EMG PARAMETERS AND KINESTHETIC DIFFERENTIATION DURING THE FREE-THROW OF BASKETBALL PLAYERS WITH VARIOUS LEVELS OF ATHLETIC EXPERIENCE

Paweł Pakosz

Opole University of Technology, Faculty of Physical Education and Physiotherapy

Address for correspondence:
Paweł Pakosz
Opole University of Technology, Faculty of Physical Education and Physiotherapy
Prószkowska 76/9A, 45-758 Opole
Phone: (+48) 77 449 8321, fax: (+48) 77 449 82 50
E-mail: p.pakosz@po.opole.pl

Abstract. Rationale and objective of the study: In the study of coordination of motor abilities, motor performance tests without examining the internal structure of the movement were used. The objective of this study was to examine the kinesthetic differentiation capacity level and to stimulate muscles during a test among basketball players in intermediate and specialist stages of training. Material and methods: Among ten basketball players from two equal groups at different level of advancement in sport, who play at different positions on the field, kinesthetic differentiation capacity was assessed by the „Basketball shooting with different balls" test. In order to assess the muscle involvement during the test, they were connected to the EMG amplifier. Results: More advanced basketball players obtained better results in the test, by an average of 7.4 point out of 60. Tested muscle bioelectric tension was lower by 21.8% in advanced players and the difference in the non-dominant hand was as high as 34.6%. Conclusions: The research indicates that advanced players obtain better level of kinesthetic differentiation and their average muscle bioelectric tension during throws is lower compared to beginner players. The difference in bio-electrical muscle tension in the time of throwing different balls was smaller in basketball players who are more advanced in training, and in both groups in the dominant hand. Mean values of EMG signal in a selected time interval show greater variability among the more advanced players.

Key words: Motor coordination capacities, electromyography (EMG), sports level, muscle bioelectrical activity level, arm muscles

Introduction

Motor coordination capacities are important in the process of sports training. In the training, they determine the level, quality and speed of motor learning, improvement and stability of motor skills, as well as their adequately efficient use in changing conditions (Blume 1981; Raczek 1991). In basketball, the researchers (Knight 1984; Couzens et al. 1987) define them as the capacities that, at similar level as other factors, determine the final success of the team during a match.

The process of training the muscles of the body leads to motor learning or motor function improvement. These are the processes of acquiring new or developing existing skills or information that lead to alterations in one's behavior. As a result, a person needs increasingly smaller amount of energy to perform physical activity, because they perform motion with greater precision (Przewęda and Wasilewski 1979; Starosta 2001).

Considering the coordination capacities, the advancement in team sports games is mostly determined by the high level of kinesthetic differentiation capacities, time-spatial orientation, motor adaptation, fast response and coupled movements. Insufficient development of one of these abilities prevents from achieving good results (Zimmermann 1982; Hirtz and Saaa 1998).

The kinesthetic differentiation capacity determines high precision and economy of the entire motion, as well as individual stages of a motion cycle. Its essence lies in adoption, evaluation and processing of information about joint angular position (spatial components), state of the involved muscles tension (strength components) and speed (time component). It is based on the accurate perception of strength parameters, time and space in the course of motor function in terms of the best solution for the entire motor task. This precise "sensing" allows for proper dosage of control impulses, enabling the optimal course of motor activity (Zimmermann and Nicklisch 1981; Roth and Winter 2002; Omorczyk and Lyakh 2009).

The kinesthetic differentiation capacity constitutes, as it were, the highest level of motor coordination, resulting in the high precision of movements (Zaroń et al. 2008). To improve the technique, experiences derived from muscles need to be monitored constantly; without it the high precision of movements cannot be achieved (Przewęda and Wasilewski 1979; Lambery et al. 2002).

The research by Starosta (2006), conducted among figure skaters, shows that higher advancement in sport is associated with greater precision in performing certain movements.

