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The effect of brain death and coma on gastric myoelectrical activity

STOMACH

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Original Article

ABSTRACT

Background/Aims: Gastrointestinal motility problems and delayed gastric emptying in patients admitted to intensive care units are important because they can contribute to different problems. Herein we aimed to measure the changes in gastric myoelectrical activity with electrogastrography (EGG) following brain death (BD) and compare the results to those from patients in a deep coma without BD.

Materials and Methods: Fifteen patients with BD and nine in a deep coma with a Glasgow Coma Score from 3 to 8 were included. An enteral nutrition solution was given via a nasogastric tube between 45 min of fasting and the postprandial periods. The mean dominant frequency (MnDF), normal gastric slow wave ratio (%), tachygastria and bradygastria (%), power ratio (PR: dominant power after test meal/fasting), and dominant frequency instability coefficient were evaluated.

Results: The median of MnDF was determined 3.20±0.6 (BD) vs 3.05±0.5 (control), p>0.05. Patients with BD displayed tachygastria, particularly during the fasting state, with this disturbance decreasing during the postprandial period (from 41% to 15%). However, none of the differences between the groups were statistically significant. PR was pathologic in 4/15 (26.7%) patients in the BD group and 4/9 (44.4%) patients in the control group (p=0.288).

Conclusion: Patients with coma or BD bouth might have gastric myoelectrical activity disturbances. BD does not show more severe disturbance than coma wihouth BD. EGG might be useful as a non-invasive and easy-to-use technology; however, it needs further improvement.

Keywords: Brain death, enteral feeding, gastric myoelectrical activity, gastric emptying

INTRODUCTION

Many gastrointestinal motility problems, particularly delayed gastric emptying, are seen in patients admitted to intensive care units (ICUs). However, scientific data regarding these problems are limited (1). Gastric emptying problems are particularly important because they can cause problems such as gastric distention, nutritional intolerance, gastroesophageal reflux disease, and pulmonary aspiration. Different methodologies have been used to detect gastric retention, but with limited success.

Patients with critical conditions should not be moved and cannot wait for 4 h, and this restricts the use of the gold standard test: gastric emptying scintigraphy with a solid meal. The measurement of gastric retention using the paracetamol absorption technique, the ultrasound-assisted measurement of gastric volume, and 13 C-labeled octanoic acid are other tests that have had very limited success, while the satiety drink test cannot be performed on these patients.

Electrogastrography (EGG) is a non-invasive, ambulatory test that is an indirect marker of gastric contractility and emptying, and it has been used for years to measure the gastric myoelectrical activity (2,3). This technique detects gastric pacemaker abnormalities, including bradygastria, tachygastria, and arrhythmia, as well as a food-related increase in the power of myoelectrical activity from skin electrodes. Its clinical usefulness is still under evaluation (4). It has been emphasized that EGG by itself cannot diagnose a specific disease, but it can show evidence of gastric motor dysfunctions. This might be similar with other techniques such as gastric emptying.

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Patients with brain death (BD) are candidates for organ transplantation but need to remain in an adequate nutritional state. Enteral access for nutrition is always preferable; however, it is not always possible for reasons such as gastric emptying problems. No data exist on changes in gastric myoelectrical activity and emptying following BD, and changes in gastric myoelectrical activity that occur in case of a breakdown in brain function are unknown. The only study that has used EGG has shown that dysrhythmias increase following brain trauma-related coma (1).

In the present study, we aimed to measure changes in gastric myoelectrical activity with EGG following BD and compare the results to those from patients in a deep coma without BD (CWBD) to evaluate the value of EGG as a non-invasive test.

MATERIALS AND METHODS

Fifteen patients (group I) within the criteria of BD according to the Turkish Transplantation Association and nine patients (group II) with coma (Glasgow Coma Score 3–8) were included. The mean age was 45.5 (17–69) years for group I and 41.0 (18–63) years for group II (p=0.59) (Table 1). Demographic data, patient characteristics, and blood test results were recorded.

