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# EVALUATION AND REHABILITATION OF FUNCTIONAL ANKLE INSTABILITY IN WRESTLERS

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## ABSTRACT

**Objectives:** The aim of the present study was to evaluate functional deficits after an ankle sprain in collegiate wrestling students and to examine the effectiveness of two different balance rehabilitation programs on balance ability.

**Methods:** Thirty-three collegiate wrestling students with functional ankle instability were randomly divided into three groups. One subject group (n=10) underwent no specific balance training (control group). The remaining two groups followed an intervention balance program for 4 weeks, 3 times per week, 20 min per time using balance boards. One of the two training groups performed the exercise in a swimming pool- the "pool" group (N=13), and the other at the ground- the "land" group (N=13). Balance ability was assessed before and after the 4 week balance training program. Balance assessment included a stability index recorded on a Biodex Stability System. The functional ability evaluations used the "figure of 8" and "triple jump" tests.

**Results:** The results showed that in both training groups balance and functional ability of the injured leg were significantly improved after the training period. In the final measurements no statistical significant differences between the injured and healthy limb were found.

**Conclusion:** The present study indicates that the performance of balance exercises in or out of the water by wrestling athletes with functional ankle instability improves their balance ability.

**KEYWORDS:** Ankle; Balance; Ankle Instability; Ankle Rehabilitation

## INTRODUCTION

Wrestling is unique among athletics (Halloran, 2008). It is considered to be one of the most physically demanding sports among high school and college athletics. A wrestler needs to have not only strength and endurance but also technical skill to be successful (Halloran, 2008). However, as expected in a physical contact sport, the athletes are prone to occasional injury. Wrestling injuries account for the second most frequent sports injuries after football (Centers for Disease Control and Prevention, 2006). Lateral ankle sprains are one of the most prevalent injuries in high school, collegiate and recreational sports (Buchanan et al., 2008). According to the United States National Collegiate Athletic Association (NCAA), the most commonly injured body part was the knee at 21% of all reported wrestling injuries, while the ankle was the third most common injury at 9% (Newton et al., 2002). Similarly, many investigators reported that in collegiate wrestling, the ankle joint was one of the most commonly injured regions (Jarrett et al 1998; Agel 2007; Yard et al 2008; Shadgan et al., 2010)

Functional ankle instability (FAI) is a condition that occurs after an ankle sprain in approximately 40% of patients (Freeman, 1965; Bosien et al., 1955). Functional ankle instability has been defined in many ways, including the "disabling loss of reliable static and dynamic support of a joint" (Vaes et al., 1998) and a tendency for the foot to give way" (Freeman 1965b). Experimental studies have demonstrated a correlation between impaired proprioception and FAI. Moreover, deficits have been identified in postural stability control (Fu & Hui-Chan, 2005; Nakagawa & Hoffman, 2004). As a result, many studies have been conducted which report that exercise rehabilitation aimed at retraining proprioceptive deficits associated with FAI, such as using multiaxial platforms or wobble boards, is associated with positive outcome (Baltaci & Kohl, 2003; Mattacola & Dwyer, 2002; Wilkerson & Nitz, 1994).

The wobble board is commonly used in the rehabilitation of FAI and is designed to assist the reeducation of the proprioceptive system by improving mechanoreceptor function and restoring the normal neuromuscular feedback loop (Rozzi, Lephart, Sterner, & Kuligowski, 1999). The wobble board training improves single leg stance ability (Rozzi et al 1999; Gioftsidou et al., 2006) and postural sway (Bernier & Perrin, 1998; Gauffin, Tropp & Odenrick, 1988; Malliou et al. 2004; Malliou et al., 2008, Gioftsidou et al., 2006) On the other hand, the pool can be a safe environment used at the first stage of musculoskeletal injuries rehabilitation (ACL, MCL) or for the rehabilitation of

chronic musculoskeletal disease, such as knee osteoarthritis and chronic low back pain (Hinman et al 2007). However, the use of a pool environment for functional ankle instability rehabilitation has not been reported. When using the pool environment for lower limb training, subjects try to stand in the water and maintain a stable upright stance over the base of support, while water movement and turbulence play an important role by overloading the postural control systems especially during one leg stance (Melzer et al., 2008). While water-based training is a non-weight bearing condition for the joints, keeping balance is a difficult task due to turbulence which is produced in the water.

The purpose of this study was a) to investigate functional deficits in collegiate wrestling students after an ankle sprain and b) to examine the effectiveness of two different rehabilitation training programs (the first performed on land and the second in a pool environment) on balance ability.

