Foreword

On Publication of the Collected Reports of the Shiatsu Therapy Research Lab

The first edition of the *Collected Reports of the Shiatsu Therapy Research Lab*, which contained 11 reports, was published five years ago by the Japan Shiatsu College to commemorate the Lab's 10th anniversary. The research studies it presented received high commendation from readers both in Japan and abroad. Now, in this current edition, we have gathered additional reports produced over the following five years and combined them with those of the previous collection, all in one volume, and are making it available for the first time in English.

Despite the wealth of everyday clinical experience shiatsu therapists have accumulated treating disorders such as neuralgia and muscular pain, reducing the pain of childbirth, facilitating the natural passage of ureter stones, and so on, for a long time these successes were not formally presented in the form of scientific research papers. In recent years, however, senior students of our college have been presenting papers at medical-related academic conferences to announce the results of their ongoing clinical studies, thereby contributing greatly to the success of the Shiatsu Therapy Research Lab. Also in recent years, we have received inquiries from shiatsu therapists' associations and government agencies in various Western countries requesting materials that demonstrate a scientific basis for shiatsu. I hope these collected reports will facilitate the process of attaining legal recognition for shiatsu therapy in countries around the world.

In closing, I would like to express my deepest appreciation to Professor Hidetoshi Mori and Associate Professor Hideo Ohsawa of the Tsukuba College of Technology for their supervision and guidance, and to the successive generations of teaching advisors and researchers for their ongoing efforts. I hope they will continue to produce the same good, high quality research in the future as we find within these pages.

March 2013

Hiroshi Ishizuka
Principal, Japan Shiatsu College

It has been 15 years since the Shiatsu Therapy Research Lab was established, and above all we owe a debt of gratitude to the students of the Japan Shiatsu College, whose dedicated efforts over the years have allowed us to continue our research activities. Without their support and the enormous amount of time they invested working together to produce each report, the success of this research program would not have been possible. Editing these reports has been a trip down memory lane for me, as I recall the faces of individual students and the many memorable experiences we shared. I am confident that now, having embarked on their careers as shiatsu therapists working in clinical settings, they have become aware more than ever of the value of the basic research we have done here.

Since our first study conducted in 1998, which confirmed shiatsu's effect on reducing heart rate, we have continued to report on other effects of shiatsu, including lowering blood pressure, increasing muscle blood volume, improving muscle pliability and spinal mobility, stimulating gastric motility, and stimulating the pupil contraction response. This volume presents a clear picture of the path our research has followed to date, with each new study building on the results of past reports.

I would like to express my heartfelt appreciation to the participants in the Shiatsu Therapy Research Lab for all of their efforts since its inception. Each and every one of the reports they have produced has been notable. I would also like to thank professors Mori and Ohsawa for their supervision and guidance. It has been thanks to all of you that we were able to assemble these Collected Reports in our 15th year. I hope that they will be of use to everyone involved in shiatsu therapy.

March 2013

Kazuo Watanabe
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Contents

Effects of Shiatsu Stimulation on the Cardiovascular System

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Supervisors: Kazuo Kokubo, Masahiro Fujii, Takashi Namikoshi, Matsuko Namikoshi
Hideo Ohsawa (Tsukuba College of Technology), Hidetoshi Mori (Tsukuba College of Technology)

I. Introduction

Shiatsu, a form of manual therapy, has long been known to stimulate the body's natural healing power for improved health. Shiatsu has shown great promise in alleviating the symptoms of diseases and unidentified illnesses. However, little research has been conducted into the physiological effects of shiatsu, and there is a need to scientifically verify the effectiveness of shiatsu and explain the mechanisms of its therapeutic effectiveness.

It is recognized that somatosensory stimulation of an organism using manual pressure stimulation evokes a reflex response in the various internal organs via the autonomic nervous system[1,2]. This somatovisceral reflex is thought to be responsible for the therapeutic effectiveness of shiatsu.

Here we report on the results of research into the effects of shiatsu on the cardiovascular system through observation of heart rate and fingertip pulse wave, conducted as a first step toward clarifying the physiological effects of shiatsu.

II. Methods

1. Subjects

Research was conducted on 27 healthy adults (12 males, 15 females) aged 18–64 years (mean age: 37.3 ± 13.8 years old).

Test procedures were fully explained to each test subject and their consent obtained. They were also asked to abstain from eating, smoking, ingestion of stimulants, or vigorous exercise for two hours prior to testing.

2. Test period

April 11 to June 5, 1998

3. Test location

Testing was conducted in the shiatsu research lab at the Japan Shiatsu College. Room temperature was 25 ± 1.5°C with subdued lighting and silence maintained.

4. Items measured

A polygraph system (Nihon Kohden Corp. model RM-7000) was used to measure the following items:

(1) Heart rate

A pulse tachometer (Nihon Kohden Corp. model AT-601G) was used to calculate the momentary heart rate (hereafter, 'heart rate') as triggered by the ECG's R wave (the second deflection on the ECG).

(2) Fingertip pulse wave

The fingertip volume pulse wave (hereafter, 'pulse wave') was measured on the second digits of each hand and foot using a reflex pickup (Nihon Kohden Corp. model MPP-3A).

(3) Respiratory curve

The respiratory curve was measured using a thermistor breathing pickup (Nihon Kohden Corp. model TR-712T) inserted into the nasal cavity.

5. Data recording

The items measured in (1) to (3) above were recorded on magnetic tape using a data recorder (Sony model PC208AX), in addition to continuous recording using a polygraph thermal recording device.

6. Data analysis

After completion of testing, data was replayed and transferred to a personal computer (IBM 300GL) via an A/D convertor (BIOPAC Systems, Inc. model MP-100), then analyzed using data analysis software (AcqKnowledge, BIOPAC Systems, Inc.). Analysis was performed on heart rate and pulse wave data from one minute prior to stimulation to one minute after stimulation. However, data due to pronounced body motion, artifact, or swallowing was omitted.

7. Stimulation

Full-body treatment is standard for Namikoshi shiatsu[3], but because mobility of the test subject was limited due to attachment of the ECG electrodes and other constraints, the areas to which shiatsu was applied were limited to the following (Fig. 1):

(1) Point 1, left lateral crural region: approximately 3 cm disto-lateral to the tibial tuberosity. This is the point where the common peroneal nerve emerges from the popliteal region to the lateral lower leg and divides into the deep and superficial peroneal nerves. Standard pressure was applied using thumb-on-thumb pressure for 5 seconds, repeated 10 times.

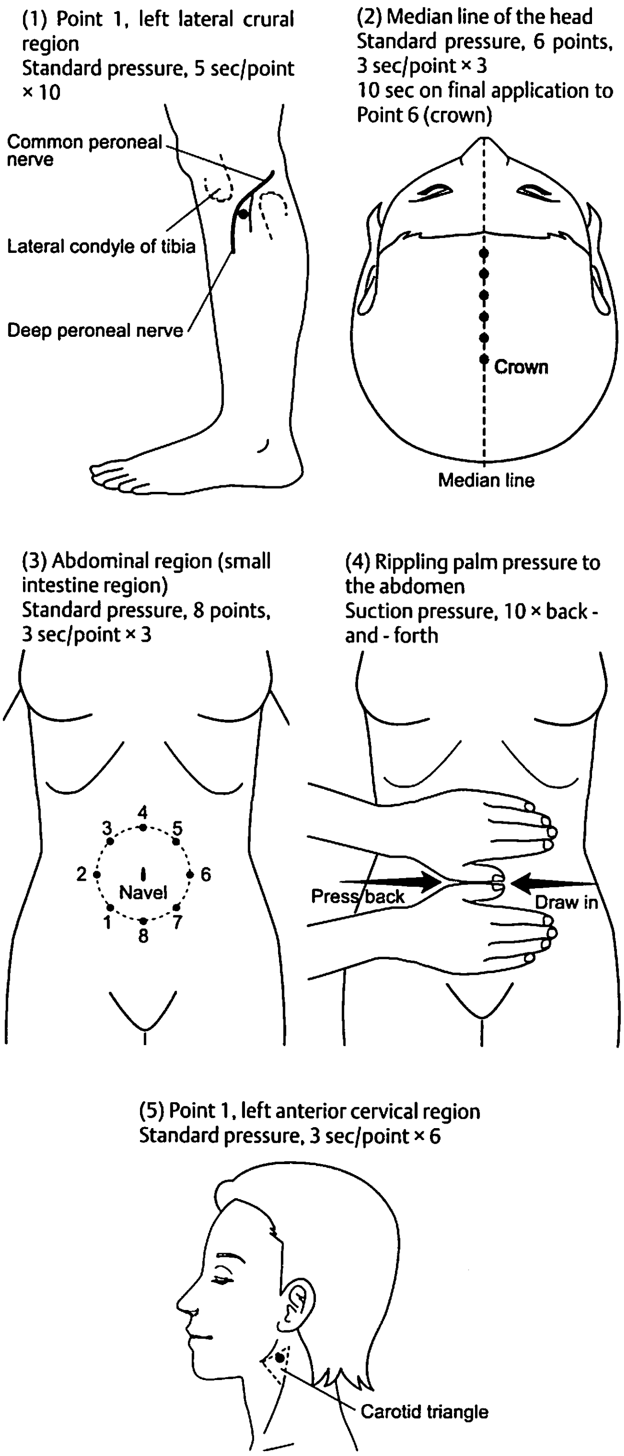

Fig. 1. Areas and methods of shiatsu application (Namikoshi style)
Adapted from *The Complete Book of Shiatsu Therapy* by Toru Namikoshi

(2) Median line of the head: 6 points, located along the median line between the hairline and the crown. Standard pressure was applied using thumb-on-thumb pressure, 3 seconds per point, repeated 3 times, with pressure maintained for 10 seconds on final application to crown of head.

(3) Abdominal region (small intestine region): referred to as the small intestine region in Namikoshi shiatsu, consisting of 8 points located clockwise around the navel, with Point 1 located diagonally to the right (test recipient's right) and inferior to the navel. Standard pressure was applied using two-thumb pressure, 3 seconds per point, repeated 3 times.

(4) Rippling palm pressure to the abdomen: standard pressure is not used here; instead the therapist applies the palms of both hands to the abdominal region, centered on the navel, and draws the descending colon toward him with his fingers, then presses the ascending colon away with the heels of his hands. This back-and-forth suction pressure was repeated 10 times.

(5) Point 1, left anterior cervical region: located on the medial margin of the sternocleidomastoid muscle, near the carotid artery in the carotid triangle. Positioned behind the test recipient's head, the therapist applied standard pressure using one-thumb pressure with the left hand for 3 seconds, repeated 6 times.

All treatment was carried out by the same therapist, applying approximately 5–15 kg pressure, depending on the comfort level of the test recipient. All standard pressure was applied using gradual increase and decrease of pressure.

8. Test procedure

Testing commenced after the subject had been lying quietly for a minimum of 20 minutes in the supine position.

Stimulation was carried out in the following order: Point 1, left lateral crural region; median line of the head; abdominal region (small intestine region); rippling palm pressure to the abdomen; Point 1, left anterior cervical region. A minimum of 5 minutes was allowed between each shiatsu procedure, and heart rate and pulse wave were allowed to stabilize before the next stimulation was applied.

9. Statistical processing

Data were analyzed at 10 second intervals from 1 minute prior to 1 minute after stimulation. The measurement taken 10 seconds prior to commencement of stimulation was used as the control in order to establish a standard value for evaluating response, shown as 100%. Other measurements were converted to percentage and expressed as mean ± SE.

Statistical verification was carried out using analysis of variance according to Dunnett's multiple comparison test, with <5% considered significant.

III. Results

During testing there were no instances requiring cessation of treatment due to pain or discomfort. Pulse wave results shown are for the left hand, the same side as to which the stimulus was applied, as measurements taken at hands and feet on both sides displayed the same trends.

1. Point 1, left lateral crural region

Figure 2 indicates changes to heart rate and pulse wave due to stimulation of Point 1 of the left lateral crural region. Heart rate showed a significant reduction between 10 sec after commencement of stimulation and 20 sec after completion, with a maximum reduction of 6.6% at 30 sec after commencement of stimulation. Pulse wave showed a significant reduction of 18% at 10 sec after commencement of stimulation, before promptly returning to pre-stimulation levels.

2. Median line of the head

Figure 3 indicates changes to heart rate and pulse wave due to stimulation of the median line of the head. Heart rate showed a significant reduction between 10 sec and 60 sec after commencement of stimulation, with a maximum reduction of 5.4% at 20 sec after commencement of stimulation. Pulse wave showed a significant reduction of 20% at 10 sec after commencement of stimulation, before promptly returning to pre-stimulation levels.

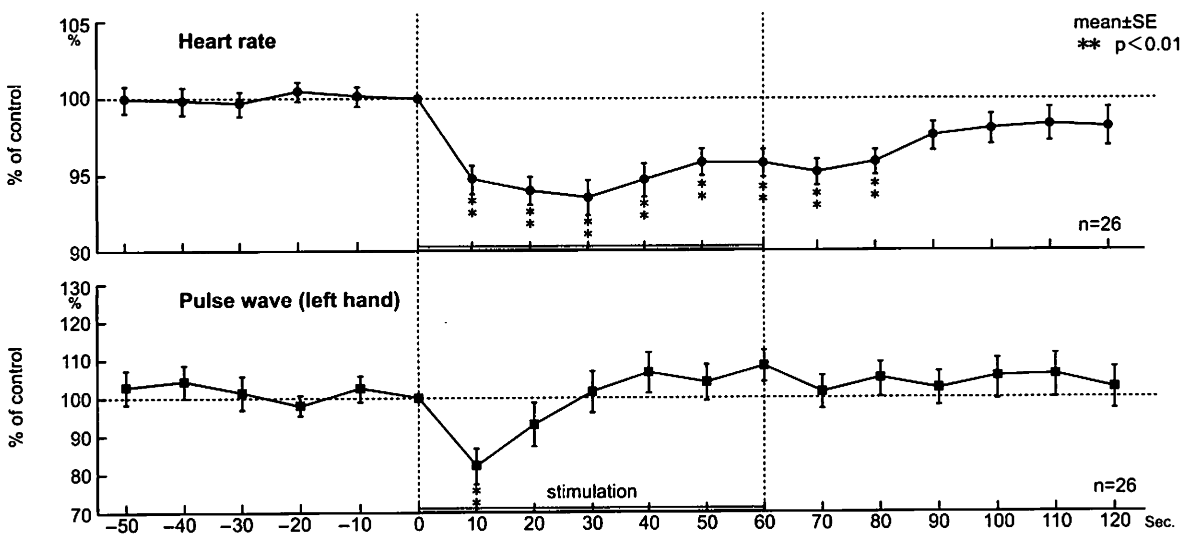

Fig. 2. Changes to heart rate and pulse wave (left hand) due to stimulation of Point 1 of the left lateral crural region

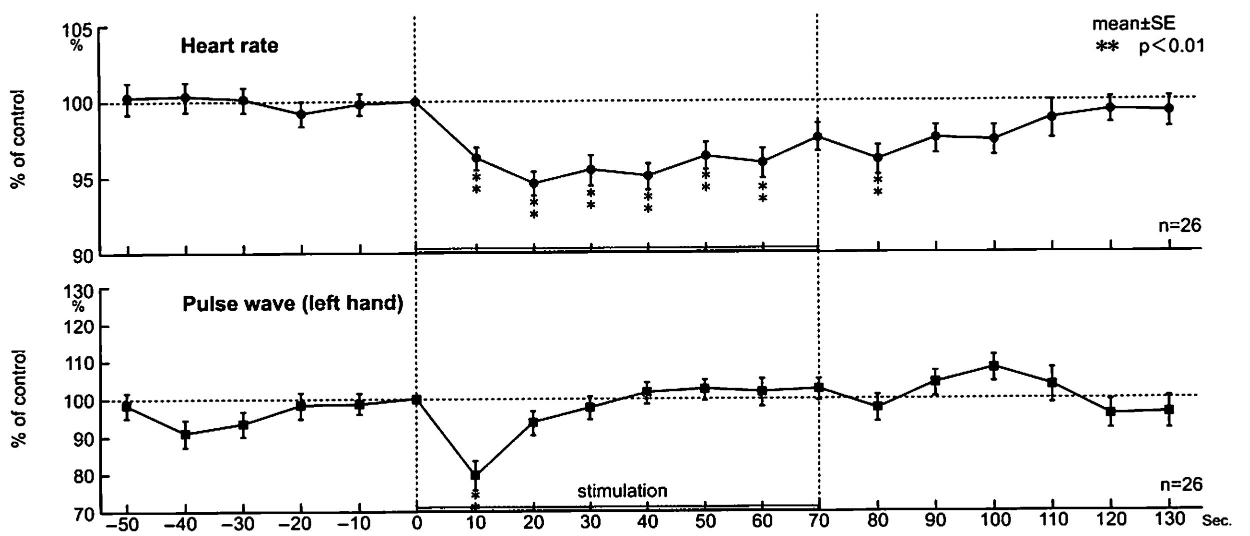

Fig. 3. Changes to heart rate and pulse wave (left hand) due to stimulation of median line of the head

3. Abdominal region (small intestine region)

Figure 4 indicates changes to heart rate and pulse wave due to stimulation of the abdominal region (small intestine region). Heart rate showed a significant reduction between 10 sec after commencement of stimulation and 10 sec after completion, with a maximum reduction of 6.7% at 20 sec after commencement of stimulation. Pulse wave showed a significant reduction of 16% at 10 sec after commencement of stimulation, before promptly returning to pre-stimulation levels.

4. Rippling palm pressure to abdomen

Figure 5 indicates changes to heart rate and pulse wave due to stimulation using rippling palm pressure. No significant change to heart rate due to stimulation was detected. Pulse wave showed a significant reduction of 24% at 10 sec after commencement of stimulation, before promptly returning to pre-stimulation levels.

5. Point 1, left anterior cervical region

Figure 6 indicates changes to heart rate and pulse wave due to stimulation of Point 1 of the left anterior cervical region. Heart rate showed a significant reduction between 10 sec and 30 sec after commencement of stimulation, with a maximum reduction of 6.5% at 20 sec after commencement of stimulation. Pulse wave showed a significant reduction of 24% at 10 sec after commencement of stimulation, before promptly returning to pre-stimulation levels.

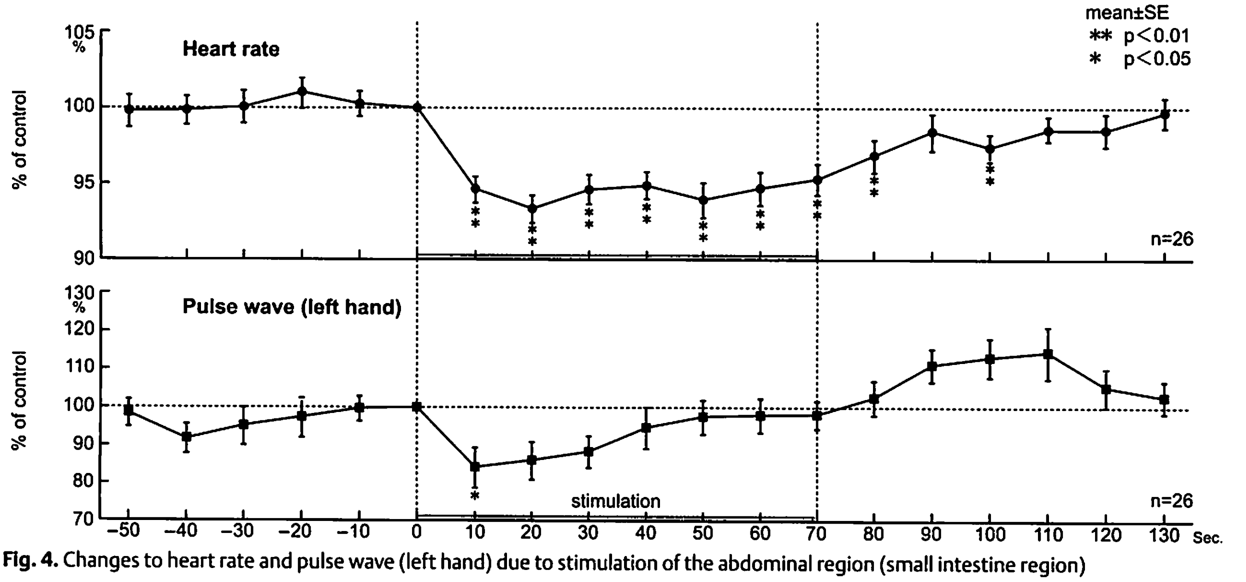

Fig. 4. Changes to heart rate and pulse wave (left hand) due to stimulation of the abdominal region (small intestine region)

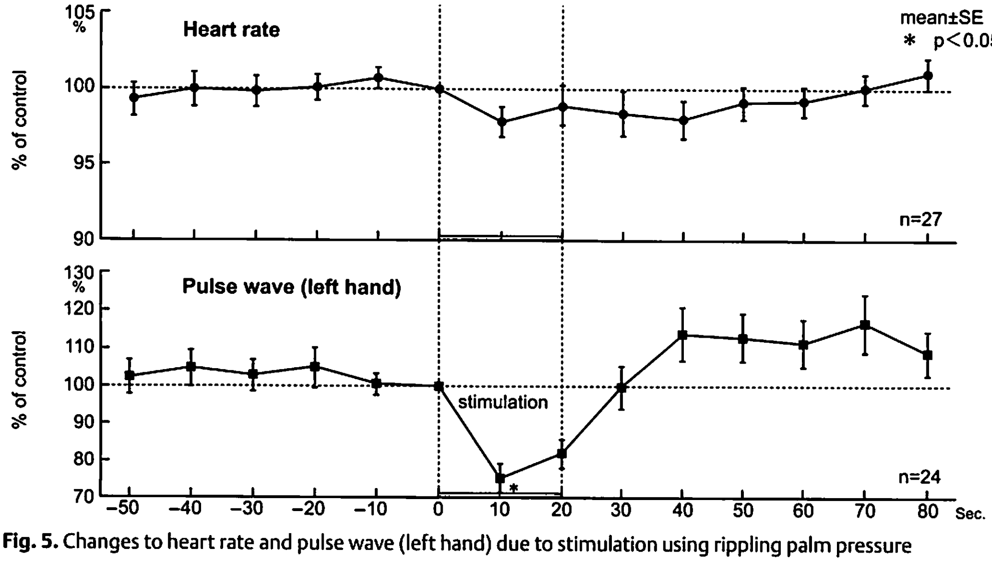

Fig. 5. Changes to heart rate and pulse wave (left hand) due to stimulation using rippling palm pressure

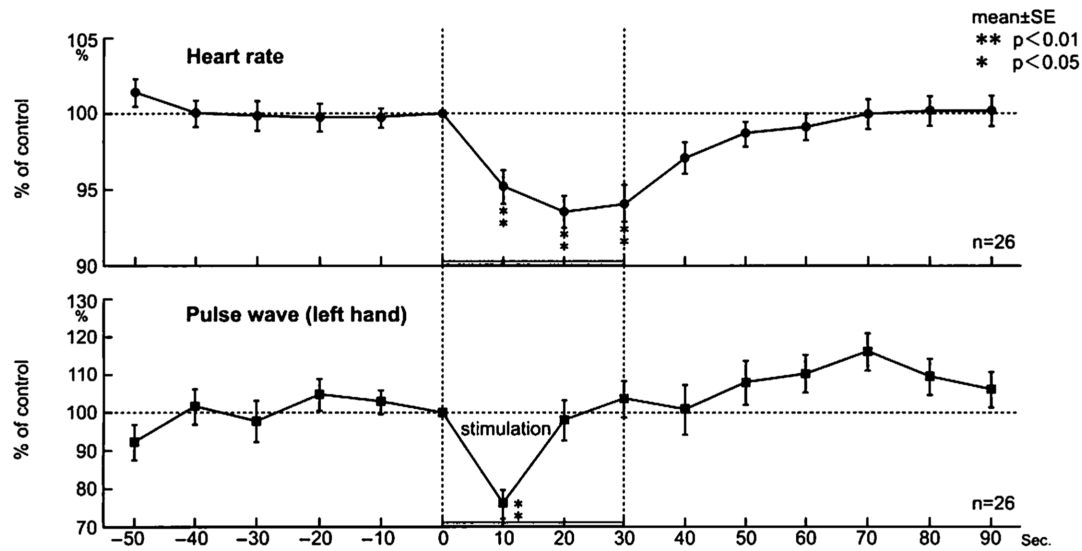

Fig. 6. Changes to heart rate and pulse wave (left hand) due to stimulation of Point 1 of the left anterior cervical region

IV. Discussion

The test results confirm a significant reduction in heart rate due to shiatsu stimulation using standard pressure. Changes to heart rate due to somatosensory stimulation have been reported by many researchers. Sato et al (1976) and Kimura et al (1995) have reported an increase in heart rate in anesthetized rats due to nociceptive mechanical stimulation of the skin[4,5]. Nishijo et al (1979) reported an increase in heart rate in healthy adults when subjected to heat pain stimulation using an algesimeter[6]. The shiatsu stimulation tested here involved standard pressure not accompanied by pain sensations in the test subjects, and showed that the effect of shiatsu stimulation on heart rate is clearly different from that of nociceptive stimulation.

This heart rate reduction response due to shiatsu stimulation using standard pressure was confirmed through stimulation of regions corresponding to a variety of spinal segments, including Point 1 of the lateral crural region, supplied by the L_5 segment; the median line of the head, supplied by the trigeminal nerve; the abdominal region (small intestine region), supplied by the T_{10-12} segments, and Point 1 of the anterior cervical region, supplied by the C_3 segment. Kimura et al (1995) reported that, in rats with the central nervous system intact, nociceptive mechanical stimulation throughout the body produced a universal response of increased heart rate[5]. Although the direction of the heart rate response differs between nociceptive mechanical stimulation and shiatsu stimulation, it is highly probable that the heart rate reduction response due to shiatsu stimulation is also universal.

Also, because suction pressure (rippling palm pressure) to the abdomen produced a different heart rate response to that of standard pressure applied using gradual increase and decrease of pressure, there is a possibility that somatic responses vary depending on the shiatsu technique applied. Further study is required into effects of different techniques and amounts of pressure.

Heart rate is known to be regulated by the beta-mediated sympathetic nervous system and the parasympathetic nervous system. While it would be difficult to determine the efferent mechanism of the heart rate reduction response due to shiatsu stimulation based on the findings shown here, it is likely due either to suppression of the beta-mediated sympathetic nervous system, the stimulation of the parasympathetic nervous system, or a combination of the two. Further basic research is required.

Pulse wave was also significantly reduced immediately after stimulation of all regions. This response is probably due to stimulation of the alpha-mediated sympathetic nervous system.

It is our hope that these research results will form a basis for clarifying the effect of shiatsu stimulation on blood pressure and other cardiovascular system functions.

V. Conclusions

Study of the effects of shiatsu stimulation on the cardiovascular systems of healthy adult test subjects yielded the following results:

1. Heart rate was significantly reduced during stimulation of Point 1 of the left lateral crural region, the median line of the head, the abdominal region (small intestine region), and Point 1 of the left anterior cervical region.

2. Pulse wave was significantly reduced immediately after commencement of stimulation of Point 1 of the left lateral crural region, the median line of the head, the abdominal region (small intestine region), rippling palm pressure to the abdomen, and Point 1 of the left anterior cervical region.

Based on the above findings, it is apparent that shiatsu stimulation results in a heart rate reduction response and transitory pulse wave reduction response.

In closing, we would like to express our appreciation to the students of the Japan Shiatsu College who participated in this research. This research was carried out as a dying wish of Toru Namikoshi, former Principal of the college.

References

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6 Nishijo K , Mori H et al: Jintai ni okeru taisei-shinzohansha. Riryou no Kagaku 7: 10-15, 1979 (in Japanese)

Effects of Shiatsu Stimulation on Blood Pressure

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I. Introduction

Shiatsu therapy produces a variety of therapeutic effects, including alleviation of pain and regulation of autonomic functions; however, many questions remain to be answered about these effects and their mechanisms. It is recognized that somatosensory stimulation of an organism using manual pressure stimulation evokes a reflex response in the various internal organs via the autonomic nervous system[1,2]. This somatovisceral reflex is thought to be responsible for the therapeutic effectiveness of shiatsu.

In order to clarify the effects of shiatsu and the mechanisms involved, the Japan Shiatsu College has been conducting research into the effects of shiatsu on the cardiovascular system. Last year, we reported on reduction in heart rate due to shiatsu stimulation[3].

Building on last year's results, this year we report on changes in blood pressure due to shiatsu stimulation, as measured using a noninvasive continuous blood pressure manometer.

II. Methods

1. Subjects

Research was conducted on 37 healthy adults (22 males, 15 females) aged 22-65 years (mean age: 40.7 years old).

Test procedures were fully explained to each test subject and their consent obtained. They were also asked to abstain from eating, smoking, ingestion of stimulants, or vigorous exercise for two hours prior to testing.

2. Test period

April 11 to July 17, 1999

3. Test location

Testing was conducted in the basic medical research lab at the Japan Shiatsu College. Room temperature was 25 ± 1.5°C with subdued lighting and silence maintained.

4. Items measured

(1) Blood pressure

A continuous blood pressure manometer (Japan Colin Jentow-7700) was used to derive blood pressure from the left radial artery using tonometry.

(2) Heart rate

A pulse tachometer (Nihon Kohden Corp. model AT-601G) was used to calculate the momentary heart rate (hereafter, 'heart rate') as triggered by the ECG's R wave (the second deflection on the ECG).

(3) Fingertip pulse wave

The fingertip volume pulse wave (hereafter, 'pulse wave') was measured on the second digits of the right hand and foot using a reflex pickup (Nihon Kohden Corp. model MPP-3A).

(4) Respiratory curve

The respiratory curve was measured using a thermistor breathing pickup (Nihon Kohden Corp. model TR-712T) inserted into the nasal cavity.

5. Data recording

The items measured in (1) to (4) above were continuously recorded using a thermal recording device on a polygraph system (Nihon Kohden Corp. model RM-7000), as well as being transferred and saved to a personal computer (IBM 300GL) via an A/D convertor (BIOPAC Systems, Inc. model MP-100). The data were also recorded on magnetic tape using a data recorder (Sony model PC208AX).

6. Data analysis

After completion of testing, data was analyzed using data analysis software (AcqKnowledge, BIOPAC Systems, Inc.). Analysis was performed on blood pressure, heart rate, and pulse wave data from one minute prior to stimulation to one minute after stimulation. However, data due to pronounced body motion, artifact, or swallowing was omitted.

7. Stimulation

Full-body treatment is standard for Namikoshi shiatsu[4], but because mobility of the test subject was limited due to attachment of the ECG electrodes and other constraints, the areas to which shiatsu was applied were limited to the following three regions (Fig. 1):
(1) Point 1, left lateral crural region: approximately 3 cm disto-lateral to the tibial tuberosity. This is the point where the common peroneal nerve emerges from the popliteal region to the lateral lower leg and divides into the deep and superficial peroneal nerves. Standard pressure was applied using thumb-on-thumb pressure for 5 seconds, repeated 10 times.
(2) Abdominal region (small intestine region): referred to as the small intestine region in Namikoshi shiatsu, consisting of 8 points located clockwise around the navel, with Point 1 located diagonally to the right (test recipient's right) and inferior to the navel. Standard pressure was applied using two-thumb pressure, 3 seconds per point, repeated 3 times.
(3) Point 1, left anterior cervical region: located on the medial margin of the sternocleidomastoid muscle, near the carotid artery in the carotid triangle. Positioned behind the test recipient's head, the therapist applied standard pressure using one-thumb pressure with the left hand for 3 seconds, repeated 6 times.

All treatment was carried out by the same therapist, applying approximately 5–15 kg pressure, depending on the comfort level of the test recipient. All standard pressure was applied using gradual increase and decrease of pressure.

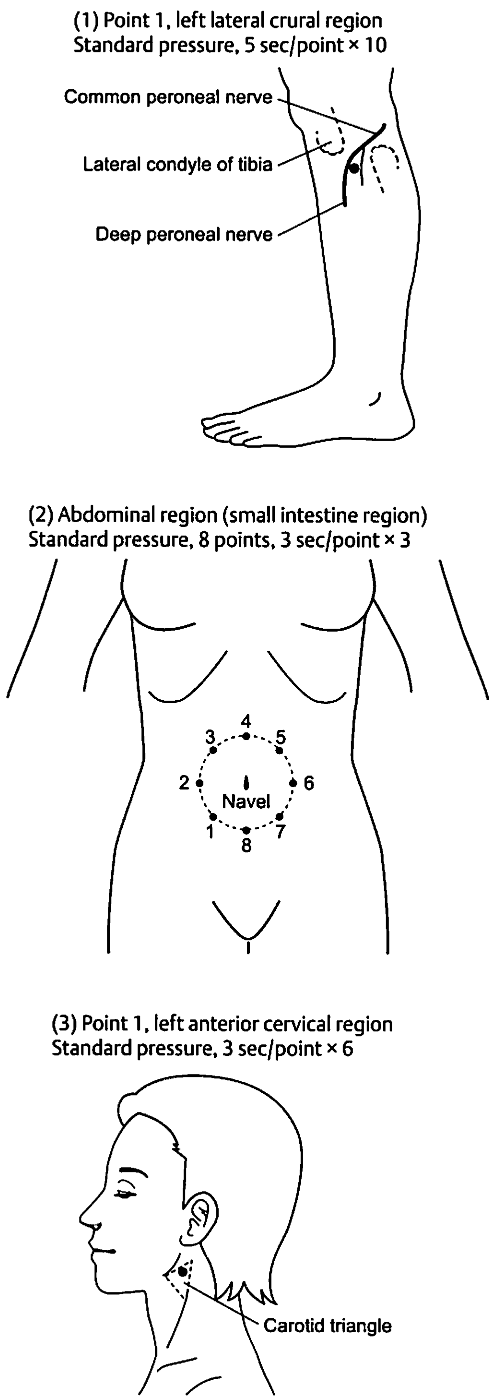

Fig.1. Areas and methods of shiatsu application (Namikoshi style)
Adapted from *The Complete Book of Shiatsu Therapy* by Toru Namikoshi

8. Test procedure

Testing commenced after the subject had been lying quietly for a minimum of 20 minutes in the supine position.

Stimulation was carried out in the following order: Point 1, left lateral crural region; abdominal region (small intestine region); Point 1, left anterior cervical region. A minimum of 5 minutes was allowed between each shiatsu procedure, and blood pressure, heart rate, and pulse wave allowed to stabilize before the next stimulation was applied.

9. Statistical processing

Data were analyzed at 10 second intervals from 1 minute prior to 1 minute after stimulation. Measurements taken during 1 minute prior to commencement of stimulation were averaged and used as the control in order to establish a standard value for evaluating response, shown as 100%. Other measurements were converted to percentage and expressed as mean ± SE.

Statistical verification was carried out using analysis of variance according to Dunnett's multiple comparison test, with <5% considered significant.

III. Results

During testing there were no instances requiring cessation of treatment due to pain or discomfort.

1. Point 1, left lateral crural region

Figure 2 indicates changes to blood pressure, heart rate, and pulse wave due to stimulation of Point 1 of the left lateral crural region. Systolic blood pressure rose briefly at 10 seconds after commencement of stimulation, then gradually declined, showing a significant drop between 10 seconds and 30 seconds after commencement of stimulation. A maximum decline of 3.0% was observed at 10 seconds after completion of stimulation. Diastolic blood pressure rose briefly 10 seconds after commencement of stimulation, showing a more or less significant decline between 20 seconds after commencement and 60 seconds after completion of stimulation. A maximum decline of

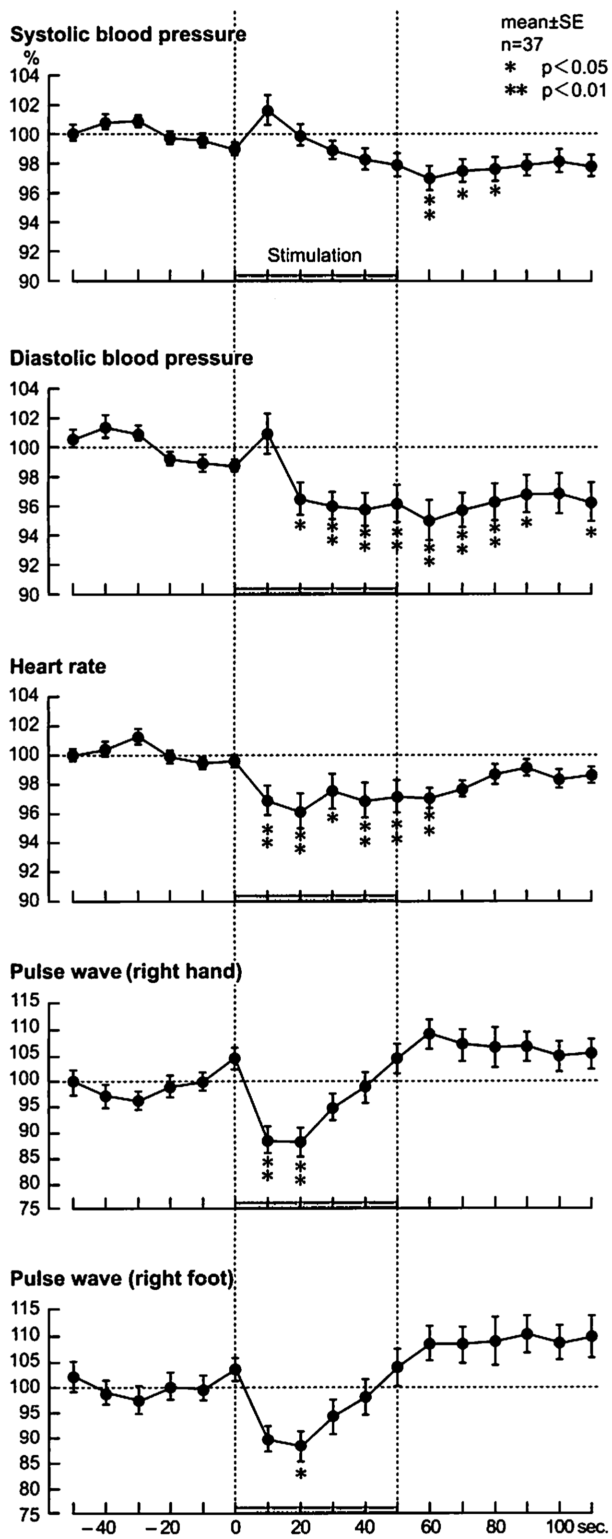

Fig. 2. Effects of shiatsu stimulation of Point 1 of the left lateral crural region
Horizontal axis indicates lapsed time; vertical axis indicates percentage change, with 100% equalling the average value during 1 minute prior to stimulation.

