The construction of ileal pouch–anal anastomosis (IPAA) is the procedure of choice for patients with ulcerative colitis or familial adenomatous polyposis who require colectomy. Furthermore, IPAA has the advantage of preserving the natural route of defecation, unlike the Brooke’s ileostomy or continent ileostomies. On the other hand, the natural history of patients with the ileal pouch can be complicated by various surgical procedure–associated mechanical adverse events as well as inflammatory and functional disorders. Pouch strictures are one of the most common adverse events after IPAA, with a reported frequency ranging from 10% to 17%. Pouch strictures may or may not be related to Crohn’s disease (CD). Pouch strictures can be primary and secondary, based on the etiology, and distal afferent limb, inlet, pouch body, and anastomotic strictures, based on the location. There are scant published data on the management of ileal pouch strictures. Medical therapy seems to be of limited value in the management of these strictures. Because of the mechanical nature of these strictures, endoscopic balloon dilation (EBD) and endoscopic stricturotomy are effective to reduce the need for surgery and the risk for pouch failure. Resection and anastomosis and stricturoplasty are 2 main surgical treatment modalities, which could be used to salvage the pouch. In this narrative review, we summarize the key findings of the currently available literature and construct a management algorithm for clinicians taking care of patients with ileal pouches.

**PATIENTS AND METHODS**

Restorative proctocolectomy with IPAA is the surgical treatment of choice for patients with medically refractory ulcerative colitis (UC), UC-associated neoplasia, or familial adenomatous polyposis. Although the construction of continent ileostomy or the Kock pouch was first described in 1965, the pelvic ileal pouch was first introduced in 1978. A number of configurations of pelvic ileal pouches have been created, including J, S, W, H, and T pouches with a hand-sewn or a stapled anastomosis. Of those, the J pouch is the most commonly constructed. Stapled anastomosis without mucosectomy has become a preferred technique to hand-sewn anastomosis with mucosectomy, because of better functional outcomes of the former. The risk of dysplasia may be increased theoretically in patients with stapled anastomosis without mucosectomy. However, mucosectomy has not been shown to be totally protective for patients from the development of neoplasia at the pouch body or cuff and/or anal transitional zone (ATZ). Mucosectomy, however, has been routinely performed in patients during pouch construction for underlying colitis-associated neoplasia in the rectum. In the authors’ practice, mucosectomy is occasionally performed to treat patients with refractory inflammation of the cuff.

It is important to recognize and appreciate the landmarks of an ileal pouch. The anatomic landmarks of the J pouch body include the afferent limb, which extends from the pouch inlet, and the efferent limb, which leads to the tip of the J area. These 2 limbs make a U turn and confer a figure J to the dome of the pouch. The classic owl’s eye appearance in the proximal pouch body on pouch endoscopy is indicative of a healthy J pouch. The outlet area is located at the pouch–anal anastomosis site (Fig. 1). The S pouch, on the other hand, is made up of

**Abbreviations:** ATZ, anal transitional zone; CD, Crohn’s disease; EBD, endoscopic balloon dilation; IBD, inflammatory bowel disease; IPAA, ileal pouch-anal anastomosis; NSAID, nonsteroidal anti-inflammatory drug; TNF, tumor necrosis factor; UC, ulcerative colitis.

**DISCLOSURE:** All authors disclosed no financial relationships relevant to this publication.

This video can be viewed directly from the GIE website or by using the QR code and your mobile device. Download a free QR code scanner by searching “QR Scanner” in your mobile device’s app store.

