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THE EFFECT OF DIFFERENT ACTIVATION STIMULI ON SIZE AND DURATION OF PAP EFFECT

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Abstract
The aim of this paper is to determine the presence of PAP effect and its time periods in the application of different activation stimuli on upper extremities. PAP effect has been determining as a difference in the distance of the medicine ball throw with stimuli (PAP 1,3,5,7,10,12 minutes) and without stimuli (PRE-PAP). The study was participated by 24 students of Faculty of Sport and Physical Education, University of Sarajevo (age = 22.24 ± 1.21; body mass = 74.57±7.23). The students threw the medicine ball from a sitting position on a chair, before and after (1,3,5,7,10 and 12 minutes) activation stimuli which consisted of 3x3 90% 1RM incline bench press, bench press and military press. The analysis of the data obtained shows that there is an acute increase in the distance of the medicine ball throw. The highest positive statistically significant pre and post-AP changes occurred in the seventh minute for IBP (13.52 cm and 2.38%; p = .047) and BP (12.17 cm and 2.14%; p = .052). These results suggest that IBP and BP application performance results in a statistically significant PAP effect within the seventh minute, and that there is a presence of some (non-statistically significant) positive PAP effects in the application of all three (BP, IBP, MP) activation exercises between fifth and tenth minute, however pointing out that their value is the greatest between fifth and seventh minute.

Key words: **strength, military press, medicine ball, 1RM, activation**

Introduction

Improving new training strategies, as one of the primary aims, focuses on promotion of strong athlete performance (Vrcić et al. 2018), and as one of the widest known methods for improving those performances is PAP (Post-activation Potentiation). Post-Activation Potentiation (PAP) is defined as an increase in muscle performance after a conditioning contraction (Xenofondos et al. 2010). Just increasing this efficiency accompanied by neuromuscular changes can contribute to improving performance in exercises that require strength, speed or power (Talović et al. 2018; Borba et al. 2017; MacIntosh et al. 2012). However, there is a very small number of studies which focused on PAP effects on upper extremities (Beller et al. 2012; Baker 2004; Brandenburg 2005; Ebben and co-authors 2000; Hrysomallis and Kidgell 2001; Marković and co-authors 2008 and Vrcić et al. 2018). Even though studies show that there is no precise optimum time of PAP effect, especially when it comes to the power of the upper extremities, the analysis of the research has led to the finding that the best PAP effects present themselves between seventh and twelfth minute. (Vrcić et al. 2018; de Assis Ferreira et al., 2012; Bevan et al. 2009; Kilduff et al. 2007).

As far as the authors are aware, neither of the previous studies has researched the difference in the size of PAP effect in the application of different activation stimuli when it comes to upper extremities. Considering that this study focuses on analysing three activations, thrusts (bench press, incline bench press and military press) and that they have the similar structure, if perceived from a biomechanical aspect, it means that the effects will be the greatest if the exercise itself is bio-mechanically similar as to the exercise of throwing a medicine ball from the chest. When it comes to bench press thrust, the study conducted by Marković et al. 2008 reveals that the use of upper-body heavy resistance exercise (bench press) before ballistic throwing movements against moderate external loads might be an efficient training strategy for improving an athlete's upper-body explosive performance. Likewise, a study conducted by Vrcić et al. 2018 concluded that 3x3-90% of 1RM on incline bench press can lead to statistically significant improvement in the distance range, if it is the case of throwing a medicine ball from the chests. Up to this point, the authors believe that the Military press has not been used as an activation exercise, therefore there are no relevant sources

which would be used to compare the results gained from this study within the context of a Military press.
The general aim of this study is to determine the presence of PAP effect and its time periods in the application of different activation stimuli on upper extremities. In addition, this study aims at determining differences in the size of PAP effects when applied in three activation exercises, and which primarily differentiate themselves regarding the angle under which muscle force overcomes external load.

Methods

Sample

The sample of this study consisted of 24 male students of the Faculty of Sport and Physical Education, University of Sarajevo, who at the time of testing were of a good health and physically active. All the students have stated that they did not have any upper extremities' injuries in the past five years. The basic characteristics of the students (mean±SD) are: age (22.24 ± 1.21), body mass (74.57 ± 7.23), maximum bench press 1RM strength (82.06± 18.83), maximum incline bench press 1RM strength (67.71 ± 13.88), maximum Military press 1RM strength (52.93 ± 9.22). All the students have consented to be tested and have likewise been informed about all the details and reasons as to why this study is to be performed.

