Effects of Shiatsu Stimulation to the Lateral Cervical and Superior Nuchal Line Regions 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[3)], 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, antebrachial region, and interscapular region significantly reduce pupil diameter[8)-13)]. On the other hand, shiatsu stimulation to the lateral crural region did not result in significant reduction in pupil diameter[9)].

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

II. Methods

1. Subjects

Research was conducted on 35 healthy adult students and instructors of the Japan Shiatsu College (24 male, 11 female) between the ages of 19 and 63, with an average age of 34.7 ± 11.2 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 16 and July 13, 2016. 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), with the subject in the supine position. Changes in blood pressure and heart rate were measured using a continuous blood pressure manometer (MediSense MUB101) (Fig. 2), detected at either the right middle or the right ring finger (Fig. 3).

Fig. 1. Binocular electronic pupillometer (Newopto Corp. ET-200)

Fig. 2. Measurement using continuous blood pressure manometer (MediSense MUB101)

Fig. 3. Scene from research lab

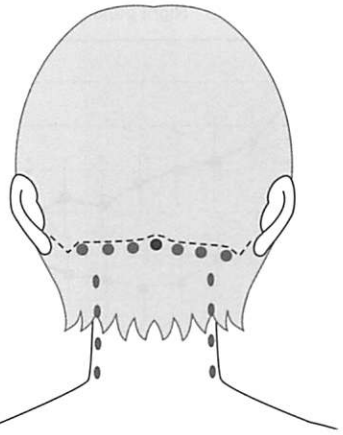

Fig. 4. Area of stimulation
4 points of lateral cervical region; 3 points of superior nuchal line; 1 point of medulla oblongata

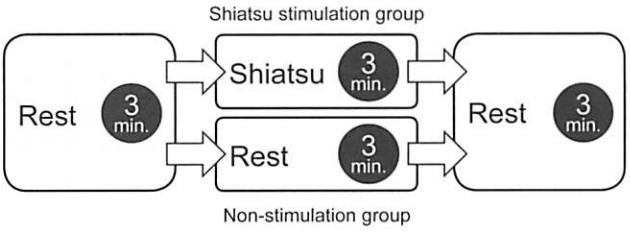

Fig. 5. Test procedure

4. Stimulation

With the subject in the supine position, stimulation was applied bilaterally to the four points of the lateral cervical region, bilaterally to the three points of the superior nuchal line, and to the one point of the medulla oblongata (occipital condyle) (Fig. 4). 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 5)

Prior to testing, 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 test subjects on different days.

For the stimulation group, test subjects rested in the lateral position for 3 minutes prior to shiatsu stimulation (60 seconds prior to stimulation: Control), followed by 3 minutes of stimulation (St. 0, St. 30, St. 60, St. 90, St.120, St.150), and 3 minutes post-stimulation (Af. 0, Af. 30, Af. 60, Af. 90, Af.120, Af.150), for a total of 9 minutes.

For the non-stimulation group, test subjects rested 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 mark affixed within their field of vision.

6. Data analysis

The measurement taken 60 seconds prior to stimulation (Control) 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

Pupil diameter, heart rate, and blood pressure were subject to linear analysis using a mixed-model, Bonferroni multiple comparison. The groups were compared using reciprocal effect. Significance level was 5%.