All patients were mechanically ventilated and had nasogastric tubes at least five days before the study for enteral nutrition. Cutaneous gastric myoelectrical activity was measured with an EGG equipment (MMS; The Netherlands, UPS-2020) following an 8h fasting period. The first 45 min of the fasting period was recorded and followed by an enteral nutrition solution (Biosorb oral 300 mL, 300 kcal, 35% fat) given at room temperature via a nasogastric tube for over 30 min with a perfusion pump. Another 45 min of postprandial recording was completed. All medications and mechanical ventilation parameters were kept stable during the measurements.

As shown in Figure 1, bipolar active surface electrodes were placed along the antral axis. The skin was carefully shaved when necessary. All measurements were recorded at a frequency of 1 Hz with six surface electrodes and one reference electrode. The internal high- and low-pass filters were set at 1.8 and 16 cpm, respectively. The running spectral analysis method was used for the electrogastrographic recordings (5). The collected data were digitized and then analyzed with a computer program (Orion2 ver.8.2; MMS, The Netherlands). Each tracing was visually evaluated by a blinded observer to exclude possible artefacts, and artefacts were eliminated. Dominant frequency, normal gastric slow wave ratio (NGSW %), tachygastria and bradygastria (%), power ratio (PR: dominant power after test meal/fasting), and the dominant frequency instability coefficient (DFIC) were evaluated. A mean dominant frequency (MnDF) of gastric slow waves from 2.4 to 3.7 cpm was defined as normogastria, from 3.7 to 9 cpm as tachygastria, and from 0.5 to 2.4 cpm as bradygastria. A normogastria ratio of ≥70% was accepted as normal, which means that ≥70% of MnDF within the measured period was within normal values. A PR (MnDP after test meal/fasting) ratio of >1 reflected an increase in gastric contractility and of ≤1 was accepted as pathologic as MnDP was expected to increase after a meal. The results obtained from patients with BD were compared to those from the control group who were without BD but were in a deep coma.

Exclusion criteria were as follows: pregnancy, active upper gastrointestinal bleeding, pancreatitis, chronic renal failure, cancer except non-melanoma skin cancers, alcoholism, drug abuse, known gastrointestinal motility disease, rheumatologic diseases such as progressive systemic sclerosis, abdominal surgery except hysterectomy, abdominal hernia correction, appendectomy, uncontrolled diabetes mellitus, or any other disease that may have an effect on EGG. Written informed consent was obtained from all patients' relatives. The study was approved by the Ege University Ethical Committee 05-11.2/11-26.12.2005.

RESULTS

Fifteen patients (group I) with BD and nine patients (group II) in a deep coma, giving a total of 24 patients, were included in the study. All the BD patients were receiving inotropic and/or vasopressor medications, except for two patients in this group.

The majority of patients had central nervous system diseases, such as subarachnoid hemorrhage, subdural hematoma, or post-CPR hypoxia (Table 2). The median of dominant frequency was found to be 3.20±0.6 (BD) vs 3.05±0.5 (control), and no significant difference was found (p>0.05).

Percentage of Normal Gastric Slow Waves: All measurements were pathologic and exhibited <70% for normal gastric slow waves (NGSW), except for postprandial normogastria in the control group (coma patients). As shown in Figure 2, patients with BD demonstrated tachygastria, especially in the fasting state, but this disturbance decreased during the postprandial period (from 41% to 15%). None of the differences between the groups reached statistical significance.

Table 1. Demographic data and laboratory values of the groups

	Age	Man/Woman	Sodium (mmol/L)	Potassium (mmol/L)	Calcium (mg/dL)	Glucose (mg/dL)	Creatinine (mg/dL)
Group I	45.5 (17–69)	8/7	153±12	3.8±0.8	0.87±0.1	217±124	1.7±1.05
Group II	41.0 (18–63)	8/1	144±11	3.8±0.7	0.88±0.1	167±38	1.13±0.43

* p>0.05 for all comparisons except gender and blood glucose levels.

