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The effectiveness of proprioceptive balance board training program: an intervention mechanism in the reduction of ankle sprain

Mehdi Kasbparast Jr, Hamidreza Keshavarzi, Shahnaz Molaei, Omid Yaghoobpour Yekani

Department of Sport Injury and Biomechanics, Physical Education and Sport Sciences College, Karaj branch, Islamic Azad University, Karaj, Iran

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Abstract

Ankle sprains are the most common musculoskeletal injuries that occur in athletes, and they have a profound impact on health care costs and resources. The purpose of this study is to present the findings of a randomized controlled trial that investigated the effect of balance training in the reduction of ankle sprain. First of all selected two group (Experimental=28 & Control=19) from collegiate athlete male. All of them were the collegiate students male with ankle sprains. Then experimental group does proprioceptive balance board training program for a 7 week, after this time information about pain, swelling, stability and strength was collected via questionnaire. The results of this study revealed that proprioceptive balance board training is affected on reduction of ankle sprain.

* **Corresponding Author:** Mehdi kasbparast JR ✉ Mehdikasbparast@gmail.com

Introduction

Participation in sport and physical activity is accompanied by the risk of injury. With the current promotion of a physically active lifestyle, an increased number of sports injuries can be expected (Parkkari *et al.*, 2001). Fortunately, most are not life threatening, and the health benefits of sport and physical activity are generally greater than the risks involved. However, sports injuries can cause pain and other physical inconvenience, which result in use of healthcare resources and absenteeism from work. Owing to their demand on our financial healthcare resources, sports injuries have been suggested to be the most under-recognized public health problem (Janda *et al.*, 1997). Chronic ankle instability (CAI) is a condition characterized by numerous ankle sprains and the recurring sensation of ankle instability, which result in activity limitations and participation restrictions (Hertel, 2008) Sprains to the lateral ankle ligaments are the most common injury incurred by competitive athletes. While these injuries are often perceived as being innocuous, almost half of individuals who suffer an initial sprain still have residual symptoms one year later(Van Rijn *et al.*, 2008).Sports that register the highest incidence of ankle sprains are those requiring sudden stops and pivoting, such as soccer, volleyball, and basketball. These specific movements often result in ankle inversion during plantar flexion, which is the most common type of ankle sprain (Mohammadi, 2007). Research has shown that 25%-40% of athletes who suffer from an ankle sprain will experience a recurrent sprain due to acquired instability (Mc Guine *et al.*, 2006; Eisenhart *et al.*, 2003). Therefore, it has been postulated that strengthening the evertor muscles, which provide support to the lateral ligaments of the ankle, will prevent recurrent ankle inversion injuries (Tropp *et al.*, 1985).Ankle sprains not only result in numerous visits to emergency care facilities (Kannus *et al.*, 1991) and significant time loss from sports participation(Tropp *et al.*, 1985) but they can also cause long term disability (Braun *et al.*, 1999; Gerber *et al.*, 1998) and have a major impact on health care costs and resources (US Consumers Product Safety Commission, written communication, March 2005).Symptoms including pain, weakness, and sensations of the ankle “giving way” during functional activities are common. Up to one-third of first time ankle sprainers will go on to develop chronic ankle instability (Van Rijn *et al.*, 2008). Because a high percentage of ankle sprain cases are associated with residual functional deficiencies, there is a need to identify effective clinical interventions that address the long term deficits associated with CAI.The primary objective of this randomized intervention trial was to determine if a program of balance training, implemented to reduce the risk of ankle sprains in collegiate male. This study also sought to balance training reduced the severity of ankle sprains.

Material and methods

Previous authors have reported an incidence of ankle sprains in athletes that ranged from 11% to20% (Bahr *et al.*, 2002; Garrick *et al.*, 1977; Powel *et al.*, 1999; Thacker *et al.*, 1999; Verhagen *et al.*, 2000). On the basis of these data, we projected a sprain rate for this study of 15% in both group. A controlled clinical pilot trial was set up with both a control group (CG) and an experimental group (EG) of mixed collegiate athlete male. The EG followed a prescribed (Table 2) specific balance training program. During the 7 week follow up period, all subjects from the experimental group followed a set proprioceptive balance board training program. The program consisted of 10 basic exercises on and off the balance board, with variations on each exercise and a gradual increase in difficulty and intensity during the 7 week. The study included 47 individuals with self reported CAI, who were randomly assigned to a balance experimental group (n = 28) and control group (n = 19). All of them were the collegiate students male. The balance experimental group participated in 21 supervised balance training sessions over a 7-week period. The control group maintained the same level of activity they had reported prior to study enrollment.

