

ORIGINAL RESEARCH

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EFFECT OF DYNAMIC BALANCE TRAINING ON AGILITY IN MALE BASKETBALL PLAYERS

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ABSTRACT

Background: Athletes focus their training on two major goals, i.e., avoidance of the injury and increasing the performance. Balance training has been widely used in competitive sports to improve the balance and thus reduce the risk of injury, for example, ligamentous sprains, which are very common in Basketball. On the other hand, various drills are being used to improve the performance parameters such as agility. Our effort is to find out an exercise program which focuses on balance training and see whether it has any effect on agility.

Methods: The study design was a Pretest-Posttest Control-Group Design. 30 healthy school level Male Basketball Players were selected from V-One Basketball Academy, Don Bosco Basketball Academy, Modern School Basketball Academy, New Delhi. They were randomly divided into two groups. Group A performed dynamic balance training 3 sessions per week for 4 weeks. Group B performed conventional exercises throughout the duration of the study. Outcome measure, i.e., T- test was measured pre and post 4 week period.

Results: Data analysis was done by Independent t test and Paired t test for between group analysis and within group analysis respectively. There was a significant reduction in T-test times in the experimental group as compared to the control group ('p' value <0.05) while there was no significant improvement in the control group.

Conclusion: Four weeks of dynamic balance training significantly improved agility as detected by T-test. Thus it can be concluded that the used protocol can be incorporated in the training regimes to reduce the risk of injury as well as improve the performance.

Keywords: Dynamic balance, Agility, Basketball, Balance training, T-test, sports injury

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INTRODUCTION

Competitive sports are dependent on multiple components of training and the development of strength, power, and endurance.¹⁻³ Balance training is a relatively recent phenomenon in the fitness industry that has developed into a primary point of interest for consumers and fitness professionals.⁴⁻⁷

Basketball requires lateral, forward, and backward movements during which the centre of gravity (COG) is often at the edge of the base of support (BOS).⁷ To maintain balance, it is necessary to have a functional awareness of the BOS to better accommodate the changing COG.⁸ In order to maintain postural control, the body is in a state of continuous movement, adjusting to keep the centre of gravity over the base of support.⁹

Athletic trainers often prescribe exercises in an attempt to enhance an athlete's postural control or balance and perhaps reduce the risk of injury. The goal of balance training is to improve balance through perturbation of the musculoskeletal system that will facilitate neuromuscular capability, readiness, and reaction.^{4,10,11} Traditionally, balance training has involved single-limb stance activities on stable and unstable surfaces.^{12,13} Self reported improvements in functional status have been demonstrated in response to balance training.^{12,14} These balance training programs may have not appropriately challenged the sensorimotor system to elicit a detectable change in postural control.

A progressive balance training program which had been designed to challenge a subject's ability to maintain a single limb stance while performing various balance activities such as predictable and unpredictable changes in direction, landing from a hop, and dynamic reaching tasks was used for dynamic balance training.¹⁵⁻¹⁷

Functional ability can be exemplified by the performance of a sport related task.¹⁸ These tasks require appropriate control of the neuromuscular and musculoskeletal systems, including the proprioceptive systems. It is presumed that balance training has the most profound effect on the somatosensory and proprioceptive control systems^{7,15,18,19}; however its relation and effect on agility has not been studied in athletic population. Yaggie et al (2006)²⁰ found that 4 weeks of balance training improved performance of sports related activities in recreationally active individuals. T-test, which has been widely used in literature, was used to measure agility.^{20,21}

METHODS

Study design: This study was a randomized control trial in which healthy school level male basketball players were randomly assigned to one of the two groups: a balance training group or the control group. The balance training group underwent 12 supervised balance training sessions during a 4-week period. The control group maintained the same level of activity before study enrolment and continued their conventional exercises for the duration of 4 weeks. Measurement of agility was taken before and after the 4-week intervention and in both the balance training and the control groups.

Subjects: 33 healthy school level basketball players were randomly selected to participate in the study. Out of which 3 subjects dropped from the study due to musculoskeletal injuries. As a result, 30 subjects completed the study. Subjects were included from the age group of 15-20 years with a BMI of 18.5-24.9 and playing basketball for last 3 years. No subjects had a history of acute muscle soreness or muscle strain or any lower extremity injury, vestibular problems (e.g., vertigo), visual problems (e.g., blind in one eye), or a concussion in the 12 weeks before the study as reported by the subject. Before testing, all subjects signed an informed consent form along with their guardian's signature in the case of minor.