Copyright © 2017 by the American Society for Gastrointestinal Endoscopy

http://dx.doi.org/10.1016/j.gie.2017.01.043

(footnotes continued on last page of article)
3 limbs with 2 U turns. Therefore, the S pouch normally has a larger volume than the J pouch. The additional 2 to 3–cm segment of bowel of efferent limb in an S pouch facilitates easy reach to the ATZ, thus reducing the tension at the anastomosis (Fig. 2). Both J and S pouches may develop strictures at the pouch inlet, outlet, or loop ileostomy site (Fig. 3). Some patients with UC impaired anal sphincter function or perianal disease not related to CD are candidates for IPAA, but they can be eligible for having a Kock pouch or continent ileostomy after proctocolectomy. The Kock pouch has been constructed as a rescue or secondary operation for highly selected patients who failed J pouches. The main landmark for the Kock pouch is the nipple valve, which maintains fecal continence and allow for intubation with a catheter. Patients with the Kock pouch can develop strictures at the skin, nipple valve, or pouch inlet. The Barnett continent intestinal reservoir, another form of continent ileostomy and a modification of the Kock pouch with a strengthening valve by a loop of small bowel, is less commonly constructed. One of the theoretical advantages of the Barnett continent intestinal reservoir over the Kock pouch is to decrease the propensity for nipple valve slippage.

Despite its impact on UC symptoms, patient quality of life, and the risk for colitis-associated neoplasia, the restorative proctocolectomy with IPAA procedure often is associated with inflammatory and noninflammatory disorders including pouchitis, CD of the pouch, inflammation of the cuff, irritable pouch syndrome, strictures, and fistulas. We have proposed a disease classification system for ileal pouch disorders: surgery-related and/or mechanical adverse events; inflammatory or infectious disorders; functional disorders; dysplasia or neoplasia; and systemic or metabolic disorders. The etiopathogenesis of the majority of those disease conditions is largely unknown. Those conditions adversely affect surgical outcomes and patient health-related quality of life. More importantly, some of these adverse events can lead to pouch failure with pouch excision, pouch revision, or permanent diversion. It should be pointed out that patients may present with a combination of these conditions or disease states, and the disease phenotype(s) may change over time, making the diagnosis, differential diagnosis, and management of those disorders challenging.

**Search and screening strategy**

A comprehensive literature review for English language studies in Embase, Medline, Ovid, and Cochrane library for studies published from 1990 to 2016 was conducted. Additional studies were supplemented from the bibliographies of relevant articles. The keywords and the Mesh headings used to perform the search were CD of the pouch, endoscopic balloon dilation, ileal pouch, medical therapy (immunomodulators and biologics), restorative proctocolectomy, stenosis, stricture, and stricturoplasty. No language restrictions were used. The last date of the search was December 31, 2015. In addition to published data in the literature, the authors have incorporated opinions and personal experience (unpublished data) where relevant.

**Frequency of pouch stricture**

The reported frequency of ileal pouch strictures after IPAA ranges from 10% to 17%. One study from the Cleveland Clinic including 3707 consecutive patients undergoing IPAA reported a cumulative prevalence of early and late anastomotic strictures to be 5% and 11%, respectively, during a median follow-up of 84 months. Similar results were reported from the Mayo Clinic (11%-17%) during a mean (± standard deviation [SD]) follow-up of 10 ± 6 years. Two common locations of the pouch stricture are the pouch inlet (the junction between the neoterminal ileum or afferent limb and the pouch body) and the pouch outlet (the pouch-anal anastomosis). The less-common locations include mid-pouch and distal small intestine, and the site of prior loop ileostomy. Of note, CD of the pouch can cause strictures anywhere along the GI tract.

**Etiology and risk factors**

Common causes of strictures in the ileal pouch include pelvic sepsis, anastomatic tension, and surgery-associated tissue ischemia. Other common causes are the use of nonsteroidal anti-inflammatory drugs (NSAIDs) or CD of the pouch. A persistence of stricture after the discontinuation of NSAIDs or an isolated stricture at the pouch–anal anastomosis in the absence of a fistula or mucosal lesion favors a diagnosis of surgically related stricture. Furthermore, 1 study of 115 patients found that the stapler size and the presence of a nonfunctioning ileostomy, anastomotic dehiscence along with pelvic sepsis were risk factors for strictures in the ileal pouch. Hand-sewn technique, mesenteric tension, decreased blood supply, or increased body mass index also may contribute to the development of a stricture.