Higher level of kinesthetic differentiation, according to Stefaniak (2008), is characterized by higher advancement level of athletes in martial arts. Konrad (2007) believes that the EMG (electromyography) can be used to determine the condition of muscle training. Well-trained muscles have low bioelectric tension at work, while untrained muscles performing work of the same kind have a tendency to higher bioelectric tension. Therefore, according to Konrad (2007), the EMG plays an important role in biomechanical tests, enabling objective evaluation of neuromuscular activation during any kind of activity, in which there is no equal methods to this one. Kubaszczyk (2001) examining the coordination capacity, stated that the strongest relationships with special efficiency occur for kinesthetic differentiation capacity, where he showed a very high correlation. It is a capacity, which is defined as one of the key characteristics in basketball (Raczek 1991).

Kinesthetic differentiation is one capacity in basketball play which can determine many key aspects of the player's performance during a game, such as: accuracy, ability to move, and adaptation to changing conditions for a better control of the game. Therefore, the study of kinesthetic differentiation capacities and abilities of their assessment is of great importance in the field of sports.

Motor coordination capacities were usually tested using motor performance tests, ignoring the internal structure of motion. This paper attempts to assess the level and specificity of muscle bioelectric tension, examined using the EMG during kinesthetic differentiation test in basketball players, at various stages of sports training. EMG signal analysis gives information about the time and bioelectrical tension when muscles are active (Borysiuk and Zmarzły 2005). An attempt was made to find answers to the following questions:

1. What is the difference in the level of kinesthetic differentiation capacity in basketball players at intermediate and special stage of training?
2. Are there any inter-group differences in muscle bioelectric tension in time of performing throws with different balls?
3. What is the relationship of task performance efficiency to the difference in muscle bioelectric tension between throws with different balls?

Material and method

The study test was carried out in two groups of equal number of players from the University Sports Association (AZS) of the Opole University of Technology. The first group consisted of five players who are in the intermediate stage of training; in the second group there were players of the specialist stage of training. Players of the intermediate stage were at the average age of 16.4 years, while the more advanced players were at the average age of 22.4 years. The selected players declared his right hand as the dominant and played at different positions in the team, from point guard to center, forming teams which play in Polish second and third basketball divisions. To assess capacity, the "Basketball shooting with different balls" test was selected from a set of assessment tests for specific coordination capacity (Raczek et al. 2002). Players' task was to perform 10 shots in the basket from the free-throw line. Players standing behind the foul line were shooting, alternately, balls of different weights (500 g and 650 g) and sizes (ball 5 and 7), certified by the FIBA (Figure 1). Each shot was worth points, based on the accuracy. For a shot without hitting the backboard and rim – 3 points, a shot where the basketball hits the backboard or rim (bank shot) – 2 points, missed shot when the basketball hits the rim or backboard – 1 point, and 0 points for airball. Person being tested performed two series of shots.

Figure 1. A player during kinesthetic differentiation test

Furthermore, the EMG system of Noraxon company was applied as a research tool, which records muscle activity, so-called dynamic EMG in training conditions with the wired communication between pre-amplifiers and the signal collecting unit. A digital signal recording EMG parameters is sent using telemetric transmission to the computer. Four surface electrode pairs were placed over the flexor (biceps brachii) and extensor (triceps brachii), muscles of both elbow joints. Electrodes were affixed according to the SENIAM recommended electrode placement. The measurement of each test started at the moment of lifting the ball up for shooting, when the bioelectric activation of muscles began to grow, and ended at the moment of bringing hands down after the throw, when total muscle bioelectric tension already reached its minimum. Such measurement and analysis were performed for each player, for each of the 20 throws that he performed during the test.

The test was conducted at the beginning of the annual microcycle training for both groups in the hours of afternoon training, in the same period. The test was preceded by a general warm-up.

The results were processed by basic methods of statistical analysis. Arithmetic mean, standard deviation, minimum and maximum values and variation coefficient were calculated. To analyze the EMG results, Myo Research XP MT 400 software from NORAXON was used. The EMG signal was previously filtered and smoothed.

