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Effects of Intensity of Warm up on Iemg Response During Bench Press

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Abstract: The purpose of this study was to investigate the effect of four different warm-up conditions on the iEMG of agonist muscles during a 75% 1RM bench press. The subjects were eight healthy males in their 20's from Chungnam Province, Republic of Korea. The iEMGs of the pectoralis major, the anterior deltoid and the triceps brachii lateral head were measured at the bench press. A mixed-design two-way ANOVA was calculated and the significance level was set at $p<0.05$. First, the iEMG changes in the pectoralis major, anterior deltoid and Triceps brachii lateral head were gradually higher in the 3, 6 and 9 sets. Second as the set of 3, 6 and 9 sets was progressed, iEMG changes showed the highest increase in triceps brachii lateral head, followed by anterior deltoid and pectoralis major order. Third, iEMG of pectoralis major, anterior deltoid and triceps brachii lateral head did not show significant difference at 75% 1RM bench press according to preparation exercise. In conclusion, a large number of preparatory exercises result in excessive muscle activity of the upper arm, resulting in decreased performance in this exercise. Therefore in this study, three sets of preparation exercises are considered to be the most suitable preparation exercise.

Key words: iEMG, warm-up, bench press, RM (Repeated Maximum), anterior deltoid, triceps brachii

INTRODUCTION

In general, warm-up exercises increase the body temperature by activating the respiratory circulation system which ensures flexibility of the main body joints and they are performed for a longer time when the body temperature is low and can be combined with simple gymnastics or low-intensity running (Moon, 2003). A warm-up is perceived as an important factor in injury prevention and it has a positive effect on exercise performance by softening nerves and muscles as well as by facilitating the respiratory circulatory system's activity (McGowan *et al.*, 2015). It has been reported that the appropriate intensity and duration of aerobic warm-up exercises positively affect power, endurance and muscular strength also the lower the intensity and duration, the more effective they are (Gray and Nimmo, 2001).

EMG contains the starting point of contraction of muscles and information on the mechanism of action related to muscular control. Analysis of EMG provides information on various biomechanical mechanisms such as: anatomical movements, fatigue injury and generation of force. EMG analysis is used not only for injury prevention, medical diagnosis but also for rehabilitation and training (Bolek, 2003). In recent studies, the introduction of EMG has been generalized as an evaluation method for muscle activity and quantitative measurement of EMG values has been known as an objective method (Stastny *et al.*, 2017).

The most effective 10 RM exercise sequence for weight training is to perform 10 times at 50% 10RM in the first set, 10 times at 75% 10 RM in the second set and 10 times at 10 RM in the third set 6 (Kraemer *et al.*, 2002). The bench presses have been divided into a group without warm-up, a group with stretching and a group with resistance warm-up exercises. The best bench press performance was determined for the last condition resistive warm-up exercise (Sung, 2011).

According to the American College of Sports Medicine (ACSM), 5-10 min of warm-ups are recommended in combination with stretching, strength training, walking or light running and a program was designed to gradually increase the metabolic volume of rest to the level of exercise (Shrier, 2004). Several studies have been conducted to investigate the effect of warm-ups on the physiology, physical fitness and exercise performance (Kwon and Kim, 2007).

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Studies such as on exercise intensity, stretching methods, aerobic warm-up exercise and in warm-ups for weight training have been carried out to examine various aspects but few on the difference of strength and set numbers of warm-ups for weight training. In this study, we determined the appropriate quantity of preliminary exercise sets before weight training by examining the effect of 75% 1RM bench press exercise on EMG responses.

MATERIALS AND METHODS

Subjects: The subjects of this study were eight male college students attending the college of physical education at D. College in Chung-Nam Province, Republic of Korea. They were selected after a medical examination which determined that no health problems existed and they had more than 6 months experience in weight training. The subjects fully understood the study purpose, participated voluntarily and signed a written consent form. Picture of characteristics of the subjects are shown in (Table 1).

Study design: In a preliminary assessment of 1RM bench presses, their repetition frequency, muscle strength and 75% weight of 1RM were measured. A total of four types of warm-up were performed and 75% 1RM bench press was performed after warm-up. The number of repetitions per set during the preliminary measurement was the same as the number of repetitions during the 75% 1RM measurement in the preliminary measurement and the resting time was set to 2 min between the sets. EMG (Electromyographic) measurements were performed at 75% 1RM bench press during and after each warm-up type conditions. Measurements were performed randomly at intervals of 1 week.