CD of the pouch is one of the common causes of ileal pouch strictures. Although the true incidence of CD of the pouch after restorative proctocolectomy is not known, the reported cumulative frequency ranged from 2.7% to
13%. Fulminant colitis or toxic colitis with transmural inflammation may make the distinction of CD and UC difficult, and those patients may be labeled as having indeterminate colitis. Patients with indeterminate colitis may have a slightly higher risk for CD of the pouch. More importantly, de novo CD of the pouch may develop weeks, months, or even years after IPAA, which makes up the majority of the CD patients who have the pouch. It is believed that IPAA surgery might reset the “immune thermostat” and create a CD-friendly environment. Like those patients with CD not related to the pouch, patients with CD of the pouch can present with inflammatory, fibrostenotic, or fistulizing forms. Stricturing and fistulizing CD of the pouch is one of the most frequent causes of pouch failure.

Surgery-related ischemic strictures result from compromised blood flow and/or tension on blood vessels that supply the ileum during pouch construction. This appears to be more evident in obese patients or those with a short mesentery. Surgical techniques also may count. One study of 168 patients reported that anastomotic strictures appear to be more common in patients who had hand-sewn anastomoses than in patients with stapled anastomoses (8% vs 22%). A separate study of 2120 IPAA patients reported that the stapler size (28-29 mm vs 31-33 mm) did not appear to have an impact on the frequency of anastomotic leakage, stricture, long-term functional outcomes, and patient quality of life. However, the study confirmed that long fibrotic strictures were more commonly seen in patients with hand-sewn anastomosis than that in those with stapled anastomoses.

In addition to strictures, bowel obstructions may be caused by bezoars, afferent limb syndrome, efferent limb syndrome, prolapse, and a twisted pouch. Afferent limb syndrome occurs in the pouch inlet area when a loop of ileum becomes trapped between the sacrum and the pouch body or there is a sharp angulation between the afferent limb and pouch body.
Efferent limb syndrome results from the bend of the long efferent limb in patients with an S pouch or an angulation between the pouch body and a long rectal stump in patients with a J pouch. Endoscopic examination typically shows normal mucosa of the afferent limb and pouch body with an absence of intrinsic strictures. Pouch bezoars are seen mostly in patients with continent ileostomies (a Kock pouch or a Barnett continent intestinal reservoir) because of the nature of the pouch outlet, in other words, the nipple valve. These patients are managed with endoscopic or surgical treatment including basket, Roth Net, mechanical lithotripsy tripod, snares, or laser or US lithotripsy.27

**DIAGNOSIS**

For the evaluation of magnitude of adverse events associated with stricturing ileal pouch disorders and guidance of appropriate therapy, optimum diagnostic modalities to differentiate inflammatory from fibrotic strictures are being sought.

**Clinical presentations**

Patients with pouch strictures may present with minimal or florid symptoms. Their symptoms often are nonspecific, including early satiety, bloating, nausea, vomiting, diarrhea, abdominal pain, urgency, blood in stools, and dyschezia. Some patients may present with refractory gastroesophageal reflux disorder, whereas others may experience obstruction or complete small-bowel obstruction. A stricture at the nipple valve in the Kock pouch may lead to difficulty in catheter intubation. Patients with long-term, high-degree strictures may have anemia, malnutrition, and weight loss.

**Pouch endoscopy and imaging**

A number of diagnostic modalities have been used to enhance the accuracy of detecting ileal pouch strictures. Anastomotic pouch strictures can be detected by a careful digital examination. These include magnetic resonance imaging, magnetic resonance enterography, CT enterography (Fig. 4A), contrast pouchogram or gastrografin enema (Fig. 4B and C), small-bowel follow-through, and pouch endoscopy. Our previous study of 66 patients with ileal pouches evaluated the accuracy of these modalities and found that the gastrografin enema (91%), magnetic resonance imaging (92%), and pouch endoscopy (95%) had a higher accuracy than CT enterography (74%) for the diagnosis of inlet or afferent strictures.28 However, all 4 diagnostic modalities had similar accuracy for outlet strictures. Furthermore, a separate study of 42 patients with IPAA found a gastrografin enema to be 100% sensitive (6/6 patients) and the specificity to be 92% (33 of 36 patients) for detecting clinically relevant strictures if an anastomotic stricture diameter of \( \geq 8 \) mm was considered as the cut value for obstructive symptoms.29 We currently advocate the gastrografin enema as the first-line diagnostic modality of choice to detect ileal pouch strictures, irrespective of their locations. However, a combination of these modalities increases the diagnostic yield as compared with each single modality alone. On the other hand, pouch endoscopy can deliver therapeutic intervention in addition to diagnostic evaluation. In our Pouch Center, we routinely use gastrografin enemas to delineate the location, degree, length, and number of strictures and to guide the subsequent therapeutic pouch endoscopy. In patients suspected of having a fistula or abscess, magnetic resonance imaging, magnetic resonance enterography, or CT enterography may be used.