Subjects

Before participation, the subjects read and signed an informed-consent or -assent form approved by researcher for the Protection of Human Subjects. They had experienced 1 or more ankle sprains within the past 12 months and at least 3 or more ankle sprains within the past 36 months, but at the time of the study had no visual swelling or pain, were recruited as subjects with CAI. All subjects had no history of fracture or major surgery in either lower extremity. Subjects were included in this study if they presented with an active range of ankle joint motion of at least 15" of dorsiflexion and 45" of plantar flexion and were also able to complete the test tasks. Subjects were excluded from this study if they presented with ankle joint pain, joint swelling, a history of insulin dependent diabetes mellitus, any rheumatologic disorders, or any systemic disease that might interfere with sensory input. To determine ankle ligament laxity, the trainer performed an anterior drawer test on the ankle with the subject in a seated position. Leg dominance was determined by asking the athlete which leg he would use to kick a ball. The configuration of the medial longitudinal arch was determined by using the Feiss line, which was measured when the athlete stood with his weight on both feet (Palmer *et al.*, 1990). The Feiss line is a line drawn from the medial malleolus to the head of the first metatarsal. If the navicular tubercle intersected the line, the arch was graded as neutral. If the tubercle was above the line, the arch was graded as supinated. If the tubercle was below the line, the arch was graded as pronated. Subject characteristics, such as age, height, body mass index and body weight, are provided in Table 1.

Table 1. Subject characteristics

	Age (Y)	Height (cm)	Weight (kg)	BMI
Experimental group	22.7	177.3	76.2	21.6
Control group	21.9	175.4	75.7	21.5
All subjects	22.3	176.3	75.9	21.55

The Balance Training Program

Subjects in the experimental group performed a 7-phase balance training program, the components of which are shown in Table 2. The program was based on a compilation of the rehabilitation and balance training protocols validated and published in prior studies (Bernier *et al.*, 1998; Hoffman *et al.*, 1995; Holm *et al.*, 1999; Lephart *et al.*, 1997;). Phases 1 through 4 consisted of 5 exercise sessions per week for 4 weeks before the start of the season. In phase 5 (maintenance phase), the subjects performed the program 3 times per week for 10 minutes. In all phases, each exercise was performed for 30 seconds, and the legs were alternated during a 30 -second rest interval between each exercise. The exercise program included (1) maintaining a single leg stance on a flat surface with eyes open and closed; (2) performing functional sport activities such as throwing, catching, and dribbling on 1 leg; (3) maintaining double-leg stance while rotating the balance board; (4) maintaining a single-leg stance on the balance board with eyes open and closed; (5) performing functional sport activities while in single-leg stance on the board; (6) and (7) were the repeated phase of 4 &5 with longer time (15 minutes). The functional sport activities included dribbling and catching a ball with hand and kicking. The balance board that was used consisted of a wooden disk 40 centimeter in diameter with a 10 centimeter half sphere attached to the bottom. The sphere allowed approximately 17° of angulations in all planes. Members of each team were encouraged to take part in the experimental program as a group and were given the option of performing the exercises before or after practice. Control subjects did not take part in any prevention or balance training exercises beyond their normal conditioning exercises.

Table 2. The Balance Training Program

Time	Surface	Eyes	Training
Week1	Floor	Open	Single-Leg stance
		Open	Single-Leg stance wile swinging the raised leg
		Open	Single-Leg squat (30°-45°)
		Open	Single-leg stance while performing functional activities
Week2	Floor	Closed	Single-Leg stance
		Closed	Swinging the raised leg
		Closed	Single –leg squat (30°-45°)
Week3	Board	Open	Single-leg stance
		Open	Swinging the raised leg
		Open	Single-leg squat (30°-45°)
		Open	Double-leg stance while rotating the board
Week4	Board	Closed	Single-leg stance
		Open	Swinging the raised leg
		Open	Single-leg squat (30°-45°)
		Open	Single-leg stance while rotating the board
Week5	Board	Closed	Single-leg stance
		Open	Single-leg squat (30°-45°)
		Open	Single-leg stance while rotating the board
		Open	Single-leg stance while performing functional activities
Week6	Board	Closed	Single-leg stance
		Open	Swinging the raised leg
		Open	Single-leg squat (30°-45°)
		Open	Single-leg stance while rotating the board
Week7	Board	Closed	Single-leg stance
		Open	Single-leg squat (30°-45°)
		Open	Single-leg stance while rotating the board
		Open	Single-leg stance while performing functional activities

