Double-Peaked High-Pressure Zone at the Esophagogastric Junction in Controls and in Patients with a Hiatal Hernia: A Study Using High-Resolution Manometry

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The lower esophageal high-pressure zone (HPZ) consists of the intrinsic lower esophageal sphincter (LES) and the diaphragmatic sphincter. In patients with a hiatal hernia these constituents are separated. We performed high-resolution manometry of the esophagogastric HPZ in six controls, six patients with a small hernia, and six patients with a large hernia. Prevalence of a double-peak pressure profile of the HPZ was noted. Pressures and distances between the peaks were assessed. Prevalence of the double-peak profile was similar between patients with a small hernia and controls, but patients with a large hernia showed a higher prevalence with inspiration (P < 0.05) than the others. The distance between the two peaks was larger in patients with a large hernia (P < 0.05). In conclusion, high-resolution manometry makes it possible to distinguish the diaphragmatic pressure component from the LES. Two pressure peaks can be found both in hernia patients and in healthy volunteers.

KEY WORDS: hiatal hernia; high-resolution manometry; esophagogastric junction; esophageal manometry; esophageal motility.

An intraluminal high-pressure zone (HPZ) between the esophagus and the stomach prevents reflux of gastric contents into the esophagus. Both the intrinsic lower esophageal sphincter (LES) and the right diaphragmatic crus are believed to contribute to this antireflux barrier (1–3). In patients with a hiatal hernia, part of the gastric mucosa is tented through the diaphragmatic hiatus and the LES is separated from the diaphragmatic sphincter. This spatial separation can be identified with endoscopy, radiology, and, also, manometry (4–8). With pull-through manometry two distinct pressure zones can occasionally be identified in patients with a hiatal hernia, the proximal zone representing the LES and the distal the diaphragmatic sphincter. However, with these techniques, only a snapshot image of the esophagogastric HPZ is obtained. With sleeve sensor manometry the double-peaked HPZ morphology cannot be observed, because with this device only the highest pressure over the sleeve sensor membrane is registered. New technical developments have led to the introduction of micromanometry (9). Micromanometry catheters contain smaller lumina compared to conventional manometry catheters and are perfused at very low perfusion rates. This development has opened doors to the recording of pressures with an array of...
The aim of this study was to investigate whether the contribution of the LES and the diaphragm to the HPZ at the esophagogastric junction can be distinguished using high-resolution manometry and to assess dynamic changes in the HPZ over time, after a meal, and during the respiratory cycle.

METHODS

Subjects. We studied six healthy volunteers (three men and three women; mean age, 37 years; range, 23–58 years), six gastroesophageal reflux disease patients (four men and two women; mean age, 46 years; range, 32–57 years) with a proven sliding hiatal hernia of approximately 3 cm, and six gastroesophageal reflux disease patients (four men and two women; mean age, 59 years; range, 36–74 years) with a proven sliding hiatal hernia of approximately 5 cm. All subjects recently underwent an upper endoscopy to rule out the presence of a hiatal hernia in the healthy volunteers and to confirm the presence of the sliding hernia in the patients. Erosive esophagitis (Los Angeles classification higher than A) and Barrett epithelium were exclusion criteria. All subjects gave written informed consent and the protocol was approved by the medical ethical committee of the University Medical Center Utrecht.

Study Protocol. The use of gastric acid-inhibitory drugs and drugs that influence gastrointestinal motility were discontinued 5 days before the study. After an overnight fast, the subjects consumed a standardized liquid nutrient meal of 380 ml (150 kcal/100 ml; 13% protein, 39% carbohydrate, 48% fat) (Nutridrink, Nutricia, The Netherlands) and the study was continued for another 2 hr.

Manometric Assembly. An 18-channel water-perfused sil-icone rubber catheter (outer diameter, 4.0 mm; length, 75 cm; channel diameter, 0.4 mm) was used for manometric recordings in controls and in patients with a small hiatal hernia (Figure 1A). The assembly incorporated five proximal sideholes. The sidehole most clearly showing swallow-induced pharyngeal contractions was selected for recording swallows during the measurement. There were four esophageal sideholes at 5-cm intervals and seven sideholes at 1-cm intervals at the distal end of the catheter. The sideholes are numbered with respect to sidehole 0, which is the sidehole that is positioned at the squamocolumnar junction. In the patients with a hiatal hernia of 5 cm a catheter with four additional sideholes at the distal end of the catheter was used (Figure 1B). This made it possible to position the catheter in such a way that the high-resolution area of the catheter straddled both LES and diaphragm in these patients. All sideholes were perfused at a rate of 0.08 ml/min using a pneumatic/hydraulic perfusion system (Dentsleeve Pty Ltd., Wayville, South Australia).

Pressures were measured with external pressure transducers (Abbott, Sligo, Ireland). Pressure data were stored in digital format in two 12-channel dataloggers (Medical Measurement Systems, Enschede, The Netherlands), using a sample frequency of 8 Hz. At the end of the study all data were transferred to the hard disc of the computer.

Data Analysis. In the analysis, pressure readings were divided into 2-min segments. In these 2-min segments basal end-expiratory and basal end-inspiratory pressure was determined for each of the channels 10 to −3, referenced to intragastric pressure. Determination of these pressures for the 2-min segments was performed at the first time point in each 2-min segment without LES relaxation (either swallow-associated or spontaneous), peristaltic contraction, or straining.

A pressure peak was identified when the pressure was above 1.5 kPa compared to the gastric baseline pressure. It was noted whether there were one or two separate pressure peaks within the HPZ. Based on the tracings in the distal esophagus, HPZs were categorized as having either one or two pressure peaks (Figure 2). A HPZ was regarded as double-peaked when at least one sidehole measured a pressure lower than 1.5 kPa between the two peaks. The distance between the two pressure peaks of the double-peaked shaped HPZ was determined by measuring the distance between the pressure channels that were measuring these pressure peaks. In the analysis, the 2-min segments...