Exercise program: The type of warm-up was performed with different sets of type 1-NON set, type 2-3 set, type 3-6 set, type 4-9 set and then 75% 1RM bench press was performed. The NON set conditions were the conditions of the exercise are 75% 1RM bench press without warm-up. The 3 sets conditions were performed in the order of 30×50×70/75% 1RM→75% 1RM. The 6 sets conditions were performed in the order of 30×40×50×60×70×80×90/75% 1RM→75% 1RM Bench press. The 9 sets conditions were performed in the order of 10×20×30×40×50×60×70×80×90/75% n→1RM 75% 1RM Bench press. The exercise program is shown in Fig. 1.

Table 1: Characteristics of the subjects (M¡¾SD)

Variables	n = 8
Age (year)	23.5±4.14
Height (cm)	176.4±3.81
Weight (kg)	76.3±15.13
Career (months)	27.32±12.36

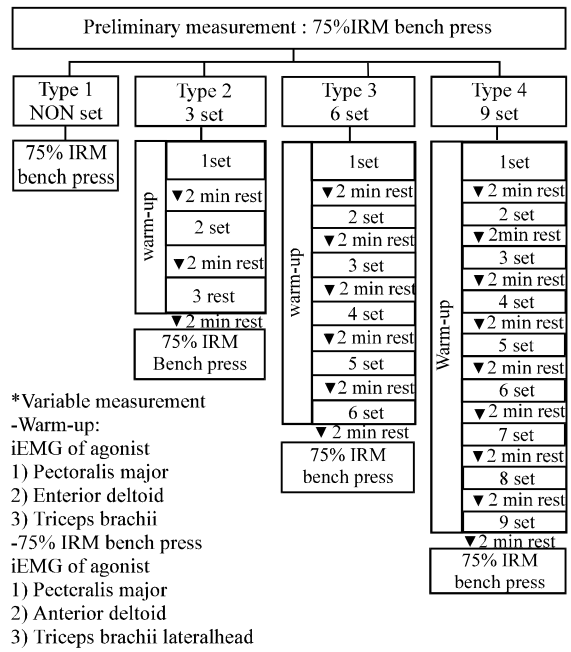

Fig. 1: Experimental design

Variable measurement: Surface EMG (Laxtha Inc., Daejon City, Republic of Korea) and iEMG were used to measure and analyze the subject's muscle activity. Two surface electrodes were attached at a distance of 1 cm from the insertion point of the endotracheal electrodes. Tape was used at the attachment area to prevent noise. The measured muscles were the pectoralis major, the anterior deltoid and the lateral head of the triceps brachii. The electrode attachments of the pectoralis major, anterior deltoid, triceps brachii are four points apart from the anterior axillary fold to the inside of the trunk, the electrodes are attached to the acromion at a distance of three fingers from the anterior edge of the acromion, Distal to four fingers apart. EMG attachment position of each muscle table is shown in Table 2. In order to minimize skin resistance, the hair was removed and the skin polished at the electrode attachment area and then wiped with alcohol for disinfection before an electrode was fixed. The Reference Voluntary Contraction (RVC) was used as a quantification method for comparing individuals, muscles and repeated measurements. The shape and regions of the attachment parts are shown in Fig. 2.

The subject's bench press 1RM was estimated using the indirect estimate formula (Pescatello, 2013) and then the estimated load was measured using the direct

Table 2: Attachmentpart

Muscle	Position	Attachment part
Pectoralis major	A supine position	Anterior axillary fold
Anterior deltoid	Place the palm upwards while the sides arm is positioned on both sides	From the front edge of the peaks down three hand widths apart
Triceps brachii	Pronation your arm at 90 degrees abduction	Posterior axillary fold 4 fingers above the circle

Fig. 2: The shape and regions of the attachment parts

measurement method (Gray *et al*., 2002). After that, 75% 1RM was again measured based on the measured 1RM. The bench press method was conducted on the basis of national strength and conditioning association (Hansson *et al*., 2000).

RESULTS AND DISCUSSION

Change of iEMG during the type 2 condition warm-up: Changes in the iEMG of the pectoralis major were significant (p<0.001). Post-hoc test results showed higher values in the second set (p<0.05) than in first and third set (p<0.01) and the first and third set higher than the second set. The same significant differences were found in anterior deltoid iEMG (p<0.001) with higher values in the second set (p<0.01) than the first and third set (p<0.001) and the first and third set higher than the second set (p<0.001). Significant differences were also detected in the triceps brachii lateral head's iEMG (p<0.001): higher second set (p<0.01) than the first and third set (p<0.001) and the first and third set higher than the second set. The table for changes in iEMG between type 2 warm-up condition sets is shown in Table 3 and the graphs are shown in the Fig. 3.

