Diagnostic yield of routine push enteroscopy with a graded-stiffness enteroscope without overtube

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Background: Push enteroscopy has become a standard procedure for evaluation of small intestinal disorders. Its diagnostic yield and acceptability, however, has been hampered by the use of an overtube, which is both inconvenient and potentially hazardous. This study assessed the clinical value of enteroscopy with a graded-stiffness videointerroscope without an overtube.

Methods: A total of 121 consecutive patients (mean age 59 years, range 12-89 years) underwent diagnostic enteroscopy. All procedures (n = 126) were performed with a push-type graded-stiffness videointerroscope without an overtube. Indications were the following: unexplained iron deficiency anemia (45%), GI bleeding (29%), abdominal pain (6%), malabsorption (5.5%), imaging abnormality (5.5%), diarrhea (4%), intestinal obstruction (3%), and vomiting (2%).

Results: The mean depth of instrument insertion distal to the pylorus was 121 cm. A diagnosis was made in 40% of all procedures. The findings included ulcerations or erosions in 43%, angioectasia in 35%, inflammation in 14%, tumors in 6%, and varices in 2%. In all cases of a positive enteroscopic diagnosis, therapeutic maneuvers were performed, and no patient needed a further diagnostic procedure. Patient comfort was good. No complications were observed.

Conclusions: Routine enteroscopy with a graded-stiffness enteroscope without an overtube is safe and comfortable for the patient and the endoscopist, and has a clinical efficacy comparable with that reported for enteroscopy with use of an overtube. A prospective, randomized study is warranted to assess the exact role of this form of enteroscopy in patient care. (Gastrointest Endosc 2003;57:877-81.)
and the yield of pathologic findings have been questioned. Thus, a graded-stiffness enteroscope was developed that is intended for use without an overtube. This study is the first one reporting on the efficacy and safety of enteroscopy with a graded-stiffness enteroscope without an overtube in routine clinical practice.

**PATIENTS AND METHODS**

A total of 137 enteroscopic procedures were performed in the investigators’ unit from January 1997 to June 2001. All 126 peroral diagnostic procedures (in 121 patients) were included in this study. Eleven procedures performed intraoperatively or by means of a stoma were excluded. The study was approved by the Institutional Review Board of the investigators’ medical center.

All enteroscopies were performed by experienced, board-certified gastroenterologists and with the patient under conscious sedation with intravenous administration of midazolam (5 mg) and fentanyl (0.05 mg). If the patient was uncomfortable during the procedure, an additional dose of midazolam was given. When peristaltic movements interfered with the examination, hyoscine-N-butyl bromide (Buscopan, Boehringer Ingelheim Ltd., Bracknell, Berkshire, U.K.), 10 to 40 mg, was given intravenously.

Enteroscopy was performed with a video push-type enteroscope (Pentax VSB-3440, ASAHI Optical Co., Tokyo, Japan) with a working length of 220 cm and external diameter of 11.5 mm that was designed to be used without an overtube. During manufacturing, a polyurethane coating is applied homogeneously onto the surface of the insertion tube. During this process, there is a continuous change in the components of the material so that a gradual increase in the stiffness of the enteroscope from distal to proximal is achieved. The stiffness profile of the graded-stiffness enteroscope compared with that of a standard, uniform-grade enteroscope (VSB-2900, Pentax) is shown in Figure 1. Because of this special manufacturing technique, the use of an overtube to prevent looping of the enteroscope during the examination is not needed (personal communication from Pentax). The enteroscope was introduced orally and passed to the duodenum distal to the major duodenal papilla. Thereafter, it was advanced by intermittent pushing and suctioning. The final position of the tip, as well as absence of gastric looping, was confirmed by fluoroscopy. Depth of insertion was recorded as the distance beyond the pylorus (total depth minus distance to pylorus; both measured endoscopically from the incisor teeth). Any patient or operator discomfort was recorded by the endoscopist and also assessed by the need for additional doses of sedative medication.

The outcome measures were the following: (1) technical success, in terms of depth of insertion and ease of performance; (2) diagnostic yield; (3) need of further investigation(s); (4) influence on therapy; (5) complication rate; and (6) evidence of patient discomfort (necessitating administration of additional doses of sedative drugs).

