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Original Article

Comparison of posturographic parameters between young taekwondo and tennis athletes

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Abstract. [Purpose] Physical activity can influence the development of postural control and balance. Therefore, the aim of study was to use posturography assessment to compare balance control on the Romberg test between athletes in two very different sports, taekwondo and tennis. [Participants and Methods] Twenty-nine young athletes participated in the study, 11 forming the taekwondo group and 18 the tennis group. Posturography was performed using the FreeMed system (Sensor Medica). Between-group differences were evaluated using unpaired Student's t-test. [Results] There was a significance between-group difference in the centre of pressure and the ellipse surface area with no between-group difference in frontal and sagittal plane postural control. [Conclusion] The taekwondo athletes displayed greater stability than tennis athletes, with a smaller ellipse area and a decrease in the amplitude of oscillations of the centre of pressure along the frontal plane, adaptations which likely reflect the demands of the taekwondo. Further studies are needed to support these conclusions.
Key words: Postural control, Posturography, Balance

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INTRODUCTION

The postural system refers to a 'set of structures' of the central nervous system whose principal role is to maintain standing position against gravity by resisting external forces. The central nervous system interprets, integrates and selects information from various sensory inputs (somatosensory, visual and vestibular) to produce required motor outputs to maintain static and dynamic balance[1)]. Sport-specific training can influence the postural system through its influence on sensory organization and the reinforcement of specific balance strategies[2–4)]. As an example, Del Percio et al. reported that karate-trained athletes had a better ability to analyse and integrate sensory inputs for balance control than a control group[5)]. In the same way, other studies have demonstrated that judoka athletes utilize more somatokinesthetic information than dancers, who use more on visual information[6–8)]. Fong et al. further highlighted that taekwondo training could facilitate the development of single stance postural control[9, 10)]. To date, however, the effect of specific athletic training on the development of postural strategies and balance control has not be explicitly evaluated[7, 11)]. Therefore, in this study, the aim was to evaluate differences in postural control and balance for two very different sports, taekwondo (TKD) and tennis, where TKD principally involves kicking, while tennis eye-hand coordinated movements performed during sprints, with quick changes in speed, and fast cutting motions[9, 10, 12)]. Knowing that posture control strongly influences sports performance and injuries[13–16)] and that TKD and tennis are popular among children and adolescents, the study specifically sought to compare and contrast balance strategies in young athletes who trained for either TKD or tennis.

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PARTICIPANTS AND METHODS

The study group was formed of 29 participants and the total sample was entirely made up of male participants (age, 10.4 ± 3.6 years; height, 138.3 ± 22.3 cm; weight, 38.4 ± 19 kg). Participants were recruited according to the criteria for the recruitment of children approved by the ethics committee of the University of Palermo. All participants gave a informed consent for the anonymous use of data for research purposes. The study was performed in compliance with the Declaration of Helsinki, and the principles of the Italian data protection act (196/2003) were observed. The study design was approved by the Departmental Research Committee (Consiglio di Dipartimento SPPF Prot. n. 280/2017; punto all'ordine del giorno numero 7; approval number: 280/2017/MEDF-02/11). Prior to enrolment, all parents provided informed consent and children their informed assent. Participants were divided into two groups based on their principal sport training, the TKD (n=11) and the tennis group (n=18). Relevant characteristics of participants in the two groups were as follows: TKD group (age, 11.1 ± 4.8 years; height, 154.1 ± 22.7 cm; and weight, 38.2 ± 6 kg); and tennis group (age, 10.5 ± 2.6 years; height, 129.1 ± 16.1 cm; weight, 33.8 ± 3.5 kg). Participants were recruited from sports associations in Palermo, Italy, using the following inclusion criteria: similar age; same geographic location (within Palermo), and regular training in the sport discipline of choice (TKD or tennis) for at least 6 months. Prospective participants were screened on the exclusion criteria previously described by Houghton et al. and in our own previous studies[17–19]: auditory or visual impairment (reduced visual acuity allowable if corrected with lens/glasses); and orthopaedic injury involving the lower extremities[17–19]. All assessments of balance control were performed at the research unit of the Department of Psychology and Educational Science, University of Palermo, between January 2016 and July 2016. Posturography assessments were performed using the FreeMed baropodometric platform (the FreeStep v.1.0.3 88 software, Sensor Medica, Guidonia Montecelio, Roma, Italy)[19]. The balance platform includes 24 K gold sensors, providing high repeatability and reliability of measurements. Each participant performed the Romberg test in a standardized position, so that the center of gravity was in the sagittal axis of the platform, with feet placed side-by-side and apart at the angle of 30° with heels separated by 4 cm[20]. Posturography values were analysed using the FreeStep software. The system samples postural sway, in real time, at a frequency of 25 Hz. The following parameters of the statokinesigram were measured with eyes open: length of the path of sway (SP) of the centre of mass (CoP); ellipse surface area (ES); coordinates of the CoP along the frontal (X; right-left; x-mean) and sagittal (Y; forward-backward; y-mean) planes[18]. The ES and the coordinates along the frontal and sagittal parameters were used and can't modify significantly by the sampling rate, according to the 1981 Kyoto conventions[20, 21]. Differences in measured variables of balance control were compared between the TKD and tennis groups using unpaired Student's t-tests, and the 95% confidence interval (95% CI) of the difference between group means. The unpaired Student's t-tests used to evaluate anthropometric differences between group. A p-value <0.05 was considered to be statistically significant. All analyses were performed using StatSoft's STATISTICA software (Windows, Vers. 8.0; Tulsa, OK, USA).

