Comparison of Transient Heart Rate Reduction Associated with Acupuncture Stimulation in Supine and Sitting Subjects

Kenji Imai, Hiroshi Kitakoji

Summary
We investigated the difference in transient heart rate reduction associated with brief acupuncture in 20 healthy subjects at rest in a supine and in a sitting position. After the subjects had been at rest for about 20 minutes, acupuncture needling using the sparrow-pecking method, in which the needle is moved vertically lifting and thrusting, was performed for one minute at the Shousanli point on the right forearm (LI10). The procedure was carried out with the subjects in a supine position and in a sitting position. The position for stimulation of each subject, either supine or sitting, was selected at random, and on different days. The results showed that the average heart rate reduction associated with stimulation in supine subjects was 3.6±0.19 (mean ± standard error (SE)) beats per minute (bpm), while that for sitting subjects was about 7.0±1.07 (mean ± SE) bpm, indicating that stimulation reduces heart rate to a greater degree in subjects who are sitting (p<0.05, Mann-Whitney test). These results would be consistent with a mechanism involving reduced sympathetic drive to the heart, as sympathetic nerve activity has more influence on the heart rate in the sitting than in the supine position.

Keywords
Acupuncture, heart rate, autonomic nerves.

Introduction
It is already known that acupuncture stimulation induces a transitory reduction in heart rate.1-10 There are various views concerning the mechanism of this response, which is a general response that occurs when points on the arms, legs and trunk are stimulated.1 One is that it occurs via the efferent pathway of the parasympathetic nerves,1-3 while another is that it occurs via both the sympathetic and parasympathetic nerves.4-8 Also, Nishijo et al report that light stimulation which is applied while a seated subject is exhaling mostly inactivates the parasympathetic nerves,6 suggesting that posture is a major influence. Nevertheless, there are currently virtually no reports verifying this influence quantitatively.3

This is a report of an investigation of the difference between reduced heart rate associated with acupuncture stimulation in healthy subjects resting in a supine position or sitting.

Methods
This was an open experimental study with two phases for each subject.

Subjects
The subjects were 20 healthy volunteers (10 males, 10 females, average age 23). No subjects reported cardiovascular or pulmonary disorders, and none had taken any medications for at least two weeks before the study. The trials were conducted after receiving written consent from the subjects following a full explanation of trial details. The Ethics Committee of Meiji University of Oriental Medicine approved this study.

Measurement of Heart Rate
Three disposable Ag-AgCl electrodes were affixed to the subject’s chest, and measurement of the electrocardiogram (ECG) was performed using a bioelectric amplifier (1253A in Polygraph system 360, NEC-Sanei Company, Inc., Japan). The time constant and high cut-off filter of the recording equipment were set at 0.03 seconds and 30Hz, respectively. The amplified ECG signal was on-line digitised at 200Hz sampling rate by an analogue-to-digital converter (Mac Lab2e, A/D instruments) installed in a personal computer.
The R wave was ascertained from the electrocardiogram, and the heart rate continuously calculated on the software (charts 3.4 included with the Mac Lab2e, A/D instruments) (figure 1). Baseline measurement of heart rate was conducted over a 120 second period before acupuncture stimulation, and measurement continued for the 60 second period of acupuncture stimulation (figure 2).

Acupuncture Stimulation and Trial Period
A sealed envelope method was used to randomly select the posture of stimulation of each subject in the first phase of the trial. A computer generated random sequence (samplesize version 2) was used to create the order of envelopes by a researcher not directly involved in the experiment. The second phase for each subject was conducted on a different day. After they had rested for about 20 minutes in either a supine or sitting posture, the subjects received acupuncture stimulation for one minute to the Shousanli point on the right forearm (LI10). The sparrow-pecking method, in which the needle is moved vertically lifting and thrusting, was employed using stainless steel needles (0.18mm diameter, 40mm long, Seirin Group).
Co., Japan) inserted to a depth of 15 to 20 mm. All experiments were performed in a room with the temperature controlled between 25 and 27°C. A total of 40 experiments were performed: 20 during the first phase, in which the posture was selected by the random method detailed above, and a further 20 in the second phase in which each subject was tested in the relevant alternate posture.

**Statistical Analysis**

Wilcoxon's test was used to compare the heart rate before and after acupuncture in each posture, and the results are expressed as mean ± standard deviation (SD). The degree of transient heart rate reduction associated with acupuncture for individual subjects in each posture was compared using the Mann-Whitney test, and the results are expressed as mean ± standard error (SE). P-values below 0.05 were considered significant.

**Results**

The mean heart rate in supine subjects was 64 beats per minute (bpm) compared to about 73.6 bpm in sitting subjects, a difference of about 10 bpm. In supine subjects, the heart rate changed from 64±8.6 bpm before acupuncture needle insertion to 60.4±8.7 bpm after insertion, a decrease of about 3.6±0.79 bpm (p<0.05, Wilcoxon test) (figure 3-a). In sitting subjects, the heart rate changed from 73.6±9.6 bpm before acupuncture needle insertion to 66.7±8.7 bpm after insertion, a decrease of about 7.0±1.07 bpm (p<0.01, Wilcoxon test) (figure 3-b).

Comparing the reduction in heart rate associated with needle insertion for both postures, the greater reduction in sitting subjects is statistically significant (p<0.05, Mann-Whitney test) (figure 4).

**Discussion**

Transient heart rate reduction induced by acupuncture in humans has already been documented by many investigators. With regard to the mechanism of heart rate reduction associated with acupuncture needle insertion, among the previous reports there have been those that view accentuation of parasympathetic tone as playing a role, while others view both suppression of sympathetic tone and accentuation of parasympathetic tone as playing a role. Imai reported that atropine sulphate administration blocked the acupuncture-induced heart rate reduction, and he suggested that the mechanism that slows the heart rate is activation of the parasympathetic cholinergic system. Sugiyama et al showed muscle sympathetic nerve activity (MSNA) increased transiently with the suppression of heart rate during rotation of an acupuncture needle in the Tsusanli acupoint (ST36), and

![Figure 3](image-url) Changes of heart rate induced by acupuncture stimulation in supine subjects (a) and in sitting subjects (b).
concluded that the co-activation of cardiac vagal and muscle sympathetic nerves is evoked by the acupuncture stimulation. Finally, Nishijo et al reported an increase in cardiac vagal activity and a decrease in cardiac sympathetic nerve activity as reflex responses elicited by acupuncture stimulation applied to the forearm.6

The above findings, however, are based on observations in resting supine subjects. It is already known that the sitting position induces greater activation of the sympathetic nervous system than the supine position.11 This study investigated the heart rate changes resulting from acupuncture stimulation to a point on the forearm (LI10) in sitting subjects, i.e. when sympathetic nerve function is relatively accentuated, and in resting supine subjects. The results indicate a larger reduction in heart rate in the sitting subjects. Tamura et al reported that the R-R interval of the ECG was significantly prolonged during acupuncture in both supine and head-up (60° head-up tilt) positions.3 Increases in R-R interval due to acupuncture were not significantly different between the two positions, which does not compared fully with our results. We observed different heart rate changes between the supine and sitting positions. Even though our results are limited, they indicate that in sitting subjects with a heart rate that is influenced by a state of sympathetic activation, acupuncture needle insertion significantly reduces the heart rate. Therefore, it is speculated that there is a decrease in cardiac sympathetic efferent nerve activity during acupuncture in sitting subjects, which results in a slowing of the heart rate. Further research is needed to clarify the mechanism involved.

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Figure 4 Comparing the reduction in heart rate associated with acupuncture for both positions.
Reference list


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