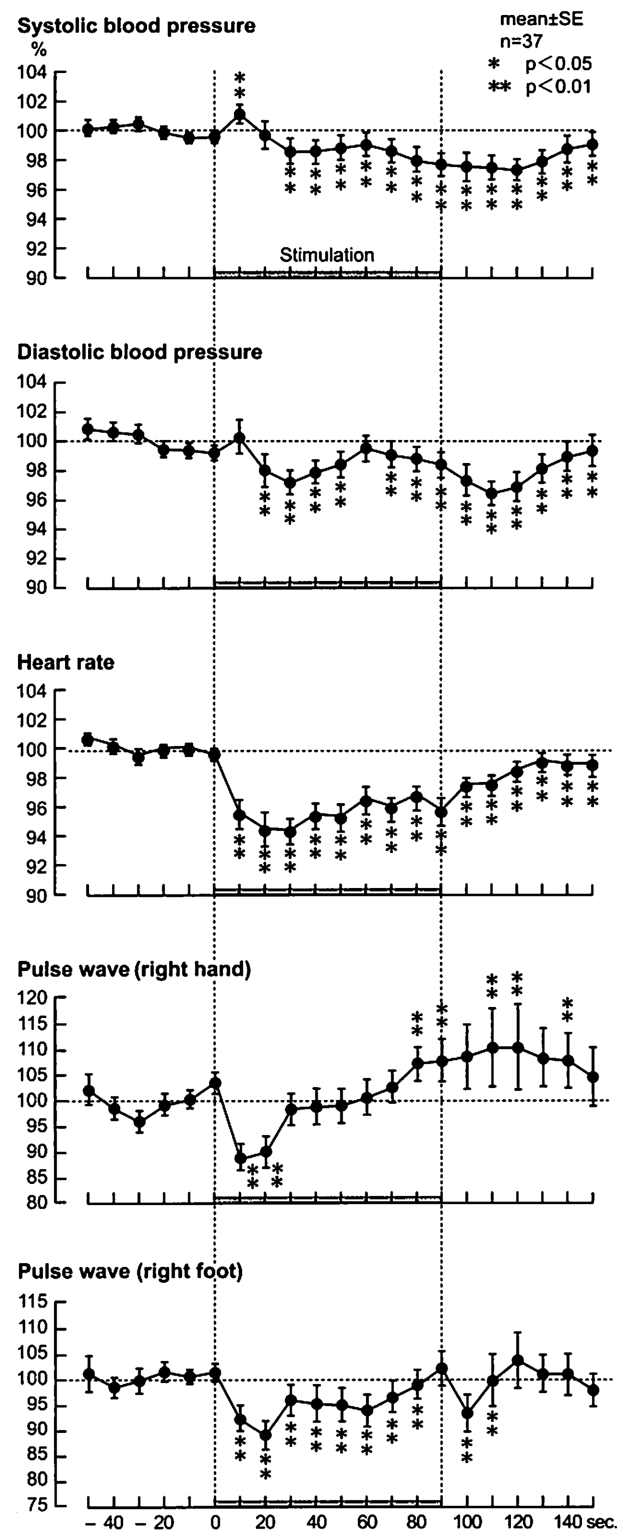

Fig. 3. Effects of shiatsu stimulation of the abdominal region
Horizontal axis indicates lapsed time; vertical axis indicates percentage change, with 100% equalling the average value during 1 minute prior to stimulation.

4.9% was observed at 10 seconds after completion of stimulation. Heart rate showed a significant reduction between 10 seconds after commencement of stimulation and 10 seconds after completion of stimulation. A maximum reduction of 3.9% was observed at 20 seconds after commencement of stimulation. Right-hand pulse wave showed significant reduction between 10 and 20 seconds after commencement of stimulation. A maximum reduction of 11.9% was observed at 20 seconds after commencement of stimulation, after which it promptly returned to pre-stimulation values. After completion of stimulation, it displayed an upward trend. Right-foot pulse wave showed a maximum reduction of 11.9% at 20 seconds after commencement of stimulation, which was significant, after which it promptly returned to pre-stimulation values. After completion of stimulation, it displayed an upward trend.

2. Abdominal region (small intestine region)

Figure 3 indicates changes to blood pressure, heart rate, and pulse wave due to stimulation of the abdominal region (small intestine region). Systolic blood pressure rose briefly at 10 seconds after commencement of stimulation, then showed a more or less significant drop between 30 seconds and 60 seconds after commencement of stimulation. A maximum decline of 2.7% was observed at 30 seconds after completion of stimulation. Diastolic blood pressure showed a more or less significant decline between 20 seconds after commencement and 60 seconds after completion of stimulation. A maximum decline of 3.5% was observed 20 seconds after completion of stimulation. Heart rate showed a significant reduction between 10 seconds after commencement of stimulation and 60 seconds after completion of stimulation. A maximum reduction of 5.6% was observed at 30 seconds after commencement of stimulation. Right-hand pulse wave showed significant reduction between 10 and 20 seconds after commencement of stimulation. A maximum reduction of 10.8% was observed at 10 seconds after commencement of stimulation, after which it gradually increased. Significant increase was observed in the latter half of the stimulation period and post-stimulation. Right-foot pulse wave showed more or less significant reduction between 10 seconds after commencement of stimulation and 20 seconds after completion. A maximum reduction of 11.4% was observed at 20 seconds after commencement of stimulation, before promptly returning to pre-stimulation values after completion of stimulation.

3. Point 1, left anterior cervical region

Figure 4 indicates changes to blood pressure, heart rate, and pulse wave due to stimulation of Point 1 of the left anterior cervical region. Systolic blood pressure rose briefly at 10 seconds after commencement of stimulation, then gradually declined, showing a significant drop between 10 seconds and 40 seconds after completion of stimulation. A maximum decline of 3.6% was observed at 20 seconds after completion

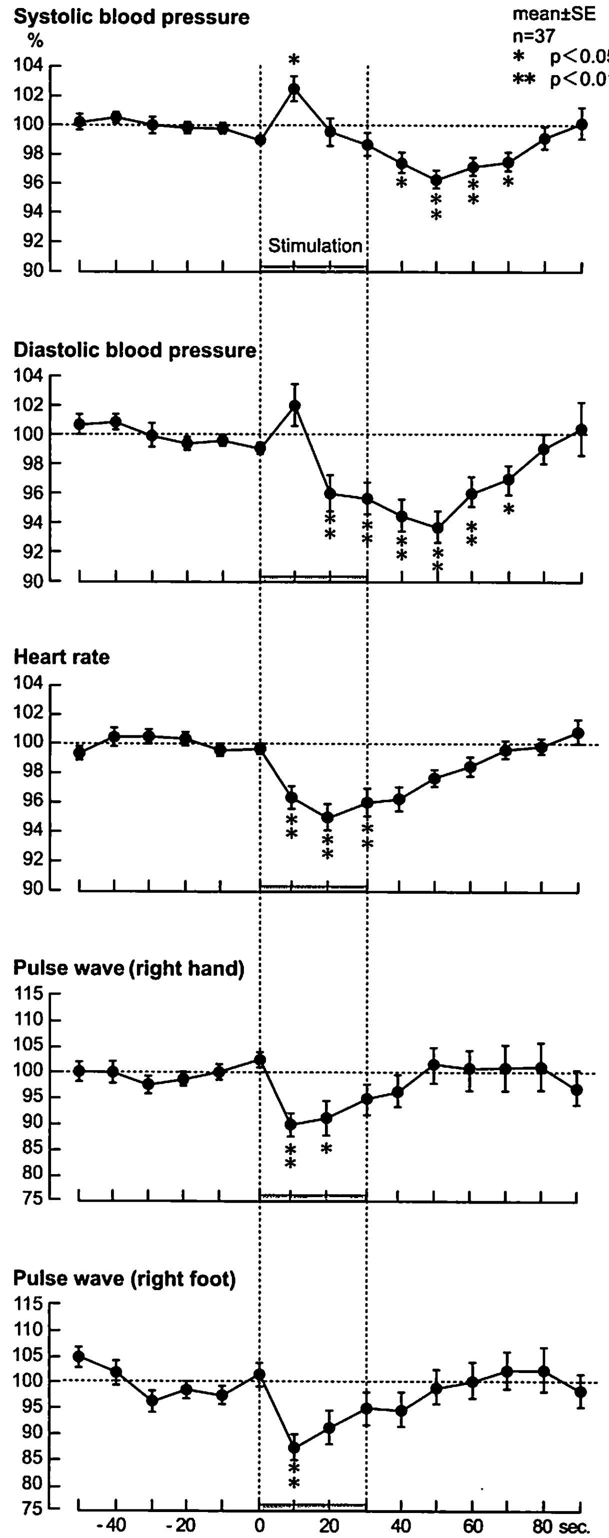

Fig. 4. Effects of shiatsu stimulation of Point 1 of the left anterior cervical region
Horizontal axis indicates lapsed time; vertical axis indicates percentage change, with 100% equalling the average value during 1 minute prior to stimulation.

of stimulation. Diastolic blood pressure rose briefly at 10 seconds after commencement of stimulation, then showed a significant decline between 20 seconds after commencement and 40 seconds after completion of stimulation. A maximum decline of 6.2% was observed at 20 seconds after completion of stimulation. Heart rate showed a significant reduction between 10 and 30 seconds after commencement of stimulation. A maximum reduction of 5.0% was observed at 20 seconds after commencement of stimulation. Right-hand pulse wave showed significant reduction between 10 and 20 seconds after commencement of stimulation. A maximum reduction of 10.4% was observed at 10 seconds after commencement of stimulation, after which it promptly returned to pre-stimulation values. Right-foot pulse wave showed a maximum reduction of 12.4% at 10 seconds after commencement of stimulation, which was significant, before promptly returning to pre-stimulation values.

IV. Discussion

In the previous study, we confirmed that heart rate and pulse wave were reduced through application of shiatsu stimulation using standard pressure[3]. In this study, we also confirmed that blood pressure is significantly lowered.

It was observed that, immediately after commencement of shiatsu stimulation, blood pressure underwent a transient rise, then lowered during the latter half of stimulation and after completion. From the fact that the transient rise in blood pressure immediately after commencement of stimulation coincided with the reduction response in fingertip pulse wave in the hand and foot, we may assume that it was due to dermovascular constriction in the hands and feet due to stimulation of the alpha-mediated sympathetic nervous system. The drop in blood pressure during the latter half of stimulation and after completion may have been due to vasodilation arising subsequent to dermovascular constriction. It is known based on numerous studies that nociceptive mechanical stimulation causes a rise in blood pressure[1,2], but the effect of shiatsu on blood pressure has been shown here to differ from that of nociceptive stimulation.

The pulse wave response to stimulation of both Point 1 of the left lateral crural region and Point 1 of the left anterior cervical region were consistent. Pulse wave fluctuations in the right foot observed during stimulation of the abdominal region (small intestine region) may have been due to the effect of pressure on the abdominal aorta during abdominal shiatsu.

This research confirmed a reduction in blood pressure due to shiatsu stimulation of all regions studied, including Point 1 of the lateral crural region, supplied by the L_5 segment; the abdominal region (small intestine region), supplied by the T_{10-12} segments; and Point 1 of the anterior cervical region, supplied by the C_3 segment. Kimura et al reported that in anesthetized rats nociceptive mechanical stimulation produced a universal response of increased blood pressure, caused by a supraspinal reflex mediated in the brain stem[5]. Although the direction of the response differs between nociceptive mechanical stimulation and shiatsu stimulation, it is highly probable that the blood pressure reduction response due to shiatsu stimulation is also universal. Further research is required involving stimulation of additional regions using standardized stimulation techniques.

The hypotensive response due to shiatsu stimulation observed here may also be related to reduced heart rate and vasodilation in internal organs, but it would be difficult to confirm this with the current research.

In the future, we hope to build on the current study results to clarify the effect of shiatsu stimulation on circulatory functions such as blood-flow volume in cutaneous and muscular tissues.

V. Conclusions

Study of the effects of shiatsu stimulation on the blood pressure of healthy adult test subjects yielded the following results:

1. Blood pressure was significantly reduced during and after stimulation.
2. Heart rate was significantly reduced during stimulation.
3. Pulse wave was significantly reduced immediately after commencement of stimulation.

Based on the above findings, it is apparent that shiatsu stimulation results in lower blood pressure, lower heart rate, and transitory reduction in pulse wave.

In closing, we would like to express our appreciation to the instructors and students of the Japan Shiatsu College who participated in this research. This research was carried out as a dying wish of Toru Namikoshi, former Principal of the college.

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Effects of Shiatsu Stimulation on Peripheral Circulation

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I. Introduction

Shiatsu therapy produces a variety of therapeutic effects, including alleviation of pain and regulation of autonomic functions; however, many questions remain to be answered about these effects and their mechanisms. It is recognized that somatosensory stimulation of an organism using manual pressure stimulation evokes a reflex response in the various internal organs via the autonomic nervous system[1,2]. This somatovisceral reflex is thought to be responsible for the therapeutic effectiveness of shiatsu. In order to shed light on the effects of shiatsu and the mechanisms involved, the Japan Shiatsu College has conducted research into the reduction of blood pressure and heart rate due to shiatsu stimulation, which were reported on at the congress of the Japan College Association of Oriental Medicine[3,4]. Building on these past results, this year we report on changes in peripheral circulation due to shiatsu stimulation, as measured by muscle blood volume and thermography.

II. Methods

1. Subjects

Research was conducted on 33 healthy adults (23 males, 10 females) aged 20–70 years (mean age: 41.0 years old).

Test procedures were fully explained to each test subject and their consent obtained. They were also asked to abstain from eating, smoking, ingestion of stimulants, or vigorous exercise for two hours prior to testing.

2. Test period

April 20 to July 19, 1999

3. Test location

Testing was conducted in the shiatsu research lab at the Japan Shiatsu College. Room temperature was 25 ± 1.5°C with subdued lighting and silence maintained.

4. Items measured

(1) Muscle blood volume

A tissue SO_2-Hb volume monitor (Bio Medical Science Inc. model PSA-III N) was used to derive muscle blood volume in the tibialis anterior muscle at the midpoint of the right lateral crural region.

(2) Skin temperature

Skin temperature was measured in the right anterior crural region using a thermograph (Nihon Kohden Corp. model Infra-eye 1200).

(3) Fingertip pulse wave

The fingertip volume pulse wave (hereafter, 'pulse wave') was measured on the second digits of the right hand and foot using a reflex pickup (Nihon Kohden Corp. model MPP-3A).

(4) Blood pressure

A continuous blood pressure manometer (Japan Colin Jentow-7700) was used to derive blood pressure from the left radial artery using tonometry.

(5) Heart rate

A pulse tachometer (Nihon Kohden Corp. model AT-601G) was used to calculate the momentary heart rate (hereafter, 'heart rate') as triggered by the ECG's R wave (the second deflection on the ECG).

(6) Respiratory curve

The respiratory curve was measured using a thermistor breathing pickup (Nihon Kohden Corp. model TR-712T) inserted into the nasal cavity.

5. Data recording

Items measured above, including muscle blood volume, fingertip pulse wave, blood pressure, heart rate, and respiratory curve were continuously recorded using a thermal recording device on a polygraph system (Nihon Kohden Corp. model RM-7000), as well as being transferred and saved to a personal computer (IBM 300GL) via an A/D convertor (BIOPAC Systems, Inc. model MP-100). The data were also recorded on magnetic tape using a data recorder (Sony model PC208AX).

Thermograms were saved to floppy disc using a floppy drive attached to the thermograph device.

6. Stimulation

Full-body treatment is standard for Namikoshi shiatsu[5], but because mobility of the test subject was limited due to attachment of the ECG electrodes and other constraints, the areas to which shiatsu was applied were limited to the following three regions (Fig. 1):

(1) Point 1, right lateral crural region: approximately 3 cm disto-lateral to the tibial tuberosity on the right leg. This is the point where the common peroneal nerve emerges from the popliteal region to the lateral lower leg and divides into the deep and superficial peroneal nerves. Standard pressure was applied using thumb-on-thumb pressure for 5 seconds, repeated 15 times.

(2) Point 1, left lateral crural region: same region as above, at the tibial tuberosity on the left leg.

(3) Abdominal region (20 points + small intestine region): the 20 abdominal points of Namikoshi shiatsu are arranged along a line that begins at the epigastric fossa, runs down the midline to the bladder, then describes a circle that follows the colon. Standard pressure is applied using two-thumb pressure, 3 seconds per point, repeated 3 times. The small intestine region, consisting of eight points evenly spaced clockwise around the navel with Point 1 located diagonally to the right (patient's right) and inferior to the navel, was also treated with standard pressure applied using two-thumb pressure, 3 seconds per point, repeated 3 times.

Each application of force consisted of approximately 5–15 kg pressure, depending on the comfort level of the test recipient. All standard pressure was applied using gradual increase and decrease of pressure.

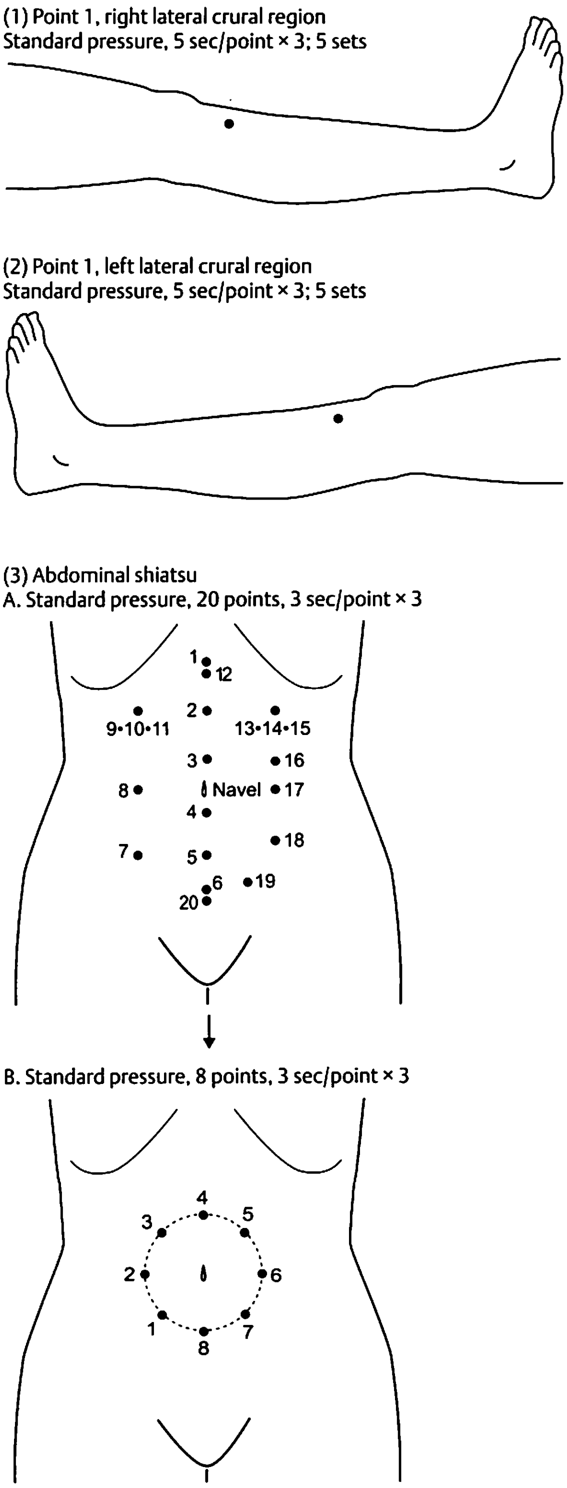

Fig. 1. Areas and methods of shiatsu application (Namikoshi style)

7. Test procedure

Testing commenced after the subject had been lying quietly for a minimum of 20 minutes in the supine position.

Stimulation was carried out in the following order: Point 1, right lateral crural region; Point 1, left lateral crural region; abdominal region (20 points + small intestine region). A minimum of 10 minutes was allowed between each shiatsu procedure, and blood pressure, heart rate, and pulse wave allowed to stabilize before the next stimulation was applied.

8. Data analysis

After completion of testing, muscle blood volume, fingertip pulse wave, blood pressure, and heart rate data were analyzed using data analysis software (AcqKnowledge, BIOPAC Systems, Inc.). Analysis was performed from 1 minute prior to stimulation to 7 minutes after stimulation. However, data due to pronounced body motion, artifact, or swallowing was omitted.

For thermograph data, average skin temperature for the right, upper crural region indicated in Figure 3 was analyzed.

9. Statistical processing

Data were analyzed at 1 minute intervals from 1 minute prior to 7 minutes after stimulation. Measurements taken during 10 seconds prior to commencement of stimulation were averaged and used as the control in order to establish a standard value for evaluating response. Other measurements were averaged and expressed as a variation from this standard value, expressed as either amount of change or rate of variability.

Statistical verification was carried out using analysis of variance according to Dunnett's multiple comparison test, with <5% considered significant.

III. Results

During testing there were no instances requiring cessation of treatment due to pain or discomfort.

1. Point 1, right lateral crural region

Figure 2 indicates changes to muscle blood volume (right tibialis anterior muscle), right foot pulse wave height value, right upper crural region skin temperature, heart rate, and blood pressure due to stimulation of Point 1 of the right lateral crural region.

Muscle blood volume declined briefly immediately after stimulation before recovering to its immediately pre-stimulation level 1 minute later, then gradually increased, showing a significant increase at 6 minutes after completion of stimulation. Right foot pulse wave increased immediately after stimulation, with a maximum increase of 22.5%, but there was no significant difference.

Skin temperature showed a significant increase of 0.4°C immediately after stimulation, returning to pre-stimulation values at 3 minutes after completion of stimulation. Figure 3 shows a typical thermogram of skin temperature change due to shiatsu stimulation of Point 1 of the right lateral crural region.

Heart rate showed a significant decrease immediately after stimulation, later returning to pre-stimulation values.

Significant changes to systolic or diastolic blood pressure were not confirmed.

2. Point 1, left lateral crural region

Figure 4 indicates changes to muscle blood volume (right tibialis anterior muscle), right foot pulse wave height value, right upper crural region skin temperature, heart rate, and blood pressure due to stimulation of Point 1 of the left lateral crural region.

Muscle blood volume (in the right tibialis anterior muscle) decreased slightly immediately after stimulation, then showed an upward trend, but a significant difference was not confirmed.

Right foot pulse wave increased after stimulation, with a maximum increase of 22.5%, but a significant difference was not confirmed.

Skin temperature declined significantly between 3 minutes and 7 minutes after stimulation.

Heart rate showed a downward trend immediately after stimulation, but a significant decline was not confirmed.

Systolic blood pressure decreased immediately after

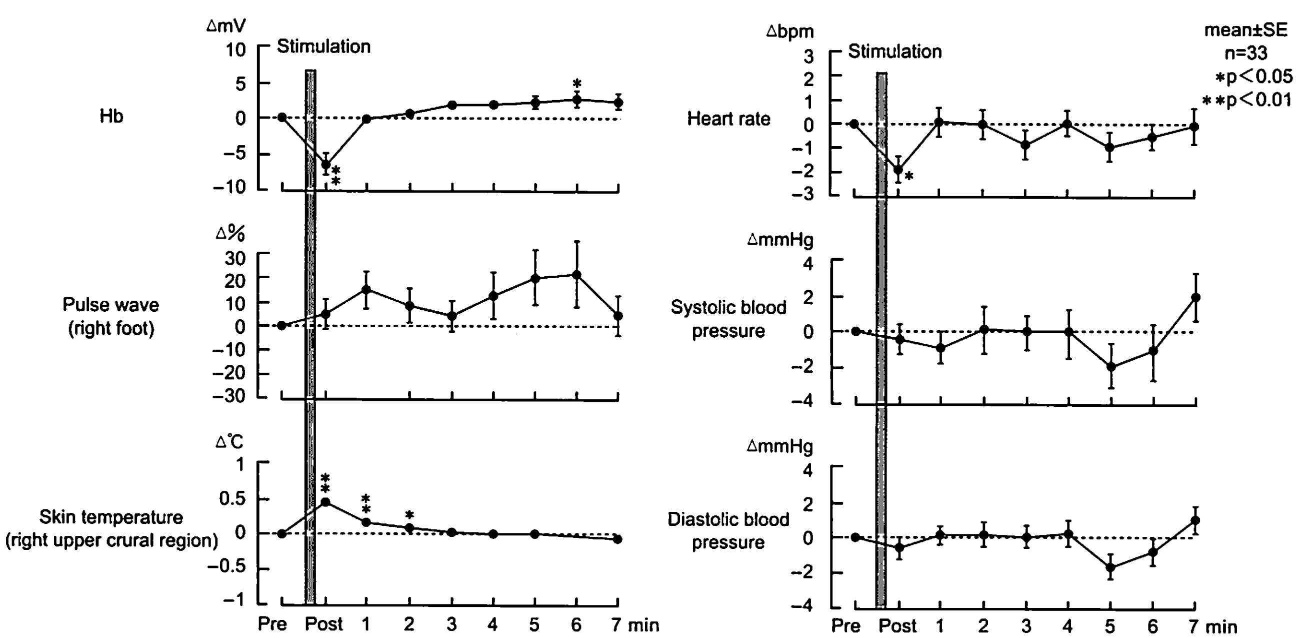

Fig. 2. Effects of shiatsu stimulation of Point 1 of the right lateral crural region
Muscle blood volume (Hb), skin temperature, heart rate, and systolic/diastolic blood pressure show the amount of change compared to the 10 seconds prior to stimulation. Pulse wave is expressed as the rate of variability compared to the 10 seconds prior to stimulation.

stimulation, with a significant decrease of 3.4 mmHg confirmed at 3 minutes after stimulation. Diastolic blood pressure showed a downward trend immediately after stimulation, but a significant difference was not confirmed.

3. Abdominal region (20 points + small intestine region)

Figure 5 indicates changes to muscle blood volume (right tibialis anterior muscle), right foot pulse wave height value, right upper crural region skin temperature, heart rate, and blood pressure due to stimulation of the abdominal region (20 points + small intestine region).

Muscle blood volume began to increase immediately after stimulation, with a significant increase confirmed between 2 minutes and 7 minutes after stimulation. A maximum increase of 3.6 mV was

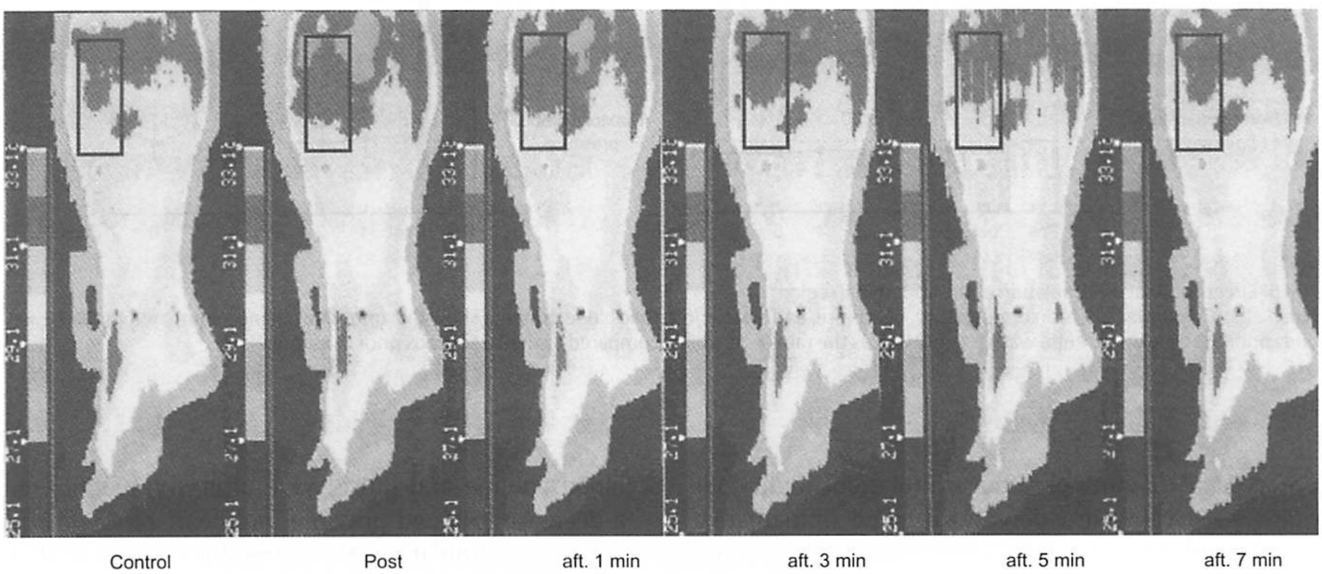

Fig. 3. Changes to skin temperature in crural region due to shiatsu stimulation of right lateral crural region
A thermogram of the lower leg is shown. The box indicates the area measured.

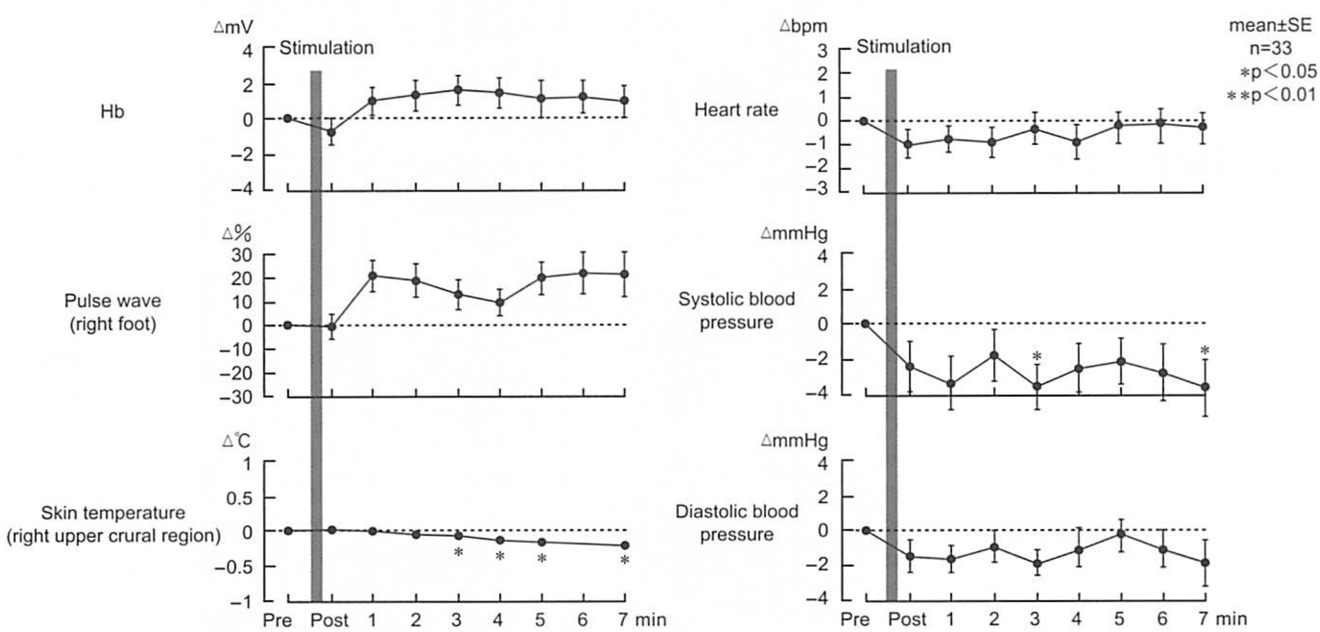

Fig. 4. Effects of shiatsu stimulation of Point 1 of the left lateral crural region
Muscle blood volume (Hb), skin temperature, heart rate, and systolic/diastolic blood pressure show the amount of change compared to the 10 seconds prior to stimulation. Pulse wave is expressed as the rate of variability compared to the 10 seconds prior to stimulation.

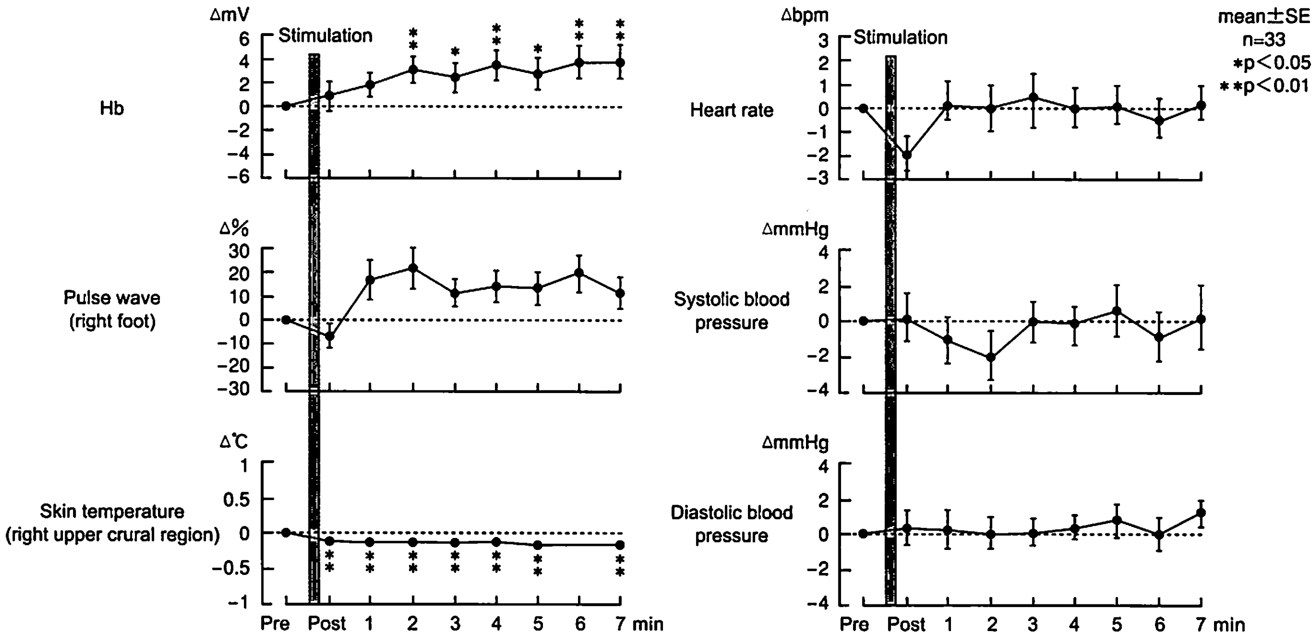

Fig. 5. Effects of shiatsu stimulation of the abdominal region
Muscle blood volume (Hb), skin temperature, heart rate, and systolic/diastolic blood pressure show the amount of change compared to the 10 seconds prior to stimulation. Pulse wave is expressed as the rate of variability compared to the 10 seconds prior to stimulation.

observed at 6 minutes after stimulation. Right foot pulse wave showed a downward trend immediately after stimulation, then began to increase, with a maximum increase of 20.5% at 2 minutes after stimulation.

Skin temperature showed a significant decline between immediately after and 7 minutes after stimulation.

Systolic blood pressure showed a downward trend 2 minutes after stimulation, but a significant difference was not confirmed. Diastolic blood pressure did not change significantly.

IV. Discussion

Reports by Koyata et al[3] and Ide et al[4] confirmed that shiatsu stimulation using standard pressure lowered blood pressure and heart rate during and after stimulation (observation continued until 1 minute after stimulation). In this study, in addition to indicators of circulatory function, we also examined peripheral circulatory functions including muscle blood volume and skin temperature. Also, previous reports[3,4] analyzed data from during stimulation and 1 minute after stimulation, but in this report analysis was extended to 7 minutes after stimulation. Because there is a possibility of muscle blood volume readings taken during stimulation being adulterated by artifacts, analysis was not carried out for data taken during stimulation for this study.

This study confirmed an increase in both muscle blood volume and pulse wave after stimulation and a decrease in blood pressure and heart rate immediately after stimulation. Also, a trend was observed that, when immediately after stimulation skin temperature increased, muscle blood volume decreased, and when skin temperature decreased, muscle blood volume increased.

Both muscle blood volume and pulse wave height value increased due to shiatsu stimulation. This case, the fact that the increase in muscle blood volume and pulse wave height was not accompanied by an increase in blood pressure would appear to indicate that the reaction was not a blood pressure dependent response, but due instead to suppression of sympathetic nervous activity governing peripheral blood vessels. Also, the fact that muscle blood volume and pulse wave height increased on the leg opposite to the one being stimulated suggests that the increase was due to dilation of blood vessels on the opposite side due not to axon reflex alone, but also to a spinal or brainstem mediated reflex. Increase in muscle blood volume due to abdominal stimulation may have been due to suppression of sympathetic nervous activity, which resulted in an increase in muscle blood volume and pulse wave in the lower limb.

The test results obtained here indicating an increase in muscle blood flow in response to shiatsu stimulation imply that shiatsu stimulation would have a positive effect on muscle tension and muscle pain.

V. Conclusions

Study of the effects of shiatsu stimulation on the peripheral circulation of healthy adult test subjects yielded the following results:

1. When immediately after stimulation skin temperature increased, muscle blood volume decreased, and when skin temperature decreased, muscle blood volume increased.
2. Muscle blood volume and pulse wave height increased immediately after stimulation.
3. Blood pressure and heart rate decreased immediately after stimulation.

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

References

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Effects of Shiatsu Stimulation on Muscle Pliability

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I. Introduction

Shiatsu therapy produces a variety of therapeutic effects, including alleviation of pain and regulation of autonomic functions; however, many questions remain to be answered about these effects and their mechanisms. In order to shed light on the effects of shiatsu and the mechanisms involved, the Japan Shiatsu College has investigated the effect of shiatsu stimulation on heart rate[1], blood pressure[2], and peripheral circulation[3], and found that it reduces blood pressure and heart rate while increasing muscle blood volume. These findings were reported at the congress of the Japan College Association of Oriental Medicine.

Building on these past results, this year we report on changes to muscle stiffness due to shiatsu stimulation as detected using a tactile sensor system.

II. Methods

1. Subjects

Research was conducted on 39 healthy adults (29 males, 10 females) aged 20–62 years (mean age: 38.5 years old).

Test procedures were fully explained to each test subject and their consent obtained. They were also asked to abstain from eating, smoking, ingestion of stimulants, or vigorous exercise for two hours prior to testing.

2. Test period

April 14 to July 14, 2001

3. Test location

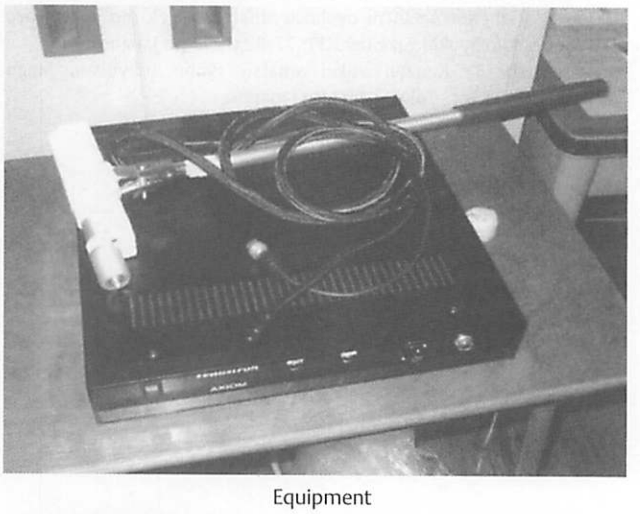
Testing was conducted in the shiatsu research lab at the Japan Shiatsu College. Room temperature was 25 ± 1.5°C with subdued lighting and silence maintained.

4. Items measured

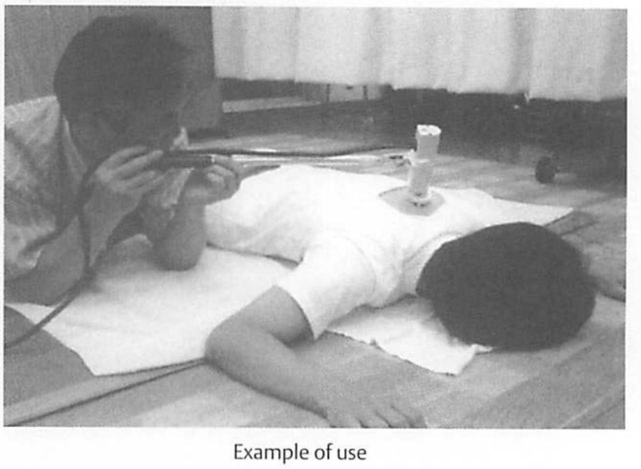
(1) Standing forward flexion (Finger Floor Distance, or FFD)

(2) Muscle pliability (muscle stiffness)

A tactile sensor system (Venustron mfg. by Axiom Co., Ltd.) was used to derive muscle pliability in the erector spinae muscles. Erector spinae muscles were measured at the height of $Th_{3\text{-}4}$ in the interscapular



Equipment



Example of use

Fig. 1. Tactile sensor system

region, and at the height of $L_{3\text{-}4}$ in the infrascapular and lumbar region. Figure 1 shows the testing equipment and an example of its use.

(3) The following items were measured using a polygraph system (Nihon Kohden Corp. model RM-7000):

[1] Heart rate: A pulse tachometer (Nihon Kohden Corp. model AT-601G) was used to calculate the momentary heart rate (hereafter, 'heart rate') as triggered by the ECG's R wave (the second deflection on the ECG).

