

Effects of Shiatsu Stimulation to the Anterior Cervical 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 tone¹⁾.

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 pressure²⁾, increased muscle blood flow³⁾, and increased electrogastrography dominant power⁵⁾⁻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, and head region significantly reduces pupil diameter. On the other hand, shiatsu stimulation to the lateral crural region did not result in significant reduction in pupil diameter⁸⁾⁻¹¹⁾.

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

II. Methods

1. Subjects

Research was conducted on 26 healthy adult students and instructors of the Japan Shiatsu College (16 male,

10 female) between the ages of 19 and 61, with an average age of 35.6 ± 10.9 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 19 and September 8, 2014. Regarding the test environment, room temperature was $22 \pm 2.0^\circ\text{C}$, humidity was $79 \pm 15.0\%$, 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).



Fig. 1. Binocular electronic pupillometer

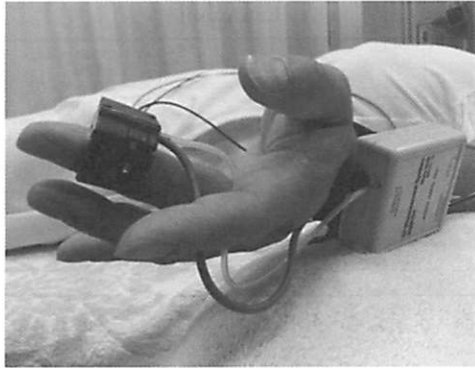


Fig. 2. Measurement using continuous blood pressure manometer



Fig. 5. Measurement using pupillometer

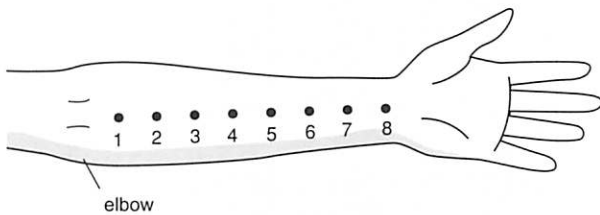


Fig. 3. Eight points on median line of medial antebrachial region

4. Stimulation

Area of stimulation (Fig. 3)

With the test subject in the supine position, stimulation was applied using two-thumb pressure to the eight points of the median line of the right medial antebrachial region, as per basic Namikoshi shiatsu.

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 26 test subjects on different days.

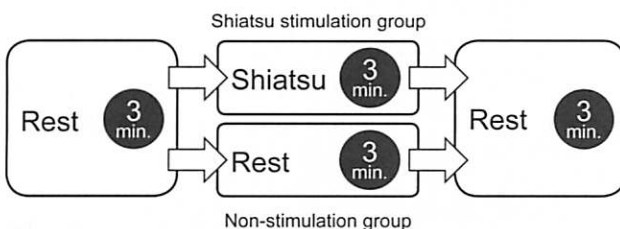


Fig. 4. Test procedure

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

For measurement of pupil diameter, test subjects were told to focus on a 1.5 cm mark affixed within their field of vision.

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 reciprocal 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)

For right pupil diameter, no chronological reciprocal effect was displayed between the stimulation and non-stimulation groups. In the stimulation group, transient right pupil dilation was observed immediately after commencement of stimulation, followed by a trend toward constriction, with significant constriction measured at 150 seconds during stimulation ($p = 0.03$) and at 60 seconds post-stimulation ($p = 0.046$), compared

