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THE EFFECT OF TRANSCUTANEOUS NERVE STIMULATION (TENS) ON GASTRIC ELECTRICAL ACTIVITY

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TENS became widely accepted method of treatment pain syndromes in clinical practice. Lately has been shown that its affects also gastrointestinal tract by releasing NANC neurotransmitter VIP. The aim of this study was to evaluate the effects of TENS on gastric myoelectric activities measured by electrogastrography (EGG). Eighteen healthy men (mean age 23.1 ± 1.7) were included in the study. Healthy volunteers were divided on 3 groups each 6 persons: with normogastria occurring at 94.5 ± 7% of recording time — group A, with predominant bradygastria (36.6 ± 14%) — group B and with tachygastria (33 ± 14%) — group C. In fasted condition EGG (Synectics, Sweden) was recorded with skin electrodes. TENS 15 min was performed with use of Sinus 5 stimulator (6 Hz, 0.1ms duration, intensities 10 — 20mA, Zimmer, Germany). Stimulating electrodes were placed on non-dominant hand.

Results: None of the subjects during TENS reported any side effects or symptoms, during all studies. In group A in the fasting recordings, after TENS, an decrease of the normal values in the range 2 — 4cpm down to 78.5 ± 21% of recording time (p = 0.03) occurred. The dominant frequency in the bradygastric region increased up to 17.7 ± 7% of the total recording. In group B TENS decreased bradygastria level from 36.6 ± 14% to 20.6 ± 15% (p = 0.02). TENS did not significantly affect tachygastria in group C. Amplitude of the EGG signal after TENS in group B and C increased by 40 and 150% respectively (p < 0.05). Significant decrease of the amplitude was observed in group A (13%). We conclude that TENS by activating centrally mediated somato-visceral reflexes affects gastric electrical activity. Our results suggest that TENS may be useful in treatment of the gastric dysrhythmia.

Key words: Transcutaneous Electrical Nerve Stimulation (TENS), electrogastrography (EGG)

INTRODUCTION

Transcutaneous Electrical Nerve Stimulation (TENS) is one of the most used neuromodulating techniques that has been widely accepted treatment for pain syndromes (1). The mechanisms of the TENS consist both direct influence
on the autonomic system and an indirect effect on release hormonal mediators like encephalins and VIP (2). TENS induced neuromodulation, activates of somato-visceral reflexes, changes the afferent autonomic impulsation and autonomic nervous system effects on visceral organs (2). Somatic and visceral afferents converge on the same neurons in lamina 5 of the dorsal horn of the spinal cord. TENS by increasing afferent output could activate visceral reflexes relaying not only at the level of spinal cord and prevertebral ganglia but also at central connections.

The application of TENS in gastroenterology has shown that the stimulation decrease lower esophageal sphincter LES and sphincter Oddi basal pressures (3, 4). Moreover TENS has been lately used in the treatment of cardiac ischemic syndromes because its pain inhibiting effects and reducing adrenergic activity as indicated by reduced catecholamine levels (5). On the other hand there is certain level of functional integrity of autonomic innervation between heart and gastrointestinal tract as has been shown by Gayheart (6) and Nakai (7). They proved that esophageal or gastric distentions induce cardiovascular responses. This facts implement that TENS effects on cardiac autonomic system could also affect gastric myoelectric activity.

It is well known that gastric motility is governed by its intrinsic electrical rhythm that is by modulated the parasympathetic, sympathetic and enteric nervous system and gastrointestinal hormones. Electrogastrography (EGG), skin recording of gastric electrical control activity (ECA) has an established place in diagnosis of functional gastric disturbances, being noninvasive method of measurement gastric myoelectric activity (8, 9). It has been proved by Hausken (10) that stress related changes in autonomic system function are responsible for antral dysmotility. Thus it could be hypothesised that both TENS action on cardiac nerves and peptides release should induce change gastric myoelectric activity.

Aim of this study was to evaluate the effects of TENS on gastric myoelectric activities in healthy subjects.

MATERIALS AND METHODS

Study subjects

Eighteen healthy men, non-smokers, no drinking, taking no drugs, aged 20 — 23 (mean age 21 ± 1.7), included in the study had neither clinical symptoms or pathological changes found in ultrasonographic and endoscopic examinations in the upper part of the GI tract. (Table 1). The patients were informed about the purpose of the study and agreed to participate. The consent was obtained from the Board of Local Ethics Committee Protocol. The examinations were performed after a 12 h fasting period, at rest in supine
position. The investigations were commenced 20 min after the patient had taken his supine position, starting with 1 hour fasting EGG. Afterwards, through the period of 15 min TENS was carried out. After the end of TENS, completed EGG was performed through the next period of 1 hour. In control studies recording of EGG on separate days in the same subjects in random fashion were repeated with TENS electrodes placed but not activated (sham stimulation).

TENS

Transcutaneous electrical nerve stimulation was performed by means of a stimulator Sinus 5 (Zimmer Electromedizin — Germany). Electrodes were placed on non-dominant hand, a negative one on the dorsal web between the first and the second metacarpal bones and positive at the ulnar border of the same hand dermatomes C8 — Th1 (11). These dermatomes were selected in order to elicit centrally relaying somatovisceral reflexes. The stimulation was being carried out for 15 minutes using low frequency currents 6 (Hz), of 0.1 ms duration at intensities of 10 — 20 (mA) until reaching sub-threshold stimuli (or paresthesia) in the stimulated hand. Each patient has threshold TENS stimulation determined on separate day. Threshold values of TENS were then used in experimental series.

