	Repetition×Sets
1.	First two weeks-Maintain proper balance in a double and single limb stance.	10×3
2.	Weeks 2/4- Maintain proper balance in a double and single limb stance surface on the floor.	10×3
3.	Weeks 4/6- Standing position in a double and single limb stance combined with throwing and catching	10×3

[Table/Fig-5]: Group B (BOSU ball exercises).
Rest between exercises-10-20 seconds; Rest between set of exercises-40-60 seonds

Protocol of Strengthening Exercise

The athletes sat on the floor one end of the band wrapped around the metatarsal head of the foot and other end therapist is holding one end of Theraband. Exercises were performed in 4 directions: dorsiflexion, plantar flexion, inversion and eversion in long sitting position and full knee extended. Exercise was performed with the colour band that was prescribed for the subject or with a colour that allowed him to complete two to three sets of 10 to 15 repetitions with mild fatigue on the last set. Then progression was done to the next colour band when patient was able to complete the three sets of 10 to 15 repetitions. All these exercise were done for about three to five seconds per repetition the full range of motion. Increasing number of sets participants were progress each week. Before moving on to the next set athletes completed all four directions [7].

[Table/Fig-6]: Maintaining balance on BOSU ball in unilateral, bilateral stance during dynamic activities like catching ball.

STATISTICAL ANALYSIS

The data was analysed by using the software package Statistical Package for Social Sciences (SPSS 24.0) for window version. Mean and standard deviation of all the variables were calculated. The level of significance was set at $p<0.05$. Repeated measure ANOVA test and Student t-test was used to compare the intergroup differences.

RESULTS

Mean comparison of age, height, weight and BMI was done. The study was done on 60 players who were equally divided into two groups, with 30 subjects in each group. Between group analysis of these baseline characteristics showed that there was no significant difference in mean age, mean height.

Changes in Muscle Strength

The results of present study showed improvement in dorsiflexion, plantar flexion, inversion and eversion ankle muscle strength in both groups i.e., Group A and Group B. Group which performed BOSU ball along with strengthening exercise showed improvement in dorsi flexor muscle strength by 88.16%, plantar flexor muscle strength by 72.71%, invertor muscle strength by 91.92% and evertor muscle strength by 76% at the end of 6th week as compared from baseline value. Group A in which wobble board along with strength exercise was performed showed improvement in dorsi flexor muscle strength by 57.59%, plantar flexor muscle strength by 55.21%, invertor muscle strength by 56.8% and evertor muscle strength by 47.05% at the end of 6th week from the baseline value. Between groups, comparison showed that Group B (BOSU ball group) showed highly significant improvement in dorsi flexor muscle strength by 30.57%, plantar flexor muscle strength by 17.5%, invertor muscle strength by 35.12% and evertor muscle strength by 28.95% as compared to Group A on 6th week [Table/Fig-7].

Changes in Functional performance as measured by figure of eight Hop test

At the end of 6th week Group A showed 67.47% improvement and Group B showed 61.21% improvement from the baseline value. Between groups comparison showed that group B (BOSU ball group) showed highly significant improvement by 6.24% as compared to group A [Table/Fig-8].

Ankle muscle strength	Groups	Mean baseline	Std. Deviation	Mean 3rd week	Std. Deviation	Mean 6th week	Std. Deviation	t-value	p-value
Dorsi flexon	Wobble board	8.3027	1.28284	10.566	1.05279	13.08	1.76	04.69	0.001**
	BOSU ball	8.282	1.33624	11.734	1.70502	15.58	2.34		
Plantar flexion	Wobble board	8.2483	1.40924	10.2603	1.08069	12.7963	1.21441	2.66	0.01*
	BOSU ball	8.1033	1.39376	11.379	2.08258	13.999	2.15771		
Inversion	Wobble board	7.4967	1.3115	10.31	1.52	11.764	1.18738	2.40	0.021*
	BOSU ball	6.8167	1.91571	11.25	1.82	13.072	2.74542		
Eversion	Wobble board	7.82	1.43	9.09	1.77	11.51	2.08	2.10	0.032*
	BOSU ball	7.21	1.48	10.77	1.80	12.69	2.10		

[Table/Fig-7]: Comparative table of ankle muscle strength.
Mean comparison of Dorsiflexion, Plantar Flexion, Inversion, Eversion between the groups; p-value <0.001 (Highly significant); p-value <0.05 (Significant)

