Effects of Right Stellate Ganglion Block on the Autonomic Nervous Function of the Heart
—— A Study Using the Head-up Tilt Test ——

Satoshi Koyama, MD; Nobuyuki Sato, MD; Kimimoto Nagashima, MD*; Hitoshi Aizawa, MD; Yuichiro Kawamura, MD; Naoyuki Hasebe, MD; Hiroshi Iwasaki, MD*; Kenjiro Kikuchi, MD

The effect of peripheral sympathetic block on the autonomic nerve function of the heart was studied using the head-up tilt test (HUTT) and right stellate ganglion block (RSGB). Blood pressure (BP), heart rate (HR) and the parameters of power spectral analysis of HR variability recorded during the HUTT were measured in 8 patients with chronic pain syndrome before and after RSGB. In the control state, the mean HR and the LF/HF component recorded during HUTT significantly increased whereas the HF component markedly decreased. Conversely, the mean HR and LF/HF and HF components during HUTT did not significantly alter after the RSGB procedure. There were no significant differences between the BP values before and after RSGB. These results suggest that RSGB suppresses cardiac sympathetic function without significantly affecting BP and thus may be a safe and effective therapy for the chronic pain syndrome. (Circ J 2002; 66: 645–648)

Key Words: Cardiac sympathetic function; Chronic pain syndrome; Head-up tilt test; Heart rate variability; Stellate ganglion block

Methods

Patients

Eight patients with chronic pain syndrome of the right arm and who did not have evidence of cardiac disease or take any medications known to affect the cardiovascular system were studied (3 males/5 females; age range, 44–81 years, mean 55.7). All patients had undergone RSGB for pain management. All subjects were informed about the experimental protocol of the study.

Study Protocol

Patients remained supine for 20 min for the baseline electrocardiogram (ECG) and blood pressure (BP) recordings (Fig 1A), after which continuous ECG monitoring and a Holter ECG were begun. BP, which was measured in the right upper arm, and HR were recorded every minute. After recording the baseline measurements, the patients underwent the HUTT at 80 degrees for 20 min on a tilt table with a foot plate and a waist belt support (Fig 1B). Then, while they were still supine, they underwent pharmacologic blockade of the right stellate ganglion by means of the anterior paratracheal approach (Fig 1C); that is, a 21-gauge needle was passed anteriorly between the trachea and the carotid artery located several millimeters anterior to the lateral process of the spine. The stellate ganglion and surrounding tissue were infiltrated with 8 ml of 1% mepivacaine solution. All stellate ganglion blocks were performed by the same anesthesiologist. The success of the blockade was defined by the appearance of Horner’s syndrome (myosis, ptosis, and enophthalmos) and by an alteration in the warmth of the skin on the ipsilateral arm. After Horner’s syndrome was induced, the subjects were kept supine for 20 min in order to estimate the effect of the RSGB (Fig 1D) and then the HUTT was repeated at 80 degrees for 20 min for the...
Analysis of BP and HR
The BP and HR were recorded every minute and the data subdivided into 4 groups: control supine, control HUTT, RSGB supine and RSGB HUTT. Data were expressed as mean±SD.

Analysis of the Holter ECG
The Holter ECG data were reviewed on a computer display (Marquett 8000T, USA) by the same cardiologist, and frequency–domain analysis was performed with HRV software V2 (Marquett Co). A time series of 256 consecutive RR intervals comprising only normal sinus rhythm in a stationary state were selected. Power spectra were quantified by measuring the area in 2 frequency bands: the high frequency component (HF) from 0.15 to 0.40 Hz and the low frequency component (LF) from 0.04 to 0.15 Hz. The ratio of the LF components to the HF components (L/H) was also derived as an index of the sympatho-vagal balance. Data were again divided into 4 groups: control supine, control HUTT, RSGB supine, and RSGB HUTT. Data were expressed as mean±SD.

Statistical Analysis
Continuous variables were presented as mean±SD. The Wilcoxon signed-ranks test was used for statistical evaluation of the data analysis. A value of p<0.05 was considered significant.

Results
BP, HR and power spectral analysis parameters of HRV before and during HUTT are shown in Fig 2. In the control state, there were no significant differences between the mean systolic BP (SBP) and diastolic BP (DBP) in the supine position and during the HUTT (Fig 2A,B). On the other hand, the mean HR during the HUTT increased significantly (p<0.05) (Fig 2C), and the decrease in the HF during the HUTT was also significant (p<0.05) (Fig 2E). As for the LF and LF/HF components, there were no significant differences in the values of LF between the supine position and the HUTT, whereas the increase in the LF/HF during the HUTT was significant (p=0.0431) (Fig 2D,F).

