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Evaluation of Ankle Joint Position Sense in Children Taekwondo Practitioners with Ankle Sprain

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Abstract

Background: Taekwondo (TKD) is a martial art and popular sport worldwide. Many practitioners start TKD training at a very young age. Various studies explored benefits and risk factors of TKD training in children for rehabilitation and injury prevention. However, evidence on peripheral mechanism underlying proprioceptive control in this population is limited. This study aimed to examine the ankle joint position sense (JPS) in children TKD practitioners with history of ankle sprains in comparison to non-TKD practicing children.

Methods and Findings: Twenty children TKD practitioners (age 9.28 ± 1.20 years) with history of ankle sprains and twenty healthy children undertaking only physical education at school (age 9.35 ± 1.27 years) were recruited. Biodex Multi-joint system was used to measure JPS at 5°, 15° and 30° of ankle plantarflexion of both dominant and non-dominant sides of all children. Errors in passive reproduction of each target position were compared between the two groups. Results revealed that passive JPS of the dominant and non-dominant ankles of the two groups were not different ($p>0.05$). Errors in passive reproduction of all target positions of the TKD group were greater than those of the control group ($p<0.05$).

Conclusions: Passive JPS could indicate function of mechanoreceptors without motor efforts. Greater errors in passive reproduction of children TKD practitioners with history of ankle sprains may indicate impairments of function of mechanoreceptors. Ankle joint receptors may deteriorate due to previous ankle sprains. Even though the proprioceptive control requires both peripheral and central mechanisms, detection of peripheral impairments may be of useful to rehabilitation program. Further studies in early detection and intervention for children TKD practitioners with history of ankle sprains are recommended.

Keywords: Ankle; Children; Joint position sense; Taekwondo

Introduction

Taekwondo (TKD) is a Korean martial art and popular sport. This sport involves high functional skills with bare hands and feet [1]. TKD practitioners need to use their skills while balancing on one foot, therefore proprioception is needed in controlling movement and protective responses [2]. Proprioceptive sensation is defined as the perception of awareness of joint position and movement [3]. It is assessed by the measurements of kinesthesia and joint position sense (JPS). Kinesthesia is the measurement of the threshold for perception of slow passive movement, while JPS is objectively assessed by determining the error associated with active or passive reproduction of a joint angle [4]. Previous research suggested that the active and passive JPS measure different aspects of proprioception [5]. Since active JPS examines both sense of effort and sense of joint position, it may not purely reflect the accuracy of JPS [6]. In addition, previous research found that the anesthetic block of the ankle joint affected only the passive JPS [7]. The joint receptors may only involve in perception of passive movement [7]. Thus passive JPS is more suitable to measure function of joint receptors [7]. Moreover, Ashton-Miller et al. suggested that the exercise programs aimed to improve proprioception should use a proprioceptive measure that does not involve a motor task [8]. Since active JPS requires memory of the motor task and peripheral feedback, improvement in the peripheral proprioceptive mechanism should be better assessed by a passive JPS [9].

Many studies supported the positive effects of TKD on balance and motor performance using functional tests such as a computer post urography system, a sensory organization test (SOT) and unilateral stance test (UST), single leg standing balance [10-12]. Few studies assessed effects of TKD training in improving JPS. A study in reported the long-term effect of TKD training in improving active JPS [12]. However, this benefit was not found in short-term training. Since long-term training is needed to improve the cortical control of the joint, the active JPS measures both sense of effort and sense of joint position [8-13]. Therefore, active JPS changed in long-term training only [12]. Passive JPS measure was not included in the study, therefore the effect of TKD on JPS without motor task was not examined.

With the increasing popularity of TKD, many practitioners start TKD training at a very young age. In children population, somatosensory function matures at the age of three or four years [14,15], proprioceptive sensation further refines through the age 18 years [16]. During refinement, JPS becomes more reliable but it is not more accurate [16]. Accuracy of JPS in children may be affected by various factors such as training and injuries to the joint structures. Recent research indicated that the ankle joint was one of the most frequently injured while practicing taekwondo [17]. TKD practitioners were exposed to risk of injuries during both training and competitions. Since early detection of proprioceptive loss is of importance to designing proper proprioceptive training for children athletes, this study aimed to assess function of joint receptors in children Taekwondo practitioners with a history of ankle sprains and to compare the function of dominant and non-dominant ankles of the children.