[2] Fingertip pulse wave: The fingertip volume pulse wave (hereafter, 'pulse wave') was measured on the second digits of the right hand and foot using a reflex pickup (Nihon Kohden Corp. model MPP-3A).

[3] Respiratory curve: The respiratory curve was measured using a thermistor breathing pickup (Nihon Kohden Corp. model TR-712T) inserted into the nasal cavity.

5. Data recording

Muscle pliability data was transferred and saved to a personal computer (IBM 2611-456) from the tactile sensor via the control unit.

Items measured above, including heart rate, fingertip pulse wave, and respiratory curve were continuously recorded using a thermal recording device on a polygraph system, as well as being transferred and saved to a personal computer (IBM 300GL) via an A/D convertor (BIOPAC Systems, Inc. model MP-100). The data were also recorded on magnetic tape using a data recorder (Sony model PC208AX).

6. Analysis of muscle pliability data

The tactile sensor system uses an internal motor to move the probe tip in the direction of the target, then measures the hardness of the material the tip contacts. The probe tip vibrates at high frequency, and when it contacts a substance its frequency changes under the influence of the natural oscillation of the substance, and the hardness of the substance is expressed numerically. When encountering a soft substance, the frequency of the tip's vibration decreases significantly. The result is expressed as the angle of a line drawn between data points. The angle is inversely proportional to muscle stiffness.

7. Stimulation (Fig. 2)

Full-body treatment is standard for Namikoshi shiatsu[4], but due to the area being measured, shiatsu application was limited to the following areas in the prone position:

(1) 5 points, left and right interscapular region (treatment performed between the scapula and the spine on the erector spinae muscles, along a line parallel to the spine)

(2) 10 points, infrascapular and lumbar regions (10 points along a line parallel to the spine, starting at Point 5 of the interscapular region and ending at the height of the fifth lumbar vertebra)

Standard pressure was applied, 3 seconds per point, repeated 3 times, then 5 seconds of pressure was applied to Point 10, repeated 3 times.

All treatment was carried out by the same therapist, applying approximately 5–15 kg pressure, depending on the comfort level of the test recipient. All standard pressure was applied using gradual increase and decrease of pressure.

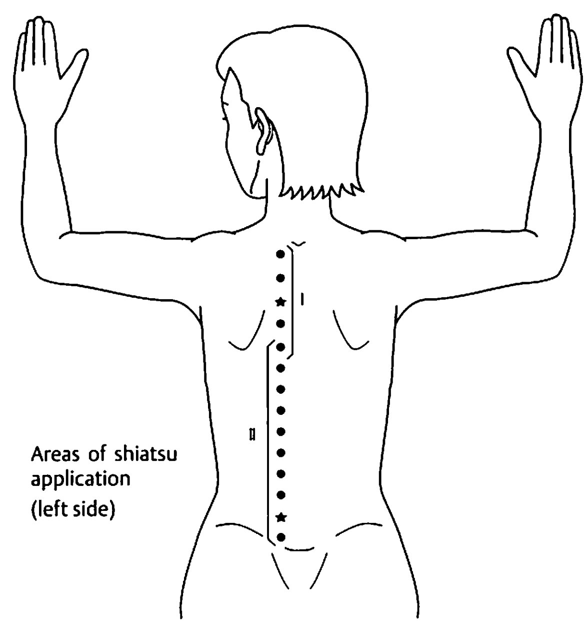
8. Test procedure

Testing commenced after the subject had been lying quietly for a minimum of 20 minutes in the prone position.

Stimulation was carried out in the following order:

(1) Pre-treatment standing forward flexion measurement

(2) Left pre-treatment measurements



Shiatsu areas

I. 5 points, interscapular region

II. 10 points, infrascapular and lumbar region

Shiatsu methods

Standard pressure, 3 sec/point × 3 sets

Pressure was also applied to Point 10 (lumbar region) for 5 sec × 3 times

The above operations were performed on the left and right sides (subject in the prone position)

Measurements were taken bilaterally in each region at the points indicated by the '★'.

Fig. 2. Areas and methods of shiatsu application (Namikoshi style)

(3) Treatment of 5 points, left interscapular region and 10 points, left infrascapular and lumbar region
(4) Left post-treatment measurements
(5) Right pre-treatment measurements
(6) Treatment of 5 points, right interscapular region and 10 points, right infrascapular and lumbar region
(7) Right post-treatment measurements
(8) Post-treatment standing forward flexion measurement

In addition, non-stimulation testing was performed on 14 cases, in which the above procedures were followed but with no shiatsu stimulation applied.

9. Statistical processing

Pre-and post-treatment data for standing forward flexion were expressed as mean values ± standard error.

Data for muscle stiffness were converted into the angle of the slope of a straight line connecting the pre- and post-treatment values and expressed as mean values ± standard error.

Statistical verification was carried out using a t-test.

III. Results

1. Standing forward flexion

(1) Stimulation group

Of 39 subjects who received shiatsu stimulation from the interscapular to the lumbar region, 28 (72%) showed an increase in standing forward flexion, 10 (26%) showed a decrease, and 1 was unchanged.

(2) Comparison to non-stimulation group

Non-stimulation testing was performed on 14 of the 28 subjects who showed an increase in standing forward flexion.

Of the 14 subjects in the non-stimulation group, 9 (64%) showed a decrease in standing forward flexion and 5 (36%) showed an increase. The average for all 14 test subjects was +0.4 cm ± 0.4 cm.

The effect for the 14 members of the shiatsu stimulation group corresponding to the subjects in the non-stimulation group were as follows: 3 (21%) showed a decrease and 11 (79%) showed an increase. The mean values for all 14 test subjects was −0.7 cm ± 0.7 cm (Fig. 3).

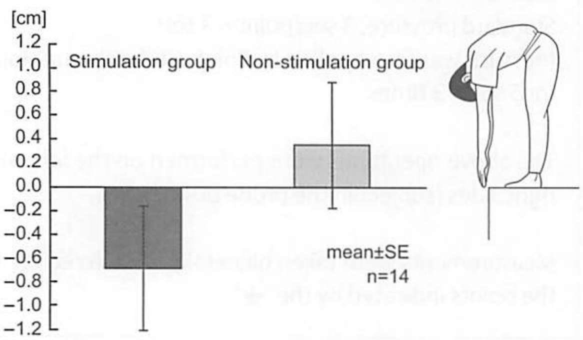


Fig. 3. Effect of shiatsu stimulation on standing forward flexion (FFD)

2. Muscle pliability

Of 39 test subjects, after eliminating cases contaminated with artifacts during measurement, 27 cases were analyzed for the interscapular region and 23 cases for the lumbar region.

(1) Stimulation group

[1] Left interscapular region stimulation

Of 27 subjects, 10 (37%) showed increased pliability of the left erector spinae at the level of $Th_{3\text{-}4}$ as a result of shiatsu stimulation to the left interscapular region.

[2] Right interscapular region stimulation

Of 27 subjects, 12 (44%) showed increased pliability of the right erector spinae at the level of $Th_{3\text{-}4}$ as a result of shiatsu stimulation to the right interscapular region.

[3] Left infrascapular and lumbar region stimulation

Of 23 subjects, 13 (57%) showed increased pliability of the left erector spinae at the level of $L_{3\text{-}4}$ as a result of shiatsu stimulation to the left infrascapular and lumbar region.

[4] Right infrascapular and lumbar region stimulation

Of 23 subjects, 14 (61%) showed increased pliability of the right erector spinae at the level of $L_{3\text{-}4}$ as a result of shiatsu stimulation to the right infrascapular and lumbar region.

A significant difference was not confirmed in any of the results from [1] to [4].

(2) Comparison to non-stimulation group

As with standing forward flexion, non-stimulation testing was carried out on 14 subjects (and cases contaminated with artifacts eliminated), and the results of those test subjects were compared to their results as members of the shiatsu stimulation group.

Figure 4 shows the effect of shiatsu stimulation on muscle stiffness for the members of the shiatsu stimulation group corresponding to the subjects in the non-stimulation group. The vertical axis represents the value of post-stimulation angle minus the pre-stimulation angle.

[1] Left interscapular region stimulation

Angle change in the 14 subjects of the non-stimulation group was −0.95 ± 0.25° (mean ± SE). Pre- to post-treatment angle change in the shiatsu stimulation group was −0.68 ± 0.18°.

[2] Right interscapular region stimulation

Angle change in the 14 subjects of the non-stimulation group was +0.51 ± 0.14°. Pre- to post-treatment angle change in the shiatsu stimulation group was +1.49 ± 0.25°.

[3] Left infrascapular and lumbar region stimulation

Angle change in the 12 subjects of the non-stimulation group was +0.27 ± 0.08°. Pre- to post-treatment angle change in the shiatsu stimulation group was +0.92 ± 0.27°.

[4] Right infrascapular and lumbar region stimulation

Angle change in the 13 subjects of the non-stimulation group was −0.89 ± 0.25°. Pre- to post-treatment

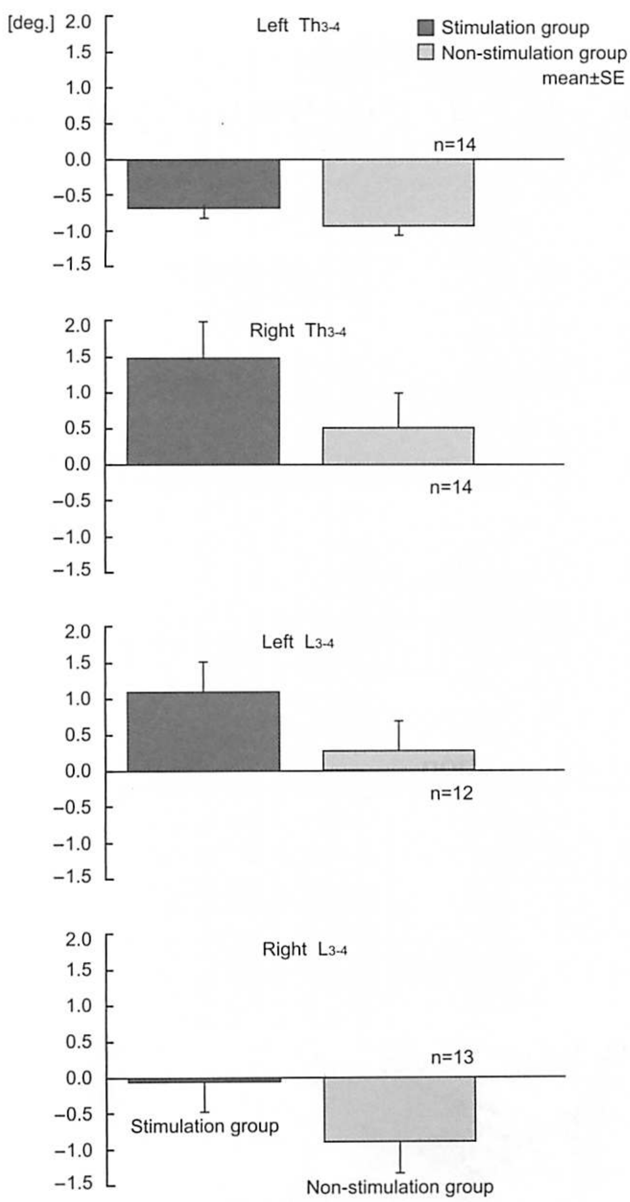


Fig. 4. Effect of shiatsu stimulation on muscle stiffness

angle change in the shiatsu stimulation group was +0.19 ± 0.05˚.

A significant difference was not confirmed in any of the results from [1] to [4].

In all of the sections of erector spinae muscle measured bilaterally at the heights of Th_{3-4} and L_{3-4}, a greater tendency toward improvement in muscle pliability was recognized in the stimulation group than in the non-stimulation group.

IV. Discussion

This study showed that muscle became more pliable in the area subject to shiatsu stimulation and, as a result, standing forward flexion was improved.

The Japan Shiatsu College previously reported[3] that muscle blood volume increases due to shiatsu stimulation. Taking into consideration that 1) since blood flow increased locally in the area of stimulation it was possibly due to an axonal reflex[5]; and 2) it was accompanied not by an increase in blood pressure but by a decrease, we suggested the possibility that this increased muscle blood volume reaction was due, not to an increase in blood flow dependent on blood pressure, but to suppression of sympathetic nervous activity regulating the peripheral vascular system.

The increased pliability in muscles subject to shiatsu stimulation in the current study may be due to an increase in muscle blood volume from increased blood flow caused by either axonal reflex or sympathetic nerve suppression, resulting in increased muscle pliability.

It is also possible that shiatsu stimulation caused changes in the tension of the motor nerves supplying the skeletal muscle.

Concerning the effect of shiatsu stimulation on standing forward flexion, in this study stimulation was applied only to the back region, but one may assume that a greater effect would be obtained by combining this with treatment of other areas such as the anterior and posterior femoral regions. This is a topic for future research.

The results obtained in this study confirming improvement in muscle pliability due to shiatsu stimulation suggest that shiatsu can be effective in treating symptoms accompanying muscle tension, such as stiff shoulders and lumbar pain.

V. Conclusions

Study of the effects of shiatsu stimulation on muscle pliability in healthy adult test subjects yielded the following results:

1. Improvement in standing forward flexion was confirmed.
2. Improvement in muscle pliability was confirmed by measurements taken using a tactile sensor system.

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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2002

Effects of Shiatsu Stimulation on Muscle Pliability (Part 2)

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I. Introduction

Shiatsu therapy produces a variety of therapeutic effects, including alleviation of pain and regulation of autonomic functions; however, many questions remain to be answered about these effects and their mechanisms. To address these issues, the Japan Shiatsu College is conducting ongoing studies into shiatsu and has found that shiatsu stimulation reduces heart rate[1] and blood pressure[2] while increasing peripheral muscle blood volume[3]. These findings were reported at the congress of the Japan College Association of Oriental Medicine.

At last year's conference, we reported on improvements to muscle pliability due to shiatsu stimulation as measured using standing forward flexion and a tactile sensor system[4]. In that study, however, while results using the tactile sensor system showed a tendency toward improvement, they did not confirm a significant difference.

We surmised that data may have been affected by such factors as the fact that, due to the area being measured, subjects were compelled to maintain the same prone position for 40 minutes or longer and that the tactile sensor system was not properly held stationary due to changes in the subjects' position during respiration. We also felt there was room to reexamine the data processing methods used.

For these reasons, for this followup report we have elected to reexamine the effects of shiatsu stimulation on muscle pliability after reconsidering the measurement positions, procedures, and data processing methods.

II. Methods

1. Subjects

Research was conducted on 30 healthy adults (22 males, 8 females) aged 23–61 years (mean age: 39.9 years old).

Test procedures were fully explained to each test subject and their consent obtained. They were asked to abstain from eating, smoking, ingestion of stimulants, or vigorous exercise for two hours prior to testing. They were also asked to refrain from receiving shiatsu or other stimulation on the day of testing.

2. Test period

May 11 to July 13, 2002

3. Test location

Testing was conducted in the shiatsu research lab at the Japan Shiatsu College. Room temperature was 25 ± 1.5°C with subdued lighting and silence maintained.

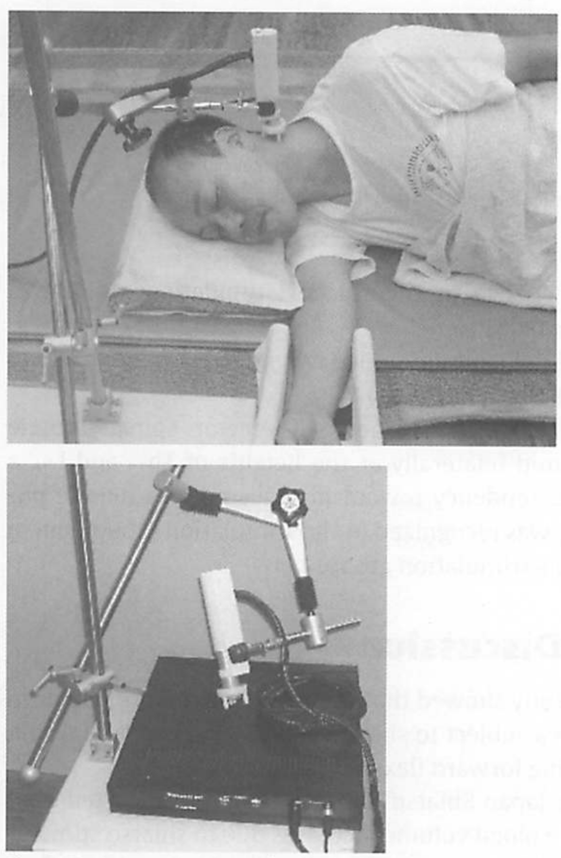


Fig. 1. Testing equipment and an example of its use

4. Items measured

A tactile sensor system (Venustron mfg. by Axiom Co., Ltd.) was used to measure muscle pliability (stiffness) in the muscles of the lateral cervical and suprascapular regions. Figure 1 shows the testing equipment and an example of its use.

5. Data recording

Data was transferred and saved to a personal computer (IBM 2611-456) from the tactile sensor via the control unit.

6. Stimulation (Fig. 2)

Full-body treatment is standard for Namikoshi shiatsu[5], but due to the area being measured, shiatsu application was limited to the following areas in the lateral position:

[1] 4 points, left and right lateral cervical regions

(From immediately inferior to the mastoid process to immediately above the suprascapular region)

[2] 1 point, left and right suprascapular regions

For the lateral cervical region, pressure was applied, in order, for 3 seconds per point from immediately inferior to the mastoid process to immediately above the suprascapular region, taking care to apply approximately even pressure to each point. For the suprascapular region, pressure was applied repeatedly for 5 seconds per application. Treatment was performed to each region for one minute.

Treatment was carried out by 2 therapists on their own respective test subjects after measures were taken to ensure that they applied similar amounts of pressure.

Approximately 5–15 kg pressure was applied, depending on the comfort level of the test recipient.

Standard pressure application methods were employed (pressure gradually increased, sustained, and gradually decreased).

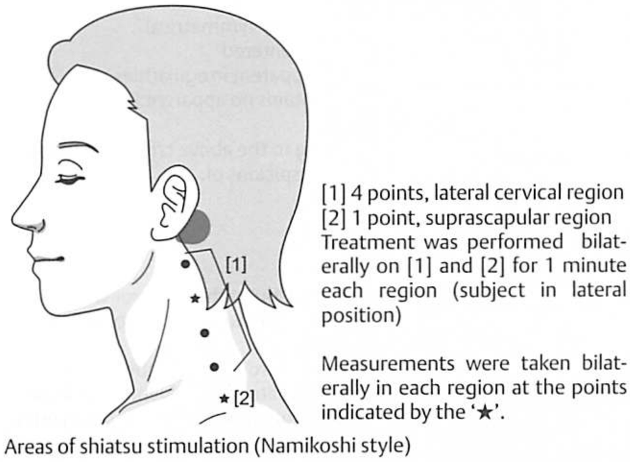


Fig. 2. Areas of stimulation and measurement locations

7. Test procedure (Fig. 3)

Test subjects filled out a questionnaire prior to the test day containing information on smoking habits, everyday symptoms, and other information, and a brief interview was conducted on test day to determine their physical condition.

The measurement areas were marked and the following stimulation was carried out after the subject had been resting in the supine position for 5 minutes on a mat laid out on the floor.

(1) 5 minutes rest in the left lateral position (left side up)
(2) Pre-treatment measurement, left lateral cervical region
(3) 4 points treated for 1 minute, same region
(4) Post-treatment measurement, same region
(5) Pre-treatment measurement, left suprascapular region
(6) 1 point treated for one minute, same region
(7) Post-treatment measurement, same region
(8) Measurement 5 minutes post-treatment, left lateral cervical region
(9) Same, left suprascapular region
(10) 5 minutes rest in the right lateral position (right side up)
(11) Same operations applied as in (2) to (9) above, to the right lateral cervical and suprascapular regions.

On completion of the above testing, subjects were re-interviewed to determine treatment comfort levels, subjective changes, and other information. Also, on 15 of the 30 subjects, testing was performed in which they were subject to no shiatsu stimulation for the same period of time as if shiatsu were applied (referred to as 'non-stimulation' below).

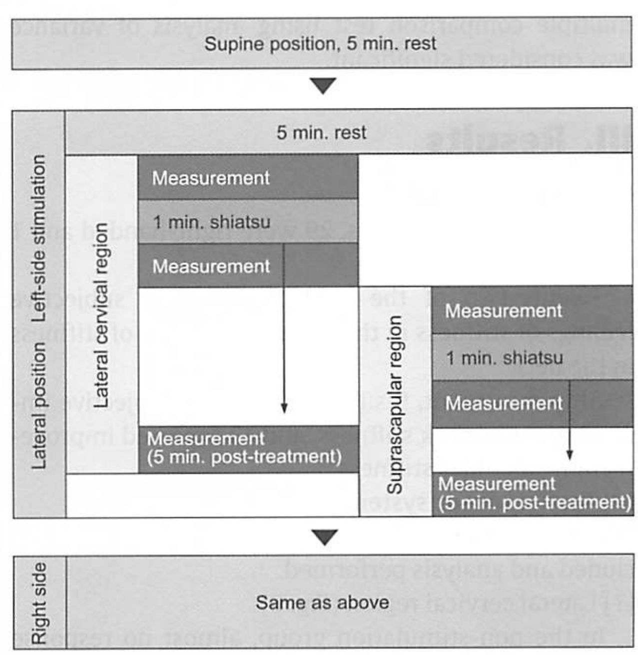


Fig. 3. Test procedure

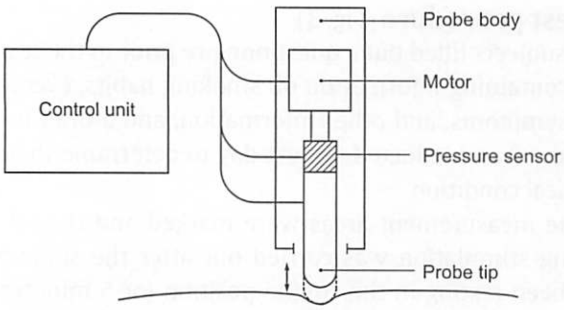


Fig. 4. Schematic diagram of tactile sensor system

8. Data processing

(1) Tactile sensor system (Fig. 4)

The tactile sensor system uses an internal motor to move the probe tip in the direction indicate by the arrow, then measures the hardness of the material the tip contacts.

The probe tip vibrates at high frequency, and when it contacts a substance its frequency changes under the influence of the natural oscillation of the substance, and the hardness of the substance is expressed numerically. When encountering a soft substance, the frequency of the tip's vibration decreases significantly.

For each measurement, 3 types of data can be obtained: travel distance of probe tip (hereafter, push distance); pressure generated during travel (hereafter, push pressure); and change in frequency.

(2) data processing

The ratio of the change in push pressure to the change in frequency ($\Delta f/\Delta P$ [Hz/g]) when push distance is varied from 7–8mm is determined, and the mean values ± standard error shown for before and after stimulation.

For statistical processing, <5% according to Dunnett's multiple comparison test using analysis of variance was considered significant.

III. Results

(1) Interview results

Of the 30 test subjects, 29 were right-handed and 1 was left-handed.

Twenty-two of the subjects reported subjective feelings of stiffness in the shoulders and 11 of stiffness in the neck.

After treatment, 9 subjects reported subjective improvement in neck stiffness, and 13 reported improvement in shoulder stiffness.

(2) Tactile sensor system results

Data in which errors were detected (Fig. 5) were excluded and analysis performed.

[1] Lateral cervical region (Fig. 6)

In the non-stimulation group, almost no response was detected on either side.

With shiatsu stimulation, a mild tendency toward increased pliability was observed on both sides, but a significant difference was not confirmed.

Using pre-stimulation values as the control, the differences immediately post-stimulation and 5 minutes post-stimulation were determined. In the stimulation group, the differences were as follows. Immediately post-stimulation: –0.16 ± 0.23 (Hz/g) left, 0.28 ± 0.26 right; 5 minutes post-stimulation: 0.43 ± 0.24 left, 0.43 ± 0.24 right.

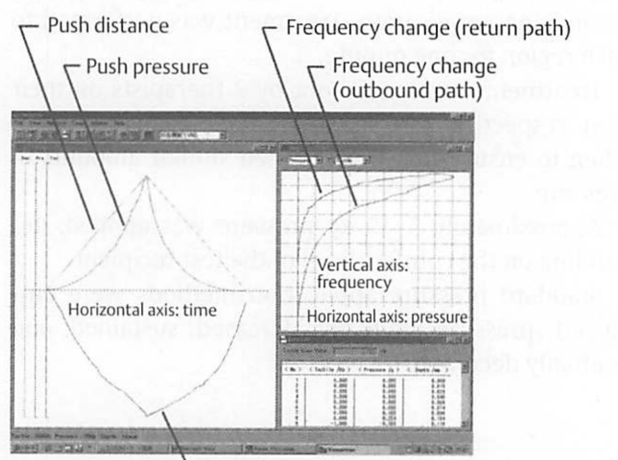
In the non-stimulation group, the differences were as follows. No stimulation (after the same amount of time lapsed as for immediately post-stimulation in the shiatsu stimulation group): –0.07 ± 0.19 left, –0.04 ± 0.25 right; 5 minutes post non-stimulation: –0.01 ± 0.15 left, –0.07 ± 0.48 right.

[2] Suprascapular region (Fig. 7)

In the non-stimulation group, as with the lateral cervical region almost no response was detected.

With shiatsu stimulation, a tendency toward increased pliability was confirmed bilaterally and, in the right suprascapular region, a significant difference was recognized both immediately and 5 minutes post-stimulation.

Using pre-stimulation values as the control, the



[1] Pressure waveform approx. bilaterally symmetrical
[2] Pressure waveform peak approx. centered
[3] Pressure waveform contains no apparent irregularities
[4] Frequency change waveform contains no apparent irregularities on outbound path

Errors were determined according to the above criteria, as failure to conform to these criteria raised suspicions of:
a. Change in posture of test subject
b. Change in muscle tension
c. Improper fixation of the sensor body
d. (rarely) improper sensor operation

A numerical standard was not used, but rather an error was determined if 2 or more students were in agreement of error for a given case.

In addition to exclusion of errors according to the above criteria, there were also several cases in which data was accidentally deleted (overwritten) during data recording due to computer operating error, resulting in a lower n value.

Fig. 5. Measurement screen and error determination

differences post-stimulation and 5 minutes post-stimulation were determined. In the stimulation group, the differences were as follows. Immediately post-stimulation: 0.67 ± 0.42 left, 0.88 ± 0.23 right; 5 minutes post-stimulation: 0.20 ± 0.37 left, 1.11 ± 0.36 right.

In the non-stimulation group, the differences were as follows. No stimulation (after the same amount of time lapsed as for immediately post-stimulation in the shiatsu stimulation group): 0.31 ± 0.27 left, 0.03 ± 0.50 right; 5 minutes post non-stimulation: 0.00 ± 0.43 left, 0.28 ± 0.70 right.

IV. Discussion

The increased pliability in muscles subject to shiatsu stimulation in the current study may be due to an

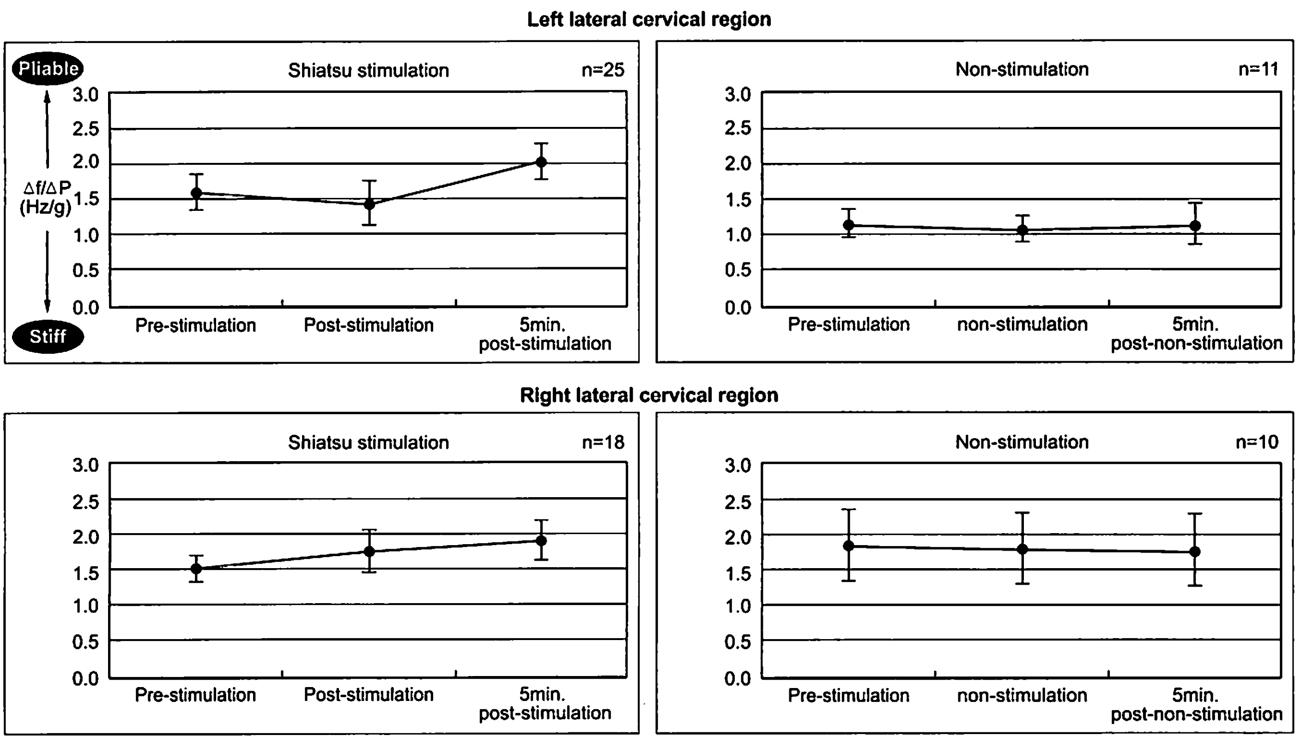


Fig. 6. Change in push distance vs. frequency

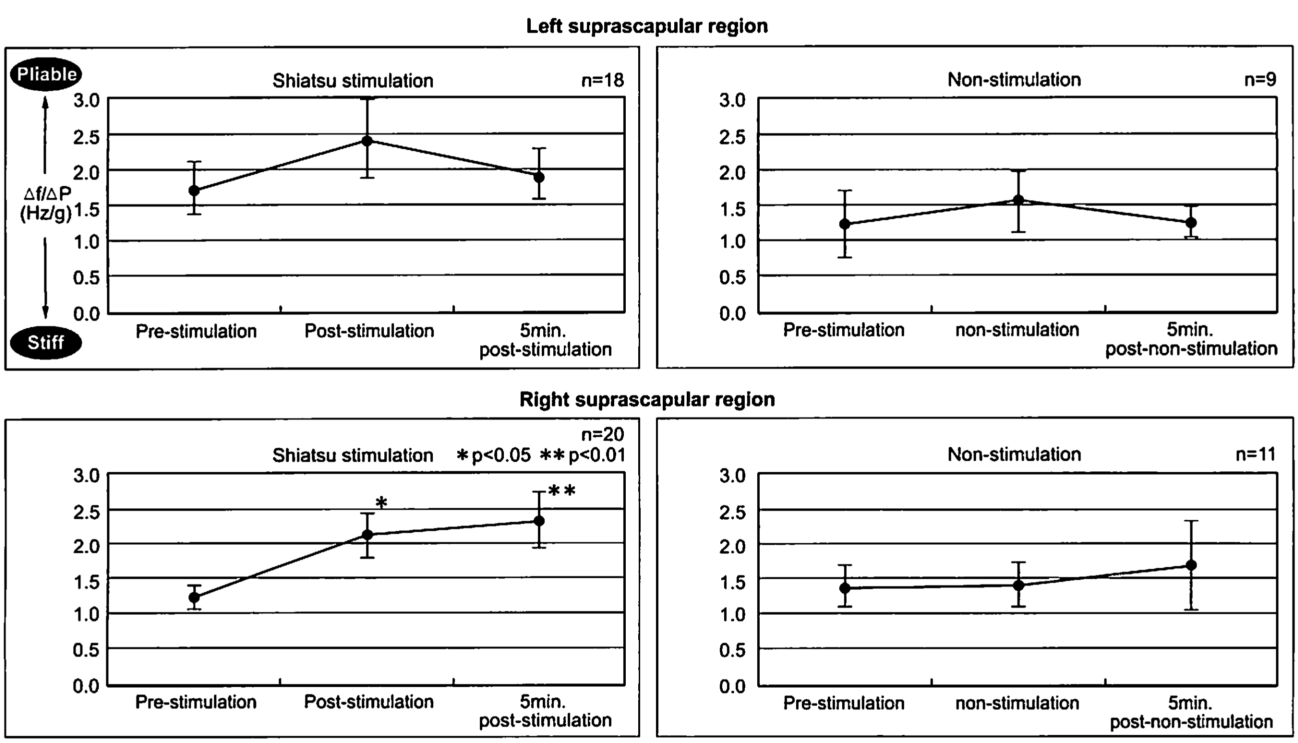


Fig. 7. Change in push distance vs. frequency

increase in muscle blood volume from increased blood flow caused by either axonal reflex[6] or sympathetic nerve suppression[3], resulting in increased muscle pliability. It is also possible that shiatsu stimulation caused changes in the tension of the motor nerves supplying the skeletal muscle.

The outcome that increased pliability in the right suprascapular region was significant compared to other regions. This may have been influenced by treatment of the left side and the right lateral cervical region. Whether local stimulation exerts an influence on other areas is a topic for future research.

The results obtained in this study confirming improvement in muscle pliability due to shiatsu stimulation suggest that shiatsu can be effective in treating symptoms accompanying muscle tension, such as stiff shoulders and lumbar pain.

V. Conclusions

Study of the effects of shiatsu stimulation (to the lateral cervical and suprascapular regions) on muscle pliability in healthy adult test subjects yielded the following results:

Muscle pliability tended to improve with shiatsu stimulation, with a significant difference in the right suprascapular region.

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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Effects of Shiatsu Stimulation on Muscle Pliability (Part 3)

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Supervisors: Jun'ichi Kurosawa, Hiroshi Ishizuka, Matsuko Namikoshi
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I. Introduction

Shiatsu therapy produces a variety of therapeutic effects, including alleviation of pain and regulation of autonomic functions; however, many questions remain to be answered about these effects and their mechanisms.

To address these issues, the Japan Shiatsu College is conducting ongoing studies into the effects of shiatsu stimulation on physiological functions and has found that shiatsu stimulation reduces heart rate[1] and blood pressure[2] while increasing peripheral muscle blood volume[3] and improving muscle pliability[4,5]. These findings were reported at the congress of the Japan College Association of Oriental Medicine.

Building on these past results, this year we report on further research into shiatsu's effect on muscle pliability, this time using a Spinal Mouse® to make detailed observations on intervertebral range of motion, in addition to measurements of standing forward flexion and muscle stiffness.

II. Methods

1. Subjects

Research was conducted on 40 healthy adults (22 males, 18 females) aged 19–62 years (mean age: 37.4 years old).

Test procedures were fully explained to each test subject and their consent obtained. They were asked to abstain from eating, smoking, ingestion of stimulants, or vigorous exercise for two hours prior to testing. They were also asked to refrain from receiving shiatsu or other stimulation on the day of testing.

2. Test period

April 19 to July 19, 2003

3. Test location

Testing was conducted in the shiatsu research lab at the Japan Shiatsu College. Room temperature was 25 ± 1.5°C with subdued lighting and silence maintained.

4. Items measured

Standing forward flexion was measured using a standing forward flexion gauge (Yagami Co., Ltd); muscle pliability was measured using a Venustron (Axiom Co., Ltd.) muscle stiffness sensor; and spinal range of motion was measured using a Spinal Mouse® (Index Co., Ltd.) spinal measurement device. Figure 1 shows the testing equipment and an example of its use.

5. Data storage

Data from the muscle stiffness sensor was transferred via the control unit and stored on a personal computer (IBM 2611-456). Data from the Spinal Mouse® was transferred via the base station and stored on a personal computer (IBM 2655-P3J).

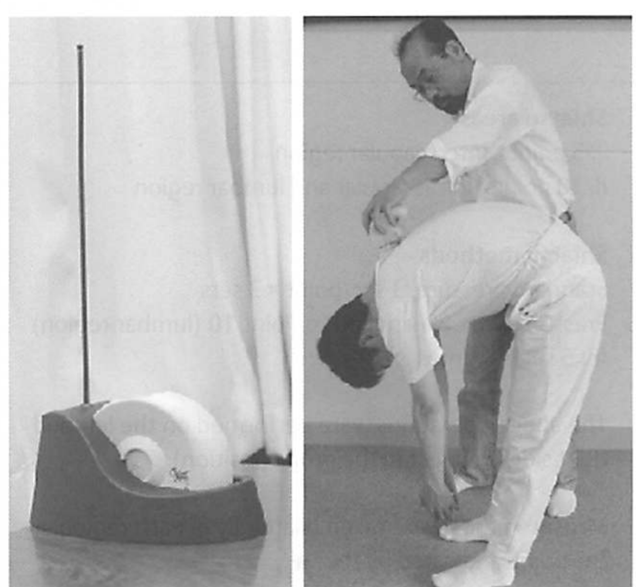


Fig. 1. Testing equipment and an example of its use

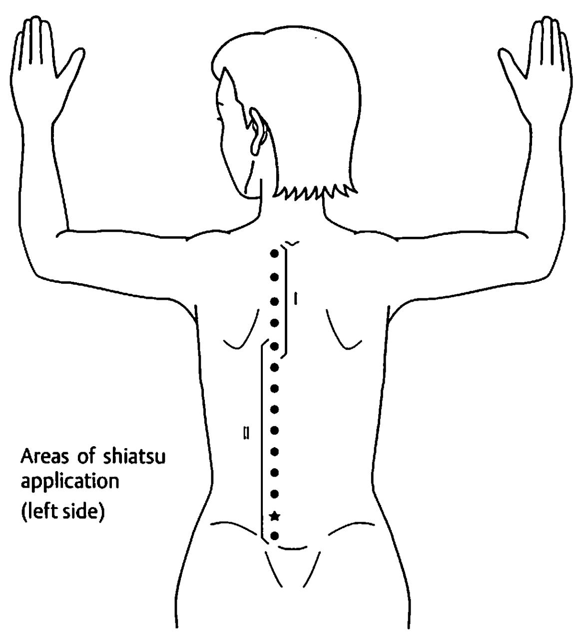
6. Stimulation (Fig. 2)

Full-body treatment is standard for Namikoshi shiatsu[6], but due to the area being measured, shiatsu application was limited to the following regions in the prone position:

(1) 5 points, left and right interscapular region (treatment performed between the scapula and the spine along the erector spinae muscles, parallel to the spine)
(2) 10 points, left and right infrascapular and lumbar regions (along the erector spinae muscles, parallel to the spine, starting at Point 5 of the interscapular region and ending at the height of the fifth lumbar vertebra)

Pressure was applied for 3 seconds per point, repeated 3 times, then pressure was applied to Point 10 for 5 seconds, repeated 3 times.

Treatment was carried out by 2 therapists after measures were taken to ensure that they applied similar amounts of pressure. In principle, male test subjects were treated by the male therapist and female subjects treated by the female therapist.



Shiatsu areas
I. 5 points, interscapular region
II. 10 points, infrascapular and lumbar region

Shiatsu methods
Standard pressure, 3 sec/point × 3 sets
Pressure was also applied to Point 10 (lumbar region) for 5 sec × 3 times

The above operations were performed on the left and right sides (subject in the prone position)

Measurements were taken bilaterally in each region at the points indicated by the '★'.

Fig. 2. Areas of shiatsu application and pliability measurement points

Approximately 5–15 kg pressure was applied, depending on the comfort level of the test recipient.

