Effects of Shiatsu Stimulation to the Subscapular 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[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 have studied 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, interscapular region, and lateral cervical and superior nuchal line regions 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 due to shiatsu stimulation of the subscapular 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 34 healthy adult students and instructors of the Japan Shiatsu College (17 male, 17 female) between the ages of 20 and 64, with an average age of 38.2 ± 10.8 years old. Test procedures were fully explained to each test subject and their prior informed written consent obtained.

2. Test period and location

Testing was conducted in the basic medicine research lab at the Japan Shiatsu College between April 28 and June 30, 2017. Regarding the test environment, room temperature was 25 ± 2.0℃, humidity was 65 ± 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 (Newopto Corp. ET-200)

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

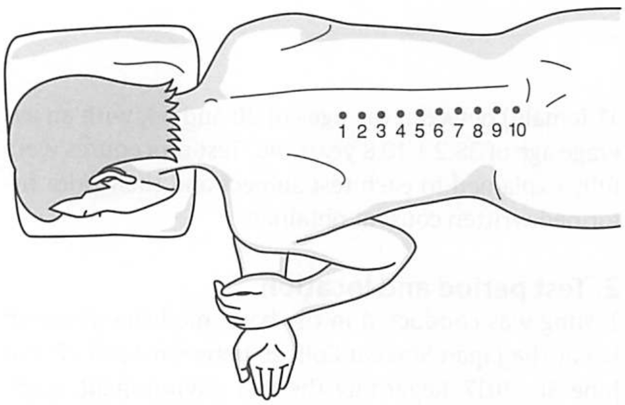

Fig. 3. 10 points of subscapular region

4. Stimulation

Area of stimulation (Fig. 3)

With the subject in the right lateral position, stimulation was applied to ten points parallel to the spine in the subscapular region, in accordance with the ten points of basic Namikoshi shiatsu for the left subscapular region, using thumb-on-thumb pressure. 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.

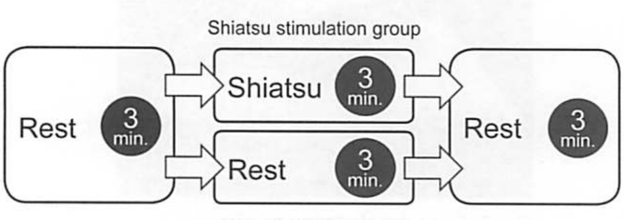

Fig. 4. Test procedure

Fig. 5. Measuring pupil diameter using pupillometer

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, followed by 3 minutes of stimulation, and 3 minutes post-stimulation, for a total of 9 minutes, during which time their pupil diameter, blood pressure, and heart rate were measured.

For the non-stimulation group, test subjects rested in the lateral position, as with the stimulation group, for 9 minutes, during which time their pupil diameter, blood pressure, and heart rate were measured. (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 (Bf.60) was established as the control value, and calculations performed using data taken at 30-second intervals before stimulation (Bf.), 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 were subject to linear analysis using a mixed-model, Bonferroni multiple comparison. The groups were compared using reciprocal action. Significance level was 5%.