Changes in iEMG during the type 3 condition warm-up: Changes in iEMG of the pectoralis major were significant (p<0.001). The 2nd set values were higher (p<0.05) than those in the1st and the 4th set (p<0.05), the 1st and the 4th set higher than the 3rd and 5th set (p<0.01), the third and fifth set higher than the fourth and 6th set (p<0.05) and the 4th and 6th set higher than the 5th set. Changes in the anterior deltoid's iEMG were also significant (p<0.001): higher values in the second set (p<0.05) than in the 1st and third set (p<0.05), the first and 3rd set higher

Table 3: Differences in iEMG during 75% 1RM bench press according to warm-up conditions

Variables	Source	SS	df	MS	f-values	p-values
Pectoralis	Treatment	1529.369	3	509.790	0.565	0.644
Major	Error	18951.234	21	902.440		
Anterior	Treatment	1805.509	3	601.836	0.385	0.765
Deltoid	Error	32819.485	21	1562.833		
Triceps	Treatment	6506.709	3	2168.903	0.700	0.563
Brachii	Error	65092.295	21	3099.633		

Table 4: Changes in iEMG during Type 2 condition warm-up

Variables	Source	SS	df	MS	F-values	p-values
Pectoralis	Treatment	6687.390	2	3343.695	11.629	0.001
Major	Error	4025.537	14	287.538		
Anterior	Treatment	13228.590	2	6614.295	29.5800	0.000
Deltoid	Error	3107.437	14	221.960		
Triceps	Treatment	15733.519	2	7866.759	33.225	0.000
Brachii	Error	3314.800	14	236.771		

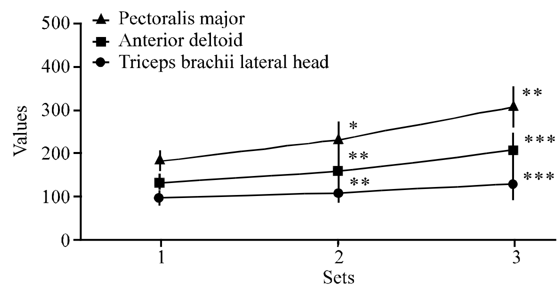

Fig. 3: Change of iEMG between sets during type 2 warm-up conditions; *p<0.05, **p<0.01, ***p<0.001

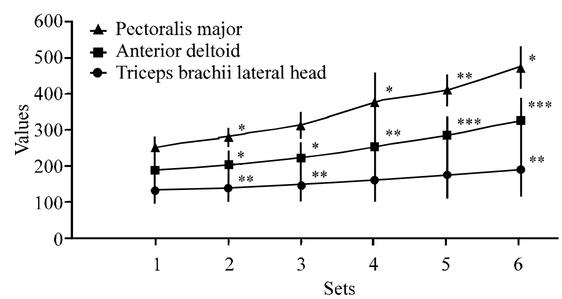

Fig. 4: Change of iEMG between sets during Type 3 warm-up conditions *p<0.05, **p<0.01, ***p<0.001

than the 2nd and 4th set (p<0.01), the 2nd and 4th set higher than the 3rd and 5th set (p<0.001), the 3rd and 5th set higher than the 4th and 6th set (p<0.05) and the 4th and 6th set higher than the 5th set. The triceps brachii iEMG changes were significant as well (p<0.001) with higher values in the 2nd set (p<0.01) than the 1st and 3rd set (p<0.05), the 1st and 3rd set higher than the 2nd and 6th set (p<0.01) and the 2nd and 6th set higher than the 5th set. Type 3 warm-up condition sets is shown in Table 4 and the graphs are shown in Fig. 4.

Table 5: Changes in iEMG during type 3 condition warm-up

Variables	Source	SS	df	MS	f-values	p-values
Pectoralis	Treatment	19010.467	5	3802.093	10.582	0.000
Major	Error	12574.857	35	359.282		
Anterior	Treatment	35582.580	5	7116.516	40.049	0.000
Deltoid	Error	6219.297	35	177.694		
Triceps	Treatment	39651.711	5	7930.342	15.054	0.000
Brachii	Error	18437.383	35	526.782		

Table 6: Changes in iEMG during Type 4 condition warm-up

Variables	Source	SS	df	MS	f-values	p-values
Pectoralis	Treatment	78819.087	8	9852.386	15.947	0.000
Major	Error	34596.983	56	617.803		
Anterior	Treatment	125242.642	8	15655.330	50.839	0.000
Deltoid	Error	17244.683	56	307.941		
Triceps	Treatment	147394.905	8	18424.363	45.140	0.000
Brachii	Error	22857.161	56	408.164		

