Journal of Combat Sports and Martial Arts
© MEDSPORTPRESS, 2011; 1(2); Vol. 2, 23-29

Assessment of postural stability in traditional karate contestants

Wojciech Bajorek[1], Wojciech Czarny[1], Paweł Król[1], Marian Rzepko[1], Grzegorz Sobota[2], Artur Litwiniuk[3]

[1] Faculty of Physical Education, University of Rzeszow, Rzeszow, Poland
[2] Department of Human Movement Academy of Sport Katowice, Poland
[3] Josef Pilsudski University of Physical Education, Warsaw, Faculty of Physical Education and Sport, Biala Podlaska, Poland

Key words: karate, ability to maintain balance, coordination, COP

Summary

Introduction. The aim was to determine, basing on stabilographic examinations, and then to present, using mean values and measures, the abilities to maintain balance (COP) among the contestants of traditional karate in consideration of interactions between each other.

Material and methods. The investigations covered the group of 32 contestants from the Polish National Team, both males and females. Postural sway was measured with the use of force platform (AMTI). The centre of foot pressure (COP) was registered with the frequency of 40Hz. NetForce software was used to register ground reaction forces during the trials. Time of each trial was 30 seconds.

Results. Higher postural sway, their range and length of COP pathway as well as postural sway velocity in mediolateral direction (ML) were observed in anterior-posterior plane (AP), which is a natural response of human body. All the variables differed significantly in both adopted positions (before and after leaning), pointing to a considerable deterioration of the body stability after adoption of the position of maximal leaning forward.

Conclusions. The condition of postural system during the test with closed eyes did not change in the studied group as compared to the non-disturbed conditions, which proves a very good state of the balance system and proper control of upright body posture. The results of the tests concerning maintaining unchanged position observed in the case of leaning forward point to bigger sway range, which, in consequence, leads to the increased external muscle torques which act on the joints in lower extremities.

Introduction

Nowadays, karate is an extremely popular sport that has become a philosophy of life for many people [1]. Traditional karate has been developing for many centuries in Japan as a martial art. Its technical basis is based on Okinawan principle of to de, which was derived from chonfa, a Japanese martial art which was the form of self-defence without using weapons. The philosophical grounds for traditional karate are provided by Japanese budo, which is a common legacy for a number of Japanese martial arts. Finally, traditional karate appeared as a combination of Okinawan martial arts and Japanese budo philosophy [2]. Fundamental concept in technical structure of traditional karate is todome waza or finishing blow, which means that a single technique should entirely render the opponent defenceless. This extraordinary technical ability makes traditional karate a real art, which brings high-quality physical fitness benefits as the training regimes focus on dynamical use of the whole body [3]. Not only does the traditional karate strive for development of a person's physical abilities; it also has beneficial effect on the state of mind and emotions, ensuring entire balance and stable emotions [4].

The practice (training) leads to development of movement patterns, which determines sports achievements. In order to ensure the stability necessary to strike a strong blow, all body parts must be used harmoniously. Attack and defence often call for maximal leaning forward, standing on one leg etc. Feet widely apart, typical for fighting stances, cause lowering of the centre of gravity, which generates powerful thrusts or kicks [5]. Wide stance, however, affects the speed during fight. Finding an optimal body posture determines the result of the confrontation. Location of the centre of gravity should be adapted to the specific situation since the centre of gravity is moving continuously during fight. Finding a golden mean between the stability and the width of the stance and the projection of the centre of gravity forces to employ the sophisticated research methods. These research problems are the focus of the sports scientists both in Poland and in the world.

The aim of this study was to determine, basing on stabilographic examinations, and then to present, using mean values and measures, the abilities to maintain balance (COP) among the contestants of the Polish National Team who train traditional karate in consideration of interactions between each other.

Material and methods

The investigations were carried out in the area of the Main Preparing Sports Centre (Centralny Ośrodek Sportu) in Zakopane on 4 September 2009 and covered a group of 32 contestants of both genders (22 males and 10 females) from the Polish National Team for traditional karate. Postural sway was measured with the use of force platform (AMTI). The centre of foot pressure (COP) was registered with the frequency of 40Hz. NetForce software was used to register ground reaction forces during the trials. Time of each trial was 30 seconds. All subjects were instructed before the trial. In order to secure comfort and minimize the effect of fatigue or boredom there was a break between each trial. For calculation of stabilographic parameters software Helter modified version for MatLab by a research team of the Department of Human Movement Academy of Sport in Katowice was used. In order to develop statistical results software Statistica version 8 was used.

