Original Article

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Effects of Temperature on Elbow Flexor Muscles (Biceps) Endurance

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Abstract

Background: Body temperature is other biologinal factor , which is known as an important indicator of muscles function. The aim of this study was to investigate the effects of temperature on elbow flexor (Biceps) muscles endurance. *Methods*: 40 male subjects (22.77±2.11, mean height of 174.99±7.57 cm and mean weight of 63.77±6.45 kg) participated in the present study. The biceps muscles endurance was measured before and after applying ice and hot packs over the forearm for 15 minutes. *Results*: The results showed a significant increase in biceps muscles endurance after heating. (r=0.57, p=0.001). it was found that, cooling the muscles leaded to significant decrease of biceps muscle endurance (P=0.214).*Conclusion*: These results suggest that elbow flexors is temperature sensitive. Therefore, further studies are needed to evaluate the effects of Heat and cold on muscular function in people working in workplaces with extreme temperature like many other biological factors, body temperature is known as an important indicator of muscles function.

Keywords: Elbow Flexor Muscles; Temperature; Muscle Strength; Endurance.

Introduction

Increasing the muscle temperature affects the contractile characteristics of muscles including rate of force production and relaxation as well as contractile velocity [1].

Most previously published measurements of the power output of skinned mammalian muscle fibres have been made at temperatures below 20°C. Power output is known to be very temperature sensitive, so it is not surprising that most of the earlier measurements are well below the value of about 100 W kg^{-1} at 20°C which West et al.found for both the rabbit and cheetah fibres (red square and red cross). The only published value for skinned fibres at temperature higher than 20°C is for rat fibres at 30°C, which produced power of 166 W kg^{-1} [2].

According to Budoff Je [1],Fry, Ac, et al [2]. Smith,T,et al [3], and Yasuo, G, et al [4], Many daily functions and sporting events require high activity levels of the flexor musculature of the forearms and hands. These are the muscles involved in gripping strength. From sports like tennis and baseball to daily activities such as carrying laundry, turning a doorknob, and vacuuming, some degree of grip strength is necessary to be successful. For example, without adequate grip and forearm strength, tennis players may run the risk of developing lateral epicondylitis, otherwise known as tennis elbow. Often overlooked or taken for granted, the strength of one's grip plays a key role in injury prevention and overall strength development. The same is the case with cricket bat gripping and upper body strength, where if not properly done the players may run the risk of developing injury risk [3-5].

In addition, warming the whole body affects the blood flow to the central parts of the human body and lessens the dynamic training capacity and muscles endurance. Furthermore, it may also impose an extra load to the cardiovascular system so as to meet the activated muscles biological needs .The high temperature environment might altered motor units firing rate as well. It is happened by improving the rate of force development and relaxation in higher temperatures in comparison with lower temperatures. Motor units firing rate is determined as a predictor for the amount of muscles force production. Therefore, the human body reduces its muscles force

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in order to protect the whole body from the probable injury of extra heating. Nonetheless, heat is commonly used in physiotherapy and sport training to enhance muscular capability [6-7].

Temperature is an important determinant of skeletal muscle function. Like most biological processes, skeletal muscle contraction is temperature sensitive. It has been known that important parameters like maximal isometric force production, the rates of force development and relaxation and maximal power production strongly depend on temperature. A greater muscle blood flow with elevation of intramuscular temperature would increase oxygen supply, thus potentially improving muscle function [8].

Physical therapists clinically use hot pack to decrease the muscle pain and spasm and to increase the extensibility of soft tissues; also, cold pack has been used for the treatment of acute musculoskeletal injuries. The relationship between local tissues 1.

Methods

A total of 40 Participants were recruited from the general community with age group 20-25 years male. The whole procedure was completely explained to them and they signed the informed consents prior to participating to the study.

Participating in any regular sport or gym activity and any history of traumatic injury, neurological disorders, skin disorders, to upper extremities were recognized as exclusion criteria. Sport and gym activity considered as exclusion criteria to diminish any confounding effects of muscle tolerance to increase the temperature.