Results

The demographic data of groups are presented in table 1. The CG and EG did not differ significantly with respect to age, height, weight and BMI (Independent t-test; $p < 0.05$).To determine the objective effects of the balance training program, and all subjects completed a single-leg static balance assessment for both limbs on the Biodex Stability System. The Biodex Stability System is a commercially available dynamic postural stability assessment and training system. This device is designed to stimulate joint mechanoreceptors and to promote reflex muscular activation necessary for joint stability. The Ankle Joint Functional Assessment Questionnaire (AJFAQ) was composed of 12 questions rating the ankle's functional ability (Table 3). The 12 AJFAQ questions were based on assessment tools previously used for evaluating the functional level of the knee joint (Lysholm *et al.*, 1982; Noyes *et al.*, 1990; Tegner *et al.*, 1985). The subjects were instructed to answer each question by checking the statement that at the time best described their involved or experimental ankle as compared with the contralateral ankle. For each question, the 5 possible answers were assigned a point value, which ranged from 0 to 4. Answers representing a lower level of symptoms or a greater functional ability were assigned a greater value. Therefore, the maximal attainable score for each question was 4, and the minimal attainable value was 0. This written assessment tool was completed by all subjects prior to and following the balance training program. The questions was about pain, swelling, ability of ankle for walking on uneven surface, stability, strength, ability for descend stairs, ability for jogging, ability to "cut," or change direction when running, ability for activity level, ability to sense ankle beginning to "roll over", Compared with the other ankle, which statement best describes ability to respond to ankle beginning to "roll over", Following a typical incident of ankle "rolling," which statement best describes the time required to return to activity? The sprain sings rates for the experimental subjects were significantly lower than for controls.

Table 3. Ankle Joint Functional Assessment Questionnaire (AJFAQ).

1. How would you describe the level of pain you experience in your ankle?

(4) Much less than the other ankle
(3) Slightly less than the other ankle
(2) Equal in amount to the other ankle
(1) Slightly more than the other ankle
(0) Much more than the other ankle

2. How would you describe any swelling of your ankle?

(4) Much less than the other ankle
(3) Slightly less than the other ankle
(2) Equal in amount to the other ankle
(1) Slightly more than the other ankle
(0) Much more than the other ankle

3. How would you describe the ability of your ankle when walking on uneven surfaces?

(0) Much less than the other ankle
(1) Slightly less than the other ankle
(2) Equal in ability to the other ankle
(3) Slightly more than the other ankle
(4) Much more than the other ankle

4. How would you describe the overall feeling of stability of your ankle?

(0) Much less stable than the other ankle
(1) Slightly less stable than the other ankle
(2) Equal in stability to the other ankle
(3) Slightly more stable than the other ankle
(4) Much more stable than the other ankle

5. How would you describe the overall feeling of strength of your ankle?

(0) Much less strong than the other ankle
(1) Slightly less strong than the other ankle
(2) Equal in strength to the other ankle
(3) Slightly stronger than the other ankle
(4) Much stronger than the other ankle

6. How would you describe your ankle's ability when you descend stairs?

(0) Much less than the other ankle
(1) Slightly less than the other ankle
(2) Equal in amount to the other ankle
(3) Slightly more than the other ankle
(4) Much more than the other ankle

7. How would you describe your ankle's ability when you jog?

(0) Much less than the other ankle
(1) Slightly less than the other ankle
(2) Equal in amount to the other ankle
(3) Slightly more than the other ankle
(4) Much more than the other ankle

8. How would you describe your ankle's ability to "cut," or change direction when running?

(0) Much less than the other ankle
(1) Slightly less than the other ankle
(2) Equal in amount to the other ankle
(3) Slightly more than the other ankle
(4) Much more than the other ankle

9. How would you describe the overall activity level of your ankle?

(0) Much less than the other ankle
(1) Slightly less than the other ankle
(2) Equal in amount to the other ankle
(3) Slightly more than the other ankle
(4) Much more than the other ankle

10. Which statement best describes your ability to sense your ankle beginning to "roll over"?

(0) Much later than the other ankle
(1) Slightly later than the other ankle
(2) At the same time as the other ankle
(3) Slightly sooner than the other ankle
(4) Much sooner than the other ankle

11. Compared with the other ankle, which statement best describes your ability to respond to your ankle beginning to "roll over"?

(0) Much later than the other ankle
(1) Slightly later than the other ankle
(2) At the same time as the other ankle
(3) Slightly sooner than the other ankle
(4) Much sooner than the other ankle

12. Following a typical incident of your ankle "rolling," which statement best describes the time required to return to activity?

