Changes to Skin Temperature in the Lower Limb Due to Shiatsu Stimulation of the Lumbodorsal Region

Japan Shiatsu College
Students: Hironori Tsukiashi, Masakazu Seo, Yukiko Nakamori, Kaoru Furukawa, Yuko Ezawa, Yukio Inaba, Takako Ogawa, Miki Ogawa, Tetsuro Komiyama, Nobuto Sugawara, Rie Susa, Tetsuya Funahara
Supervisors: Kazuo Watanabe, Hiroshi Kanda, Hiroshi Ishizuka
Hideo Ohsawa (Tsukuba College of Technology), Hidetoshi Mori (Tsukuba College of Technology)

I. Introduction

The Japan Shiatsu College has previously reported on the effects of shiatsu stimulation on the circulatory system (reduction in heart rate and blood pressure, peripheral increase in muscle blood volume, and rise in skin temperature)[1-3], the musculoskeletal system (improvements in muscle pliability and spinal range of motion)[4-8], and the digestive system (electrogastrogram changes)[9].

It is claimed that, clinically, shiatsu stimulation acts on peripheral circulation to normalize its function. Here, we report on the effect of shiatsu stimulation on skin temperature of peripheral areas in the lower leg and foot, based on observations using thermography.

II. Methods

1. Subjects

Research was conducted on 25 healthy adult students of the Japan Shiatsu College (14 males, 11 females) aged 19–62 years (average age: 38.9 years old).

Test procedures were fully explained to each test subject and their consent obtained. They were also asked to refrain from receiving shiatsu or other stimulation on the day of testing.

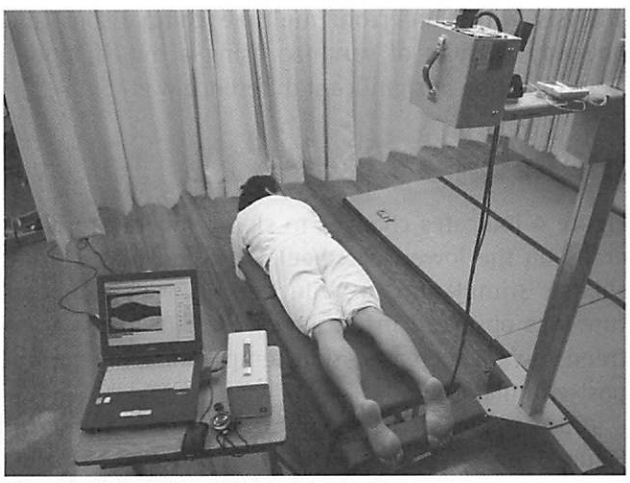

Fig. 1. Thermography equipment in use

2. Test period

April 28 to September 13, 2007, between 2PM and 5PM

3. Test location

Testing was conducted in the shiatsu research lab at the Japan Shiatsu College. Room temperature was 26 ± 1°C and humidity was 60 ± 10%.

4. Measurement

Skin temperature was measured using a thermograph (Nihon Kohden Corp. model Infra-eye 2000®) (Fig. 1).

5. Data recording

Thermograms were taken at 1-minute intervals before (15 minutes), during (5 minutes), and after shiatsu stimulation (15 minutes), for a total duration of 35 minutes.

The thermograph data was transferred via the control unit and saved to a personal computer (Fujitsu FMV-C8210).

6. Stimulation

Stimulation was carried out according to basic Namikoshi shiatsu procedure, as indicated below. Stimulation was applied by three therapists, with the degree of stimulation adjusted to ensure uniformity and regulated to as to be pleasurable for the test subject (standard pressure). One therapist treated 72% of all the test subjects.

7. Area of stimulation

Past research has shown that basic Namikoshi shiatsu[10-14] has the effect of lowering blood pressure and heart rate when applied to the lateral crural region[1-3], and of causing a local rise in skin temperature when applied to the lumbodorsal region. Full-body treatment

is standard for Namikoshi shiatsu, but for this research stimulation was applied only to the lumbodorsal and sacral regions (Fig. 2).

The areas of stimulation were the lumbodorsal region (paralleling the spine; referred to in Namikoshi shiatsu as the infrascapular region), with standard pressure (pressure gradually increased, sustained, and gradually decreased on each point) applied to the 10 points bilaterally for 2 minutes per side; and the sacral region, with 2-thumb pressure applied to the 3 points for 1 minute.