Results

Part 1. Static position, eyes open and eyes closed

For these two trials, the assessment was made while closing eyes in free standing affects stabilographic parameters. All the parameters were considered for two planes: sagittal (parameters with Y index) and frontal plane (parameters with X index).

The list of the analysed parameters:

- STD – standard deviation from the location of mean projection of the centre of gravity on base surface (COP) [cm]
- R – range of postural sway, i.e. the difference between maximal and minimal displacement of COP [cm]
- L – length of the COP pathway – total route covered by COP changing its location [cm]
- V – mean velocity at which the COP is moved [cm/s].

Closing eyes did not cause considerable changes in the registered stabilographic signals, except for reduction in postural sway in frontal plane (STDX). Higher postural sway, their range and length of COP pathway as well as postural sway velocity in mediolateral direction (ML) were observed in anterior-posterior plane (AP), which is a natural response of human body.

Part 2. Open eyes, test of maximal inclination forwards and backwards

The list of the analysed parameters:

- STD1 – standard deviation from the mean value of COP location – postural sway in initial phase (before movement) [cm]
- STD3 – postural sway in final phase (after movement) [cm]
- Range1 – range of postural sway in initial phase [cm]
- Range3 – range of postural sway in final phase [cm]
- OSR1 – standard deviation from regression curve - the value of postural sway calculated in relation to regression curve, which takes into consideration a possible trend in changes of COP location, initial phase [cm]
- OSR3 – postural sway for final phase, calculated as for OSR1 [cm]

The parameters were described only for anterior-posterior plane (AP).

Leaning forward test

All the variables differed significantly in both adopted positions (before and after leaning), pointing to a considerable deterioration of the body stability after adoption of the position of maximal leaning forward. Mean value of this sway amounted to 8.37 cm.

Leaning backward test

All the variables differed significantly in both adopted positions (before and after leaning), pointing to a considerable deterioration of the body stability after adoption of the position of maximal leaning backward. Mean value of this sway amounted to 4.17cm.

Comparison of the Contestants' Body Response for Leaning Forward and Backward

All the variables differed significantly for the positions of leaning forward and backwards. For the balance system, the

Table 1. Wilcoxon signed rank test for stabilographic parameters in both planes

Wilcoxon signed rank test. The results are significant at p <.05000				
	N - significant	**T**	**Z**	**level of p**
STDY & STDY_OZ	9	20.00000	0.296174	0.767097
RY & RY_OZ	9	18.00000	0.533114	0.593955
LY & LY_OZ	9	14.00000	1.006993	0.313939
VY & VY_OZ	9	14.00000	1.006993	0.313939
STDX & STDX_OZ	9	1.00000	2.547100	**0.010863**
RX & RX_OZ	9	8.00000	1.717812	0.085832
LX & LX_OZ	9	16.00000	0.770054	0.441269
VX & VX_OZ	9	16.00000	0.770054	0.441269

