Neuromuscular Adaptation During Resistance Training In Untrained Men

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ABSTRACT

The purpose of this study was to investigate effects of resistance training (12 weeks) on neuromuscular adaptations. 24 healthy male students were divided randomly in two groups: resistance group (n=12) and control group (n=12). The resistance group performed (70-85% 1RM) in 3 sets with 12, 10, 8 times repetition respectively and surface electromyography (SEMG), Maximal voluntary contraction (MVC), One repeat Maximum (IRM) assessment were made before, at the middle and after training. Data were analyzed with T test. In resistance group mean signal (EMG) increased significantly until the 6th week but after the 6th week it decreased and in control group there wasn’t any significant changes. In resistance group 1RM and MVC increased significantly until the 6th week and these conditions continued significantly from the sixth weeks till the twelfth week. The relationship between Amplitude of EMG and force of muscle was linear until the 6th week of training and this relationship was unlinear after the 6 week, so it is concluded that neuromuscular adaptation in resistance training depends on duration of training.

Key words: EMG, resistance training, neuromuscular adaptation.

Introduction

The development of diameter of muscle fiber or the mass of muscle may not be completely accounted by increase of the primitive contraction force, but also the neural drive of muscle fibers has an effective role in the improvement of maximal contraction force caused by training [1]. One of the best methods to evaluate neuromuscular adaptations is implementing resistance training. Resistance training affects motor units of the body which leads to special adaptation [2]. Some studies have reported that the increase in the Amplitude (SEMG) of muscles which happens because of resistance training especially during 3-4 first weeks of training, is a proof for the neural adaptation (increase in recruitment of motor units) in muscles [3-5]. On the other hand, some other studies have reported that no changes have occurred in the Amplitude (SEMG) of muscles after training [6-9]. Many factors play a role in the relation between the Amplitude of (SEMG) and the force produced by the muscles. These factors include the produced action potential of muscle fibers, the mechanical characteristics of motor units, the recruitment of motor units, estimation of action potential of motor units, the specified time of charge disc of motor units and increase in coordination level of motor units caused by exercise. In spite of the proves at hand which show the importance of neural mechanisms in resistance training, little progress has been achieved in recognizing the particular mechanism of this adaptation and the aim of this study is to investigate the relation between the Amplitude (SEMG) and production of force during 12 weeks of resistance training.

Materials and Methods

Subjects:

Twenty-four healthy men volunteered to participate in the present study. Subjects were
randomly divided into two groups: resistance group \( n=12; \) mean (SD) age 22 (1.19) years, height 173.6 (4.37) cm, and control group \( n=12; \) mean (SD) age 21.28 (0.48) years, height 176 (0.31) cm.

All subjects were considered untrained and had not participated in a regular exercise program for at least 3 months prior to the start of the study. The subjects were carefully informed about the design of the study with special information on possible risks and discomfort that might result, and subsequently signed an informed consent document prior to the start of the study. Subjects were not on any medications that would affect physical performance. In table 1 the descriptive features of the sample are illustrated.

<table>
<thead>
<tr>
<th>Table 1: The descriptive features of the sample</th>
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<tr>
<td>Group</td>
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<tr>
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<tr>
<td>Training</td>
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<tr>
<td>Control</td>
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Measurement:

The subject were carefully familiarized with the testing procedures during the actual testing occasion and two to three warm-up contractions were performed prior to the maximal test action.

Measuring The Maximal Voluntary Contraction:

The subject was in a seated position on isokinetic instrument (Biodex Model) so that the hip angle was 110. On verbal command the subject performed a maximal voluntary contraction concentric leg extension starting from a flexed position of 70 trying to reach a full extension of 180 against the resistance determined by the loads (kg) chosen. Then twenty minutes later the sample was asked to try three more contractions with 80 percent of his maximal voluntary contraction and the best was recorded [4].

Electromyography measurement:

In this study EMG activity, concurrent 80 percent of maximal voluntary contraction was recorded from the vastus lateralis muscle. The length of the signals was 15 seconds. The collected signals in the first and last three seconds were not used for analysis. In this procedure voluntary maximal muscle contraction was fixed around 80 percent of the maximal muscle contraction and the procedure was carried out three times before, at the middle(6weeks),and after (12weeks) the training.

The Measurement One Repetition Maximum:

The calculations are done by means of Technogym machine (made by Italy), using computer software and the following formula:

\[
1\text{RM} = \frac{\text{weight(kg)} - (\text{repetition} \times 0.0278)}{1.0278}
\]

Resistance Training Protocol:

12 weeks of resistance training included three periods of four-week training which according to the over-load rule the 1RM was calculated at the end of each period and the training continued. The exercises were done three times a week which included leg press, leg extension, leg curl, abduction and adduction exercises for the knee. The big muscles before the small muscles and multi-joint exercise (leg press) were performed before the single joint exercises. The exercises in the first four sets of warming up were performed with 50 percent of 1RM and in the next sets were performed with 70,80 and 85 percent of 1RM and with repetitions of 8,10,12 accordingly [15].

Statistical Analysis:

Descriptive statistics were used to derive means and standard deviations (SD) for all variables, and data are presented in the form mean (SD). Independent sample t-test was used to compare between two groups. The level of significance was set at p<0.05 for all tests. All analyses were performed using SPSS version 16.

