

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 rate¹⁻⁴, blood pressure¹⁻⁴, peripheral circulation³, and electrogastrograph activity⁴⁻⁶, 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.

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 $22 \pm 2.0^\circ\text{C}$ and humidity was $79 \pm 15.0\%$. 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. 1. Binocular electronic pupillometer



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.

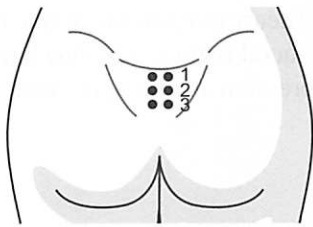


Fig. 3. Shiatsu points of the sacral region

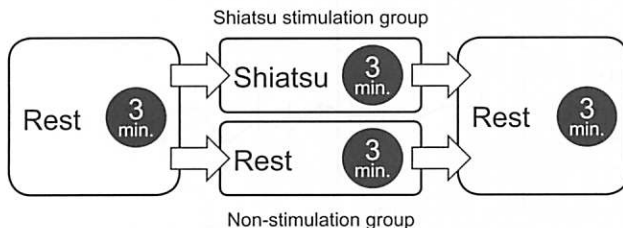


Fig. 4. Test procedure

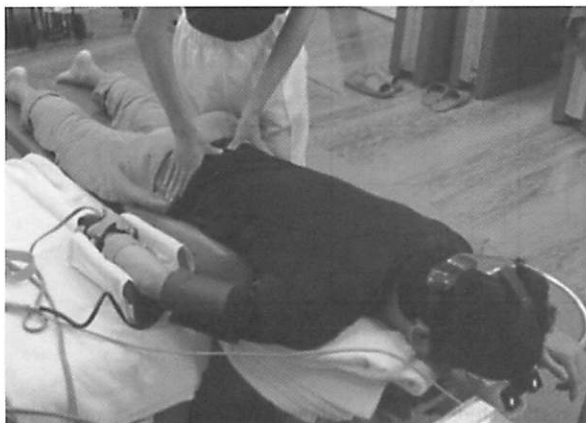


Fig. 5. Measurement using pupillometer and continuous blood pressure manometer

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 <math><5\%</math> 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 stimulation⁹, 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 al¹² and Shimura et al¹³ 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

