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Gastric and Small Intestinal Myoelectric Dysrhythmia Associated with Chronic Intractable Nausea and Vomiting

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We describe a patient with symptoms of severe nausea, vomiting, epigastric bloating and pain, and marked weight loss due to a gastrointestinal motility disturbance. Motility abnormalities were characterized by uncoordinated high pressure (as high as 300 mm Hg) contractions and uncoordinated interdigestive motor complexes in the duodenum and small intestine, and tachygastria often associated with tachyarrhythmia in the gastric myoelectric activity recordings. Uncoordinated interdigestive myoelectric complexes again were found in the duodenum and small intestine. These abnormal myoelectric activities observed in the in-vivo study were confirmed in the in-vitro study. After distal hemigastrectomy and gastrojejunostomy, the symptoms of nausea, vomiting, and epigastric pain decreased considerably. Thus, the motility abnormality found in the study appears to be responsible for the symptoms described. This is probably a new clinical entity. The importance of manometric and myoelectric study of a gastrointestinal motility for unexplained nausea and vomiting is emphasized.

NAUSEA AND VOMITING are frequently associated with digestive disorders. When the cause of these symptoms cannot be determined from conventional diagnostic methods, studies of gastrointestinal motility may become necessary. It has been recognized in recent years that the stomach and small intestine have an inherent, rhythmic myoelectric activity, that is, pacesetter potential (basic electric rhythm, slow wave). In man (1-6), the pacemaker originating in the midcorpus (1) regularly generates pacesetter potentials at a frequency of 3 to 4 cycles/min that propagate toward pylorus with increasing velocity and higher amplitude. The pacesetter potentials in the duodenum, 11 to 12 cycles/min (8), propagate aborally to reach the terminal ileum with decreasing frequency of 8 to 10 cycles/min. In fasting state, migrating myoelectric complexes occur in both stomach and small intestine and migrate aborally the entire small intestine in man (9) and in dog (10). Thus, it has been suggested that migrating myoelectric complexes function as a "housekeeper" in the gut (11).

We report a patient with unexplained nausea, vomiting, and marked weight loss, who has had motility abnormalities of both stomach and small intestine.

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Case Report

A 26-year-old white woman was admitted to The Genesee Hospital with the chief symptoms of unexplained nausea and vomiting associated with a steady weight loss of 12.9 kg in 1 year. During the next 8-month period, she had early satiety, crampy, epigastric pain and borborygmi, and lost another 62.1 kg of weight. About this time, she was unable to tolerate even liquids. Her medical history was unremarkable, and no one in her immediate family had similar symptoms. Physical findings were unremarkable. Her serum sodium was 143 meq/L; chloride, 104 meq/L; carbon dioxide, 27 meq/L; potassium, 3.7 meq/L; calcium, 9.1 mg/dL; and blood urea nitrogen, 6 mg/dL. Psychiatric consultations failed to find a psychodynamic evidence of anorexia nervosa.

The patient had a subtotal gastrectomy and gastrojejunostomy (Billroth II) and duodenojejunostomy to avoid retention of bile and pancreatic secretion. At the present time, more than 1 year after surgery, her symptoms of nausea, vomiting, and epigastric pain have considerably decreased, and she is able to tolerate solid food. Her weight before surgery of 46 kg increased to 52.9 kg and has remained steady. She has returned to work for 8 hours a day during the past several months.

Methods

Manometric study of intestinal motility was done by the method described elsewhere (12). Unlike persons with normal motor function of the small intestine, there was disruption of migrating myoelectric complexes in the duodenum. Although phase III activity (activity front) (10) in the duodenum was expected to occur within 2 hours of recording period in normal persons (12), it was observed only once in one of seven separate