(0) More than 2 days
(1) 1 to 2 days
(2) More than 1 hour and less than 1 day
(3) 15 minutes to 1 hour
(4) Almost immediately

The means and standard deviations for the subjective data (overall AJFAQ test scores) are presented by group in Table 4. Results of the ANOVA revealed a significant difference between pretest and posttest total AJFAQ scores ($F1.20 = 18.10$, $P < .01$).

Table 4. Written Ankle Joint Functional Assessment Tool [AJFAQ) total scores.

	Pretraining	Posttraining
Experimental group	17.11 ± 3.44*	25.78 ± 3.80#
Control group	22.92 ± 5.22	29.15 ± 5.27#

*indicates significant mean difference (***P*** ≤ .05) when compared with the pretraining score of the Control group.

# Indicates significant mean difference (***P*** ≤ .05) when compared with pretraining values of the same limb.

Discussion

Our main findings demonstrate improvements in balance ability of collegiate athlete male after participation in the training program. The assessment of balance ability is one method of determining the efferent, or the muscular response to afferent stimulation. Balance has been said to be mediated by the same peripheral afferent mechanism that mediates joint proprioception, but it may be more representative of lower extremity function when compared to assessments performed in a non-weight-bearing position (Irrgang *et al.*, 1994). Interestingly, the deficit in balance ability observed in the involved limb of the individuals with unstable ankles was also evident in their uninvolved limb. Interestingly, the deficit in balance ability observed in the involved limb of the individuals with unstable ankles was also evident in their uninvolved limb. These pre-training bilateral balance deficits appear to indicate that individuals with a functionally unstable ankle joint may have a deficit in lower extremity postural reactions. Individuals with ankle instability may be at greater risk of ankle joint ligamentous injury to both lower extremities, as compared with non-impaired persons, because they may be unable to effectively activate ankle muscles to protect the ankle joint from excessive joint motion. Therefore, rehabilitation programs prescribed to address existing proprioceptive deficits and to restore functional stability of patients with unstable ankles could have additional rehabilitative and preventative benefits when performed by both the involved and uninvolved ankle. Our study showed a training effect on the untrained limb of the individuals with unstable ankles when balance was assessed. This result has several important ramifications. First, the age group included in this study represents a large population of athletes participating in collegiate sport programs. Second, ankle sprains represent the highest rate of time loss injuries in this population of athletes. A decrease of ankle sprains in this group of university student athletes (as found in this study) would result in a reduction of in direct health care costs and in indirect costs per year if the program were used on a national level for collegiate athlete alone. Third, many of the athletes in university across the country do not have access to the equipment or the skilled personnel necessary to participate in an ankle sprain prevention program. Fourth, the balance boards are not expensive. Balance boards similar to those used in this study can be purchased so cheap and will last for several years. Purchasing 10 to 12 balance boards would allow many members of teams to use the boards at the same time, thus causing little disruption of other team activities and practices. Finally, the 7-phase program used in this study is time efficient and can easily be adapted to most athletic team practices and physical education class settings. This study documented that a balance training program, implemented throughout a collegiate sports program, will reduce the rate of ankle sprains in university students male. The balance training program included simple exercises and employed an inexpensive device that should be readily available to university and adolescent athletes. Further research is needed to determine whether this exercise program can significantly reduce the rate of ankle sprain in athletes without a history of a sprain or reduce ligament sprains in the knee and other lower extremity joints in collegiate athletes male.

References

Bahr R. 2002. Can we prevent ankle sprains? In: MacAuley D, Best TM, eds.Evidence-Based Sports Medicine. London, England: BMJ Books. **7,** 470-490

Bernier JN, Perrin DH. 1998. Effect of coordination training on proprioception of the functionally unstable ankle. The Journal of orthopaedic and sports physical therapy **27(4),** 264-275.
http://dx.doi.org/10.2519/jospt.1998.27.4.264

Braun BL. 1999. Effects of ankle sprain in a general clinic population 6 to 18 months after medical evaluation. Archives of Family Medicine **8(2),** 143-148.
http://dx.doi.org/10.1001/archfami.8.2.143

Eisenhart AW, Gaeta TJ, Yens DP. 2003. Osteopathic Manipulative Treatment in the Emergency Department for Patients with Acute Ankle Injuries. Journal of the American Osteopathic Association **103(9),** 417-421.