8. Test procedure

Testing was carried out on two groups: one on which shiatsu stimulation was performed in the prone position (hereafter, the stimulation group); and one that lay in the same prone position without shiatsu stimulation being performed (hereafter, the non-stimulation group).

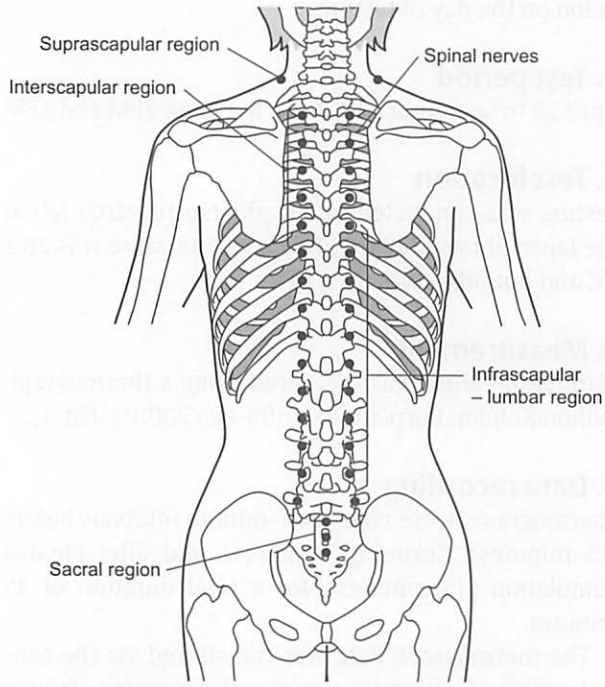

Fig. 2. Area of stimulation (lumbodorsal and sacral regions)

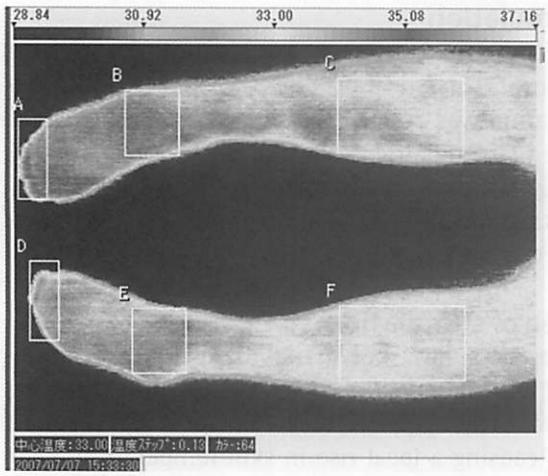

Fig. 3. Areas selected for analysis of skin temperature

The stimulation group was treated in the following order: [1] 10 minutes rest after entering the room → [2] 15 minutes rest prior to stimulation → [3] 5 minutes shiatsu stimulation (stimulation of 10 points bilaterally in the lumbodorsal region and 3 points in the sacral region) → [4] 15 minutes rest post stimulation, totaling 45 minutes. For the same 45-minute period, the non-stimulation group underwent [1] 10 minutes rest after entering the room → [2] 35 minutes rest. Test subjects were dressed in T-shirts and jerseys, with their pant legs raised above knee height.

(1) The overall condition of the test subjects was determined by asking them to complete a survey including questions on physical condition, meal times, and everyday subjective symptoms. After thermogram was completed, test subjects completed a survey to determine their feelings on the test environment, amount of shiatsu pressure, and changes in their condition due to treatment.

(2) Chilling was diagnosed using a medical questionnaire (revised Terasawa).

(3) Test precautions

The following items pertaining to the environment and test subjects were monitored and recorded during testing:

[1] that temperature and humidity remained stable
[2] that the area remained silent
[3] that subjects remained motionless
[4] that subjects remained alert

9. Data analysis

Skin temperature analysis shows mean values ± standard error from a total of six locations (A–F) within bilateral selected areas on the lower legs, heel pads, and toes (Fig. 3).

10. Statistical processing

Statistical analysis was carried out using linear analysis with Bonferroni multiple comparisons and one-way analysis of variance using a mixed model. Determination of significant difference was <5%.

III. Results

Figure 4 indicates changes to skin temperature bilaterally on the lower legs, heel pads, and toes. During shiatsu stimulation, a reduction in skin temperature was observed in the lower leg and foot, with a trend toward increased skin temperature in the foot post-stimulation.

An example of thermogram changes is shown in Figure 5.

