

## Impact of classical massage on temperature, strength and flexibility of upper limbs muscles in healthy men

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### Abstract

**Introduction.** Thermography is a one of new non-invasive method using to assess the impact of physiotherapeutic treatment for the human body. **Aim of Study.** The purpose of this study was the qualification of dependence between application of classical massage of hand and forearm and the temperature of muscles surface of the upper limb and the strength of hand and the range of motion in radio-carpal joint. **Material and Methods.** The research embraced 12 men aged 19-23 years. The Flir A325 camera was used for thermal imaging. The measurement of hand strength was made by means of analog dynamometer, and the range of motion in radio-carpal joint – was measured with the goniometer. All tests and measurements were performed twice – directly before and after the massage of hand and forearm (the right limb). Classical massage was performed on the dorsal and palmar surface of the hand and on front and back of the forearm. **Results.** After the massage the superficial temperature of massaged (studied) limb significantly rose. There was also noted some essential difference of temperature of the back surface of the limb not being massaged (control). One did not, however, observe any differences of temperature of the front surface of the left forearm and shoulder. The broadening of the range of motion in radio-carpal joint of the right limb (in all surfaces) was shown. There were no characteristic differences in the hand strength measured with the dynamometer before and after applied massage. **Conclusions.** The classical massage, though it increases the temperature of muscles and affects the enlargement of effort tolerance, is not a sufficient means for preparation to physical effort. Due to massage, the range of motion in the joint of massaged limb broadened, therefore, the effect of applied treatment is mostly loosening.

**KEYWORDS:** thermography, massage, upper limbs, untrained men, hand grip, range of motion.

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### What is already known on this topic?

Massage is the most popular physiotherapeutic treatment using to improve effects of sports training. However there is difficult to objective assess their influence for the human body. One of the new simple non-invasive method of verification physiotherapeutic treatment is thermography.

### Introduction

One of basic conditions of the preparation to effort is performing a suitable warming up. Customary practical solutions in warming up (especially in its initial part) consist of exercises which will increase general temperature of the organism. The increase of body temperature and first of all working of muscles is to improve the condition of their functioning. It was proved that the duration, power as well as speed of muscles contraction are strongly connected with

the temperature. It is accepted that as result of correct warming up – the temperature inside muscles, measured on the depth of several centimeters, can increase about 2-4°C, regardless of the depth of measurement (1-3 cm). This in turn, can contribute to 15-20% increase of power generated by muscles. The effect of this activity is the increase of contraction ability of muscles and rise of their mechanical efficiency [1, 2].

The rising of body temperature can take place as a result of active warm-up or passive warm-up. Passive methods used to elevate the internal temperature are based on the effect of external factors. Those can be e.g. sauna, hot bath, diathermy, massage (rubs) or hot compresses. From the competitor's point of view, the basic advantage of passive methods is the lack of necessity of spending his/her own energy on increasing body temperature [3].

The most often used supplementary form of the preparation to exercise is the massage. It has local and general effect on the organism. The local effect refers mostly to improvement of blood supplies and nourishing of massaged tissues, in this mostly these committed into planned physical effort. The systemic effect of the massage is connected with the haemangiectasia and enlargement of blood flow in all tissues and organs of the organism, what translates into effort tolerance of the organism [4, 5]. Externally observable effect of the massage should be heating of tissues, as the result of mentioned enlarged flow of blood [6].

The qualification of best massage in the range of power, duration or techniques can be the potential problem. It seems also that the reliance only on subjective feelings of the massaged person is inadequate for the verification of the efficiency. The internal thermometry of the body in turn does not have to reliably inform about local state because there are differences in the temperature dependent, among other things, on the distance of the position of given body part from the core. Distal parts are characterized with the lower temperature [7].

Changes in the internal temperature find their own reflection in the temperature registered on the skin surface, because it is influenced by tissues of organs situated inside the body, a thermal conductivity of the adipose tissue and muscular as well as thermal emission of the skin itself. The temperature measured on the skin surface stays, therefore, in the close relationship with the temperature of internal organs and thermal properties of depicted tissues. That is why; seeking

most proper diagnostic methods we ought to direct the attention toward the spectroscopy. Thermal imaging can have significant diagnostic proprieties, among other things in medicine or sport as the method is completely safe and non-invasive [8].

