ACUTE EFFECTS OF HOT WATER, HIGH PRESSURE MASSAGE ON THE ABILITY TO MAINTAIN BODY BALANCE IN YOUNG, HEALTHY WOMEN

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- body balance
- hot water
- pressure massage

Abstract:

INTRODUCTION: The body balance determines the ability to keep the center of gravity inside the base of support. The nervous system is responsible to maintain the body balance automatically through activation of appropriate muscle groups. Hot water, high pressure massage, which is primarily used in order to warm up and relax muscles, affects muscle proprioceptors, which provide afferent information for the sense of balance.

AIM OF THE WORK: The aim of the study was to investigate the acute effects of hot water, high pressure massage on the ability to maintain body balance in young women.

MATERIAL AND METHODOLOGY: Ten randomly selected, healthy, young women were included in this study. Each subject was given a hot water, high pressure massage which lasted 3 minutes. Body balance was measured using the AccuSway force plate (AMTI), which recorded center of pressure (COP) displacements. The balance was evaluated three times: before the treatment (T0), 20 minutes after the treatment (T1), and 14 hours after the treatment (T2).

RESULTS: Mean radius of COP sway in T1 was 0.5 ± 0.2 cm, and in T2 0.31 ± 0.06 cm ($p<0.05$). Radius standard deviation of COP sway in T1 was 0.27 ± 0.09 cm, and in T2 0.19 ± 0.04 cm ($p<0.05$). Area of COP sway in T1 was 2.13 ± 2.98 cm^2, and in T2 1.58 ± 2.39 cm^2 ($p<0.05$).

CONCLUSIONS: Single treatment of hot water, high pressure massage has not affected the body balance in young, healthy women. It has been found an improvement in balance 14 hours after the procedure as compared with the 20 minutes after the treatment.

INTRODUCTION

Balance can be defined as the ability to maintain the projection of the center of gravity (COG) within the support surface. In the case of a standing position, the support surface is the area of feet in contact with the surface and the space between the feet. Balance describes the static conditions, but when it comes to dynamic situations it is responsible for regaining the stability of the body [Juras 2003]. The system of balance control is associated with various sensory systems: vestibular, visual, proprioceptive and skin mechanoreceptors which complete proprioceptive information.

Both non-laboratory methods (static and dynamic) and laboratory tests can be used to measure body balance. Laboratory methods include a stabilography, using platforms which record the ground reactions forces [Szafraniec 2002; Szafraniec et al. 2005; Kuczyński et al. 2011]. Stabilography was used in these studies in order to evaluate the ability to maintain balance in athletes, the elderly, patients with orthopedic traumas and in neurological diseases.

The control of posture is critical and necessary in activities of daily living like walking, running, stepping up the stairs, or standing in a bus. The decrease in the ability to maintain balance, due to age or as a result of various illnesses, is related to the tendency to falls, which can cause bone fractures [Dyszkiewicz, Opara 2006]. Falls are one of the most common causes of loss of efficiency by the elderly, which requires the help of others in carrying out self-service. The problem of falls concerns 14% of the population aged 50-60 [Józefowski et al. 2015].

In many sports, acute balance control can be associated with the final performance of the athlete [Asseman et al. 2008]. Three different effects of this control of the actual posture could be mainly distinguished. In the first one, the control of posture is mainly associated with movements (football, rugby, ice hockey, judo etc.). The proper body balance leads to harmony of movement [Perrin et al. 2002; Kuczyński et al. 2011]. In the second one, standing still is linked to the performance of the sportsman (shooting, archery). In the third category there are activities requiring both the control of posture associated with movements but also the control of a steady posture (gymnastics, figure skating, diving). Athletes generally have superior balance ability compared to control subjects. Gymnasts tended to have the best balance ability, followed by soccer players, swimmers, active control subjects, and then basketballers [Hrysomallis 2011].

Hot water, high pressure massage is used not only by patients with various dysfunctions, (especially related to the musculoskeletal system) but also by healthy people and athletes. In hydrotherapy, both the pressure and temperature of water are important [Kuliński 2007; Kochański, Kochański 2009]. Hot water, high pressure massage is one of the strongest hydrotherapeutic treatments. The water temperature is 38-42 °C and the pressure of the stream exceeds 400 kPa. Such high pressure affects skin mechanoreceptors and muscle proprioceptors, initiating complex automatic reactions [Benarroch 2007]. This treatment is used by healthy people and athletes to warm up and relax muscles. Evidently hot water causes the skin and muscle temperature to rise, but the impact of high pressure massage on the physiological functions of the body remains poorly documented, and existing information is rather anecdotal. It is not known whether such a strong stimulus acting on a large receptor surface will not disturb the afferent information going to the central nervous system's areas which are responsible for control of movement or body balance. Such information would be very important both for patients, taking into account the increased risk of falls, as well as for athletes, especially those who practice disciplines that require outstanding coordination of movements and body balance.

