Ankle joint position sense in male Taekwondo athletes after wobble board training

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Manuscript Preparation
E Funds Collection

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An earlier version of this paper was presented during the International Scientific Conference "Perspectives in Physical Education and Sport" in Constanta, Romania, 21st–23rd May 2010

Source of support: Departmental sources

Received: 29 June 2011; **Accepted:** 13 July 2011; **Published online:** 16 October 2011

Abstract

Background and Study Aim: There is evidence of an improvement in sportive performance in the athletes after completing a wobble board training program. The aim of this study was to determine whether a six-week wobble board training increased the awareness of joint position sense on ankle joint proprioception in male taekwondo athletes.

Material/Methods: Eighteen male taekwondo athletes took part in this study. Participants were randomly divided into experimental and control groups. For experimental group (n=10) the average age, height, weight and experience time of the subjects were 19.50±2.07 years, 175.80±7.27 cm, 64.80±4.71 kg and 6.30±1.49 years, respectively. For control group (n=8) it was 19.88±2.30 years, 173.75±5.06 cm, 67.50±5.55 kg and 7.13±2.56 years, respectively. Experimental group took wobble board was training three times a week for the period of six weeks. To assess ankle joint position sense (JPS), passive angle reproduction test was performed by the Biodex System 3 Dynamometer (Biodex Medical Systems, Shirley, NY, USA). Passive angle reproduction test was conducted on dominant and non-dominant ankle at 5° and 25° of plantar flexion angles. Measurements were taken twice, before and after training.

Results: There was no significant difference in dominant ankle at 5° between JPS measurements before and after training in experimental group (t=1.920, p=0.087). JPS increased significantly in dominant ankle at 25° (t=3.060, p=0.014), non-dominant ankle at 5° (t=2.959, p=0.016) and 25° (t=3.213, p=0.011) in experimental group.

Conclusions: The WBT of taekwondo athletes had improved JPS, especially in non-dominant ankle. The proprioception training with wobble board may provide an advantage in using dominant leg during performing taekwondo sport moves and in decreasing the number of ankle injuries in male taekwondo athletes.

Key words: ankle • proprioception • taekwondo • training • wobble board

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Background

The term of proprioception was first described by Sherrington (1906) as a result of sensory information achieved by the central neural system through mechanoreceptors located in the ligaments, joint capsule, tendons, muscles, and skin [1]. The proprioceptive mechanism is required for correct function of the joints in sports, activities of daily life and some occupational tasks. Proprioception contributes to the motor programming of neuromuscular control during movements and at the same time contributes to muscle reflex for

providing dynamic joint stability [2,3]. Proprioception is a specialized range of the sensory shape and includes the sensation of kinaesthesia (joint movement) and joint reposition sense (joint position) [3]. Ankle proprioception has an important role in keeping balance of human body through functional activities like standing, walking and running [4,5].

Damage to the proprioception system is considered to be the main reason of functional instability after ankle injuries. Proprioception is the sensory feedback that contributes to postural equilibrium, muscle sense, joint stability. Proprioceptors are located in the skin, muscles, tendons, ligaments, and joint capsules [6]. The lack of proprioceptive feedback caused by injuries may lead to excessive or unsuitable loading of a joint [7]. It is one of the factors that lead to progressive degeneration of the joint and continued deficits in joint dynamics, balance, and coordination [8]. The biomechanical ankle platform system (BAPS) is the most widely used by physicians in rehabilitation and athletic training after ankle injuries. It helps retrain the proprioceptive system in development of mechanoreceptor function and return to normal neuromuscular coordination [9]. The effectiveness of 4–8 weeks of WBT on postural control and perceived stability has been well documented [6,10] and residual symptoms following ankle sprains can be reduced by a 12 week WBT program [11]. The debate still exists, whether training can improve proprioception or not [12]. Proprioception can be improved through exercise, especially proprioceptive exercise that requires three actions: the proprioception of the joints, balance capacity, and neuromuscular control [13].

Taekwondo is dynamic form of unarmed self-defence and generally focused on kicking techniques, which derived from other martial arts. A sudden kick and turn kicking (*dollyeo chagi, bandae dollyeo chagi etc.*) are part of Taekwondo; contestant can turn to speed and power to escape from the competitor kicking [14]. Speed and accuracy are two main factors of movement of Taekwondo. The features such as high speed, returns and kicks indicate the uniqueness of taekwondo [15].

It is important to know whether proprioception training with wobble board has any influence on the passive ankle position sense for prevention of injuries and perhaps improved performance in taekwondo. Therefore, the aim of this study was to determine whether a six-week wobble board training increased the awareness of joint position sense on ankle joint proprioception in male taekwondo athletes.

Material and Methods

Subjects

Eighteen male taekwondo athletes (from Department of Physical Education and Sport in Konya, Turkey) who had 2nd Dan of black belt and competing in national or international tournaments volunteered to take part in this study. Participants signed an Informed Consent approved by the University Ethics Committee.

