Eosinophilic esophagitis (EoE), a chronic inflammatory condition characterized by esophageal dysfunction and eosinophilic infiltrate in the esophageal epithelium, was first described by Landres et al.\(^1\) in 1978. More recently, Rubio et al.\(^2\) described lymphocytic esophagitis (LyE) as an independent entity portraying high numbers of infiltrating CD3, CD4, and CD8 expressing intraepithelial lymphocytes. Patients with EoE and LyE usually complained of dysphagia and food impaction.\(^3-5\)

There are a number of reports concerning conventional endoscopic features in EoE\(^3,4,6-9\) but few on LyE.\(^2,5\) In these reports, the endoscopic features include esophageal rings, linear furrows, whitish exudates, narrow lumen, or stenosis. Nevertheless, none of these can be considered pathognomonic for EoE\(^5\) or LyE\(^2\) because similar endoscopic features have been described in other esophageal disorders. When white-light-based conventional endoscopy was used, the esophagus appears to be normal in approximately 7% to 32% of cases of EoE\(^6-8\) and in 23% to 55% of those with LyE.\(^2,5\) In 1 study, narrow-band imaging (NBI) without magnification did not improve the ability to recognize EoE.\(^9\)

Magnifying endoscopy enables visualization of capillary vessels (intrapapillary capillary loop [IPCL]) in the esophageal mucosa.\(^10-12\) Despite magnifying endoscopy combined with NBI (NBI-ME) being widely used to detect early GI neoplasms, including esophageal neoplasms,\(^13\) no data are available concerning NBI-ME in EoE and LyE. The aim of this study was to report the endoscopic characteristics found in EoE and LyE by the aid of NBI-ME.

**PATIENTS AND METHODS**

Magnifying EGD with NBI and biopsies have been performed in cases with dysphagia and/or a history of foreign body in the esophagus at the endoscopy unit at Karolinska University Hospital since August 2011. Patients who underwent EGD between August 2011 and December 2012 were included in this study.

A magnifying endoscope (GIF-Q160Z, Olympus, Tokyo, Japan) with an NBI system (Evis Exera II, Olympus) was used in all procedures. One experienced endoscopist (K.T.) performed all endoscopic procedures. Digitized images with and without magnification and NBI were collected in the Picsara system (Mawell, Oulu, Finland).

Conventional endoscopic findings of EoE and LyE, such as mucosal rings, linear furrows, white exudates, and stenosis/narrow caliber, have been previously reported by others\(^3-5\) (Fig. 1). Regarding NBI-ME images, 1 experienced endoscopist (K.T.) reviewed all images retrospectively. Subsequently, images were selected and reviewed by 2 other experienced endoscopists (A.D. and P.T.S.) after the first reviewer's suggestion of typical abnormal findings. Consensus between the 3 endoscopists (K.T., A.D., and P.T.S.) was required before endoscopic features were classified into 1 or more abnormal finding. This study was approved by the Stockholm Ethical Committee.

**Pathologic assessment**

Pathologic assessment was conducted by 1 pathologist (CAR). The pathologic diagnosis of EoE was patterned after the Liacouras et al.\(^3\) recommendations for children and adults: greater than 15 eosinophils per high-power field in at least 1 esophageal biopsy specimen, and of LyE when more than 20 intraepithelial lymphocytes per high-power field were present, and none to occasional CD15+ intraepithelial granulocytes.\(^2\)
Patients who fulfilled the above-mentioned histopathologic criteria of EoE in biopsy specimens at initial EGD and after proton pump inhibitor (PPI) treatment were diagnosed as definitive EoE. Esophageal eosinophilia (EEo) was defined as cases in which an initial EGD was not followed by a second EGD.

**Statistical analysis**

We hypothesized that the presence of a combination of abnormal NBI-ME findings is different between EoE/LyE and GERD. The cases of EEo were, in the statistical analysis, included in the EoE/LyE group. This was based on the assumption that most EEo are in fact EoE, and the EoE and EEo patients had similar clinical symptoms and almost the same pathologic findings. Thus, NBI-ME findings were compared between the EoE/EEo/LyE group and the GERD group. Statistical differences were evaluated using the Fisher exact test. Differences at $P < .05$ were considered to be statistically significant.

