TIME ANALYSIS OF MUSCLE ACTIVATION DURING BASKETBALL FREE THROWS

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Abstract *Objective of the study:* The study assessed and compared the duration of the muscle activation in a basketball free throw, by players representing a preliminary and specialist stage of training. There was also analysed the accuracy of throws according to the stage of training, and whether individual changes in duration of activation have impact on the accuracy of free throws.
Material and methods: Players from national basketball teams second and third league of the AZS Academic Sports Club of Opole University performed twenty free throws shooting to the basket during the research study. During tests, players were equipped with EMG apparatus, which registered the time of muscle activation, when subsequent free throws were performed. Arm muscle (biceps and triceps) activation time was measured from the beginning of muscle activation to the time of completion of their work, and from muscle activation to the time of reaching the rim.
Results: Players of specialist stage of training, have 0,30 sec shorter average arm muscle time activation, counted from the beginning of activation to obtain the minimum value, from players of the preliminary stage of training. They also gained average 2 points better result in throw accuracy. Variability coefficient of throws duration was higher by 19.56% at players of the specialist stage of training. In the case of unforced extend duration of muscle activation, 80% of specialists and 40% players of preliminary group, don't score the basket.
Conclusions: It was observed that the basketball players of higher training experience, have lower average time of arm muscle activation. It was demonstrated that in players of the specialist stage of training, missed free throws were mostly caused by longer duration from the beginning of muscle activity to the rim, with players of the preliminary stage it was reverse.

Key words throw efficiency, EMG, stage of training

Introduction

The aim of the study was evaluation the level of bioelectrical activity of muscles and its relationship with the efficiency assessment of performing free throws. The authors wanted to show the relationship between muscle time reaction and accuracy of the free throw, in two different stages of training of basketball players.

Free throw shooting, that is individual activity of an individual, is regarded by many authors as crucial activity of a player during basketball matches (Argaj, 2005; Mačura, Potocký, 2009; Tománek, Vencúrik, 2008).

Free throws have particular meaning in basketball game, because if they are successful, they can play important part in victory of the team (Mačura, 2007). This mainly occurs when the last seconds of game decide on the victory and tactics of the losing team is focused at foul play.

A free throw is more effective because it is done without defender, always at the same distance, and player has 5 seconds. These are the activities unchanged during the whole match and for each player, which moreover has a stable position. The effectiveness of free throw is still determined by many factors, such as: technique, the quality of the training process, intensity and complexity of training load, psychological resilience, motivation and environment. (Gablonsky, 2005; Liu, Burton, 1999).

Internal and external factors related to performance of free throw were studied by several authors. The impact of visual acuity was observed by Vickers (1996). Duration of preparation for throwing basketball was measured by Mack (2001), Burton, MacLeod, Sanders, Coleman, (2003) and Zuzik (2011), it was proven that the success of free throws is increased with age.

Miller (2001, 1999) considers that throws in basketball require substantial accuracy. The author also proved that when the throw is off target, there is increased duration of muscular contraction.

Higgins and Späth (1972) reached the conclusion that in order to maximize accuracy, a successful motion pattern should be carefully developed. Similar recommendations for free throws are proposed by Wissel (1994), Kornecki and Lenart (1997) believe that top basketball players perform the throw in a different and individual way, as well as individually repetitive, according to a person. Therefore, it is concluded that coaches should spend more time to build a consistent pattern of motion.

The EMG system measures the bioelectrical activity of muscles, helps us to understand signaling processes in performing better. EMG (electromyography) can be used to determine the condition of muscle training (Konrad, 2007). Well trained muscles have low activation at work, while untrained muscles at the same work have a tendency to higher activation, so EMG plays an important role in study enabling objective evaluation of neuromuscular activation during any kind of activity.

Abe, Nozawa, Kondo (2009) used EMG in testing to measure the assessment of skills acquisition. They proposed a hypothesis, that visualization of EMG signal difference between the expert and beginner, as well as information of error in actual time, speeds up the learning process, especially in the initial phase of training.

The analysis of literature allowed the authors to make hypotheses, that bioelectrical activity of muscles can affect the accuracy of free throws and that motor pattern is changing, when the skills are increasing.

Material and methods

The aim of the study was to assess and compare the duration of free throws performed by basketball players, who are at preliminary and specialist stage of training. Five players of AZS Sports Club of the Opole University of Technology at the preliminary stage were at the average age of 17.6 ±1.67 years and training experience of 1.4 ±0.54 years, while five more advanced players were at the average age of 25.4 ±3.83 years and training experience of 10.2 ±1.48 years. The average height and weight of players of the preliminary stage was 183.6 ±12.52 cm and 73 ±12.55 kg, while in players of the specialist stage it was 190 ±10.49 cm and 86 ±7.03 kg. (Table 1).