## **METHODS**

**Subjects-**The participants in this study were 36 collegiate (age:  $21.02 \pm 1.3$  y) wrestlers. All participants had one functionally unstable ankle. To be characterized as functionally unstable, the participants satisfied the following criteria 1) at least one repeated injury or perception of ankle instability or “giving away” in the unstable ankle, 2) no evidence of mechanical instability as assessed by an orthopedic doctor using anterior drawer test, 3) pain free, full weight bearing and normal gait at the time of study. The average time period since the last episode of instability and injury was 2 months. Prior to any testing informed consent was obtained from all participants. Exclusion criteria for the participants included a history of lower extremity surgery or fracture, joint swelling or any systemic disease that might interfere with sensory input.

**Equipment and instruments-**The balance ability assessment was performed with the Biodex Stability System (Biodex, Inc, Shirley, NY). The Biodex Stability System (BSS) (Biodex, Inc, Shirley, NY) uses a circular platform that is free to move about the anterior-posterior (AP) and medial-lateral (ML) axes simultaneously. In addition to moving about these axes, it is possible to vary the stability of the platform by varying the resistance force applied to the platform. Springs apply this force to the underside of the platform and can be adjusted to preset resistances established by the manufacturer. Rather than measuring the deviation of the COP during static conditions, this device measures the degree of tilt about each axis during dynamic conditions. Thus, the BSS appears to provide more specific information on ankle joint movements (Arnold & Schmitz, 1998; Biodex Stability System, 1998).

### **Participants Preparation**

The subjects stood on the BSS with one leg. They were allowed to flex the support knee to no more than  $10^\circ$  but were required to maintain an upright posture with the supporting leg. Additionally, participants were instructed to keep their hands at their sides and to maintain a comfortable knee angle with the unsupported leg during testing. Once in this position, the stability platform was unlocked to allow motion. The participants were then instructed to adjust the supporting foot position until they found a position at which they could maintain platform stability. This was done to establish the participants' ideal foot positioning for testing. The platform was then locked, and participants were told to maintain the foot position. This position was used for testing.

### **Testing protocol**

The testing protocol consisted of a single 20-second test, while the platform (Figure 1) was set to freely move with the minimal resistance available (level 1). From the magnitude and duration of these deviations, a total stability index (SI) was computed by the system. The subjects performed three 20-sec practice trials and three 20-sec test trials out of which only the best SI score was further processed.



**Fig. 1.** The platform of the Biodex stability system

In agreement with previous reports (Pincivero et al. 1995; Johnson et al. 2005; Gioftsidou et al 2006), intraclass correlation coefficient values for two measurements taken in the same day ( $p > 0.05$ , Student's t-test) were 0.75 for the Biodex test.

**Procedures for completing the functional assessments**

“Figure of 8”: the participants were asked to cover the figure of 8 three times (cycle diameter was 4 m.). The time was recorded in seconds (Tropp et al., 1984; Donahoe et al., 1993; Risberg and Ekeland, 1994; Guskiewicz and Perrin 1996). “Triple jump test”: from standing position on both legs the participants first jumped onto the healthy leg, then jumped again from and to the healthy leg, and thirdly from the healthy leg to both legs. The same procedure was done on the injured leg. The score was the best jump of the three trials, recorded in meter (Risberg and Ekeland, 1994; Risberg, et al., 1995; Scholl, et al., 1999).

**Procedures for the Balance training program**

The subjects were randomly assigned to one of the three groups - two training groups and one control group. The control group (N=10) did not participate in any specific training program. Both training groups performed a 20 min training program (45sec exercise and 15sec rest), with 5 different exercises performed a) on a “hard balance board”, and b) on “air disk”, with 3 repetitions for each exercise (5 exercise X 2 boards X 2 repetitions). The first experimental group, the “land group” (N=13), performed the rehabilitation program on land (Figure 2) and the second experimental group the “pool group” (N=13), performed the same rehabilitation program in a swimming pool (Figure 3) (Detailed in Table 1).



**Fig. 2.** Balance exercise performed on the ground



**Fig. 3.** Balance exercise performed in the water

**Table 1.** Balance training program

Exercises performed on a) “hard balance board”, b) on “air disk”
1. Attempt to maintain single –limb stance”
2. Attempt to maintain single-limb stance and try to bend and extend the knee
3. Attempt to maintain single-limb stance and try to move the unsupporting leg in front and back
4. Attempt to maintain single-limb stance and try to catch and return the ball to the trainer
5. Attempt to maintain single-limb stance while the trainer from the back pouss the exerciser

ANOVA (both one way and repeated measures) was used in order to determine possible statistically significant differences among measurements, among the experimental groups and control, and among the injured and non-injured lower limb.

