Effects of Shiatsu Stimulation to the Interscapular Region on Pupil Diameter, Heart Rate, and Blood Pressure

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I. Introduction

It is known that shiatsu therapy produces a variety of physiological responses, including improvement of autonomic nervous system function and relaxation of muscle tone[1].

The Japan Shiatsu College has been conducting ongoing research to clarify the effects of shiatsu stimulation on autonomic nervous system functions, and has previously reported that shiatsu stimulation of healthy test subjects results in lower heart rate[2),3)], lower blood pressure[2)], increased muscle blood flow[4)], and increased electrogastrography dominant power[5)-7)]. These reports have shown that shiatsu stimulation affects various autonomic nervous system functions.

Because the pupil, which is innervated by autonomic nerves, is used as one indicator for autonomic nervous system function, we anticipated that shiatsu stimulation would affect pupil diameter via the autonomic nervous system. Starting in 2010, we began studying the effects of shiatsu stimulation on pupil diameter, and have shown that shiatsu stimulation to the abdomen, anterior cervical region, sacral region, head region, and antebrachial region significantly reduce pupil diameter. On the other hand, shiatsu stimulation to the lateral crural region did not result in significant reduction in pupil diameter[8)-12)].

Based on previous research, in this report we measure changes to pupil diameter, blood pressure, and heart rate due to shiatsu stimulation of the interscapular region, an area that has not been studied before.

II. Methods

1. Subjects

Research was conducted on 19 healthy adult male students and instructors of the Japan Shiatsu College between the ages of 21 and 54, with an average age of 34.7 ± 9.3 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 10 and July 25, 2015. Regarding the test environment, room temperature was 22 ± 2.0℃, humidity was 79 ± 15.0%, and illumination was 100 lux.

3. Measurement procedures

Changes in pupil diameter were measured using a binocular electronic pupillometer (Newopto Corp. ET-200) (Fig. 1).

Changes in blood pressure and heart rate were measured using a continuous blood pressure manometer (MediSense MUB101) (Fig. 2).

4. Stimulation

With the test subject in the right lateral position, stimulation was applied using two-thumb pressure to the five points of the right interscapular region, parallel

Fig. 1. Binocular electronic pupillometer

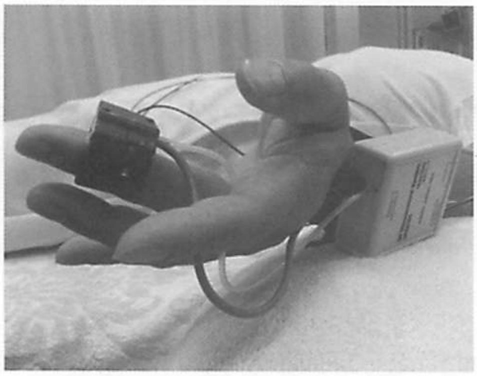

Fig. 2. Measurement using continuous blood pressure manometer

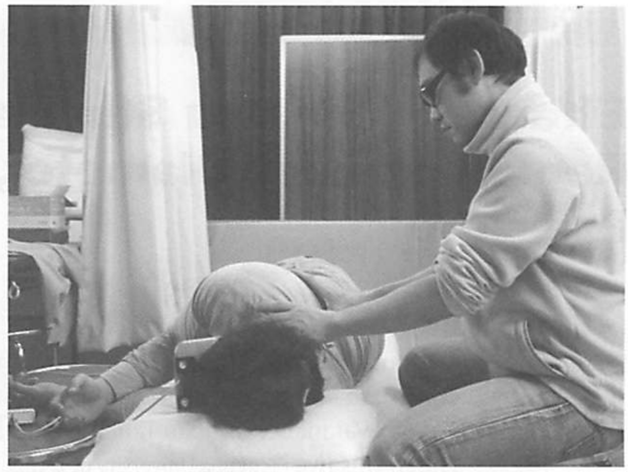

Fig. 5. Measurement of shiatsu stimulation group

to the spine, as per basic Namikoshi shiatsu (Fig. 3). Stimulation was applied for 3 seconds per point, repeated for 3 minutes using standard pressure (pressure gradually increased, sustained, and gradually decreased) with the amount of pressure applied classified as standard (pressure regulated so as to be pleasurable for the test subject).

5. Test procedure (Fig. 4)

Test subjects were 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 19 test subjects on different days.

For the stimulation group, pupil diameter, blood pressure, and heart rate were measured on test subjects resting in the lateral position for 3 minutes prior to shiatsu stimulation, 3 minutes during stimulation, and 3 minutes post-stimulation, for a total of 9 minutes.