Experimental Approach to the Problem

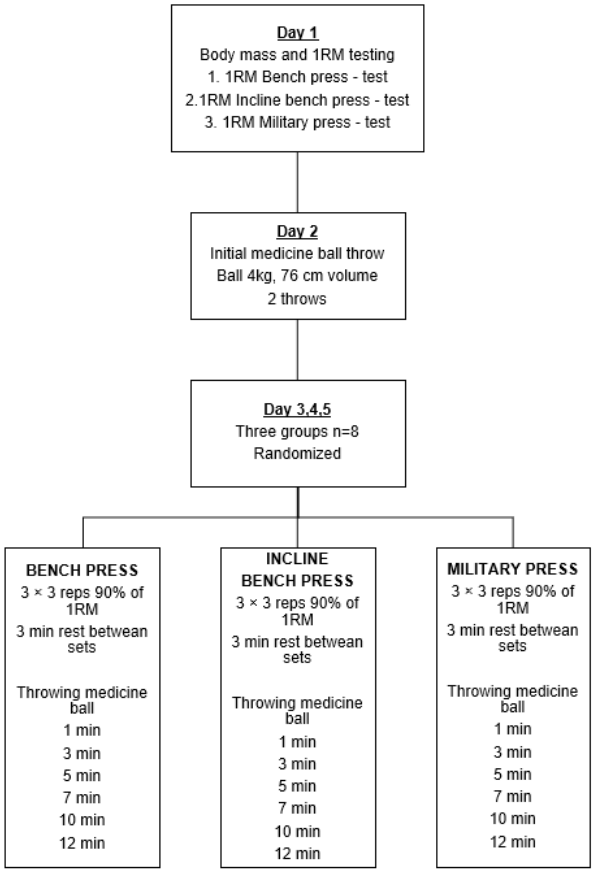
All the subjects involved in this study were asked to take 24 hours break from any physical activity, to be rested for the beginning of this study. The testing was conducted within 5 days, but between each day, there was one day of break. The first day of research the body composition parameters of each subject were determined (BC-420MA, TANITA Europe GmbH, Sindelfingen, Germany) (Čović et al. 2017), after which a standard 5-minute workout of easy running commenced (8 km · h^{-1}) followed by 5 minutes of dynamic stretching (Tsoukos et al. 2016) after which 1RM was determined. The subjects first determined One-Repetition Maximum for a bench press, after which One-Repetition Maximum for incline bench press and finally One-Repetition Maximum for military press.

One-Repetition Maximum determination

The estimate for One-Repetition Maximum for bench press was based on the recommendation of the author Markovic, G and co-authors 2008, One-Repetition Maximum for incline bench press was based on the recommendation of the author Vrcić and co-authors 2018, while the estimate for One-Repetition Maximum for Military Press was based on the recommendation of the authors Paoli and co-authors 2010. In regard to all the above stated protocols, recommendations by each author were followed without any deviations.

Seated Medicine Ball Throw

The second day of testing likewise included warm up activities after which the activity of throwing the medicine ball (4kg) commenced. The medicine ball throwing test was used on the recommendation of author Vrcić et al. 2018. The subjects were asked to throw the medicine ball from a sitting position on a chair with a medicine ball (4 kg, medical volume 76 cm) with both hands on the chest. The subjects threw the medicine ball twice each time and with a 10 second interval between each throw, to avoid acute effects of the first throw presenting itself on the second. On the third, fourth and fifth day of testing, the subjects were divided into three random groups consist out of 8 subjects. The activation stimuli were conducted on three different work area, as 3x3 with 90% 1RM, following the throwing of a medicine ball at certain time points of 1,3,5,7,10 and 12 minutes. This randomized approach was conducted to avoid learning effect, i.e. automatic throwing, which would affect the study's relevance (Graph 1.).



Graph 1. Schematic representation of the experimental protocol

Statistical Analysis

The results were processed using SPSS. 23 for Windows (IBM Corp. Chicago). Arithmetic mean values and standard deviations were calculated, for all variables, followed by paired samples T-test to determine possible differences in time periods, and ANOVA (LSD) to determine whether there are differences in the same time periods for different activation stimuli.