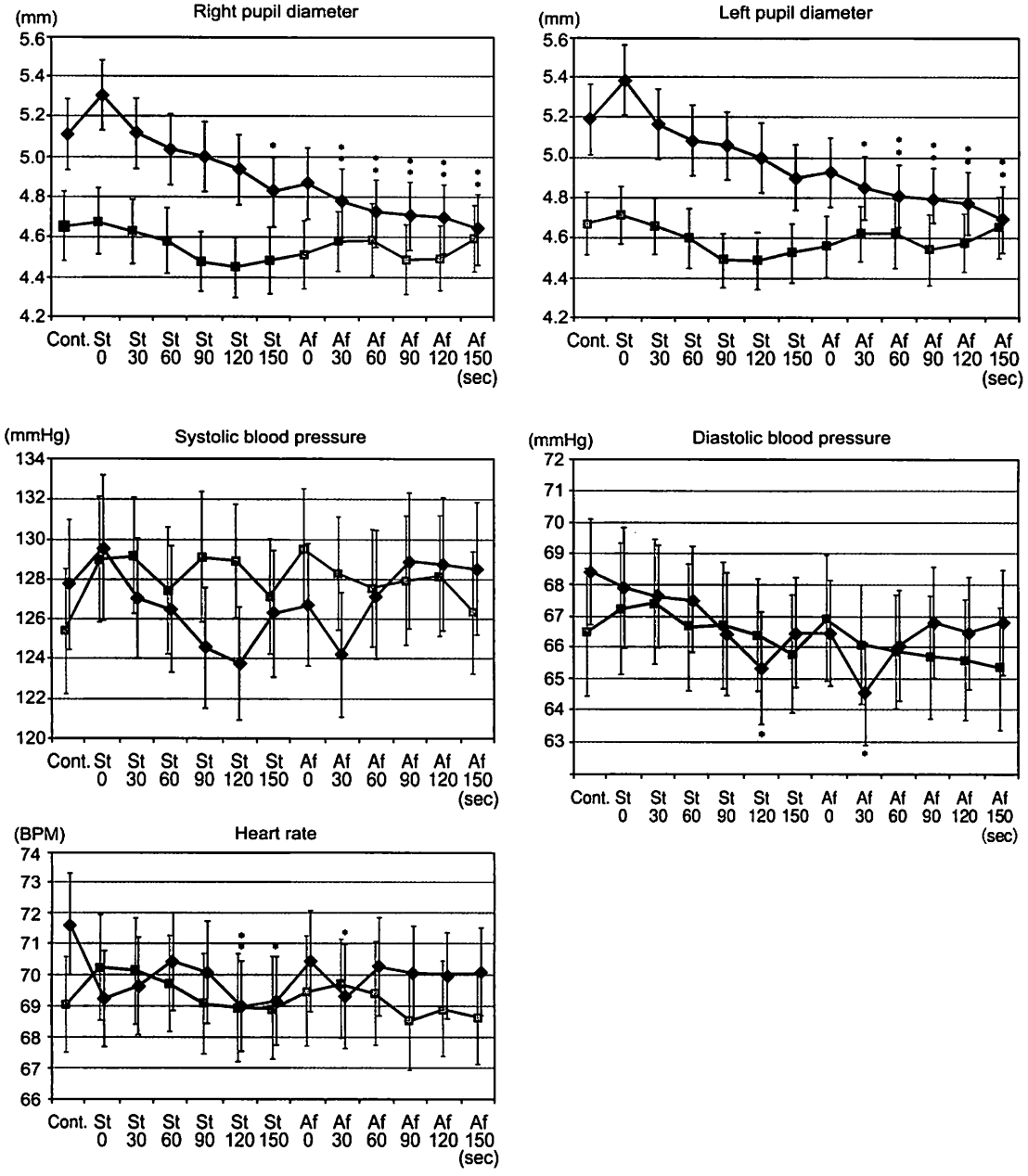

Fig. 6. Changes to pupil diameter, blood pressure, and heart rate due to shiatsu stimulation of the lateral cervical and superior nuchal line regions
The vertical axis represents pupil diameter (mm) and the horizontal axis represents elapsed time (sec). On each graph, Cont: pre-stimulation (control); St: during stimulation; Af: post-stimulation. n = 35, mean ± SE
Stimulation group: (◆), Non-stimulation group: (■), * $p < 0.05$, ** $p < 0.01$

III. Results

1. Pupil diameter (Fig. 6)

Right pupil response: In the stimulation group, pupil constriction was observed at St. 150 ($p = 0.031$), Af. 30 ($p = 0.002$), Af. 60 ($p < 0.001$), Af. 90 ($p < 0.001$), Af. 120 ($p < 0.001$), and Af. 150 ($p < 0.001$), compared to Control. In the non-stimulation group, no chronological change occurred. A comparison of chronological changes between the stimulation and non-stimulation groups indicated a cancellation effect ($p < 0.001$).

Left pupil response: In the stimulation group, pupil constriction was observed at Af. 30 ($p = 0.011$), Af. 60 ($p = 0.001$), Af. 90 ($p < 0.001$), Af. 120 ($p < 0.001$), and Af. 150 ($p < 0.001$), compared to Control. In the non-stimulation group, no chronological change occurred. A comparison of chronological changes between the stimulation and non-stimulation groups indicated a cancellation effect ($p < 0.001$).

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

Heart rate: In the stimulation group, heart rate decreased at St. 0 ($p = 0.018$), St. 120 ($p = 0.004$), St. 150 ($p = 0.01$) and Af. 30 ($p = 0.025$), compared to Control. The non-stimulation group showed chronological change.

A comparison of chronological changes between the stimulation and non-stimulation groups indicated a cancellation effect ($p < 0.011$).

Systolic blood pressure: No chronological changes compared to Control were observed in either the stimulation or the non-stimulation groups. A comparison of chronological changes between the stimulation and non-stimulation groups indicated a reciprocal effect ($p = 0.002$).

Diastolic blood pressure: In the stimulation group, diastolic blood pressure decreased at St. 120 ($p = 0.01$) and Af. 30 ($p < 0.001$) compared to Control. The non-stimulation group showed no chronological change. A comparison of chronological changes between the stimulation and non-stimulation groups indicated a cancellation effect ($p = 0.045$).

IV. Discussion

In this study, results indicated constriction of pupil diameter, decreased heart rate, and reduction of diastolic blood pressure due to shiatsu stimulation of the lateral neck and superior nuchal line regions.

It has been reported that pupil dilation occurs in response to pain stimulation[14]. 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[15), 16)], but Ohsawa et al[17] and Shimura et al[18] 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, antebrachial, and interscapular regions[8)-13)], whereas no significant pupil constriction was observed due to shiatsu stimulation of the lateral crural region[9], suggesting that the constriction response differs depending on the region. The current study shows that a pupillary constriction response also occurs due to shiatsu stimulation to the lateral cervical and superior nuchal line regions. This pupillary response suggests that shiatsu stimulation probably causes excitation of the parasympathetic nervous system.

V. Conclusions

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

Shiatsu stimulation of the lateral cervical and superior nuchal line regions resulted in pupil diameter restriction and reduced heart rate both during and after stimulation, and displayed a compensation effect compared to the non-stimulation group.

Diastolic blood pressure was reduced both during and after stimulation, and displayed a compensation effect compared to the non-stimulation group.

The above indicates that shiatsu stimulation of the lateral cervical and superior nuchal line regions 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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