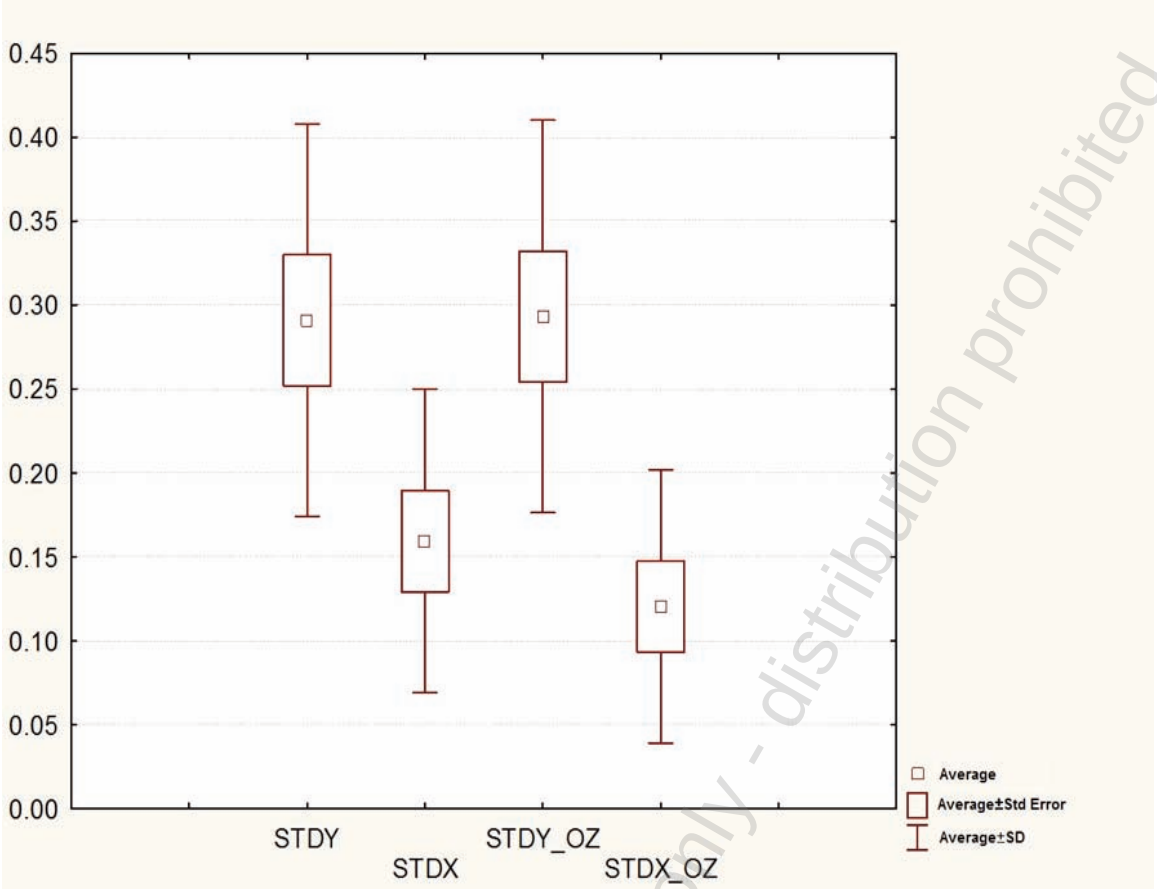

Fig. 1. Comparison of postural sway in AP (Y) and ML (X) planes during the trial with open eyes and closed eyes (OZ)