Conclusions

Presentation of the research results began with kinesthetic capacity differentiation characteristic in both groups (Figure 2). The average amount of obtained points in the test was 7.4 higher in the group where specific training was performed. Additionally, one player from this group obtained 56 points out of 60 in total; he did not hit the basket only twice, all other attempts, out of twenty, were “clean” shots. The standard deviation and variation coefficient of results for the group being in the intermediate stage of training were 4.97% and 12.36%, respectively, compared to 5.59% and 11.75% respectively for the more advanced basketball players in training. It was also noted that in both groups, frontcourt players obtained worse results than backcourt players. In the less advanced training group, frontcourt players acquired an average of 39 points, compared to 41 points in the backcourt players; and in the second group the difference amounted to 42.5 points, compared to 51 points in backcourt players.

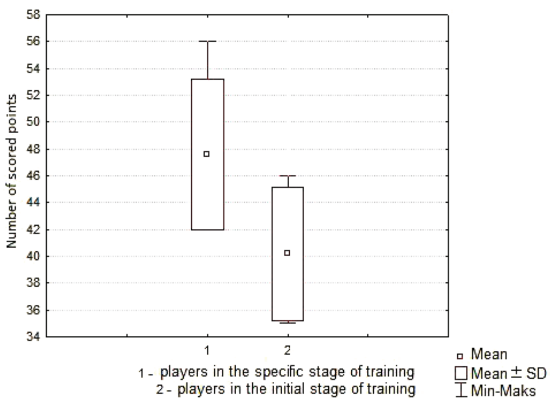

Figure 2. Test results of kinesthetic capacity differentiation – free throws with different balls (5.7), for players in specialist and intermediate stage of training

When analyzing the EMG signals during each of the throws, it was noted that all graphs were characterized by a high variability. Therefore, multiple repetition analysis was considered to average them to the “complex’s average” curve by Konrad (2007). Mean amplitude values, analyzed in the study in a given time interval, are probably the most important parameter, as they have the lowest sensitiveness to differences in duration of the analyzed intervals.

EMG signal measurement results in both groups showed that the group in specialist training stage obtained 21.8% lower bioelectric tension averages of tested muscles, which is clearly seen in the non-dominant hand muscles, in which the difference amounted to 34.6% (Table 1). Furthermore, among those with longer traineeship, less distinction in muscle bioelectric tension between throws with different balls was noticed (Figures 3 and 4).

Table 1. Averaged muscle bioelectric tension, tested in subsequent shots of kinesthetic capacity differentiation test – throws with different balls, for players in intermediate and specialist training stage

Tested muscle and ball size	Players average muscle activation in the initial stage of training [μV]	Players average muscle activation in the specific stage of training [μV]
Left triceps – ball size 7	119.83	54.98
Left triceps – ball size 5	109.43	49.77
Right biceps – ball size 7	90.42	87.23
Right biceps – ball size 5	83.35	84.99
Left biceps – ball size 7	162.23	116.13
Left biceps – ball size 5	132.20	106.96
Right triceps – ball size 7	200.17	186.25
Right triceps – ball size 5	191.00	173.08