**RESULTS**

A total of 121 patients (64 men, 57 women; mean age 59 years, range 12-89 years) underwent 126 examinations. Five patients had 2 enteroscopies each. Most procedures (n = 88, 70%) were performed on an outpatient basis in patients referred by a gastroenterologist in the community. The remainder (n = 38, 30%) were performed in hospitalized patients. The indications for enteroscopy and the yield of the procedure by indication are shown in Table 1. Iron deficiency anemia (n = 57, 45%) and GI bleeding (n = 36, 29%) were the main indications (74%), followed by abdominal pain, malabsorption, diarrhea, intestinal obstruction, vomiting, and an imaging finding. Most of the patients (n = 112, 89%), including all with iron deficiency anemia or GI bleeding, previously had undergone EGD and colonoscopy. Four patients were referred without a previous endoscopic examination because of an abnormal imaging study (CT, n = 3; upper GI contrast radiography, n = 1).

Overall, a diagnosis was made in 51 patients (40% of procedures); that is, a lesion was identified or a satisfactory answer to the question posed by the

<table>
<thead>
<tr>
<th>Indication</th>
<th>Diagnostic yield</th>
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<tbody>
<tr>
<td>Total: 100% (n = 126)</td>
<td>40% (n = 51)</td>
</tr>
<tr>
<td>Iron deficiency anemia: 45% (n = 57)</td>
<td>37% (n = 21)</td>
</tr>
<tr>
<td>GI bleeding: 29% (n = 36)</td>
<td>50% (n = 18)</td>
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<tr>
<td>Abdominal pain: 6% (n = 8)</td>
<td>38% (n = 3)</td>
</tr>
<tr>
<td>Intestinal obstruction: 3% (n = 4)</td>
<td>25% (n = 1)</td>
</tr>
<tr>
<td>Diarrhea: 4% (n = 5)</td>
<td>80% (n = 4)</td>
</tr>
<tr>
<td>Vomiting: 2% (n = 2)</td>
<td>50% (n = 1)</td>
</tr>
<tr>
<td>Imaging finding: 5.5% (n = 7)</td>
<td>43% (n = 3)</td>
</tr>
<tr>
<td>Malabsorption: 5.5% (n = 7)</td>
<td>0%</td>
</tr>
</tbody>
</table>
referring physician was obtained. The findings were the following: angioectasia (n = 18, 35%), peptic disease (n = 22, 43%), inflammatory process (n = 7, 14%), tumor (n = 3, 6%), and esophageal varices (n = 1, 2%). In 32 patients (63%), the significant finding was within reach of a standard upper endoscope. In the 93 patients who underwent enteroscopy because of anemia or GI bleeding, a diagnosis was made in 39 (42%). In patients in whom the indication was diarrhea (n = 5), an imaging abnormality (n = 7), and abdominal pain (n = 8), a diagnosis was made in, respectively, 4 (80%), 3 (43%), and 3 (38%) patients. In patients with intestinal obstruction (n = 4) or vomiting (n = 2), the diagnostic yield was, respectively, 25% (n = 1) and 50% (n = 1). For patients with malabsorption (n = 7), the diagnostic yield of enteroscopy was nil.

The mean depth of advancement of the enteroscope distal to the pylorus was 121 (39) cm; 22 of the patients (18%) were examined to 50 cm, 28 (22%) to 100 cm, and 76 (60%) to 150 cm. Hence, the depth of insertion in the majority of patients (n = 104, 83%) was 100 cm to 150 cm or more, or about 2 to 3 loops of small bowel. All examinations were completed within 30 minutes.

None of the 51 patients with a positive enteroscopic diagnosis had a further diagnostic procedure during a mean follow-up of 23 months. In comparison, a further investigation was conducted in 9 of 75 patients (12%) with a negative enteroscopy result and led to a diagnosis in 4 (44%). In 51 (100%) of the 51 patients with an enteroscopic diagnosis, the enteroscopic findings influenced subsequent therapy, including endoscopic treatment for angioectasia, medical treatment for peptic ulcer or Crohn’s disease, and resection of a carcinoma.