### **Aim of Study**

The main cognitive objective of this research was the qualification of dependence between the application of classical massage on the hand and forearm and the temperature of muscles surface of the upper limb and the hand strength and the range of motion in radio-carpal joint – at healthy, inactive men.

### **Material and Methods**

12 healthy men not practicing sport were studied. The average age of studied persons was 20.67 years ( $\pm 1.49$ ), the body mass 78.58 kg ( $\pm 16.75$ ), and the body height 179.67 cm ( $\pm 7.59$ ).

The Flir A325 camera was used for thermal imaging. The camera had a valid certificate. Additionally the camera was calibrated for reproducibility and accuracy of readings according to the Glamorgan's guidelines. Care was taken to ensure that the camera was perpendicular to the scanned surface. The distance between the camera and the object photographed was 2,5 m, the ambient temperature was 22-24°C and humidity 48-50%. Before each thermography the humidity was measured with a hygrometer [9, 10].

Hand strength was measured by means of analog dynamometer. The dynamometer had an option of regulating the arrangement of the handle to individual preferences of the person exercising. The measuring exactitude of the device was 0.1 N. Measurement in compliance with the guidelines of American Society of Hand Therapists was performed in the basic position with the hand along the trunk, without the contact with other body part [10, 11]. The measurement of radio-carpal joint mobility was made with the goniometer. The range of motion was observed in two surfaces: fibular (flexion and extension) and frontal (abduction and adduction). All tests and measurements were performed twice – directly before and after the massage of the hand and forearm. All persons had the right limb massaged; however, measurements were made both on the right limb – studied, as well as left – control. Everybody were right-handed.

Classical (manual) massage was applied on the dorsal and palmar surface of the hand and front and back of

the forearm. The person massaged was arranged in the lying position on the back with the upper limb in light abduction. In compliance with the methodology of classical massage there were used techniques which are recommended for the purpose of achieving the neuromuscular stimulation and preparation of muscles to the effort. Therefore, there was used: stroking with the aim of warming and giving elasticity to skin, the increase of secretory functions of sweat-glands and of tallow. Then one used rubbing to cause congestion of massaged areas, to enlarge the elasticity of muscles, tendons and whole copula-articular system and to eliminate muscular indurations of various origins. Kneading was used for the purpose of regulation of muscular tonus (with mechanical influence on deep sensibility receptors), acceleration of blood and lymph circulation making easy the tissue exchange in muscles (nourishing and metabolites lead). All techniques were performed fluently, but energetically [4, 12].

To elaborate empirical given there were used statistical tools such as the arithmetical mean together with the standard deviation and Wilcoxon signed-rank test. Level  $p < 0.05$  was established as of minimum significance. Calculations were performed with the Statistica 10 program under the license of the Medical University of Warsaw.

**Results**

As the result of applied massage the superficial temperature of the right forearm increased significantly. However, there were no significant differences of the temperature of the left forearm and shoulder and the right shoulder noted (Table 1).

Due to massage also increased the range of motion of flexion, extension and abduction in radio-carpal joint of the right limb. The difference yet was close to being significant. In the left limb there were not observed any characteristic differences in all motions (Table 2).

There were observed no characteristic differences in hand strength measured with the dynamometer before and after the applied massage (Table 3).

**Discussion**

Obtained results do not allow the univocal estimation of the influence of massage on physiological parameters of upper limbs. Difficult is also the estimation of its effect as the form of preparing for the physical effort. On one hand one the enlargement of the motion range was obtained in the joint, on the other however, there was no essential influence of the massage ( $p > 0.05$ ) on hand grip strength. The ascertainment can be ventured that the decisive role for obtained effect of the warming up has not the magnitude of the temperature change, but the kind of impulse causing it. Even though massage, similarly to physical effort, contributes to the rise of body temperature, the mechanism of the effect is here different. First of all taking up physical exercise causes