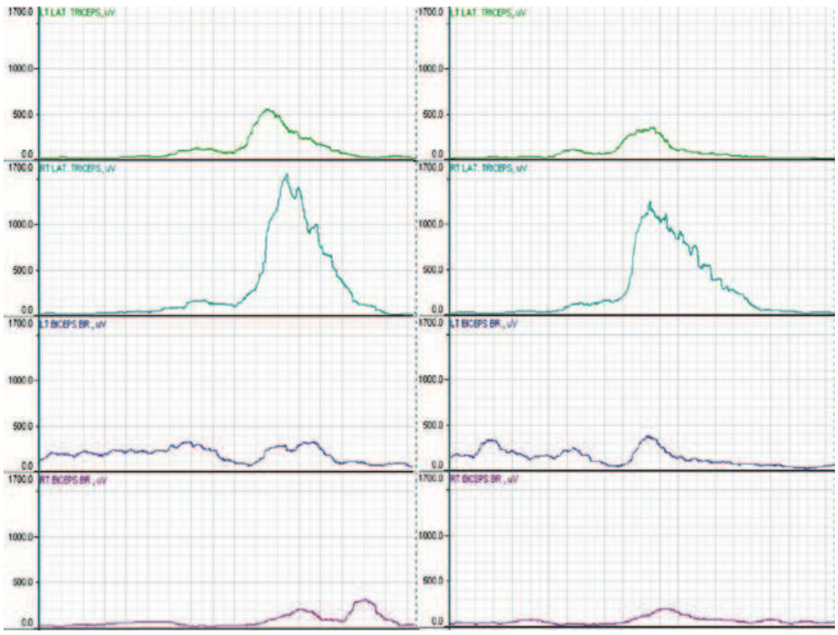

Figure 3. Course and values of EMG signals of shoulder muscles (triceps, biceps), of right (RT) and left (LT) limb of a player in intermediate training stage during shooting motion: on the left – shot with ball of size 5, on the right – ball of size 7 [μV]

In this group, throws with lighter ball generated mean bioelectric tension value of 5.62% smaller compared to the throws with a heavier ball. In the less advanced group, the difference already amounted to 9.59%.

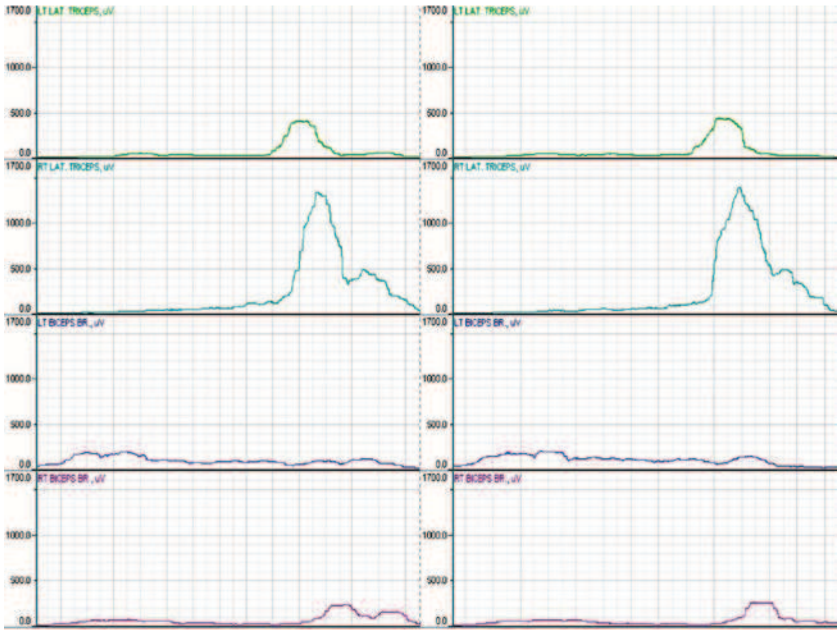

Figure 4. Course and values of EMG signals of shoulder muscles (triceps, biceps), of right (RT) and left (LT) limb of a player in specialist training stage during shooting motion: on the left – shot with ball of size 5, on the right – ball of size 7 [μV]

Comparing the muscles of right and left limb, it can be further noted that EMG signal differences arising from ball changes are more proximal in the dominant hand. Players, from the specialist training stage, obtained more proximal means in this hand than in the left hand by 3.87%. In the second group the difference was 4.81%.

Averaging the bioelectric tension results during shots with different balls, it can be concluded that in both groups the mean bioelectric tension differentiation coefficient was higher in shots with a large ball and in more training advanced players it was 10.4%; in less advanced peers it was at the level of 7.3%, compared to 7.6% and 5.5% in shots with a smaller ball. However, no significant differences, when it comes to bioelectric tension variability considering the left and right hand, were marked. In both groups they were at the level of up to 0.3%.