The overall level of comfort, as reported by the endoscopists, was good. Most patients (n = 69, 55%) received the standard dosages of sedation drugs (midazolam 5 mg, fentanyl 0.05 mg); 11 (9%) received less. An additional dose of sedative medication was administered to 46 patients (36%); mean dosages were midazolam, 6.3 mg, and fentanyl, 0.05 mg. Twelve patients received Buscopan (mean dose 19 mg). The only minor complication recorded was tiny mucosal abrasions of the bowel mucosa occasionally seen on enteroscope withdrawal. These had no clinical consequences. No severe or clinically significant complications were observed. All patients were discharged after 2 hours of observation in the recovery room.

### DISCUSSION

The clinical utility of routine enteroscopy with a graded-stiffness push enteroscope without an overtube was studied in an effort to avoid the disadvantages of using an overtube for the procedure, mainly patient’s discomfort and associated complications. The enteroscope was designed for use without an overtube because of its graduated stiffness, which reduces looping in the stomach. The graded stiffness was imparted by a special process for adding a polyurethane coating to the insertion tube. As a consequence, this instrument provides the advantages of an overtube with respect to depth of insertion without the potential risks, such as mucosal stripping and perforation, that are more frequent with the use of an overtube compared with standard upper endoscopy. Three main clinical aspects of

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**Table 2. Comparison of yield of examination (%) by indication in published studies and present study**

<table>
<thead>
<tr>
<th>Reference</th>
<th>General deficiency anemia</th>
<th>GI bleeding</th>
<th>Abdominal bleeding</th>
<th>Imaging abnormality</th>
<th>Diarrhea and malabsorption</th>
<th>Therapeutic intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overtube</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>—</td>
<td>6%</td>
<td>20%</td>
<td>78%</td>
<td>22%</td>
<td>0%</td>
</tr>
<tr>
<td>4</td>
<td>56.5%</td>
<td>69%</td>
<td>72%</td>
<td>20%</td>
<td>45%</td>
<td>—</td>
</tr>
<tr>
<td>7</td>
<td>—</td>
<td>67%</td>
<td></td>
<td></td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>8</td>
<td>72%</td>
<td>—</td>
<td>80%</td>
<td>55%†</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>9</td>
<td>67%</td>
<td>—</td>
<td></td>
<td>64%</td>
<td>82%</td>
<td>—</td>
</tr>
<tr>
<td>14</td>
<td>47%</td>
<td>—</td>
<td></td>
<td>53%</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>29</td>
<td>—</td>
<td>53%</td>
<td></td>
<td>57%</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>30</td>
<td>—</td>
<td>48%</td>
<td>57%</td>
<td></td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>No overtube</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>—</td>
<td>—</td>
<td></td>
<td>55%</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>23*</td>
<td>—</td>
<td>—</td>
<td>43%</td>
<td>—</td>
<td>0%</td>
<td>24%</td>
</tr>
<tr>
<td>25</td>
<td>—</td>
<td>28%</td>
<td>—</td>
<td></td>
<td>100%</td>
<td>—</td>
</tr>
<tr>
<td>26</td>
<td>—</td>
<td>41%</td>
<td>—</td>
<td></td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Present</td>
<td>40%</td>
<td>37%</td>
<td>50%</td>
<td>42%</td>
<td>43%</td>
<td>33%</td>
</tr>
</tbody>
</table>

* A study from India, with a high incidence of parasitic worms as a cause of bleeding.
† 55% of patients evaluated for small bowel disease based on clinical suspicion or abnormal small bowel radiography findings.
enteroscopy with this instrument were evaluated: technical success, diagnostic yield, and safety.

Technical success was evaluated primarily by reference to the depth to which the investigation could be conducted. Push enteroscopy usually can be performed to 40 to 150 cm distal to the ligament of Treitz.14,23 In the published reports, there is considerable variation in the insertion depth achieved with an enteroscope,2,5-8,10-12,14,15,23-26 However, there is no truly reliable method for measuring depth of enteroscopic insertion. The small bowel can either be pleated onto the insertion tube of an enteroscope or stretched over it. Indeed, surgeons debate the length of the small bowel as measured intraoperatively. Insertion depths ranging from 45 cm to 120 cm have been reported with an overtube.2,24 Without an overtube, the depth tends to be somewhat less, although the reported range, between 40 cm and 125 cm, is similar to that achieved with an overtube.23,27 In part, this could be attributable to different methods of assessment: fluoroscopy, or metric measurement from teeth or duodenum during maximal insertion and while pulling back the instrument.17 In the present study, a metric measurement from the pylorus, which is easily identifiable, of the investigated small intestine was used. Fluoroscopy was used to verify the absence of a gastric loop. The mean depth of investigation was 121 cm (range 50-150 cm), which compares favorably with that reported, notwithstanding the limitations mentioned above.