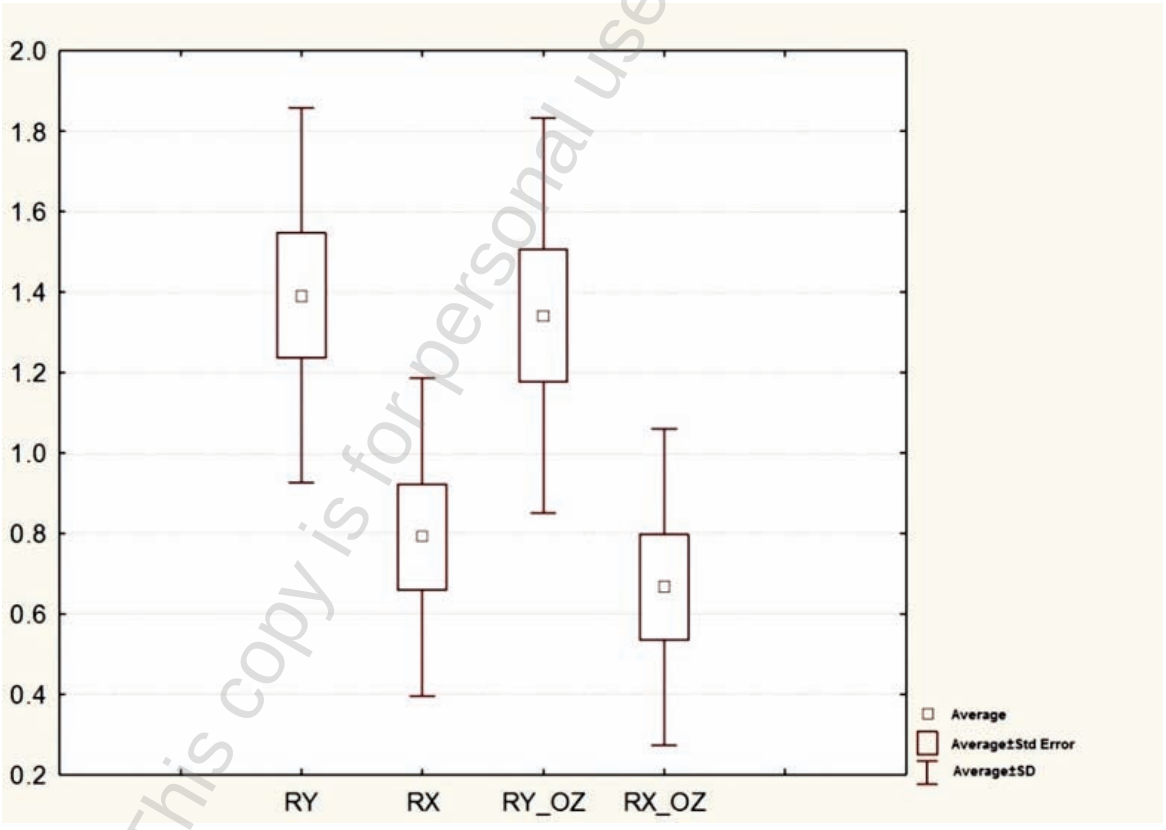

Fig. 2. Comparison of the range of postural sway in AP (Y) and ML (X) planes during the trial with open eyes and closed eyes (OZ)

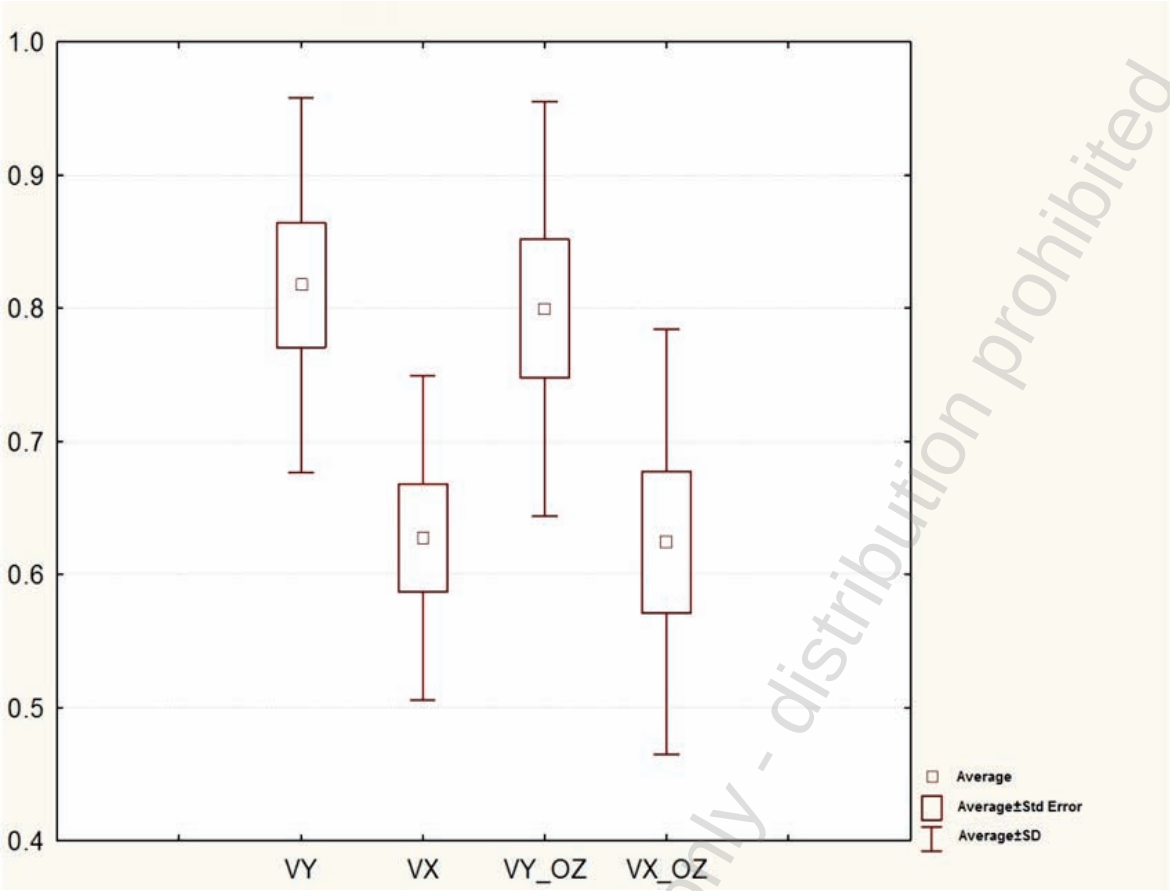

Fig. 3. Comparison of the velocity of postural sway in AP (Y) and ML (X) planes during the trial with open eyes and closed eyes (OZ)