Table 1. Data on the examined players depending on the stage of training

	Players of the preliminary stage of training	Players of the specialist stage of training
Age [years]	17.6 ±1.67	25.4 ±3.83
Height [cm]	183.6 ±12.52	190 ±10.49
Weight [kg]	73 ±12.55	86 ±7.03
Training experience [years]	1.4 ±0.54	10.2 ±1.48

Players' task was to perform twenty free throws in standard training conditions. The initial nature of the study and the difficulties in making time-consuming test procedures, have influenced the numbers of studied players. Study tests were conducted at the beginning of the annual microcycle training for both groups in the hours of afternoon training, in the same period. Selected players with declared handedness played in both groups at different positions, from point guard to center, being members of second and third basketball league.

The EMG system of Noraxon Company was applied as research tool, it 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 pairs of electrodes were placed between the motor point and the tendon trailers along the longitudinal axis of the muscle, according to the SENIAM methodology. The duration of arm muscle activation was measured from the beginning of muscle activation to the time of obtaining their minimum activation after the throw, and from muscle activation to the time of reaching the rim by the ball. The time assessment of motion was measured using the EMG, considering the involvement of arm flexor muscles (musculus biceps brachii) and arm extensor muscles (musculus triceps brachii) of the right and left sides of the body. Data analysis was performed using the MyoResearch XP MT 400, after the signal was cleaned and smoothed. The video was recorded with camera, which shoots 60 frames per second.

Data analysis was made using MyoResearch XP MT 400. The sampling rate was 1000 Hz. The root mean square (RMS) values of EMG signals were calculated for consecutive segments of 50 ms. The video was recorded by a camera with 60 frames per second in sync with the record of EMG. Moment of muscle activity was determined using 3SD factor in the MyoResearch XP, MT 400. The combination of EMG recording with video recording allowed reliably to determine the time muscle activation in both groups and enables to accurately recreate studies in the future.

To verify hypothesis, statistical analysis software STATISTICA 12 was used. The structure of the groups was characterized by the arithmetic mean and standard deviation, and in order to determine differences between groups coefficient of variation was calculated and Tukey test was used.

Results

Presentation of the results was started from the average duration of biceps' and triceps' muscle activation, when free throws were performed, from the beginning of activation to the time of obtaining the minimum value after the throw was performed. Among players, who are at the preliminary stage of training, it was 2.31 s; whereas in players at the specialist stage of training, it was at the level of 2.01 s. Average duration of muscle activation among players with lower training experience was in the range of 2.07 to 2.59 s. In the second group, it was more diversified and ranged from 1.28 to 2.93 s; however, in case of three players, this time was less than 2 s. Significant difference can be seen in the variation in variability of muscle activation among individuals in the subsequent throws. Average coefficient in basketball players with less training experience was 10.86% and in those with longer practice, it was at the level of 30.42% (Table 2).

Table 2. The results of statistical analysis depicting average times of throws, standard deviation and coefficient of variation of the time for individual players, depending on the stage of training

	Players of the preliminary stage of training	Players of the specialist stage of training
Free throws made	13.40	15.40
Average time of free throw from the beginning of muscle activation to the lowest activation value after shot		
Average free throw time [s]	2.31	2.01
Standard deviation	0.25	0.61
Coefficient of variation [%]	10.86	30.42
Average time of free throw from the beginning of muscle activation to time when ball reach the rim		
Average free throw time [s]	2.17	2.04
Standard deviation	0.17	0.32
Coefficient of variation [%]	7.74	15.62

Considering the time that has elapsed since the beginning of muscle activation to the time of reaching the target, in this case – the rim, preliminary stage players obtained longer average duration of the motion by 0.13 s. The coefficient of variation in both groups differed by 7.88% (Table 2).