The score of kinesthetic differentiation test was not related to the percentage difference in bioelectric stimulation between shots of large and small ball. The player acquiring high test score in the group of more advanced basketball players obtained a little difference in muscle bioelectric tension in relation to the group, while in the second group it was quite the opposite. Furthermore, other test results have also indicated the lack of hierarchy in this context.

Discussion

After analyzing the test results of kinesthetic capacity differentiation, variations in the presented advancements between the two groups were observed. Consequently, rational training significantly enhances the capacity of persons involved in a training, which confirms the results of previous studies (Popowczak et al. 2011). What is more, the means of backcourt players (in positions 1 to 3) were better than frontcourt players (4 and 5) in both groups. In the group of more advanced basketball players, the difference amounted to 8.5 points, and in the second group only to 2 points, which may indicate that during training process, the kinesthetic capacity differentiation is being more developed in backcourt players.

The study allowed analyzing the bioelectric activity level of shoulder muscles and showed that bioelectric activity mean of shoulder muscles is higher in less advanced players. This confirms the opinions of Borysiuk (2006) and Salvatore et al. (2008) that the level of advancement effects bioelectric tension; the higher the advancement the lower the bioelectric tension. Also other results of studies (Starosta 2001) indicate that the higher the advancement is, the less energy is required to perform actions; and in this case it was proved that along with the energy also the muscle bioelectric tension is decreasing. Furthermore, the bioelectric tension difference among groups is visible in the left hand, which is more and more successfully used by players that gain bigger and bigger advancement (Stoeckel and Weigelt 2012). This is also confirmed in studies by Kuśnierz (2004), who stated that upon properly selected training exercises, the development (course) of lateralization process can be controlled. Based on these results, it can be concluded that by the training aimed at symmetric work of both hands, the muscle bioelectric tension differentiation between dominant and non-dominant limb can be decreased. It turns out that the non-dominant limb is the one whose work has become more economical during the training process.

It was also shown that the difference in mean bioelectric tension between ball throws of different weights is getting closer with the increase in length of traineeship. In advanced players, when the ball is changed, muscles work with more proximal mean bioelectric tension than in less advanced peers, which probably allows obtaining better results in the test. However, studying individual group relationships, it can be concluded that the number of points obtained in the test and muscle bioelectric tension differences between shots of various balls were associated. Apparently, the results are also influenced by any other parameter, so further studies in this context are needed, since it is assumed that the coordination sphere of human motor potential has the largest development potentials (Popowczak et al. 2011).

Final Conclusions

Based on the test results and their analysis, following conclusions were presented:

1. More experienced players achieved lower mean muscle bioelectric tension during shots with different balls, and higher level in kinesthetic differentiation test.

2. Efficiency in performing the task is not directly related with the difference in muscle stimulation between throwing different balls by individual players.

3. As a result of training, in the non-dominant hand, muscle stimulation decrease is more rapid than in the dominant hand.

4. The difference in bioelectric muscle tension in time of throwing different balls was smaller in basketball players who are more advanced in training, and in both groups in the dominant hand.

5. Variation coefficient of player's bioelectric tension is higher during bigger ball throwing and in the group of specialist training stage.

References

Blume D.D. Marking coordinative abilities and possibilities of development in the training process [in German]. Wissenschaftliche Zeitschrift der DHFK. 1981; 11 (3): 17–41.

Borysiuk Z. Time structure of information processes in selected fighting sports [in Polish]. AWF Warszawa 2006.

Borysiuk Z., Zmarzły D. Surface electromyography (Semg) as a research tool of psychomotor reactions [in Polish]. Annales Universitatis Mariae Curie-Skłodowska Lublin. 2005; 60 (16): 188–192.