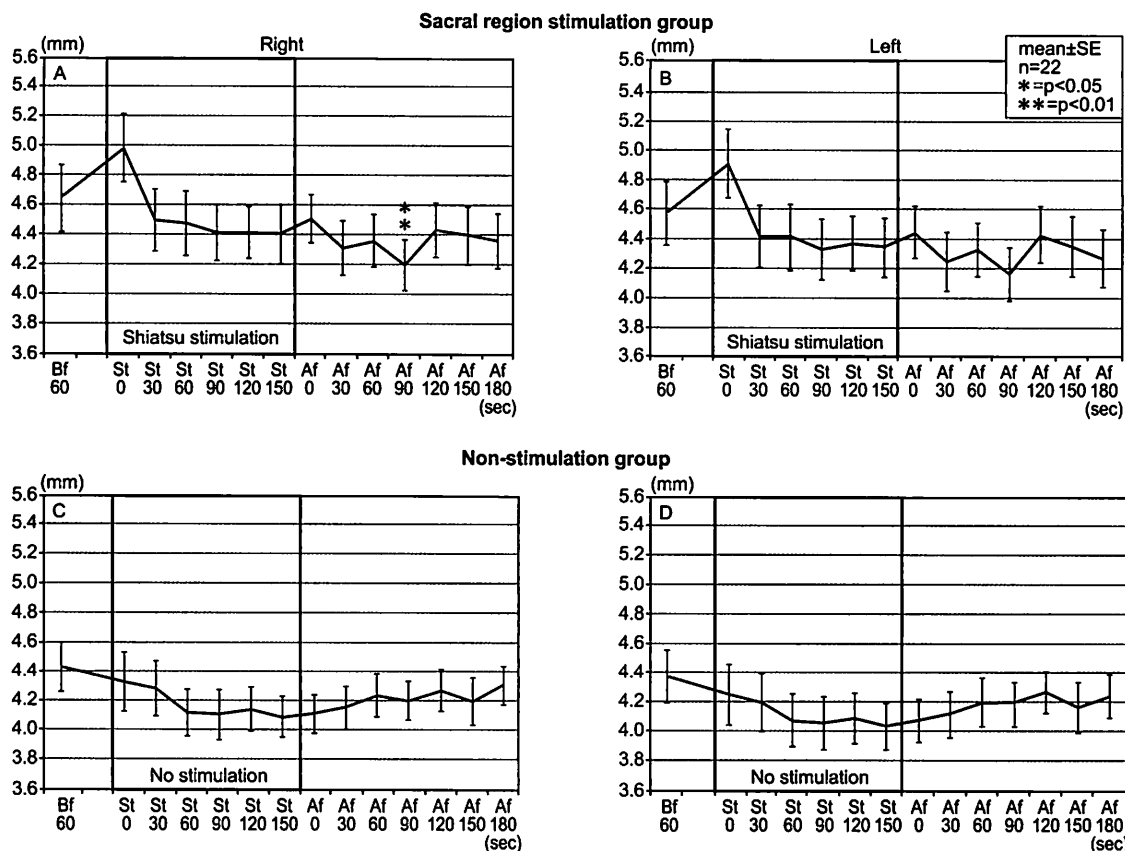


Fig. 6. Changes to pupil diameter due to shiatsu stimulation of the sacral region
 A: Right pupil (sacral region stimulation group), B: Left pupil (sacral region stimulation group), C: Right pupil (non-stimulation group), D: Left pupil (non-stimulation group). On each graph, the vertical axis represents 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 rate¹⁻⁴. 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 response²,

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 al², 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.