**RESULTS**

Twenty-one adult patients (median age, 39 years; range, 18-82) who subsequently were histologically diagnosed as EoE/EEo or LyE were investigated. Eleven patients were diagnosed as EoE/EEo (4 patients were diagnosed as definitive EoE by a second endoscopy after PPI treatment) and 11 as LyE. Ten patients with erosive GERD were included as a control group. Clinical features of the patients are shown in Table 1.

**Conventional endoscopy**

Endoscopic features of EoE/EEo and LyE are summarized in Table 2 (Fig. 1). Mucosal rings were seen in 14 patients with EoE/EEo or LyE, linear furrows in 15, white exudates in 9, and stenosis in 9 patients. At least 1 of these abnormal findings was seen in 18 of 21 patients (85.7%). Three patients, all of whom had LyE, did not have any of the 4 abnormal endoscopic features. Thus, all 10 patients with EoE/EEo had at least 1 abnormal finding. Two patients needed balloon dilatation (1 EoE/EEo, 1 LyE). In the 10 patients with GERD, mucosal rings were seen in 2, linear furrows in 2, white exudates in none, and stenosis in 2. At least 1 abnormal finding was seen in 5 of 10 patients (50.0%).
The retrospective review of the images identified the following 3 abnormal NBI-ME features: (1) beige color of the mucosa (normal mucosa has light green color), (2) increased and dot-shaped congested IPCLs, and (3) invisibility of submucosal vessels (normal mucosa has cyan-colored vessels). All images were categorized as having abnormal features by consensus among 3 experienced endoscopists (K.T., A.D., and P.T.S.).

NBI-ME features of EoE/EEo and LyE are summarized in Table 2 (Fig. 2). Beige color of mucosa was seen in 19 of 21 patients with EoE/EEo or LyE, increased and congested IPCLs with dot shapes in 20, and invisibility of submucosal vessels was seen in 19 patients. In 20 patients (95.2 %), at least 1 abnormal endoscopic finding was seen. All 3 NBI-ME features were seen in 19 patients (90.5%). Twelve patients (5 EoE/EEo, 7 LyE) had these abnormal findings in a patchy pattern (Fig. 2E), and 3 of those had histologically normal mucosa in biopsy specimens taken from NBI-ME normal mucosa.

In the 10 patients with EoE/EEo, all of the above-mentioned findings were seen. In 1 patient with LyE, none of the aforementioned features was found, and only 1 feature (increased and congested IPCLs) was seen in another patient with LyE. These 2 patients did not have any abnormal findings in conventional endoscopy.

In GERD patients, no patient had all 3 findings. We found increased and congested IPCLs in 3 patients, but none of the GERD patients showed beige discoloration of mucosa or invisibility of submucosal vascularity. Nineteen of 21 patients with EoE/EEo/LyE had all 3 abnormal findings of NBI-ME, but none of the patients with GERD had them (P < .0001) (Table 3).

**DISCUSSION**

The use of magnifying endoscopy is increasing at various hospitals. At magnifying endoscopy, the depth of invasion of apparently superficial esophageal cancer can be determined by assessment of the IPCL. Magnifying endoscopy with narrow-band imaging has been reported in EoE. The hypothesis in that study was that NBI would highlight the endoscopic findings of EoE, but there was no increased diagnostic yield with NBI. There are few reports on endoscopic findings of LyE. To our knowledge, there are no published data of NBI-ME for EoE or LyE.