**Table 1.** Temperature [°C] of surface of upper limbs before and after the massage

Limb	Side	Part of body	Before	After	Difference [p]
Examined	front	forearm	32.62±0.54	32.98±0.49	<b>0.005</b>
		arm	33.16±0.43	33.34±0.55	0.244
	back	forearm	32.26±0.39	32.59±0.43	<b>0.015</b>
		arm	32.21±0.37	32.33±0.71	0.513
Control	front	forearm	32.71±0.55	32.76±0.69	0.786
		arm	33.19±0.47	33.16±0.45	0.843
	back	forearm	32.36±0.48	32.34±0.43	0.821
		arm	32.15±0.46	32.35±0.55	0.148

**Table 2.** Range of motion [°] radial-carpal joints before and after the massage

Limb	Move	Before	After	Difference [p]
Examined	flexion	63.33±10.31	68.89±8.93	<b>0.030</b>
	extension	54.44±8.45	61.11±11.40	<b>0.016</b>
	abduction	25.56±5.27	28.33±5.00	<b>0.013</b>
	adduction	33.89±4.85	40.56±7.26	0.057
Control	flexion	58.89±8.93	60.00±7.50	0.347
	extension	57.67±9.50	60.56±8.07	0.233
	abduction	25.20±6.61	25.56±4.64	0.760
	adduction	34.44±6.80	36.67±7.07	0.169

**Table 3.** Hand strength [kg] before and after the massage

Limb	Before	After	Difference [p]
Examined	57.70±10.49	58.00±12.39	0.931
Control	51.95±13.20	54.60±12.31	0.134

the increase of inner and outer muscular co-ordination, what seems of key importance [13, 14]. This effect cannot be expected after massage. Besides, the effect of warming up can be the rise of bioelectric activity of muscles, analyzed by means of electromyogram signal [8]. It seems finally that the decisive role is played here by the matter of effort resemblance, which is easily obtained in the purposely planned dynamic warming up, and cannot be in the passive one. In the research with the use of thermal imaging it was confirmed that the greatest influence on the rise of effort tolerance as the result of undertaken preparatory exercises, have those kinds of exercises whose structure of motion, effort energetics or requirements concerning the neuromuscular co-ordination are similar to the basic effort. However, in this range, in analyzed forms of preparatory exercises there is not observed any univocal dependence between the temperature and the effort tolerance, and only decreasing of the temperature together with prolonging time sometimes and growing intensity of the effort [3, 15, 16].

Potential differences in the effort tolerance obtained as the result of different forms of warming up, can be explained with other physiological mechanisms, in various degrees (depending on the activity) activated during the warming up. One of them is the efficiency of thermoregulation mechanisms which by enlarging the effort tolerance make the image obtained by means of thermogram different depending on the typology of the studied person. Although it is proved that during properly long lasting exercise, the metabolic production of warmth increases depending on the body mass of the exercising person and the intensity of undertaken effort [17].

Moreover, as the result of improvement of thermoregulation mechanisms function, the excess of warmth (mostly with the transpiration) is more efficiently emitted from the organism. Therefore, paradoxically we can expect the drop of superficial body temperature. The more dynamic form of exercises we use the greater drop of temperature we can expect. We have in mind here the specific convection, which is the relocation of air at the body, occurring at the contact of body with the air of different temperature, what changes the relative thickness of air. Thereby, in spite of changes of the internal temperature of muscle, the external surface can be chilled. Such observations were already described in several works [3, 15, 18, 19].

In massage there are other mechanisms, there is enlarged inflow of blood to „kneaded” body parts, what

can result in increasing of the superficial temperature [20, 21]. As far as so awaited reaction on performed effort of considerable intensity is the body temperature reduction, then in the case of massage this reaction should be inverse, because the temperature rise proves better supply of muscles with oxygen and nutrients [22-24].

### Conclusions

1. Classical massage, though increases muscles temperature affects the development of effort tolerance, is not a sufficient means of preparation for the physical exercise.
2. Due to massage, the range of motion in the massaged limb joint enlarged, which mostly proves the loosening effect of applied treatment.
3. Received results are basis for continued research on greater and more diverse groups.

### What this paper adds?

The presented study demonstrates new methods of non-invasive assessment of physiotherapeutic treatments. Effect of hand massage is difficult to verify (thermal imaging can be one of the methods). Obtained results are basis for continuation of research (with the use of other investigative tools).

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