Standard pressure application methods were employed (pressure gradually increased, sustained, and gradually decreased).

7. Test procedure

Test subjects filled out a questionnaire prior to the test day containing information on smoking habits, everyday symptoms, and other information. A brief interview was conducted on test day before testing to determine their physical condition.

Markings for measurements using the Spinal Mouse® were applied over the right erector spinae muscles at the heights of C_7 and S_3; markings for measurements of muscle pliability were applied over the left and right erector spinae at the height of the area between L_4 and L_5.

Measurements for standing forward flexion and spinal range of motion were carried out on a 45cm platform. Rest periods, measurement of muscle pliability, and treatment were carried out on a futon mattress laid out on a tatami-matted floor.

Stimulation was carried out in the following order:

(1) Pre-treatment standing forward flexion and spinal range of motion measurements
(2) 5 minutes rest (supine position)
(3) Pre-treatment muscle pliability measurement, left side
(4) Treatment of 5 points, left interscapular region, and 10 points, left infrascapular and lumbar region
(5) Post-treatment muscle pliability measurement, left side
(6) Pre-treatment muscle pliability measurement, right side
(7) Treatment of 5 points, right interscapular region and 10 points, right infrascapular and lumbar region
(8) Post-treatment muscle pliability measurement, right side
(9) Post-treatment standing forward flexion and spinal range of motion measurements

Test subjects were re-interviewed post-treatment to determine comfort or discomfort during treatment, subjective changes, and other information. In addition, non-stimulation testing was performed on 11 of the 40 test subjects, in which the above procedures were followed but with no shiatsu stimulation applied.

8. Data processing

Changes in before and after measurements for standing forward flexion, muscle pliability, and spinal range of motion were subject to statistical processing using a t-test.

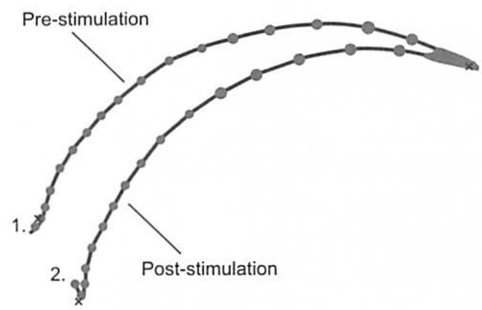


Fig. 3. Image showing results of measurements taken using Spinal Mouse®

For muscle pliability, the value used was the ratio of the change in push pressure to the change in frequency ($\Delta f/\Delta P$ [Hz/g]) when push distance was varied from 7–8 mm.

For spinal range of motion, the value used was the angle between a straight line through the averaged intervertebral angles from C_7 to S_3 and a straight line projected perpendicularly from the base point at S_3 (Fig. 3).

III. Results

1. Standing forward flexion (Fig. 4)

(1) Stimulation group

Of the 40 subjects who received shiatsu stimulation, 30 showed improvement and 10 showed no improvement. The average difference between pre- and post-treatment measurements was −1.80 ± 1.76 cm, which was confirmed as a significant difference.

(2) Non-stimulation group

Of the 11 subjects in the non-stimulation group, 7 became worse and 4 improved. The average before-after difference was 0.20 ± 1.92 cm. A significant difference was not confirmed.

2. Muscle pliability (Figs. 5, 6)

(1) Stimulation group

After eliminating data tainted by measurement device malfunction, of 37 measurements taken on the left side, 19 showed improvement and 18 did not. The average before-after difference was 0.50 ± 2.23 Hz/g, which was not a significant difference. Of 37 measurements taken on the right side, 22 showed improvement and 15 did not. The average before-after difference was −2.30 ± 2.58 Hz/g, which was not a significant difference.

(2) Non-stimulation group

Of 11 measurements taken on the left side, 7 became worse and 4 showed improvement. The average before-after difference was 0.60 ± 1.58 Hz/g. Of 11 measurements taken on the right side, 8 became worse and 3 showed improvement. The average before-after difference was 4.97 ± 3.89 Hz/g. A significant difference was not confirmed.

3. Spinal range of motion (Fig. 7)

(1) Stimulation group

After eliminating data tainted by measurement device malfunction, of 38 measurements taken, 17 showed improvement, 5 showed no change, and 16 showed no improvement. The average before-after difference was −1.11 ± 2.23°, which was not a significant difference.

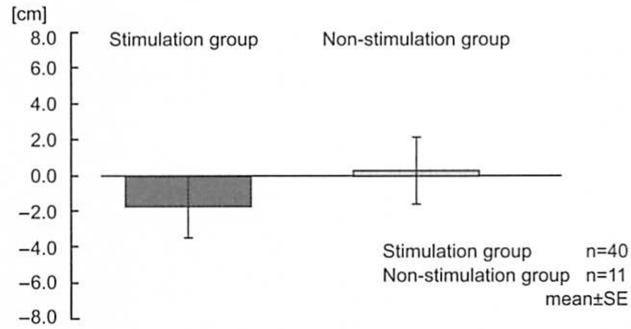


Fig. 4. Effect of shiatsu stimulation on standing forward flexibility

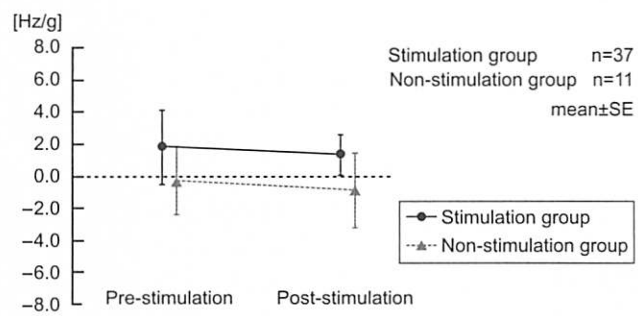


Fig. 5. Effect of shiatsu stimulation on muscle pliability (left)

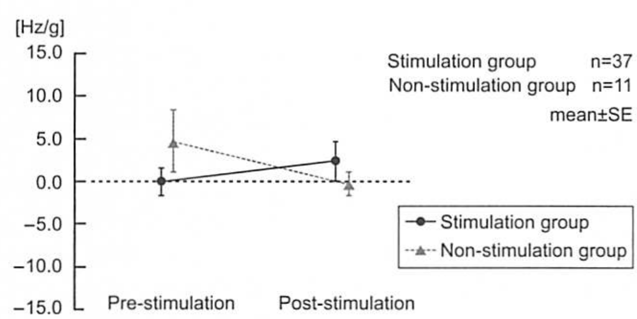


Fig. 6. Effect of shiatsu stimulation on muscle pliability (right)

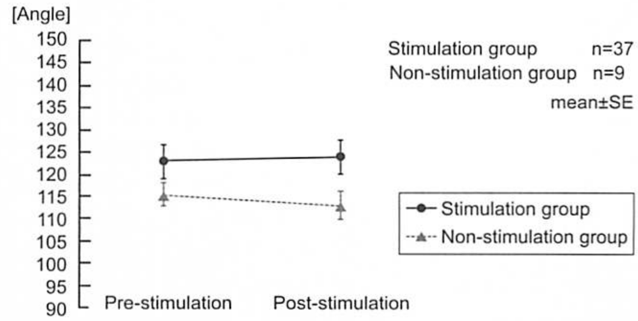


Fig. 7. Effect of shiatsu stimulation on spinal range of motion

(2) Non-stimulation group

After eliminating data tainted by measurement device malfunction, of 9 measurements taken, 8 became worse and 1 showed improvement. The average before-after difference was 2.40 ± 2.33°, which was not a significant difference.

4. Before-after difference in intervertebral range of motion

Results from statistical analysis of standing forward flexion, muscle pliability, and spinal range of motion indicate that a significant before-after difference was obtained in standing forward flexion. In the 30 cases in which standing forward flexion improved, a pre/post-treatment difference was observed in the range of motion between individual vertebrae. The most notable change in angle (average increase: 1.11 ± 1.76°) occurred between Th_{11} and Th_{12}. Results of the t-test did not confirm a significant difference ($p<0.1$).

IV. Discussion

The results of this study indicating a significant improvement in standing forward flexion due to shiatsu stimulation corresponds to that of Asai et al[4], indicating a phenomenon of high reproducibility.

The fact that a significant change in muscle pliability could not be confirmed may be due to the following two points: [1] that the measurement point was located between two vertebrae where the resulting change in intervertebral range of motion was small; and [2] that, as opposed to research conducted by Sugata et al[5], in which pressure was applied for 5 seconds to one point and continued for 1 minute, this time pressure was applied for 3 seconds per point and repeated 3 times, due to factors such as test subjects' limb positions and the area being stimulated.

The fact that a significant change in spinal range of motion was not observed may be because results of improved intervertebral range of motion obtained in the thoracic vertebrae were counteracted by the physiological lordosis of the lumbar vertebrae, while results of improved intervertebral range of motion in the lumbar vertebrae were counteracted by the physiological kyphosis in the thoracic vertebrae. This is being considered as a topic for future study.

Among reasons for the notable change in $Th_{11\text{-}12}$ intervertebral flexion among the 30 subjects who showed improvement in standing forward flexion, aside from improved pliability of the erector spinae muscles, the possible influence of tension in the psoas major muscle and even the strong mechanical load placed on $Th_{11\text{-}12}$ by the posture adopted in standing forward flexion itself cannot be discounted. This is being considered as a topic for future study.

Improvements in muscle pliability and joint range of motion due to shiatsu stimulation may be due to an increase in muscle blood volume[3] from increased blood flow caused by either axonal reflex[7] or sympathetic nerve suppression, resulting in increased muscle pliability. It is also possible that shiatsu stimulation caused changes in the tension of the motor nerves supplying the skeletal muscle.

The results obtained in this study confirming a tendency toward improvement in muscle pliability and joint range of motion in the spine due to shiatsu stimulation suggest that shiatsu can be effective in treating symptoms accompanying muscle tension, such as back and lumbar pain.

V. Conclusions

Study of the effects of shiatsu stimulation (to the interscapular, infrascapular, and lumbar regions) on muscle pliability in healthy adult test subjects yielded the following results:

Spinal range of motion, as indicated by standing forward flexion, showed significant improvement due to shiatsu stimulation, particularly with a notable increase in range of motion between Th_{11} and Th_{12}.

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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Effects of Shiatsu Stimulation on Spinal Mobility and Muscle Stiffness

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I. Introduction

In last year's study, we reported on research into changes in muscle stiffness in the erector spinae at the L_4-L_5 level and changes in standing forward flexion and spinal range of motion after application of shiatsu stimulation consisting of basic Namikoshi shiatsu treatment to the back and lumbar regions in the prone position[1-3].

It is common to experience pain in the hamstrings and gastrocnemius muscles during standing forward flexion.

Therefore, for this year's study, we selected test subjects who have difficulty touching their hands to the floor during standing forward flexion-so-called 'stiff bodied' people-and measured changes in muscle stiffness in their hamstrings and gastrocnemius, along with changes in standing forward flexion and spinal range of motion, after application of shiatsu stimulation to the gluteal region and posterior lower limb.

II. Methods

1. Subjects

Research was conducted on 27 healthy, stiff-bodied males (aged 18–57 years; average age: 32.2 years old) with standing forward flexion values ranging from −2.3 cm to −24.5 cm (average: −10 cm).

2. Test location and test period

Testing was conducted in the shiatsu research lab at the Japan Shiatsu College between April 17 and June 26, 2004, on Saturday afternoons from 1:30PM to 5:00PM.

3. Items measured

Standing forward flexion was measured using a standing forward flexion gauge (Yagami Co., Ltd) and spinal range of motion was measured using a Spinal Mouse® (Index Co., Ltd.) spinal measurement device, with measurements carried out in three postures: erect, forward flexion, and posterior flexion. Muscle stiffness was measured using a Venustron (Axiom Co., Ltd.) muscle stiffness sensor, with measurements carried out bilaterally at the midpoints of the biceps femoris and the gastrocnemius.

Figures 1 and 2 show the testing equipment and examples of its use.

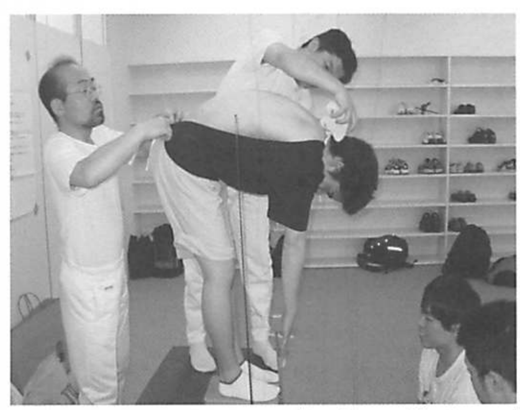

Fig. 1. Measurement using standing forward flexion and the Spinal Mouse®

Fig. 2. Measurement using the Venustron

4. Data storage

Data was stored on a personal computer via the Spinal Mouse® and Venustron systems.

5. Stimulation (Fig. 3)

Full-body treatment is standard for Namikoshi shiatsu[4], a portion of which was carried out on the gluteal region and posterior limb in the prone position, as indicated below:

(1) 3 points, sacral region; 4 points, gluteal region; Namikoshi Point

(2) 10 points, posterior femoral region; 3 points, popliteal fossa

(3) 8 points, posterior crural region; 6 points, gastrocnemius muscle

(4) 3 points, calcaneal tubercle; 3 points, lateral and medial calcaneal region

(5) 4 points, plantar region; 1 point, arch of foot

Pressure was applied for 3 seconds per point, repeated 3 times per operation; for the Namikoshi Point, Point 1 inferior to the ischium, and the final application to Point 3 of the plantar region, continuous pressure was maintained for 5 seconds on the individual point, repeated 3 times. Standard pressure application methods were employed throughout (pressure gradually increased, sustained, and gradually decreased). Approximately 5–15 kg pressure was applied, depending on the comfort level of the test recipient.

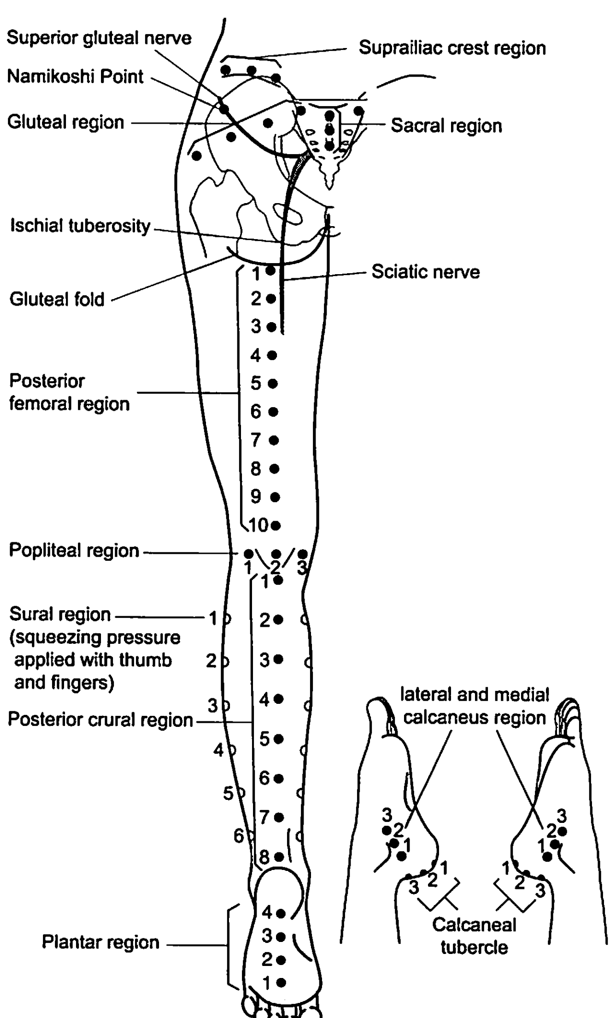

Fig. 3. Areas of shiatsu application (adapted from *The Complete Book of Shiatsu Therapy*, by Toru Namikoshi)

6. Test procedure

Markings for measurements using the Spinal Mouse® were applied over the right erector spinae muscles at the heights of C_7 and S_3; markings for measurements of muscle stiffness were applied bilaterally at the midpoints of the biceps femoris and the gastrocnemius.

Measurements for standing forward flexion and spinal range of motion were carried out on a 45 cm platform. Measurement of muscle stiffness and shiatsu treatment were carried out on a futon mattress laid out on a tatami-matted floor.

Stimulation was carried out in the following order, after test subjects filled out a questionnaire listing back pain and other everyday symptoms:

(1) Pre-treatment standing forward flexion and spinal range of motion measurements (erect, forward flexion, posterior flexion)

(2) Pre-treatment muscle stiffness measurements

(3) Treatment of sacral region, posterior leg, and plantar region according to basic Namikoshi shiatsu procedures

(4) Post-treatment muscle stiffness measurements

(5) Post-treatment standing forward flexion and spinal range of motion measurements

Test subjects were re-interviewed post-treatment to determine comfort or discomfort during treatment, subjective changes, and other information, and therapists recorded observations on changes in muscle tension, indurations, and other information.

7. Data processing

(1) Spinal range of motion (Figs. 4, 5)

Measurements were made using a Spinal Mouse® in erect, forward flexion, and posterior flexion postures. Spinal angle of inclination was calculated based on a straight, vertical line projected from the base point at S_3, with the incline angle of a straight line connecting

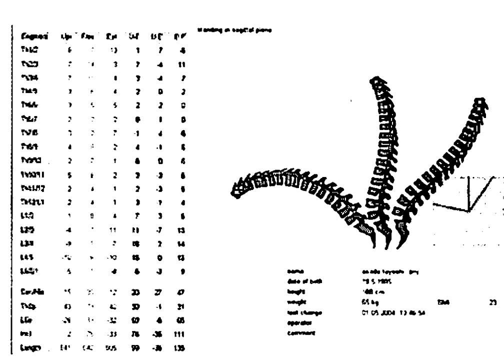

Fig. 4. Spinal Mouse® measurement data

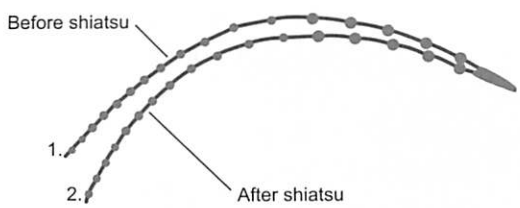

Fig. 5. Comparison of standing forward flexion before and after shiatsu

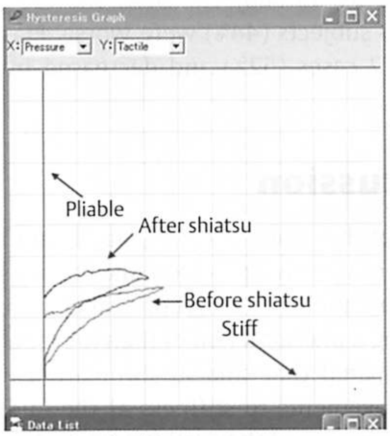

Fig. 6. Graph of Venustron measurements

C_7 to S_3 shown as positive to indicate forward flexion and negative to indicate posterior flexion. Spinal angle of inclination is the angle of inclination, based on a horizontal line, between each vertebra including the sacrum, shown as positive to indicate forward flexion and negative to indicate posterior flexion.

Figure 5 shows superimposed graphs of standing forward flexion before and after shiatsu, indicating increased spinal mobility after shiatsu.

(2) Muscle stiffness (Fig. 6)

The round-trip change in vibration frequency when the tactile sensor was depressed with a force of 30 g was compared before and after stimulation.

The graph's x-axis indicates the depression pressure and the y-axis the sympathetic vibration frequency. The slope of the graph line indicates greater muscle stiffness as it approaches the x-axis, and greater muscle pliability as it approaches the y-axis. Muscle elasticity is indicated by the difference in vibration frequency between depression and retraction pressure, with elasticity being greater the less the difference.

III. Results

1. Standing forward flexion (Fig. 7)

Pre-stimulation values were −9.9 ± 1.2 cm (mean ± SE) and post-stimulation values were −6.6 ± 1.4 cm, indicating a significant improvement ($p<0.01$). Of the total, 23 cases showed an improvement of 1 cm or greater, 2 cases showed no change, and 2 cases showed a change for the worse. The average before-after change, calculated by subtracting the post-stimulation measurement value from the pre-stimulation measurement value, was 3.3 cm.

2. Spinal range of motion

(1) Spinal angle of inclination (Fig. 8)

Pre-stimulation values were +105.1 ± 1.5° and post-stimulation values were +108 ± 1.9°, indicating a significant improvement ($p<0.01$). Of the total, 19 cases showed an improvement, 2 cases showed no change, and 6 cases showed a change for the worse. The average before-after change was 2.8°.

(2) Sacral angle of inclination (Fig. 9)

Pre-stimulation values were +56.5 ± 1.9° and post-stimulation values were +61.6 ± 2.3°. Of the total, 24 cases showed an improvement, 0 cases showed no change, and 3 cases showed a change for the worse. The average before-after change was 4.8°, which was recognized as a significant difference ($p<0.01$).

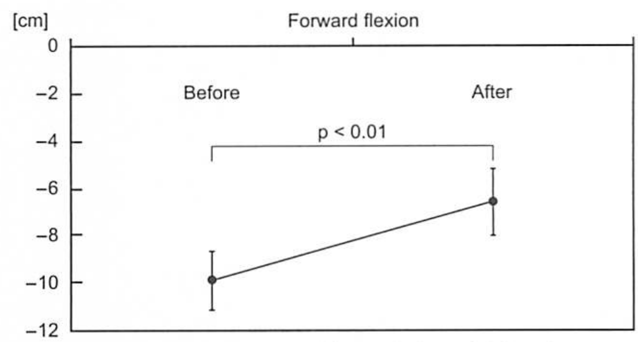

Fig. 7. Change in standing forward flexion before and after shiatsu

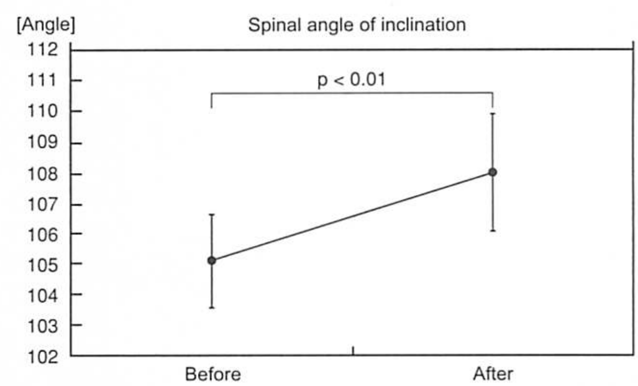

Fig. 8. Change in spinal angle of inclination before and after shiatsu

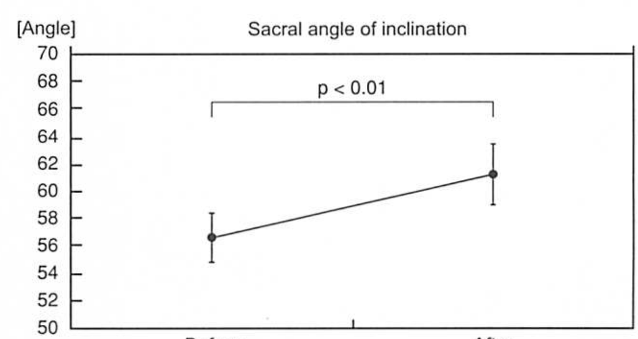

Fig. 9. Change in sacral angle of inclination before and after shiatsu

3. Correlation between standing forward flexion and spinal range of motion

(1) The changes in standing forward flexion and spinal angle of inclination before and after shiatsu had a correlation coefficient of r=0.817, confirming a significant correlation. (Fig. 10)

(2) The changes in standing forward flexion and sacral angle of inclination before and after shiatsu had a correlation coefficient of r=0.598, confirming a significant correlation. (Fig. 11)

4. Muscle stiffness

Of 23 test subjects, not counting 4 eliminated due to data errors:

(1) At the midpoint of the left biceps femoris, for muscle stiffness, 9 subjects (40%) showed improvement, 13 subjects (57%) were worse, and 1 subject (4%) showed no change. Elasticity increased in 12 cases (52%) and decreased in 11 cases (48%).

(2) At the midpoint of the right biceps femoris, for muscle stiffness, 11 subjects (48%) showed improvement and 12 subjects (52%) were worse. Elasticity increased in 14 cases (60%) and decreased in 9 cases (40%).

(3) At the midpoint of the left gastrocnemius, for muscle stiffness, 12 subjects (52%) showed improvement, 10 subjects (44%) were worse, and 1 subject (4%) showed no change. Elasticity increased in 15 cases (65%) and decreased in 8 cases (35%).

(4) At the midpoint of the right gastrocnemius, for muscle stiffness, 13 subjects (57%) showed improvement and 10 subjects (44%) were worse. Elasticity increased in 12 cases (52%) and decreased in 11 cases (48%).

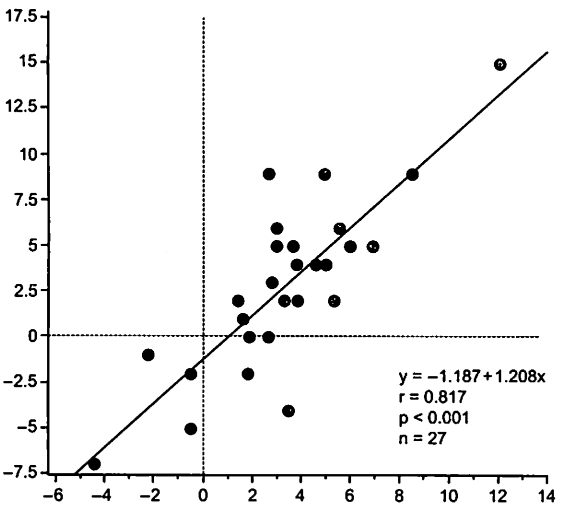

Fig. 10. Correlation of changes to standing forward flexion and spinal angle of inclination

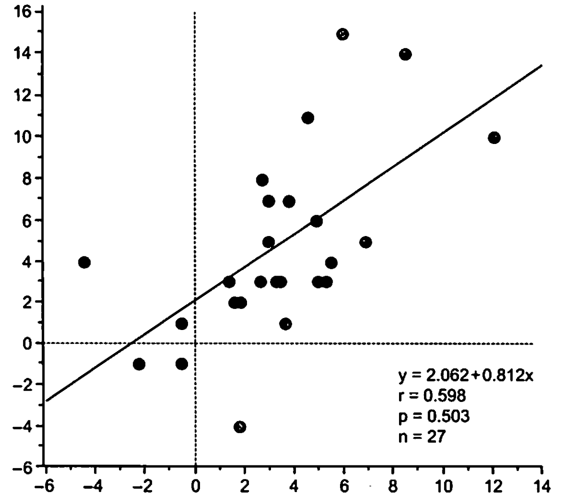

Fig. 11. Correlation of changes to standing forward flexion and sacral angle of inclination

IV. Discussion

The results of this study showing significant improvement in standing forward flexion due to shiatsu stimulation corroborate the findings of Asai et al[1] and Eto et al[3], indicating a phenomenon of high reproducibility.

We anticipated that shiatsu stimulation would result in improvements to stiffness at the midpoints of the biceps femoris and the gastrocnemius, but clear results could not be obtained from measurement values of the muscle stiffness sensor. Possible reasons for this are:

(1) The Venustron measurement sensor was depressed 10 mm, just as last year, but this depth may have been too shallow for large muscles such as the biceps femoris and the gastrocnemius.

(2) The locations where pain occurs in the hamstrings and gastrocnemius during forward flexion are near the tendons, not the muscle belly, so perhaps measurements should have been taken where the indurations occur. This is being considered as a topic for future study.

V. Conclusions

Spinal range of motion and standing forward flexion were improved by shiatsu stimulation to the posterior lower limb.

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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Effects of Abdominal Shiatsu Stimulation on Spinal Mobility

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I. Introduction

In previous studies up until last year, we have reported on changes to standing forward flexion and spinal mobility due to shiatsu stimulation using basic Namikoshi shiatsu procedures on the dorsal surface of the body[1,3,4].

Building on these past results, this year we report on the effects of shiatsu stimulation to the ventral surface of the trunk by performing shiatsu stimulation to the abdominal region and investigating changes to standing forward flexion and spinal mobility.

II. Methods

1. Subjects

Research was conducted on 47 healthy males, aged 18–64 years (average age: 35.5 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.

2. Test period

May 7 to September 17, 2005

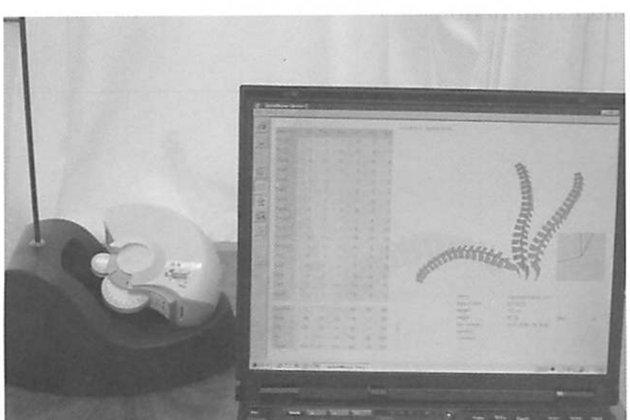

Fig. 1. Spinal Mouse®

3. Test location

Testing was conducted in the shiatsu research lab at the Japan Shiatsu College. Room temperature was 25 ± 1°C.

4. Measurement devices (Fig. 1)

Standing forward flexion was measured using a standing forward flexion gauge (Yagami Co., Ltd), muscle pliability was measured using a Venustron muscle stiffness sensor (Axiom Co., Ltd.), and spinal range of motion was measured using a Spinal Mouse® spinal measurement device (Index Co., Ltd.).

5. Data storage

Data from the muscle stiffness sensor was transferred via the control unit and stored on a personal computer (IBM 2611-456). Data from the Spinal Mouse® was transferred via the base station and stored on a personal computer (IBM 2655-P3J).

6. Stimulation (Fig. 2)

Full-body treatment is standard for Namikoshi shiatsu, a portion of which was carried out on the inguinal and abdominal regions in the supine position, as indicated below:

(1) 1 point, palm pressure, inguinal region; applied bilaterally
(2) 9 points, palm pressure, abdominal region
(3) 20 points, 2-thumb pressure, abdominal region

Pressure was applied for 3 seconds per point, repeated 3 times per operation, except for the inguinal region, where pressure was applied for 5 seconds per point, repeated 3 times.

Treatment was carried out by 2 therapists after measures were taken to ensure that they applied similar amounts of pressure. Approximately 5–15 kg pressure was applied, depending on the comfort level of the test recipient. Standard pressure application methods were employed throughout (pressure gradually increased, sustained, and gradually decreased).

7. Test procedure

Test procedures were fully explained to each test subject and their consent obtained. They also filled out a questionnaire listing back pain and other everyday symptoms.

Markings for measurements using the Spinal Mouse® were applied over the right erector spinae muscles at the heights of C_7 and S_3; markings for measurements of muscle pliability were applied bilaterally at the following acupoints: *Zhishi* (BL52), *Shenshu* (BL23), *Dachangshu* (BL25), and *Geguan* (BL46). Muscle stiffness was measured at the location indicated in Figure 3.

Measurements for standing forward flexion and spinal range of motion were carried out on a 45 cm platform. Relaxation, measurement of muscle stiffness, and shiatsu treatment were carried out on a futon mattress laid out on a thin mat laid out on the floor.

(1) Pre-treatment spinal range of motion and standing forward flexion measurements

(2) 5 minutes rest (prone position) *During this period, pre-treatment muscle stiffness measurements (prone) were carried out on 9 randomly selected test subjects

(3) Treatment of inguinal region and abdominal region according to basic Namikoshi shiatsu procedures (supine position)

(4) 5 minutes rest (supine) *After this period, post-treatment muscle stiffness measurements (prone) were carried out on 9 randomly selected test subjects

(5) Post-treatment spinal range of motion and standing forward flexion measurements

After completion of the above test procedures, therapists recorded observations on changes in muscle tension, indurations, and other information.

In addition, non-stimulation testing was performed on 15 of the test subjects, in which no shiatsu stimulation applied during the above procedures.

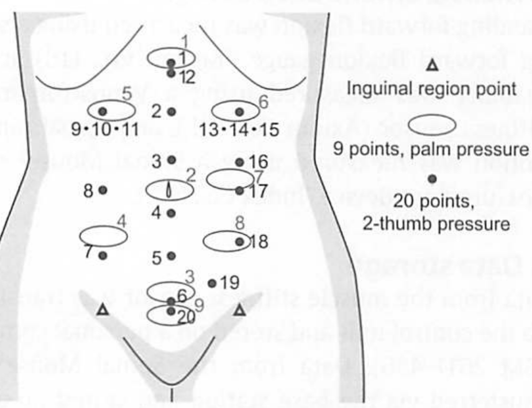

Fig. 2. Treatment area (excerpt from reference 5)

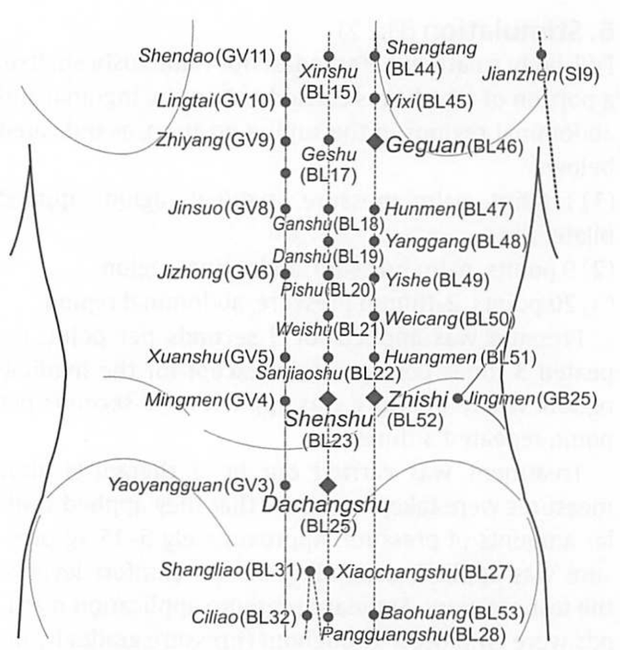

Fig. 3. Muscle stiffness measurement locations (excerpt from reference 6)

8. Data processing

Changes in before and after measurements for standing forward flexion and spinal range of motion were subject to statistical processing using a t-test.

(1) Spinal mobility (Fig. 4)

Measurements were made using a Spinal Mouse® in erect, forward flexion, and posterior flexion postures. Spinal angle of inclination was calculated based on a straight, vertical line projected from the base point at S_3, with the incline angle of a straight line connecting C_7 to S_3 shown as positive to indicate forward flexion and negative to indicate posterior flexion. Spinal angle of inclination is the angle of inclination, based on a horizontal line, between each vertebra including the sacrum, shown as positive to indicate forward flexion and negative to indicate posterior flexion.

For purposes of this study, changes of less than 1° were treated as within the margin of error, indicating no change.

(2) Muscle stiffness (Fig. 5)

The round-trip changes in load and vibration frequency when the tactile sensor was depressed with a maximum force of 100 g were compared before and after stimulation.

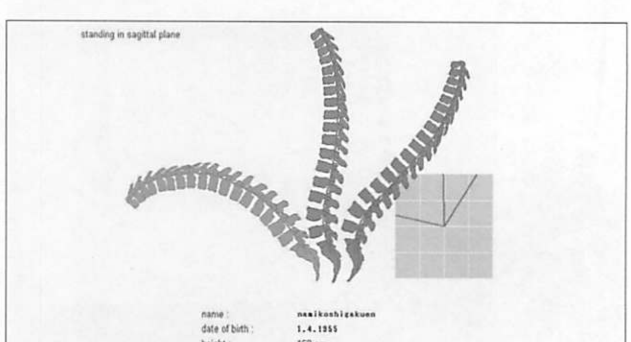

Fig. 4. Screen image of spinal range of motion measurement

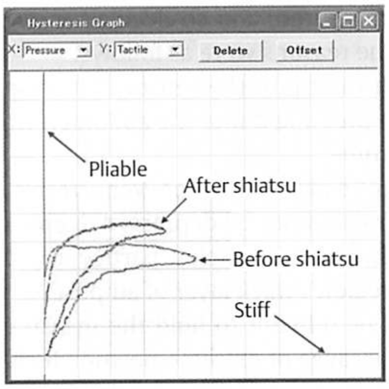

Fig. 5. Screen image of muscle stiffness measurements

The graph's x-axis indicates the depression pressure and the y-axis the sympathetic vibration frequency. The slope of the graph line indicates greater muscle stiffness as it approaches the x-axis, and greater muscle pliability as it approaches the y-axis. Muscle elasticity is indicated by the difference in vibration frequency between depression and retraction pressure, with elasticity being greater the less the difference.

III. Results

1. Standing forward flexion (Fig. 6)

Pre-stimulation values were 2.7 ± 1.3 cm (mean ± SE) and post-stimulation values were 4.9 ± 1.2 cm, indicating a significant improvement ($p<0.01$). Improvement occurred in 36 of 47 cases, with 1 case showing no change, and 10 cases showing a change for the worse. The average before-after change, calculated by subtracting the post-stimulation measurement value from the pre-stimulation measurement value, was 2.15 ± 0.54 cm.

In the 15 non-stimulation cases, there was not a significant before-after change in measurements.

2. Spinal range of motion during forward flexion

(1) Spinal angle of inclination (Fig. 7)

After eliminating data tainted by equipment malfunction, pre-stimulation values were +109.2 ± 1.6° and post-stimulation values were +110 ± 1.7°, which did not indicate a significant improvement. Of a total of 39 cases, 16 cases showed an improvement, 14 cases showed no change, and 9 cases showed no improvement. The average before-after change was 1.8 ± 0.92°.

(2) Sacral angle of inclination (Fig. 8)

Pre-stimulation values were 61.9 ± 1.8° and post-stimulation values were 65.4 ± 1.9°, indicating a significant improvement ($p<0.01$). Of a total of 39 cases, 24 cases showed an improvement, 8 cases showed no change, and 7 cases showed no improvement. The average before-after change was 3.5 ± 0.9°.