**TABLE 2. Clinical features and findings of conventional endoscopy and NBI-ME in patients with EoE/EEo, LyE, and GERD**

<table>
<thead>
<tr>
<th></th>
<th>Total EoE/EEo/LyE</th>
<th>EoE/EEo</th>
<th>LyE</th>
<th>GERD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total patients</td>
<td>21</td>
<td>10</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>Median age (range)</td>
<td>39 (18-82)</td>
<td>40.5 (18-63)</td>
<td>39 (26-82)</td>
<td>62 (38-84)</td>
</tr>
<tr>
<td>PPI effect* (effective/ineffective/uncertain)</td>
<td>3/6/12</td>
<td>2/4/4</td>
<td>1/2/8</td>
<td>2/0/8</td>
</tr>
<tr>
<td>Conventional endoscopy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mucosal rings</td>
<td>14</td>
<td>8</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Linear furrows</td>
<td>15</td>
<td>9</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>White exudates</td>
<td>9</td>
<td>7</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Narrow-caliber/stenosis</td>
<td>9</td>
<td>5</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>At least 1 of the above findings</td>
<td>18 (87.5%)</td>
<td>10 (100%)</td>
<td>8 (72.7%)</td>
<td>5 (50%)</td>
</tr>
<tr>
<td>Magnifying endoscopy</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beige color</td>
<td>19</td>
<td>10</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>Increased and congested IPCLs</td>
<td>20</td>
<td>10</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>Invisibility of submucosal vessels</td>
<td>19</td>
<td>10</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>At least 1 of the above findings</td>
<td>20 (95.2%)</td>
<td>10 (100%)</td>
<td>10 (90.9%)</td>
<td>3 (30%)</td>
</tr>
<tr>
<td>All above findings</td>
<td>19 (90.5%)</td>
<td>10 (100%)</td>
<td>9 (81.8%)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

NBI-ME, Magnifying endoscopy with narrow-band imaging; EoE, eosinophilic esophagitis; EEo, esophageal eosinophilia; LyE, lymphocytic esophagitis; PPI, proton pump inhibitor; IPCLs, intrapapillary capillary loops.

*PPI effects were judged by the patients’ symptoms.

**Magnifying endoscopy with NBI**

The retrospective review of the images identified the following 3 abnormal NBI-ME features: (1) beige color of the mucosa (normal mucosa has light green color), (2) increased and dot-shaped congested IPCLs, and (3) invisibility of submucosal vessels (normal mucosa has cyan-colored vessels). All images were categorized as having abnormal features by consensus among 3 experienced endoscopists (K.T., A.D., and P.T.S.).

NBI-ME features of EoE/EEo and LyE are summarized in Table 2 (Fig. 2). Beige color of mucosa was seen in 19 of 21 patients with EoE/EEo or LyE, increased and congested IPCLs with dot shapes in 20, and invisibility of submucosal vessels was seen in 19 patients. In 20 patients (95.2 %), at least 1 abnormal endoscopic finding was seen. All 3 NBI-ME features were seen in 19 patients (90.5%). Twelve patients (5 EoE/EEo, 7 LyE) had these abnormal findings in a patchy pattern (Fig. 2E), and 3 of those had histologically normal mucosa in biopsy specimens taken from NBI-ME normal mucosa.

In the 10 patients with EoE/EEo, all of the above-mentioned findings were seen. In 1 patient with LyE, none of the aforementioned features was found, and only 1 feature (increased and congested IPCLs) was seen in another patient with LyE. These 2 patients did not have any abnormal findings in conventional endoscopy.

In GERD patients, no patient had all 3 findings. We found increased and congested IPCLs in 3 patients, but none of the GERD patients showed beige discoloration of mucosa or invisibility of submucosal vascularity. Nineteen of 21 patients with EoE/EEo/LyE had all 3 abnormal findings of NBI-ME, but none of the patients with GERD had them (P < .0001) (Table 3).
In this report we describe findings in 21 patients with EoE/EEo or LyE who underwent conventional endoscopy and NBI-ME. With conventional endoscopy, 85.7% of patients (18/21) had at least 1 abnormal finding. The findings of LyE seemed to be more subtle than those of EoE/EEo. When NBI-MB was used, 90.5% of patients (19/21) had all 3 abnormal findings: beige-colored mucosa, increased and congested IPCLs, and invisibility of submucosal vessel. Sharma et al reported that patients with GERD had an increased number of IPCLs in NBI-ME. In the present study, increased and congested IPCLs were seen in some patients with GERD, but none of the GERD patients had all 3 above-mentioned NBI-ME findings (Fig. 3). Therefore, coexistence of these 3 NBI-ME findings might indicate suspicion of EoE/EEo or LyE. After reviewing the NBI-ME images, consensus was reached by all 3 experienced endoscopists. The interobserver reliability of these criteria should, however, be tested in a prospective study with a higher number of cases.

Previous descriptions of histologic findings in EoE pathology include not only eosinophilic infiltrate in the epithelium but also basal zone hyperplasia, spongiosis, fibrosis of lamina propria, and papillary elongation. These pathologic findings may be the cause of the...
disappearance of submucosal vessels and appearance of dot shapes of IPCls in NBI-ME. In the LyE cases, pathology initially showed intraepithelial lymphocytes in peripapillary fields, and Haque and Genta reported that a striking amount of intercellular edema (spongiosis) was seen.