Functional performance	Groups	Mean	SD	t-value	p-value
Baseline	Wobble board	9.5257	0.53237	0.483	0.631
	BOSU ball	9.4393	0.82148		
3rd week	Wobble board	7.4603	1.12374	0.665	0.509
	BOSU ball	7.2437	1.38654		
6th week	Wobble board	5.6963	1.19335	-0.454	0.652
	BOSU ball	5.8493	1.41053		

[Table/Fig-8]: Comparison between the groups for Functional performance.
Difference of means from baseline to 3rd week; Difference of means from 3rd week to 6th week; Difference of means from baseline to 6th week; **p-value <0.001 (Highly Significant); *p-value <0.05 (Significant)

Changes in Agility Scores as Measured by T test

At the end of 6th week, Group A showed 23.98% improvement and Group B showed 40.44% improvement from baseline value. Between groups comparison showed that group B (BOSU ball group) highly significant improvement by 16.46% as compared to group A [Table/Fig-9].

Agility	Groups	Mean	SD	t-value	p-value
Baseline	Wobble board	17.3157	1.01458	-1.491	0.141
	BOSU ball	17.8513	1.68647		
3rd week	Wobble board	15.3057	1.29046	0.337	0.737
	BOSU ball	15.1697	1.79521		
6th week	Wobble board	13.9717	1.37007	2.11	0.039*
	BOSU ball	12.7113	2.97127		

[Table/Fig-9]: Comparison between the groups for Functional performance.
*: Significant; Difference of means from baseline to 3rd week; Difference of means from 3rd week to 6th Week; Difference of means from baseline to 6th week; **p-value <0.001 (Highly Significant); *p-value <0.05 (Significant)

Changes in Dynamic Balance Score

The results of present study showed improvement in within group analysis with respect to Anterior, PM and PL components of Dynamic Balance in both groups i.e., Group A and Group B. Group B which performed BOSU ball along with strengthening exercise showed improvement in dynamic balance by 24.44% at the end of 6th week. Group A which performed wobble board along with strength exercise showed improvement in dynamic balance by 20.46% at the end of 6th week from the baseline value. Between groups, comparison showed that group B (BOSU ball group) showed highly significant improvement in dynamic balance of right leg by 3.98% [Table/Fig-10].

DISCUSSION

In the present study, the effect of six weeks of comparison of Wobble board and BOSU ball along with strength training was done to see the effects on dynamic balance, agility, ankle muscle strength and functional performance in recreational runners with chronic ankle instability. Results showed improvement in both the groups but statistically BOSU ball group showed better improvements compared to wobble board group.

Effect on Muscle Strength

BOSU ball device is used for Ankle muscle activation when both sides of ball are used. According to Leetun DT et al., both sides use of BOSU ball or balance trainer has become popular among fitness trainers. BOSU ball along with strength exercises also focus on the mind and body coordination. It can decrease anxiety and increase athletic performance [8].

The findings of this study are in accordance with the results of Demir A 2019. They compared the effect of balance disc and BOSU ball in runners and found that the strength of ankle dorsi flexor and plantar flexor muscle groups improved in athletes. Results showed improvement in both the groups but statistically BOSU ball group showed better improvements compared to balance disc group [9].

Results of the study by Balogun J et al., found that a muscle must be under stressed to a greater degree than it is regularly used in order for the muscle to respond by enhancing contractile force capacity. The strength gained during the exercise training is directly related to the workload applied. Researcher got large increases in lower extremity strength with the highest degree of ankle dorsiflexiors because the tibialis anterior muscle is commonly under stressed up to 80% maximal voluntary isometric contraction do exercise on a wobble board [10].

Effect on Functional Performance

Lower legs muscular strength component plays an important role in determining the functional performance of the player that needs high performance to get the better of body weight and gravity. Improved lower limb muscle strength seen in the present study resulted in improved functional performance in both groups as measured by figure of 8 Hop test. This test is generally used to evaluate ability of an athlete to return to sports after injury. This result is similar to the study done by Yaggie et al. The participants

Dynamic balance	Groups	Mean baseline	Std. Deviation	Mean 3rd week	Std. Deviation	Mean 6th week	Std. Deviation	t-value	p-value
Anterior component	Wobble board	131.63	22.88299	104.71	12.20084	123.22	20.33269	2.017	0.049*
	BOSU ball	133.83	8.58515	98.03	14.74792	111.28	25.28265		
Posteriomedial (PM)	Wobble board	138.33	8.18734	114.83	12.34928	128.21	18.24562	2.19	0.033*
	BOSU ball	139.32	9.73274	109.06	20.86371	117.38	20.01058		
Posteriolateral (PL)	Wobble board	145.60	8.21927	124.78	14.84633	140.65	10.22583	0.519	0.026*
	BOSU ball	150.28	7.19157	119.99	16.97737	138.61	10.22583		

[Table/Fig-10]: Mean scores of dynamic balance in both groups.
p-value <0.001 (Highly significant); p-value <0.05 (Significant)

performed balance training using BOSU ball that brought improvement in sports specific skill [11].

