

RAPID COMMUNICATION

New method for long-term monitoring of intragastric pH

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Abstract

AIM: Consecutive monitoring of intragastric pH using the Bravo® capsule.

METHODS: We put threads through a Bravo® capsule and then affixed it to the gastric wall by endoscopic hemocclipping in seven subjects. Study data were uploaded to a computer *via* Datalink every 48 h. In this way, repeated monitoring of intragastric pH was undertaken.

RESULTS: All subjects were able to monitor gastric pH over a 1-wk period, and five for > 2 wk. No complications were encountered during the monitoring. After pH monitoring, we safely retrieved the capsule endoscopically.

CONCLUSION: Clipping a Bravo® capsule onto the gastric wall enabled long-term intragastric pH monitoring. This is a methodological report of pH monitoring over a period of > 2 wk.

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Key words: Gastric pH; Ambulatory monitoring; Bravo system

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INTRODUCTION

The Bravo® pH monitoring system is a catheter-less system. It has been reported to be useful clinically because it enables monitoring without pain while the

subject undertakes daily activities^[1-5]. The Bravo® capsule is attached to the esophageal mucosa by suction *via* the delivery system, and it is usually eliminated spontaneously within 1 wk^[2]. According to manufacturer Medtronic, the average life of a capsule's battery is 14 d, and consecutive pH monitoring is theoretically possible until the capsule battery goes flat. We used these characteristics of the Bravo® capsule to develop a new method for long-term monitoring of intragastric pH^[6].

MATERIALS AND METHODS

Subjects and materials

The subjects of this study were seven *Helicobacter pylori*-negative volunteers. The Bravo® pH monitoring system (Medtronic, Shoreview, MI, USA), nylon threads, flexible overtube® (Sumitomo Bakelite, Tokyo, Japan), and stainless steel hemoclips (HX-200L-135; Olympus Optical, Tokyo, Japan) were prepared.

Preparation for Bravo® capsule

First, we removed the Bravo® capsule from its delivery system and we tied two nylon threads to the capsule and made each thread into a 2-cm diameter ring. Next, we confirmed a connection between the capsule and the receiver. The capsule was then calibrated in buffer solutions.

Placement of the Bravo® capsule

Endoscopic examinations with sedation were conducted on the subjects and results revealed the absence of any abnormal lesions. The flexible overtube was back-loaded onto the endoscope prior to the procedure. We carefully inserted the flexible overtube® with the tip of the endoscope inside the stomach. The Bravo® capsule was then passed through the tube into the stomach. Using hemoclips, the threads attached to the capsule were fixed on the greater curvature of the upper corpus (Figure 1).

Schedule

We administered antacids to determine whether the Bravo® capsule precisely monitored changes in intragastric pH. The subject was administered 150 mg ranitidine hydrochloride orally twice daily at 8:00 and 20:00 h. No limitation of meals and activities was imposed but meal times were set at 7:00, 12:00 and 19:00 h. Alcohol and tobacco were prohibited.

Analysis of pH data

Study data were uploaded to a computer *via* Datalink



Figure 1 Bravo® capsule in the stomach. The Bravo® capsule was placed onto the gastric wall in the greater curvature of the upper corpus. Threads attached to the capsule were fixed by hemoclips.

(Medtronic) every 48 h and analyzed using basic computer software (EXCEL; Microsoft, Redmond, WA, USA). After monitoring was completed, the fixed Bravo® capsules were removed endoscopically. We cut the threads tied to the capsule using scissors forceps (FS-3L-1; Olympus Optical), and put the capsule in the Roth Retrieval Net TM (United States Endoscopy Group, Mentor, OH, USA). Then, we retrieved the capsule by pulling it into an attachment mounted on the tip of the fiberscope.

Ethics

This study was approved by our hospital ethics committee and informed consent for participation in the study was obtained from all subjects.

RESULTS

Placement of the Bravo® capsules took less than 5 min. No complications or side effects were observed during pH monitoring. All subjects were able to perform normal daily activities. Two of the seven subjects ended gastric pH monitoring because their capsule batteries went flat (at d 7 and 13). The other five succeeded in pH monitoring for 16 consecutive days. During this study, the average rate of captured data per day was 97.7%. A selection of the pH monitoring data is shown in Figure 2.

Gastric acid secretion was suppressed, beginning on the first day of ranitidine intake. However, during the medication period, the percentage time with pH < 4 increased and the median pH decreased. At the time of re-administration, the effect of the drug developed more slowly than at the first time it was given.

Retrieval of the Bravo® capsules took less than 5 min. No capsule suffered any damage.