Changes in iEMG during the type 4 condition warm-up: Just as in the other two conditions, pectoralis major iEMG changes were also significant (p<0.001). Post-hoc test results revealed higher values in the 3rd set (p<0.05) than in the 2nd and 4th set (p<0.01), 2nd and 4th set values higher than the 3rd and in 5th set (p<0.01), 3rd and 5th set higher than the 6th and 7th set (p<0.05), 6th and 7th set higher than the 6th and 9th set (p<0.05) and the 6th and 9th set higher than the 8th and changes in the iEMG of anterior deltoid were significant as well (p<0.001): higher values in the 3rd set (p<0.05) than in the 2nd and 4th set (p<0.01), the 2nd and 4th set higher than the 3rd and 5th set (p<0.01), the 3rd and 5th set higher than the 6th and 7th set (p<0.05), the 6th and 7th set higher than the 6th and the 9th set (p<0.01) and the 6th and 9th set higher than the 8th and Triceps brachii iEMG changes were also significant (p<0.001). Post-hoc test results showed higher values in the 2nd set (p<0.01) than in the 1st and 3rd set (p<0.001), the 1st and 3rd set higher than the 2nd and 4th set (p<0.01), the 2nd and 4th set higher than the 3rd and 5th set (p<0.01), the 3rd and 5th set higher than the 6th and 7th set (p<0.001), the 6th and 7th set higher than the 6th and 9th set (p<0.01) and the 6th and 9th set higher than the 8th and type 4 warm-up condition sets is shown in Table 5 and the graphs are shown in Fig. 5.

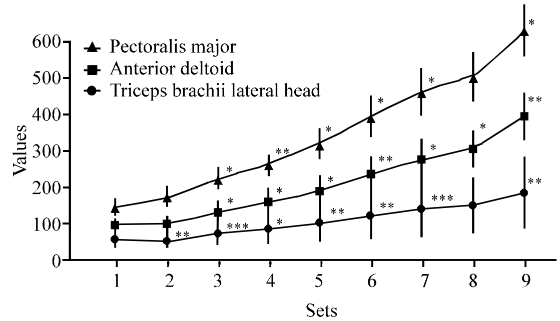

Fig. 5: Change of iEMG between sets during type 4 warm-up; *p<0.05, **p<0.01, ***p<0.001

iEMG difference between 75% and 1RM for each of type 1-4: There was no significant difference in iEMG between the 75% 1RM bench press after warm-up by type 1-4 conditions. The Table for the iEMG difference at 75% 1RM bench press after the preparatory exercise by type 1-4 conditions is as shown in Table 6.

The purpose of this study was to investigate the effect of warm-up intensity differences on iEMG response during bench press.

The warm-up conditions were NONset condition, 3set condition, 6 set condition and 9 set condition and 75% 1RM bench press measured all-out after warm-up. The rest between sets and the break before 75% 1RM bench press were 2 min. All of the iEMG differences in the preparatory exercise in this study increased progressively between all sets except for the difference between 1 set and 2 sets of type 4. However, there was no significant difference between 1 and 2 sets of type 4 but it showed an increasing tendency. As the momentum increases, muscle activity increases and that increase in muscle activity correlates significantly with both EMG and muscle strength (O'Shea, 1996). This suggests that the iEMG increased due to the gradually intensifying fatigue caused by exercise intensity and momentum as the number of sets grew during the warm-up.

In the present study, there was no statistically significant difference in iEMG between sets of 75% 1RM bench presses according to the set of exercise sets. As the load applied to the active muscle increases, the iEMG increases and is associated with the accumulation of muscle fibers (Haff and Triplett, 2015). There is a rate of increase or fatigue and reflexes of motion units and forces. In this study, all four conditions were aimed at maximum repetition at 75% 1RM and it was considered that iEMG values did not showany significant difference regardless of the preparation motions because the active muscles were exhausted.

In this study, the iEMG changes of type 2 and pectoralis major, anterior deltoid, Triceps brachii lateral head gradually increased as the number of sets increased from 1-3sets. The 6 sets of warm-up the iEMG of the pectoralis major, the anterior deltoid and the triceps brachii lateral head of the exercise condition gradually increased from 1-6 sets as the set number increased. The 9 sets the iEMG of the pectoralis major and the anterior deltoid of the exercise condition gradually increased as the number of sets increased from 2-9 sets and the number of sets increased from 1-9 sets And gradually increased.