Table 2. Wilcoxon test results for leaning forward

Wilcoxon signed-rank test. The results are significant at p<0.05				
	N - significant	**T**	**Z**	**p level**
Std1 & Std3	7	1.000000	2.197401	**0.027993**
Range1 & Range3	7	1.000000	2.197401	**0.027993**
OSR1 & OSR3	7	0.000000	2.366432	**0.017961**

Table 3. Mean value and standard deviation for the observed parameters in leaning forward trial

Parameter	**Mean [cm]**	**STD[cm]**
Std1	0.26	0.119
Range1	1.06	0.467
OSR1	0.21	0.101
Std3	0.55	0.136
Range3	2.55	0.456
OSR3	0.45	0.093
ZAKRES	8.37	1.406

Table 4. Wilcoxon test results for leaning backward

Wilcoxon signed-rank test. The results are significant at p				
	N - significant	**T**	**Z**	**p level**
Std1_T & Std3_T	6	0.000000	2.201398	**0.027709**
Range1_T & Range3_T	6	0.000000	2.201398	**0.027709**
OSR1_T & OSR3_T	6	0.000000	2.201398	**0.027709**

Table 5. Mean value and standard deviation for the observed parameters in leaning backward trial

Parameter	Mean [cm]	STD[cm]
Std1_T	0.34	0.146
Range1_T	1.55	0.579
OSR1_T	0.29	0.094
Std3_T	0.43	0.106
Range3_T	2.16	0.525
OSR3_T	0.38	0.115
ZAKRES_T	4.17	1.758

Table 6. Wilcoxon test results for determination of significantly different parameters in both leaning tests

Wilcoxon signed-rank test. The results are significant at p<0.05				
	N - significant	**T**	**Z**	**p level**
Std3 & Std3_T	6	0.00000	2.201398	**0.027709**
Range3 & Range3_T	6	0.00000	2.201398	**0.027709**
OSR3 & OSR3_T	6	0.00000	2.201398	**0.027709**
OSR_1_3 & OSR_1_3_T	6	6.00000	0.943456	0.345448
OSR_2_3 & OSR_2_3_T	6	1.00000	1.991741	**0.046400**
OSR_3_3 & OSR_3_3_T	6	1.00000	1.991741	**0.046400**
ZAKRES & ZAKRES_T	6	0.00000	2.201398	**0.027709**