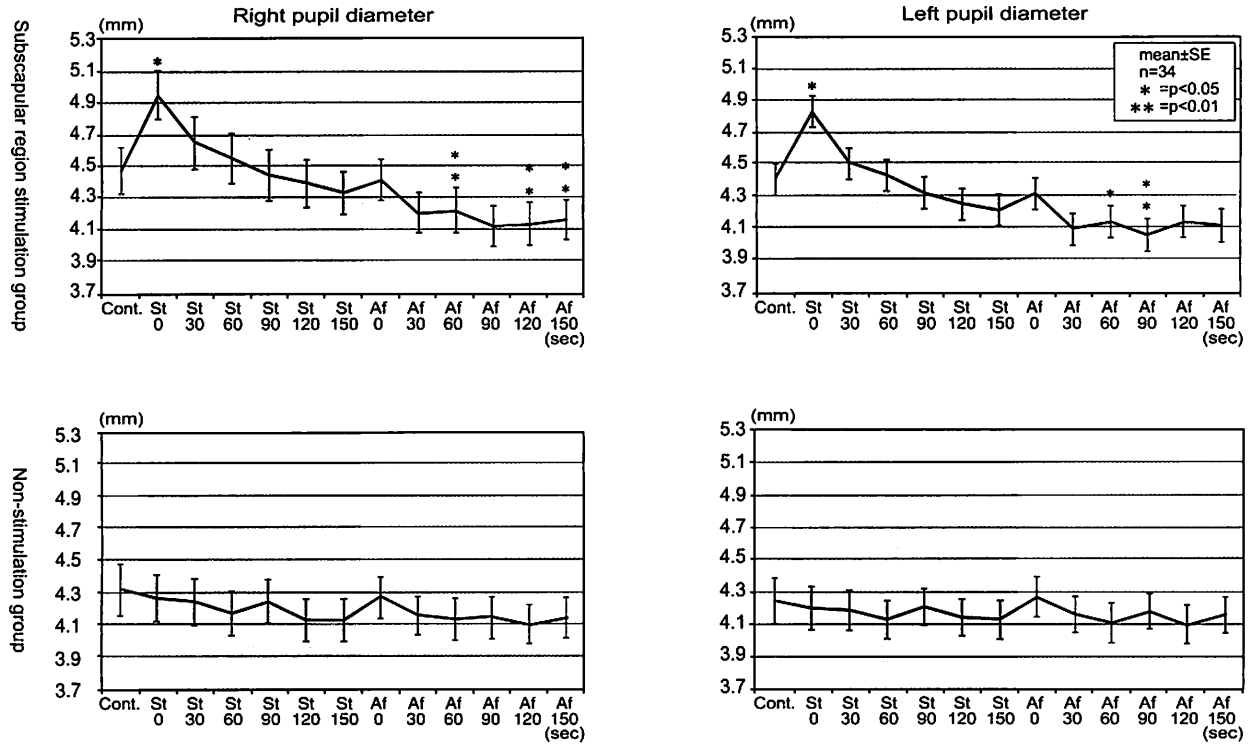

Fig. 6. Changes to pupil diameter due to shiatsu stimulation of the subscapular region
The vertical axis represents pupil diameter (mm) and the horizontal axis represents elapsed time (sec). On each graph, Cont: pre-stimulation (control); St: during stimulation; Af: post-stimulation. n = 34, mean ± SE, * p < 0.05, * * p < 0.01

III. Results

1. Pupil diameter (Fig.6)

Right pupil response: In the stimulation group, significant pupil dilation of 4.95 ± 0.91 mm (p < 0.001) was observed immediately after stimulation began, followed by gradual, continuing, significant pupil constriction observed post-stimulation at 60 sec. (4.17 ± 0.79 mm (p < 0.002)), 120 sec. (4.13 ± 0.80 mm (p = 0.003), and 150 sec. (4.16 ± 0.73 mm (p = 0.010)), compared to pre-stimulation (Control) values of 4.47 ± 0.85 mm (average ± SD). 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, significant pupil dilation of 4.83 ± 0.79 mm (p < 0.001) was observed immediately after stimulation began, followed by gradual, continuing, significant pupil constriction observed post-stimulation at 30 sec. (4.08 ± 0.64 mm (p = 0.029)) and 60 sec. (4.09 ± 0.71 mm (p = 0.004), compared to Control values of 4.40 ± 0.78. 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 (Fig. 7)

In the stimulation group, significant reduction in heart rate was observed during stimulation at 30 sec. (69.0 ± 9.6 bpm (p < 0.001)), 60 sec. (69.8 ± 10.0 bpm (p = 0.001)), and 120 sec. (70.4 ± 10.4 bpm (p = 0.032)), compared to the Control. value of 72.4 ± 10.3 bpm. In the non-stimulation group, no changes occurred. A comparison of chronological changes between the stimulation and non-stimulation groups indicated no cancellation effect (p < 0.001).

3. Blood pressure

No changes in systolic or diastolic blood pressure were observed in either the stimulation or the non-stimulation groups.

IV. Discussion

In this study, results indicated significant constriction of pupil diameter and decreased heart rate. Blood pressure did not show a significant response.

It has been reported that pupil dilation occurs in response to pain stimulation[15]. We may assume that a dilation response did not occur in this study because subjects received standard shiatsu stimulation, which