Once informed consent was obtained, subjects were randomly allocated to either a balance training group or a control group. The balance training group consisted of 15 male subjects ((mean \pm S.D.) age = 16.33 \pm 0.617 yrs; height = 173.93 \pm 4.758 cms; weight = 64.33 \pm 5.827 kg; BMI = 21.27 \pm 1.841 kg/m²). The control group also consisted of 15 male subjects. (mean \pm S.D. age = 16.60 \pm 0.632 yrs; height = 174.80 \pm 3.028 cms; weight = 62.47 \pm 3.270 kg; BMI = 20.44 \pm 1.00 kg/m²).

PROCEDURES

The dependent variable Agility was measured by T-test. The control group continued their regular training regime and the experimental group did the below mentioned balance training exercises in addition to the regular training.

BALANCE TRAINING PROGRAM: Subjects randomly assigned to the 4-wk progressive balance training program participated in 12 supervised training sessions, three sessions per week. The progressive balance training program was designed to challenge a subject's ability to maintain a single-limb stance while performing various balance activities.¹⁶ During each session, subjects performed dynamic balance activities designed to

challenge recovery of single-limb balance efficiently after a perturbation and to effectively develop spontaneous strategies to execute movement goals. As a subject developed proficiency within the program, the task and environmental constraints placed on the sensorimotor system were progressively increased. Each activity contained seven levels of difficulty through which subjects were advanced. These novel activities were intended to promote the restoration of functional variability within the sensorimotor system. Activities included 1) hop to stabilization, 2) hop to stabilization and reach, 3) hop to stabilization box drill, 4) progressive single-limb stance balance activities with eyes open, and 5) progressive single-limb stance activities with eyes closed.

Following is the protocol used for the study:

Single-Limb Hops to Stabilization

(10 Repetitions per Direction)

Subjects perform 10 hops in each direction. Each repetition consists of a hop from the starting position to the target position (18, 27, or 36 inches). After stabilizing balance in a single-limb stance, participants hop in the exact opposite direction back to the starting position and stabilize in the single-limb stance. Four directions of hops:

- 1) anterior/posterior,
- 2) medial/lateral,
- 3) anterolateral/posteromedial, and
- 4) anteromedial/posterolateral.

Participants are not able to move to the next level in each category until they demonstrate 10 repetitions error-free. Errors are determined on the basis of the following:

- a. Touching down with opposite limb
- b. Excessive trunk motion ($>30^\circ$ lateral flexion)
- c. Removal of hands from hips during hands on hips activities
- d. Bracing the nonstance limb against the stance limb
- e. Missing the target

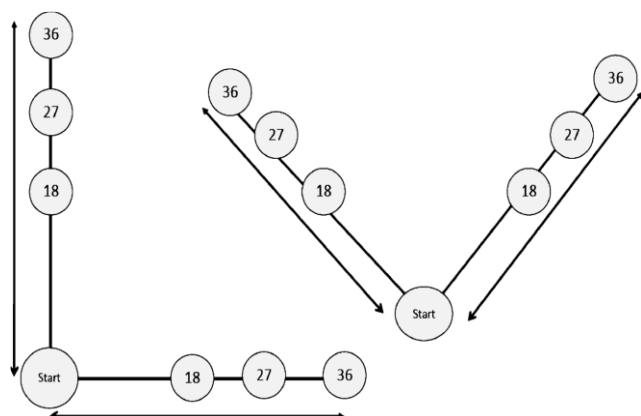


Figure. 1

Hop to Stabilization and Reach

(Five Repetitions)

Combined with the mentioned exercises, however, after stabilization in the single-limb stance, participants have to reach back to the starting position. Repetitions are counted in the same manner mentioned previously. Participants hop, stabilize, and reach back to the starting position. Then they hop back to the starting position and reach to the target position. Participants are not able to advance to the next level in each direction until they demonstrate five repetitions error-free. Errors are determined on the basis of the following:

- a. All errors associated with hop to stabilization
- b. Using the reaching leg for a substantial amount of support during reaching component

All directions for Hop to Stabilization and Hop to Stabilization and Reach have seven levels of difficulty to progress:

1. 18-inch hop. Allowed to use arms to aid in stabilizing balance after landing.
2. 18-inch hop with hands on hips while stabilizing balance after landing.
3. 27-inch hop. Allowed to use arms to aid in stabilizing balance after landing.
4. 27-inch hop with hands on hips while stabilizing balance after landing.
5. 36-inch hop. Allowed to use arms to aid in stabilizing balance after landing.
6. 36-inch hop with hands on hips while stabilizing balance after landing.
7. 36-inch hop from a 6-inch platform.