3. Muscle pliability

Results for muscle stiffness measurements taken bilaterally at 8 points are as follows. Improvement rates are shown separately for muscle stiffness (change in pressure) and muscle elasticity (change in frequency). Left *Zhishi* (BL52): stiffness improved in 3 cases (33%) and elasticity in 3 cases (33%); right *Zhishi* (BL52): stiffness improved in 5 cases (56%) and elasticity in 6 cases (67%). Left *Shenshu* (BL23): stiffness improved in 3 cases (33%) and elasticity in 6 cases (67%); right *Shenshu* (BL23): stiffness improved in 7 cases (78%) and elasticity in 5 cases (56%). Left *Dachangshu* (BL25): stiffness improved in 6 cases (67%) and elasticity in 3 cases (33%); right *Dachangshu* (BL25): stiffness improved in 5 cases (56%) and elasticity in 5 cases (56%). Left *Geguan* (BL46): stiffness improved in 3 cases (33%) and elasticity in 4 cases (44%); right *Geguan* (BL46) (excluding 1 case due to data error): stiffness improved in

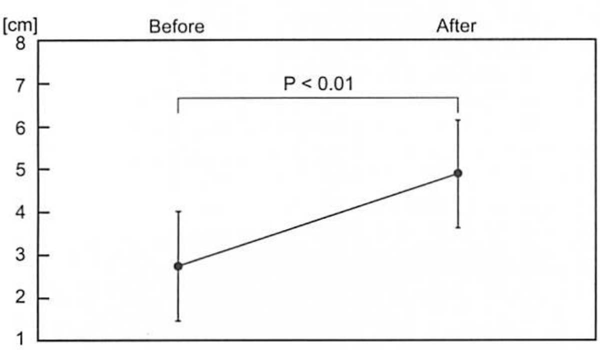

Fig. 6. Change in standing forward flexion before and after shiatsu

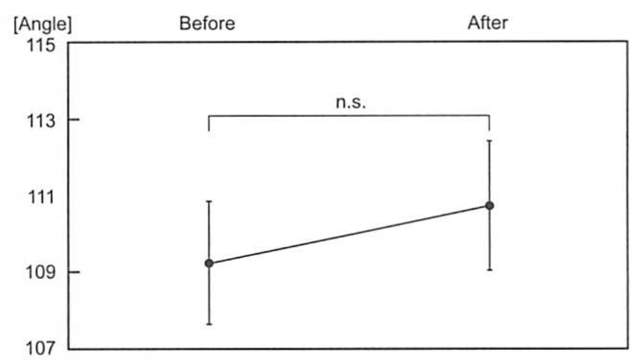

Fig. 7. Change in spinal range of motion during forward flexion

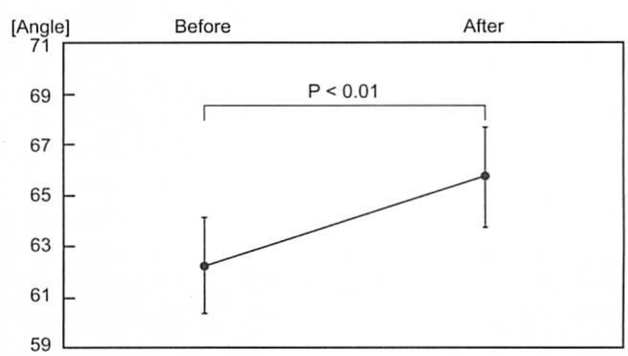

Fig. 8. Change in sacral range of motion during forward flexion

4 cases (50%) and elasticity in 4 cases (50%). Right-side measurement points showed a comparatively higher rate of improvement, but overall a definite trend was not confirmed.

IV. Discussion

In this study, standing forward flexion improved significantly due to shiatsu stimulation of the abdominal region.

Eto et al[3] demonstrated that shiatsu stimulation of the back and lumbar regions improved standing forward flexion and muscle pliability of the same region and concluded that the mechanism for this was due to an increase in muscle blood volume[2] from increased blood flow caused by either axonal reflex[8] or sympathetic nerve suppression, resulting in increased muscle pliability. Tazuke et al[4] performed shiatsu on the posterior lower limb, including the hamstrings, which are a limiting factor in standing forward flexion, and reported improvements to standing forward flexion and spinal range of motion.

Therefore, standing forward flexion values were improved by shiatsu stimulation to all areas, including the back and lumbar region, posterior lower limb, and abdominal region.

As in this study, unlike previous studies, stimulation was applied to the abdominal region on the ventral surface of the trunk, the following factors may be considered as causes for improvement in standing forward flexion.

The rectus abdominis connects "the anterior surfaces of the 5th to 7th costal cartilages and the xiphoid process" with the "pubic crest"[7]. The appropriate amount of tension in the rectus abdominis causes the pelvis to tilt posteriorly, allowing the hip joints to flex effectively. However, excessive tension in the rectus abdominis causes the pelvis to tilt excessively posteriorly, forcing the hip joints to extend. Thus, alleviating excessive tension in the rectus abdominis may improve the sacral angle of inclination, thereby increasing range of motion in the hip joints resulting in improved standing forward flexion. In addition, it is also possible that the rectus abdominis also exerts an influence via its upper attachments to the costal cartilages, causing changes to elevation of the thorax and mobility of the thoracic vertebrae; this is being considered as a topic for future study.

In reports by Eto et al[3] and Tazuke et al[4], muscle stiffness was measured in the areas subject to shiatsu stimulation; in this study, we initially planned to measure muscle stiffness both in the stimulated area and the remote area of the back and lumbar region, but determined that it would be difficult to obtain proper measurements due to the relationship between Venustron's measurement sensor and the nature of the area to be measured, and so decided to measure the back only. The reasons were as follows:

(1) Although the tip of the sensor is hemispherical, it is likely that pressing it into the abdomen would cause muscle guarding.

(2) It was anticipated that the Venustron's measurement sensor could not be depressed deeply enough to reach the abdominal muscles, particularly due to the abdominal region's thick layer of adipose.

(3) It would be difficult to hold the measurement device stable because of extreme positional changes due to respiration.

We hope that in the future, we will be able to reexamine our measurement procedures and accurately measure abdominal muscle stiffness, providing evidence to support the test findings of this study.

The results obtained in this study indicate that shiatsu stimulation to the abdominal region can be effective in cases of lumbar pain accompanied by muscle tension, especially when it is difficult to move the body from the supine position.

V. Conclusions

From this study involving 47 adult males, the following is evident:

Spinal range of motion, as indicated by standing forward flexion, showed significant improvement due to Namikoshi-style shiatsu stimulation of the abdominal and inguinal regions.

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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Electrogastrogram Changes Due to Shiatsu Stimulation of the Lower Leg

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I. Introduction

In the 22nd through the 29th congresses of the Japan College Association of Oriental Medicine, we reported on the effects of shiatsu stimulation on the circulatory system[1-3] (reduction in heart rate and blood pressure, peripheral increase in muscle blood volume, and rise in skin temperature) and the musculoskeletal system[4-8] (improvements in muscle pliability and spinal range of motion).

It is claimed that shiatsu stimulation clinically has a normalizing effect on internal organ function. Here, we report on whether shiatsu stimulation has an effect on gastrointestinal motility as tested using an electrogastrograph, which permits noninvasive measurement of gastric motility.

II. Methods

1. Subjects

Research was conducted on 21 healthy adult students from this college, including 15 males and 6 females (average age: 37.0 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.

2. Test period

June 17 to September 16, 2006, between 2PM and 5PM

3. Test location

Testing was conducted in the shiatsu research lab at the Japan Shiatsu College. Room temperature was 26.3 ± 1.3°C and humidity was 58.3 ± 12.9%.

4. Measurement device (Fig. 1)

Electrogastrograph (NIPRO)

5. Stimulation

The lateral crural region was selected as the area to be stimulated, as previous research showed that treatment of this region using basic Namikoshi shiatsu procedure resulted in reductions in blood pressure and heart rate[1-3], and we were interested to observe what effect it would have on gastric motility. Stimulation was carried out according to standard Namikoshi procedure[9], as indicated below.

(1) Area of stimulation (Fig. 2)

[1] Point 1, lateral crural region (corresponding to Zusanli [ST36][10])

[2] 6 points, lateral crural region

(2) Method of stimulation

The left and right crural regions were treated using standard pressure (pressure gradually increased,

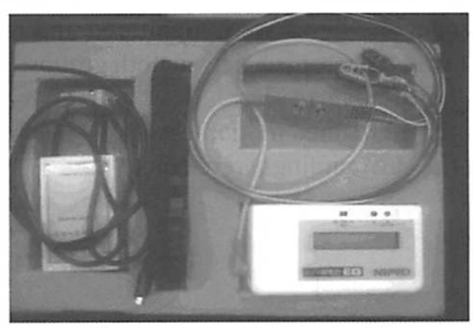

Fig. 1. Electrogastrograph (EG)

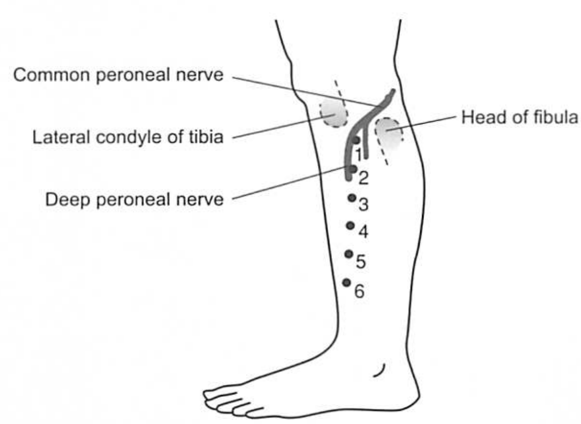

Fig. 2. Area of shiatsu stimulation (left lateral crural region)

sustained, and gradually decreased), with pressure to Point 1 sustained for 5 seconds, repeated 3 times, and pressure to the 6 points of the lateral crural region applied for 3 seconds per point, repeated 4 times.

Stimulation was applied by 2 therapists, with pressure regulated so as to be pleasurable for the test subject.

6. Test procedure

The overall condition of the test subjects, which consisted of a stimulation group and a non-stimulation group, was determined by asking them to fill out a survey including questions on physical condition, meal times, and usual abdominal condition. Measurement electrodes were applied as per the NIPRO electrogastrograph's operating manual (Fig. 3).

(1) Stimulation group

[1] 10 minutes rest (supine position)

[2] 5 minutes treatment (bilateral treatment of Point 1, lateral crural region and the 6 points of the lateral crural region)

[3] 15 minutes rest (supine position)

Measurement was carried out during the 30 minutes in which the above procedures [1] – [3] were applied. After measurement was completed, test subjects were asked to complete a survey to determine their feelings on the experimental environment, amount of shiatsu pressure, and changes in abdominal condition due to treatment.

(2) Non-stimulation group

30 minutes rest (supine position)

(3) Test precautions

The following items were monitored and recorded during testing for test subjects in both groups:

[1] that they remained alert

[2] that they remained motionless

[3] that the surroundings were quiet

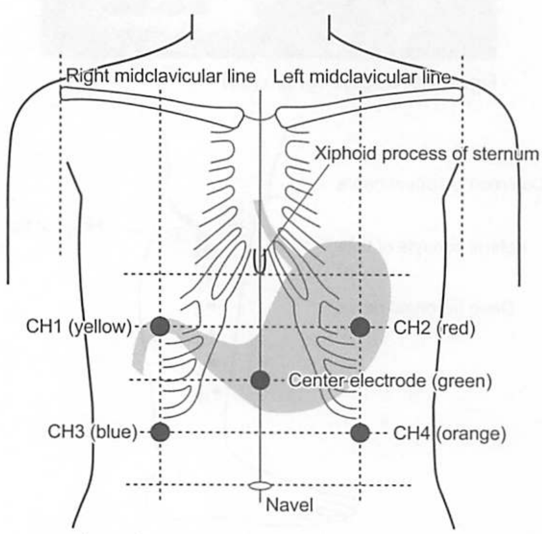

Fig. 3. Electrode positioning

(4) Other

Regarding test subjects' meals on the day of testing, preliminary testing compared response to shiatsu stimulation on both full and empty stomachs and found no difference, therefore no limitations on meal times were established for this experiment.

7. Outcome measures and analytical objects

(1) Outcome measures

[1] Dominant power (hereafter, DP)

Indicator of the degree of peristalsis

[2] Frequency

Number of peristaltic contractions per minute

Stomach peristalsis normally occurs at 3 contractions per minute. Because the normal range is that figure ± 1, peristalsis has been classified in similar papers to this one[11] as slow-wave (greater than or equal to 0 but less than 2), normal-wave (greater than or equal to 2 but less than or equal to 4), and fast-wave (greater than 4 but less than or equal to 9).

(2) Analytic object data

The object was defined as those subjects in whom DP fluctuations decreased during the pre-treatment rest period, with the objective set at less than 5% variation between the 7-minute mark and 10-minute mark of the rest period. As a result, 18 of the 21 subjects in the stimulation group and 6 of the 6 subjects in the non-stimulation group were included in the analytic object data.

(3) Evaluation period (Fig. 4)

The electrogastrograph data was analyzed before, during, and after stimulation, as shown below.

[1] Pre-treatment (control value): Average value over 3 minutes immediately prior to treatment

[2] During treatment: Average value over 5 minutes during treatment

[3] Post-treatment: Average value over 5 minutes immediately following treatment

The control value was taken from data during minutes 7–10 of the 10-minute pre-treatment rest period, when data fluctuations were absent.

(4) Statistical processing

For frequency, multiple comparison procedure was conducted using the F-test after conducting analysis of variance of the two-way layout of the average values between each channel. The significance level was <5%.

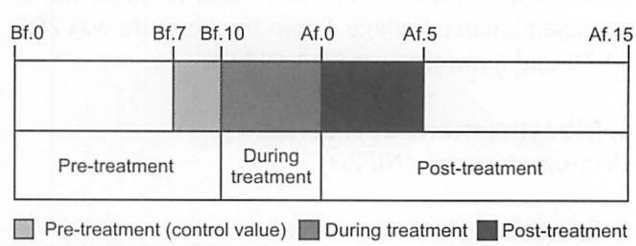

Fig. 4. Evaluation period

III. Results

1. Comparison of dominant power (DP)

An increase of DP over the control value was observed in 2 of 6 subjects in the non-stimulation group and 15 of 18 subjects in the stimulation group, indicating that the DP increase in the stimulation group was significant.

Concerning DP peak, of the 15 members of the stimulation group showing increased DP, 3 subjects peaked during the 5 minutes of treatment and 12 subjects peaked during the 5 minutes post-treatment, indicating a trend for the DP peak to occur post-treatment (Table 1). A typical example of DP response is shown in Figure 5.

When DPs of each channel were compared, it was found that DP increased over the control value in 14 subjects for CH1, 15 subjects for CH2, 15 subjects for CH3, and 11 subjects for CH4. For all channels, DP peak occurred after completion of treatment, and was significant for CH1-3 (Table 2).

Table 1. Comparison of DP peaks

	During treatment	Post-treatment
Stimulation group	3	12
Non-stimulation group	2	

(Unit: number of people)

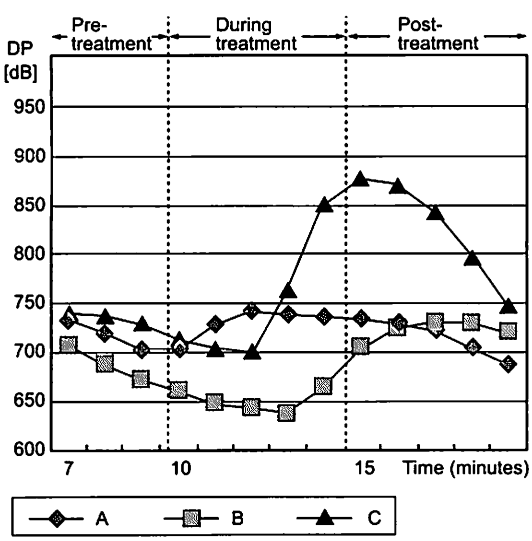

Fig. 5. Typical DP response pattern (stimulation group)

Table 2. DP comparison for each channel

	During treatment	Post-treatment	Total
CH1	0	14	14
CH2	2	13	15
CH3	0	15	15
CH4	1	10	11

(n=18)

2. Comparison of frequency

(1) Change in average frequency over time

Changes in average frequency over time for all test subjects are shown in Figures 6 and 7.

When the above frequency data for each channel was subject to analysis of variance, a trend toward variations within the normal range was observed, regardless of the subject's sex or condition of their stomach, without a significant difference over time. However, the non-stimulation group showed a slight trend toward decline compared to the stimulation group.

(2) Change in frequency

Examining individual frequency changes, Table 3 shows the number of people who exhibited variations within the normal frequency range during testing. For purposes of comparison, figures indicate the number of people who displayed changes relative to the control value both during and after treatment, as for the DP evaluation.

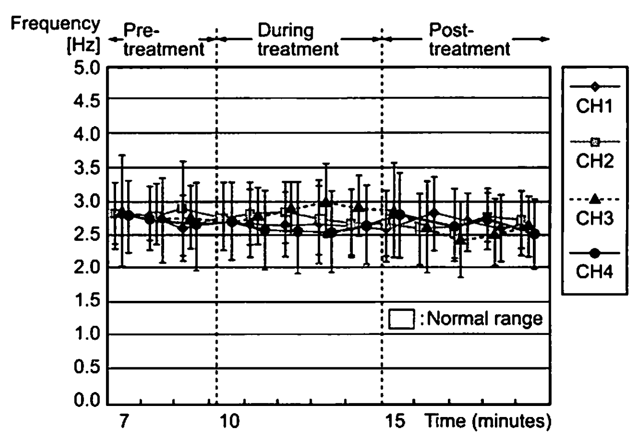

Fig. 6. Stimulation group

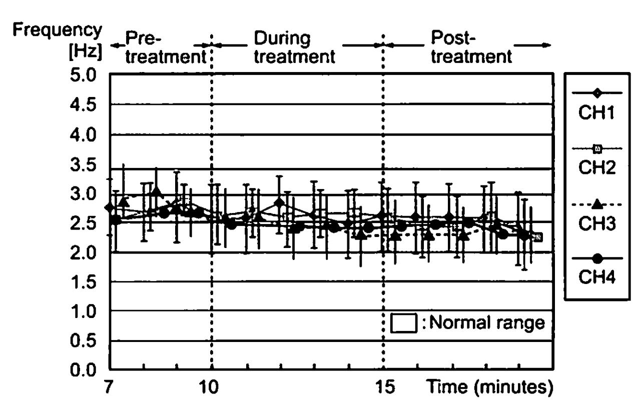

Fig. 7. Non-stimulation group

Table 4 lists results for cases displaying frequency variations outside the normal frequency range for each channel.

Table 5 indicates trends seen for all channels, taken from Table 4.

The above data of variations outside the normal frequency range indicate the same trend toward change occurring post-treatment as was observed in increases to DP, with post-treatment changes observed in 7 of the 12 cases in the stimulation group, which is significant.

Table 3. Subjects showing variations within the normal frequency range

Electrode	Non-stimulation group	Stimulation group
CH1	3 / 6	16 / 18
CH2	4 / 6	15 / 18
CH3	3 / 6	14 / 18
CH4	4 / 6	15 / 18

(Units: number of people)

Table 4. Variations outside the normal frequency range for each channel

Channel	Change	Pre-treat-ment	During treat-ment	Post-treat-ment	Number of cases: Stimulation group	Number of cases: Non-stimulation group
CH1	Change during treatment	—	○	—	1	
	Change during and post-treatment	—	○	○		2
	Change post-treatment	—	—	○	1	1
CH2	Change during treatment	—	○	—	1	1
	Change post-treatment	—	—	○	2	1
CH3	Change during treatment	—	○	—	2	1
	Change post-treatment	—	—	○	2	2
CH4	No change	—	—	—	1	
	Change during treatment	—	○	—		1
	Change during and post-treatment	—	○	○		1
	Change post-treatment	—	—	○	2	

—: Same frequency range as control value ○: Change

Table 5. Variations outside the normal frequency range

	Pre-treatment	During treatment	Post-treatment	Stimulation group	Non-stimulation group
No change	—	—	—	1 / 12	0 / 10
Change during treatment	—	○	—	4 / 12	3 / 10
Change during and post-treatment	—	○	○	0 / 12	3 / 10
Change post-treatment	—	—	○	7 / 12	4 / 10

IV. Discussion

The fact that shiatsu stimulation of the crural region caused DP to increase in the electrogastrograph seems to indicate that it promoted gastrointestinal motility. The mechanism for this response may have been due either to stimulation of activity in the vagus nerve, which regulates the stomach, or inhibition of sympathetic nerve activity.

Sato et al have reported in detail on responses and neurological mechanisms involving stomach motility in anesthetized rats due to pinch stimulation[12] and acupuncture stimulation[13]. They reported conclusively that stimulation of the abdominal region suppressed stomach motility via a spinal segment reflex that stimulated the portion of the sympathetic nervous system supplying the stomach, while stimulation of the hind limb mildly stimulated stomach motility via a supraspinal reflex that stimulated activity in the vagus nerve, which regulates stomach function. Therefore, the mechanism behind the electrogastrograph response due to shiatsu stimulation of the crural region in healthy human subjects in this test is likely to be the same, despite differences in species and the presence or absence of anesthetic.

Noguchi et al[14] reported that duodenal motility was stimulated in anesthetized rats using electro-acupuncture stimulation of the footpad of the hind limb, and it is possible that the shiatsu stimulation of the crural region reported on herein also influenced duodenal and small intestine motility, in addition to stomach motility. Future study will be required to investigate the influence of shiatsu stimulation on intestinal motility.

Because the electrogastrograph electrodes were attached to the abdominal region, shiatsu stimulation was not implemented on the torso in this experiment due to the strong likelihood of artifact contamination due to shiatsu stimulation. However, because an increase in post-treatment electrogastrograph DP due to shiatsu stimulation of the crural region was observed here, we hope to test the effect of shiatsu stimulation of the torso in the future.

V. Conclusions

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

Namikoshi-style shiatsu stimulation to the lateral crural region resulted in increased dominant power (DP). Frequency was within the normal frequency range and was unaffected.

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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Electrogastrogram Changes Due to Shiatsu Stimulation of the Abdominal Region

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I. Introduction

The Japan Shiatsu College has been conducting ongoing research into the effects of shiatsu stimulation on physiological functions. In the 22nd through 24th congresses of the Japan College Association of Oriental Medicine, we reported that shiatsu stimulation of the abdominal region reduced heart rate[1] and blood pressure[2], and increased peripheral muscle blood volume[3].

As a follow-up to our study conducted last year, "Electrogastrogram changes due to shiatsu stimulation of the lower leg,"[4] this year we report on electrogastrogram changes due to shiatsu stimulation of the abdominal region, in order to confirm the effects of shiatsu stimulation on gastrointestinal motility.

II. Methods

1. Subjects

Research was conducted on 27 healthy adult students from this college, including 13 males and 14 females (average age: 36.8 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.

2. Test period

April 1 to September 22, 2007

3. Test location

Testing was conducted in the shiatsu research lab at the Japan Shiatsu College. Room temperature was 25.0 ± 2.0°C and humidity was 63.0 ± 12.0%.

4. Measurement

Measurement was carried out using an electrogastrograph (NIPRO), with measurement electrodes applied to the following areas (Fig. 1).

Center electrode: midway between the xiphoid process of the sternum and the navel

CH1: at the intersection of a line running horizontally through the point midway between the xiphoid process of the sternum and the center electrode and the right midclavicular line

CH2: at the intersection of a line running horizontally through the point midway between the xiphoid process of the sternum and the center electrode and the left midclavicular line

CH3: at the intersection of a line running horizontally through the point midway between the center electrode and the navel and the right midclavicular line

CH4: at the intersection of a line running horizontally through the point midway between the center electrode and the navel and the left midclavicular line

5. Stimulation

Stimulation was carried out according to standard Namikoshi procedure[5], as indicated below.

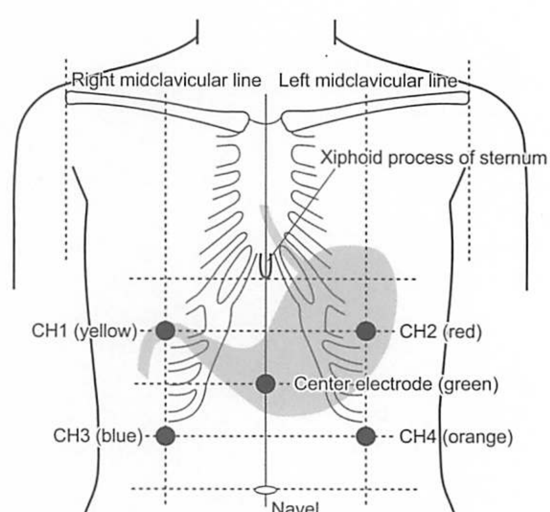

Fig. 1. Electrode positioning

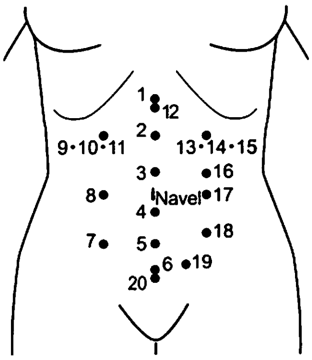

Fig. 2. 20 points, abdominal region

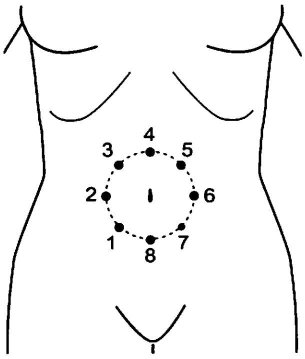

Fig. 3. 8 points, circumference of navel region

(1) Area of stimulation

[1] 9 points, palm pressure, abdominal region

Palm pressure combined with palpation was applied in the following order: solar plexus, small intestine, bladder, cecum, liver, spleen, descending colon, sigmoid colon, rectum.

[2] 20 points, 2-thumb pressure, abdominal region (Fig. 2)

[3] 8 points, 2-thumb pressure, circumference of navel region (Fig. 3)

(2) Method of stimulation

The respective areas were treated using standard pressure (pressure gradually increased, sustained, and gradually decreased), with pressure applied for 3 seconds per point, repeated 3 times.

Pressure was regulated so as to be pleasurable for the test subject (standard pressure).

6. Test procedure

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

The stimulation group was treated in the following order: 15 minutes rest → 10 minutes stimulation → 15 minutes post-stimulation rest. The non-stimulation group rested for 40 minutes, the same amount of time as the test period for the stimulation group.

(1) The overall condition of the test subjects was determined by asking them to fill out a survey including questions on physical condition, meal times, and usual abdominal condition. After measurement was completed, test subjects completed a survey to determine their feelings on the experimental environment, amount of shiatsu pressure, and changes in abdominal condition due to treatment.

(2) Test precautions

The following items were monitored and recorded during testing for test subjects in both groups:

[1] that they remained alert

[2] that they remained motionless

[3] that the surroundings were quiet

(3) Other

Regarding test subjects' meals on the day of testing, no limitations on meal times were established.

7. Outcome measures

[1] Dominant power (hereafter, DP)

Indicator of the size of electrical response activity (ERA) in gastric smooth muscle cells accompanying peristalsis. Raw data measured using the electrogastrograph is subject to spectral analysis using MBFA and classified as slow-wave (0–2 cpm), normal-wave (2–4 cpm), and fast-wave (4–9 cpm)[4], to express changes in the electric potentials of their respective frequency bands.

[2] Frequency

The frequency of the highest amplitude taken from the 0–9 pm waveforms each minute

8. Data analysis

[1] Data taken during the 10-minute periods pre- and post-stimulation (hereafter, 10-minute interval average value) were analyzed.

[2] Data were also analyzed chronologically every 5 minutes (hereafter, 5-minute spot average value).

Data gathered during stimulation were treated with caution, as there was a probability of artifact contamination.

9. Statistical processing

Bonferroni multiple comparisons and one-way analysis of variance using a linear mixed model. The significance level was <5%.

III. Results

1. DP before and after shiatsu stimulation

There were three test segments (15 minutes rest pre-stimulation, 10 minutes shiatsu stimulation, and 15 minutes rest post-stimulation). The pre-stimulation 10-minute interval average value was established as the control value and compared to the post-stimulation 10-minute interval average value.

(1) DP comparison between stimulation and non-stimulation groups

In the non-stimulation group, DP was more or less unchanged in all 3 cases, whereas in the stimulation group an increase in DP was confirmed in 26 of 27 cases.

Because the non-stimulation group consisted of 3 subjects, we were unable to conduct a pre-post-stimulation comparison with the stimulation group. In the stimulation group, the post-stimulation DP value increased ($p<0.001$) (Fig. 4).

(2) DP comparison for each frequency band

Post-stimulation DP increased significantly ($p<0.001$)

compared to pre-stimulation DP for slow-wave, normal-wave, and fast-wave frequency bands. There was no interaction between the electrogastrograph's slow-, normal-, and fast-wave bands due to shiatsu stimulation. Normal-wave values were higher than those for either slow-wave or fast-wave ($p<0.001$) (Fig. 5).

(3) DP comparison for each channel

Post-stimulation values increased for all channels ($p<0.001$).

There was no interaction between channels (hereafter, CH) due to shiatsu stimulation. There was a trend ($p<0.09$) for CH2 values to be lower than CH3 and CH4; there was a trend ($p<0.09$) for CH2 values to be lower than CH3 and CH4 (Fig. 6).

2. Chronological changes to DP

DP rose in response to shiatsu stimulation then fell post-stimulation, returning to pre-stimulation levels 15 minutes post-stimulation (Fig. 7).

3. Comparison of frequency

(1) Comparison of average frequencies before and after treatment

Comparison of pre-and post-stimulation 10-minute interval average values for all channels revealed no change (Fig. 8).

(2) Chronological changes to frequencies

A trend was observed for frequencies to gradually increase, then stabilize in the 2.5–3.0 cpm range

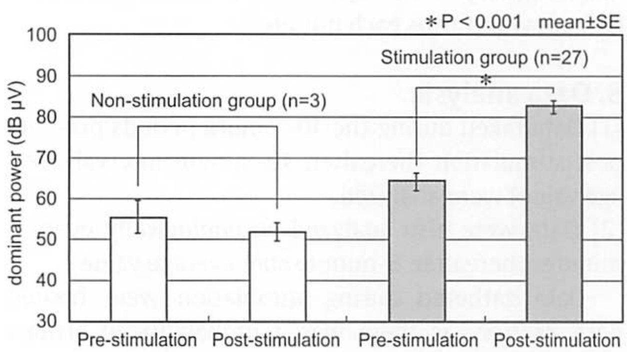

Fig. 4. DP comparison for shiatsu stimulation and non-stimulation groups

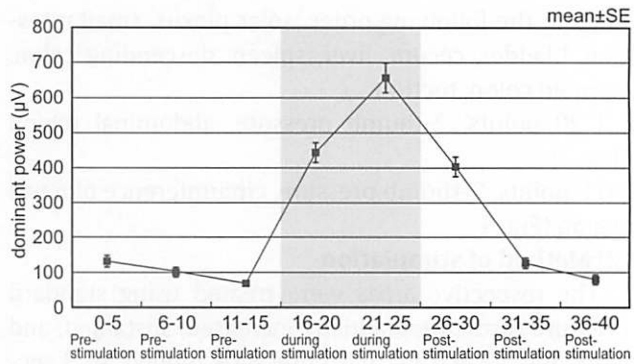

Fig. 7. Changes to dominant power

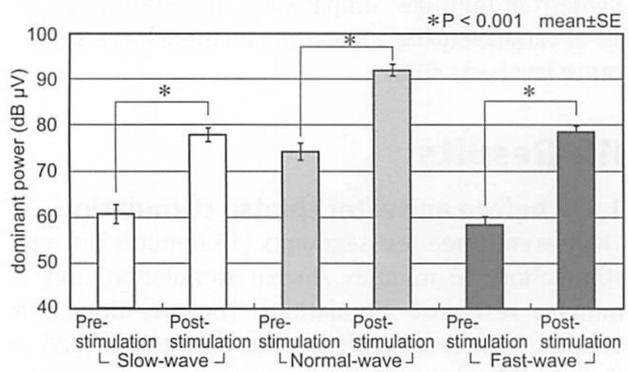

Fig. 5. DP comparison for each frequency band

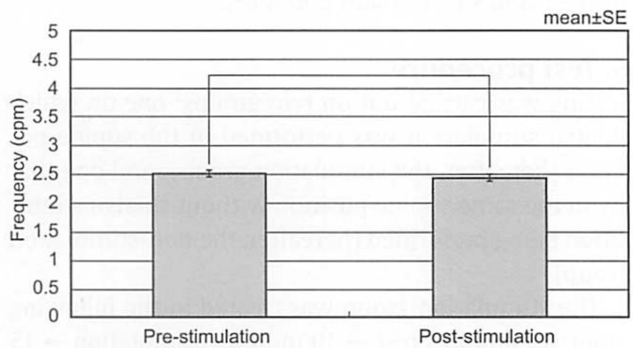

Fig. 8. Comparison of pre- and post-stimulation average frequencies

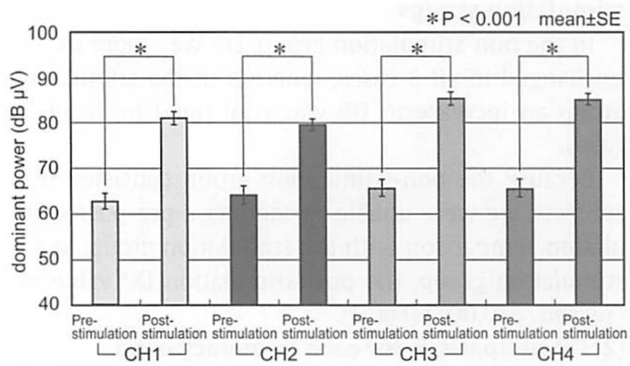

Fig. 6. DP comparison for each channel

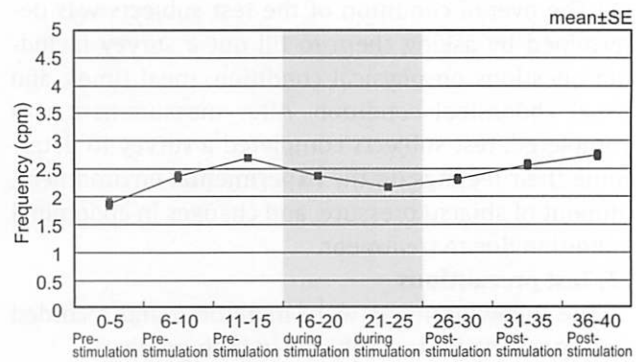

Fig. 9. Chronological changes to frequencies

during minutes 11–15 of the rest period. Frequency dropped slightly on all channels during shiatsu stimulation, then tended to once again rise gradually during post-treatment. These chronological changes occurred within the normal frequency range (Fig. 9).

4. Comparison of DP depending on presence of abdominal symptoms

(1) Comparison of 10-minute intervals before and after shiatsu stimulation

Subjects were divided into those with abdominal symptoms (9 cases) and without (18 cases), based on medical histories (survey forms).

In comparison of the 10-minute intervals before and after shiatsu, a large increase in DP from 93 to 304 was observed in subjects with feelings of abdominal bloating and a small increase in DP from 111 to 188 in subjects with constipation (Fig. 10).

(2) Changes in DP depending on presence of symptoms

DP rose during treatment, regardless of whether or not symptoms were present.

Although the number of cases was small, among the 3 subjects who reported abdominal bloating the rise in DP tended to continue after shiatsu stimulation ended, while among the 6 subjects who reported constipation a lower rise in DP due to shiatsu stimulation was observed (Fig. 11).

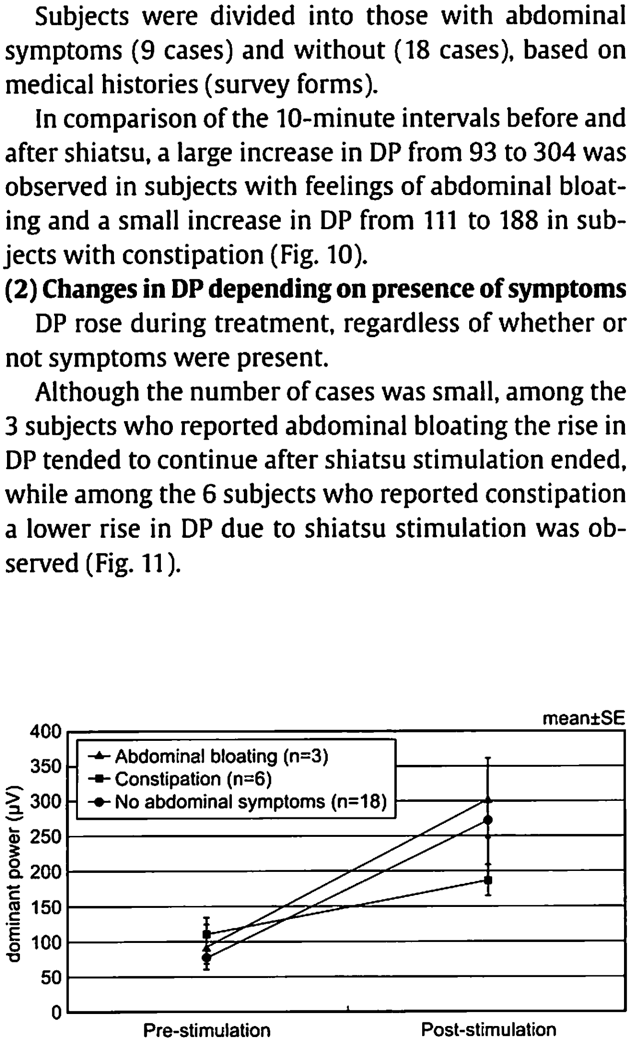

Fig. 10. Comparison of 10-minute intervals before and after shiatsu stimulation

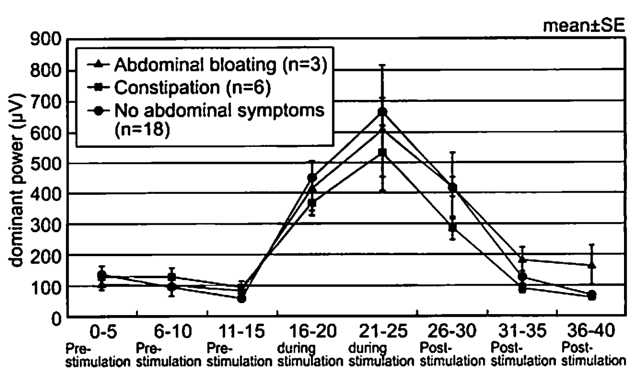

Fig. 11. Changes in DP depending on presence of symptoms

IV. Discussion

As with the results of last year's study on shiatsu stimulation of the lateral crural region, a rise in DP due to shiatsu stimulation of the abdominal region was confirmed. This is probably because abdominal shiatsu promotes peristalsis of the gastrointestinal tract.

It has been reported that pinch stimulation[6] and acupuncture stimulation[7] of the abdominal region in anesthetized rats suppressed stomach motility via a spinal segment reflex that stimulated the portion of the sympathetic nervous system supplying the stomach. Also, Imai et al[8] reported a decrease in DP due to acupuncture stimulation of the abdominal region and, since this also occurs when the parasympathetic blocking agent atropine is administered, concluded that the mechanism occurs via the sympathetic nerves.

The results obtained from shiatsu stimulation of the abdominal region in this study confirm a rise in DP, with the opposite effect of acupuncture stimulation of the human abdomen reported by Imai et al.

Because the depth of needle insertion is normally regulated so as not to pierce the peritoneum, it is difficult to conceive that the needle tip would reach the intramural plexus of the gastrointestinal tract or the abdominal organs, so the reaction to acupuncture stimulation of the abdominal region is probably due to stimulation of sympathetic nerve function via a somatovisceral reflex.

On the other hand, the shiatsu stimulation of the abdominal region conducted in this study involved deep pressure stimulation of the abdomen while observing the subject's response, and it is possible that the abdominal organs or intramural plexus were directly stimulated. Therefore, the stimulation response of gastrointestinal peristalsis due to abdominal shiatsu observed here may have been due to a viscero-visceral reflex mechanism in which the abdominal organs or the intramural plexus were stimulated and visceral afferent nerves formed the afferent path.

V. Conclusions

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

Shiatsu stimulation to the abdominal region resulted in increased dominant power (DP). Frequency varied within the normal frequency range and the effect was limited.

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

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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.

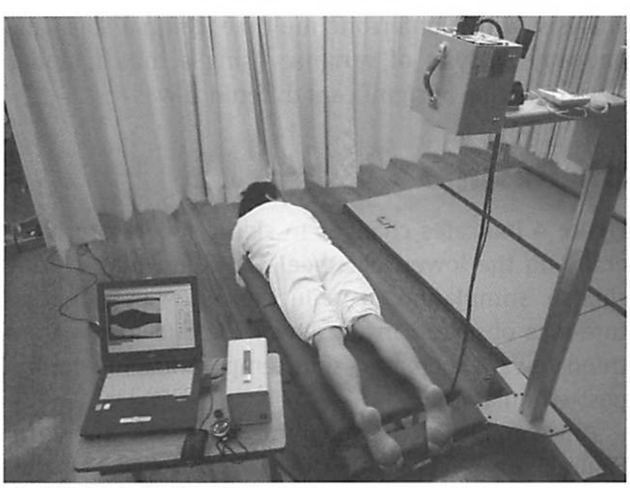

Fig. 1. Thermography equipment in use

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).