The distinction between NSAID-induced strictures, surgical ischemia–associated strictures, and CD–related strictures can be difficult. Clinical history and response to therapy may yield some clues. The avoidance of NSAIDs resulting in complete or partial resolution of a stricture and concurrent mucosal ulceration may suggest the diagnosis of medication-related adverse effect. Empiric therapy with biologic agents may help distinguishing a CD stricture from a surgical ischemia–associated stricture, based on the improvement of the stricture and/or adjacent mucosal inflammation.
Pouch strictures can be classified as (1) the primary versus secondary or anastomotic ones, based on the etiology; and (2) inflammatory or fibrotic or mixed, based on the histopathologic features; (3) ones at the afferent limb, loop ileostomy site, inlet, pouch body, or anastomosis, based on the location; and (4) single versus multiple, based on the number; (5) short (<4 cm) and long (>4 cm) (Table 1). This classification system has helped to direct proper therapy at our Pouch Center at the Cleveland Clinic. For example, inflammatory, nonfibrotic strictures may be amenable to medical therapy. Single, short, straight fibrotic strictures have benefited most from EBD or endoscopic needle-knife stricturotomy. Multiple, long, or angulated strictures may be treated by surgery. One study classified outlet strictures into fibrotic and nonfibrotic by digital examination and concluded that the nonfibrotic strictures were more responsive to bougie dilation than fibrotic strictures, which eventually required surgical therapy. Patients with pouches with a diverting ileostomy tend to develop distal pouch strictures easily, in addition to diversion pouchitis. Sometimes the stricture is so tight that it completely seals the pouch outlet (see Discussion below).

### MEDICAL TREATMENT

The treatment of pouch strictures consists mainly of 3 forms—medical, endoscopic, and surgical. Each has pros and cons. The role of medical therapy in the treatment of stricturing disease of the pouch has been controversial and challenging. In fact, the majority of studies either excluded patients with fibrostenosis or included them only in small patient populations to draw any conclusions (Table 2). A study of 22 patients with IPAA with CD-like adverse events, including 8 fibrostenotic strictures, reported that 7 of 8 were successfully treated with azathioprine/6-mercaptopurine, with no patients requiring stoma during a mean (± SD) follow-up of 97 ± 12 months. The authors suggested that azathioprine/6-mercaptopurine may be considered as the initial therapy in fibrostenotic pouch strictures, rather than anti-tumor necrosis factor (TNF) biologics.

---

**TABLE 1. Classification of ileal pouch strictures**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Classification</th>
<th>Subclassification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pouch configuration</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>J</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S</td>
</tr>
<tr>
<td>Continent ileostomies (Kock pouch or Barnett continent intestinal reservoir)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diverted pouch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td>Primary</td>
<td>Small bowel or afferent limb</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pouch inlet</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pouch body</td>
<td></td>
</tr>
<tr>
<td>Nipple valve (in Kock pouch or Barnett continent intestinal reservoir)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secondary/anastomotic</td>
<td>Loop ileostomy site</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pouch-anal anastomosis</td>
<td></td>
</tr>
<tr>
<td>Nature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inflammatory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fibrostenotic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No.</td>
<td>Single</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Multiple</td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>Short (&lt;4 cm)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Long (&gt;4 cm)</td>
<td></td>
</tr>
<tr>
<td>Concurrent conditions</td>
<td>Simple</td>
<td>Isolated stricture</td>
</tr>
<tr>
<td></td>
<td>Complex</td>
<td>Fistula</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Abscess</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Angulated stricture</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ischemia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Radiation</td>
</tr>
</tbody>
</table>
contrast, in another case series of 26 patients with IPAA with CD of the pouch, including 5 with fibrostenotic strictures and 17 (67%) treated with infliximab, were able to retain their pouches after a median follow-up of 22 months. Additionally, another study of 17 patients with IPAA, with CD-like adverse events including 2 with fibrostenotic strictures, reported that 14 (82%) patients were able to retain their pouches after adalimumab therapy.