The aim of the study was to investigate the acute effects of a hot water, high pressure massage on the ability to maintain body balance in young women.

MATERIAL AND METHODS

Ten healthy, young women (mean ± SD, age: 23.0 ± 1.1 years; height: 165.8 ± 4.0 cm; body mass: 57.1 ± 6.7 kg) volunteered to participate in the study. Exclusion criteria included medications affecting balance, balance disorders, disorders of the muscular or nervous system, any acute disease or illness causing a significant fever, regular physical activity (defined as more than two times a week for at least two hours per day). All participants were informed of the risks and provided written informed consent.

Each participant underwent a single treatment of hot water, high pressure massage, which was performed by a qualified physiotherapist. The treatment was carried out between 6.00 and 8.00 p.m. Body balance was evaluated three times: before the treatment (T0), 20 minutes after the treatment (T1) and 14 hours after the treatment (T2).

The massage device was equipped with a flexible hose. The water pressure during the treatment was approximately 400 kPa and the water temperature at 40 ºC. The treatment lasted 3 minutes (massage of the back side of the body – 1.5 min; massage of the front side of the body – 1.5 min). During the procedure the women wore two-piece swimsuits. The subjects stood at a distance of 3 meters from the massage equipment. The water pressure massage was performed according to the directions shown in Fig.1.

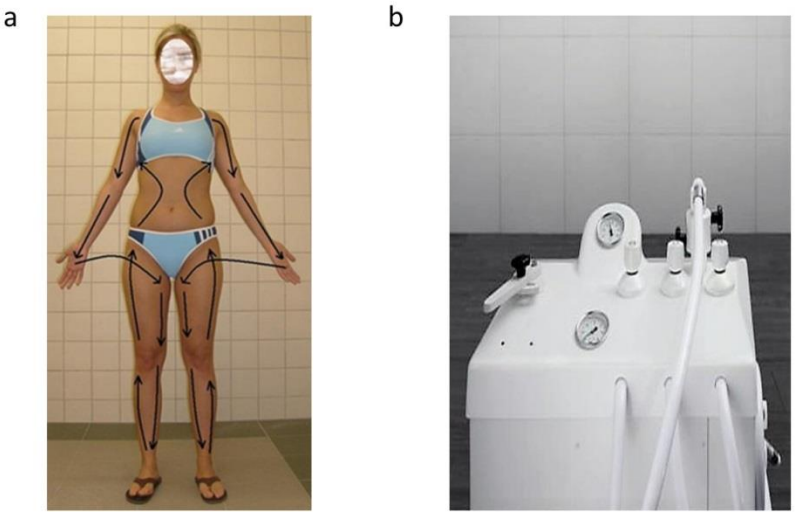

Fig.1. a) Directions of massage with water stream; b) Equipment used in the study to perform high pressure water massage [own sources].

The AMTI AccuSway Balance force plate was used to evaluate body balance. The system records displacements of COP in sagittal and frontal plane. The following parameters were calculated by a dedicated computer program: mean radius of COP displacement (RA), standard deviation of COP radius displacement (SD), area of COP displacement (AR), COP path length (PL), and mean velocity of COP displacement (MV).

Each subject performed the balance test with closed eyes. The trial lasted 32 seconds. The subject was dressed in sports clothes, without shoes. On the platform, the person took an upright posture with upper limbs freely falling along the torso, with feet set respectively to the points marked on the force plate. The study began with carrying out maximum body sway in four main directions: forward, backward, and sideways, setting individual stability limits. While doing this, the person could not tear out her feet off the force plate.

All statistical analyses were performed using Statistica 12.5 (StatSoft, USA). The distribution of data was checked for normality with the Shapiro-Wilk test. The obtained results were subjected to basic statistical analysis by calculating the arithmetic mean ($\bar{x}$) and the standard deviation (SD) of tested parameters. In order to determine the statistically significant differences, the ANOVA test for repeated measurements was used with further post-hoc analysis (LSD Fisher test). Statistically significant differences were observed when $p<0.05$.