For the non-stimulation group, pupil diameter, blood pressure, and heart rate were measured on test subjects resting in the lateral position, as with the stimulation group, for 9 minutes. (Fig. 5)

For measurement of pupil diameter, test subjects were told to focus on a mark affixed within their field of vision.

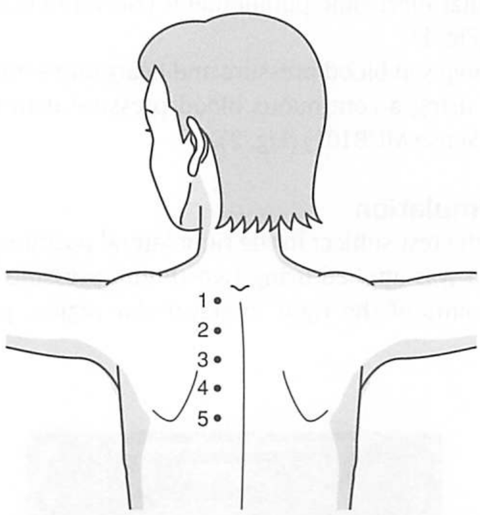

Fig. 3. Area of stimulation (5 points of interscapular region)

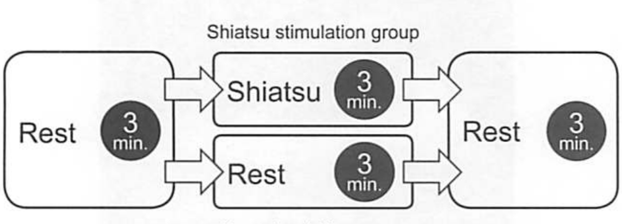

Fig. 4. Test procedure

6. Data analysis

The measurement taken 60 seconds prior to stimulation (Bf.60) was established as the control value, and calculations performed using data taken at 30-second intervals during stimulation (St.) and post-stimulation (Af.) Analysis was performed using IBM SPSS Statistics (ver. 22).

7. Statistical processing

Chronological changes to pupil diameter, heart rate, and blood pressure for each group were subject to linear analysis using a mixed-model, Bonferroni multiple comparison, and alternation effect was subject to linear analysis using a mixed model. A significance level of <5% was determined to be significant.