Similarly, a separate study of 48 patients with IPAA with CD of the pouch, including 8 patients with fibrostenotic strictures, reported a complete response in 16 (35%), partial response in 10 (21%), and no response in 22 (46%) patients treated with adalimumab during a median follow-up of 25.1 months. The main outcomes of these studies were symptom response and/or surgery-free survival. It is unlikely that the current medical therapy with currently available agents can deter the progression of stricture or dissolve the existing fibrotic strictures. On the other hand, whether anti-TNF biologic therapy promotes formation of strictures by rapid mucosal healing in patients with pouches is not known. Two separate studies found that the requirement for the use of immunomodulators or anti-TNF biologics and the diagnosis of CD of the pouch (hazard ratio 9.9; 95% confidence interval, 1.7–57.1) were associated with pouch failure. The authors believe that the higher rate of pouch failure in patients who require the use of immunomodulators and/or anti-TNF biologics may be related to the presence of underlying disease of the pouch, especially CD of the pouch.

In summary, there are no sufficient data for advocating medical therapy for ileal pouch strictures. First of all, pouch patients should avoid the use of NSAIDs. Medical therapy may have a role in controlling inflammatory components in strictures and in adjacent inflamed bowel and in helping prevent the development of new strictures. Currently, medical therapy is advocated in conjunction with endoscopic and/or surgical treatment. This is particularly true in patients with CD strictures. Proper medical treatment of the inflammatory type of CD of the pouch may reduce the risk for the development of new strictures and/or fistulas. On the other hand, the role of medical therapy in treating surgical ischemia-associated strictures is limited.

### ENDOSCOPIC TREATMENT

Endoscopic therapy plays a major role in the management of pouch strictures. The goals of endoscopic therapy are several-fold: (1) relief of symptoms; (2) avoidance of surgery or at least spacing out the need of frequent surgical interventions; (3) prevention of pouchitis or enteritis from fecal stasis; and (4) possible prevention of development of fistulas proximal to the stricture. Bearing in mind these goals, we typically deliver therapy to the patient regardless of the presence or absence of symptoms.

The main endoscopic treatment modalities include EBD, endoscopic stricturotomy (including needle-knife stricturotomy), and luminal stent placement. When the therapeutic procedures are performed, the endoscopist always should have in mind and be ready to implement if needed: Plan A (steadily aiming at the targeted area), Plan B (having a rescue plan in case of bleeding or perforation), and Plan C (surgical back-up).

---

### TABLE 2. Published studies on efficacy of medical therapy in patients with ileal pouch strictures

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample size</th>
<th>Type of pouch</th>
<th>Disease duration</th>
<th>Median or mean follow-up</th>
<th>Medical therapy</th>
<th>Stricture location</th>
<th>EBD</th>
<th>P/CMT</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ricart</td>
<td>7</td>
<td>NA</td>
<td>4.3 y</td>
<td>13.4 wk</td>
<td>IFX</td>
<td>NA</td>
<td>NA</td>
<td>ATX, CS, IM</td>
<td>FS patients not included in the study</td>
</tr>
<tr>
<td>Colombel</td>
<td>26</td>
<td>NA</td>
<td>4.5 y</td>
<td>21.5 mo</td>
<td>IFX</td>
<td>5</td>
<td>Pre-pouch ileal, mid-pouch</td>
<td>Yes</td>
<td>ATX, CS, IM</td>
</tr>
<tr>
<td>Shen</td>
<td>17</td>
<td>J/S</td>
<td>NA</td>
<td>8 wk</td>
<td>ADA</td>
<td>2</td>
<td>NA</td>
<td>S-ASA, CS, IM, IFX</td>
<td>Concurrent EBD therapy is necessary for FS-CD of the pouch</td>
</tr>
<tr>
<td>Ferrante</td>
<td>28</td>
<td>J/S</td>
<td>NA</td>
<td>10 wk and 20 mo</td>
<td>IFX</td>
<td>0</td>
<td>NA</td>
<td>ATX, CS, IM</td>
<td>FS patients not included in the study</td>
</tr>
<tr>
<td>Haveran</td>
<td>32</td>
<td>J</td>
<td>17.4 ± 3.7 mo</td>
<td>97 ± 11.8 mo</td>
<td>AZA/6-MP</td>
<td>6</td>
<td>Proximal small-bowel or pouch inlet</td>
<td>No</td>
<td>ATX, S-ASA, CS, IFX</td>
</tr>
<tr>
<td>Li</td>
<td>48</td>
<td>J/Kock, S</td>
<td>NA</td>
<td>8 wk</td>
<td>ADA</td>
<td>8</td>
<td>Proximal small-bowel or pouch inlet</td>
<td>Yes</td>
<td>ATX, B, S-ASA, IFX</td>
</tr>
</tbody>
</table>