EGG

Using an EGG recorder Digitrapper III (Synectics, Sweden) made Electrogastrography. Using Hamming window of 111 sec modified equipment Electrogastrogram 6.3 (Synectics, Sweden). Motion artefacts caused by the interference with coughs and movements of the patients, defined as an elevation of the baseline in all frequency spectra were visually inspected and cancelled. After visual inspection of recording artefacts caused by the

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<tr>
<th></th>
<th>Group A</th>
<th>Group B</th>
<th>Group C</th>
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<tbody>
<tr>
<td>Number</td>
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<td>n = 6</td>
<td>n = 6</td>
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<tr>
<td>Sex (M/F)</td>
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<td>4/2</td>
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<tr>
<td>Age (yr.)</td>
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<td>23 ± 2.6</td>
<td>23 ± 3.4</td>
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<tr>
<td>Range</td>
<td>19 — 41</td>
<td>20 — 27</td>
<td>19 — 26</td>
</tr>
<tr>
<td>Type of dysrhythmia</td>
<td>Predominant normogastria (94.5 ± 7%)</td>
<td>Predominant bradygastria (36.6 ± 14%)</td>
<td>Predominant tachygastria (33 ± 14%)</td>
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Table 1. Characteristic of patients.
interference with coughs and movements of the patients were eliminated, computer-based analysis of the results was obtained. Transcutaneous electrodes Ag-AgCl were placed on the standard points of the prepared skin location. Therefore artefacts were not considered in the computer-based analysis of the results. Cutaneous electrodes Ag-AgCl were placed on the prepared skin location in the standard position along the antral axis in the upper abdomen. EGG recording lasted at least two hour in TENS and sham stimulation experiments. EGG spectral analysis divided powers in bradygastria (0.75—2 cpm), normogastria (2—4.5 cpm) and tachygastria (4.5—9 cpm) frequency range.

Statistical Analysis. For statistical evaluation of EGG values between control and TENS experiments were compared using paired Student’s t test. Results are expressed as mean ± SD.

RESULTS

Investigated subjects were divided on 3 groups each 6 persons; group A with normogastria occurring at 98 ± 4% of recording time, group B with dysrhythmias,
predominant bradygastria 39 ± 9% and group C with tachygastria type 33 ± 9% of recording time.

**Effect of TENS on EGG**

None of the subjects during TENS reported any side effects or symptoms, during the all studies. In group A in the fasting recordings, after TENS, an decrease of the normal values in the range 2 — 4 cpm down to 78.5 ± 21% of recording time (p < 0.05) occurred. The dominant frequency in the bradygastric region averaged 17.7 ± 7% of the total recording. In group B TENS decreased bradygastria level from 36.6 ± 14% to 20.6 ± 15% (p < 0.05) after TENS bradygastria returned to prestimulation level. TENS did not significantly affect tachygastria in group C (Fig. 1). Amplitude of EGG signal after TENS in group B and C increased by 40 and 150% (p < 0.05) respectively. Decrease in the amplitude of the signal in comparison to control values was observed only in group A by 13%. (Fig. 2).
DISCUSSION

Wall and Sweet (1967) (12) primarily used TENS in the treatment of pain in sixties on the basis of gate theory of pain introduced by Melzack and Wall (1988) (13). Guelrud e et al. (1991) (3, 4) described relaxatory effects of TENS on lower esophageal sphincter (LES) pressures and basal sphincter Oddi pressure in patients with achalasia and biliary dyskinesia. He attributed these effects of TENS to 30% increase in plasma VIP level that is known neuropeptide with inhibitory neurotransmitter activity in nonadrenergic noncholinergic (NANC) pathways of autonomic nervous system (ANS) (2, 14). These responses of ANS has been explained as an overflow of the neuronal release of VIP, but ANS during TENS may release also other neurotransmitters contained in VIPergic neurons such as peptide histidine isoleucine (PH I), neuropeptide Y (NPY) and galanin (15, 16). Chang et al. (2) used TENS to stimulate esophageal acupuncture points and observed improved LES relaxation and percent of peristaltic contractions in the esophageal body. They suggest that TENS activate somato-visceral reflexes. TENS techniques have been shown to be beneficial in patients with angina and the syndrome X patients. Sanderson et al. (1997) (19) observed in syndrome X patients fall in the heart rate x pressure product after TENS. Effects of electrical stimulation depends of frequency and localisation of stimulation (20, 21, 22).

Gastric ECA (slow waves) originate in a pacemaker region located on the greater curvature of the stomach. The slow waves are propagated distally and circumferentially and ultimately migrate towards pylorus every 20 (s) in man. Thus normal frequency gastric slow waves is approximately 3 cycles per minute (23). Effects of TENS lasted more then one hour. This suggest that in TENS action on gastrointestinal tract other then the gate theory mechanism must be involved, probably resetting activity of the spinothalamic cells, by recurrent inhibition of preganglionic sympathetic cells and/or spinobulbar mechanisms (24). Similar to our results were obtained by Camilleri et al. (1984) who by activating somato-visceral reflexes with TENS observed reduction of antral motility index but not change in pulse, blood pressure or circulating catecholamine levels. Differences may be caused by Camilleri’s different experimental design, feeding, rate pulse measurements and invasive procedure like tracheal intubation or blood sampling. He attributed effects of TENS to increased plasma beta-endorphin level (11). Lack of amplitude increase after TENS in our studies strongly supports his observation of decreased antral motility. Opposite results of electrical stimulation of acupuncture points observed Lin et al. (1997). After electrical stimulation he observed an increase in the percentage of normal frequency slow waves. However he stimulated acupuncture point not nerves, located not only on hand, but also on legs and he used high stimulation frequency. Besides his native Chinese patients have high degree of gastric dysrhythmia (21).
We conclude that TENS by activating centrally mediated somato-visceral reflexes of brain-gut axis influence gastric electrical activity. Our results suggest that TENS could be probably useful in treatment of the functional disturbances of gastric myoelectric activity.

REFERENCES


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