RESULTS

The measured variables of the statokinesigram for the two groups are shown in Table 1. Overall, variables were lower for the TKD than tennis group, indicative of greater balance stability in TKD than tennis athletes. There were no significant between-group differences with regard to the CoP control in the frontal (x-mean) and sagittal (y-mean) planes. However, the results did identify adaptations in the pattern of CoP oscillations along the frontal plane that were specific to TKD training. On the X axis, the oscillations were more uniform in TKD group than the Tennis group, this can deduce from the smaller standard deviation of the TKD (Table 1 and Fig. 1).

DISCUSSION

Sway during quiet standing with eyes open was significantly lower with TKD than tennis training, with a significantly lower ES for the TKD than tennis group. This result is not consistent with the conclusions of Fong et al.[22], which might reflect the young age of our study cohort and, consequently, the shorter period of sport-specific training. The greater stability in TKD trained athletes, compared to tennis trained athletes, might reflect a more effective central integration of sensory inputs with TKD than tennis training. In the same line, the findings of Chow et al. who examined the relationship between sport-specific experience and balance ability[23], with the ankle strategy providing a more responsive control of standing balance than the hip strategy[21, 24]. TKD requires performance of combinations of high level kicking, such as jumping, spinning and sliding kicks, both during training and competition. These movements would greatly stimulate the peripheral sensory receptors of the foot and ankle, which might enhance the capacity of the central nervous system to use this information to produce adequate responses balance responses[25]. Andersson et al. reported a functional association between postural control and cognitive functioning, with the decrease in sway, observed in some athletic groups, being due to an increase in cognitive arousal during the balance task[26]. The data support this finding to some extent, with the lower amplitude of sway in TKD versus tennis athletes (Table 1) being associated with a normalization of oscillations in the frontal plane (x-mean, Table 1 and Fig. 1). Of note was finding that this decrease in the amplitude of frontal plane oscillations was more noticeable to the left than to the

Table 1. The measured anthropometric and variables of the statokinesigram for the two groups

	TKD group	Tennis group	p
Participants (n)	11	18	
Age (yrs)	11.1 ± 4.8	10.5 ± 2.6	ns
Height (cm)	154.1 ± 22.7	129.1 ± 16.1	p<0.01
Weight (kg)	38.2 ± 6	33.8 ± 3.5	p<0.01
Ellipse surface area (ES) (mm^2)	317.71 ± 241.8	584.4 ± 384.6	p<0.05
Length of the path of sway (SP) (mm)	600.4 ± 203.9	750 ± 145.8	p<0.05
X mean (mm)	−5.023 ± 4.8	−9.647 ± 15.7	ns
Y mean (mm)	−30.65 ± 12.4	−31.52 ± 13.2	ns

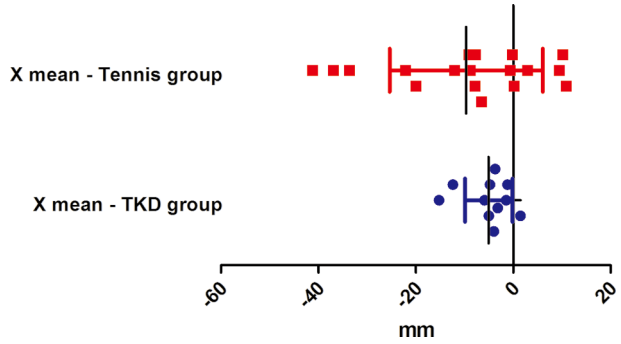

Fig. 1. Comparison of the average X mean values between TKD group and Tennis group.

right (Fig. 1), which might reflect a further subdivision of balance control between the support and the attacking foot, which is intrinsic to the discipline. If this hypothesis is confirmed by future studies, it would be useful to develop training interventions that could overcome this left-right difference, which could increase with continued TKD experience and lead to the risk for injury. The limitations of this study are that: it was possible to insert a minimum experience time limit for the sport practiced (6 months) but not a maximum limit, the precise history of all the participants could not be obtained. The total sample was entirely made up of male participants. Furthermore, the anthropometric measurements were significantly different between groups (Table 1). In conclusion, the study indicate that TKD training provides a more effective stimulus for the sensory-motor organization of balance control, compared to tennis. Further studies are needed to determine if increased experience in tennis would result in the development of alternative postural strategies, such as facilitation of visual information, which, ultimately, would improve balance control.

Conflict of interest

All authors declare that they have no conflict of interest. No financing.

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