Subjects were randomly divided into experimental and control groups. For experimental group (n=10) the average age, height, weight and experience time of the subjects were 19.50±2.07 years, 175.80±7.27 cm, 64.80±4.71 kg and 6.30±1.49 years, respectively. For control group (n=8) it was 19.88±2.30 years, 173.75±5.06 cm, 67.50±5.55 kg and 7.13±2.56 years, respectively. Participants were excluded if they had a lower extremity injury, vestibular problems and visual problems. Exclusions were assessed by questioning the participants. Subjects were instructed to refrain from any exercise before test.

Proprioception test

Ankle proprioception was measured by examining JPS with the Biodex (Biodex Medical Systems, Shirley, NY, USA) isokinetic dynamometer using a passive reproduction test. Proprioception measurements were recorded twice, before and after WBT in dominant and non-dominant ankle. Each subject first had a standardized warm up phase on the lower extremity cycle for 5 minutes. After warm up phase successive subjects sat upright with both knees and hips flexed and the feet in neutral posture and were asked to close the eyes during the test to eliminate visual input. The foot of the subject was aligned with the axis of the dynamometer. In the passive reproduction test, the system moved the subject foot from the neutral posture noted as 0° to the target angle (first 5° and after 25° of plantar flexion) with an angular velocity of 2°/s and held the subject foot there for 5 s. After the adapter reached again the neutral posture, subject tried to replicate the target angle in a passive manner by using the hand-operated button to stop the movement when felt that the correct angle was reached. The deviation from the target angle was noted. This procedure was repeated three times for each angle and the mean of deviations was registered as absolute error for each subject [16–18].

Wobble board training

The experimental group took WBT program in addition to standard taekwondo training. The control group entirely performed standard taekwondo training. The WBT was

Turn Kicking (*Dollyo Chagi* / Round Kick) – The practitioner raises his knee, turns hips, pivots on the non-kicking foot, and snaps the kick horizontally into the target at an 80 to 90 degree angle.

Turn Kicking (*Mom-Dollyo Chagi* / *Bandae Dollyeo Chagi*) – The body is turned round and the foot is directed upward and pushes the back leg straight toward the target, hitting it with the heel while watching over the shoulder. The foot is stretched up aiming at the opponent's face.

Taekwondo Foot Techniques – *Ap chagi* / Front kick, *Dollyo chagi* / Round kick, *Yeop chagi* / Side kick, *Dwi chagi* / Back kick, *Nerio Chagi* / Axe kick, *Mom-dollyo Chagi* / Turning kick.

Ankle Joint Position – In the passive reproduction test the system moved the subjects foot from the neutral posture noted as 0° to the target angle (first 5° and then 25° of plantar flexion).

Table 1. The wobble board training schedule.

Weeks	Work time (s)	Repetition	Rest between sets (s)	
1st week	10	6	10	On stable surface and wobble board
2nd week	15	5	15	On stable surface and wobble board
3rd week	20	4	20	On stable surface and wobble board
4th week	25	3	25	On stable surface and wobble board
5th week	30	2	30	On wobble board
6th week	35	1	35	On wobble board

Table 2. Subjects' demographic characteristics.

Variables	Groups	n	Mean	SD
Age (year)	Experimental group	10	19.50	2.07
	Control group	8	19.88	2.30
Body height (cm)	Experimental group	10	175.80	7.27
	Control group	8	173.75	5.06
Body weight (kg)	Experimental group	10	64.80	4.71
	Control group	8	67.50	5.55
BMI (kg/m^2)	Experimental group	10	21.37	2.07
	Control group	8	22.27	4.18
Experience time (year)	Experimental group	10	6.30	1.49
	Control group	8	7.13	2.56

adapted from previous studies [19–23] and performed on wobble board (Table 1). The experimental group was trained 20 minutes, 3 times per week for the period of 6 weeks. On each training day, subjects performed a 5 minute warm up before WBT. Training was performed with open eyes and closed eyes on dominant and non-dominant leg. Subjects were requested to perform dorsiflexion/plantar flexion and inversion/eversion exercises while their knee joints were at 45 degrees flexion.

Statistical analysis

The Shapiro-Wilk test for normality was performed. Data from passive reproduction test were examined with a *t*-test for independent samples to determine significant differences among the experimental and control groups. *T*-test for dependent samples was used to determine significant differences among measurements, before and after training. A significance level of 0.05 was set for the study. Analyses were conducted using SPSS 16.0.

Results

Subjects' demographic characteristics are presented in Table 2.

Taekwondo athletes' passive reproduction test means ±SD before (pre-test) and after training (post-test) in dominant and non-dominant legs are shown in Table 3 and 4.