Unanticipated Hop to Stabilization:

Participants stand in the middle of a nine-marker grid (see Figure 2). A sequence of numbers was displayed on a computer screen in front of the participants. Each number corresponded to a target position to which they would hop. As the progression of numbers changed, participants would hop to the new target position. The hop to stabilization rules were applied for this activity; however, in this case, participants were allowed to use any combination of hops (AP, ML, AM/PL, or AL/PM) they desired to accomplish the goal of getting through the sequence error-free. As a participant developed proficiency, the amount of time per move was reduced. In each session, participants performed three sequences of numbers.

Levels of unanticipated hop to stabilization

Level 1: 5 s per move.

Level 2: 3 s per move.

Level 3: 1 s per move.

Level 4: If subject can progress to completion of all moves within 1 s without error, a foam pad will be placed on one of the numbers during the sequence.

The subject will then continue the progression at the same level of intensity. If he or she cannot complete the course error-free, the time constraint will be reduced to the level below.

Level 5: If subject can progress to completion of all moves at Level 3 with the foam pad error-free, a step will be added to an additional number.

Level 6: If a subject progresses error-free, an additional foam pad will be added to one of the numbers, resulting in two foam pads and one step.

Level 7: If a subject progresses error-free, an additional step will be included, resulting in two foam pads and two steps.

Errors were determined on the basis of the following:

- Touching down with opposite limb
- Excessive trunk motion ($>30^\circ$ - lateral flexion)
- Removal of hands from hips during hands on hips activities
- Bracing the nonstance limb against the stance limb
- Missing the target

Each sequence of numbers is random such as 9, 7, 1, 6, 4, 5, 3, 8, 2.

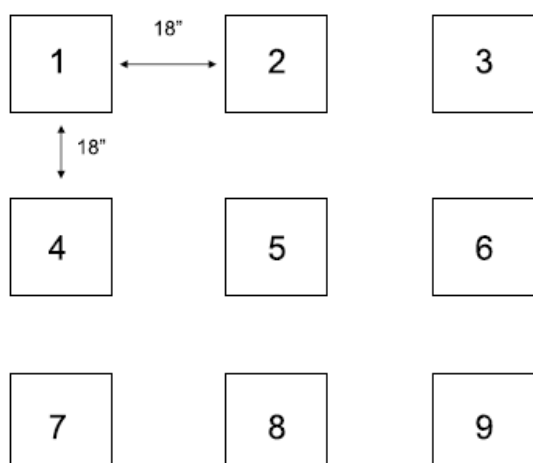


Figure 2

Single-Limb Stance Activities:

Participants perform three repetitions of single-limb stance activities. Each activity (eyes open and eyes closed) has seven levels of difficulty.

Single-limb stance eyes open

- Arms across chest on hard floor for 60 s
- Arms across chest for 30 s on foam pad
- Arms across chest for 60 s on foam pad
- Arms across chest for 90 s on foam pad

Ball toss on foam

- 30 s with arms across chest; 20 throws with a 6-lb medicine ball
- 60 s with arms across chest; 20 throws with a 6-lb medicine ball
- 90 s with arms across chest; 20 throws with a 6-lb medicine ball

Single-limb stance eyes closed

- Arms out on hard floor for 30 s
- Arms across chest on hard floor for 30 s
- Arms across chest on hard floor for 60 s
- Arms out on foam pad for 30 s
- Arms across chest for 30 s on foam pad
- Arms across chest for 60 s on foam pad
- Arms across chest for 90 s on foam pad

Participants are not able to advance to the next level in each category until they demonstrate three repetitions error-free.