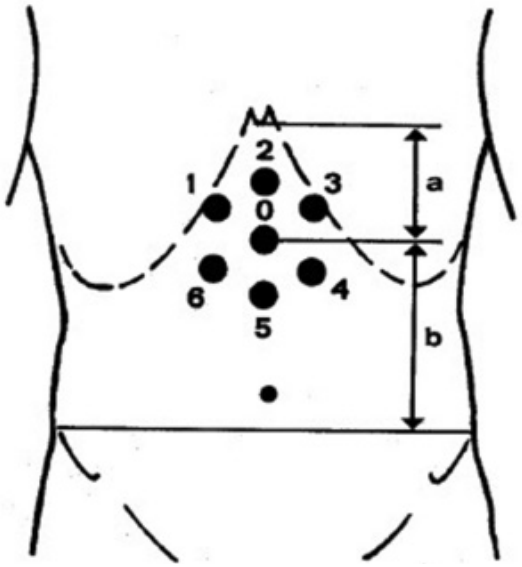

Figure 1. Electrode placement.

Table 2. Diagnosis of patients

	Subarachnoid or subdural hemorrhage	Post CPR Hypoxia	Other diseases
Group I (n=15)	13	1	1
Group II (n=9)	5	3	1

CPR: cardiopulmonary resuscitation

Interestingly, when patients with BD were divided into two groups according to their blood glucose levels, patients with high glucose levels exhibited better NGSW than the normal glucose level group (67.2 and 66.1% for fasting and postprandial periods in the high glucose group and 32.0% and 49.1% following feeding for the normal glucose level group). PR (MnDP after test meal/fasting) value of <1 was defined as pathologic as the MnDP is expected to increase after a meal (Figure 2). The number of subjects with a ratio of <1 was 4/15 (26.7%) for the BD group and 4/9 (44.4%) for the control group (p=0.288).

DISCUSSION

To the best of our knowledge, this is the first study addressing the effect of BD on gastric myoelectrical activity using EGG, which is a noninvasive and indirect measurement of gastric motility and emptying. This has an important aspect on such patients because gastric emptying problems are common and involve clinical significance. In addition to this, less is known about the central control of gastric myoelectrical activity and the results of BD.

Previous studies have been performed on coma patients and compared them to healthy controls. The main aim of the present study was to evaluate whether gastric myoelectrical activity changes following BD, that is, if the loss of higher brain centers results in disturbances in gastric function. Our results showed that both groups, the BD and control (coma) patients, demonstrated a pathologic percentage of "normal gastric slow waves" (NGSW<70%) without any statistically significant difference

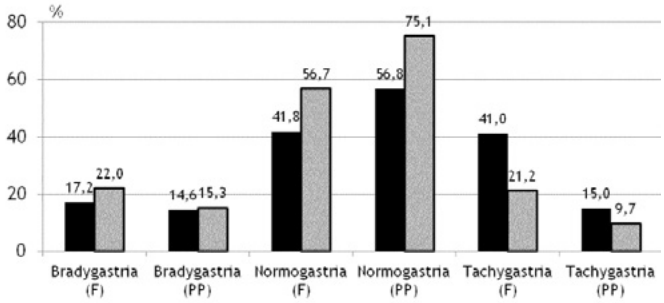

Figure 2. Differences in EGG parameters between the groups.
EGG: electrogastrography
* p>0.05 for all comparisons

between the groups. The exception was postprandial normogastria in the control group. These data indicate that patients with deep coma (GCS 3≤8) and patients with BD have gastric motility disturbances, but those who are BD do not have more severe disturbances. These data are also supported by another finding, namely related to PR, where about one-third of the whole group exhibited a pathologic response to feeding. Feeding did not increase the power of gastric myoelectrical activity. Our data have some clinical relevance, such as patients with BD have more disturbed gastric emptying problems and should be taken care of more carefully. Additionally, brain control is important to maintain better control.