Results and Discussion

The quantities for Amplitude of EMG, MVC and 1RM of vastus lateralis muscle (VL) belonging to the control group and resistance group is illustrated in table 2. Six weeks of training had has significant effects on the Amplitude of EMG of (VL) muscle (p =0.001, t=9.73) but in the control group there had not been any significant changes (p = 0.739, t=0.342). 12 weeks of training has had significant effect on the Amplitude of electromyography signal of (VL) muscle (p =0.001, t=4.2) but in the control group there had not been any significant changes (p =0.938, t=0.08). Also from the sixth week to the twelfth week the training group had reduced the amplitude of electromyography signal of (VL) muscle significantly (p =0.001, t=1.05). Six weeks of training had increased the 1RM significantly (p=0.001, t=20.8), but in the control group there had not been any significant changes (p=0.001, t=0.265). 12 weeks of
training had significant effect on the 1RM (p=0.001, t=21.3), but in the control group there had not been any significant changes (p=0.859, t=0.181). Also from the sixth week to the twelfth week the 1 RM in training group had increased significantly (p=0.001, t=16.5). Six weeks of training had increased the MVC significantly (p=0.001, t=12.3), but in the control group there had not been any significant changes (p=0.859, t=0.181). Also from the sixth week to the twelfth week the MVC in training group had increased significantly (p=0.001, t=8.4).

Table 2: The quantities for the Amplitude of EMG, MVC and 1RM belonging to control group and training group

<table>
<thead>
<tr>
<th>Variables</th>
<th>Control group</th>
<th>Training group</th>
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<tr>
<td></td>
<td>Before the test</td>
<td>At the middle of the test</td>
</tr>
<tr>
<td>Amplitude of EMG</td>
<td>249.78</td>
<td>249.95</td>
</tr>
<tr>
<td>One maximal repetition</td>
<td>82.83</td>
<td>82.74</td>
</tr>
<tr>
<td>Maximal voluntary</td>
<td>145.41</td>
<td>145.08</td>
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</table>

Discussion:

The most important finding of this study shows that neuromuscular adaptation correlates with the kind of training and the duration of training. Physical activity is one of the factors which by exerting pressure on different parts of the body and changing the quality and function of systems in the body. The musculoskeletal system is one of the systems which are capable of structural and functional adaptation when exposed to training. This system is composed of two parts: nerves and muscles. It has been proved that when a muscle under training, especially resistance training of the kind hypertrophy, muscles become stronger. The strength increase is often parallel with increase of the mass of muscles (structural adaptation) and their fibers (muscular hypertrophy). It has been proved that the strength of muscles can increase because of the change in the function without increase in the mass of muscles. These changes in the function are not only related to the contraction of muscles (structural adaptation) but also the nerves or neuromuscular unit contribute to these changes.

In other research the role of nerve system adaptation in increase force of muscle is shown in two ways: Firstly by showing the changes in neural parameters which is caused by taking part in training and secondly, since the created changes in muscle strength is not parallel with its structural changes, which is believed to be reflected as mass increase in the muscle. Folland (2007) reported that there is a lack of proportion between increase of muscle force and its size. Especially in the first stages of training the role of nerve adaptation can be emphasized [11]. Garner (2008) reported that the amplitude of electromyography signal and the mechanical tension during isometric contractions correlate with each other. Furthermore, increase in the amount of contraction forces leads to increase in the number of motor units [12]. Some other studies show that there was an increase in the amplitude of electromyography signal because of resistance training during the first weeks [3-5].

All in all, all the studies have claimed that if nerve adaptations are to happen there will do so in the first weeks of resistance training. The findings of this study show the increase in the amplitude of electromyography signal, 1RM, and maximal voluntary contraction until the 6th week.

This is because there has been an adaptation gained from training in which the individuals have trained their muscles voluntarily [3, 13]. And this is probably because of increase in recruitment of motor units and their coordination [10, 14]. There is a linear relation between the amplitude of electromyography signal and the force produced by the muscles. Since the structural adaptation (muscular hypertrophy) which leads to increase in force of muscle happens after a few weeks of training, the findings of this study show that from the sixth week to the twelfth week the relation between the amplitude of electromyography signal and the force produced by the muscles is no linear, this is because there has been a decrease in the amplitude of electromyography signal and an increase in maximal voluntary contraction and 1RM. The fact that there is no linear relation here is probably because of the speed of charge disk of motor units, and decrease in recruitment of motor units and reduction in co-activation of antagonist muscles. By putting together the findings of this study it is concluded that resistance training of the kind hypertrophy has been valued as a good exercise in recent years for medical and rehabilitation purposes and prevention from injuries.

Conclusion:

Changes in neuromuscular pattern construction depend on the period of training. In our pattern in the first weeks of training there is a linear relation between the amplitude of electromyography signal and the force produced by the muscle, but from the sixth week on, the relation between the amplitude of
electromyography signal and the force produced by muscles is not linear.

Acknowledgements

This study was supported by a grant from the science and research branch, Islamic Azad University, Tehran, Iran. The authors would like to express their thanks to the subjects who took part in the study.

Reference