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Electromyographical investigation of anterior deltoid and trapezius muscles during three different variations of front raise

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Abstract
The purpose of the study was to analyze the muscles activation of Anterior Deltoid and Trapezius muscles while performing three different variations of Front Raise (FR). Ten healthy men volunteers (age = 22.5 ± 1.649 years) performed 5 repetitions of three different variations of Front Raise. Surface ElectroMyoGraphy (SEMG) was used for measuring muscle electrical activity that occurs during muscle contraction. The three different variations of Front Raise (FR) were Prone Grip Front Raise (PGFR), Hammer Grip Front Raise (HGFR) and Supine Grip Front Raise (SGFR). Repeated measure ANOVA identified overall significant differences in both the muscles, while performing the three different variations of Front Raise (FR). LSD Post hoc test was performed to find where the differences exit. It was found that Anterior Deltoid muscle was more active while performing SGFR (1373 ± 106.977) than PGFR (1169.5 ± 131.90) and HGFR (1269.0 ± 112.827). Also while performing the exercises, the anterior deltoid muscles was found to be more isolated in SGFR (964.10 ± 112.1) than PGFR (1040.90 ± 92.117) and HGFR (1036.90 ± 64.129), as with Supine Grip the activation of trapezius muscles was comparatively less. Supine Grip Front Raise is the most effective exercise for the Anterior Deltoid muscle activation as compared to other variations. Even SGFR can be performed for better isolation of anterior deltoid as the trapezius muscles shows less activation in SGFR as compared to PGFR and HGFR.

Keywords: Electromyography, muscle activation, front raise, anterior deltoid and trapezius

1. Introduction
Our Shoulder is the most movable joint in the human body. It plays a key role in nearly every upper body exercises. Even deltoids are among the most important muscles we use in our daily life. While pushing, pulling or lifting things over our heads, the shoulder muscles always come into play. Broad shoulders are one of the most masculine traits that a man could ever possibly have, and almost all men want a set of broad shoulders which makes a person look strong and confident. Also it can even make one's waist look slimmer that gives a look of "V" shaped torso [7].

The deltoid muscle is a rounded, triangular muscle located on the uppermost part of the arm and the top of the shoulder consist of three parts i.e. anterior, middle and posterior deltoid. There are different exercises for each of these different parts of deltoid. Isolation or focus exercises for each muscle is necessary for overall strength, growth and fine shape of the muscle as only one exercise can't solve the purpose. That's why trainers/bodybuilders prefer variation of exercises for overall development of a muscle. Just like on any muscle, one needs to use high volume with low repetitions to make his shoulders grow bigger, broader, wider, and stronger. The more the muscle contraction, more will be the muscle activation.

Electromyography (EMG) is the study of muscle function through analysis of the electrical signals emanated during muscular contractions. It is used to measure the electrical signal associated with the activation of the muscle. This may be voluntary or involuntary muscle contraction. The EMG activity of voluntary muscle contractions is related to tension which means higher the load lift by the individual, higher will be the muscle contraction that results in higher muscles activation [4]. For measuring the activity of superficial muscles surface electromyography (SEMG) is used.

Surface ElectroMyoGraphy (SEMG) is a non-invasive technique for measuring muscle electrical activity that occurs during muscle contraction and relaxation cycles. As the subject contracts the muscles by moving the joints, the electrode detects the action potentials of the muscles and provides an electronic readout of the contraction intensity and duration. EMG is the most accurate way of detecting the presence and extent of muscle activity [1, 2, 6, 8].

As it was discussed earlier that variations in exercises are required for the overall development of a muscle, the purpose of this study was to analysis muscles activation of Anterior Deltoid and Trapezius muscles while performing three different variation of Front Raise (FR).

2. Methods and Materials

2.1 Subjects

A group of Ten healthy male volunteers (age = 22.5 ± 1.649 years) from Lakshmibai National Institute of Physical Education, Gwalior (MP) were recruited on a voluntary basis for the study. The participants were asked to consume a small meal with plenty of liquid 2 hours before testing. Further, the participants were asked not to perform other physical exercises on the day of testing and on the day before testing. All the participants were tested between 10 am and 2 pm on weekdays. All the participants were informed about the purpose and content of the study. The subjects had at least 2 years of weight training experience.

2.2 Exercise Description

Three variations of front raise were selected for the study i.e. Prone Grip Front Raise (PGFR), Hammer Grip Front Raise (HGFR), Supine Grip Front Raise (SGFR). The subjects were familiarized with the exercises, and 10 RM for each subject was determined on a separate day before testing. All the exercises were performed in a proper technique and in a controlled manner that is, lifting and lowering without a sudden jerk or acceleration, for 5 consecutive repetitions. For analysis, the mean value of 5 repetitions (maximum Raw EMG value) was selected for each subject as a raw score for muscle activation.