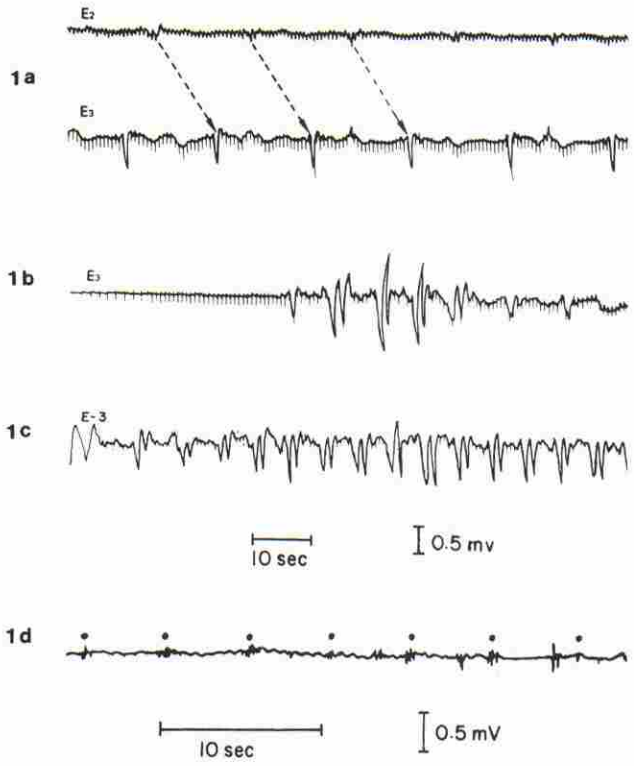

Figure 1a. A recording of normal propagation of pacesetter potentials that propagate at a frequency of 3 cycles/min with a regular interval from the corpus (*E2*) to the antrum (*E3*). **b.** A recording from the distal antrum (*E3*) of our patient, showing a long electrically silent period that was followed by irregularly occurring pacesetter potentials with faster frequency than normal (tachyarrhythmia). The short bleeps represent the electrocardiogram. **c.** A recording from the same distal antrum (*E3*) at a different time, showing 8 cycles/min with regular interval (tachygastria). **d.** A recording from the proximal duodenum when action potential occurred regularly. The dots represent the expected action potential whose frequency would be 12 cycles/min. There were three extra unexpected action potentials appearing in this recording.

recordings that lasted 2 hours each. In addition, sustained contractile activities with intraluminal pressure as high as 300 mm Hg, lasting 40 to 120 seconds, were observed frequently. The only phase III activity observed was followed by a phase II activity instead of phase IV and phase I as it occurs in normal persons.

Several pharmacologic agents and gut hormones, intravenously administered twice or more, failed to affect the motility abnormality. These agents included atropine sulfate, 1.4 mg given in a 1-hour period; pentagastrin, 0.25 μg/kg body weight · h; secretin, 0.5 clinical units/kg body weight · h; propranolol, 80 μg/min for 40 min; and naloxon, 1.2 mg in 50 mL of 5% dextrose in water for 1 hour.

Because of her refractory nausea, vomiting, inability to eat, and abnormal duodenal motility, further studies were needed to determine the exact nature and extent of the motility abnormalities. Chronic implantations of several platinum electrodes on the serosal surface of the gut were considered, and the study protocol was approved by the Human Use Committee of The Genesee Hospital in June 1979. An informed written consent was obtained from the patient after the purpose and possible risks were explained. The three electrodes and eight electrodes were implanted on the serosal surface of the distal stomach and the upper small intestine respectively. The preparation of electrodes, the method for implantation of electrodes, and recording of myoelectric activity were described elsewhere (13). The total recording times for both stomach and small intestine were 944 minutes and 1411 minutes respectively.

The quality of the recording of E1 (fundus) was poor. The electrode E2 in the midcorpus of the stomach recorded pacesetter potentials at a frequency of 3 cycles/min at a regular interval. Although the pacesetter potentials of E2 propagated to E3 in the distal antrum at times (Figure 1a), the pacesetter potentials in the antrum (E3) showed irregular rhythms or fast runs of pacesetter potentials (more than 5 cycles/min) appearing in bursts. The recording of E3 showed pacesetter potentials occurring at a regular frequency of 3 cycles/min for 601 minutes out of a total recording period of 944 minutes. During the remaining 343 minutes, tachyarrhythmia (Figure 1b) and tachygastria (Figure 1c) as defined in a previous communication (13), were observed.

Tachygastria was defined as when the pacesetter potential occurred in a burst of abnormally rapid frequencies of 5 cycles/min or more at regular intervals that persisted for 1 minute or longer. Tachyarrhythmia was defined as when the pacesetter potential occurred with a frequency of 5 cycles/min or more, but the interval between each pacesetter potential was irregular. Both dysrhythmias were followed by a compensatory pause. In addition to these abnormalities, retropropagation of pacesetter potentials occurred in the antrum when tachygastria continued for a long period.

In the duodenum, several abnormalities of phase III (activity front) were observed. Phase III occurred rarely in the duodenum, but when present, it occurred simultaneously in both duodenum and proximal jejunum (E4, E5, E6). Unlike in normal patients, phase III did not migrate aborally in the jejunum. The pacesetter potentials in the duodenum were small in amplitude and difficult to analyze, but the action potential could be clearly recorded. The frequency of pacesetter potentials was assumed by counting the repetitive frequency of action potential, for action potentials always followed pacesetter potentials that had increased to 14 to 15 cycles/min (Figure 1d). The pacesetter potentials in the jejunum occurred regularly at a rate of 12 cycles/min. Neither pentagastrin, 0.25 or 0.5 μg/kg body weight · h, nor secretin, 0.5 CU/kg body weight · h, reversed these abnormal myoelectric activity patterns. Each agent was randomly tested twice on separate days.

The patient had an exploratory laparotomy 2 weeks after the initial surgery to remove the implanted electrodes and to resect distal half of the stomach and a 10 cm segment of the proximal jejunum.