RESULTS

Mean radius of COP displacement in T0 was 0.41 ± 0.18 cm; in T1 0.5 ± 0.2 cm and in T2 0.31 ± 0.06 cm. There was a statistically significant decrease in RA between T1 and T2 ($p<0.05$) - Fig.2.

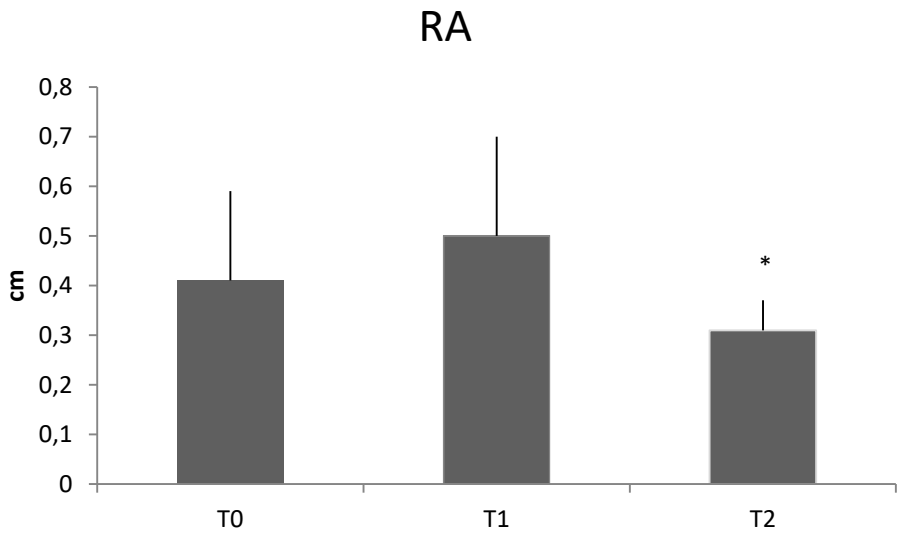

Fig.2. Mean values (± SD) of RA in subsequent balance tests; * $p<0.05$ (statistically significant difference between T1 and T2 tests).

In subsequent tests, the following values of standard deviation of COP radius displacement were obtained: T0 0.23 ± 0.11 cm; T1 0.27 ± 0.09 cm and T2 0.19 ± 0.04 cm. There was a statistically significant decrease in SD between T1 and T2 ($p<0.05$) – Fig.3.

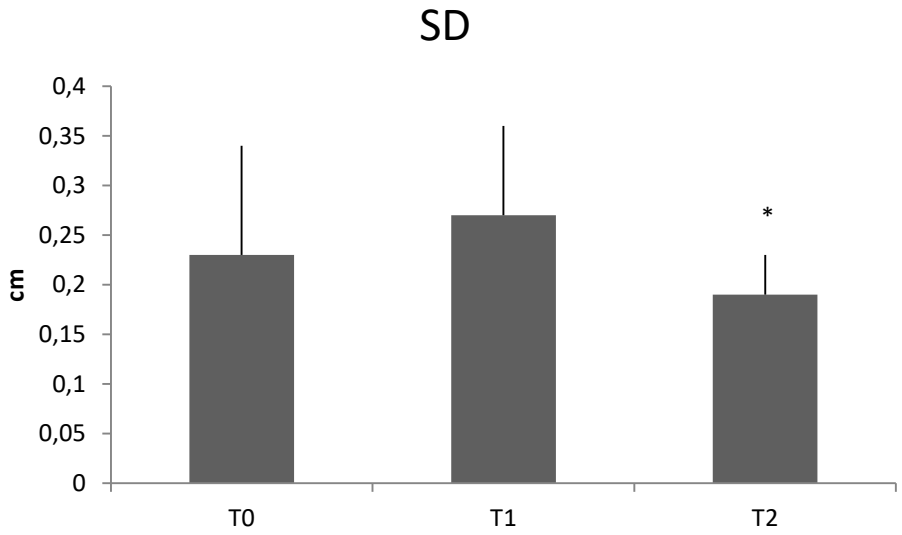

Fig.3. Mean values (± SD) of SD in subsequent balance tests; *$p<0.05$ (statistically significant difference between T1 and T2 tests).

Area of COP displacement in T0 amounted to 1.85 ± 0.94 cm^2, in T1 2.13 ± 1.12 cm^2 and in T2 1.58 ± 0.72 cm^2. There was a statistically significant decrease ($p<0.05$) of AR values in T2 compared to T1 (Fig.4).