III. Results

1. Pupil diameter (Fig. 6)

Right pupil diameter: In the stimulation group,

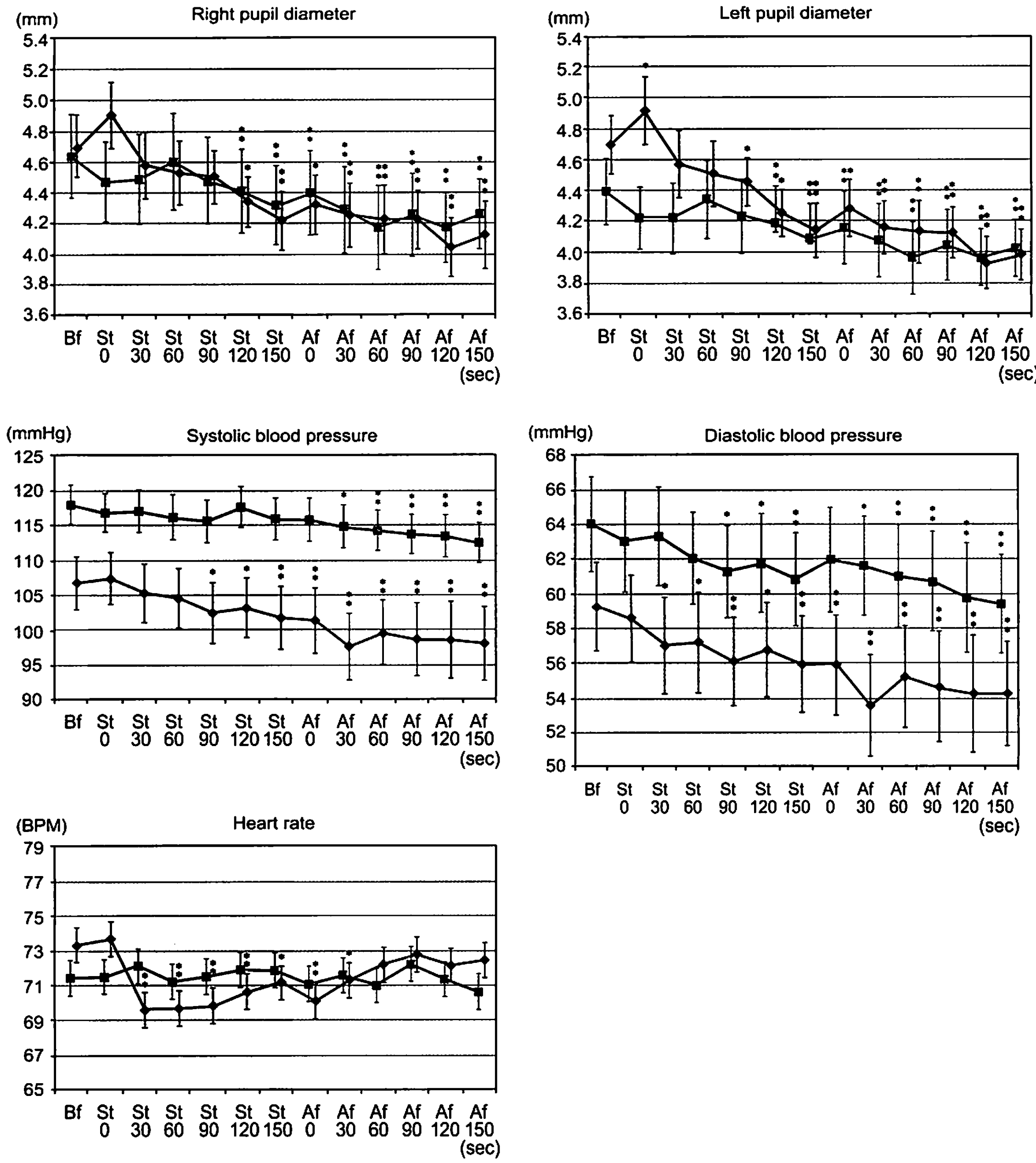

Fig. 6. Changes to pupil diameter, blood pressure, and heart rate due to shiatsu stimulation of the interscapular region
The vertical axis represents pupil diameter (mm) and the horizontal axis represents elapsed time (sec). On each graph, Bf: pre-stimulation (control); St: during stimulation; Af: post-stimulation.
Stimulation group: (◆), Non-stimulation group: (■), * $p < 0.05$, ** $p < 0.01$

transient right pupil dilation was observed immediately after commencement of stimulation, followed by a trend toward constriction, with constriction measured at 120 seconds ($p = 0.003$) and 150 seconds ($p < 0.0001$) during stimulation and at 0 seconds ($p = 0.002$), 30 seconds ($p < 0.0001$), 60 seconds ($p < 0.0001$), 90 seconds ($p < 0.0001$), 120 seconds ($p < 0.0001$), and 150 seconds ($p < 0.0001$) post-stimulation, compared to pre-stimulation (Control). The non-stimulation group displayed significant constriction at 120 seconds ($p = 0.05$) and 150 seconds ($p = 0.005$) during the stimulation period and at 0 seconds ($p = 0.037$), 30 seconds ($p = 0.002$), 60 seconds ($p < 0.0001$), 90 seconds ($p = 0.001$), 120 seconds ($p < 0.0001$), and 150 seconds ($p = 0.001$) during the post-stimulation period, compared to the pre-stimulation period (Control). No chronological alternation effect was displayed between the two groups ($p = 0.067$).

Left pupil diameter: In the stimulation group, transient right pupil dilation was observed immediately after commencement of stimulation ($p = 0.044$), followed by a trend toward constriction, with constriction measured at 90 seconds ($p = 0.024$), 120 seconds ($p < 0.0001$), and 150 seconds ($p < 0.0001$) during stimulation and at 0 seconds ($p < 0.0001$)), 30 seconds ($p < 0.0001$), 60 seconds ($p < 0.0001$), 90 seconds (p

< 0.0001), 120 seconds (p < 0.0001), and 150 seconds (p < 0.0001) post-stimulation, compared to pre-stimulation (Control). The non-stimulation group displayed significant constriction at 120 seconds (p = 0.044) and 150 seconds (p = 0.003) during the stimulation period and at 0 seconds (p = 0.019), 30 seconds (p = 0.002), 60 seconds (p < 0.0001), 90 seconds (p = 0.001), 120 seconds (p < 0.0001), and 150 seconds (p < 0.0001) during the post-stimulation period, compared to the pre-stimulation period (Control). No chronological alternation effect was displayed between the two groups (p < 0.0001).