The diagnostic yield of push enteroscopy in the identification of lesions potentially responsible for bleeding in the small intestine ranges from 17% to 89% of cases.2-4,6-8,10,14,20-24,28,29 The diagnostic yield in the present study in patients with iron deficiency anemia (37%) and those with GI bleeding (50%) are within this range. Several factors may explain the differences in the diagnostic yield of push enteroscopy.1,2,23,27 Study populations are not always comparable, for example, with regard to age, geographic region, indications, medication history, and length of bowel examined. Moreover, angioectasia can be confused with traumatic lesions, and the subjective interpretation of a finding by the examiner could introduce bias in assessing the diagnostic yield. Furthermore, some findings, (e.g., small-bowel diverticula) could, in some series, be accepted as a probable source of bleeding, whereas, this finding may be ignored in other series. Taking all of these limitations into consideration, the results of the present study are comparable with those obtained with the more cumbersome enteroscopy with an overtube.

The diagnostic yield of push enteroscopy in reported studies compared with that in the present trial is shown in Table 2. The yield in the present series was greater in cases of overt GI bleeding compared with those of iron deficiency anemia (50% vs. 37%), in concordance with some previous studies.2 The yield among patients with diarrhea was 80% and patients with an abnormal imaging finding was 43%, which are also within the range found in previous trials (37%-82%).27 Although enteroscopy with the graded-stiffness enteroscope was of some value in the assessment of abdominal pain, small bowel obstruction, and vomiting (diagnostic yields, respectively, 38%, 25%, 50%), and of no value in the investigation of malabsorption, the numbers of patients with these indications were small. The findings at enteroscopy had consequences in terms of therapy (endoscopic, medical, or surgical) in all patients. These observations correlate well with those in other studies (Table 2), further underscoring the value of enteroscopy.

The locations of the enteroscopic findings in the present study were within the reach of a standard upper endoscope in a substantial number of patients (63% of cases with a positive finding), and these lesions were thus missed at prior examinations. A similar observation was made in other studies; in published reports, from 13% to 60% of the total positive findings were within segments of the gut accessible with a standard upper endoscope.1,2,7,12,14,20,23,29 The high rate in the present series may be related in part to the fact that the initial evaluation did not include a repeat EGD after a first negative examination. Moreover, the positive finding within the reach of a standard upper endoscope in some cases was substantiated by the discovery of an additional, more distant lesion (e.g., angioectasia, Crohn’s disease).

Although the design of the present study did not include a direct, randomized comparison of enteroscopy with the graded-stiffness enteroscope with a conventional enteroscope with overtube, it was the subjective impression of the endoscopists that the examination with the graduated-stiffness instrument technically was easier to perform. Usually there was no need to apply counterpressure to the abdomen during the procedure, and all examinations were completed within 30 minutes. Because the patient’s comfort is difficult to quantitate when sedative medication is given, this parameter was assessed based on the subjective impression of the endoscopist, as well the need for additional doses of sedative drugs during the examination; both were favorable. Most importantly, the examination was extremely safe, with no complications, in contrast to studies in which enteroscopy was performed with an overtube.

The present retrospective, nonrandomized, single-center study with subjective assessment of the
procedure difficulty and the patient’s comfort has obvious limitations, and, thus, accurate assessment of the role of enteroscopy with a graded-stiffness instrument without an overtube will require a prospective, controlled study. However, the present series is relatively large and provides initial data to suggest the usefulness of this form of enteroscopy. Moreover, the results support the general consensus that push enteroscopy, with state-of-the-art instruments at least 2 meters in length, should be regarded as a standard procedure and that the small bowel should be intubated as far as possible.

In summary, enteroscopy with a graded-stiffness enteroscope and no overtube is safe, comfortable for patients, technically easy to perform, and has a satisfactory diagnostic yield compared with enteroscopy performed with the more cumbersome overtube. Given the range of differences in the technical attributes of available enteroscopes, prospective controlled trials are needed to establish the exact role of each type in clinical practice.

DISCLOSURE

The study was not supported by any commercial company, nor do the investigators have any commercial interest in the enteroscopes used.

REFERENCES