**RESULTS**

According to the results, no difference ( $p > 0.05$ ) in balance ability was found in the control group between baseline testing and re-testing 4 weeks later. In contrast, the 4 week balance training program improved ( $p < 0.05$ ) all balance and functional performance indicators in both of the two training groups. However, the rate of the improvement ( $p > 0.05$ ) did not vary between the two groups. Finally, no statistically significant differences were found between the injured and healthy limb in the testing after the completion of the training program (Table 2).

**Table 2.** Balance and functional stability assessments

	Pre Training				Post Training			
	Group "Land"		Group "Pool"		Group "Land"		Group "Pool"	
	Healthy	Injured	Healthy	Injured	Healthy	Injured	Healthy	Injured
SI (°)	3.21±1.8	7.42±2.7 †	3.22±1.2	7.31±2.7 †	3.23±1.5	3.36±1.9 *	3.29±1.5	3.42±1.2 *
Jump	5.39±0.9	4.79±0.7 †	5.42±0.9	4.83±0.9 †	5.33±0.9	5.29±0.8 *	5.35±0.9	5.30±0.8 *
Figure 8	8.81±0.47		8.73±0.54		7.48±0.56*		7.67±0.29*	

† indicates  $p < 0.05$  between injured and healthy limb balance training,

\* indicates  $p < 0.05$  between "pre" and "post" training.

## DISCUSSION AND CONCLUSIONS

The main objectives of this study were to investigate 1) whether a previous ankle sprain influences the collegiate wrestling students balance and functional ability, and b) whether the effectiveness of balance training program is affected by the environment in which it is performed, namely on land or in a swimming pool. It was found that 1) a previous ankle sprain caused functional deficits, and influenced the balance and functional ability of the the collegiate wrestling students, and 2) the balance training program effectiveness was not affected by the program environment.

In previous studies, impaired postural control is frequently evident in subjects with both acute and repetitive ankle sprains. Similarly, functional deficits in postural control are consistently recognized in subjects with chronic ankle instability. These postural deficits are most likely secondary to a combination of impaired neuromuscular control and proprioception (Docherty et al., 2006; Wikstrom et al., 2006; Ross and Guskiewicz 2006; Holmes & Delahunt, 2009). As far as postural deficits are concerned, the present study found higher instability scores at the initial measurement, which is in accordance with the results of previous studies which studied subjects with FAI (Docherty et al., 2006; Wikstrom et al., 2006).

Concerning the second objective of our study, it was found that both balance training programs decrease the postural instability of the subjects, which agrees with previous reports (Bernier & Perrin, 1998; Eils & Rosenbaum, 2001; Gauffin, Tropp, & Odenrick, 1988; Rozzi et al., 1999; Ross & Guskiewicz, 2006). Previous reasearch has also shown that wobble board training improves single leg stance ability (Rozzi et al., 1999) and postural sway (Bernier & Perrin, 1998; Gauffin, Tropp, & Odenrick, 1988; Eils & Rosenbaum, 2001) in participants with FAI. Wester et al (1996) showed that patients with FAI who underwent wobble board training experienced significantly fewer recurrent sprains during a follow-up period than those who did not follow a training programme. As far as the exercise equipment is concerned, it is identical to the Bernier & Perrin (1998), and Eils & Rosenbaum (2001) studies, involving modalities such as ankle disks, tilt boards and single-leg standing activities.

The duration of the present study balance training programs was 4 weeks, 3 times per week. Similar period for balance training on individuals with functionally unstable ankles was used by Clark and Burden (2005) and the results of their study showed an increased perception of ankle stability during and after exercise program, consistent with the results of the present study. While Sodermann et al. (2000) found no effect of balance board training on the ankle sprains, with the respect to the duration of the program, the overall results of the present study support the performance of balance exercises by wrestling athletes with functional ankle instability in order to improve their proprioception ability.

Regarding the water-based balance training program, the focus was on adapting the land-based balance exercises to water environment, adding hand movement to create water turbulance, which would contribute to the progressive exercises difficulty with the aim to improve balance ability. The water turbulance during balance exercises challenges balance control in multiple directions, and in addition, when perturbations are applied by instructors in predictable and unpredictable manners could allow subjects to exercise safely and progress when needed (Melzer et al 2008). Before Melzer et al (2008) research, no study had proposed using a water-based training program that includes perturbations to improve stability.

## CONCLUSION

The findings of this study advocate the use of balance exercise programme for rehabilitation of wrestling collegiate athletes with functional ankle instability. The results demonstrated that wrestling collegiate athletes with a previous ankle sprain experienced balance and functional deficits. A balance training program performed on balance boards increased the balance and functional ability of the participants. The performance of balance exercises can take place in either a pool or land environment, with the same positive effect.

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