2.3 Experimental Approach to the Problem

The EMG signals were recorded from the surface electrodes positioned over the 2 muscle bellies (i.e. anterior deltoid and trapezius). The Surface Electromyography signal generated by the muscle fibers is captured by the electrodes, then amplified and filtered by the sensor before being converted to a digital signal by the encoder. It is then sent to the computer by an optical fiber connected to TT USB to be processed, displayed and recorded by the Infiniti software. The MyoScan-Pro sensor's active range is from 20 to 500 Hz. It can record SEMG signals of up to 1600 microvolts (μV), RMS. A/D Converter (Encoder; ProComp Infiniti) has 2 channels (C and D) sampling at 256 samples per second.

2.4 Statistics Analysis

For testing the assumption of normality and to know the nature of data the descriptive statistics (mean, standard deviation, skewness, kurtosis etc.) and Shapiro-Wilk's test was used. All data are presented with their mean and standard deviations. A repeated measure analysis of variance (ANOVA) was used to detect the mean differences between three variations of front raise exercise. For this purpose Statistical Package for Social Science (SPSS) version 20.0 was used. The level of significance was set at 0.05.

3. Results and Discussion

A departure from symmetry can be indicated by looking at the Skewness value, as if the value of skewness is more than twice its standard error then the data is considered to be skewed. Here, from table 1 it can be seen that all the variables are symmetrically distributed as none of the variables skewness is greater than twice its standard error. Similarly, the value of kurtosis for the data to be normal of any of the variable is not more than twice its standard error of kurtosis hence none of the kurtosis values are significant. In other words the distribution of all the variables is meso-kurtic [10].

Further for testing the normality Shapiro – Wilks test was used. It compares the scores in the sample to a normally distributed set of scores with the same mean and standard deviation. If the test is non – significant (p>.05) it tells that the distribution of the sample is not significantly different from a normal distribution (i.e. it is probably normal) and vice – versa. Here from table – 1 we can see that none of the variables p – value is less than.05, hence the data is normally distributed.

Table 1: Descriptive Statistics and Test of Normality

	Prone Grip		Hammer Grip		Supine Grip	
	A.D	**Trapezius**	**A.D**	**Trapezius**	**A.D**	**Trapezius**
Mean	1169.5	1040.90	1269.0	1036.90	1373.0	964.10
Std. Error of Mean	41.710	29.130	35.679	20.279	33.829	35.449
Std. Deviation	131.90	92.117	112.827	64.129	106.977	112.100
Skewness	.161	-.690	-1.009	.208	-.337	-.241
Std. Error of Skewness	.687	.687	.687	.687	.687	.687
Kurtosis	-.856	-.785	1.614	-1.005	-.958	-1.250
Std. Error of Kurtosis	1.334	1.334	1.334	1.334	1.334	1.334
Shapiro – Wilk (p-vaule)	.707	.188	.498	.829	.429	.408

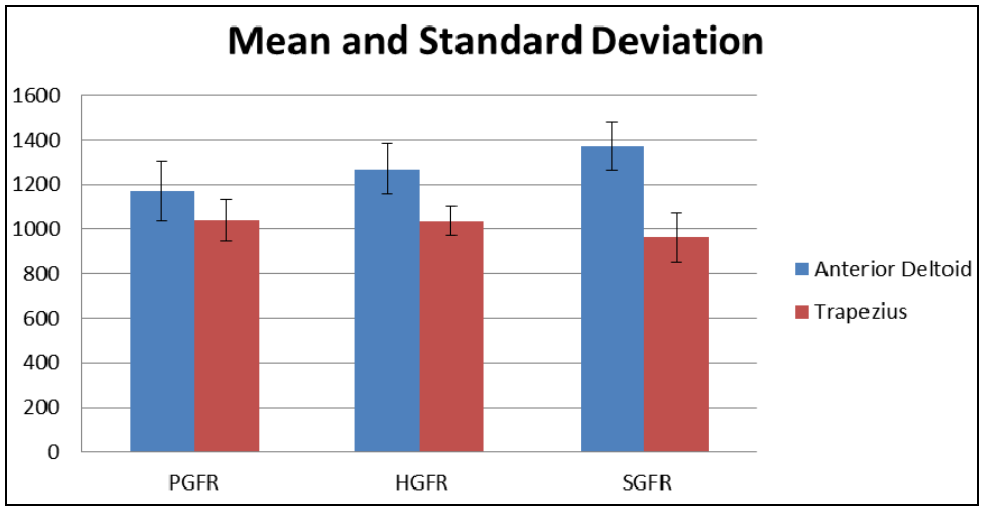

Fig 1: mean value along with the error bars (standard deviation) of muscles activation (Anterior Deltoid and Trapezius) during three different grip Front Raise (FR)