Also, response to shiatsu stimulation with respect

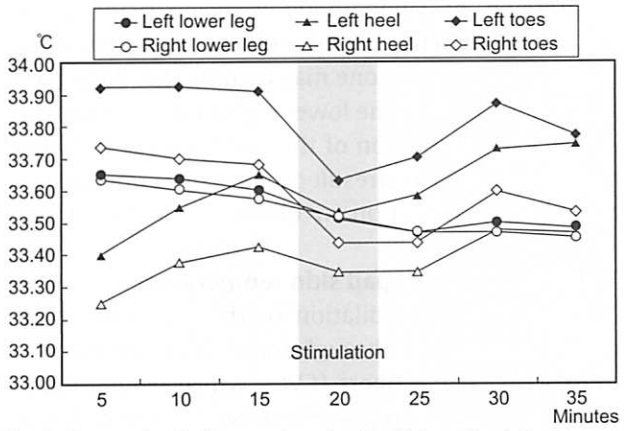

Fig. 4. Changes in skin temperature due to shiatsu stimulation

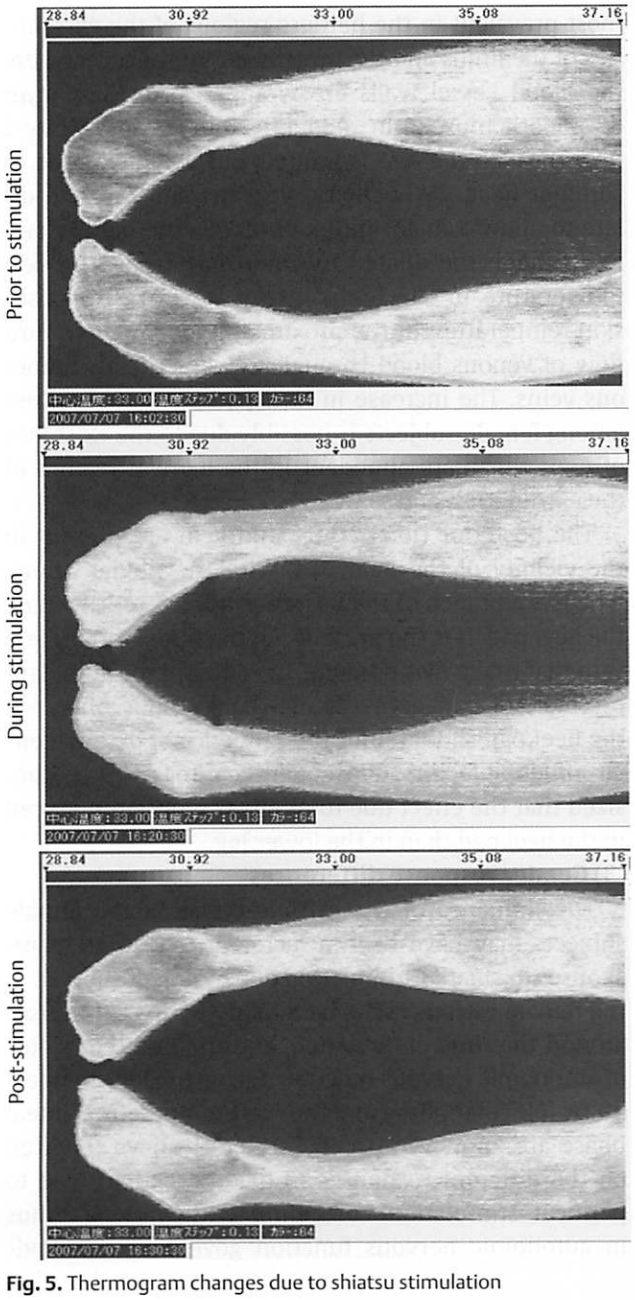

Fig. 5. Thermogram changes due to shiatsu stimulation

to skin temperature changes in the heel pad and toe region differed between males (n=14) and females (n=11).

(1) Lower leg

Skin temperature decreased in both male and female test subjects.

(2) Heel pad

In male subjects, no change was observed in skin temperature of the heel pad. However, in female subjects skin temperature in the heel pad increased post-stimulation.

(3) Toe region

Skin temperature decreased in male subjects, but there was no change to skin temperature in female subjects.

(4) In the non-stimulation group, skin temperature in the lower leg and foot decreased in both male and female subjects.

No change was observed in male subjects, whether or not they had reported subjective symptoms of chilling, either during or after stimulation (Fig. 6).