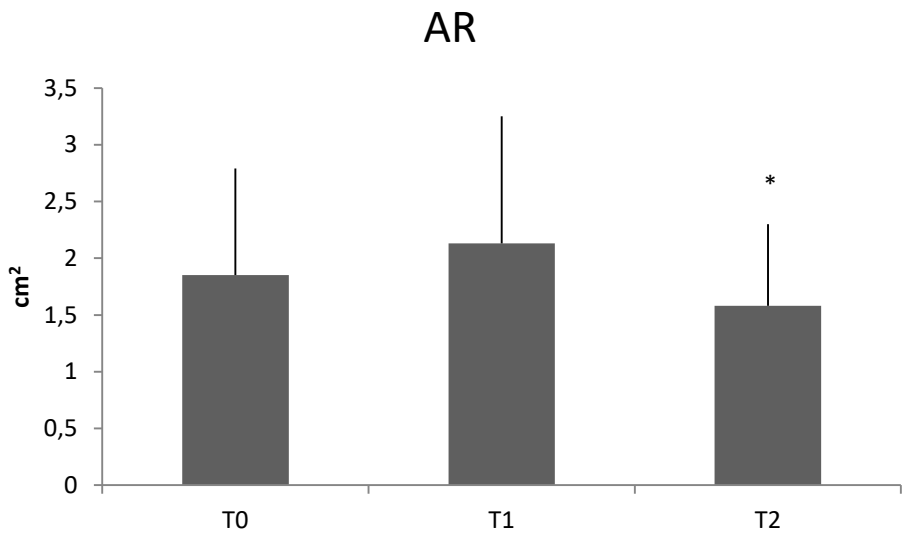

Fig.4. Mean values (± SD) of AR in subsequent balance tests; * $p<0.05$ (statistically significant difference between T1 and T2 tests).

Path length in T0 was 39.27 ± 7.48 cm, in T1 38.47 ± 6.98 cm and in T2 38.62 ± 7.39 cm (Fig.5). There were no statistically significant differences between subsequent measurements.

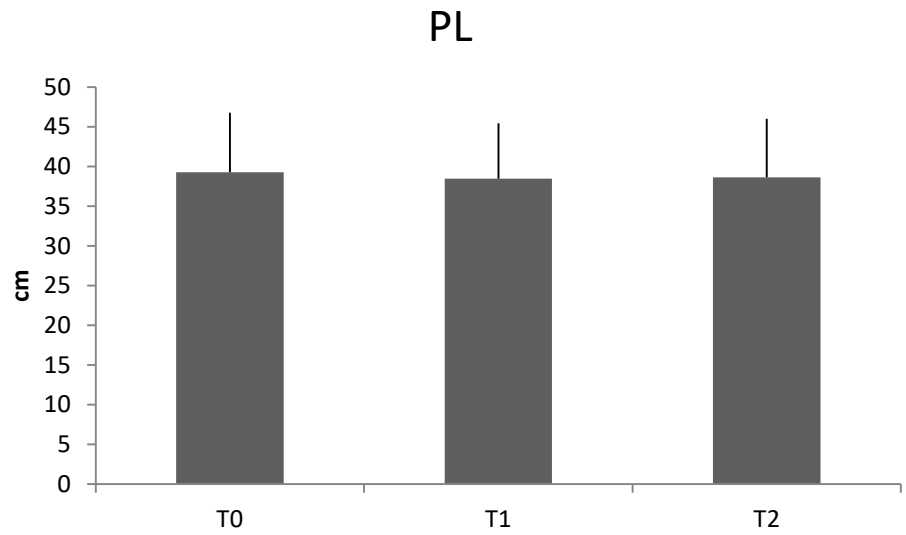

Fig.5. Mean values (± SD) of PL in subsequent balance tests.

COP mean velocity in T0 has reached 1.31 ± 0.25 cm/s, in T1 1.28 ± 0.23 cm/s, and in T2 1.37 ± 0.27 cm/s (Fig.6). There were no statistically significant differences between subsequent measurements.