Results

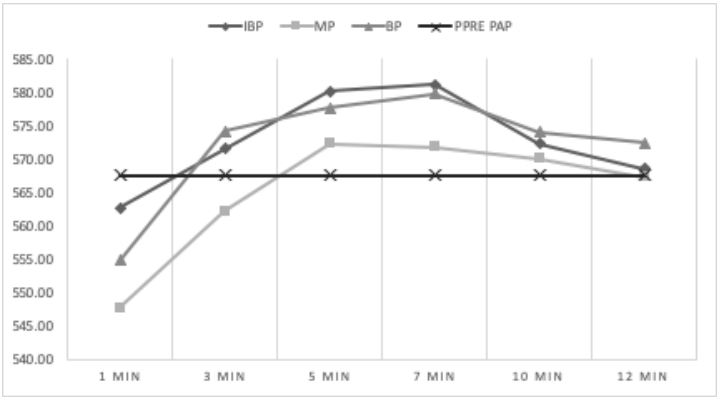
Table 1 presents the results of arithmetic mean and standard deviations of treated variables. It is noticeable that the results of the pair sample T-test show statistically significant difference in variable IBP7 (p = .047), MP1 (p = .018), BP7 (p = .052). Likewise indicated by ANOVA (LSD test) one can notice that there are no statistically significant differences for different activation stimuli in same time periods.

Table 1. Descriptive statistics and results of T-test and ANOVA (LSD test)

Variables	Mean	Std. Deviation	T - test	ANOVA LSD
Weight	74.57	7.23	/	
BP	82.07	18.83	/	
IBP	67.72	13.89	/	
MP	52.93	9.23	/	
PRE-PAP	567.62	49.90	/	
IBP1	562.70	51.56	.461	IBP1 with MP1 – p=.357 IBP1 with BP1 – p=.628 BP1 with MP1 – p=.661
IBP3	571.57	49.01	.560	IBP3 with MP3 – p=.564 IBP3 with BP3 – p=.874 BP3 with MP3 – p=.462
IBP5	580.17	47.18	.060	IBP5 with MP5 – p=.653 IBP5 with BP5 – p=.887 BP5 with MP5 – p=.759
IBP7	581.13	57.14	**.047**	IBP7 with MP7 – p=.592 IBP7 with BP7 – p=.938 BP7 with MP7 – p=.647
IBP10	572.26	54.92	.420	IBP10 with MP10 – p=.895 IBP10 with BP10 – p=.915 BP10 with MP10 – p=.812
IBP12	568.61	58.58	.908	IBP12 with MP12 – p=.939 IBP12 with BP12 – p=.828 BP12 with MP12 – p=.770
MP1	547.70	58.61	**.018**	
MP3	562.22	56.83	.362	
MP5	572.35	67.17	.488	
MP7	571.83	59.66	.525	
MP10	570.00	62.94	.694	
MP12	567.26	62.29	.958	
BP1	554.83	50.35	.077	
BP3	574.13	54.24	.282	
BP5	577.70	56.49	.097	
BP7	579.78	55.12	**.052**	
BP10	574.09	51.50	.269	
BP12	572.43	53.84	.350	

BP = Bench press; IBP = Incline bench press; MP = Military press; PRE - PAP = medicine ball distance before PAP; IBP/MBP/BP 1 = Distance after 1 minute; IBP/MBP/BP 3 = Distance after 3 minutes; IBP/MBP/BP 5 = Distance after 5 minutes; IBP/MBP/BP 7 = Distance after 7 minutes; IBP/MBP/BP 10 = Distance after 10 minutes; IBP/MBP/BP 12 = Distance after 12 minute

Graph 2. The Structure of the throwing range distance in minutes



Discussion

The main aim of this paper is to determine the presence of PAP effect and its time periods in the application of different activation stimuli on upper extremities. Primarily PAP effect was determined as the difference in the throwing distance of a medicine ball with (PAP- 1,3,5,7,10,12 min) and without (PRE-PAP) the application of activation exercises. In addition, the aim of this study was to determine the difference in PAP effect's size when applying three activation exercises, which fundamentally differentiate themselves in regard to the angle under which muscle force overcomes external load. The assumption is that the exercise (IBP), which is biomechanically the closest to throwing the medicine ball from the chest, should have the greatest positive transfer, i.e. the greatest PAP effect. This assumption is in line with the research conducted by Naclerio and co-authors 2015, which points towards individual effects of different activation protocols in regard to the size and characteristics of PAP effect.