Errors were determined on the basis of the following:

- Subjects touching down with opposite limb
- Excessive trunk motion ($>30^\circ$ - lateral flexion)
- Removal of arms from across chest during specified activities
- Bracing the nonstance limb against the stance limb

RESULTS

The results were analysed using SPSS 20.0 software.

Agility

Mean (\pm S.D.) values are listed in table 1. Independent t test and paired t test revealed that for the balance training group T-test values were significantly greater than the control group posttest measures and were also significantly greater after balance training compared with their pre test values.

	Experimental group (Mean \pm S.D.)	Control group (Mean \pm S.D.)	t test	
			t value	'p' value
Pre test (secs)	12.35 \pm 0.74	12.13 \pm 0.50	-0.911	0.370
Post test (secs)	11.62 \pm 0.70	12.09 \pm 0.43	2.195	0.037*

*Significant at 'p' value < 0.05

Table 1: Between group analysis of agility

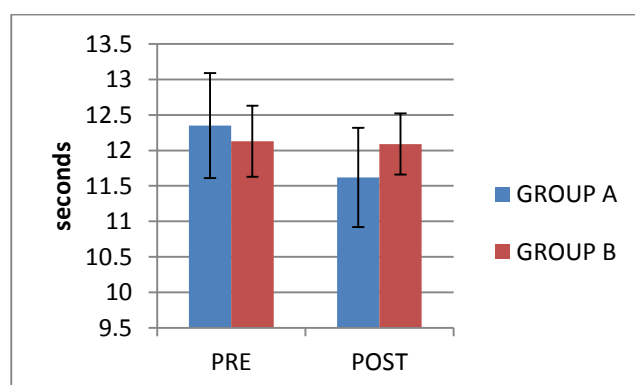


Figure 3: Between group comparison of T - test

DISCUSSION

We found that 4 weeks of balance training significantly improved agility as detected by T-test. The findings of our study are consistent with a study done by James A. Yaggie et al (2006).²² They studied the effects of balance training on selected skills on 36 healthy recreationally active volunteers who were divided randomly into experimental and the control group. The experimental group was given balance training using a Both Sides Up balance trainer (BOSU) 3 times a week for 4 weeks. Agility was measured using shuttle run. They concluded that the treatment group experienced a significant decrease in shuttle run time on pre and post intervention measurements, and thus an improvement in agility.

It has been documented widely in literature that consistent activity and training of the lower extremities influence the reaction time, proprioception and muscle activation of ankle musculature. Various researches have examined peroneal reaction time. It has been found that in chronically unstable ankles there is a loss of reactionary control of the lateral musculature of the ankle. It leads to poor muscle activation, joint motion, and alteration of the centre of pressure of the foot.²³ According to Lentell et al (1990)²⁴, the instability of ankle is due to the presence of proprioceptive deficits rather than the muscle weakness. Due to these reasons, there is modification throughout the kinetic chain which alters the inverse dynamics of the knee and hip. It causes a delay in the inherent mechanisms which are used to control posture and balance. Therefore, the training of lateral ankle muscles will enhance reaction and proprioception influences of the lower extremity and will result in improved postural control.

In the above mentioned study done by James A. Yaggie et al (2006)²², they found the improvement in agility in recreationally active athletes caused by balance training done on Both Side Up (BOSU) trainer. In the present study, target population was basketball players. So the training effect in already conditioned athletes may be attributed to the fact that the balance training protocol used in this study involved more hopping and cutting activities.

The presence of significant improvement in agility may also be attributed to neurological adaptation to activity and proprioceptive action of the trained joints and soft tissues. Another factor that might have played role in improvement could be motor recruitment. According to Potteiger et al (1999),²⁵ the improvements due to plyometrics were a result

of enhanced motor unit recruitment pattern. According to Craig (2004),²⁶ neural adaptations usually occur when athletes respond or react as a result of improved coordination between the CNS signal and proprioceptive feedback. However, it could not be determined whether synchronous firing of the motor neurons or better facilitation of neural impulses to spinal cord resulted in neural adaptations. Therefore, more studies are needed to determine neural adaptations as a result of dynamic balance training and how it affects agility.²⁰

Considerations for future research include training on injured population and comparison with some traditional forms of rehabilitation. Further, the research should be done on large sample size and on a female population.

Conclusion

The 4-wk progressive balance training program that emphasized dynamic stabilization after landing from a hop in a variety of directions and conditions significantly improved agility.

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