DISCUSSION

Using the standard vacuum method, it is more difficult to attach the Bravo® capsule to a large lumen such as the stomach, than to the esophagus. It took us 15 min to place the capsule using the conventional method. The capsule was then eliminated on the fifth day. In previous studies of the Bravo® system, intragastric pH monitoring was carried

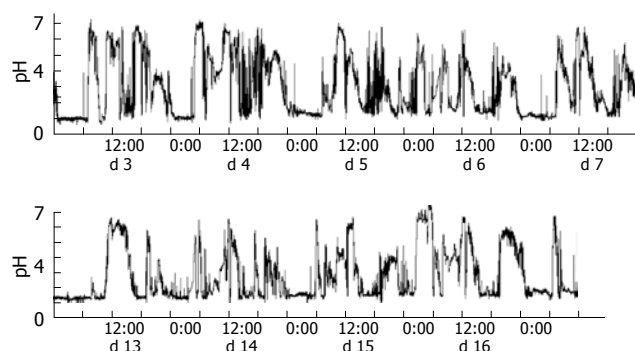


Figure 2 Intragastric pH graph monitored by the Bravo® pH capsule. The upper graph shows d 3-7 of pH monitoring, and the lower graph shows d 13-16 after placement of the Bravo® capsule in one subject.

out for just 48 h^[7-9]. Since an endoscopic procedure and administration of premedication can influence gastric acid secretion^[10], a longer period for pH monitoring would be helpful for diagnosis^[11-13]. In our study, we were able to monitor gastric pH for at least 1 wk.

We had some difficulty in passing threads through the capsule beforehand, but we needed only about 5 min to affix the capsule under endoscopic guidance^[7]. The Bravo® system has been reported to be safe^[2,14,15], although there is a report of esophageal perforation during attachment of the capsule^[16]. We used a flexible overtube® so that the capsule could pass safely through the cervical esophagus, a physiologic stricture. However, complications with the flexible overtube® have been reported^[17], and so care must be taken when inserting it.

In addition, the precision of long-term pH monitoring using an antimony electrode fixed in stomach may create problems. However, in our study, pH rhythm was reflected by the effects of meals and medication, but the precision itself was not influenced. Some studies have suggested that the effects of histamine H2-receptor antagonists are attenuated during continuous treatment; an effect expressed as tolerance or tachyphylaxis^[18-21]. Tachyphylaxis of ranitidine was observed in our study. The rates of captured data per day in the esophagus and stomach have been reported as 97.7% to 99.3%^[7,14] and 98.3%^[7], respectively. In our study, the rate was high and did not decrease over the 16-d period.

After monitoring for 16 d, we endoscopically retrieved the fixed capsules from the stomach. The Bravo® capsule attached to the esophagus by suction was eliminated spontaneously through the gastrointestinal tract. However, we confirmed that a capsule fixed to the stomach for a long period did not suffer any damage.

H2-receptor antagonists and proton-pump inhibitors rapidly and potently suppress gastric acid secretion and are widely used for treatment of acid-related diseases^[22-27]. However, they have some clinical weaknesses, tachyphylaxis and nocturnal gastric acid breakthrough^[28-30], which have not been resolved. One reason has been the availability of only intermittent pH monitoring, but not long-term continuous monitoring. Our method is useful clinically not only for the diagnosis of acid-related diseases, but also for the elucidation of their problems.

In conclusion, we present a newly developed method for easy and simple long-term monitoring of intragastric pH using the Bravo® pH monitoring system.

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COMMENTS

Background

The Bravo® capsule is usually attached to esophageal mucosa by suction via the delivery system and eliminated spontaneously within 1 wk. However, consecutive pH monitoring is theoretically possible until the capsule battery goes flat.

Research frontiers

It has been reported that an endoscopic procedure and administration of premedication can influence gastric acid secretion when using the Bravo® pH monitoring system. In previous studies of the Bravo® system using its conventional vacuum method of attachment, it was only possible to carry out intragastric pH monitoring for 48 h.

Innovations and breakthroughs

Clipping of a Bravo® capsule onto the gastric wall enabled intragastric pH monitoring for > 2 wk. The methodology is easy and simple.

Applications

Our method is clinically useful, not only for diagnosis of acid-related diseases, but also for the elucidation of tolerance of H₂-receptor antagonists and nocturnal gastric acid breakthrough of proton-pump inhibitors.

Terminology

Bravo® pH monitoring system is a catheter-less pH monitoring system.

Peer review

The authors have reported a modified method for long-term monitoring of intragastric pH using the Bravo capsule fixed on the gastric wall by endoscopic hemoclipping. The contents of the manuscript are reasonable, and this may be a useful method for the elucidation of tolerance to H₂-receptor antagonists and nocturnal gastric acid breakthrough of proton-pump inhibitors, as the authors state.

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