Influence of change in posture on the gastric myoelectrical activity in healthy subjects

Morimasa Kato and Fumitaka Asano
1) Department of Health and Nutrition, Yonezawa Women's Junior College of Yamagata Prefecture
2) Gram Corporation

Abstracts
Gastric motor activity is enhanced by increasing parasympathetic nerve activity. However, it is not known whether position changes affect the gastric myoelectrical activity. This study investigated whether the change from sitting to supine alters gastric myoelectrical activity using the electrogastrogram (EGG) technique. Eight healthy males participated in this study. They were tested in the sitting position for 20 minutes and then in the supine position 20 minutes. The EGG signals were analyzed using fast Fourier transformation, and we compared peak amplitude and frequency. The parasympathetic nerve activity was evaluated using the high-frequency (HF) components in the heart rate variability from electrocardiogram. The change in posture increased the amplitude of EGG, while the peak frequency did not differ in the two positions. The position change increased the HF components. These results suggest that it is necessary to keep the same body position for an accurate clinical evaluation of gastric myoelectrical activity.

Key words
Electrogastrogram, position change, parasympathetic nerve activity

Introduction
Gastric myoelectrical activity affecting gastric motility is regulated by intramural nerves, extramural autonomic nerves, the endocrine system, and blood flow. Therefore, changes in autonomic nerve activity caused by postural changes may also alter gastric myoelectrical activity. Gastric myoelectrical activity can be measured noninvasively from the abdominal surface using electrogastrography (EGG), which is widely used in clinical and physiological research. Parkman et al. reported indices for electrogastrographic measurement and showed that posture changes affect the EGG amplitude. However, there have been few reports on the effects of posture change on gastric myoelectrical activity, and no consensus has been reached.

Jonderko et al. investigated the effects of the sitting and supine positions on gastric myoelectrical activity on two different days. Although they found no difference in the two conditions before meal loading; the amplitude of the gastric myoelectrical activity was higher in the supine position with meal loading, and this was postulated to be due to the shorter distance from the electrode to the stomach in the supine position. Nagai et al. examined the acute effects of posture change on the EGG and reported that the gastric myoelectrical activity showed an increased appearance of peak amplitude frequency (peak frequency) and decreased spectral amplitude on changing from standing to supine positions. However, they did not consider the effects of autonomic nerve activity in their solely
postural change experiment. Further, because their EGG measurement time was shorter than used in other reports, the effects of postural change on gastric electrical activity were not examined adequately.

We hypothesized that the changes in gastric electrical activity associated with postural changes also involve autonomic nerve activity. We investigated the effects of changing posture from sitting to supine on the gastric electrical activity and autonomic nerve activity.

Methods

Subjects

Eight healthy male volunteers (age: 20.9±0.20 years, height: 170.0±2.61cm, weight: 62.7±2.94kg, BMI: 21.8±1.11) participated in this study. They had no present or significant past history of gastrointestinal disease. None of subjects had taken any medication. All subjects gave their informed consent to the experimental protocol.

Experimental procedures

The subjects were allowed to get accustomed to the apparatus to be used before measurement and the protocol for the testing session, and on the experimental day, they were allowed to visit the laboratory following fasting for at least 6 hours prior to the study. For the effect of position change, each subject was measured in a sitting position for 20 minutes and in the supine position for 20 minutes. In the sitting position, the subjects sat down depend of the backrest and both hands put on the armrest with chair. After the recording with seated position, the subjects were then lying on the table. The change in body position was completed within one minute. The subjects were asked to awake, not to talk and to remain as still as possible the whole recording period to avoid motion artifacts.

Electrogastrography

Five Ag/AgCl adhesive disc electrodes (11mm diameter, Vitrode M, Nihon Kohden, Tokyo, Japan), which were filled with electrolytic gel, were attached to the abdominal skin surface. The skin surface was cleaned and gently scrubbed until the appearance of redness in order to minimize the skin impedance. The arrangement of four electrodes and one reference electrode is shown in Figure 1. Four channel monopolar recordings were conducted with a portable recording device (Nipro EG, Nipro, Osaka, Japan). EGG signals were isolated using a band-pass filter between 2.1 cpm (roll off, 18 dB/octave) and 5.4 cpm (roll off, 48 dB/octave), and then digitally recorded (13 bits) at sampling rate of 1Hz. The EGG data was transferred to a personal computer via RS-232C port, and running spectral analysis was performed with analytical software (BIMUTAS II, Kissei Comtec, Japan). A spectrogram was calculated from using the fast Fourier transform (FFT) with Hanning window. The waveform obtained from the EGG was a wave of about 3 cycles per minute, and considering the component of the frequency of 2 - 4 cpm as a normal range of frequency (1-3), its amplitude and the peak frequency were compared.
Electrocardiography

Three Ag/AgCl disk electrodes (11mm diameter, Vitrode M, Nihon Kohden, Tokyo, Japan) were attached to the chest wall. The electrodes were filled with electrolytic gel to attach using adhesive tape. The skin was cleaned and abraded at the site of lead attachment in order to minimize the skin impedance. The ECG was recorded from a bipolar lead of chest and all signals were digitized at sampling rate of 1 kHz using 16 bits analog to digital converter (Powerlab 8/30, ADI Instruments Japan Inc.). The converter was connected to a personal computer (Mate J, NEC Corporation) and signals of ECG were stored on a hard disk for later analyses. The ECG analyses were performed with commercial software (BIMUTAS II. Kissei Comtec, Japan).