Participants were asked to sit on a chair, put their forearms on the armrest in a way that shoulder adducted and in neutral rotation, elbow neutral, forearm supinated and wrist in 0^0 extension. The subjects were asked to squeeze the dynamometer three times, for the testing positions with 1-minute resting period between each trial in order to overcome fatigue. To measure the strength of elbow flexors after taking all 3 readings we calculated the mean of the readings. The final mean strength was noted for data analysis. After a 10 to 15 minute rest, participants Then, a 40-42 degree hot pack was applied biceps muscle for 15 minutes. Afterwards, same procedure was applied for measurement of strength /endurance of elbow flexors with a 2-day wash out, the procedure was conducted again on the same participants. Although in the second session participants' forearms were exposed to an ice pack cooled in refrigerator temperature (0 centigrade degree). Before and immediately after the 15-minute ice application, elbow flexor muscle endurance was assessed. A methodological study has been conducted prior to the main procedure to evaluate the intra examiner reliability for measuring the endurance of elbow flexor muscles in which the muscle endurance was measured two times, one day apart, prior to the performing the main study

Results

The male subject selected in the study had a mean age of 22.77±2.11, mean height of 174.99±7.57 cm and mean weight of 63.77±6.45 kg.

The Effect of Temperature on Elbow Flexor Muscles Endurance

	Pre	Post Heating	Post Cooling
Elbow flexor muscles endurance	38.99±5.66	40.66±6.5	36.33±5.43
Skin Temperature (c°)	37.3±0.25	38.7±28	34.33±1.07

For correlation of hot application and muscle endurance (r=0.57, p=0.001) which means that application of hot will increase muscle endurance as compare to application of cold (r=.233, p=.214).

The paired t-test revealed that applying hot pack induce a significant increase in the muscle endurance (P=0.001) while the application of ice pack reduced the muscle endurance significantly (P=0.214). The skin temperature improved significantly after heating, whereas decreased by cold pack (P<0.001).

Discussion

The results of the present study demonstrated a significant increase in elbow flexor muscles endurance after heating them Temperature is considered as an important determinant of muscles function. There are two theories which explain the effects of heating on muscles function. In the first view, it is assumed that increasing in muscles temperature lead to enhance muscles function due to more blood flow to the muscles. This theory has been developed based on the results of previous

studies demonstrating an improve in dynamic training capacity followed by active or passive muscle warm up. Contrary to this, the second theory explains the fact that doing exercises in a hot environment reduces dynamic training capacity due to general fatigue presumed as a result of core temperature increase [6-7].

The present study results are in accordance with the study done by Nodehi-Moghadam A et al.(2014) which suggest that application of applied a hot pack on wrist flexor muscles and the muscle endurance was improved probably due to enhanced blood flow to the muscles. The second theory was not checked in our study as we heated the muscles locally. Therefore we did not confront negative effects of general heating and its impact on core temperature the contractile velocity increased significantly in this temperature range [8].

Temperature is considered to be significant determinant of skeletal muscle function and performance. Muscle force generation and power output vary with changes in body temperature. An optimal temperature range at which the best performance of muscle isometric contraction occurs has been described. It has also been demonstrated that muscle contraction forces and rate of force development were impaired at low muscle temperatures and voluntary muscular force production capabilities were reported to be affected below 27^0C without core temperature change In fact, Rutkove showed that even a low degree of cooling decreased the rate of muscular force production [9].

The adductor pollicis muscle in man, when cooled from 38 to 28 deg C and stimulate with electrical stimulation also showed little effect of titanic strength by temperature. Below this temperature maximum strength was rapidly reduced. The same results were seen in the human quadriceps by Gerrits et al (2000) while half relaxation time was inversely related to muscle temperature [8]. A significant decrease in Maximal Voluntary Contraction (MVC) strength in the order of 10% was recorded in the TA after cooling; however, there was no change for the GM. Several studies have shown that cooling with water decreases isometric strength in superficial muscles. Holewijn and Heus also monitored a drop in maximal handgrip force after 30min local cooling at 15^0C. Comeau et al. evaluated the effects of environmental cooling on force production in the thigh muscles and registered a significant force drop in the quadriceps and hamstrings at temperatures 10 °C or below [9-11] as per study done by Mark W. Cornwall (1994) In both male and female subjects, the force-time curve shifts to the right following cold application but not with heat application [12].

Conclusion

The results of the present study demonstrated that grip capability is related to the muscles temperature. Increase in muscles temperature caused muscles endurance enhancement. However, applying cold on the muscles reduced their endurance.

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