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

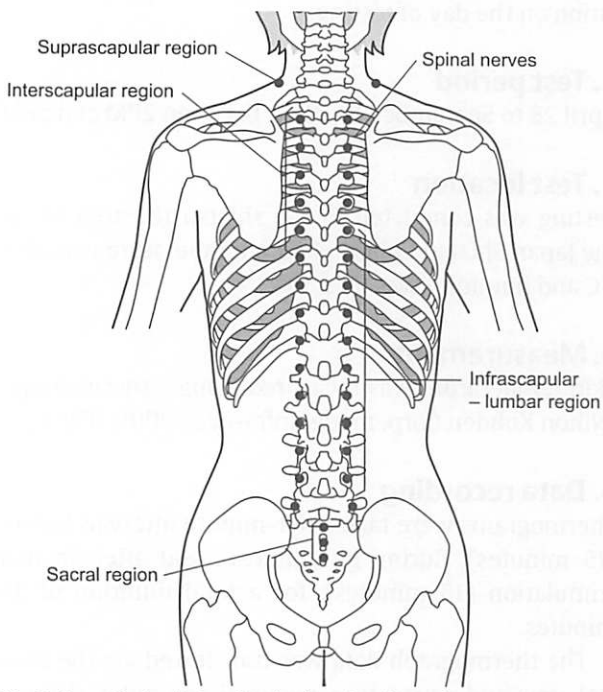

Fig. 2. Area of stimulation (lumbodorsal and sacral regions)

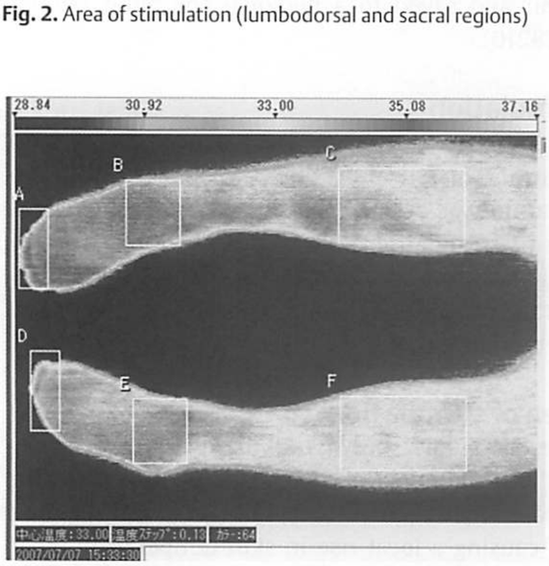

Fig. 3. Areas selected for analysis of skin temperature

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

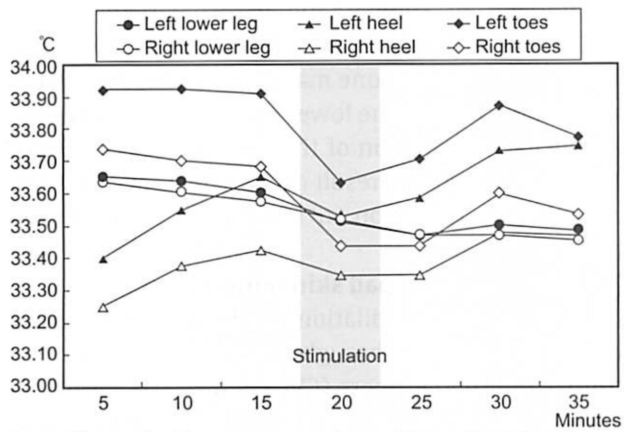

Fig. 4. Changes in skin temperature due to shiatsu stimulation

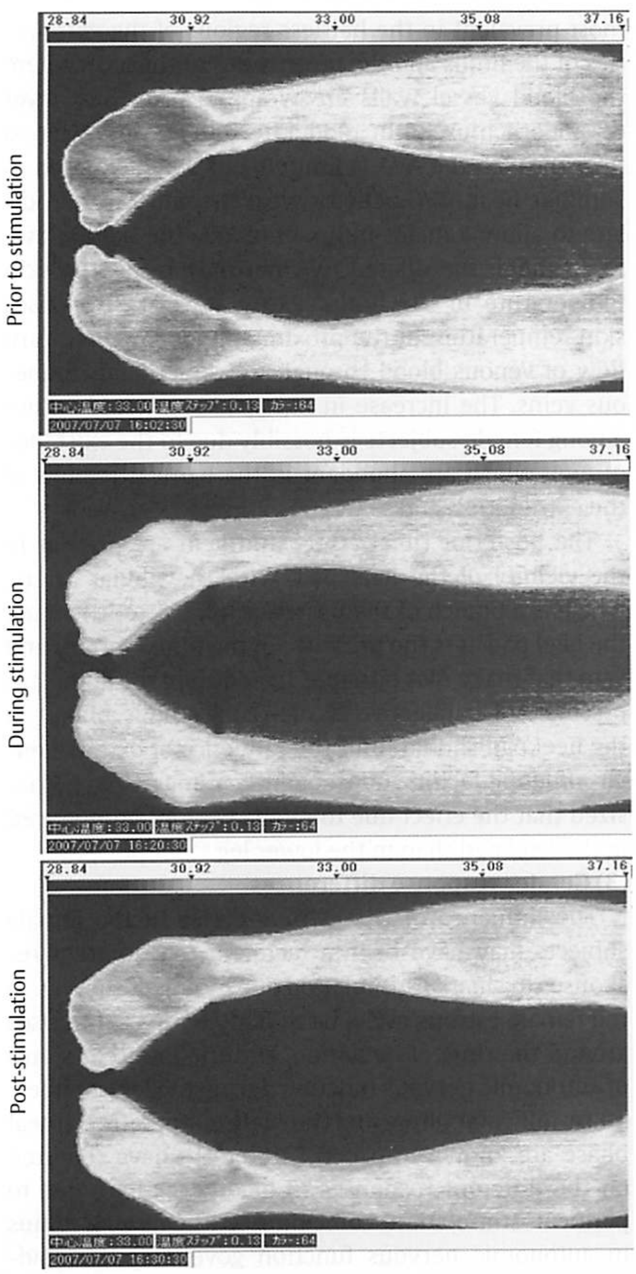

Fig. 5. Thermogram changes due to shiatsu stimulation

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).

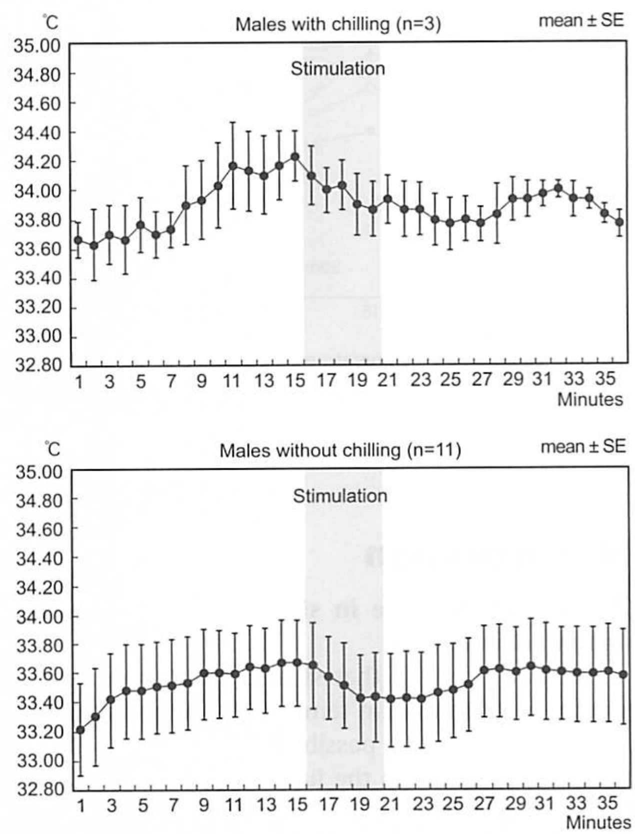

Fig. 6. Changes in skin temperature of left heel pad due to shiatsu stimulation (males)

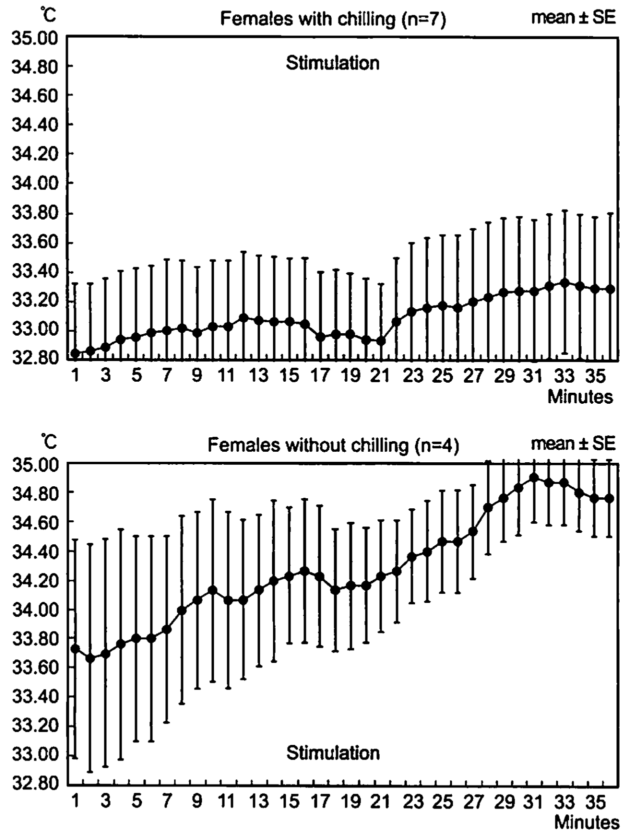

Fig. 7. Changes in skin temperature of left heel pad due to shiatsu stimulation (females)

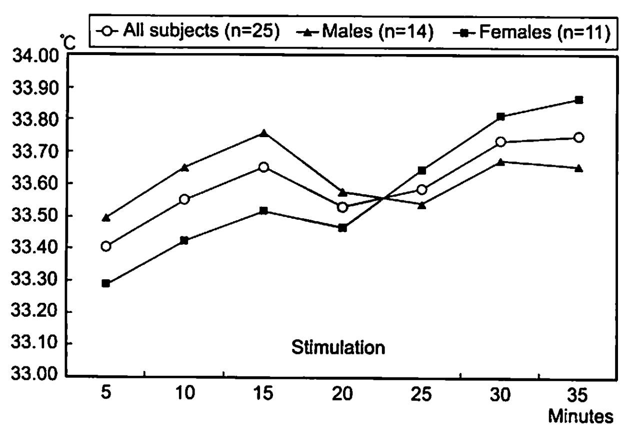

Fig. 8. Changes in skin temperature of left heel pad due to shiatsu stimulation

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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Effect on Spinal Mobility of Shiatsu Stimulation to the Inguinal Region

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Supervisors: Kazuo Watanabe, Tomoko Tanaka, Hiroshi Kanda, Hiroshi Ishizuka
Hideo Ohsawa (Tsukuba University of Technology), Hidetoshi Mori (Tsukuba University of Technology)

I. Introduction

The Japan Shiatsu College has previously conducted research into the effects of shiatsu stimulation on heart rate, peripheral circulation (pulse wave height, skin temperature, muscle blood volume), blood pressure, and spinal mobility. We reported responses including reduction in heart rate post-stimulation and reduced pulse wave height values in fingertip pulse wave during stimulation[1]; reduction in blood pressure during and after stimulation[2]; increase in heel pad skin temperature immediately post-stimulation[3]; and increased skin temperature accompanied by decreased muscle blood volume and decreased skin temperature accompanied by increased muscle blood volume immediately post-stimulation[4]. Concerning spinal flexibility, finger-floor distance (FFD) improved due to shiatsu stimulation of the dorsal region[5], as did standing forward flexion due to shiatsu stimulation of the abdominal and inguinal regions[6]. We were thus able to confirm shiatsu stimulation's action on the circulatory system and its effect on standing forward flexion.

The spine is freely mobile, capable of anteflexion, dorsiflexion, left and right lateral flexion, and left and right rotation. It is understood that, while individual intervertebral range of motion (ROM) is slight, the articulation of the spine's interrelated joints creates significant range of motion overall[6]. We have shown that, by using shiatsu stimulation to reduce muscular tension in the muscles that support and reinforce those joints in the dorsal and ventral regions, spinal range of motion is increased[5,6,8,9].

In this study, to further investigate spinal mobility, we applied shiatsu stimulation to the inguinal region, through which pass the iliacus and psoas major muscles, referred to collectively as the iliopsoas, a postural support muscle. The objective of this research was to study the effect of stimulation of the inguinal region on spinal mobility relating to spinal ROM in anteflexion and dorsiflexion.

II. Methods

1. Subjects

Research was conducted on 30 healthy adult students of the Japan Shiatsu College (18 males, 12 females) aged 18–67 years old (average age: 39.5 ± 14.1 years old).

2. Test period

April 1 to September 20, 2008, on Saturdays between 1:30PM and 6PM

3. Test location

Testing was conducted in the 5th-floor shiatsu training hall at the Japan Shiatsu College. Room temperature was 25.0 ± 2°C and humidity was 63.0 ± 12.0%.

4. Measurement procedures and devices used

Spinal mobility was measured using a Spinal Mouse® (Index Co., Ltd.). This device enabled measurement of angle and range of motion of each intervertebral space on both the sagittal and coronal planes from the body surface (Fig. 1).

In this test, to assess spinal ROM on the sagittal plane, we investigated anteflexion ROM and dorsiflexion ROM using angles at various locations (spinal inclination angle, thoracic kyphotic angle, lumbar lordotic angle, sacral/pelvic inclination angle), as measured in standing neutral (posture while standing), maximum anteflexion (posture of maximum anteflexion from standing), and maximum dorsiflexion (posture of maximum dorsiflexion from standing) positions. Anteflexion ROM is the difference between measurement values in the standing neutral and maximum anteflexion positions, and dorsiflexion ROM is the difference between measurement values in the standing

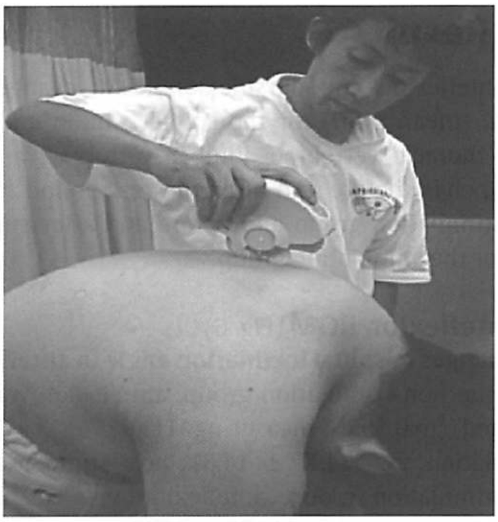

Fig. 1. Measurement using Spinal Mouse®

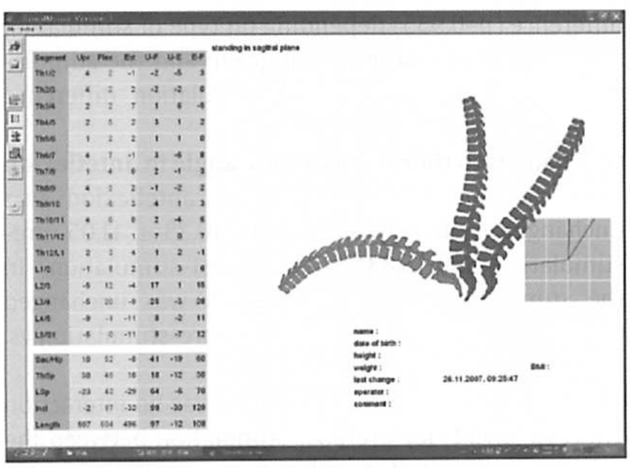

Fig. 2. Spinal ROM measurement screen

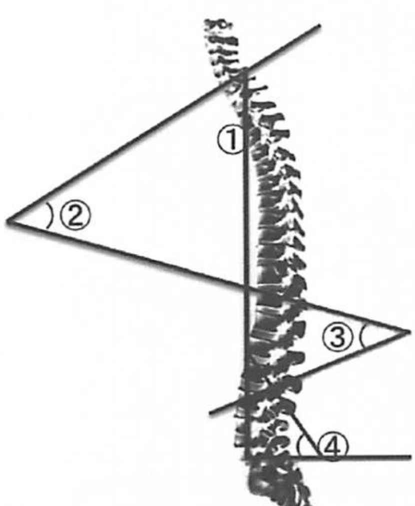

Fig. 3. Measurement items: angle of curvature of spine and individual locations.

neutral and maximum dorsiflexion positions (Fig. 2).

Measurement involved taking the segmental angle, consisting of the angle between a line joining the superior and inferior spinous processes and a vertical line, inputting the data recorded using the Spinal Mouse® into a computer, and abstracting the anteflexion and dorsiflexion of the sagittal curve.

Measurement items are shown below (Fig. 3).

① Spinal inclination angle (SIA): Indicates the measure of overall ROM using a straight line between the 1st thoracic vertebra and the 1st sacral vertebra. Expressed as the angle between that line and a vertical line.

② Thoracic kyphotic angle (TKA): Indicates the curvature from the 1st to the 12th thoracic vertebrae, or the overall thoracic curve.

③ Lumbar lordotic angle (LLA): Indicates the curvature from the 1st to the 5th lumbar vertebrae, or the overall lumbar curve.

④ Sacral/pelvic inclination angle (SIA): The sacral inclination angle is the angle measured, but because the sacrum is joined to the pelvis via the sacroiliac joints, it corresponds to the pelvic inclination angle.

5. Shiatsu stimulation (Fig. 4)

Palm pressure was applied for 5 seconds per point to each of the 3 basic Namikoshi shiatsu points in the inguinal region (following the inguinal ligament, Point 1: medioinferior to the anterior superior iliac spine; Point 2: over the arterial pulse; Point 3: superolateral to the pubic bone), bilaterally for 5 minutes per side, for a total of 10 minutes. All shiatsu stimulation was applied using standard pressure application methods (pressure gradually increased, sustained, and gradually decreased), and the amount of pressure used in stimulation was classified as standard pressure (pressure regulated so as to be pleasurable for the test subject)[10].

Because the use of palm pressure is a basic procedure in shiatsu, it was categorized as shiatsu ("finger pressure") for the purpose of this study.

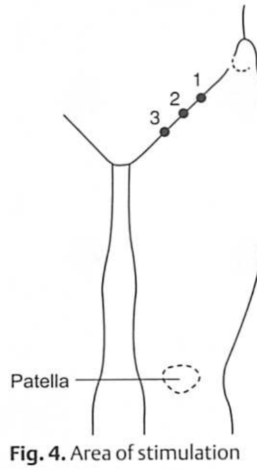

Fig. 4. Area of stimulation

6. Test procedure (Fig. 5)

Test procedures were fully explained to each test subject and their consent obtained. They were also questioned on subjective symptoms such as lumbar pain as well as regular exercise habits.

Two tests were performed, one in which shiatsu stimulation was not applied (hereafter, the non-stimulation group) and one on which shiatsu stimulation was applied (hereafter, the stimulation group). Both tests were applied to all 30 test subjects on different days.

(1) Non-stimulation group

15 minutes rest → measurement → 10 minutes rest → measurement

(2) Stimulation group

15 minutes rest → measurement → 10 minutes shiatsu stimulation → measurement

Rest and stimulation were carried out in the supine position; measurement was carried out in the standing position.

7. Analysis

In analysis of inter-group pre/post-stimulation data between the non-stimulation and stimulation groups, each angle measured (spinal inclination angle, thoracic kyphotic angle, lumbar lordotic angle, and sacral/pelvic inclination angle) was analyzed using Bonferroni multiple comparison and two-way analysis of variance using a general linear model. In analysis of pre/post-stimulation data for the non-stimulation and stimulation groups, each angle measured was analyzed using Bonferroni multiple comparison and one-way analysis of variance. Analytical software used was SPSS Ver.15, with a significance level of ≤5% taken as significant.

III. Results

For anteflexion and dorsiflexion ROM, changes are shown (mean ± SD) for the spinal column and each area (thoracic vertebrae, lumbar vertebrae, and sacrum/pelvis) before and after the rest period for the non-stimulation group and before and after stimulation for the stimulation group.

1. Anteflexion ROM (Fig. 6)

(1) Changes to spinal inclination angle in anteflexion

In the non-stimulation group, anteflexion was unchanged (p=0.592), measuring 113.97 ± 13.87° pre-stimulation vs. 114.17 ± 14.61° post-stimulation. In the stimulation group, anteflexion was unchanged (p=0.439), measuring 113.83 ± 13.14° pre-stimulation vs. 114.70 ± 13.85° post-stimulation.

For the spinal column, there was no interaction effect (p=0.57) for pre/post-stimulation between the non-stimulation and stimulation groups. There was no difference (p=0.955) depending on type of stimulation between the non-stimulation group and the stimulation group, and no pre/post-stimulation difference (p=0.364).

(2) Changes to thoracic kyphotic angle in anteflexion

In the non-stimulation group, anteflexion was unchanged (p=0.697), measuring 16.33 ± 11.05° pre-stimulation vs. 15.83 ± 11.12° post-stimulation. In the stimulation group, anteflexion was unchanged (p=0.445), measuring 15.93 ± 12.26° pre-stimulation vs. 14.97 ± 11.23° post-stimulation.

For the thoracic vertebrae, there was no interaction effect (p=0.794) for pre/post-stimulation between the non-stimulation and stimulation groups. There was no

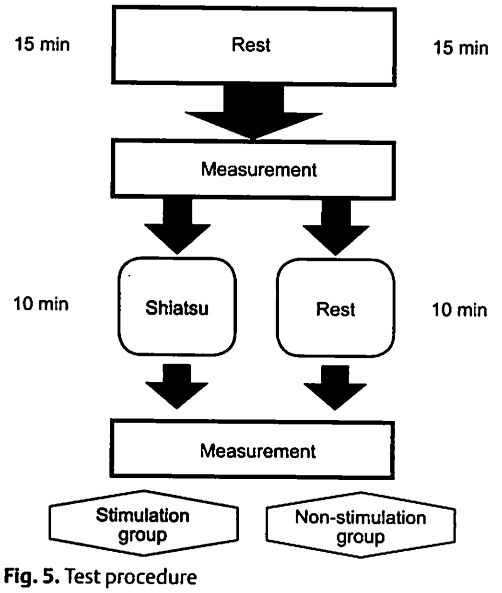

Fig. 5. Test procedure

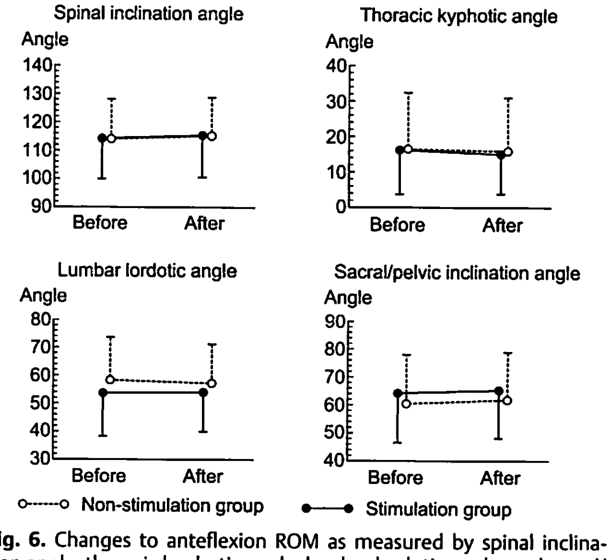

Fig. 6. Changes to anteflexion ROM as measured by spinal inclination angle, thoracic kyphotic angle, lumbar lordotic angle, and sacral/pelvic inclination angle, resulting from non-stimulation and shiatsu stimulation

difference (p=0.823) depending on type of stimulation between the non-stimulation group and the stimulation group, and no pre/post-stimulation difference (p=0.413).

(3) Changes to lumbar lordotic angle in anteflexion

In the non-stimulation group, anteflexion was unchanged (p=0.207), measuring 58.57 ± 15.25° pre-stimulation vs. 57.10 ± 13.94° post-stimulation. In the stimulation group, anteflexion was unchanged (p=0.798), measuring 53.70 ± 14.01° pre-stimulation vs. 54.03 ± 15.03° post-stimulation.

For the lumbar vertebrae, there was no interaction effect (p=0.299) for pre/post-stimulation between the non-stimulation and stimulation groups. There was no difference (p=0.283) depending on type of stimulation between the non-stimulation group and the stimulation group, and no pre/post-stimulation difference (p=0.512).

(4) Changes to sacral/pelvic inclination angle in anteflexion

In the non-stimulation group, anteflexion was unchanged (p=0.209), measuring 60.33 ± 17.68° pre-stimulation vs. 61.43 ± 17.26° post-stimulation. In the stimulation group, anteflexion was unchanged (p=0.585), measuring 64.00 ± 16.31° pre-stimulation vs. 64.90 ± 17.57° post-stimulation.

For the sacrum and pelvis, there was no interaction effect (p=0.914) for pre/post-stimulation between the non-stimulation and stimulation groups. There was no difference (p=0.415) depending on type of stimulation between the non-stimulation group and the stimulation group, and no pre/post-stimulation difference (p=0.282).

2. Dorsiflexion ROM (Fig. 7)

(1) Changes to spinal inclination angle in dorsiflexion

In the non-stimulation group, spinal ROM decreased significantly (p=0.046), measuring -34.47 ± 8.66° pre-stimulation vs. -32.53 ± 9.87° post-stimulation. In the stimulation group, spinal ROM increased significantly (p=0.008), measuring -32.87 ± 8.60° pre-stimulation vs. -35.37 ± 9.73° post-stimulation.

For the spinal column, interaction effect was shown (p=0.001) for pre/post-stimulation between the non-stimulation and stimulation groups. There was no difference (p=0.789) depending on type of stimulation between the non-stimulation group and the stimulation group, and no pre/post stimulation difference (p=0.659).

(2) Changes to thoracic kyphotic angle in dorsiflexion

In the non-stimulation group, dorsiflexion was unchanged (p=0.844), measuring 3.63 ± 11.48° pre-stimulation vs. 3.97 ± 12.69° post-stimulation. In the stimulation group, dorsiflexion was unchanged (p=0.947), measuring 2.10 ± 13.50° pre-stimulation vs. 2.20 ± 15.23° post-stimulation.

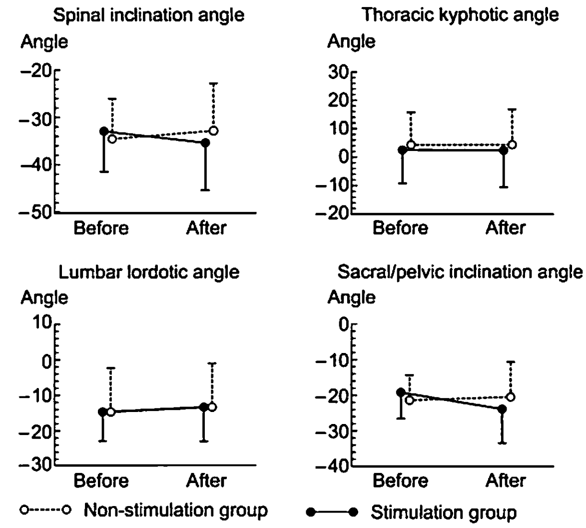

Fig. 7. Changes to dorsiflexion ROM as measured by spinal inclination angle, thoracic kyphotic angle, lumbar lordotic angle, and sacral/pelvic inclination angle, resulting from non-stimulation and shiatsu stimulation

For the thoracic vertebrae, there was no interaction effect (p=0.917) for pre/post-stimulation between the non-stimulation and stimulation groups. There was no difference (p=0.613) depending on type of stimulation between the non-stimulation group and the stimulation group, and no pre/post-stimulation difference (p=0.847).

(3) Changes to lumbar lordotic angle in dorsiflexion

In the non-stimulation group, dorsiflexion was unchanged (p=0.461), measuring -14.40 ± 6.99° pre-stimulation vs. -13.27 ± 12.11° post-stimulation. In the stimulation group, dorsiflexion was unchanged (p=0.292), measuring -14.67 ± 8.30° pre-stimulation vs. -13.17 ± 9.52° post-stimulation.

For the lumbar vertebrae, there was no interaction effect (p=0.859) for pre/post-stimulation between the non-stimulation and stimulation groups. There was no difference (p=0.974) depending on type of stimulation between the non-stimulation group and the stimulation group, and no pre/post-stimulation difference (p=0.207).

(4) Changes to sacral/pelvic inclination angle in dorsiflexion

In the non-stimulation group, dorsiflexion was unchanged (p=0.594), measuring -21.13 ± 6.99° pre-stimulation vs. -20.40 ± 9.62° post-stimulation. In the stimulation group, dorsiflexion increased (p=0.006), measuring -19.27 ± 7.66° pre-stimulation vs. -23.70 ± 11.55° post-stimulation.

For the sacral/pelvic angle, interaction effect was shown (p=0.014) for pre/post-stimulation between the non-stimulation and stimulation groups. There was no difference (p=0.737) depending on type of stimulation between the non-stimulation group and the stimulation group, and a trend toward pre/post stimulation difference (p=0.074).

IV. Discussion

The purpose of this study was to investigate changes to spinal range of motion due to shiatsu stimulation of the inguinal region. The results indicate that spinal range of motion in dorsiflexion showed a pre/post-stimulation difference (interaction effect) during stimulation: shiatsu stimulation resulted in an increase in spinal ROM, whereas no shiatsu stimulation resulted in a decrease in spinal ROM. In dorsiflexion, the pelvis (sacral inclination angle) also showed a pre/post-stimulation difference (interaction effect) during stimulation, with shiatsu stimulation resulting in increased pelvic ROM and no shiatsu stimulation resulting in no change to pelvic ROM.

Joints in the thoracic spine, lumbar spine, and pelvis are all involved in spinal ROM, and it has been shown that a flexible person can attain a maximum of 250° cumulative ROM in these joints between anteflexion and dorsiflexion[7].

Houki et al[11] analyzed the postures of 168 subjects between the ages of 19 and 65 using a Spinal Mouse®. In anteflexion, males achieved 89.9 ± 15.1° and females 85.3 ± 21.7°, and in dorsiflexion, males achieved -29.8 ± 11.3° and females -22.0 ± 11.1°.

Hakuta et al[12] analyzed the standing postures of 89 subjects between the ages of 18 and 28 using a Spinal Mouse®. In anteflexion, males achieved 97.1 ± 16.0° and females 96.1 ± 18.2°, and in dorsiflexion, males achieved -40.1 ± 12.8° and females -38.0 ± 9.0°.

In this study, pre-stimulation anteflexion figures were 113.97 ± 13.87° for the non-stimulation group and 113.83 ± 13.14° for the stimulation group, while pre-stimulation dorsiflexion figures were -34.47 ± 8.66° for the non-stimulation group and -32.87 ± 8.60° for the stimulation group. This indicates that spinal ROM was greater for subjects in this study than in previous studies by Houki et al and Hakuta et al. Spinal ROM in dorsiflexion was analogous to that seen in previous studies by Houki et al and Hakuta et al.

In the inguinal region, which was the area subject to shiatsu stimulation in this study, the psoas major originates on the lumbar transverse processes and the iliacus originates on the ilium, both inserting on the lesser trochanter of the femur. The action of the iliopsoas is to flex the hip joint (anteflexion), but it is likely that the relaxation of tonus in this pair of muscles can also affect dorsiflexion. From this, we surmise that shiatsu stimulation of the inguinal region caused increased pelvic ROM, which was accompanied by increased spinal dorsiflexion ROM.

We have previously reported that shiatsu stimulation of the lumbodorsal region, posterior lower limb, abdomen, and inguinal regions result in increased (improved) spinal ROM in anteflexion (FFD, or finger-floor distance)[5,6,8,9]. In this study involving shiatsu stimulation to the inguinal region, it was thought that not including shiatsu stimulation to the lumbodorsal region and posterior lower limb was a factor in the results obtained for ROM in anteflexion. It was also suggested that the relaxation of tonus in erector spinae and posterior lower limb muscles have an important effect on anteflexion ROM. One more factor to take into consideration was that spinal ROM in anteflexion was greater in this study (pre-stimulation) than ROM in anteflexion measured in previous studies.

V. Conclusions

In this study involving 30 healthy adults, the following results were obtained through measurement of anteflexion and dorsiflexion of the spine and its various segments using a Spinal Mouse®.

Shiatsu stimulation of the inguinal region caused increased pelvic ROM, which was accompanied by increased spinal dorsiflexion ROM.

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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Effect on Autonomic Nervous Function of Shiatsu Stimulation to the Anterior Cervical Region

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I. Introduction

The Japan Shiatsu College has previously reported in issues 22–31 of the Journal of the Japan College Association of Oriental Medicine 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 (gastrointestinal motility)[9-10].

Sato et al[9] and Kurosawa et al[10] reported that shiatsu stimulation to the lower leg and to the abdominal region promote gastrointestinal motility. Based on those results, in this study we will investigate what effect shiatsu stimulation to the anterior cervical region has on gastrointestinal motility and on the circulatory system.

II. Methods

1. Subjects

Research was conducted on 21 healthy adult students from this college, including 12 males and 9 females (average age: 38.8 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.

2. Test period

May 24 to August 20, 2008

3. Test location

Testing was conducted in the basic medicine research lab at the Japan Shiatsu College. Room temperature was 25.0 ± 2.0°C and humidity was 63.0 ± 12.0%.

4. Outcome measures

(1) Blood pressure

A continuous blood pressure manometer (Japan Colin Jentow-7700) was used to derive blood pressure from the right radial artery using tonometry.

(2) Heart rate

A pulse tachometer (Nihon Kohden Corp. model AT-601G) was used to calculate the momentary heart rate (hereafter, 'heart rate') as triggered by the ECG's R wave (the second deflection on the ECG).

(3) Dominant power (DP)

DP is an indicator of the size of electrical response activity (ERA) in gastric smooth muscle cells accompanying peristalsis. Raw data measured using the electrogastrograph (NIPRO) is subject to spectral analysis using MBFA and classified as slow-wave (0–2 cpm), normal-wave (2–4 cpm), and fast-wave (4–9 cpm), to express changes in the electric potentials of their respective frequency bands.

(4) Frequency

The frequency is the highest amplitude taken from the 0–9 cpm waveforms each minute.

The measurement electrodes for the electrogastrograph were applied to the following areas (Fig. 1).

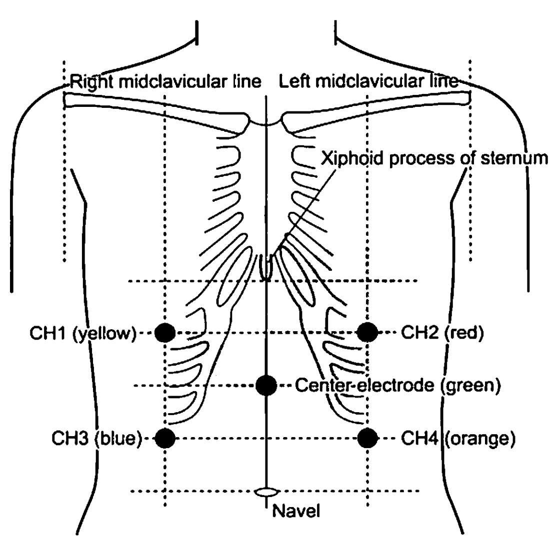

Fig. 1. Electrode positioning

CH1: at the intersection of a line running horizontally through the point midway between the xiphoid process of the sternum and the center electrode and the right midclavicular line

CH2: at the intersection of a line running horizontally through the point midway between the xiphoid process of the sternum and the center electrode and the left midclavicular line

CH3: at the intersection of a line running horizontally through the point midway between the center electrode and the navel and the right midclavicular line

CH4: at the intersection of a line running horizontally through the point midway between the center electrode and the navel and the left midclavicular line

Center electrode: midway between the xiphoid process of the sternum and the navel

5. Stimulation

With the therapist positioned behind the test subject's head, standard pressure was applied using the left thumb, 3 seconds per application for 5 minutes, to a single point on the medial border of the sternocleidomastoid muscle near the area over the carotid artery in the carotid triangle (Fig. 2).

Pressure was regulated so as to be pleasurable for the test subject (standard pressure).

6. Test procedure

The overall condition of the test subjects was determined by asking them to fill out a survey including questions on physical condition, meal times, and usual abdominal condition. After measurement was completed, test subjects completed a survey to determine their feelings on the experimental environment, amount of shiatsu pressure, and changes in abdominal condition due to treatment.

(1) Measurement procedure

Measurements were taken for the 35 minutes that elapsed while the following operations [1]–[3] were performed:

[1] 15 minutes rest (supine position)
[2] 5 minutes treatment
[3] 15 minutes rest (supine position)

(2) Test precautions

The following items were monitored and recorded during testing:

[1] that they remained alert
[2] that they remained motionless
[3] that the surroundings were quiet

(3) Other

Regarding test subjects' meals on the day of testing, no limitations on meal times were established.

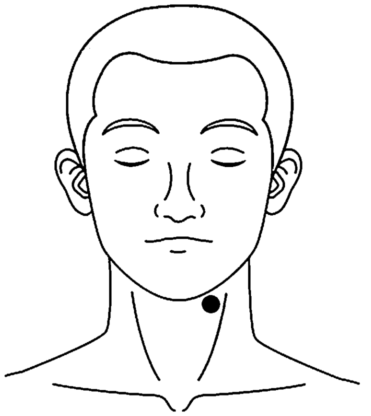

Fig. 2. Point 1, left anterior cervical region

7. Data analysis

(1) Chronological changes to blood pressure and heart rate

Taking the average value during 1 minute prior to stimulation as the control value (cont.), comparisons were made at 1 minute (St.1), 2 minutes (St.2), 3 minutes (St.3), 4 minutes (St.4), and 5 minutes (St.5) during stimulation, and for 1 minute (Af.1), 3 minutes (Af.3), 5 minutes (Af.5), 10 minutes (Af.10), and 15 minutes (Af.15), after stimulation.

(2) Chronological changes to DP and frequency

Taking the average value during 5 minutes prior to stimulation as the control value (cont.), comparisons were made with the average values during stimulation (St.0-5), immediately after stimulation (Af.0-5), 5 minutes after stimulation (Af.6-10), and 10 minutes after stimulation (Af.11-15).

8. Statistical processing

Chronological changes to blood pressure, heart rate, and electrogastrograph were analyzed using Bonferroni multiple comparison and one-way analysis of variance using a general linear model. Analytical software used was SPSS Ver.15, with a significance level of $\leq 5\%$ taken as significant.

III. Results

During testing there were no instances requiring cessation of treatment due to pain or discomfort.

1. Changes to blood pressure

(1) Maximum blood pressure

Maximum blood pressure decreased significantly ($p=0.003$) 2 minutes after commencement of stimulation (Fig. 3).

(2) Minimum blood pressure

Minimum blood pressure decreased significantly 1 minute ($p=0.022$) and 2 minutes ($p=0.017$) after commencement of stimulation, with a trend toward lower blood pressure ($p=0.06$) indicated during the 5 minutes of stimulation (Fig. 4).