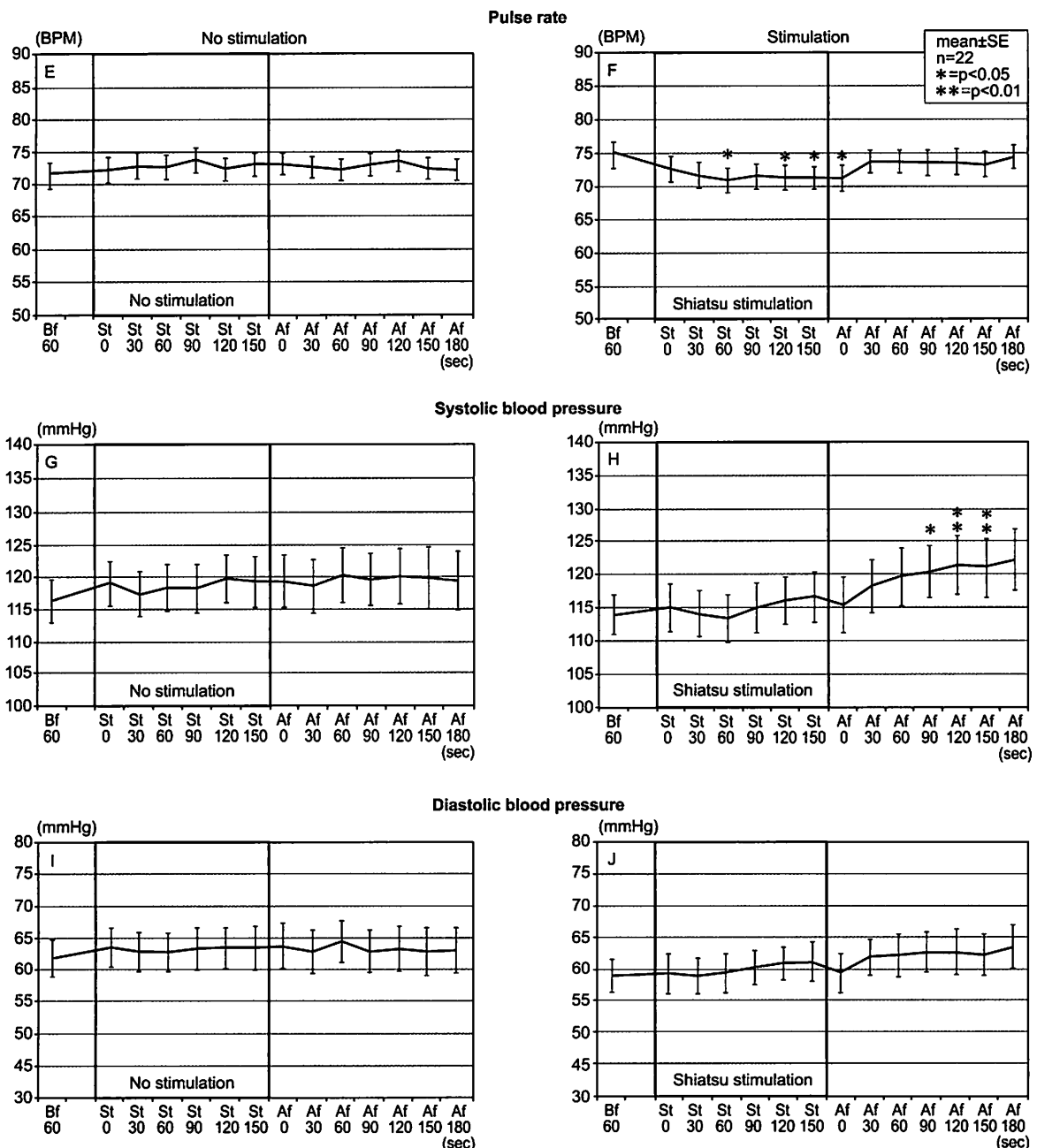


Fig. 7. Changes to pulse rate and blood pressure due to shiatsu stimulation of the sacral region

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.

References

- 1 Koyata S et al: Shiatsu shigeki ni yoru shinjunkankei ni oyobosu koka ni tsuite. *Toyo ryoho gakko kyokai gakkaiishi* 22: 40-45, 1998 (in Japanese)
- 2 Ide Y et al: Ketsuatsu ni oyobosu shiatsu shigeki no koka. *Toyo ryoho gakko kyokai gakkaiishi* 23: 77-82, 1999 (in Japanese)
- 3 Kamohara H et al: Massho junkan ni oyobosu shiatsu shigeki no koka. *Toyo ryoho gakko kyokai gakkaiishi* 24: 51-56, 2000 (in Japanese)
- 4 Kato R et al: Zenkeibu shiatsu shigeki ga jiritsu shinkei kino ni oyobosu koka. *Toyo ryoho gakko kyokai gakkaiishi* 32: 75-79, 2008 (in Japanese)
- 5 Sato K et al: Katai shiatsu shigeki ni yoru idenzu no henka. *Toyo ryoho gakko kyokai gakkaiishi* 30: 34-38, 2006 (in Japanese)
- 6 Kurosawa K et al: Fukubushiatsu shigeki ni yoru idenzu no henka. *Toyo ryoho gakko kyokai gakkaiishi* 31: 55-58, 2007 (in Japanese)
- 7 Kurihara K et al: Fukubu shiatsu shigeki ga dokochokkei ni oyobosu koka. *Toyo ryoho gakko kyokai gakkaiishi* 34: 129-132, 2010 (in Japanese)
- 8 Yokota M et al: Zenkeibu • katai gaisokubu no shiatsu shigeki ga dokochokkei ni oyobosu koka. *Toyo ryoho gakko kyokai gakkaiishi* 35: 77-80, 2011 (in Japanese)
- 9 Oono S: Pharmacological studies on pupillary reflex dilation. *J Pharmacol* 15: 91-112, 1965
- 10 Ward AAJ, Reed HL: Mechanism of pupillary dilation elicited by cortical stimulation. *J Neurophysiol* 9: 329-335, 1946
- 11 Lowenstein O, Loewenfeld IE: Role of sympathetic and parasympathetic systems in reflex dilation of the pupil: pupillographic studies. *Arch Neurol Psych* 64 (3): 313-340, 1950
- 12 Ohsawa H, Yamaguchi S, Ishimaru H et al: Neural mechanism of pupillary dilation elicited by electro-acupuncture stimulation in anesthetized rats. *J Auton Nerv Syst* 64 (2-3): 101-6, 1997
- 13 Shimura M, Ohsawa H, Tomita A, Sato A: Hifu shingai shigeki ni yoru hanshasei dokohanno. *Jiritsushinkei* 37 (5): 584-590, 2000 (in Japanese)