All study designs were retrospective.

FS, Fibrostenotic; CD, Crohn’s disease; EBD, endoscopic balloon dilation; P/CMT, prior or concurrent medical treatment; NA, not available; IFX, infliximab; ATX, antibiotics; CS, corticosteroids; IM, immunomodulator; ADA, adalimumab; 5-ASA, aminosalicylic acid; AZA, azathioprine; 6-MP, 6-mercaptopurine; B, budesonide.
Settings of endoscopic therapy

The right patient, the right lesion, and the right endoscopist in an elective setting with adequate surgical backup are key for successful endoscopic therapy. Patients with malnutrition or those who have severe comorbidities or are on concurrent immunosuppressive therapy (particularly systemic corticosteroids and anti-TNF biology), or those in an emergent setting are at a high risk for procedure-associated adverse events, and, hence, the procedure should be avoided or postponed. Pouch patients with underlying UC may have concurrent primary sclerosing cholangitis, and the latter is often associated with portal hypertension or, to a lesser extent, thrombocytopenia or coagulopathy. Endoscopic intervention in patients with primary sclerosing cholangitis may carry a greater risk for bleeding adverse events than those without. The risks and benefits of endoscopic therapy in patients with primary sclerosing cholangitis should be carefully balanced.

Adequate bowel preparation is necessary before endoscopic therapy. Per-oral lavage with polyethylene glycol is preferred over mineral oil enemas for bowel preparation, for its efficacy and less time used at the procedure-preparation suite. Furthermore, functionality and availability of appropriate equipment and supplies for EBD should be assessed. Discontinuation of antithrombotic agents and/or anticoagulants should be individualized, with the risks and benefits of thromboembolic events and bleeding being carefully balanced. Because of the lack of the large bowel, minimum air insufflation is needed during diagnostic and therapeutic pouch endoscopy. In addition, carbon dioxide insufflation is preferred to room air.

In most cases, endoscopic therapy can be carried out in an outpatient setting, without fluoroscopy. Patients normally require conscious sedation. There are several sedation modalities for therapeutic endoscopy in pouch patients. Conscious sedation may have advantages over general anesthesia because light sedation may enable the endoscopist to get patient feedback for the amount of discomfort experienced during the procedure, which may be important in guiding the endoscopist as to the duration, degree, pressure, and number of insufflations for endoscopic therapy. Oversedation should be avoided, because it may mask the pain response for impending perforation, and the access to strictures may be challenging because of difficulty in changing the patient position.

Endoscopic evaluation should include segmental biopsies of the afferent limb, pouch body, and anal transitional zone or cuff. The location of the stricture can be documented by preprocedure abdominal imaging and be confirmed by pouch endoscopy. The degree of stricture can be quantified by the endoscopist based on the degree of resistance to the passage of the upper endoscope (0 = no resistance; 1 = mild resistance; 2 = moderate resistance; 3 = severe resistance, 4 = pinhole and not traversable). A pouch–anal anastomosis stricture is suspected when the anal canal cannot freely admit the endoscopist’s little finger during digital examination. Furthermore, the length of each stricture is estimated and documented.

Extreme cautions should be taken for the therapeutic pouch endoscopy. Patients should be observed at recovery room at least 30 minutes after the procedure. Patients are closely monitored for signs of excessive bleeding and visceral perforation. Patients are advised to stay in the periphery of the hospital the same day of the procedure, in case bleeding or late-onset perforation. The endoscopist should have a lower threshold to order an abdominal radiograph if perforation is suspected.