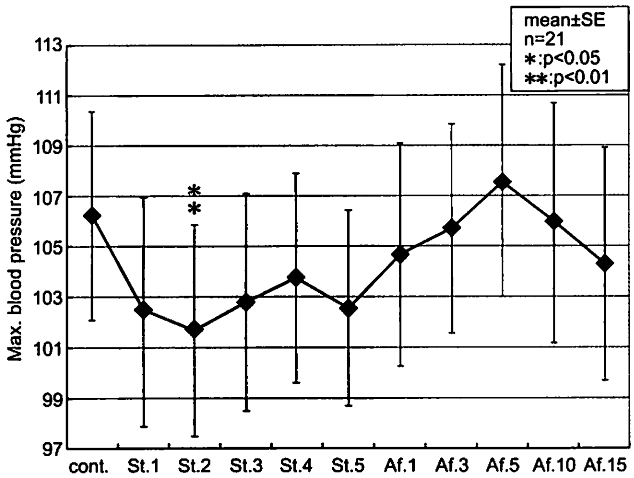

Fig. 3. Changes to maximum blood pressure

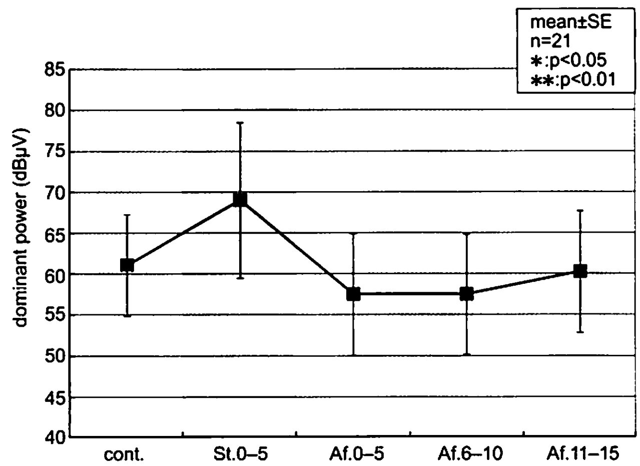

Fig. 6. Changes to DP

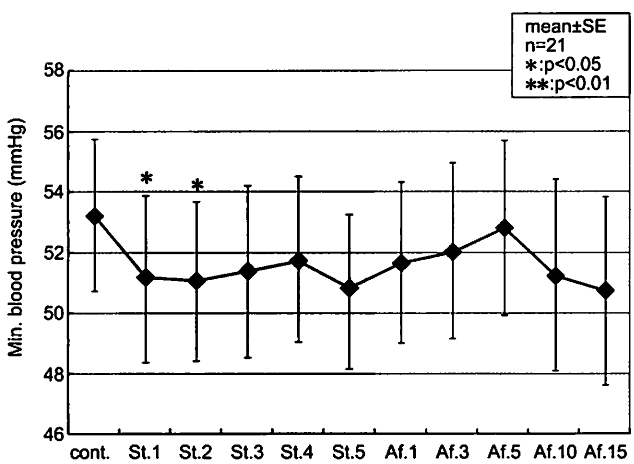

Fig. 4. Changes to minimum blood pressure

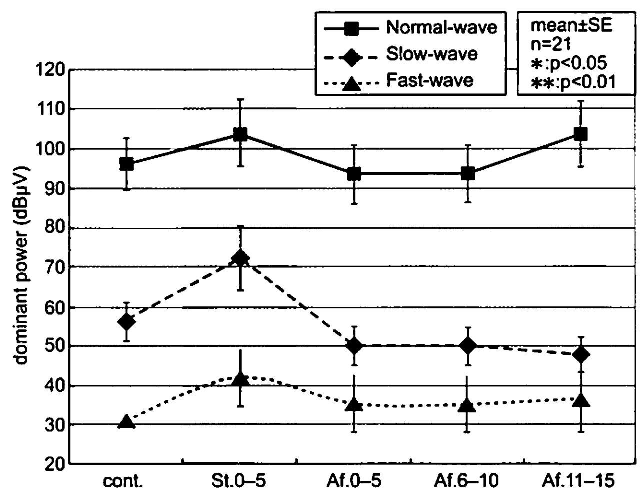

Fig. 7. Changes to DP for each frequency range

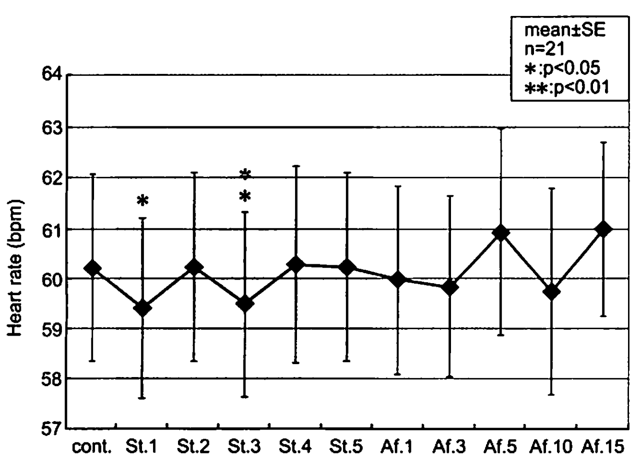

Fig. 5. Changes to heart rate

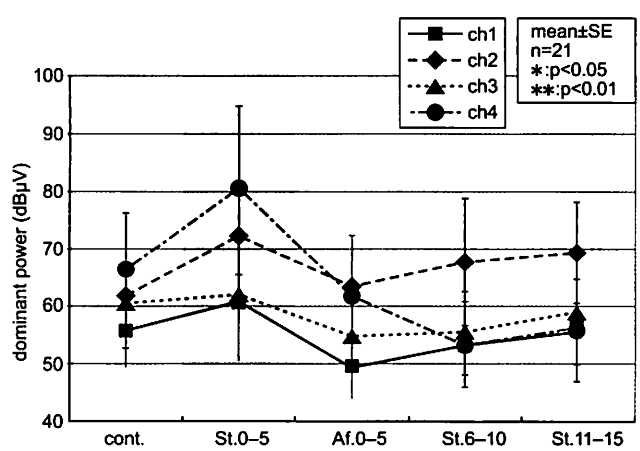

Fig. 8. Changes to DP for each channel

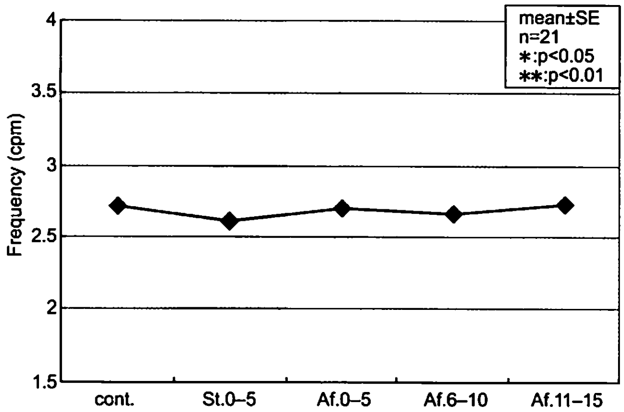

Fig. 9. Changes to frequency

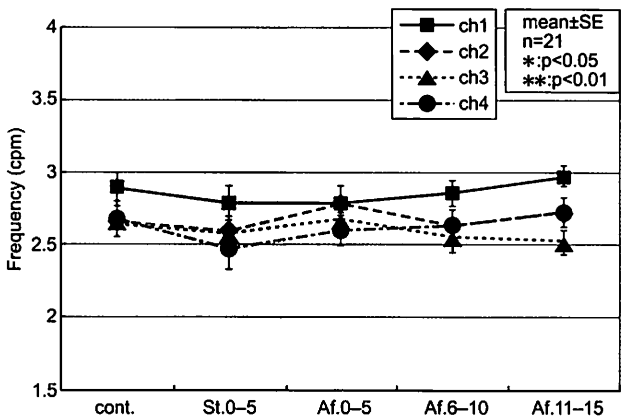

Fig. 10. Changes to frequency for each channel

2. Heart rate

Heart rate decreased significantly 1 minute (p=0.013) and 3 minutes (p=0.001) after commencement of stimulation, and showed a trend toward reduction (p=0.094) during 4 minutes of stimulation (Fig. 5).

3. Changes to DP

(1) DP

A significant chronological change to DP was not observed (Fig. 6).

(2) Changes to DP for each frequency range

A significant chronological change was not observed in any of the slow-wave, normal-wave, or fast-wave ranges.

There was no interaction between slow-wave, normal-wave, and fast-wave ranges on the electrogastrogram due to shiatsu stimulation (Fig. 7).

(3) Changes to DP for each channel

No significant chronological changes were observed in any of the channels (Fig. 8).

4. Changes to frequency

(1) Frequency

Frequency did not exhibit a significant, chronological change, varying within the normal frequency range (Fig. 9).

(2) Changes to frequency for each channel

No significant, chronological changes were observed for any of the channels (Fig. 10).

IV. Discussion

Significant reductions were observed in maximum blood pressure, minimum blood pressure, and heart rate due to shiatsu stimulation of the anterior cervical region. This may have been caused by a response to stimulation of the skin and muscles of the cervical region involving either suppression of sympathetic nervous function or excitation of parasympathetic nervous function regulating the heart, or involving suppression of sympathetic nervous function regulating vascular function. It may also have been caused by a depressor response involving a pressoreceptor reflex due to pressure applied to the carotid sinus. This result is the same as reported by Koyata et al[1] and Ide et al[2].

Sato et al[9] considered whether the rise in DP due to shiatsu stimulation of the lateral crural region occurred via a supraspinal reflex that excited activity in the vagus nerve, which regulates the stomach. Kurosawa et al[10] also reported a rise in DP due to shiatsu stimulation of the abdominal region. This may have been due to a viscero-visceral reflex mechanism via the visceral afferent nerves as a result of stimulation of the abdominal organs or the intramural plexus.

Both Koyata et al[1] and Ide et al[2] also reported decreases in blood pressure and heart rate due to shiatsu stimulation of the lower leg and the abdominal region.

In this study, shiatsu stimulation of the anterior cervical region resulted in decreases in blood pressure and heart rate, but an increase in DP was not confirmed, making it clear that the reaction to shiatsu stimulation with respect to DP differs between stimulation of the anterior cervical region and stimulation of the lower leg and abdominal regions.

Imai et al[11] suggested that the effect of acupuncture stimulation on the stomach, heart, and sweat glands in humans is based on autonomic regulatory mechanisms that are independent for each system. This may also be the case for the responses of the circulatory and digestive systems in this study.

Based on the above, it is clear that shiatsu stimulation of the anterior cervical region affects blood pressure and heart rate, but does not affect gastric motility.

V. Conclusions

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

1. Shiatsu stimulation of the anterior cervical region resulted in significant reduction of blood pressure

during stimulation.
2. Heart rate decreased significantly during stimulation.
3. A significant change in dominant power (DP) was not observed. Frequency also varied within normal range, with little effect.

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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Effect on Pelvic Angle of Shiatsu Stimulation to the Gluteal Region

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I. Introduction

The Japan Shiatsu College has previously conducted research into the effects of shiatsu stimulation on heart rate, peripheral circulation (pulse wave height, skin temperature, muscle blood volume), blood pressure, and spinal mobility. We reported responses including reduction in heart rate post-stimulation and reduced pulse wave height values in fingertip pulse wave during stimulation[1]; reduction in blood pressure during and after stimulation[2]; increase in heel pad skin temperature post-stimulation[3]; and increased skin temperature accompanied by decreased muscle blood volume and decreased skin temperature accompanied by increased muscle blood volume immediately post-stimulation[4]. Concerning spinal flexibility, finger-floor distance (FFD) improved due to shiatsu stimulation of the dorsal region[5], as did standing forward flexion due to shiatsu stimulation of the abdominal and inguinal regions[6]. We have shown that shiatsu stimulation acts on the circulatory system, affects standing forward flexion, and increases spinal range of motion by alleviating muscle tension[5-10].

Tazuke et al[6] reported that shiatsu stimulation to the gluteal region and posterior lower limb significantly improved spinal mobility, standing forward flexion, and sacral angle of inclination. In this study, we investigate whether spinal mobility is affected when the area of shiatsu stimulation is limited to the gluteal region alone. Furthermore, because a human being's center of gravity is located slightly anterior to the second sacral vertebra[11], it can be hypothesized that, when the incline of the sacrum is changed due to shiatsu stimulation, this also affects the line of gravity. We investigate this issue as well in this report.

II. Methods

1. Subjects

Research was conducted on 20 male students of the Japan Shiatsu College (average age: 35.55 ± 3.31 years old). Test procedures were fully explained to each test subject and their consent obtained.

2. Test period and location

Testing was conducted in the basic medicine research lab at the Japan Shiatsu College between May 16 and September 19, 2009. Room temperature was 25.0 ± 2.0˚C and humidity was 68 ± 12.0%.

3. Measurement procedures

Spinal mobility and spinal inclination angle in the standing position were measured using a Spinal Mouse® (Index Co., Ltd.). The line of gravity was measured using photographs taken using a digital camera (Canon IXY Digital 920 IS) (Figs. 1, 2).

(1) Measurement of spinal mobility (Spinal Mouse®)

The Spinal Mouse® enabled measurement of angle and range of motion of each intervertebral space on

Fig. 1. Measurement using Spinal Mouse®

Fig. 2. Spinal ROM measurement screen

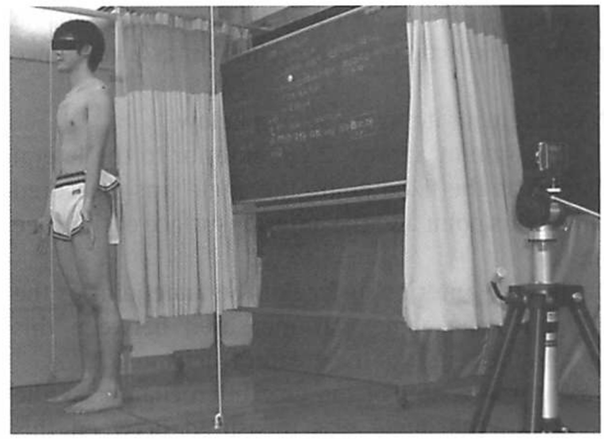

Fig. 4. Photography with digital camera

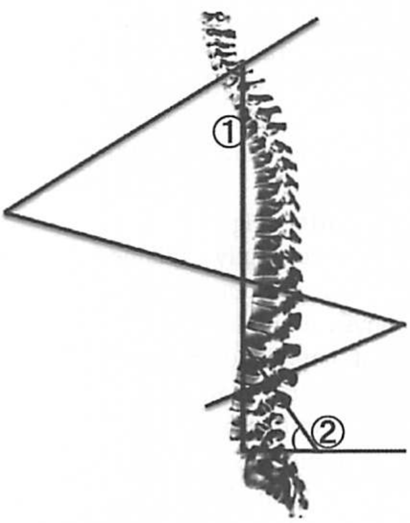

Fig. 3. Measurement items: ① Spinal inclination angle and ② Sacral/pelvic inclination angle

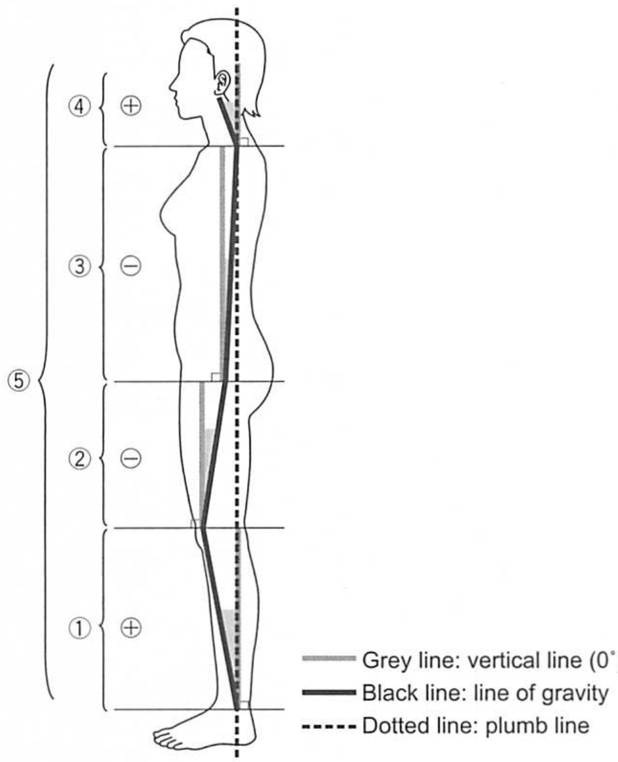

Fig. 5. Measurement items: line of gravity

both the sagittal and coronal planes from the body surface.

In this study, we assessed spinal ROM on the sagittal plane using spinal inclination angle and sacral/pelvic inclination angle measured in anteflexion and dorsiflexion (Fig. 3). Anteflexion ROM is the difference between measurement values in the neutral standing and maximum anteflexion positions, and dorsiflexion ROM is the difference between measurement values in the neutral standing and maximum dorsiflexion positions. For the line of gravity, we measured the spinal inclination angle in the neutral standing position.

Measurement items are shown below.

① Spinal inclination angle: Indicates the measure of overall ROM using a straight line between the 1st thoracic vertebra and the 1st sacral vertebra. Expressed as the angle between that line and a vertical line.

② Sacral/pelvic inclination angle: The sacral inclination angle is the angle which is measured, but because the sacrum is joined to the pelvis via the sacroiliac joints, it corresponds to the pelvic inclination angle.

(2) Measurement of line of gravity (photography using digital camera)

In order to measure the line of gravity, photographs were taken using a digital camera according to the following procedure (Figs. 4, 5). Landmark stickers were applied to the acromial process, the center of the greater trochanter, the anterior surface of the knee joint, and a point approx. 2 cm anterior to the lateral malleolus, which mark the passage of the line of gravity on the sagittal plane[12]. Two strings with weights attached (hereafter, plumb lines) were hung from the ceiling and subjects were photographed using a digital camera while standing between these lines with their limbs in the anatomical position. At this time, the plumb line was aligned using the lateral malleolus as the reference point. This is because we felt that, since other points not in contact with the floor were capable of motion, they could not be relied on as a reference point[13].

Measurement items are shown below.

① Taking a point approx. 2 cm anterior to the lateral malleolus as the fixed point, the angle was measured between this point and the anterior surface of the knee joint.

② Taking the anterior surface of the knee joint as the fixed point, the angle was measured between this point and the center of the greater trochanter.

③ Taking the center of the greater trochanter as the fixed point, the angle was measured between this point and the acromial process.

④ Taking the acromial process as the fixed point, the angle was measured between this point and the ear lobe.

⑤ The angle consisting of the sum of all angles from the lateral malleolus to the ear lobe (①, ②, ③, ④) was calculated (hereafter, malleolus-to-lobe angle). Each of these landmarks was connected with a line and the angles measured.

Measurements were taken using fixed points at a point approx. 2 cm anterior to the lateral malleolus, the anterior surface of the knee joint, the center of the greater trochanter, the acromial process, and the ear lobe. At each fixed point a vertical line and a horizontal line were drawn intersecting at right angles, with angles in which the body was anterior to the vertical line taken as positive and angles in which the body was posterior to the vertical line taken as negative. The vertical line, 90° to horizontal, was taken as 0°. For evaluation, the malleolus-to-lobe angle (⑤) was used.

4. Stimulation

(1) Area of stimulation (Fig. 6)

With the test subject in the prone position, stimulation was applied using thumb-on-thumb pressure to the 4 points of the gluteal region and the single Namikoshi Point, as per basic Namikoshi shiatsu.

4 points, gluteal region: 4 points located on a line along the gluteus maximus, extending from Point 1 on the lateral border of the posterior superior iliac spine to the greater trochanter.

Namikoshi Point: Targeting the gluteus medius, 1 point located approximately one quarter of the way along a line connecting the anterior superior iliac spine with the base of the sacrum[8].

(2) Duration and method of stimulation

Stimulation was applied to the 4 points of the gluteal region for 3 seconds per point, repeated for 3 minutes, then to the Namikoshi Point for 5 seconds per application, repeated for 2 minutes. This was repeated bilaterally for a total stimulation period of 10 minutes duration. Stimulation was applied using standard pressure (pressure gradually increased, sustained, and gradually decreased), and the amount of pressure used in stimulation was classified as standard (pressure regulated so as to be pleasurable for the test subject).

5. Test procedure (Fig. 7)

Test procedures were fully explained to each test subject and their consent obtained. They were also questioned on physical condition, regular exercise habits, and dominant hand and foot. Two tests were performed, one in which shiatsu stimulation was applied (hereafter, the stimulation group) and one in which shiatsu stimulation was not applied (hereafter, the non-stimulation group). Both tests were applied to all 20 test subjects on different days.

(1) Stimulation group

Test subjects rested with eyes closed for 10 minutes in the supine position. The Spinal Mouse® was used to measure spinal range of motion in anteflexion and dorsiflexion, along with spinal angle of inclination in the neutral standing position. Photographs were taken using a digital camera showing side views from both sides. After measurement, shiatsu stimulation was

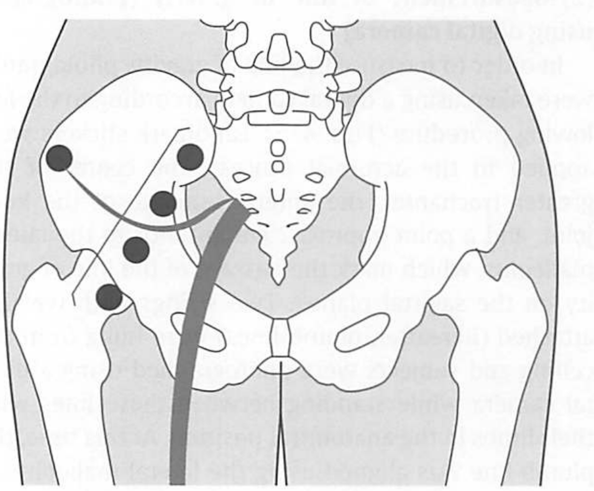

Fig. 6. Area of stimulation

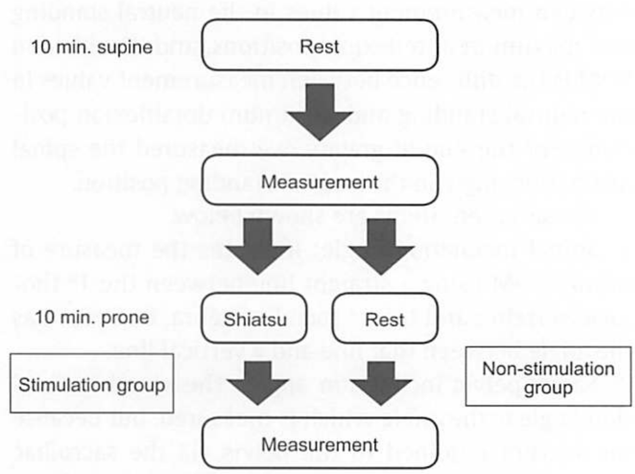

Fig. 7. Test procedure

applied for a total of 10 minutes in the prone position, consisting of 3 minutes to the left gluteal region, 2 minutes to the left Namikoshi Point, 3 minutes to the right gluteal region, and 2 minutes to the right Namikoshi Point. After stimulation, the same measurements were taken using the Spinal Mouse® and digital camera.

(2) Non-stimulation group

For the non-stimulation group, instead of shiatsu stimulation, test subjects rested for 10 minutes in the prone position. All other procedures were the same as for the stimulation group.

6. Statistical processing

Using SPSS Ver.15 software, pre/post-stimulation measurement values from the Spinal Mouse® and digital camera were analyzed using Fisher multiple comparison and two-way analysis of variance using a general linear model. Each pre/post-stimulation comparison was also compared using Fisher multiple comparison and one-way analysis of variance. A significance level of ≤5% was determined to be significant.

III. Results

1. Spinal ROM in anteflexion (Fig. 8)

(1) Changes to sacral/pelvic inclination angle in anteflexion

In the non-stimulation group, anteflexion was almost unchanged, measuring 57.32 ± 3.01° (mean ± SE) pre-stimulation vs. 57.16 ± 3.28° post-stimulation. In the stimulation group, there was a trend toward an increase, measuring 58.50 ± 3.72° pre-stimulation vs. 59.70 ± 4.30° post-stimulation, but a statistically significant variation was not observed.

(2) Changes to spinal inclination angle in anteflexion

In the non-stimulation group, anteflexion was almost unchanged, measuring 107.95 ± 3.48° pre-stimulation vs. 108.00 ± 3.31° post-stimulation. In the stimulation group, there was a trend toward a decrease, measuring 109.40 ± 3.38° pre-stimulation vs. 108.50 ± 3.23° post-stimulation, but a significant variation was not ascertained.

2. Spinal ROM in dorsiflexion (Fig. 9)

(1) Changes to sacral/pelvic inclination angle in dorsiflexion

In the non-stimulation group, dorsiflexion was almost unchanged, measuring 21.37 ± 2.83° pre-stimulation vs. 21.95 ± 2.94° post-stimulation. In the stimulation group, dorsiflexion was almost unchanged, measuring 22.10 ± 2.28° pre-stimulation vs. 22.10 ± 2.37° post-stimulation.

(2) Changes to spinal inclination angle in dorsiflexion

In the non-stimulation group, there was a trend toward a decrease, measuring 39.21 ± 2.69° pre-stimulation vs. 38.05 ± 3.04° post-stimulation, but a significant

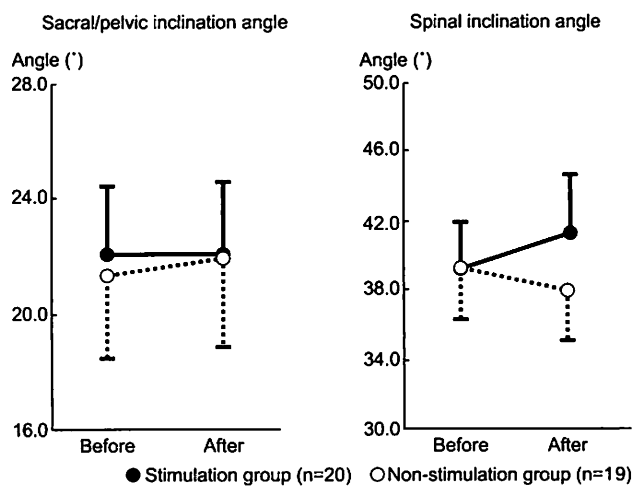

Fig. 9. Dorsiflexion ROM sacral/pelvic inclination angle and spinal inclination angle for non-stimulation and shiatsu stimulation groups

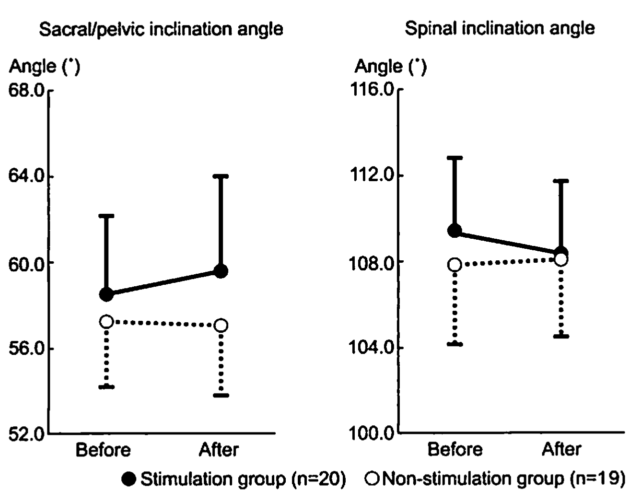

Fig. 8. Anteflexion ROM sacral/pelvic inclination angle and spinal inclination angle for non-stimulation and shiatsu stimulation groups

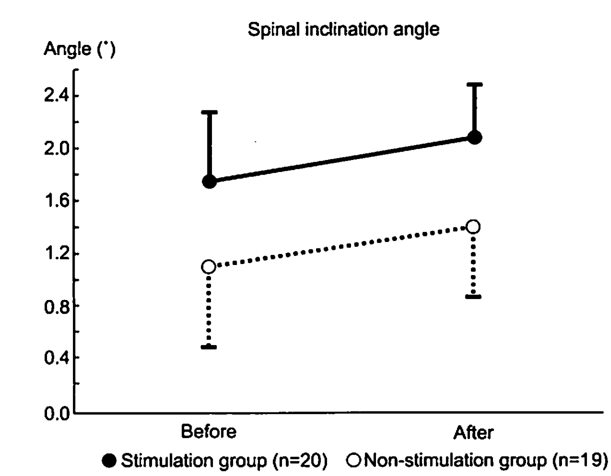

Fig. 10. Neutral standing spinal inclination angle for non-stimulation and shiatsu stimulation groups

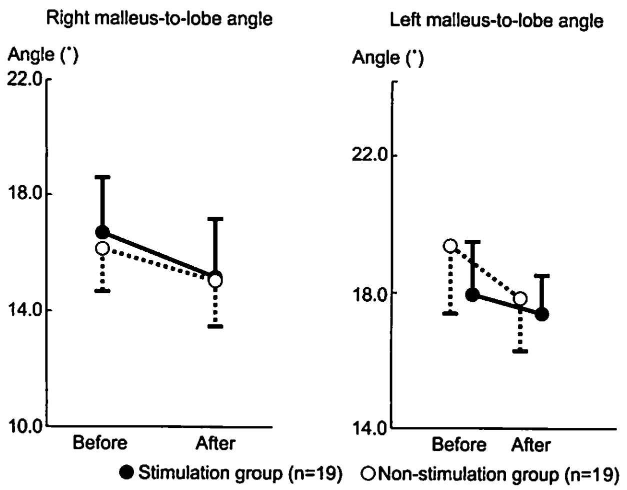

Fig. 11. Neutral standing left and right lateral lines of gravity for non-stimulation and shiatsu stimulation groups

variation was not ascertained. In the stimulation group, there was a trend toward an increase, measuring 39.10 ± 2.78˚ pre-stimulation vs. 41.35 ± 3.17˚ post-stimulation, but a significant variation was not ascertained.

3. Line of gravity

(1) Changes to spinal inclination angle in neutral standing position (Fig. 10)

In the non-stimulation group, there was a trend toward an increase, measuring 1.11 ± 0.58˚ pre-stimulation vs. 1.42 ± 0.50˚ post-stimulation, but a significant variation was not ascertained. In the stimulation group, there was a trend toward an increase, measuring 1.75 ± 0.49˚ pre-stimulation vs. 2.10 ± 0.36˚ post-stimulation, but a significant variation was not ascertained.

(2) Changes to right malleus-to-lobe angle (Fig. 11)

In the non-stimulation group in the neutral standing position, there was a trend toward a decrease, measuring 16.16 ± 1.34˚ pre-stimulation vs. 15.11 ± 1.64˚ post-stimulation, but a significant variation was not ascertained. In the stimulation group, there was a trend toward a decrease, measuring 16.74 ± 1.86˚ pre-stimulation vs. 15.32 ± 1.86˚ post-stimulation, but a significant variation was not ascertained.

(3) Changes to left malleolus-to-lobe angle (Fig. 11)

In the non-stimulation group in the neutral standing position, there was a trend toward a decrease, measuring 19.21 ± 1.89˚ pre-stimulation vs. 17.63 ± 1.44˚ post-stimulation, but a significant variation was not ascertained. In the stimulation group, there was almost no change, measuring 17.72 ± 1.54˚ pre-stimulation vs. 17.28 ± 1.08˚ post-stimulation.

IV. Discussion

At the Japan Shiatsu College, we are conducting ongoing research into the effects of shiatsu stimulation on spinal mobility, reporting on which regions of the body produce improved mobility in response to shiatsu stimulation and which have no effect. Tazuke et al[6] reported that shiatsu stimulation of the gluteal region and posterior lower limb resulted in significant improvement of spinal mobility, standing forward flexion, and sacral inclination angle, while Eto et al[5] reported that improved spinal mobility was not observed with shiatsu stimulation of the interscapular and subscapular regions.

In this study, shiatsu stimulation of the gluteal region did not result in significant change, either in the stimulation group or the non-stimulation group, to any of the measurement items, including ROM in anteflexion, ROM in dorsiflexion, and spinal inclination angle and bilateral line of gravity in the neutral standing position.

Whereas the gluteus maximus—the muscle stimulated during shiatsu stimulation of the gluteal region—is employed in large motions such as climbing stairs, the hamstrings work to support the hip joints when the trunk is leaning forward in activities such as washing one's face over a sink, so it is thought that the hamstrings are under tension more frequently in everyday use[9]. Therefore, the hamstrings should be more actively involved as a factor influencing spinal mobility. This may be the reason why shiatsu stimulation to the gluteal region had no effect on spinal mobility.

The fact that shiatsu stimulation to the posterior lower limb effects changes in spinal mobility[6] suggests that, not only the hamstrings, but also the triceps surae may be involved. Further research is required to determine the relationships of the hamstrings and triceps surae to spinal mobility.

Concerning the line of gravity, ideally a person's balance in the neutral standing position is maintained by tension in tendons and the triceps surae, but in reality, maintaining balance in response to gravity and other external forces requires the interaction of the anti-gravity muscles (erector spinae, gluteals, biceps femoris, semimembranosus, semitendinosus, etc.) and a variety of other muscles[12], and this may be why an effect was not observed with stimulation of the gluteal muscles alone. Future study of the effect of shiatsu stimulation on the line of gravity must be multifaceted, involving stimulation of not just individual muscles, but antagonists (extensor groups and flexor groups), with changes observed not only over the whole body, but in specific areas, including the anterior surface of the knee joint, center of the greater trochanter, acromial process, and ear lobe.

By clarifying that shiatsu stimulation of the gluteal region has no effect on spinal mobility, the results of this study suggest that shiatsu stimulation to the posterior lower limb plays an important role in affecting spinal mobility.

V. Conclusions

Shiatsu stimulation to the gluteal region performed on 20 healthy, adult male test subjects yielded the following results:

1. No significant change was observed to sacral/pelvic inclination angle or spinal inclination angle in anteflexion or dorsiflexion.
2. No significant change was observed in spinal inclination angle or bilateral line of gravity in the neutral standing position.

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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Effect on Pupil Diameter of Shiatsu Stimulation to the Abdominal Region

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I. Introduction

The Japan Shiatsu College has previously conducted research into the effects of shiatsu stimulation on various physiological functions, reporting in issues 22–24 of the Journal of the Japan College Association of Oriental Medicine on the effect of shiatsu stimulation to the abdominal region in reducing heart rate[1] and blood pressure[2] and increasing peripheral muscle blood volume[3], and in issue 31on its stimulation of gastrointestinal motility[4].

It has been reported that the effect of somatosensory stimulation on organ effectors differs with respect to mechanism and response depending on the organ or body involved[5]. Therefore it is necessary to investigate the response to shiatsu stimulation for each organ effector.

In this report, we study a function not researched in previous reports, using an electronic pupillometer to measure pupillary reaction as a means of evaluating autonomic nervous function.

II. Methods

1. Subjects

Research was conducted on 29 healthy adult students of the Japan Shiatsu College (17 male, 12 female), with an average age of 39.8 ± 13.1 years old. Test procedures were fully explained to each test subject and their prior consent obtained.

2. Test period and location

Testing was conducted in the basic medicine research lab at the Japan Shiatsu College between April 17 and July 24, 2010. Room temperature was 25.0 ± 2.0°C and humidity was 65 ± 12.0%. Illumination was 100 lux.

3. Measurement procedures

Pupil diameter was measured using a binocular electronic pupillometer (Newopto Corp. ET-200) (Fig. 1).

4. Stimulation

(1) Area of stimulation (Fig. 2)

With the test subject in the supine position, stimulation was applied using two-thumb pressure to the 20 points of the abdominal region, as per basic Namikoshi shiatsu.

(2) Duration and method of stimulation

Pressure was applied to the 20 points of the abdominal region, 3 seconds per point, repeated for 3 minutes

Fig. 1. Binocular electronic pupillometer

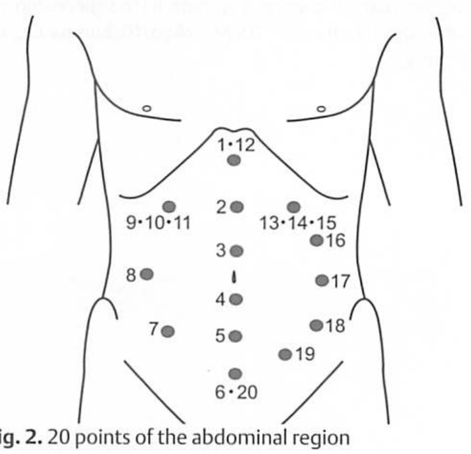

Fig. 2. 20 points of the abdominal region

Fig. 3. Measurement using pupillometer

duration. Stimulation was applied using standard pressure (pressure gradually increased, sustained, and gradually decreased), and the amount of pressure used in stimulation was classified as standard (pressure regulated so as to be pleasurable for the test subject).

5. Test procedure

Test procedures were fully explained to each test subject and their prior consent obtained. They were also questioned on physical condition and history of eye disease. Two tests were performed, one in which shiatsu stimulation was applied (hereafter, the stimulation group) and one in which no shiatsu stimulation was applied (hereafter, the non-stimulation group). Both interventions were carried out on all 29 test subjects on different days.

For measurement using the electronic pupillometer, test subjects laid in the supine position, fixing their gaze during testing on a 1.5 cm diameter mark affixed to the ceiling 250 cm above the floor (Fig. 3).

(1) Stimulation group

In the supine position, test subjects rested for 3 minutes with their eyes open, then received 3 minutes of shiatsu stimulation to the abdominal region. They rested for another 3 minutes post-stimulation. Pupil diameter was measured for 9 minutes in total. (Fig. 4)

(2) Non-stimulation group

For the non-stimulation group, test subjects rested in the supine position instead of receiving shiatsu. All other procedures were the same as for the stimulation group.

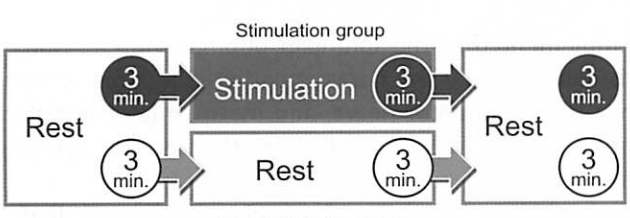

Fig. 4. Test procedure

6. Data analysis

Of the 3 minutes of pre-stimulation rest, 3 minutes stimulation, and 3 minutes post-stimulation, the measurement taken 60 seconds prior to stimulation (Bf.) was established as the control value, with average values during stimulation (St.) and post-stimulation (Af.) calculated at 30 second intervals.

7. Statistical processing

In analysis of inter-group pre/post-stimulation data between the non-stimulation and stimulation groups, pupil diameter measurement values were analyzed using Bonferroni multiple comparison using a general linear model. Chronological inter-group differences between the non-stimulation and stimulation groups were analyzed using Bonferroni multiple comparison and two-way analysis of variance. A significance level of <5% was determined to be significant.

III. Results

On the right side, an interaction effect was displayed between chronological changes to pupil diameter (p=0.044) (Fig. 5).

In the stimulation group, a gradual trend to contraction was displayed during the 3 minutes rest in the supine position pre-stimulation, with dilation occurring immediately at commencement of stimulation, dilating to (St.0) 5.376 ± 0.205 (mean ± SE) from the control value of 5.226 ± 0.222, followed by a gradual trend to contraction during stimulation, contracting to 4.874 ± 0.227 at St.150. Immediately post-stimulation (Af.0), dilation once again occurred to 4.997 ± 0.208, but then a gradual trend to contraction was displayed, with a diameter at 60 seconds post-stimulation (Af.60) of 4.750 ± 0.213 and maximum contraction of 4.710 ± 0.215 occurring at 90 seconds post shiatsu stimulation (Af.90). Contraction continued until 150 seconds post-stimulation (Af.150).

A significant difference in contraction of the stimulation group's right-side pupil diameter was confirmed using multiple comparisons in which pre-stimulation values were compared to 60 seconds post-stimulation (Af.60) (p=0.038) and 90 seconds post-stimulation (Af.90) (p=0.009).