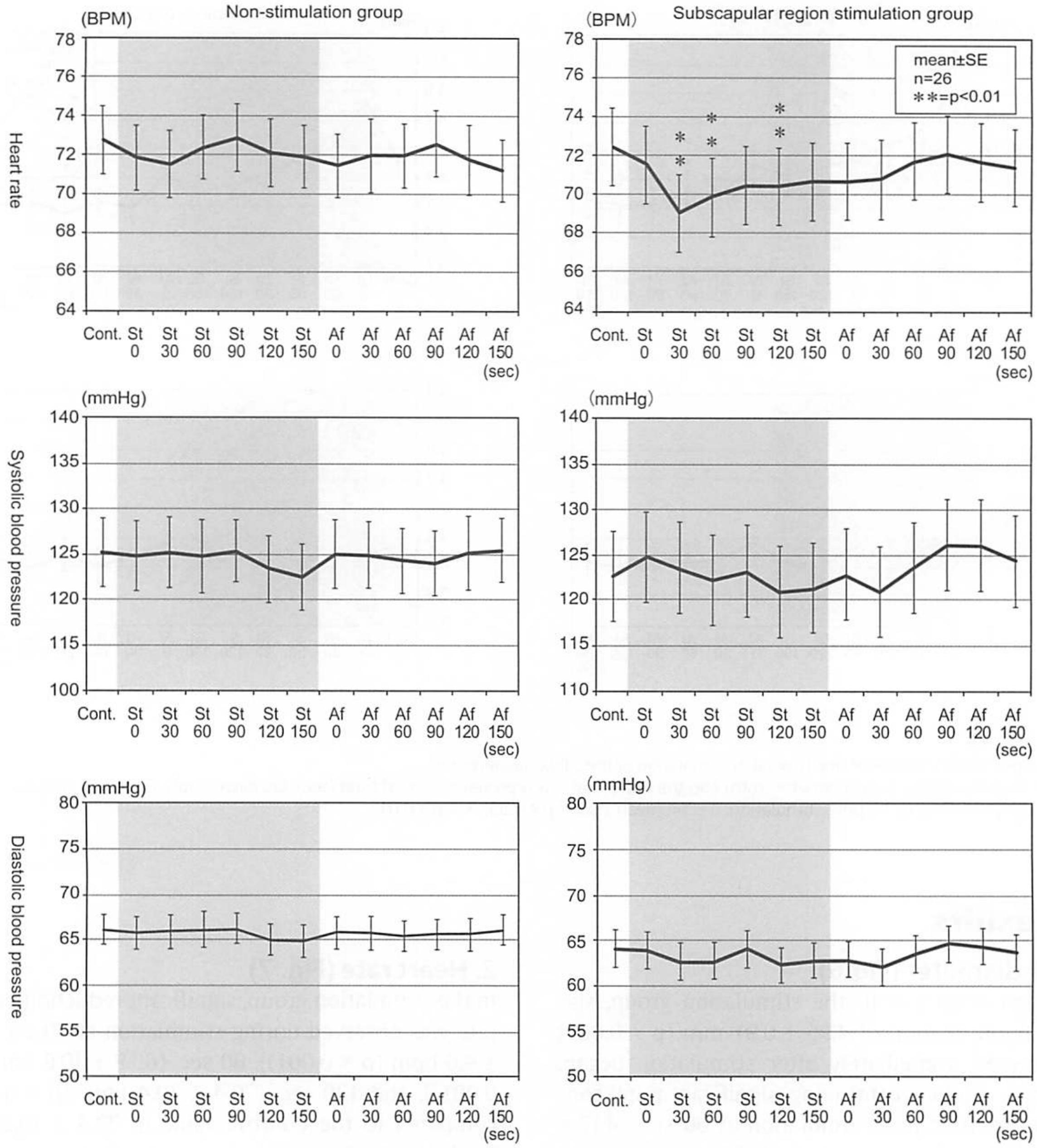

Fig. 7. Changes to heart rate and blood pressure due to shiatsu stimulation of the subscapular region
The graphs on the left represent the non-stimulation group and the ones on the right represent the subscapular stimulation group. On each graph, the vertical axis represents heart rate (bpm) or blood pressure (mmHg) and the horizontal axis represents elapsed time (sec).

is 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[16), 17)], but Ohsawa et al[18)] and Shimura et al[19)] 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 have confirmed that significant pupil constriction occurs with shiatsu stimulation to the abdominal, anterior cervical, sacral, head, antebrachial, interscapular, and lateral cervical and superior nuchal line regions[8)-14)]. The current study shows that a pupillary constriction response also occurs due to shiatsu stimulation to the subscapular region. This pupillary response suggests that shiatsu stimulation probably causes excitation of the parasympathetic nervous system.

A reduction in heart rate (pulse) was observed due to shiatsu stimulation of the subscapular region. Heart rate is known to be regulated by the beta sympathetic nervous system and the parasympathetic nervous system. In this study, shiatsu stimulation resulted in reduction of heart rate (pulse), from which we can infer that shiatsu stimulation probably either suppresses the beta sympathetic nervous system, stimulates the parasympathetic nervous system, or a combination of the two.

A significant reduction in blood pressure was not observed as a result of stimulation of the subscapular region.

However, previous research has reported that shiatsu stimulation of almost all areas of the body results in pupillary constriction and reduction of heart rate and blood pressure[2)-14)].

The fact that a change in blood pressure was not observed in this study, similar to what was reported by Ide et al[3)] in a study conducted using pain-free standard shiatsu stimulation, may be influenced by the fact that shiatsu was applied with the subject in the right lateral position, causing light pressure to be exerted on the abdominal aorta that led to a temporary rise in blood pressure. Further study is required to determine the effect of subject positioning during shiatsu application.

Previous studies have confirmed that shiatsu stimulation of almost anywhere on the body, including the abdominal, anterior cervical, sacral, head, antebrachial, interscapular, and lateral cervical and superior nuchal line regions, results in pupillary constriction and reductions in heart rate and blood pressure. The results of this study of the subscapular region also showed pupillary constriction and a trend toward reduced pulse, indicating that shiatsu stimulation probably elicits systemic stimulation of the parasympathetic nervous system.

V. Conclusions

From this study consisting of shiatsu stimulation of the subscapular region performed on healthy adults in the right lateral position, the following is evident:

1. Pupil diameter was significantly constricted, and a reciprocal effect was indicated compared to the non-stimulation group;
2. Heart rate was significantly reduced, with no reciprocal effect compared to the non-stimulation group;
3. No changes to systolic or diastolic blood pressure were ascertained.

The above indicates that shiatsu stimulation of the subscapular 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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