Methods

Forty volunteer children aged between 7 and 12 years were recruited. Twenty of them were recruited from Taekwondo (TKD) training institutes. Children in TKD group had practiced TKD for 2 hours a day, 3 days a week and continuously for at least 2 years. Twenty healthy children whose age-, and gender-matched to the children in TKD group were recruited from primary schools. All children were right leg dominant, as ascertained by asking them which leg they preferred to kick a football with. Children were excluded if they had a history of fractures or arthritis of lower-extremity joints, or symptoms of central or peripheral nervous system dysfunction. Children with ankle sprain or injury within the last 6 months were also excluded from participation. All children completed an interview questionnaire prior to beginning the study. The information obtained from this questionnaire assisted in assuring that the non-TKD practicing children had undertaken only physical education at school, and only children in TKD group had history of ankle sprains occurred over six months ago. Eight of the 20 children had moderate sprains and 12 of them had mild ankle sprains. None of them sought medical treatment. All children were asymptomatic at the time of the study. Parents and their children read and signed a written informed consent before entering the study protocol. The study was approved by the Mahidol University Institutional Review Board. Passive ankle JPS of both dominant and non-dominant ankles of all children were tested using Biodex Multi-joint system, Pro # 850-000 at 5, 15 and 30 degrees of ankle plantarflexion. Inter- and intra-tester reliability were examined in 10 children prior to the commencement of the study, with ICC (2, K)=0.985, $p<0.05$ and ICC (3, K)=0.987, $p<0.05$, respectively.

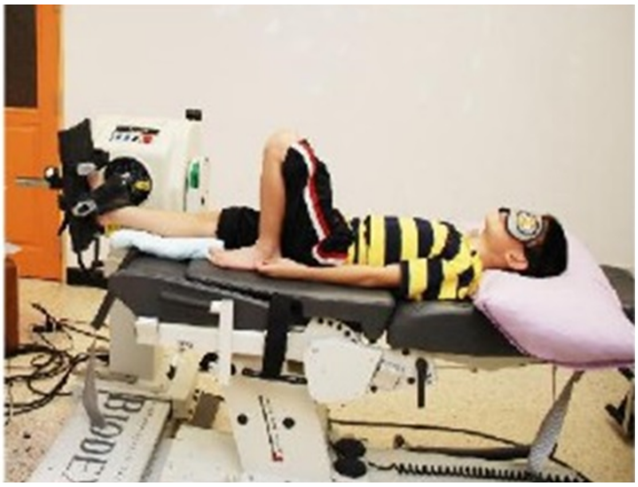

Figure 1 Measurements of Passive Joint Position Sense using Biodex Multi-joint system.

For testing procedure, children lied in supine position with their testing foot placed on the Biodex's footplate and strapped **Figure 1.** The children were blindfolded during testing to eliminate visual input. From neutral ankle position, the machine moved the child's ankle through each of the three target positions at a speed of one degree per second and then stopped. The child concentrated on this position for 10 seconds and then the ankle was returned to the start position. Then, the ankle was moved through full range at a speed of one degree per second and children were asked to press the light switch once the ankle was moved to the target position. This procedure was repeated for three trials at each target angle with each ankle.

Statistical Analysis

Errors in passive reproduction of each target were calculated from the absolute difference between the target and the reproduced position. Sample size was calculated from previous study at type I error of 0.05, 80% power, the optimum number was set at 20 children per group. The statistical analyses were performed using SPSS 18.0 for Windows (SPSS, Inc, Chicago, Ill). A p-value of less than 0.05 was considered statistically significant. Kolmogorov-Smirnov goodness of fit was used to test for data distribution. All data were distributed normally. Descriptive analysis was used to analyse demographic data of the children. A paired t test was used to compare the data between dominant and non-dominant ankles. Independent t-test was used to compare the data between groups.

Results

Characteristics data of children in the two groups are present in **Table 1.** There were no differences between the 2 groups with respect to age, weight and height. Gender distribution was equal for each group (10 boys and 10 girls per group).

Table 1 Characteristic data and results of independent t-test.