The disturbances in gastric emptying in these patients are particularly important because they complicate the nutritional status and balance, which is crucial for ICU patients. Most patients with moderate to severe head injury initially do not tolerate enteral nutrition.

Gastrointestinal motility problems, especially delayed gastric emptying in intensive care unit patients, are widely emphasized in the literature. However, only a limited number of studies have been performed, and these were mainly performed with nuclear medicine techniques using radionuclide-labeled meals. Gastric emptying scintigraphy remains the most widely utilized test to measure gastric emptying. On the other hand, there are still concerns about the standardization of the test, including the test meal utilized, the duration of imaging (2 vs 4h), and quantification of the data (e.g., half time of emptying vs percentage of meal emptied) that are reported (6).

The first studies on brain injury and gastric emptying were performed in the early 1990s. Ott el al. (7) prospectively evaluated liquid gastric emptying in 12 cases with moderate-severe traumatic brain injury. All the patients exhibited delayed emptying at the beginning, which partially improved by the third week. They concluded that, especially in the early stage of brain injury, alterations in gastric emptying were common and might have an effect on enteral nutrition (7).

Another study investigated gastric emptying of liquid meals in 35 patients with moderate to severe head injury and compared

the results to those in healthy controls (n=16). No data were provided that identified whether the patients were brain dead. The half time of gastric emptying was significantly prolonged (57.2 vs 29.4 min, p<0.05). It was interesting that a short duration of injury and a low Glasgow coma score were accompanied by longer gastric emptying (8).

Techniques other than gastric emptying scintigraphy, such as the phenol red technique and the paracetamol test, have been used for the evaluation of impaired gastric emptying in patients in ICUs. Using the phenol red technique, Weeks et al. (9) measured gastric emptying in six male subjects with severe head injury. They showed a relationship between head injury and a decrease in gastric emptying, and these changes were also correlated with a negative energy balance (9). Another study on the rate of paracetamol absorption as an indicator of the gastric emptying rate failed to show any difference in gastric emptying between patients with head injury and healthy controls in a relatively small population after head injury (10). The only study that used EGG was performed by Thor et al. (11) with 24 patients who had craniocerebral trauma. Their results indicated that in patients with post-traumatic cerebral injury and coma, the function of the brain–gut link is altered. There is a severe disorder of upper gut motility that is associated with gastric dysrhythmia–bradygastria resulting from an increased cholinergic output. This leads to intestinal feeding intolerance.

The wireless motility capsule has emerged as a novel, noninvasive method to test gastric function in an outpatient setting. A recent study was performed using this technique to evaluate gastric emptying and small bowel transit times in eight critically ill trauma patients in comparison to healthy volunteers. The gastric emptying time (13.9 vs 3.0h) and total transit time (10 vs 1.2 days) were significantly longer in critically ill patients than in healthy volunteers (12).

A recent study addressed the effect of mental stress on EGG and other tests in patients with postprandial distress syndrome and compared the results to those from healthy controls. The patient group showed significant higher levels of stress hormones and sympathetic hyperactivity without any difference on EGG (13).

The limitations of our study include using a small number of patients and a variety of underlying diseases, which makes comparison between the groups difficult. However, it is very difficult to perform such a study in a large homogeneous group of patients. Additionally, studies in the literature have been performed with small number of patients, either without a control group or healthy controls, which we believe are not suitable for comparison. Our results revealed that all patients in the group with BD or those in a deep coma but without BD had gastric myoelectrical pathologies. However, there was no difference between the two groups, and this indicates that the results were independent of the existence of BD and were mainly related to coma status. Because current diagnostic modalities to detect gastric motility disturbances are limited, EGG might be used as a noninvasive and easy-to-use technology, but it needs improvement and more data from larger ICU patient series. We believe that an ideal study would include patients before and after BD.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Ege University (05-11.2/11-26.12.2005).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

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