Couzens G., Gandolifi G. Hoops! The Official National Basketball Players Association Guide to Playing Basketball. Mcgraw-Hill, New York 1987.

Hirtz P., Saaa H. The training in the sports games and the perfection of coordinative abilities [in German]. Körpererziehung. 1998; 10: 410–415.

Ji L., Huang B. A discussion on psychological characteristics of female basketball sharpshooters. Sport Science. 1987; 7 (2): 61–64.

Knight B. Conditioning for the transition game. American Fitness Quarterly. 1984; 3: 44–49.

Konrad P. ABC of EMG. Practical introduction to kinesiological electromyography [in Polish]. Technomex Spółka z o.o., Gliwice 2007.

Kubaszczyk A. Level of Coordinational Motor Abilities and Technical Skills of Basketball Players [in Polish]. Wychowanie Fizyczne i Sport. 2001; 4: 480–498.

Kuśnierz C. Lateralization and school performance in school children [in Polish]. Studia i Monografie OW, Politechnika Opolska. 2004; 159.

Lambery S., Viaud-Delmon I, Berthoz A. Influence of a sensorimotor confilct on the memorization of a path traveled in virtual reality. Brain Res. Cogn. Brain Res. 2002; 14 (1): 177–186.

Omorczyk J., Lyakh V. Dynamics of development of coordination motor abilities by female students academy of physical education in Cracow. Young sports science of Ukraine. 2009; 3: 122–128.

Popowczak M., Majorowski M., Cichy I., Kałużny K. The level of coordination motor abilities of students participating in the Basketmania program [in Polish]. Rozprawy Naukowe Akademii Wychowania Fizycznego we Wrocławiu. 2011; 33: 25–30.

Przewęda R., Wasilewski E. Motor learning [in Polish]. Roczniki Naukowe AWF w Warszawie. 1979; 24: 143–174.

Raczek J. Coordination motor skills (theoretical and empirical base and the importance of sport) [in Polish]. Sport Wyczynowy. 1991; 5–6: 7–19.

Raczek J., Mynarski W., Ljach W. Shaping and diagnosing coordination motor abilities. Handbook for teachers, trainers and students [in Polish]. AWF Katowice 2002.

Roth K., Winter R. Development of coordinative abilities [in German]. In G. & B. Ludwig (Hrsg.). Koordinative Fähigkeiten – koordinative Kompetenz. 2002: 97–103.

Salvatore M., Aglioti S., Cesari P., Romani M., Urgesi C. Action anticipation and motor resonance in elite basketball players. Nature Neuroscience. 2008; 9: 1109–1116.

Starosta W. The concept of modern training in sport. Studies in Physical Culture and Tourism. 2006;13 (2): 9–23.

Starosta W. The science of human movement in the system of physical education (sport) [in Polish]. Medycyna Sportowa. 2001; 14 (4): 143–151.

Stefaniak T. Precision in recreation of the set power by combat sports athletes [in Polish]. Studia i Monografie AWF we Wrocławiu. 2008; 90: 62–72.

Stoeckel T., Weigelt M. Plasticity of human handedness: Decreased one-hand bias and inter-manual performance asymmetry in expert basketball players. Journal of Sports Sciences. 2012; 30 (10): 1037–1045.

Zatoń M., Zatoń K., Zygadło A. Changes in kinesthetic differentiation capacity in the skiing learning process [in Polish]. Antropomotoryka. 2008; 44: 37–47.

Zimmermann K. Essential coordination skills for sports games [in German]. Theorie und Praxis der Körperkultur. 1982; 6: 439–448.

Zimmermann K., Nicklisch R. Training coordinative skills and its importance for the technical and technical-tactical, capabilities of the athletes [in German]. Theorie und Praxis der Körperkultur. 1981; 10: 764–768.

Cite this article as: Pakosz P. EMG parameters and kinesthetic differentiation during the free-throw of basketball players with various levels of athletic experience. Centr Eur J Sport Sci Med. 2013; 2: 31–38.