Effect of Pulsed Shortwave Diathermy on Average Isometric Peak Torque of Quadriceps Muscle in Normal Subjects

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ABSTRACT

Objective: To study the effect of deep heating produced by a 20 minute application of thermal pulsed shortwave diathermy on isometric average peak torque of the quadriceps muscle in normal subjects.

Methods: Fifteen normal subjects participated in this study. They were tested before and immediately after the application of pulsed shortwave diathermy using isokinetic dynamometer. The testing procedure consisted of 3 consecutive repetitions of maximum voluntary isometric contraction trials of the dominant quadriceps femoris muscle on isokinetic dynamometer.

Results: There was no significant effect of using pulsed shortwave diathermy on isometric average peak torque of quadriceps in normal subjects.

Conclusion: The finding of this study suggests that the isometric average peak torque of quadriceps is not influenced by single session of thermal pulsed shortwave diathermy.

Key words: Shortwave diathermy, Quadriceps muscle, Heating, Temperature, Peak torque.

INTRODUCTION

Methods of warm-up can be divided into two categories, passive and active (1). A passive warm-up involves increasing muscle or core temperature through the use of heat modalities (2). Active warm-up is the increase in muscle or core temperature through exercises (3).

The value of warming-up is a worthy research problem because it is not known whether warming-up benefits, harms, or has no effect on individuals (4). Research is conflicting in regards to the beneficial effects of heating on strength performance. Variations in intensity of temperature, method of heating and site of temperature measurement are diverse among studies (5, 6).

Some investigators (14, 15) found a significant correlation between muscle temperature and maximal isometric strength in normal subjects and reported a significant increase in isometric muscle strength after increase of muscle temperature by active warm-up. In another studies (16-18) in which shortwave diathermy was used as a method of deep heating, a significant
increase in quadriceps isometric strength was observed.

On the other hand, some investigators (19-21) found no significant change in muscle strength after immersion in 40°C water bath heat application in normal subjects. Other studies (22-24) found that muscular strength did not change significantly in any of the passively heated conditions compared to the controls. In addition to that a study by Thornley et al (25) found that an isometric knee extension peak torque was not significantly affected by local different temperature gel pack application.

The relationship between deep heat and muscular strength has received limited attention. Furthermore, there are contradictions between the limited numbers of studies that examined the effects of passive deep heating on muscle peak torque. Consequently there is a great need for more research in this area in order to reach a conclusion. Therefore the purpose of this current work is to examine the effect of using pulsed shortwave diathermy on average isometric peak torque of quadriceps in normal subjects in an attempt to use this information in clinical practice to enhance muscle performance.

MATERIALS AND METHODS:

Participants

Fifteen normal male and female subjects with age ranged from 20-35 years with a mean of 28.73 (±4.44) and body mass index ranged from 22-26.5 kg/cm² with a mean of 26.42(±3.32) participated in this study. All the participants provided written informed consent prior to the participation in the study.

Exclusion criteria

Subjects with Metal implants, cardiac pacemakers, peripheral vascular diseases of the lower limb, pregnancy, fever, professional athletes, history of lower limb pain within the last 3 months, history of cardiovascular or sensory problems were excluded from the study.

Instrumentation

A. The Biodex system 3 isokinetic dynamometer: The Biodex system 3 isokinetic dynamometer multi-joint testing and rehabilitation system (Biodex medical system, Shirely, New York, USA) is one of the modern isokinetic systems that are widely used in research, clinical settings and rehabilitation (Fig. 1).

B. Shortwave diathermy: Diatermed II 4022 device manufactured by Carci Ltd, Brazil was used in this study (Fig. 2).

PROCEDURES:

Assessment procedure of quadriceps isometric average peak torque

Each subject was familiarized with testing procedure by performing 3 consecutive learning trials for quadriceps muscle. The subject was instructed to sit on the biodex chair with knees off at the edge of the chair, adjusting the back support to allow hip angle of 85 degree to the horizontal. The subject was stabilized in the test position by straps around the trunk and thigh. The inferior portion of the shin pad was adjusted 2 inches above the medial malleolus of the tested limb. The fulcrum of the lever arm was aligned with the most inferior aspect of the lateral epicondyle of the femur of the tested limb (anatomical axis of rotation of the tested knee). The speed of dynamometer was set at zero degree per second (isometric contraction) and the knee was positioned at 60° flexion as recommended by (26-30) as shown in (Fig.3).
Each subject was instructed to hold into the sides of the chair with both hands during the testing procedures. Subject was instructed to perform three consecutive maximum voluntary isometric contraction (MVIC) trials of the dominant quadriceps femoris muscle group. Each trial was held for five seconds which was followed by relaxation for five seconds. During the test, each subject received constant verbal encouragement to exert his maximum effort.