Figure 1 shows that in Supine Grip Front Raise (SGFR) the muscles activation of Anterior Deltoid is more than the other two variations of FR. And in case of Prone Grip Front Raise (PGFR) the EMG response of Anterior Deltoid muscle is lower than the other two variations of FR. Similarly, the Trapezius muscle shows higher muscle activation in Prone Grip Front Raise (PGFR) and lower muscle activation in case of Supine Grip Front Raise (SGFR).

Table 2: Mauchly's Test of Sphericity and corrections

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Anterior Deltoid	.880	1.023	2	.600	.893	1.000	.500
Trapezius	.980	.162	2	.922	.980	1.000	.500

Mauchly's Test of Sphericity was used to test the equality of variances of the differences between the treatment levels. Repeated measures ANOVAs (within-subject factors) are particularly susceptible to the violation of the assumption of sphericity, as violation causes the test to become too liberal (i.e., an increase in the Type I error rate). Therefore, determining whether sphericity has been violated is very vital. Mauchly's Test of Sphericity tests the null hypothesis that the variances of the differences are equal. Thus, if Mauchly's Test of Sphericity is statistically significant (p <.05), we can reject the null hypothesis and accept the alternative hypothesis that the variances of the differences are not equal (i.e., sphericity has been violated) [5]. The results of Table 2 show that the assumption of sphericity has not been violated as mauchly's test was not significant.

Table 3: A summary of the with – in group repeated measure analysis of variance in the three different exercises in relation to muscles activation in Anterior Deltoid and Trapezius

Muscles	Groups	Type III Sum of Squares	df	Mean Square	F	Sig.
Anterior Deltoid	Sphericity Assumed	207095.000	2	103547.500	8.284	.003
	Error	224995.000	18	12499.722		
Trapezius	Sphericity Assumed	37380.267	2	18690.133	4.150	.033
	Error	81057.733	18	4503.207		

The ANOVA table shows that statistical difference was observed when comparing the muscle activation or the EMG responses of Anterior Deltoid and Trapezius muscles with the 3 different variations of front raise exercises. It means the EMG responses of the Anterior Deltoid and Trapezius muscles in various selected freehand exercises were not similar.

In the above table, for both the cases p – value is less than.05. Hence the F-ratio for Anterior Deltoid and Trapezius is significant at 5% level. In this case the null hypothesis is rejected; therefore at least one of the means will be different. Since ANOVA does not tell us where the difference lies; LSD post hoc test was used to get the clear picture.

The result of LSD post hoc test reveals that, in case of the muscles activation in Anterior Deltoid, significant difference was found between Prone Grip Front Raise and Supine Grip Front Raise, which means SGFR is more effective in activating the muscles of Anterior Deltoid than the other variations of the exercises. But it should be noted that the arm should remain straight while performing the Supine Grip Front Raise, flexing arm while lifting weight (SGFR) may activate biceps brachii and put less pressure on Anterior deltoid and Trapezius. When it comes to muscle activation of Trapezius, both the exercises i.e. PGFR and HGFR shows significant differences with the SGFR. This indicates that while performing front raises with Prone and Hammer Grip the trapezius muscles is more efficiently activated than the SGFR.

Variation in exercise is becoming the essence of muscle growth. Variation is all-important for avoiding plateau or for continuous gains, both due to physiological and psychological reasons. Nothing works forever, and without enough variety,

the body will hit the plateau sooner or later – sooner in the case of intermediate and advanced trainees and a little later in the case of beginners [9]. Also, in this study the variation of front raise was selected for better results, better isolation and continues growth of the muscles. Supine Grip Front Raise was found to be a good variation of Front Raise exercise.

4. Conclusion

This study compared the muscle activity of Anterior Deltoid and Trapezius during three different variations of front raises. Supine Grip Front Raise was found to be the most effective exercise for the Anterior Deltoid as compared to other variations. Also while performing the exercises, the anterior deltoid muscles is found to be more isolated in SGFR than PGFR and HGFR, as with Supine Grip the activation of trapezius muscles is comparatively less. Further it was concluded that Supine Grip Front Raise was an effective variation of Front Raise exercise for working on anterior deltoid.

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