2. Heart rate and blood pressure (Fig. 6)

Heart rate: In the stimulation group, heart rate decreased at 30 seconds (p < 0.0001), 60 seconds (p < 0.0001), 90 seconds (p < 0.0001), 120 seconds (p < 0.001) and 150 seconds (p = 0.01) during stimulation and at 0 seconds (p < 0.0001) and 30 seconds (p = 0.015) post-stimulation, compared to pre-stimulation (Control). The non-stimulation group showed no change compared to pre-stimulation (Control). A chronological alternation effect was displayed between the stimulation and non-stimulation groups (p < 0.0001).

Systolic blood pressure: In the stimulation group, systolic blood pressure decreased at 90 seconds (p = 0.017), 120 seconds (p = 0.047), and 150 seconds (p = 0.005) during stimulation and at 0 seconds (p = 0.003), 30 seconds (p < 0.0001), 60 seconds (p < 0.0001), 90 seconds (p < 0.0001), 120 seconds (p < 0.0001), and 150 seconds (p < 0.0001) post-stimulation, compared to pre-stimulation (Control).The non-stimulation group showed a decrease at 30 seconds (p = 0.014), 60 seconds (p = 0.004), 90 seconds (p = 0.001), 120 seconds (p = 0.001), and 150 seconds (p < 0.0001) in the post-stimulation period, compared to the pre-stimulation period (Control). No alternation effect was displayed between the groups (p = 0.051).

Diastolic blood pressure: In the stimulation group, diastolic blood pressure decreased at 30 seconds (p = 0.023) 60 seconds (p = 0.036), 90 seconds (p = 0.001), 120 seconds (p = 0.012), and 150 seconds (p = 0.001) during stimulation and at 0 seconds (p = 0.001), 30 seconds (p < 0.0001), 60 seconds (p < 0.0001), 90 seconds (p < 0.0001), 120 seconds (p < 0.0001), and 150 seconds (p < 0.0001) post-stimulation, compared to pre-stimulation (Control).The non-stimulation group showed a decrease at 90 seconds (p = 0.014), 120 seconds (p = 0.043), and 150 seconds during the stimulation period and at 30 seconds (p = 0.031), 60 seconds (p = 0.007), 90 seconds (p = 0.003), 120 seconds (p < 0.0001) and 150 seconds (p < 0.0001) in the post-stimulation period, compared to the pre-stimulation period (Control). No alternation effect was displayed between the groups (p = 0.622).

IV. Discussion

In this study, results indicated changes to pupil diameter, heart rate, and systolic and diastolic blood pressure due to shiatsu stimulation of the interscapular region. Also, additive action was displayed for left-side pupil diameter and heart rate, relative to the non-stimulation group.

Pupil diameter is governed by sympathetic nerves (cervical sympathetic nerves), which control the dilator pupillae muscle, and parasympathetic nerves (oculomotor nerve), which control the sphincter pupillae muscle. The pupillary constriction response due to shiatsu stimulation observed in this study was probably due to an autonomic nervous system response involving either stimulation of the parasympathetic nervous system, which controls the sphincter pupillae muscle, suppression of the sympathetic nervous system, which controls the dilator pupillae muscle, or a combination of the two.

It has been shown that the sympathetic nervous system is involved in pupillary responses involving the higher brain centers[13), 14)], but Ohsawa et al[15)] and Shimura et al[16)] showed that reflexive pupil dilation occurs in anesthetized rats due to electro-acupuncture and pinch stimulation, and is unaffected by severing 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.

Previous studies conducted up to last year have confirmed that significant pupil constriction occurs with shiatsu stimulation to the abdominal, anterior cervical, sacral, head, and antebrachial regions[8)-12)]. The current study shows that a pupillary constriction response also occurs due to shiatsu stimulation to the interscapular region. This pupillary response suggests that shiatsu stimulation probably causes excitation of the parasympathetic nervous system.

In the report on the lateral crural region by Yokota et al[9)], when comparing the stimulation and non-stimulation groups, no significant constriction in pupil diameter was observed. This suggests that the constriction response differs depending on which region is subject to shiatsu stimulation. Further study is necessary to determine the different effects of shiatsu stimulation depending on the region.

Also, although the pupillary reflex is bilaterally consensual in response to light, in this study additive action was only confirmed on the left side. It is possible that the pupillary reflex in response to shiatsu stimulation differs from the response to light.

V. Conclusions

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

Shiatsu stimulation of the interscapular region with the subject in the right lateral position resulted in left pupil diameter constriction and reduced heart rate both during and after stimulation, and displayed additive action compared to the non-stimulation group. Also, in the stimulation group, right pupil diameter constriction and reduced blood pressure occurred both during and after stimulation, with no interaction effect compared to the non-stimulation group.

The above indicates that shiatsu stimulation of the interscapular region had a greater effect on autonomic nervous system function than rest alone.

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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