In the passive reproduction test measurements for dominant leg significant differences were not found between experimental and control groups in pre-test ($t=1.115$; $p>0.05$) and post-test ($t=–0.369$; $p>0.05$) at 5°. Significant differences were not identified between experimental and control groups in pre-test ($t=–0.655$; $p>0.05$) and post-test ($t=–0.884$; $p>0.05$) for dominant leg at 25°. Passive reproduction test measurements for non-dominant leg significant differences were not found between experimental and control groups in pre-test ($t=0.998$; $p>0.05$) at 5°. A significant difference was identified between experimental and control groups in post-test ($t=–2.440$; $p<0.05$) for non-dominant leg at 5°. Passive reproduction test measurements for non-dominant leg were no different for experimental group and control group in pre-test ($t=0.260$; $p>0.05$) and post-test ($t=–0.642$; $p>0.05$) at 25°.

In experimental group for dominant ankle at 5°, a non-significant difference was found in the ankle JPS between pre-test and post-test measurements (t=1,920,

Table 3. Taekwondo athletes' passive reproduction test (absolute error at 5°) means ±SD in second.

Variables	Groups	Absolute Error (5°)	
		Pre-test	Post-test
Dominant ankle	Experimental group	1.74±1.22	0.95±0.47
	Control group	1.21±0.77	1.03±0.37
Non-dominant ankle	Experimental group	1.66±0.80	0.79±0.37*
	Control group	1.23±1.05	1.60±0.88**

* Different from pre-test (p<0.05); ** Different from experimental group in post-test (p<0.05).

Table 4. Taekwondo athletes' passive reproduction test (absolute error at 25°) means ±SD in second.

Variables	Groups	Absolute Error (25°)	
		Pre-test	Post-test
Dominant ankle	Experimental group	2.41±0.64	1.49±0.96*
	Control group	2.70±1.11	1.85±0.71
Non-dominant ankle	Experimental group	2.64±1.20	1.46±1.07*
	Control group	2.51±0.76	1.76±0.89

* Different from pre-test (p<0.05).

p>0.05). After a 6 week WBT, passive reproduction test performance increased at 5° for non-dominant leg (t=2.959; p<0.05) and at 25° for dominant (t=3.060; p<0.05) and non-dominant leg (t=3.213; p<0.05). On the other hand, no significant difference was found in the ankle position sense measurements after a period of 6 weeks between pre-test and post-test (t=0.659; p>0.05 for dominant leg and t=–1.124; p>0.05 for non-dominant leg at 5°, t=2.320; p>0.05 for dominant leg and t=1.793; p>0.05 for non-dominant leg at 25°.

Discussion

During six week WBT performed by the taekwondo athletes there was an iimprovements were observed in JPS for dominant and especially non-dominant ankles. Proprioception may also have changed with short-term acute exercise and the risk of ankle injury may further worsen due to temporary changes in neuromuscular control [24].

JPS is a component of proprioception and is often measured to assess proprioception [25]. During the test of proprioception, joint and muscle receptors are theoretically stimulated and an unspoilt motor control system is required [3]. To measure proprioception different instruments may be used, like goniometer, isokinetic dynamometer, motion analysis systems and other unique measuring systems [26].

In ankle rehabilitation wobble boards, ankle discs and balance boards played an important role [27,28]. In general the wobble board is used in rehabilitation of functional instability of the an ankle, to assist the re-education of the proprioceptive system. It has been designed to restore the normal neuromuscular feedback and improve mechanoreceptor function [29].

In the study the experimental group included 10 taekwondo athletes. Subjects' ankle positions sense significantly increased from before- to after training (Table 3). Lephart et al. [3] declared the positive impact of training as regular observable on proprioception sense. It improves the neuro-sensory and motor roads and reduces the risk of injury [3]. Some studies have well documented effectiveness of WBT on the improvement of markers of proprioception in individuals with no history of ankle instability [30,31].

When the ankle JPS after training program, was measured, it was noted that experimental group of taekwondo athletes had higher ankle JPS performance than control group, which is statistically significant especially at non-dominant ankle JPS non-dominant 5° and 25°. In taekwondo training the dominant leg is used more effectively and the taekwondo athletes apply to many of taekwondo foot technique on the dominant leg during both training and competition.

At the end of comparing the experimental and control groups' ankle JPS measures have been calculated after proprioception training program; the reason why no significant difference was found in dominant ankle joint position scores is probably due to the fact that in athletes' use their bodies unilaterally. Waddington et al. [31] investigated effect of WBT on rugby players. They took part in

WBT over five weeks. At the end of training, they found significant developments in both ankle and knee JPS.

Conclusions

Our study indicated that training with a wobble board may enable subjects to become more accurate in their foot positioning. The WBT focused on improving the athletes' body control and preparing the neuromuscular system for taekwondo specific movements. Compared with the control group that continued standard training, the WBT group had significantly improvement. The study findings may provide evidence supporting the effects of regular wobble board exercise on proprioception. Using proprioception training with wobble board may have an advantage in using dominant leg during performing techniques concerning taekwondo sport and in decreasing the number of ankle injuries in male taekwondo athletes.

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