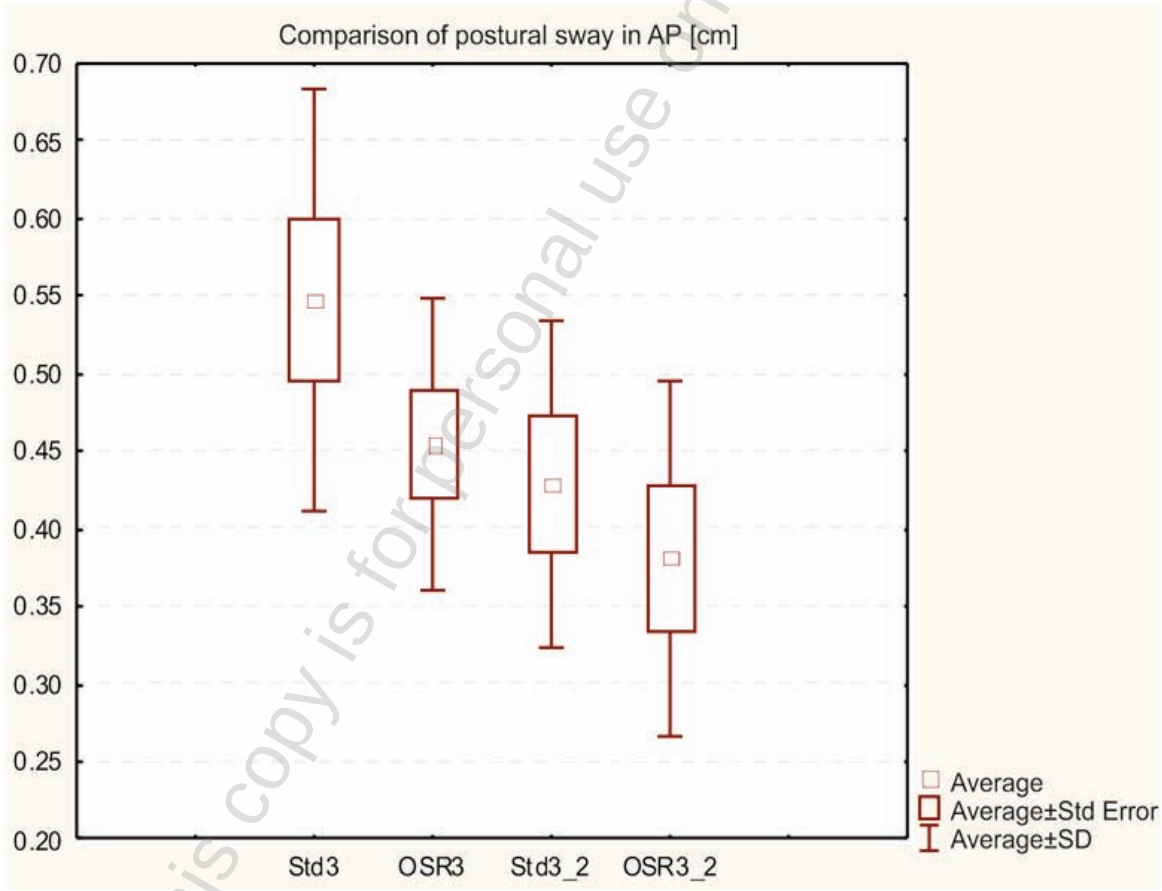

Fig. 4. Comparison of postural sway in AP (Y) plane between leaning forward and backward (index '_2')