	TKD with history of ankle sprains	Non-TKD practicing	p-value
Age (years)	9.28 ± 1.20	9.35 ± 1.27	0.861
Weight (Kilograms)	32.83 ± 7.32	28.64 ± 5.94	0.054
Height (centimeters)	135.38 ± 7.84	133.26 ± 9.83	0.456

Note: Values are mean ± standard deviation, TKD=Taekwondo.

Table 2 summarizes the results from the dominant and non-dominant ankle comparisons for TKD children with history of ankle sprains. None significant difference was showed for all target positions. **Table 3** summarizes the results from the non-TKD practicing children. There was no significant difference between the dominant and non-dominant ankle of all three target positions.

Table 2 Results of the Paired t-test to compare ankle JPS between dominant and non-dominant sides of TKD children with history of ankle sprain (n=20).

Target angle (Ą)	Side	Mean ± SD	95% Confidence Interval of Difference	p-value
30	Dominance Non-dominance	4.07 ± 2.14 3.43 ± 2.13	-0.928 to 2.195	0.407
15	Dominance Non-dominance	1.18 ± 0.94 1.13 ± 0.79	-0.595 to 0.695	0.873
5	Dominance Non-dominance	1.02 ± 0.95 1.08 ± 0.69	-0.629 to 0.496	0.807

Note: JPS=Joint position sense, TKD=Taekwondo, SD=standard deviation.

Table 3 Results of the Paired t-test to compare ankle JPS between dominant and non-dominant sides of Non-TKD practicing children (n=20).

Target angle (°)	Side	Mean ± SD	95% Confidence Interval of Difference	p-value
30	Dominance Non-dominance	1.38 ± 0.90 1.70 ± 1.03	-0.965 to 0.199	0.184
15	Dominance Non-dominance	0.52 ± 0.39 0.90 ± 0.65	-0.805 to 0.038	0.072
5	Dominance Non-dominance	0.22 ± 0.22 0.27 ± 0.23	-0.187 to 0.087	0.453

Note: JPS=Joint position sense, TKD=Taekwondo, SD=standard deviation.

Independent t-test was used to compare ankle JPS between TKD children with history of ankle sprains and non-TKD practicing children. Significant differences were fou nd at all target positions ($p<0.05$) between the two groups **Table 4.**

Table 4 Results of the Independent t-test to compare ankle JPS between TKD children with history of ankle sprains and Non-TKD practicing children.

Target angle(°)	Group	Mean ± SD	95% Confidence Interval of Difference	p-value
30	TKD children Non-TKDpracticing children	3.75 ± 2.13 1.51 ± 0.98	1.502 to 2.981	0.000*
15	TKD children Non-TKD practicing children	1.16 ± 0.86 0.71 ± 0.57	0.126 to 0.774	0.007*
5	TKD children Non-TKD practicing children	1.05 ± 0.82 0.24 ± 0.23	0.540 to 1.077	0.000*

Note: *significant at $p<0.05$, JPS=Joint position sense, TKD=Taekwondo, SD=standard deviation.

Discussion

This study reported a quantitative method to assess ankle JPS using a passive reproduction test in children with and without TKD training. All children in the TKD group had history of ankle sprains. Passive JPS was chosen because it is useful for assessing peripheral proprioceptive function without motor task. It was found that JPS of dominant and non-dominant ankles were not different in both groups. The results are consistent with the literature [18]. However, significant difference between ankle JPS of the two groups was found. TKD children with history of ankle sprains showed greater errors in reposition of ankle joint than their age- and gender-matched children without TKD training. The results indicated poorer peripheral proprioceptive function of the TKD children. Since all children in TKD group reported previous history of mild to moderate degrees of ankle sprains, impairments of the mechanoreceptors might contribute to the poorer peripheral proprioception function. This result was supported by the finding from previous research that decreased accuracy in passive JPS was found in adults with history of ankle sprain [19]. Study limitation included the inability to recruit children TKD without history of ankle sprains. All TKD children were those with mild to moderate ankle sprains without medical treatments. Results from the present study, therefore, applied to those within this criteria only. However, it has been indicated that impaired JPS was considered as a predictor of ankle sprain in athletes with no history of ankle sprain [3]. Findings of this study may suggest the benefit of assessing passive JPS in children. Although, TKD training improved functional skills of children in various ways [10,11,20] the specific function of joint receptors is need to be detected. Further studies in JPS of children with various degrees of ankle sprains and proper intervention to improve peripheral proprioception are recommended.

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