Garrick JG. 1977. The frequency of injury, mechanisms of injury, and epidemiology of ankle sprains. American Journal of Sports Medicine **5(6),** 241-242.
http://dx.doi.org/10.1177/036354657700500606

Gerber JP, Williams GN, Scoville CR, Arciero RA, Taylor DC. 1998. Persistent disability associated with ankle sprains: a prospective examination in an athletic population. Foot and Ankle International **19(10),** 653-660.
http://dx.doi.org/10.1177/107110079801901002

Hertel J. 2008. Sensorimotor deficits with ankle sprains and chronic ankle instability. Clinical Sports Medicine **27(3),** 353.
http://dx.doi.org/10.1016/j.csm.2008.03.006

Hoffman M, Payne VG. 1995. The effects of proprioceptive ankle disk training on healthy subjects. The Journal of orthopaedic and sports physical therapy **21(2),** 90-93.
http://dx.doi.org/10.2519/jospt.1995.21.2.90

Holme E, Magnusson SP, Becher K, Bieler T, Aagaard P, Kjaer M.1999. The effect of supervised rehabilitation on strength, postural sway, position sense and re-injury risk after acute ankle ligament sprain. Scandinavian Journal of Medicine & Science in Sports **9(2),** 104-109.
http://dx.doi.org/10.1111/j.1600-0838.1999.tb00217.x

Janda DH. 1997. Sports injury surveillance has everything to do with sports medicine. Sports Medicine **24(3),** 169–71.
http://dx.doi.org/10.2165/00007256-199724030-00004

Kannus P, Renstrom P. 1991. Treatment for acute tears of the lateral ligaments of the ankle: operation, cast, or early controlled mobilization. The Journal of bone and joint surgery **73(2),** 305-312.

Lephart SM, Pincivero DM, Giraldo JL, Fu FH. 1997. The role of proprioception in the management and rehabilitation of athletic injuries. American Journal of Sports Medicine **25(1),** 130-137.
http://dx.doi.org/10.1177/036354659702500126

lrrgang JJ, Whitney SL, Cox ED. 1994. Balance and proprioceptive training for rehabilitation of the lower extremity. Journal of Sport Rehabilitation **3(1),** 68-83.

Lysholm J, Gillquist J. 1982. Evaluation of knee ligament surgery results with special emphasis on use of a scoring scale. American Journal of Sports Medicine **10(3),** 150-154. http://dx.doi.org/10.1177/036354658201000306

McGuine TA, Keene JS. 2006. The Effect of a Balance Training Program on the Risk of Ankle Sprains in High School Athletes. American Journal of Sports Medicine **34(7),** 1103-1111. http://dx.doi.org/10.1177/0363546505284191

Mohammadi F. 2007. Comparison of 3 preventive methods to reduce the recurrence of ankle inversion sprains in male soccer players. American Journal of Sports Medicine **35(6),** 922-926. http://dx.doi.org/10.1177/0363546507299259

Noyes FR, Barber SD, Mangine RE. 1990. Bone patellar ligament bone and fascia lata alografts for reconstruction of the anterior cruciate ligament. The Journal of bone and joint **surgery 72(8),** 1125-1136.

Palmer ML, Epler ME. 1990. Clinical Assessment Procedures in Physical Therapy. Philadelphia, Pa: Joseph Barlow Lippincott Company. **5,** 301-302.

Parkkari J, Kujala UM, Kannus P. 2001. Is it possible to prevent sports injuries?Review of controlled clinical trials and recommendations for future work. Journal of Sports Medicine **31(4),** 985–95. http://dx.doi.org/10.2165/00007256-200131140-00003

Powell JW, Barber-Foss KD. 1999. Injury patterns in selected high school sports: a review of the 1995-1997 seasons. Jornal of Athletic Training **34(3),** 277-284.

Tegner Y, Lysholm J. 1985. Sportief bewegen engezondheidsaspecten: een verkennende studie naar kosten en baten (SEOrapportnr. 372). Amsterdam: Stichting voor Economisch Onderzoek der Universiteit van Rating systems in the evaluation of knee ligament injuries. Clinical Orthopaedic and related research **(198),** 43-49.

Thacker SB, Stroup DF, Branche CM, Gilchrist J, Goodman RA,Weitman EA. 1999. The prevention of ankle sprains in sports: a systematic review of the literature. American Journal of Sports medicine **27(6),** 753-760.

Tropp H, Askling C, Gillquist J. 1985. Prevention of ankle sprains. American Journal of Sports Medicine **13(4),** 259-262. http://dx.doi.org/10.1177/036354658501300408

Van Rijn RM, van Os AG, Bernsen RM, Luijsterburg PA, Koes BW, Bierma-Zeinstra SM. 2008. What is the clinical course of acute ankle sprains? A systematic literature review. American Journal of Sports Medicine **121(4),** 324-331.

Verhagen EALM, van Mechelen W, de Vente W. 2000. The effect of preventive measures on the incidence of ankle sprains. Clinical Journal of Sports Medicine **10(4),** 291-296. http://dx.doi.org/10.1097/00042752-200010000-00012