In the non-stimulation group, a gradual trend to contraction was displayed starting 60 seconds pre-stimulation (Bf.), when diameter was 5.138 ± 0.203, with maximum contraction of 4.812 ± 0.186 occurring immediately post-stimulation (Af.0). Multiple comparisons with pre-stimulation values indicated no significant change in right-side pupil diameter for the

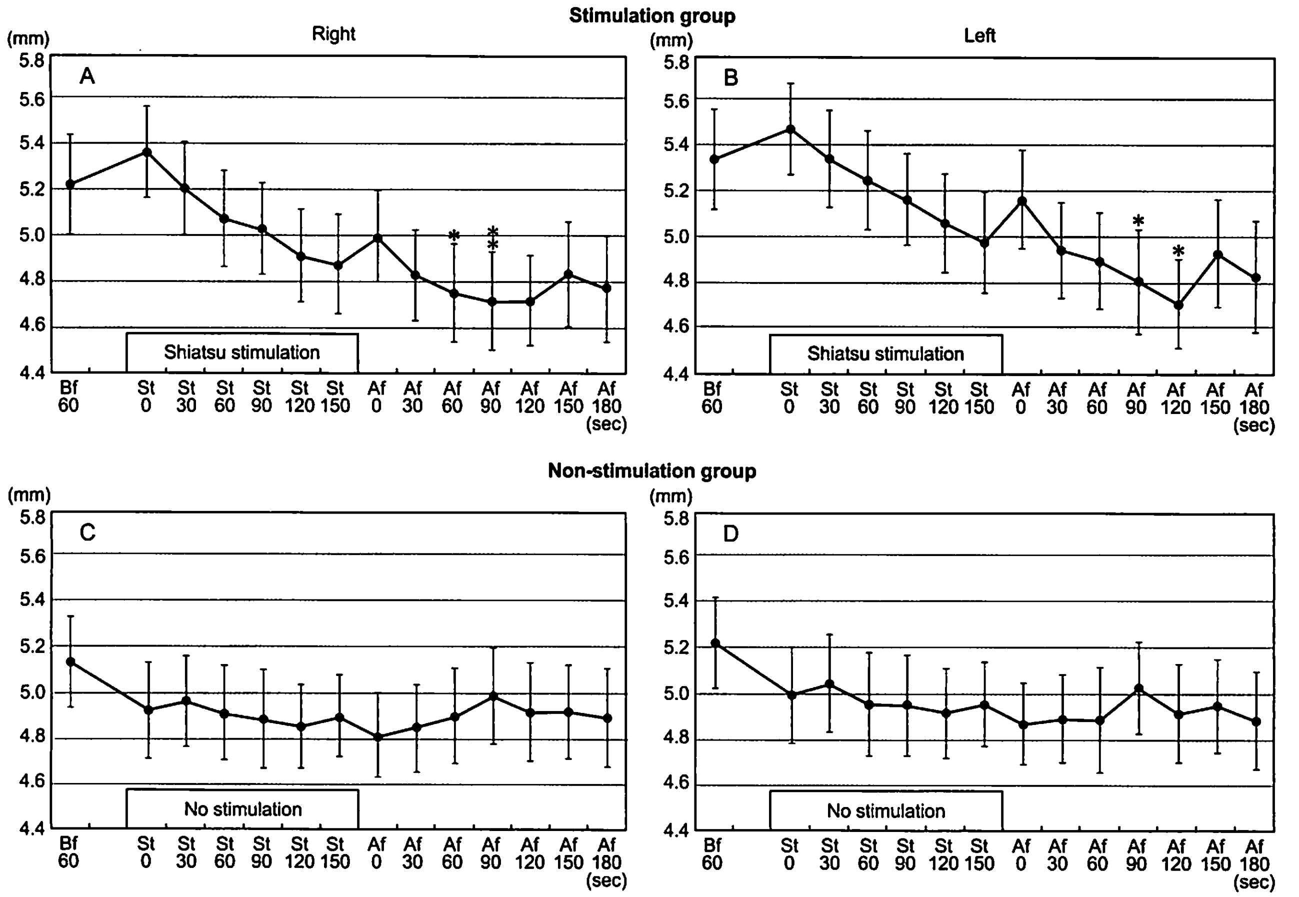

Fig. 5. Changes to pupil diameter due to shiatsu stimulation of the abdominal region
A: right pupil (stimulation group); B: left pupil (stimulation group); C: right pupil (non-stimulation group); D: left pupil (non-stimulation group). On each graph, the vertical axis represents pupil diameter (mm) and the horizontal axis represents elapsed time (sec), with mean ± SE displayed. Bf: pre-stimulation (control); St: during stimulation; Af: post-stimulation; *: $p<0.05$; **: $p<0.01$

non-stimulation group.

On the left side, no interaction effect was displayed in chronological changes to pupil diameter (p=0.064) (Fig. 5).

In the stimulation group, a gradual trend to contraction was displayed during the 3 minutes rest in the supine position pre-stimulation, with dilation occurring immediately at commencement of stimulation, dilating to (St.0) 5.488 ± 0.205 (mean ± SE) from the 60-second pre-stimulation value (Bf.) of 5.352 ± 0.225, followed by a gradual trend to contraction during stimulation, contracting to 4.981 ± 0.224 at 150 seconds after commencement of stimulation (St.150). Immediately post-stimulation (Af.0), dilation once again occurred to 5.178 ± 0.210, but then a gradual trend to contraction was displayed, with a diameter at 90 seconds post-stimulation (Af.90) of 4.812 ± 0.229 and maximum contraction of 4.717 ± 0.201 occurring at 120 seconds post shiatsu stimulation (Af.120). Contraction continued until 150 seconds post-stimulation (Af.150).

A significant difference in contraction of the stimulation group's left-side pupil diameter was confirmed using multiple comparisons in which pre-stimulation values were compared to 90 seconds post-stimulation (Af.90) (p=0.029) and 120 seconds post-stimulation (Af.120) (p=0.021).

In the non-stimulation group, a gradual trend to contraction was displayed starting 60 seconds pre-stimulation (Bf.) when diameter was 5.233 ± 0.203, with maximum contraction of 4.870 ± 0.185 occurring immediately post-stimulation (Af.0). Multiple comparisons with pre-stimulation values indicated no significant change in left-side pupil diameter for the non-stimulation group.

IV. Discussion

It is recognized that regulation of pupil diameter is implemented by the sphincter pupillae muscle, which is controlled by the parasympathetic nervous system via the oculomotor nerve, and by the dilator pupillae muscle, which is controlled by the cervical sympathetic nerves.

In this study, no significant change in pupil diameter was ascertained in the non-stimulation group, whereas in the group that received shiatsu stimulation of the abdominal region, significant contraction of pupil diameter occurred.

Possible explanations of the autonomic mechanism for this response are: [1] activity was accentuated in the parasympathetic branch of the oculomotor nerve that controls the sphincter pupillae, causing the sphincter pupillae to contract; [2] activity was suppressed in the cervical sympathetic nerves that control the dilator pupillae, causing the dilator pupillae to relax; or [3] both [1] and [2] above were influential.

We have previously reported that heart rate is reduced due to shiatsu stimulation, and that this is probably due to an autonomic nervous system response involving either accentuation of heart parasympathetic nervous activity, suppression of heart sympathetic nervous activity, or a combination of the two[1]. In this study, pupillary reaction exhibited the same tendency.

It has been reported that generally in humans and animals pupil dilation occurs in response to pain stimulation[6]. We may assume that a dilation response did not occur in this study because subjects received standard shiatsu stimulation unaccompanied by pain.

It has been reported that, in anesthetized rats, a dilation response occurs in response to manual pressure stimulation[7] and electro-acupuncture stimulation[8] under light-adapted conditions. On the other hand, it has been reported that in healthy human subjects a contraction response occurs in response to acupuncture stimulation in dark-adapted conditions[9-11]. In addition to differences in test conditions such as presence or absence of anesthesia and species differences between humans and rats, differences in pupillary reaction due to non-nociceptive somatosensory stimulation such as acupuncture and manual pressure stimulation may arise depending on illumination volume.

V. Conclusions

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

1. Shiatsu stimulation of the abdominal region resulted in significant contraction of pupil diameter.
2. A difference was observed compared to the non-stimulation group.

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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Effect on Pupil Diameter of Shiatsu Stimulation to the Anterior Cervical and Lateral Crural Regions

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I. Introduction

The Japan Shiatsu College has previously reported in issues 22–34 of the Journal of the Japan College Association of Oriental Medicine on the effect of shiatsu stimulation on the circulatory system[1–4] (reduction in heart rate and blood pressure, increase in peripheral muscle blood volume, and increased skin temperature) and the alimentary system[4–6] (stimulation of gastrointestinal motility).

Last year[7], we began investigating the effect of shiatsu stimulation on pupil diameter using an electronic pupillometer, initially investigating the effect of shiatsu stimulation to the abdominal region. From this study, it was evident that pupil diameter contracted significantly as a result of shiatsu stimulation to the abdominal region. Building on those results, this year we will study the effect on pupil diameter of shiatsu stimulation to the anterior cervical and lateral crural regions, in order to investigate the different effect of shiatsu stimulation on pupil diameter depending on the area treated.

II. Methods

1. Subjects

Research was conducted on 21 students and instructors at the Japan Shiatsu College, 14 male and 7 female (19–48 years old; average age: 33.1 ± 9.6 years old). Test procedures were fully explained to each test subject and their prior consent obtained.

2. Test period and location

Testing was conducted in the basic medicine research lab at the Japan Shiatsu College between April 23 and July 9, 2011. Room temperature was 22 ± 2.0°C and humidity was 79 ± 15.0%. Illumination was 100 lux.

3. Measurement procedures

Changes in pupil diameter were measured using a binocular electronic pupillometer (Newopto Corp. ET-200, Fig. 1), with the test subject in the supine position.

4. Stimulation

(1) Areas of stimulation (Figs. 2, 3)

With the test subject in the supine position, stimulation was applied using thumb-on-thumb pressure to the 6 points of the lateral crural region and one-handed thumb pressure to the 4 points of the anterior

Fig. 1. Binocular electronic pupillometer

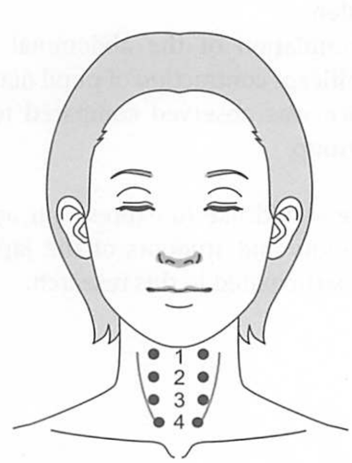

Fig. 2. 4 points of the anterior cervical region

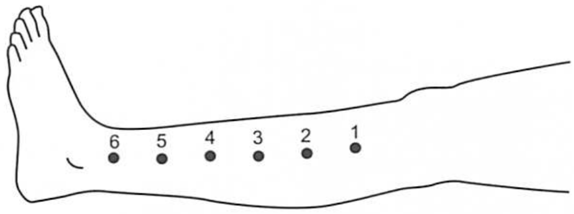

Fig. 3. 6 points of the lateral crural region

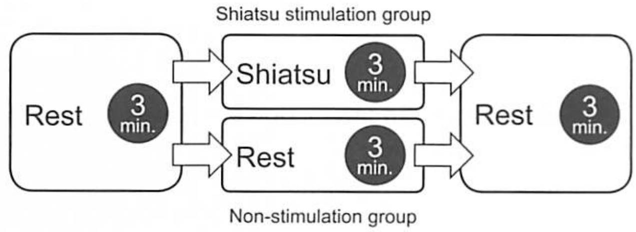

Fig. 5. Test procedure

cervical region, as per basic Namikoshi shiatsu.

(2) Method of stimulation

Stimulation consisted of pressure applications of 3 seconds per point, repeated for 3 minutes duration. Stimulation was applied using standard pressure (pressure gradually increased, sustained, and gradually decreased), regulated so as to be pleasurable for the test subject.

5. Test procedure (Figs. 4, 5)

Test procedures were fully explained to each test subject and their prior consent obtained. They were also questioned on physical condition and history of eye disease. Three tests were performed, one in which shiatsu stimulation was applied to the anterior cervical region (hereafter, the anterior cervical region stimulation group), one in which shiatsu stimulation was applied to the lateral crural region (hereafter, the lateral crural region stimulation group), and one in which shiatsu stimulation was not applied (hereafter, the non-stimulation group). The three interventions were carried out on all 21 test subjects on different days. For measurement using the electronic pupillometer, test subjects laid in the supine position, fixing their gaze during testing on a 1.5 cm diameter mark affixed to the ceiling 250 cm above the floor.

(1) Anterior cervical region stimulation group

In the supine position, test subjects rested for 3 minutes with their eyes open, then received 3 minutes of shiatsu stimulation to the anterior cervical region. They then rested for another 3 minutes post-stimulation. Pupil diameter was measured for 9 minutes in total.

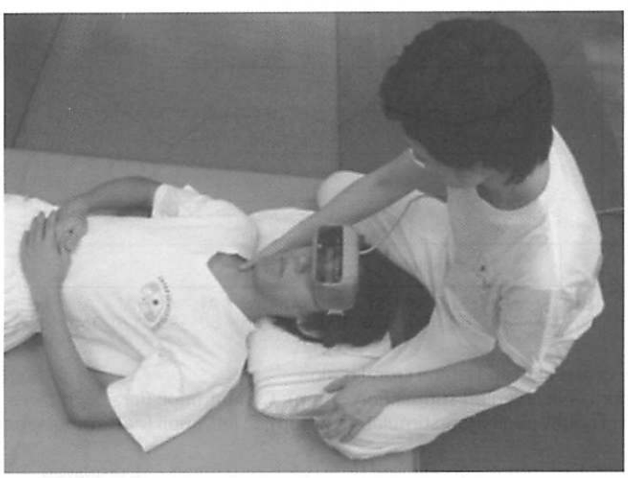

Fig. 4. Measurement using pupillometer

(2) Lateral crural region stimulation group

Procedure was the same as that for the anterior cervical region stimulation group, with stimulation carried out on the lateral crural region.

(3) Non-stimulation group

The non-stimulation group rested in the supine position for 9 minutes.

6. Data analysis

Taking pupil diameter 60 seconds prior to stimulation (Bf.60) as the control, data was analyzed for 5 seconds at 30-second intervals during stimulation (St.) and between 30 seconds (Af.) and 180 seconds post-stimulation (Af.).

7. Statistical processing

Pupil diameter measurement values were analyzed using Bonferroni multiple comparison and mixed model analysis of variance. A significance level of <5% was determined to be significant.

III. Results

On the right side, an interaction effect was displayed between chronological changes to pupil diameter ($p=0.05$).

Of the three groups, pupil diameter was larger in the non-stimulation group, both compared to the anterior cervical region stimulation group ($p=0.00$) and the lateral crural region stimulation group ($p=0.00$).

Compared to the control (Bf.60), pupil contraction occurred at 150 seconds after commencement of stimulation (St.150) ($p=0.037$), 90 seconds post-stimulation (Af.90) ($p=0.001$), and 120 seconds post-stimulation (Af.120) ($p=0.042$).

With stimulation of the anterior cervical region, compared to the control (Bf.60) significant pupil contraction occurred at 30 seconds (Af.30) ($p=0.002$), 60 seconds (Af.60) ($p=0.004$), 90 seconds (Af.90) ($p=0.00$), 120 seconds (Af.120) ($p=0.001$), 150 seconds (Af.150) ($p=0.00$), and 180 seconds (Af.180) post-stimulation.

With stimulation of the lateral crural region, there was no change compared to the control (Bf.60).

With no stimulation, there was no change compared to the control (Bf.60).

On the left side, an interaction effect was displayed between chronological changes to pupil diameter (p=0.033).

Of the three groups, pupil diameter was larger in the non-stimulation group, both compared to the anterior cervical region stimulation group (p=0.00) and the lateral crural region stimulation group (p=0.00).

Compared to the control (Bf.60), pupil contraction occurred at 150 seconds after commencement of

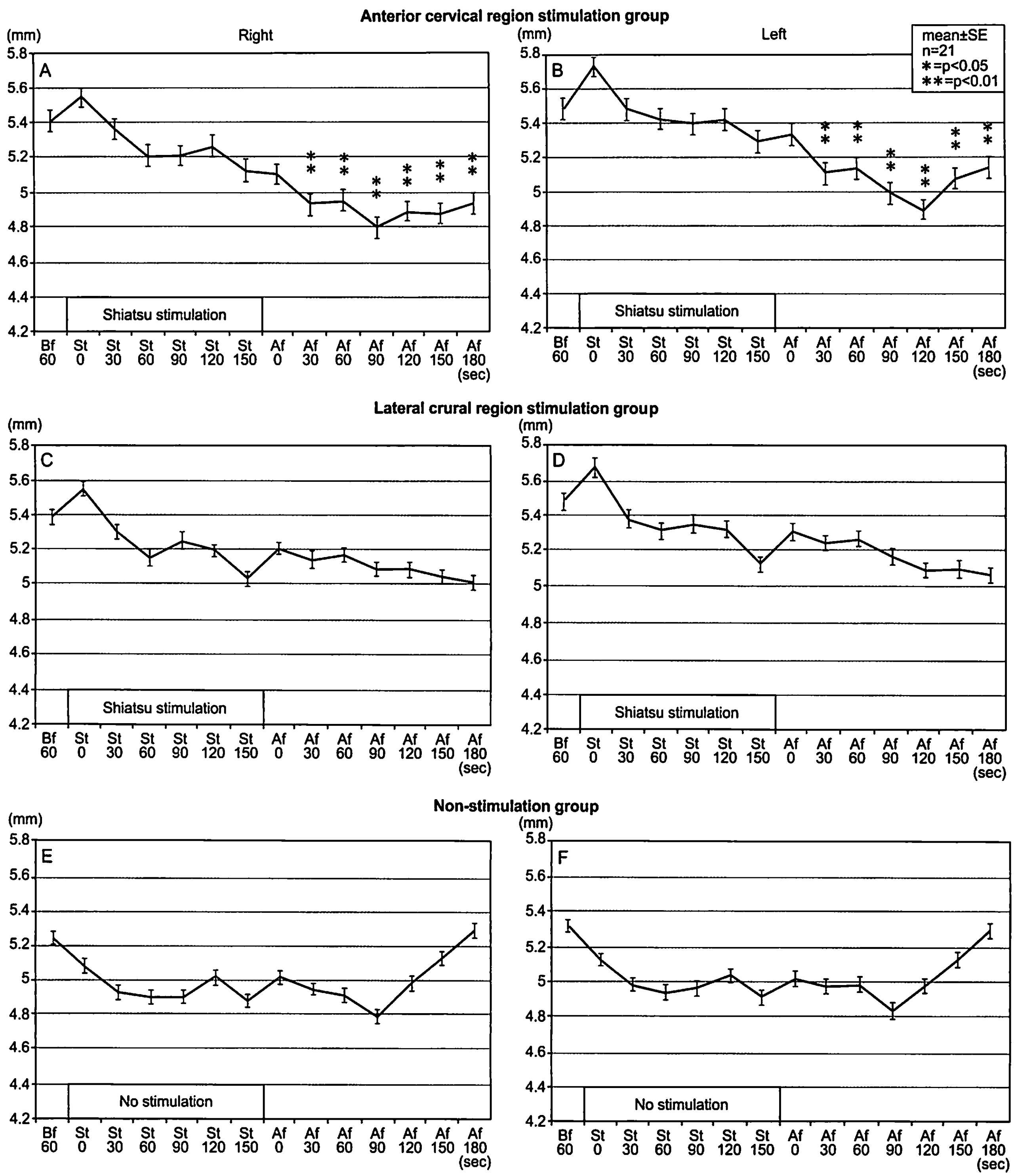

Fig. 6. Changes to pupil diameter due to shiatsu stimulation of the anterior cervical region and lateral crural region
A: right pupil (anterior cervical region stimulation group); B: left pupil (anterior cervical region stimulation group); C: right pupil (lateral crural region stimulation group); D: left pupil (lateral crural region stimulation group) ; E: right pupil (non-stimulation group); F: left pupil (non-stimulation group).
On each graph, the vertical axis represents pupil diameter (mm) and the horizontal axis represents elapsed time (sec), with mean ± SE displayed.
Bf: pre-stimulation (control); St: during stimulation; Af: post-stimulation; *: p<0.05; **: p<0.01

stimulation (St.150) (p=0.048), 90 seconds post-stimulation (Af.90) (p=0.001), and 120 seconds post-stimulation (Af.120) (p=0.001).

With stimulation of the anterior cervical region, compared to the control (Bf.60) significant pupil contraction occurred at 30 seconds (Af.30) (p=0.004), 60 seconds (Af.60) (p=0.012), 90 seconds (Af.90) (p=0.00), 120 seconds (Af.120) (p=0.00), 150 seconds (Af.150) (p=0.001), and 180 seconds (Af.180) (p=0.012) post-stimulation.

With stimulation of the lateral crural region, no significant reaction in pupil diameter was ascertained.

With no stimulation, no significant difference was ascertained.

IV. Discussion

In this study, no significant change in pupil diameter was ascertained in the non-stimulation group or the group receiving shiatsu stimulation to the lateral crural region, but significant contraction of pupil diameter did occur in the group receiving shiatsu stimulation to the anterior cervical region.

It has been reported that pupil dilation occurs in response to pain stimulation[8], however we may assume that a dilation response did not occur in this study because subjects received standard shiatsu stimulation unaccompanied by pain.

Pupil diameter is regulated by the dilator pupillae muscle, which is controlled by the sympathetic nervous system (cervical sympathetic nerves), and by the sphincter pupillae muscle, which is controlled by the parasympathetic nervous system (oculomotor nerve). The pupil contraction response due to shiatsu stimulation observed in this study may have occurred as a result of either excitation of the parasympathetic nervous system, which controls the sphincter pupillae, suppression of sympathetic nervous system, which controls the dilator pupillae, or a combination of the two.

It has been indicated in the past that the sympathetic nervous system is involved in pupillary responses involving the higher brain centers[9, 10], but Ohsawa et al[11] and Shimura et al[12] showed that reflexive pupil dilation occurs in anesthetized rats due to electro-acupuncture and pinch stimulation, and is unaffected by severing of the cervical sympathetic nerves, confirming that dilation occurs due to suppression of the parasympathetic nervous system. They also reported on the important role the parasympathetic nervous system plays in the pupillary response in reaction to somatosensory stimulation. Due to such factors as species differences, the influence of anesthetic, and differences in light and dark adaptation, further study is required in the future.

The pupil contraction response due to shiatsu stimulation of the anterior cervical region may possibly have occurred via a pressoreceptor reflex, as the carotid sinus, which contains a pressoreceptor, is stimulated. Furthermore, the response may have been easy to elicit as the output level for the autonomic efferent pathway controlling the pupil and the area subject to shiatsu stimulation are in relatively close proximity.

Further basic research is required into the mechanisms and particulars of the subconscious effect of somatosensory stimulation on pupil diameter in humans. In the future, we hope to study the effect on pupil diameter of shiatsu stimulation to other areas of the body, and to clarify the effect or shiatsu stimulation on the autonomic nervous system.

V. Conclusions

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

1. Shiatsu stimulation of the anterior cervical region resulted in significant contraction of pupil diameter.
2. With shiatsu stimulation to the lateral crural region, significant response in pupil diameter could not be ascertained.

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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Effect on Pupil Diameter, Pulse Rate, and Blood Pressure of Shiatsu Stimulation to the Sacral Region

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I. Introduction

The Japan Shiatsu College has previously reported in the Journal of the Japan College Association of Oriental Medicine on the effects of shiatsu stimulation on heart rate[1-4], blood pressure[1-4], peripheral circulation[3], and electrogastrograph activity[4-6], in order to help clarify its effects on the autonomic nervous system. Two years ago, we began studying the effect of shiatsu stimulation on pupil diameter, and have shown that shiatsu stimulation of the abdominal and anterior cervical regions result in significant reduction in pupil diameter[7,8].

In this report, building on the results of previous reports, we will study the effect on pupil diameter of shiatsu stimulation to the sacral region, while at the same time measuring blood pressure and pulse rate.

II. Methods

1. Subjects

Research was conducted on 22 students and instructors at the Japan Shiatsu College, 13 male and 9 female (average age: 35.5 ± 7.5 years old). Test procedures were fully explained to each test subject and their consent obtained and histories taken prior to testing.

Fig. 1. Binocular electronic pupillometer

2. Test period and location

Testing was conducted in the basic medicine research lab at the Japan Shiatsu College between April 28 and July 7, 2012. Room temperature was 22 ± 2.0°C and humidity was 79 ± 15.0%. Illumination was 100 lux.

3. Measurement procedures

Changes in pupil diameter were measured using a binocular electronic pupillometer (Newopto Corp. ET-200, Fig. 1), with the test subject in the prone position. A continuous blood pressure manometer (Japan Colin Jentow-7700, Fig. 2) was used to derive blood pressure and pulse rate (heart rate) from the right radial artery using tonometry.

4. Stimulation

Area of stimulation (Fig. 3)

With the test subject in the prone position, stimulation was applied using two-thumb pressure to the 3 points of the sacral region, as per basic Namikoshi shiatsu.

Treatment consisted of standard pressure applications of 3 seconds per point, applied to both bilateral points simultaneously, and repeated for 3 minutes duration. Stimulation was applied using standard

Fig. 2. Continuous blood pressure manometer

pressure (pressure gradually increased, sustained, and gradually decreased), regulated so as to be pleasurable for the test subject.

5. Test procedure (Figs. 4, 5)

Test procedures were fully explained to each test subject and their prior consent obtained. They were also questioned on physical condition and history of eye disease.

Pupil diameter was measured for 9 minutes, divided into 3 minutes pre-stimulation, 3 minutes shiatsu stimulation, and 3 minutes post-stimulation (hereafter, the stimulation group). Also, in the control group (hereafter, the non-stimulation group), pupil diameter was measured for 9 minutes with the subjects in a relaxed state in the same prone position as the stimulation group. These interventions were carried out on all 22 test subjects on different days.

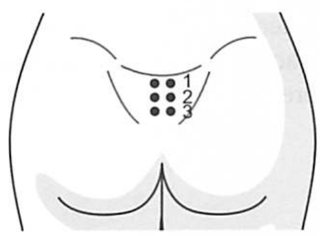

Fig. 3. Shiatsu points of the sacral region

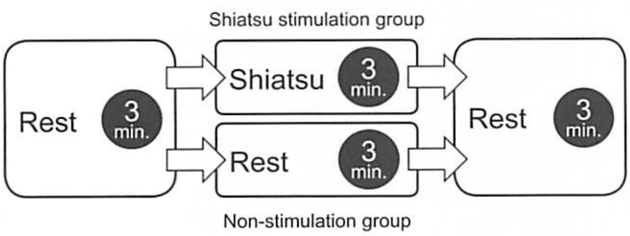

Fig. 4. Test procedure

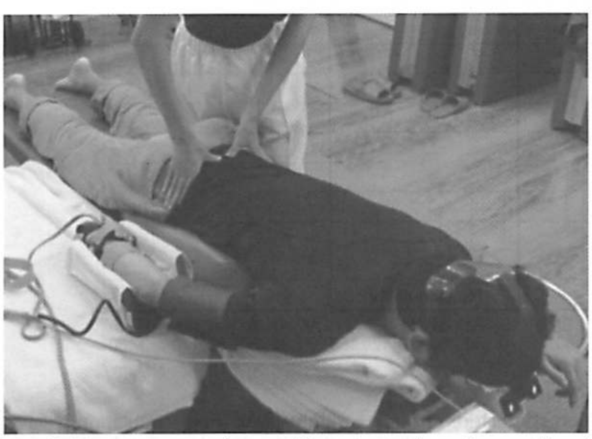

Fig. 5. Measurement using pupillometer and continuous blood pressure manometer

For measurement of pupil diameter, test subjects were made to fix their gaze on a 1.5 cm diameter mark affixed to the floor 80 cm away from the goggles.

6. Data analysis

Taking pupil diameter 60 seconds prior to stimulation (Bf.60) as the control, data was analyzed for 5 seconds at 30-second intervals during stimulation (St.) and post-stimulation (Af.).

7. Statistical processing

Post-stimulation chronological pupil diameter, heart rate, and blood pressure values for both groups (stimulation group, non-stimulation group) were analyzed using Bonferroni multiple comparison and mixed model analysis of variance. A significance level of <5% was determined to be significant.

III. Results

1. Pupil diameter (Fig. 6)

Both groups (stimulation group, non-stimulation group) displayed an interaction effect post-stimulation in chronological changes on the left side ($p=0.02$) and the right side ($p=0.023$).

With shiatsu stimulation of the sacral region, right pupil diameter was contracted at 90 seconds post-stimulation ($p=0.007$), as compared to pre-stimulation (cont.). Left pupil diameter was unchanged. In the non-stimulation group, both left and right pupil diameter were unchanged.

2. Pulse rate (heart rate) (Fig. 7)

Both groups (sacral region shiatsu stimulation group, non-stimulation group) displayed an interaction effect post-stimulation in chronological changes to pulse rate ($p=0.00$).

With shiatsu stimulation of the sacral region, pulse rate was reduced at 60 seconds ($p=0.011$), 120 seconds ($p=0.045$), and 150 seconds ($p=0.045$) during stimulation and immediately post stimulation ($p=0.029$), as compared to pre-stimulation (cont.) values. In the non-stimulation group, there was no chronological change.

3. Blood pressure (Fig. 7)

Both groups (sacral region shiatsu stimulation group, non-stimulation group) displayed an interaction effect post-stimulation in chronological changes to systolic blood pressure ($p=0.015$), but there was no interaction effect for diastolic blood pressure.

With shiatsu stimulation of the sacral region, systolic blood pressure was elevated at 90 seconds ($p=0.014$), 120 seconds ($p=0.001$), and 150 seconds ($p=0.003$) post stimulation, as compared to pre-stimulation (cont.) values. There was no chronological change in diastolic blood pressure. In the non-stimulation group, there was no chronological change in either systolic or diastolic blood pressure.

IV. Discussion

In this study, no significant change in pupil diameter was ascertained in the non-stimulation group, but significant contraction of pupil diameter did occur in the group receiving shiatsu stimulation to the sacral region.

It has been reported that pupil dilation occurs in response to pain stimulation[9], however we may assume that a dilation response did not occur in this study because subjects received standard shiatsu stimulation unaccompanied by pain.

Pupil diameter is regulated by the dilator pupillae muscle, which is controlled by the sympathetic nervous system (cervical sympathetic nerves), and by the sphincter pupillae muscle, which is controlled by the parasympathetic nervous system (oculomotor nerve). The pupil contraction response due to shiatsu stimulation observed in this study may have occurred as a result of either excitation of the parasympathetic nervous system, which controls the sphincter pupillae muscle, suppression of sympathetic nervous system, which controls the dilator pupillae muscle, or a combination of the two.

It has been indicated in the past that the sympathetic nervous system is involved in pupillary responses involving the higher brain centers[10, 11], but Ohsawa et al[12] and Shimura et al[13] showed that reflexive pupil dilation occurs in light-adapted, anesthetized rats due to electro-acupuncture and pinch stimulation, and is unaffected by severing of the cervical sympathetic nerves, confirming that dilation occurs due to suppression of the parasympathetic nervous system. They also reported on the important role the parasympathetic nervous system plays in the pupillary response in reaction to somatosensory stimulation.

In reports of the previous two years, we showed that significant contraction of pupil diameter occurs due to shiatsu stimulation of the anterior cervical and abdominal regions. In this report, we have also shown that a significant contraction response similarly occurs with shiatsu stimulation of the sacral region.

Reduction of pulse rate (heart rate) occurred due to shiatsu stimulation of the sacral region. This may have resulted from either suppression of the sympathetic

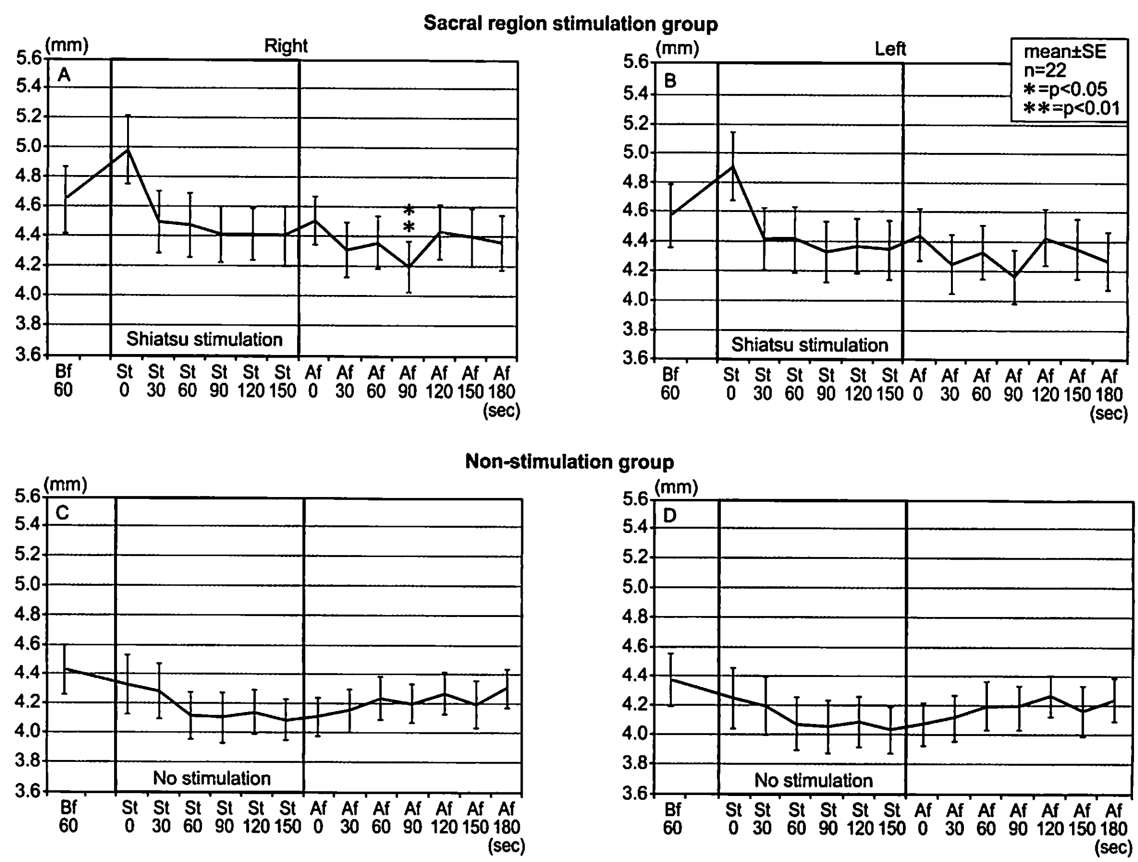

Fig. 6. Changes to pupil diameter due to shiatsu stimulation of the sacral region
A: Right pupil (sacral region stimulation group), B: Left pupil (sacral region stimulation group), C: Right pupil (non-stimulation group), D: Left pupil (non-stimulation group). On each graph, the vertical axis represents pupil diameter (mm) and the horizontal axis represents elapsed time (sec), with mean ± SE displayed. Bf: pre-stimulation (control); St: during stimulation; Af: post-stimulation

nerves or accentuation of the parasympathetic nerves controlling the heart, or a combination of the two. Previous reports from the Japan Shiatsu College have shown that shiatsu stimulation to the anterior cervical, abdominal, and lower leg regions reduces heart rate[1-4]. The observation that, similar to these areas, shiatsu stimulation of the sacral region also reduces pulse rate (heart rate) would seem to suggest that this reduction response is generalized throughout the body.

With regard to the blood pressure response to shiatsu stimulation, we have previously reported that shiatsu stimulation to the anterior cervical, abdominal, and lower leg regions elicits a depressor response[2], however in this study involving shiatsu stimulation to the sacral region an increase in systolic pressure was observed. As in the report by Ide et al[2], subjects in this study received standard shiatsu unaccompanied by pain, and measurement items other than blood pressure indicated contraction of pupil diameter and a reduction response for heart rate. Consequently, the increase in blood pressure accompanying shiatsu stimulation of the sacral region may have been a transitory one, due to light pressure exerted on the abdominal aorta while pressure application was conducted in the prone position. Further research on this phenomenon is required.

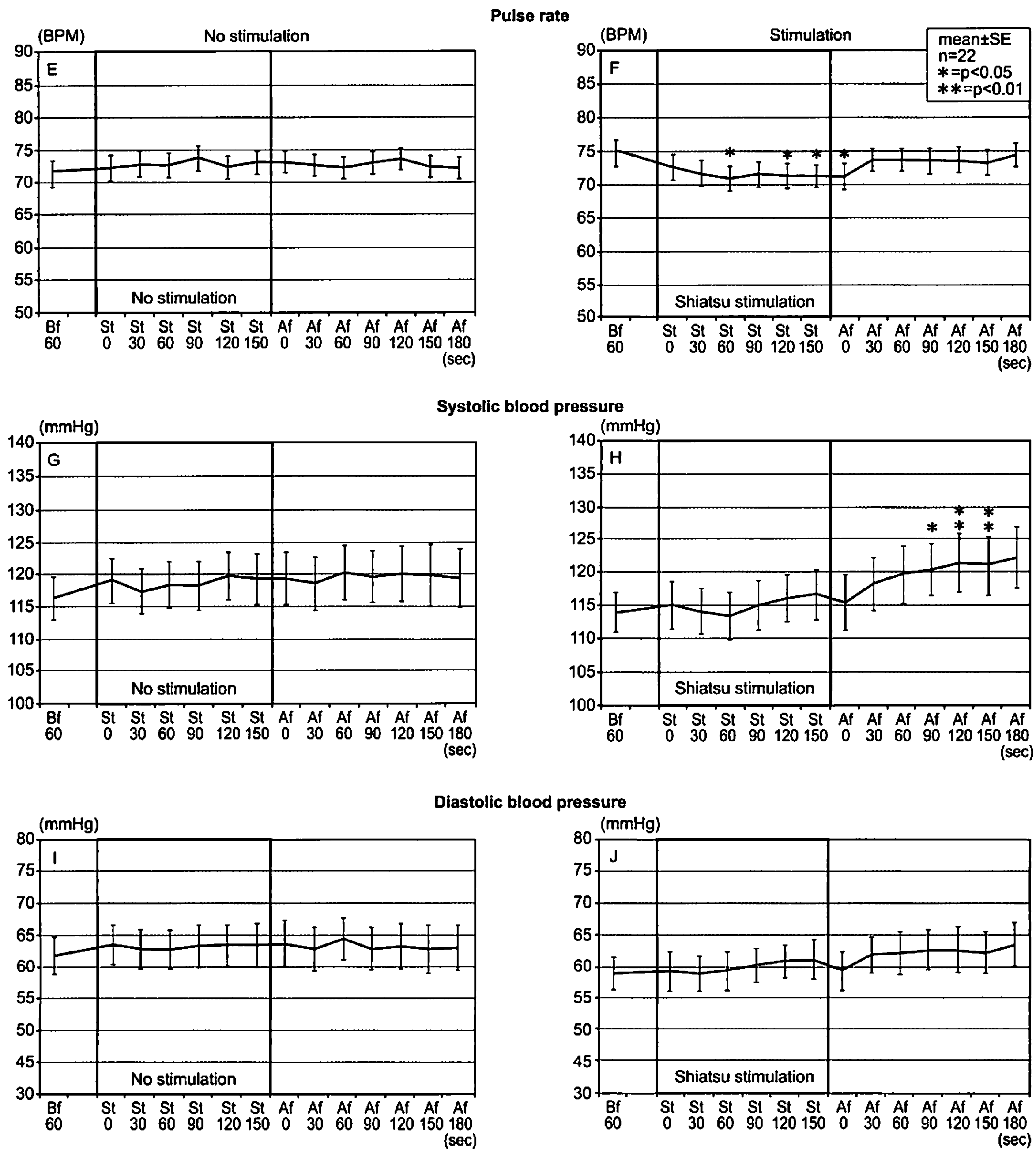

Fig. 7. Changes to pulse rate and blood pressure due to shiatsu stimulation of the sacral region

V. Conclusions

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

1. Shiatsu stimulation resulted in significant post-stimulation contraction of pupil diameter.
2. Shiatsu stimulation resulted in significant post-stimulation increase in systolic blood pressure, but no significant response in diastolic blood pressure was observed.
3. Shiatsu stimulation resulted in significant reduction of pulse rate (heart rate) during and after stimulation.

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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