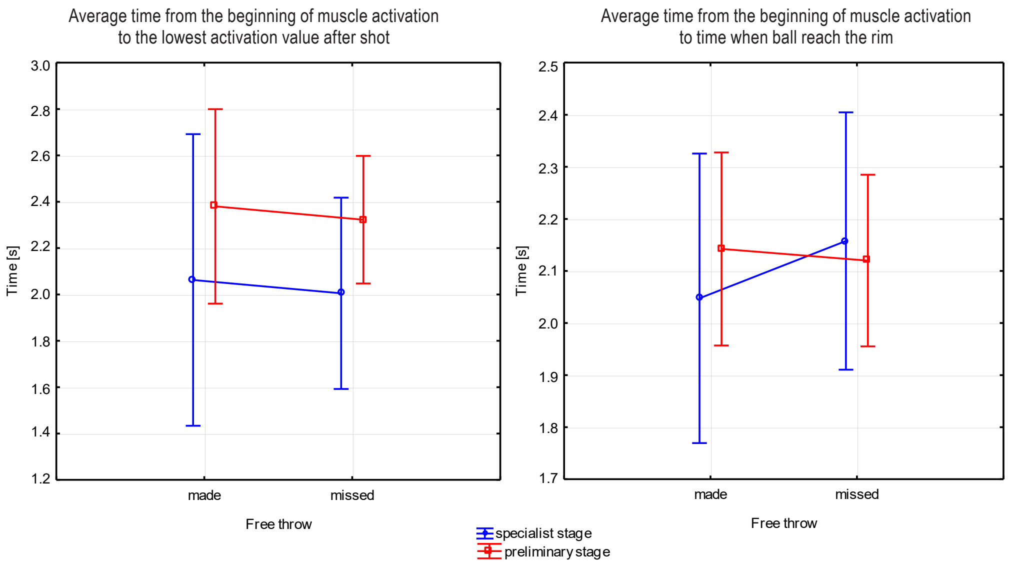

Figure 1. Average time of made and missed free throws depending on the players' stage of training

In three players of specialist stage of training and in only one in the preliminary stage of training, muscle activation ended before ball reached the rim. Four out of five players from specialist stage of training missed their shots, when arm muscle activity was longer. In the group of preliminary stage trend was different. Here, the most of players missed, when the muscle activity was shorter (Figure 1).

By examining the time of free throws, the level of abilities to shoot free throws in groups was also analysed. Players who are in the specialist stage of training on 20 points possible to gain in a trial obtained 15.4 points at average. This result was superior to players in the preliminary stage at 2 points. Furthermore, results in both groups of peripheral players, that is: point guard, shooting guard and small forward were better than under the basket players, that is: power forward and center. In more advanced in training players, they were higher by 2.33 points, and in the second group by 3.17 points (Table 2).

Time of made and missed free throws, when analysed from the beginning of muscle activation to the time of obtaining the minimum value after the throw, significant differences were not at $p \leq 0.05$.(Tukey test). Considering the time that has elapsed since the beginning of muscle activation to the time of reaching the rim, significant differences were shown only in the group of specialized stage, which are at the $p = 0.03177$ (Figure 1).

Discussion

Because of the innovative nature of the research and use of specialized equipment, in the literature there are not many studies on muscle activity during the time free throw. In these studies, “we entered” into the human body, measuring the time activation arm muscles when performing free throws. The study had its limitations, the small number of players dictated by difficulties in the implementation of time-consuming research and analysis, but in total we examined free throws 400 times, in terms of their duration.

The analysis found that basketball players who train more had shorten muscle activation, so they need less time to take free throw. However, it was noticed that more advanced in training players modulate arm muscle activation in a greater extent during performance of throw. The result of this research can expand the opinion stated by Higgins and Späth (1972), as well as Wissel (1994), that with increasing skills, the motor pattern undergoes certain changes. Players with specific stage of training more frequently change their muscle activation time during successively performed throws that those with shorter experience in training. This is probably the result of progressively higher level of kinesthetic differentiation capacity, which increases with the ongoing process of training and acquisition of skills (Zatoń, Zatoń, Zygadło, 2008). Kubaszczyk (2001) argues that this also has a strong relationship with the special efficiency.

Analysing the data, time variation during each of the successive throws of the same player could be seen, with certain regularity. When in more experienced players the average muscle activation time measured from the beginning to the time of reaching the rim was at higher value on average, then most of them performed missed throws. This can corroborate the study by Miller (1999), although in less experienced players a reverse trend was observed, so it may depends on the training experience.

The study confirmed the finding by Burton et al. (2003), Zuzik (2011) and Zwierko, Osiński (2001), because more trained players achieved by 10% better performance during trail, when free throw abilities were measured.

Conclusion

Based on the results, following conclusions were drawn:

1. With the increase of training experience, the time needed for arm muscles to perform free throw, and the time needed to overcome the distance from the initial muscle activation to the time of achieving the target, that is the rim, are reduced.
2. More experienced players possess higher ability to model the muscle activation time needed to shoot free throw, than less experienced players.
3. Missed throws were characterized by longer duration of muscle activation in basketball players with longer experience in training.
4. Basketball players of the specialist stage obtain higher level of abilities to perform free throw than players of the preliminary stage.

The results seem to confirm the hypothesis presented by the authors, that time of muscle activation may affect the accuracy of free throws, and experienced players change motor pattern of muscle activation time during free throw more.

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