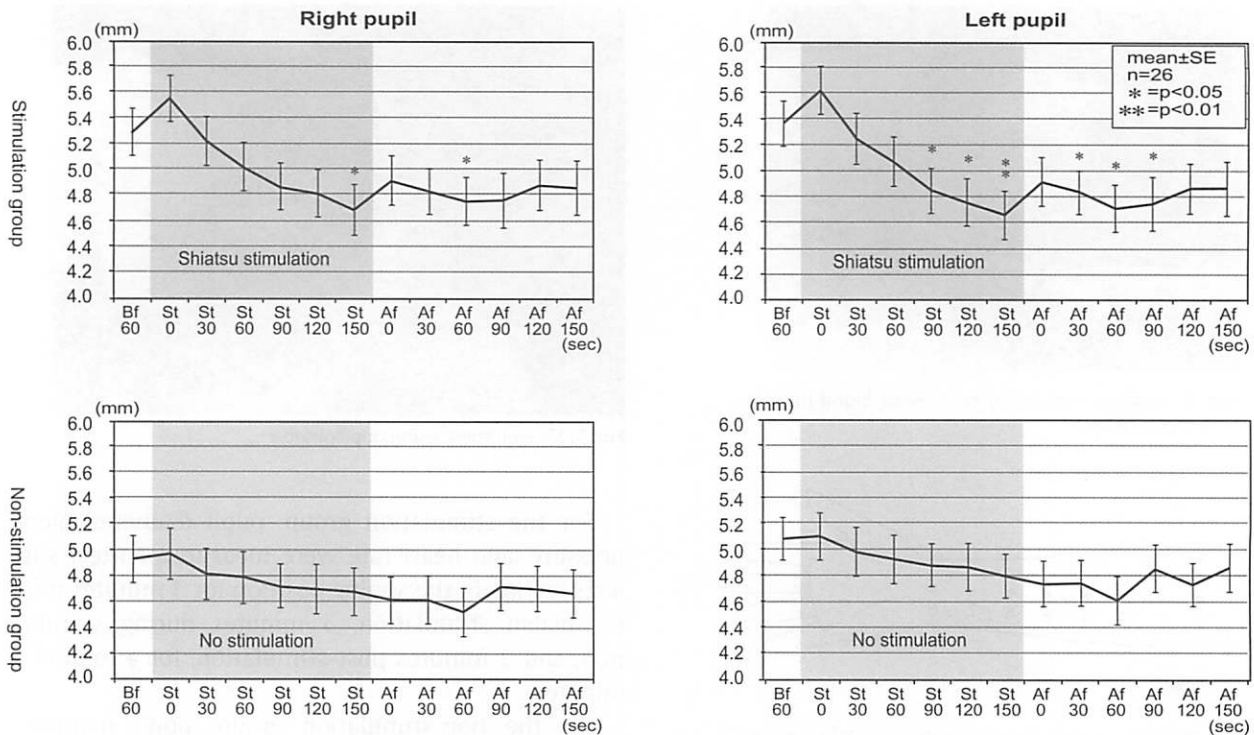


Fig. 6. Changes to pupil diameter due to shiatsu stimulation of antebrachial region
 Upper graphs show the stimulation group and lower graphs show the non-stimulation group. On each graph, the vertical axis represents pupil diameter (mm) and horizontal axis represents elapsed time (sec), with mean ± SE displayed. Bf: pre-stimulation (control); St: during stimulation; Af: post-stimulation

to pre-stimulation (control). In the non-stimulation group, right pupil diameter showed a gradual trend toward constriction, but there was no significant change compared to pre-stimulation.

For left pupil diameter, no chronological reciprocal effect was displayed between the stimulation and non-stimulation groups. In the stimulation group, transient left pupil dilation was observed immediately after commencement of stimulation, followed by a trend toward constriction, with significant constriction measured at 90 seconds ($p = 0.043$), 120 seconds ($p = 0.022$), and 150 seconds ($p = 0.009$) during stimulation, and at 30 seconds ($p = 0.035$), 60 seconds ($p = 0.012$), and 90 seconds ($p = 0.028$) post-stimulation, compared to pre-stimulation. In the non-stimulation group, right pupil diameter showed a gradual trend toward constriction, but there was no significant change compared to pre-stimulation (control).

2. Blood pressure and heart rate

With regard to systolic and diastolic blood pressure and heart rate, no chronological change was observed in either the stimulation group or the non-stimulation group (Fig. 7).

IV. Discussion

In this study, no significant change in pupil diameter

was observed in the non-stimulation group, whereas in the group that received shiatsu stimulation to the antebrachial region, significant constriction of the pupil occurred.

With regard to systolic and diastolic blood pressure and heart rate, no significant difference was observed when comparing the stimulation and non-stimulation groups.