After passing through a digital band pass filter with a pass band from 0.5 to 30 Hz, the R wave in the ECG signal was detected by a peak detection algorithm in the software. After the positions of all R wave peaks were confirmed, the beat to beat R-R intervals were resampled at 1 Hz using linear interpolation to obtain an equally sampled time series. After passing through Hanning window, a spectral analysis was performed 512 sample points for R-R intervals of the HR using the FFT. The components were classified as very low frequency (VLF) below 0.04 Hz; LF between 0.04 and 0.15 Hz; and HF between 0.15 and 0.4 Hz. In this study, we used the HF component as index of cardiac vagal nerve activity, since the validity physiological background of VLF and LF components has been argued and vagal nerve activity has been shown to be related to gastric motor activity. To examine the relative contribution, the power of HF was normalized by dividing each by total power minus VLF and multiplying this value by 100.

Analysis and statistical treatment

The intervals to be analyzed by EGG and HF component in the heart rate variability were divided into 10 minutes. The value of the first half 10 minutes and the latter half 10 minutes were averaged. Each phase of EGG data was evaluated an average value from four electrodes. The numerical value was expressed by the mean and standard error. The effects of position change were tested by paired t test. These analyses were performed with commercially available statistical software (SPSS 9.01J SPSS Inc., USA). The probability level of 5% or lower was used.
Results

Electrogastrography

The amplitude of dominant frequency of EGG, the supine position was significantly higher than the sitting position (43.0 ± 4.59 μVp-p and 32.8 ± 5.79 μVp-p). The peak frequency of EGG, there was no significant difference in the peak frequency of EGG between two positions (2.84 ± 0.06 cpm and 2.79 ± 0.05 cpm) (Figure 2).

![Figure 2](image)

**Figure 2 Comparison of peak power and frequency of EGG between sitting and supine position**

Value are expressed as the mean ± SE (n=8). *: significant difference (p<0.05).

Electrocardiogram

HF component in the heart rate variability

The HF component in the heart rate variability, the supine position was significantly higher than the sitting position (44.7 ± 4.79 and 30.0 ± 4.34) (Figure 3).

![Figure 3](image)

**Figure 3 Comparison of HF component in the HRV between sitting and supine position**

Value are expressed as the mean ± SE (n=8). **: significant difference (p<0.01).
DISCUSSION

This study investigated the effects of postural change on the gastric myoelectrical activity using the EGG technique. There was an increase in the amplitude of the EGG and in the HF component of the heart rate variability (HRV) on changing posture from sitting to supine. Therefore, changes in autonomic nerve activity that accompany the postural change modify the gastric myoelectrical activity. Consequently, in order to exclude the effects of position change, it is necessary to keep the same position during an EGG recording.

Autonomic nervous activity, endocrine factors, and blood flow may involve in the increased gastric myoelectrical activity associated with postural change. In this study, we inferred that the increased parasympathetic nerve activity accompanying the postural change was reflected in the increase in gastric myoelectrical activity. Since postural change from sitting to supine increased the HF component of the HRV, it is likely that parasympathetic nerve activity was augmented. It has been reported that increased parasympathetic nerve activity increases gastric myoelectrical activity.\(^{11,12}\)

Previously, when examining postural change and gastric myoelectrical activity, Nagai et al.\(^{7}\) reported that gastric myoelectrical activity decreased in a supine position. This result differs from ours. However, since their study did not clarify the changes in autonomic nerve activity accompanying the postural change, this point cannot be compared. In addition, their EGG recording lasted only five minutes, which differed from our study. This difference is also likely to be a factor in causing the different results. Jonderko et al.\(^{6}\) investigated the effects of food consumption in the sitting and supine positions on two different days and reported that gastric myoelectrical activity was increased in the supine position after eating. They concluded that this was because the distance between the electrodes and stomach was shorter in the supine position. We did not measure the distance from the stomach to the electrodes, but postulate that this is one factor in the increased gastric myoelectrical activity in the supine position.

No effect associated with postural change was observed in the peak frequency. Nagai et al.\(^{7}\) reported an increased peak frequency on changing posture to the supine position, but did not discuss this. Other reports indicate that the peak frequency increases with food consumption and decreases with psychological stress.\(^{9,13,14}\) Possible factors in these changes in the peak frequency are nervous system, endocrine, and blood flow factors. We observed no effect of postural change on the peak frequency because there was no burden in physical and/or psychological stimulation, such as food ingestion and psychological stress, and the subjects' contractile rhythms were within the normal range.

Although no consensus has been reached in previous reports on postural change and gastric emptying after eating, most researchers suggest that the gastric emptying of a liquid meal is slower in the supine position, as compared with sitting,\(^{15-17}\) while postural change reportedly has no effect on solid meals.\(^{18}\) In our study, increased gastric myoelectrical activity was observed in the supine position, as compared to the sitting position. This suggests that when we eat a solid meal in the supine position, it reduces the efficiency of peristalsis activity, since gastric motor function is increased in the supine position. Further investigation is needed to examine this point.

This study clarified that gastric myoelectrical activity is affected solely by changing posture, without meal loading. Autonomic nerve activity may be among the factors involved in this. This confirms the need to maintain a fixed position during EGG measurement for appropriate evaluation of gastric activity.
References

姿勢変化が胃電気活動へ与える影響

加藤守匡1）、浅野文隆2）
1）山形県立米沢女子短期大学　健康栄養学科
2）グラム株式会社