An increase in skin temperature post-stimulation was indicated in female subjects, among both those who had reported subjective symptoms of chilling and those who had not (Fig. 7).

Response differed by sex. No change was observed in males, while skin temperature rose in females (Fig. 8).

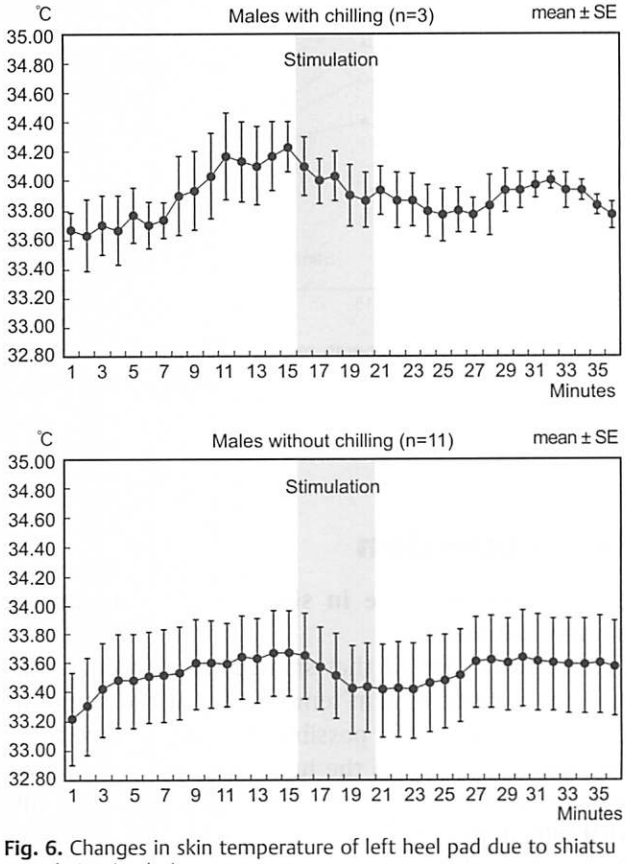

Fig. 6. Changes in skin temperature of left heel pad due to shiatsu stimulation (males)

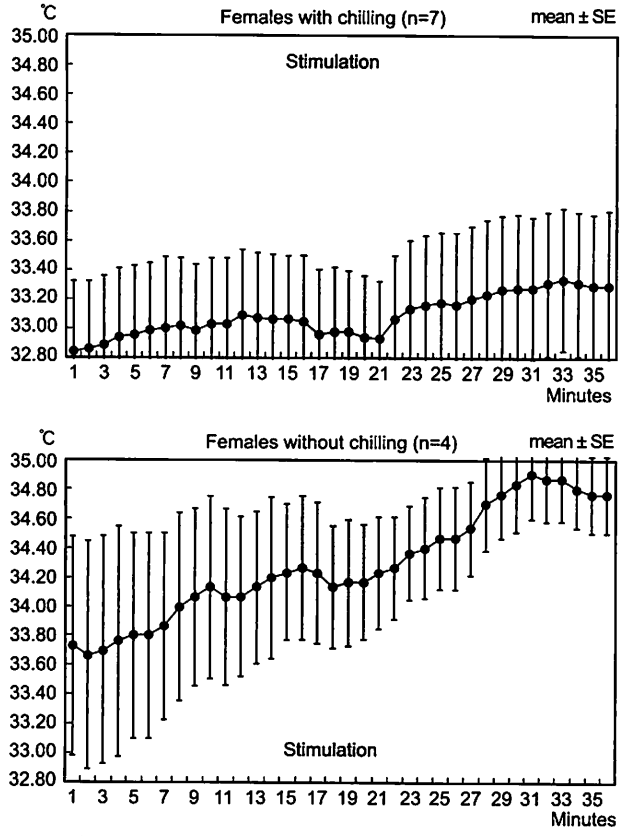

Fig. 7. Changes in skin temperature of left heel pad due to shiatsu stimulation (females)