Using a resected distal stomach and proximal jejunum extracellular myoelectric activity was recorded by the volume electrode described elsewhere (14). Studies were done with several normal antral muscles obtained from the patients who had duodenal ulcer disease but did not have nausea or vomiting. The recording from these muscles showed that the pacesetter potentials occurred in the corpus and propagated aborally in a normal frequency (Figure 2a). The area of corpus muscle obtained from our patient, however, showed pacesetter potentials at a rate of 4 cycles/min, but pacesetter potentials in the antrum occurred at a varying frequency of 4 to 6 cycles/min. After a period of the irregularity in the antrum, the propagation of pacesetter potentials in the corpus had also become irregular, as if pacemaker had shifted to the antrum from the corpus (Figure 2b). The frequency of pacesetter potentials in the jejunum was 10 cycles/min and was regular. The pacemaker, instead of being found in its proximal end, was found in the midportion of the jejunum. From this pacemaker the pacesetter potentials propagated both orad and aborad directions (Figure 2c).

Discussion

Our patient had a steady weight loss of 89.2 kg and the symptoms of nausea, vomiting, and abdominal bloating and pain by the time we recognized the motility abnormalities of the stomach and small intestine. The abnormalities included tachygastria and tachyarrhythmia associated with retropropagation of pacesetter potentials arising from an ectopic focus in the antrum and asynchrony of duodenal and proximal jejunal motility.

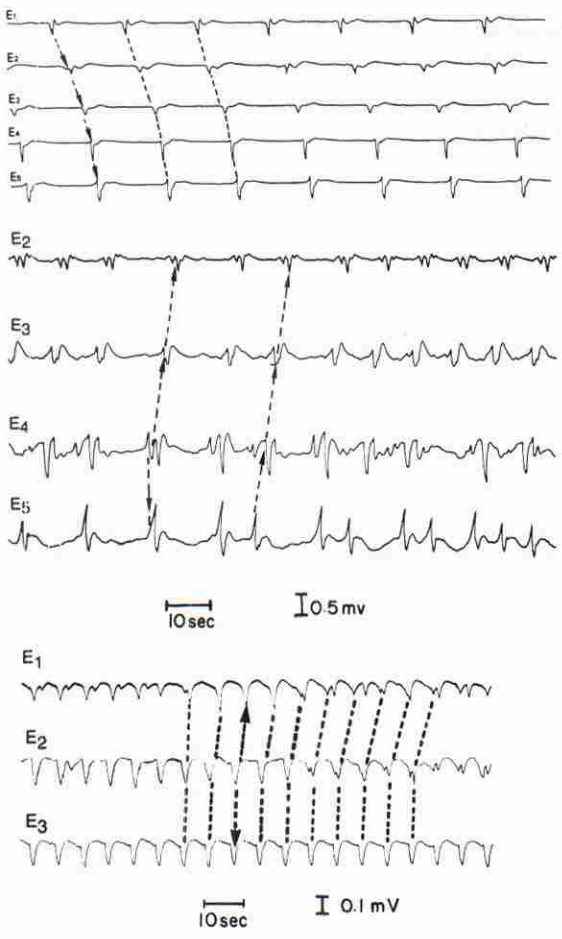

Figure 2a. A myoelectric recording from the antral muscle strip of the duodenal ulcer patient (a control) shows regularly occurring pacesetter potentials at a frequency of 4 cycles/min. It also shows normal propagation from the proximal to the distal antrum. The velocity of propagation increased as pacesetter potentials approached the distal antrum. **b.** A myoelectric recording from the antral muscle strip of our patient shows tachyarrhythmia and a shifting pacemaker from *E2* to distal antrum (*E4* or *E5*). **c.** A myoelectric recording from the proximal jejunal muscle strip from our patient shows pacemaker at the midportion (*E2*) instead of at the proximal portion (*E1*). The broken lines indicate the direction of propagation.

The frequent occurrence in this patient of intractable nausea, vomiting, epigastric bloating and pain can be attributed to antral dysrhythmia because hemigastrectomy alleviated the symptoms considerably, and after this procedure the patient was able to tolerate an adequate amount of solid food. The development of an ectopic or wandering pacemaker in the antrum with uncoordinated propagation, retropropagation of pacesetter potentials, or both could also explain the development of these symptoms; it has been shown in dogs that when an external pacemaker of the antrum was activated and retropropagation of pacesetter potentials were produced, the animal developed not only a significant delay in the gastric emptying after consuming solid food but also retching and vomiting (15). Histologic study of the antrum and a segment of the jejunum, however, did not disclose any discernible lesion in the two muscle layers or the intrinsic neurons in the gut. Thus, the pathogenesis of this clinical entity is not known.

To avoid an erroneous diagnosis of psychosomatic illness in such patients, one should be aware of this clinical entity that may not be detected by conventional diagnostic work-up, but by careful investigations on gastrointestinal motility in these patients.

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