The final result of isometric strength testing were provided in the form of testing data chart and graph record. The mean value of the 3 repititions of the experimental set in newton meter (Nm) was selected as an indicator for the quadriceps average isometric peak torque. This was done before and after the experimental procedures.

**Experimental procedure**

The diathermy unit used was diatermed II 4022, with frequency of 27.12 MHz. The diathermy was set to a treatment time of 20 minutes; Peak power (PP) of 250 W and pulse width (PW) of 400 μs. The maximum power supplied by the equipment was used with a pulse repetition rate (PRR) of 400 Hz in order to obtain a mean power (MP) of 40 W based on the work of (11, 31, 32).

The participant was positioned in supine lying on the treatment table. Shortwave diathermy application was given in pulsed mode, through coplanar technique. Capacitive electrodes were used and one of them was placed 3 cm below the anterior superior iliac spine and the other electrode was placed 3 cm above the patella as recommended to be used by (30) and showed in (Fig.4). This procedure was done for each subject in this study. This was preceded and followed by isometric assessment of quadriceps peak torque.

**Data analysis and results**

For the purpose of data analysis the statistical package for the social sciences (SPSS) computer program (version 18 windows) was used. P-value ≤ 0.05 was considered significant.

Kolomogrov-Smirnov test was used to test the normal distribution of the study variables before and after assessment. Paired t-test was used for comparison within group.

Kolomogrov-Smirnov test showed that age, weight, height, body mass index, isometric average peak torque before and after the experimental procedure were normally distributed as shown in table (1).

<table>
<thead>
<tr>
<th>Variables</th>
<th>z-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>0.57</td>
<td>0.89</td>
</tr>
<tr>
<td>Weight (Kg)</td>
<td>0.71</td>
<td>0.69</td>
</tr>
<tr>
<td>Height (cm²)</td>
<td>0.75</td>
<td>0.61</td>
</tr>
<tr>
<td>BMI (kg/cm²)</td>
<td>0.72</td>
<td>0.67</td>
</tr>
<tr>
<td>Isometric average peak torque before</td>
<td>0.46</td>
<td>0.98</td>
</tr>
<tr>
<td>Isometric average peak torque after</td>
<td>0.90</td>
<td>0.39</td>
</tr>
</tbody>
</table>

**Effect of pulsed SWD on isometric average peak torque of quadriceps**

There was no significant difference between the pre heating mean of 134.42(± 40.68) and the post heating mean of 132.93(±30.15) with t-value =0.22 and P =0.82 as shown in Fig (5).
DISCUSSION

There was no significant effect of using pulsed shortwave diathermy on isometric average peak torque of quadriceps muscle in normal subjects. The result of the current study is consistent with the theory which states that increased muscular temperature may increase action potential, conduction velocity, the rate and synchronization of cross bridge cycling, thereby increasing dynamic, but not isometric strength (6, 33). The finding of this current study coincides with previous research studies (1,6, 19, 24,34) who found that warm-up did not affect isometric strength.

Torque did not change during maximal voluntary contraction associated with heat produced by shortwave diathermy which can be explained by the fact that there is no need of greater blood, nutrients, ATP or oxygen contribution, since it is a voluntary phasic muscular contraction of high intensity and short duration, in which the proposed interval is sufficient to totally recover the energetic supplies (30, 35).

Another explanation why no significant change was noted could be attributed to the application of a single treatment of thermal pulsed shortwave diathermy rather than a series of treatments. The additive effects of pulsed shortwave over a series of treatments is a question yet to be addressed by researchers.

In agreement with the finding of our study, Bhoir (36) conducted study to determine the immediate effect of heat application upon hand grip strength measured with dynamometer. Pre-intervention grip strength was assessed for individuals who were asked to dip hand in hot water (40°C-42°C) for 30 second. Immediately after dipping grip strength was reassessed. They found that there was no significant increase in grip strength after heat application.

On the other hand, our finding is not supported by some previous investigators (16, 37, 38) who found that isometric strength was decreased after heat application. While others (17, 39, 40) showed an improvement of muscle performance after passive or active warm-up. These different findings may be due to the variability in the degree of temperature increase and warm-up methods as well as testing protocols.

Summary and conclusions

The thermal effect generated by pulsed shortwave diathermy did not show significant increase of isometric average peak torque of quadriceps muscle in normal subjects. A single 20 minute pulsed shortwave diathermy application on quadriceps muscle with mean power of 40 W was not effective to increase quadriceps isometric average peak torque. Multiple sessions and different parameters of pulsed shortwave diathermy may be required to produce a significant effect.

Acknowledgement: The authors would like to thank all the participants who kindly accepted voluntarily to participate in the study.

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