The 2 sets of exercise intensity at the time when the iEMG of the type 2 pectoralis major roots rose was 50% of 75% 1RM. The 2 sets of exercise intensity at the time when the iEMG of the type 3 pectoralis major roots rose was 40 of 75% 1RM. The 2 sets of exercise intensity at the time when the iEMG of the type 4 pectoralis major roots rose was 30 of 75% 1RM.

The 2 sets of exercise intensity at the time when the iEMG of the type 2 anterior deltoid roots rose was 50% of 75% 1RM. The 2 sets of exercise intensity at the time when the iEMG of the type 3 nterior deltoid roots rose was 40 of 75% 1RM. The 2 sets of exercise intensity at the time when the iEMG of the type 4 anterior deltoid roots rose was 30 of 75% 1RM.

The 2 sets of exercise intensity at the time when the iEMG of the type 2 trceps brachii lateral head roots rose was 50 of 75% 1RM. The 2 sets of exercise intensity at the time when the iEMG of the type 3 trceps brachii lateral head roots rose was 40 of 75% 1RM. The 3 sets of exercise intensity at the time when the iEMG of the type 4 trceps brachii lateral head roots rose was 30 of 75% 1RM. As the intensity of warm-up increases gradually, the muscle fatigue increases and muscle movement leads to additional exercise units which increases the iEMG value (Hakkinen *et al.*, 2003). This suggests that the iEMG has increased due to fatigue caused by increasing exercise intensity and momentum in bench press type 4 of this study. Although, exercise in the absence of warm-up proceeds in a state where the human body is not physiologically ready for respiratory and circulatory functions (Gray *et al.*, 2002). It would not have been achieved. In the present study, pectoralis majors iEMG of 75% 1RM bench press exercise was 121.01±94.19 in the type 1, 132.50±84.23 in the type 2, 131.78±92.43 in the in the type 3 and 140.45±89.90 in the type 4. Anterior deltoids iEMG of 75% 1RM bench press exercise was 199.63±74.86 in the type 1, 183.29±66.13 in the type 2, 180.21±74.35 in the in the type 3 and 184.45±63.25 in the type 4. Triceps brachii lateral heads iEMG of 75% 1RM bench press exercise was 214.65±79.02 in the type 1, 201.55±89.88 in the type 2, 175.10±64.96 in the in the type 3 and 195.67±76.04 in the type 4. In the present study, we did not analyze the ratio of the muscles between the conditions during the 75% 1RM bench press exercise according to the warm-up conditions. However, as shown in the results, the iEMG of the pectoralis major activity is lower than iEMG of the pectoralis major of the exercise conditions, 6 sets of war-up conditions and 9 sets of warm-up conditions and the activity of the foreskin of the anterior deltoid and the triceps brachii is higher. This suggests that the activity of the pectoralis major is not increased without warm-up but the activities of the anterior deltoid and the triceps brachii are increased. This is in agreement with the previous paperthat when the muscle pressures of the pectoral major are low during the bench press, the activity of the triceps brachii increases (Hong, 2007). In the case of the type 4, the iEMG value of the pectoralis major was higher than that of the type 2. This means that, the iEMG values of the 3 sets of the type 4 appears that the increased activity of the pectoralis major by cumulative fatigue is not increased by appropriate warm-up which is similar (Hakkinen *et al.*, 2003). Therefore, although the iEMG value of 75% 1RM after 9 sets of warm-up condition is higher than the iEMG value of 75% 1RM after 3 sets of warm-up condition, the fatigue of large breast muscle. It seems that they did not show cumulative high strength.

CONCLUSION

The purpose of this study was to investigate the effect of four different warm-up conditions on the iEMG of agonist muscles during a 75% 1RM bench press. The subjects were eight healthy males in their 20's from Chungnam Province, Republic of Korea. The iEMGs of the pectoralis major, the anterior deltoid and the triceps brachii lateral head were measured at the bench press. A mixed-design two-way ANOVA was calculated and the significance level was set at $p<0.05$. The conclusion of this study is as follows. First, the iEMG changes of the pectorals major, the anterior deltoid and the triceps major lateral head during the warm-up were gradually increased as the of type 2-4 were progressed. Second as the set of type 2-4 progressed, the iEMG change showed the highest tendency of the triceps brachii lateral head, followed by the triceps brachii lateral head and the pectoralis major. Third, 75% 1RM bench press according to preparation exercise did not show significant difference of iEMG of pectoralis major, anterior deltoid and triceps brachii lateral head. In conclusion, a many number of preparatory exercises result in excessive muscle activity of triceps brachii, resulting in decreased performance in this exercise. Therefore in this study, three sets of preparation exercises are considered to be the most suitable preparation exercise.

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