Introduction

Several authors agree that gastric electrical activity (GEA) may yield information regarding the functional status of the stomach (Abell and Malagelada, 1985; Bellahsene et al., 1985; Stoddard et al., 1981; You et al., 1980; You and Chey, 1984). Some authors (Abell and Malagelada, 1985; Bellahsene et al., 1985) suggest that improved noninvasive techniques such as that described by Mirizzi and Scafoaglieri (1983) also yield clinically relevant information. We consider that clinically essential information from GEA includes:

(a) frequency
(b) propagation velocity
(c) direction of propagation of the activity.

Transcutaneous measurement of GEA so far has been shown to provide information regarding its occurrence and frequency. This information is useful in identifying such gastric abnormalities as tachygastria. Abell and Malagelada (1985) reported being able to correlate glucagon-evoked intermittent dysrhythmias in both intraluminal and transcutaneous EGG with the onset of nausea. Some authors (Brown et al., 1975; Abell and Malagelada, 1985; Bellahsene et al., 1985) have also used some form of intraluminal electrode to confirm the extracorporeal results.

Materials and method

The electrogastrograms were recorded both with intraluminal and skin electrodes on both patients and volunteers.

To record the GEA cutaneously, three approximately equidistant Hewlett-Packard Ag/AgCl disposable ECG electrodes (type 14445C) were located 3 cm apart along the projection of the antral axis on the skin (Mirizzi and Scafoaglieri, 1983). A neutral electrode (N) was placed colinear with these electrodes as shown in Fig. 1. The neutral electrode was employed as the reference electrode for each of the other three skin electrodes.
Intraluminal GEA was recorded by introducing a tube fitted with four electrodes into the stomach of fasted subjects through the mouth. The position of the four electrodes was verified by fluoroscopy. In all measurements, the tip of the tube was positioned at the pylorus; thus locating the most distal electrode 1 cm proximal to the pylorus. The subjects were then made to lie supine and move as little as possible while the measurement proceeded. By pairing each intraluminal electrode with the neutral electrode (as reference), four channels of monopolar records were made. Recordings were made for periods of 45 to 90 minutes.

The signals were AC coupled to a Beckmann R611 polygraph with a time constant of 20 s (corresponding to a lower cutoff frequency of 0.008 Hz) for all channels. The high-frequency filters were set at 0.08 Hz for the transcutaneous channels and at 0.3 Hz for the intraluminal channels.

The recorded signals were sampled at a rate of 2 Hz, digitised and stored on an IBM AT personal computer through a Lab Master 200009, 8-channel, 12-bit A-to-D convertor manufactured by Scientific Solutions Inc. Power spectra were generated and cross-correlation analyses were performed on the IBM AT personal computer and an Amdahl 470/V7 mainframe computer. Cross-correlation was performed to ascertain phase shifts between channels and power spectrum analysis was performed to ascertain the dominant frequencies.

2.1 Description of the intraluminal electrode

The intraluminal electrodes were mounted in a Levine type 900-51 gastric tube (manufactured by Cutter (Canada) Ltd.). This is shown in Fig. 2.

Circular holes (A) and (B) were cut in the tube. Rubber membranes (M) on which the electrodes were mounted were cemented to cover the holes (A). The electrodes, which were of the Ag/AgCl type described by Kingma et al. (1983), were dimensioned to be flush with the surface of the tube at openings (B). Upon application of a light vacuum (25 cm H₂O), the membranes (M) deformed inwards causing the electrodes to be pushed outwards. In this way good contact with the mucosa pressed against the smooth muscle tissue could be made.

This construction was preferred over the often used suction-cup design. When a suction cup is used, the applied suction tends to pull the mucosa away from the underlying smooth muscle tissue (the source of the electrical signal), thus degrading the recorded signal. Pressing the mucosa against the tissue has the opposite effect.

2.2 Signal analysis

Fig. 3 shows a record from an adult female. Channels

![Fig. 3](Simultaneous recording of transcutaneous and intraluminal EGG)