In 12 patients, the abnormal NBI-ME findings were patchy, and the histologic findings also corresponded to the NBI-ME findings in these patients. The diagnosis of EoE and LyE depends on pathologic findings from biopsy specimens. Our findings suggest that biopsy specimens should be obtained from mucosa with both normal and abnormal appearance in NBI-ME.

A limitation of our exploratory study is the relatively small number of patients in whom pictures were retrospectively analyzed. The possibility that patients with EEo have other causes of eosinophilia, especially PPI-responsive eosinophilia, could not be totally disregarded because a second EGD after PPI treatment was not done in 6 patients with EoE/EEo. A larger prospective study is required to confirm our present findings.

In conclusion, by the aid of NBI-ME, 3 particular features were documented in EoE/EEo and LyE: beige discoloration of mucosa, increased and congested IPCls, and invisibility of submucosal vascularity. A larger prospective study is required to confirm the diagnostic value of these criteria.

### REFERENCES

A novel method of gastrojejunal tube placement using endoclips in pediatric patients: a case series

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Gastrojejunal (GJ) tubes are used to feed patients who are unable to tolerate gastric feeding. 1 The initial conversion of a gastrostomy (G) to a GJ tube or replacement of an existing GJ tube in children is typically performed fluoroscopically or endoscopically. 1,2 These techniques can often be time-consuming, and the endoscopic approach can be technically challenging given the predisposition for the GJ tube to displace during withdrawal of the endoscope. This case series describes an endoscopic technique in 7 pediatric patients whereby the GJ tube is anchored to the small bowel by using an endoclip. Although this technique has been reported in adults, 3 this is the first description of endoscopic GJ tube placement in children.

BACKGROUND

G tubes are often used to provide nutrition in patients who are unable to tolerate adequate oral feeding. Conversion to a GJ tube may be indicated in cases of severe reflux, aspiration pneumonia, gastroparesis, failed fundoplication, or motility disorders to directly feed into the small bowel and to provide decompression of the stomach via the gastric port. GJ tubes are not permanent and can be converted to a standard G tube in the event that the patient’s clinical situation improves and postpyloric feeds are no longer necessary. 1 Well-described adverse events of GJ tubes include clogging, duodenogastric reflux, diarrhea, tube displacement, perforations through the intestinal wall, and intussusception. 1,5

METHODS

We reviewed the medical records of 7 pediatric patients who underwent a total of 13 GJ tube placements from July 1, 2011, to June 30, 2012. The procedures were performed by the authors. The study was approved by the Institutional Review Board of Columbia University.

For each patient, a standard endoscope was passed via the mouth into the stomach. The existing G tube was removed, and the tip of the GJ tube was pushed into the stomach. We elected to use the Kimberly-Clark MIC transgastric-jejunal feeding tube (Kimberly-Clark, Roswell, GA, USA) because it is low profile, has a gastric port and a jejunal port, and has a suture loop already in place on its distal end. The French size diameter was chosen based on the existing tube in place. The length of the tube (30 or 45 cm) was chosen based on the size of the child and by laying the tube over the child before the procedure to determine which length would be most appropriate. Once the suture loop was identified in the stomach, an endoclip was passed through the endoscope to grab the loop. We tried to rotate the endoclip 180 degrees or more once the suture was captured within the stomach to secure the loop to the clip. 3 The endoclip that we used was the Resolution clip device by Boston Scientific (Natick, Mass), which requires a 2.8-mm channel and can be opened and closed a few times before deployment.

The suture loop was then pulled back into the tip of the endoscope and advanced through the pylorus to grab the loop. We tried to rotate the endoclip 180 degrees or more once the suture was captured within the stomach to secure the loop to the clip. 3 The endoclip that we used was the Resolution clip device by Boston Scientific (Natick, Mass), which requires a 2.8-mm channel and can be opened and closed a few times before deployment.

The suture loop was then pulled back into the tip of the endoscope and advanced through the pylorus into the small intestine as far as possible or until the external portion of the tube was flush against the skin. The endoclip was then deployed onto a plicae of the small intestine, securing the string attached to the J tube in place (Fig. 1).

Abbreviations: G, gastrostomy; GJ, gastrojejunal; IR, interventional radiology; J, jejunal.

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