The results suggest that PAP effect is present, but not in a consistent manner for all three stimuli and not in all time periods when they were measured. In general, one can conclude that statistically significant (p=.047) positive PAP effect has been recorded only in activation exercise IBP-7 and in the seventh minute after activation stimuli. Likewise, within the same time period of an activation exercise BP-7, a result which is on the limit (p=.052) of being statistically significant was recorded. In the other time periods, there is no statistically significant difference in IBP application. The other two activation exercises BP and MP as well do not indicate a positive statistically significant difference between PRE-PAP measurements and measurements between time intervals of one and twelfth minutes. A detailed analysis of quantitative differences in the obtained PAP effect size between different activation exercises (BP, IBP, MP) in different time intervals demonstrates that IBP causes the greatest PAP effect between fifth and seventh minute. Somewhat lesser positive effect has been recorded in BP application, while the smallest PAP effect has been

recorded in the application of MP activation exercise. It is therefore necessary to mention that there are no statistically significant differences in the size of obtained effects in regard to the three activation exercises, and one cannot with utmost certainty confirm which one is the most applicable. However, quantitative differences of PAP effect per minutes indicate that in the first "1" minute all three exercises cause the decrease in the performance as opposed to PRE-PAP. In IBP application a negative result was obtained (-4.91 cm or 0,87%), following BP (-12.78 cm or 2.25%), while in MP application a statistically significant (p= .18) decrease of a performance was indicated as opposed to PRE PAP result (-19.91 cm or 3.51 %). These results most probably come as an effect of acute fatigue, which indicates that after one minute a fatigue has overcome potentiation, therefore a negative effect was recorded in regard to the application of three activation exercises. This phenomenon has been explained by (Wilson and co-authors, 2013), who state that after an activation stimuli, at the same time PAP and muscle fatigue occur, therefore any following execution of motor task depends on the interaction of these two factors. The most probable cause is the notion that activation stimuli of high intensity can cause in non-trained persons greater levels of local muscle fatigue and lower the PAP effects (Talpey and co-authors 2014).

In MP application this effect has lasted longer than 3 minutes, and the decline in performance has been recorded (-5.39 cm or 0.95%). The other two activation exercises have caused a lesser positive PAP effect after 3 minutes, IBP (3.96 cm or 0.70%), while the effect of BP application was somewhat higher (6.51 cm or 1.15 %). Within the fifth minute after activation a PAP effect increase was recoded, which was a positive one for all three activation exercises and is as follows MP (4.47 cm or 0.83%), BP (10.09 cm or 1.78 %) and IBP (12.56 cm or 2.21%). Based on the obtained results it is noticeable that the highest PAP effect has been recorded between fifth and seventh minute, with the following results recorded for MP (4.22 cm or 0.74%), BP (12.17 cm or 2.14 %) and IBP (13.52 cm or 2.38%). The gained results suggest that after seven minutes PAP effect starts to decrease in these groups of subjects, i.e. the performance results start again to decrease towards the PRE-PAP values measured. Within the tenth minutes the results were recorded for MP (2.39 cm or 0.42%), IBP (4.65 cm or 0.82 %) and BP (6.48 cm or 1.14%). As the time periods increase the performance decreases further and after the twelfth minute of activation exercises, they are negative for MP (-0.35 cm or 0.06%), while for the other two exercises they are still within positive range but their value is minimum IBP (1.00 cm or 0.18 %) and BP (4.82 cm or 0.85%) (Graph 2.).

The study of PAP effect (pause) presence within time periods was the subject of previous studies by Wilson and co-authors (2013), who indicated that an optimum pause is different in differently trained persons, therefore seven to ten minutes after activation stimuli is optimum for those doing recreational sport, while three to seven is optimum for athletes. These facts are confirmed by a study conducted by Vrcić et al. 2018, which indicates that seven minutes is an adequate period of activation stimulus in amateurs.

Conclusion

Based on the gained results one can conclude that by applying a greater external load 3x3 90% 1RM as activation exercises for upper extremities such BP, IBP, MP quantitative differences are achieved in regard to the performance of throwing a medicine ball (4kg) from the chest, if compared to the results of throwing the medicine ball without activation. A statistically significant difference was determined between PRE-PAP results and PAP effects caused by IBP and BP application in seventh minute after activation exercises were applied, which confirms the presence of PAP effects within its minimum values between fifth and seventh minute. On the other hand, a statistically significant difference was not confirmed in the size of obtained effects of three activation exercises, indicating that the hypothesis set by the study, which assumes that the exercise similar in biomechanical structure will produce a greater PAP effect in regard to other two exercises, has not been confirmed. These results might be due to: smaller absolute strength of the subjects when performing activation exercises, relatively heavier medicine ball in comparison to other exercises where a different ball is used, lack of measuring the speed of the throwing, the lack of measuring the local fatigue – EMG, introducing a fourth activation exercise – thrust from the opposite side of incline bench.

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