It has been reported that pupil dilation occurs in response to pain stimulation¹²⁾. 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 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 al¹⁵⁾ and Shimura

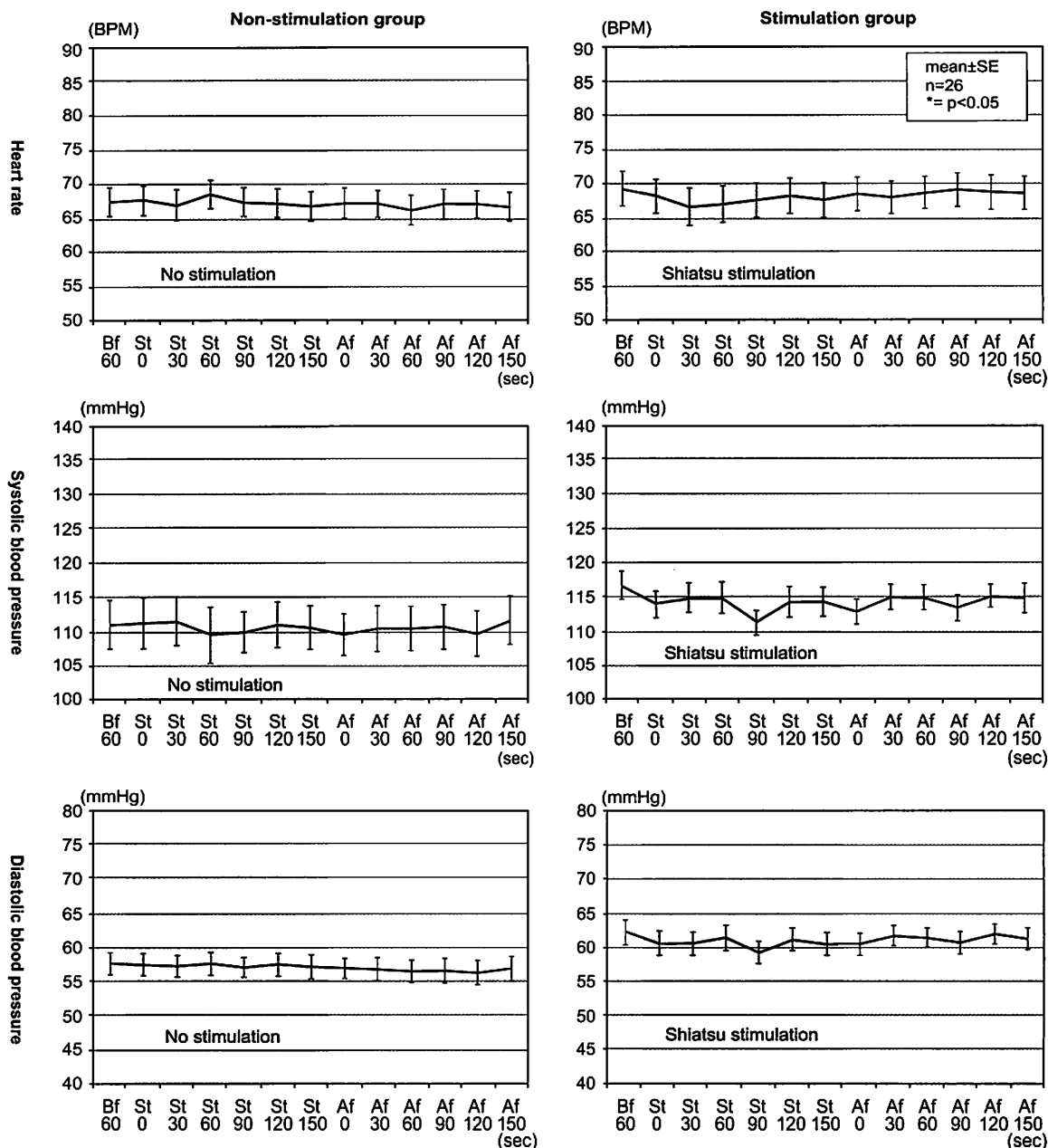


Fig. 7. Changes to heart rate and blood pressure due to shiatsu stimulation of antebrachial region

et al¹⁶⁾ 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, and head regions⁸⁾⁻¹¹⁾. The current study shows that a significant pupillary constriction response also occurs due to shiatsu stimulation to the antebrachial 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 al⁹⁾, 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.

V. Conclusions

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

1. Shiatsu stimulation of the antebrachial region resulted in significant constriction of pupil diameter compared to the non-stimulation group.
2. No change was observed in systolic or diastolic blood pressure or heart rate.

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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