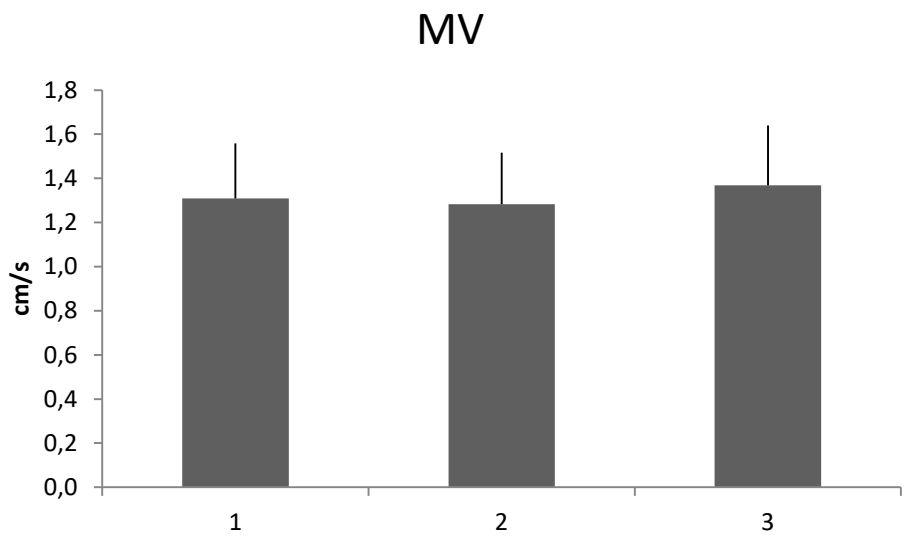

Fig.6. Mean values (± SD) of MV in subsequent balance tests.

DISCUSSION

The aim of the study was to investigate the acute effects of a hot water, high pressure massage on the ability to maintain body balance in young women. Our results indicate that hot water, high pressure massage has not affected the body balance, both 20 min after the treatment, and at a later time (after 14 hours) because there were no statistically significant differences in stabilographic parameters measured before and after the treatment. It has been found an improvement in postural stability 14 hours after the procedure as compared with the 20 minutes after the treatment. The results of this study may have an application value not only for athletes but for older people as well, who are eager to use this treatment in order to improve the properties of the muscular system. Athletes use a hot water, high pressure massage, also to make the post-exercise regeneration more efficient [Szafraniec et al. 2012]. It is executed most often after the evening training unit During the experiment, the treatment was also performed in the evening, and the assessment of its effects on body balance was extended to the next day in order to answer the question whether during morning workout any disturbances of postural mechanisms would occur. Such a situation would be very disadvantageous when performing technically difficult exercises, during which the sense of balance is particularly engaged (sports gymnastics, figure skating, judo, etc.), or when extreme posture stability is required (archery, shooting). Hot water, high pressure massage is widely offered also in sanatoriums and spas. In the elderly, the functioning of the mechanisms responsible for maintaining the balance of the body deteriorates [Błaszczyk et al. 2005; Józefowski et al. 2015]. The consequence of this situation is the increased risk of falls and their effects in the form of injuries [Szpringer, Wybraniec-Lewicka 2008]. Therefore, the information that immediately after a hot water, high pressure massage the stability of upright posture is practically undisturbed is certainly important and beneficial for patients. To confirm that the results obtained in this study also apply to the older population, one would perform a similar experiment on a more numerous group of such persons. Sefton et al. investigated the acute effects of a 60-minute full-body massage therapy treatment on static balance in healthy, older individuals [Sefton et al. 2012]. There was no immediate post-treatment effect on the balance measures. They stated significant decrease of COP displacement area and average COP velocity in double-legged stance condition over the 60 minutes following treatment,

which indicates an improvement in balance. Also Cieślik et al. found an increase in body stability (especially in the anteroposterior direction) after a single massage in young adult females [Cieślik et al. 2017]. Other researchers assessed the impact of foot massage on the body balance, especially in persons with ankle instability [Vaillant et al. 2009; LeClaire, Wikstrom 2012; McKeon, Wikstrom 2016; Wikstrom et al. 2017].

It is difficult to compare the results of our research with the results of others, because all the studies reported concerned classic massage (Swedish massage), which exerts much less pressure on tissues compared to high pressure water massage. In classic massage there is also no thermal effect of hot water. Unfortunately, there is no scientific literature on the impact of high pressure water massage on balance. This may be due to the fact that this treatment is popular mainly in the countries of the so-called Central and Eastern Europe and in many countries hydrotherapy is classified as alternative medicine. This situation reinforces our view that research in this field should be continued and include the athletes and the elderly.

CONCLUSIONS

Single treatment of hot water, high pressure massage has not affected the body balance in young, healthy women. It has been found an improvement in balance 14 hours after the procedure as compared with the 20 minutes after the treatment.

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