EBD

For EBD, we normally use a flexible, single-channel, video upper endoscope, taking advantage of its small caliber and flexibility (Fig. 5A and B), (Fig. 6A and B), (Fig. 7A and B, Video 1, available online at www.giejournal.org). A stiffer flexible sigmoidoscope may be used for multiple strictures at the inlet and afferent limb. For endoscopic therapy, balloon size is determined based on the location, degree, and length of the stricture. As in other strictures related to inflammatory bowel disease (IBD) in sites other than the pouch, the targeted balloon size should be between 18 mm and 20 mm. Sequential dilations with the same balloon up to 3 sizes may be performed. For female patients with a pouch-anus anastomotic stricture, the balloon size may not exceed 18 mm because of the concern for iatrogenic trauma leading to pouch-vagina fistula. If the stricture is traversable, EBD in a retrograde fashion is preferred, with the endoscope passing through the targeted stricture with the endoscopist’s direct view of the bowel segment proximal to the stricture. For high-grade or angulated strictures not traversable by an endoscope, antegrade, wire-guided, through-the-scope balloon dilation may be performed with the wire-exchange technique. Technical success is defined as the passage of the endoscope without resistance through the stricture. For long, fibrotic strictures refractory to multiple EBD therapy, needle-knife stricturotomy or surgical intervention may be attempted.

EBD with through-the-scope balloon has made the endoscopic therapy simpler and quicker. The advantages of through-the-scope balloon dilation include the capability for direct placement and visualization of the balloon within the endoscope. Moreover, fixed diameter and low compliance provide a measure of safety against perforation because of over insufflation. Before EBD, bougie dilation has been attempted in patients with CD strictures. The main advantages of EBD over bougie dilation include (1) a high radial dilating force as opposed to a longitudinal or shearing force by bougie dilation, being less traumatic. This is particularly important for the distal pouch or anastomotic stricture, minimizing the risk for anal sphincter damage
or the development of an iatrogenic fistula; (2) the ability of direct visualization with the endoscope; (3) the option of fluoroscopy by the use of radiopaque markers; and (4) improved patient comfort and safety.

The therapeutic role of EBD has been studied in patients with ileal pouches (Table 3). Our group was the first to report a case series of EBD in the treatment of pouch strictures. A total of 19 patients had strictures (14 inlet and
14 outlet strictures), with 11 having underlying CD of the pouch. Those patients underwent successful EBD with concurrent medical therapy. Symptoms and quality of life scores significantly improved 8 and 16 weeks after EBD, as compared with before-dilation baseline scores. In a follow-up study from our group with a larger number of patients (n = 150), EBD resulted in a 5-year, 10-year, and 25-year pouch retention rates of 97%, 90.6%, and 85.9%, respectively. After a median follow-up of 9.6 years, 131 (87%) patients were able to retain their pouches.

In these studies, one of the confounding factors was the use of concomitant medical therapy. Therefore, the improvement in patient symptoms, endoscopic stricture scores, and quality of life could be related to a synergistic effect of both EBD and medical treatment.

The efficacy and safety of EBD for stricture has been studied in patients with Kock pouches and ileostomy. Our group reported endoscopic treatment of 16 patients, with a total of 30 strictures (mean ± SD stricture length of 1.5 ± 0.7 cm) in Kock pouches. The technical success of EBD was 100%, with no procedure-related adverse events, and none of the patients required pouch revision or pouch excision during a median follow-up of 32 months. A separate study from our group evaluated the efficacy of EBD in 25 ileostomy patients with a total of 179 strictures and reported a technical success rate of 93% and surgery-free survival of 80% during a mean follow-up of 22 ± 26 months. Procedure-related adverse events were reported in 3% of those patients.

The intralesional injection of long-acting corticosteroid injectate or anti-TNF agents during EBD has been studied for strictures in patients who have CD but no ileal pouch with prior or concurrent medical treatment. Therefore, the aim of avoiding or spacing out repeat surgical interventions. There has been concern about the risk of perforation after repeat dilation of the same area. There is a lack of general consensus on the balloon size, duration of balloon insufflation, and number of dilations per session. A before-endoscopy selection criterion for EBD to mitigate the risk of adverse events may be needed. In general, the size of balloon for EBD in the treatment of pouch strictures, like those in patients with IBD without ileal pouches, should be targeted between 18 and 20 mm.