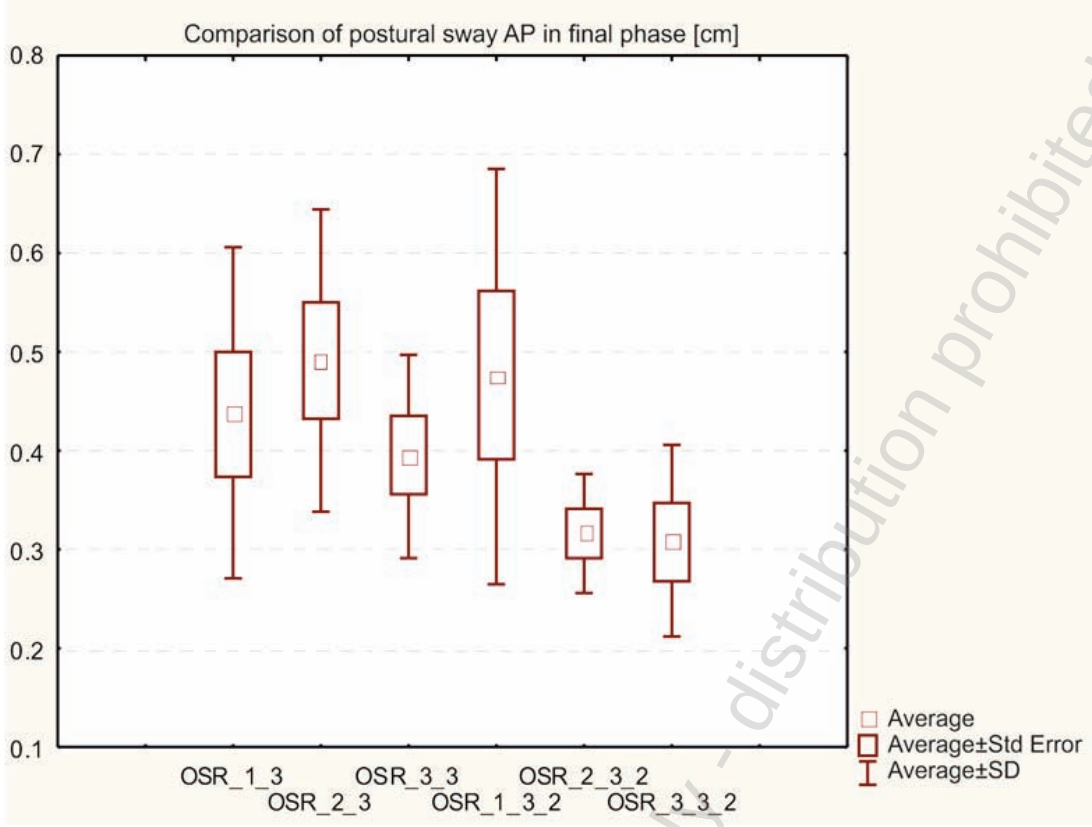

Fig. 5. Comparison of postural sway in AP (Y) plane between leaning forward and backward (index '_2') for final phase, which was divided into similar time sections

most difficult trial was in the case of the studied person maximally leaning forward (most likely connected with the biggest leaning range and, in consequence, intensified muscle action as a result of the higher muscle torque acting on the ankle joint). OSR_1_3, OSR_2_3 and OSR_3_3 show values of sway in final phase, however divided into 3 similar parts, which allows for assessment if the postural sway is increased or reduced after adoption of a new position. Wilcoxon test results proved that there are no differences between the value of postural sway in the first part of final phase, regardless of leaning direction. However, in the second and third final phase these differences appear. Fig. 5 shows that postural sway is reduced faster if the body is leaned backwards (lower values of OSR_2_3_2 and OSR_3_3_2).

Comparison of the range of leaning forward and backward shows that the expected difference in terms of biggest range of forward leaning type is observed, which is proved by a variety of studies by other authors.

Discussion

In recent years the issue connected with coordination sphere of human movement has became the field of research of numerous scientists. Many publications appeared in which the surveys of the representatives of sports disciplines were presented. [6-13] Due to the lack of synthetic data in scientific literature about the differentiation of posture stability within the groups of combat sports contestants, the authors tried to diagnose the phenomenon on the example of precisely selected group of representatives of Polish National Team in traditional karate [14].

Research and improvement in the area allows on the one hand to choose and select contestants for the discipline more effectively, and on the other hand to raise the level of championships. Thus, there is an authentic need to focus the research on the presented area of survey.

Conclusions

1. More disturbance to male and female contestants was caused by adoption of the position with maximal leaning forward rather than in the case of being devoid of vision.
2. The condition of postural system during the test with closed eyes did not change in the studied group as compared to the non-disturbed conditions, which proves a very good state of the balance system and proper control of upright body posture.
3. The results of the tests concerning maintaining unchanged position observed in the case of leaning forward point to bigger sway range, which, in consequence, leads to the increased external muscle torques which act on the joints in lower extremities.

Acknowledgments

The authors would like to thank Prof. R.M. Kalina for meaningful discussion and methodological care.