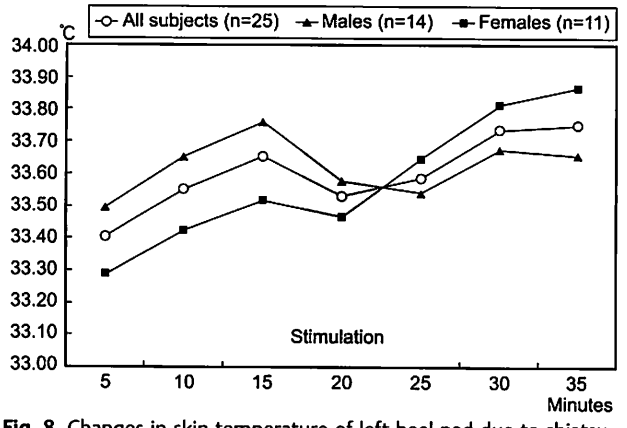

Fig. 8. Changes in skin temperature of left heel pad due to shiatsu stimulation

IV. Discussion

(1) Cause of decrease in skin temperature during shiatsu stimulation

We have reported that shiatsu stimulation results in local increase in skin temperature at the site of its application, and it is possible that skin temperature did increase locally in the lumbodorsal and sacral regions due to shiatsu stimulation. It is also possible that blood flow to pelvic organs increased due to stimulation of parasympathetic vasodilator nerves or suppression of sympathetic vasoconstrictor nerves regulating the pelvic organs, induced by shiatsu stimulation. Consequently, one may assume that decrease in skin temperature in the lower leg and foot regions during shiatsu stimulation of the lumbodorsal and sacral regions occurred as a result of the above two reactions, caused by a reduction in blood distribution to the lower limbs.

(2) Increase in heel pad skin temperature

Constriction and dilation of the cutaneous blood vessels is regulated through tonus in cutaneous vasoconstriction nerve fibers (CVC), which belong mainly to the cutaneous sympathetic nervous system. Test results from Saegusa et al[15] confirm that skin temperature automatically falls when CVC activity increases and rises when CVC activity decreases. The presence of arteriovenous anastomosis (AVA) exerts the most significant influence on cutaneous blood flow. AVA are most prevalent in the hairless regions of the extremities of the limbs and the protrusions of the face, where the blood vessel walls are wrapped in a thick layer of smooth muscle. In moderate temperatures, blood flow through the AVA is limited, but when exposed to summer heat, CVC activity weakens and the AVA dilate to allow a major influx of blood. The blood flowing through the dilated AVA not only raises the skin temperature in the limbs' extremities, it also raises skin temperature in the proximal limbs via the return flow of venous blood through the superficial cutaneous veins. The increase in heel pad skin temperature among female subjects is possibly due to the existence of AVA, which are abundant in the hairless regions of the extremities, and to CVC response.

The posterior tibial artery and vein are present in the vicinity of the heel pad, with the fibular artery, which is a branch of the posterior tibial artery, feeding the heel pad. It is the presence of the fibular artery and vein that make AVA possible. In addition, the abundant presence of connective tissue (collagenous fibers) in the heel pad should limit the influence of external environmental factors. Consequently, it may be hypothesized that the effect due to AVA was more pronounced in the heel pad than in the lower leg.

(3) Gender response differences

The influence of the estrous cycles in the female subjects may have been a factor in the different responses to shiatsu stimulation depending on gender. In the female estrous cycle, basal body temperature rises around the time of ovulation, and the different states of autonomic nervous function during the low-temperature, follicular phase and the high-temperature, luteal phase are known to occur. Sato et al[16] have reported on the different responses in bladder activity due to perineal stimulation coinciding with varying tonus in autonomic nervous function governing the bladder. From this, we may consider the possibility that

the response to shiatsu stimulation differs along with variations in autonomic nervous system tonus during these low-temperature and high-temperature phases. In this study the stage in the estrous cycle of female test subjects on the day of testing was not identified, so estrous cycle variations cannot be established, but we may consider the possibility that skin temperature responses were influenced by female estrous cycle variations.

In the future, further testing is required involving comparison with non-stimulation groups and simultaneous measurement of lumbodorsal and lower limb skin temperatures.

V. Conclusions

From this study on healthy adults, the following is evident:

1. In males, a reduction in skin temperature in the lower leg and toe regions was displayed during and after stimulation. There was no skin temperature change in the heel pad due to shiatsu stimulation.
2. In females, a reduction in skin temperature in the lower leg was displayed during and after stimulation. There was no change in the toe region, but skin temperature in the heel pad increased after stimulation.
3. Responses to shiatsu stimulation of the lumbodorsal and sacral regions differed depending on gender.

In closing, we would like to express our appreciation to the instructors and students of the Japan Shiatsu College who participated in this research.

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