Results of this study are in accordance with results by Laudner KG and Koschnitzky MM, in which participants did four week training program to determine if there were any benefits on selected functional skills. After the training session, improvement of single-leg stance duration on the BOSU balance trainer was used as one of these functional skills to determine. They found significance with their "time on ball" measures and were able to determine that there was an improvement in postural control and sport-related activities [5].

Tropp found a significant prophylactic effect of wobble board training in soccer players in the form of a reduction in the number of subsequent ankle sprains [12].

Effect on Agility

The results of present study showed improvement in agility in both the groups. Agility in sports does not comprise only the ability of changing the direction of movement, but also the capability to anticipate the movement of the opposition, read and react to specific game situations. The perception-action coupling and decision-making are critical elements in terms of developing the ability to express speed and agility capabilities under match conditions [13].

Results of this study are in accordance with results by Saraswat A et al., [14]. They examined the effects of balance training on balance, agility and speed found that four weeks of balance training significantly improved agility. According to Güler O and Eniseler N, the effects of six week dynamic balance studies on agility and vertical jump in football players, found significant improvement in agility and explosive strength [15].

In previous studies, it has been seen that balance training has a positive effect on agility and vertical jump performance including explosive power. Studies on the balance training's mechanism of action have shown that balance training reduces antagonist muscle co-activation although there was no muscle activation difference in agonist muscle as a result of balance training. As a result of the balance training agility and the vertical jump performances increased [16].

Effect on Balance

The BOSU ball is more challenging than the wobble board due to the fewer but larger and quicker direction changes in ankle inversion-eversion kinematics, resulting in a more variable activation design of the peroneal muscle [17]. In a study by Badr N, it was found that used of BOSU ball has advantage in gaining balance as an important element for attaining changes in runners results along with minimising and reducing the risks of injury and developing the centre of stability and balance which in turn affects the physical and functional performance levels [18].

The results of present study showed improvement in dynamic balance as measured by Y Balance test with respect to three components of balance i.e., Anterior, PM and PL. Dynamic balance is a complex phenomenon, which requires combination of the sensory, musculoskeletal, and nervous systems [19]. Dynamic balance refers to the ability of having suitable reactions concerning the motor system, to be able to cope up with the requirements for the quick alterations of position in the torso, while performing activities that stress on the knee joint [20].

Yoon et al., supports that after BOSU training, the static balance of the nondominant (left) foot improved by 28.5%, while the improvement in the dynamic balance was 82.5 [21]. In a study by Clark & Burdern it was found that wobble board training promoted both static and dynamic balance among athletes who suffered from functional ankle instability. The wobble board training protocol was supported by a previous work in which they adapted four weeks of wobble board training which brought significant improvement. Hence, it can be comprehended that it promoted different perception of the subject's functional stability and reduces further sprains in individuals with functionally unstable ankle [22].

Chaiwanichsiri D et al., demonstrated that concentric & eccentric muscle contractions, proprioception, coordination as well as postural control involved during various exercises of wobble board balance training program may have improved dynamic balance of athletes [23]. Another study showed that eight weeks of wobble board balance was found to be effective in improving dynamic balance. The improvement in dynamic balance following wobble board balance training [24].

The improvement in dynamic balance following wobble board balance training is consistent with findings of other studies. The reason for improvement in dynamic balance can be due to effect of training on reflex control of muscle activity when exercising in close kinematic chain. The gain in strength, better intramuscular & inter-muscular coordination & more economic activation of accessory muscles helps in attaining stabilisation of extremities & thus improves static balance [25].

Limitation(s)

Any gender specific differences were not studied. The study was done on male subjects only. No follow up was done to see if the effect of training was retained. Also the effect of training was assessed on the affected limb only.

CONCLUSION(S)

Based on results of study it is recommended that rehabitilation programme consisting of BOSU ball along with strength exercise training is recommended to improved balance, agility, ankle muscle strength and functional performance in runners with chronic ankle instability.

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