References

1. Cynarski W. Philosophy of martial arts. Ontology and axiology Asian martial arts. Ido Movement for Culture 2000; 1: 54-85.
2. Seiler KL, Seiler DJ. Karate-DO.Traditional Training for All Styles. 1st ed. K&D Seiler; 2006.
3. Cynarski WJ, Sieber L, Litwiniuk A. Perception, understanding and adaptation of Asian martial arts in the West: a sociological analysis. Arch Budo 2005. www.archbudo.com
4. Brudnak MA, Dundero D, Van Hecke FM. Are the hard martial arts, such as the Korean martial art, Taekwondo, of benefits to senior citizens? Elsevier Science. Medical Hypotheses 2002; 59 (4): 485-491.
5. Cesari P, Bertucco M. Coupling between punch efficacy and body stability for elite karate. Journal of Science and Medicine in Sport 2008; 11, 353-356.
6. Gerbino PG, Griffin ED, Zurakowski D. Comparison of standing balance between female collegiate dancers and soccer players. Gait & Posture 2007; 26: 501-507.
7. Mayagoita RE, Lotters JC, Veltink PH, Hermens H. Standing balance evaluation using a traxial accelerometer. Gait & Posture 2002; 16: 55-59. Sterkowicz S. Zagadnienia wypadków i obrażeń ciała u osób uprawiających karate (na podstawie materiałów PZU). Roczniki. Naukowe AWF Kraków1986; 21: 205-226.
8. Fredyk A. Visual input for postural control during specific exercises in clasical balet. Annales UMCS Lublin-Polonia 2005; Vol.LX, SUPPL.XVI, 104 SECTIO D: 481-486.
9. Litwiniuk A, Cynarski JW, Błach W. The level of coordination motor abilities in persons practising taekwon-do depending on the training experience. In: Coordination motor abilities in scientific research. Sadowski J. (ed.). Biała Podlaska 2005: p. 434-440.
10. Litwiniuk A, Błach W, Cynarski JW. Characterization of feet correction movements frequency in a standing position of judo fighters and non-training people. In: Coordination motor abilities in scientific research. Sadowski J. (ed.). Biała Podlaska 2005: p. 287-294.
11. Ocetkiweicz T, Skalska A, Grodzicki T. Balance estimation by using the computer balance platform: repeatability of the measurements. Gerontologia Polska 2006; 3 (14): 144-148.
12. Litwiniuk A, Wieleba A, Cynarski WJ. The structure of coordination motor abilities of the Polish Team Traditional Karate athletes In: Coordination motor abilities in scientific research. Sadowski J, Niźnikowski T. (eds.). Biała Podlaska 2008; 24: 228-231.
13. Nagano A, Hisahito N, Zhi-Wei L. An analysis of directional changes in the center of pressure trajectory during stance. Gait & Posture 2010; 3 (31): 400-402.
14. Litwiniuk A, Sadowski J, Wilczewski A, Saczuk J. Motorical and personality variables of karate competitors. Medsportpress. Research Yearbook 2007; 1 (12): 140-143.

Annexes

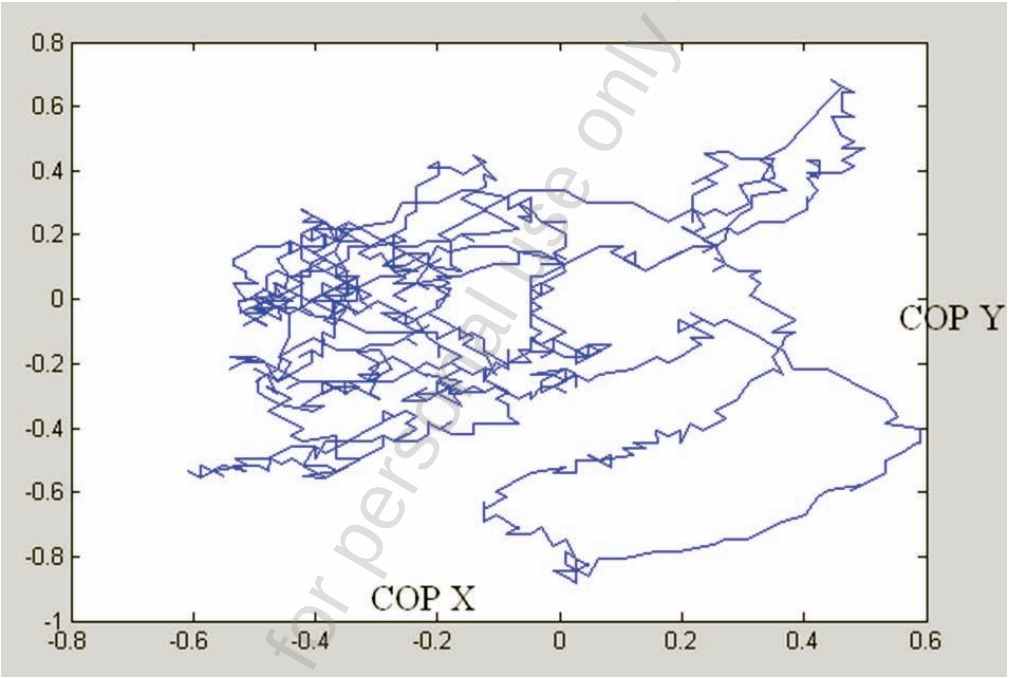

Fig. 6. The selected graphical representation of the record from AMTI platform

Address for correspondence:
Wojciech Bajorek
University of Rzeszow, Faculty of Physical Education
Towarnickiego 3 str., 35-959 Rzeszow, Poland
e-mail: wojtekbajorek@gmail.com

Received: 23.01.2011
Accepted: 14.05.2011

Source of support: URWWF/S/05