After the RSGB procedure, there were no significant differences between the SBP or DBP recorded during the supine position and the HUTT (Fig 3A,B). The mean HR during the HUTT also did not increase significantly after the RSGB (Fig 3C). Furthermore, there were no significant differences between the LF and HF recorded in the supine position and during the HUTT (Fig 3D,E). Similarly, there was not a significant increase in the LF/HF during the HUTT after the RSGB (Fig 3F).

Discussion
We aimed to clarify the effect of peripheral sympathetic block on the autonomic nervous function of the heart using the HUTT in patients who had undergone unilateral SGB. The cardiac sympathetic block was estimated by measuring the spectral analysis of HRV components, because other studies have reported that as a useful method for separately evaluating the sympathetic and parasympathetic influence on the heart and it also enables quantitative analysis of cardiac sympatho-vagal tone.

All the present patients showed an increase in HR and all but one showed an increase in the LF/HF ratio during the HUTT in the control state. More importantly, we showed that there was not an increase in the HR and LF/HF during the HUTT after the RSGB.

In normal subjects, an increase in the HR and LF/HF ratio is usually observed with the HUTT and the mechanism is as follows: passive positioning in the upright posture during the HUTT induces blood pooling in the vessels.
Effects of Stellate Ganglion Block Using the HUT

Circulation Journal Vol.66, July 2002

Effects of Stellate Ganglion Block Using the HUT

Fig 2. Blood pressure, heart rate (HR) and HR variability (HRV) while supine (A) and during the head-up tilt test (HUTT) (B) before right stellate ganglion block (RSGB). The mean HR during the HUTT increased significantly (C), the decrease in the HF component during the HUTT was significant (E), and the increase in the LF/HF during the HUTT was also significant (F).

Fig 3. Blood pressure, heart rate (HR) and HR variability (HRV) while supine (A) and during the head-up tilt test (HUTT) (B) after right stellate ganglion block (RSGB). The mean HR during the HUTT did not increase significantly after RSGB (C) and there were no significant differences between the HF component and LF/HF recorded in the supine position and during the HUTT (E,F).

Effects of Stellate Ganglion Block Using the HUT

of the legs and a decrease in the pressure of the right atrium, which in turn stimulates the cardiopulmonary pressure receptors, resulting in activation of sympathetic fibers and inactivation of parasympathetic fibers. As a result, BP is maintained and HR increases. Activation of the sympathetic fibers is also induced by a decrease in the venous return and stimulates the receptors in the carotid sinus and aortic arch. This series of signals also activate the sympathetic fibers, which increases HR and cardiac output.

In the present study, the HR during the HUTT did not increase after the RSGB and furthermore, there was no significant increase in the LF/HF during the HUTT, suggesting that RSGB might suppress reflex cardiac sympathetic activity induced by stimulation of the cardiopulmonary pressure receptors.

On the other hand, none of the patients showed a reduction in BP during the HUTT after RSGB, although vasodilation of the vessels of the right arm may have occurred. It is possible that 8 ml of 1% mepivacaine solution may also affect cardiac sympathetic function and the vessels of the ipsilateral arm to some degree, resulting in a minimal change in the mean arterial pressure. Therefore, RSGB using that dose of 1% mepivacaine solution might be a safe therapy for patients who do not have cardiac disease or take any medications known to affect the cardiovascular system.

In our study, the HF component decreased during the HUTT in the control state, and this change was suppressed after RSGB. Generally, the HF component decreases during the HUTT, because of inactivation of the cardiac parasympathetic fibers followed by a decrease in venous return.

The HF component is also modulated by an increase in the respiration rate or a decrease in the tidal volume, and that the relationship between the amplitude of the HF component and cardiac parasympathetic activity is closely dependent on the respiration rate. This phenomenon does not result from a decrease in cardiac parasympathetic activity.

To investigate the effect of respiration on the HF component, we performed a blood gas analysis in all patients before and after the HUTT, and found that there was not a significant change in the HF component.

The decrease in HF after RSGB was not statistically significant, although 7 of the 8 cases showed a tendency. It may become significant if we increase the number of subjects, so further study is required.

In our study, autonomic nervous tone was also evaluated by the dynamic change in the HRV components, which confirms the effect of SGB on autonomic nervous activity more clearly.
Conclusion

Right SGB can suppress not only cardiac sympathetic function but also parasympathetic function without significantly affecting BP and therefore may be a safe and effective therapy for patients who are suffering from the chronic pain syndrome.

References