Multiple studies have demonstrated poor correlation between the severity of patient symptoms and the severity of endoscopic or histologic inflammation. It becomes clear that the goal of medical treatment should not only be an improvement of symptoms but also the healing or slowing down of structural damage. Mucosal healing has been set as an important end point in all major randomized controlled trials and as a target of medical therapy in our daily practice. The situation in IBD-related strictures is similar. Patients with severe strictures may have no or minimal symptoms, and those with minor strictures may have marked symptoms. In addition, we do not expect that fibrotic strictures can resolve spontaneously, even with medical therapy. Those strictures can eventually cause symptoms and even complete bowel obstruction. Therefore, in the authors’ opinions, all strictures, defined as the presence of any resistance to the passage of an upper

### TABLE 3. Published studies on endoscopic balloon dilation of ileal pouch strictures

<table>
<thead>
<tr>
<th>Study</th>
<th>Study design</th>
<th>Sample size</th>
<th>No.</th>
<th>Location</th>
<th>LN, cm</th>
<th>P/CMT</th>
<th>Steroid injection</th>
<th>Balloon size, mm</th>
<th>Technical success</th>
<th>Pouch survival/failure</th>
<th>Major adverse events</th>
<th>Median or mean follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shen</td>
<td>Prospective</td>
<td>19</td>
<td>11</td>
<td>(l = 14, O = 14)</td>
<td>1</td>
<td>ATX, 5-ASA, B, IFX, IM</td>
<td>Yes</td>
<td>11-18</td>
<td>100%</td>
<td>NA</td>
<td>0%</td>
<td>6.10 ± 5.83 mo</td>
</tr>
<tr>
<td>Shen</td>
<td>Prospective</td>
<td>150</td>
<td>62</td>
<td>(l = 96, O = 73, AL = 29, b = 2, L = 4)</td>
<td>1</td>
<td>NA</td>
<td>until 2005</td>
<td>18-20</td>
<td>97.8%</td>
<td>NA</td>
<td>2%</td>
<td>9.6 y</td>
</tr>
<tr>
<td>Wu</td>
<td>Retrospective</td>
<td>151</td>
<td>57</td>
<td>(l = 91, 1.1 ± 0.6, O = 78, AL = 30, b = 3)</td>
<td>NA</td>
<td>NA</td>
<td>18-20</td>
<td>NA</td>
<td>Pouch failure rate was 19 (12.5%)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

All findings were that EBD was safe and effective. CD, Crohn’s disease; I, location; LN, length; P/CMT, prior or concurrent medical treatment; l, inlet; O, outlet; ATX, antibiotics; 5-ASA, aminosalicylic acid; B, budesonide; IFX, infliximab; IM, immunomodulator; NA, not available; AL, afferent limb; b, body; PS, pouch survival.
GI endoscope, should be treated endoscopically in order to relieve the mechanical obstruction, to halt the progression of the stricture, and to improve symptoms.

**Endoscopic stricturotomy**

We have described endoscopic stricturotomy with a needle-knife in IBD and non-IBD–related lower GI track strictures, including pouch strictures.\(^{45}\) Needle-knife stricturotomy has been performed in a growing number of patients with strictures with and without ileal pouches at our Interventional Inflammatory Bowel Disease Unit at the Cleveland Clinic.\(^{46}\) For long, fibrotic strictures refractory to multiple sessions of EBD therapy, needle-knife therapy may be a valid option in experienced hands (Video 2, available online at www.giejournal.org).

The main advantage of needle-knife stricturotomy over EBD is that the endoscopist has full control of location and depth in the stricture, in contrast to the blind (ie, uncontrollable location and depth) tear of a stricture by EBD or bougie dilation. This feature is particularly important in the treatment of distal pouches or anastomotic strictures, because the area is close to the vagina, sex nerves, and anal sphincter. We can intentionally avoid the anterior wall of the distal pouch body and anal transitional zone. The motion of the needle-knife cutting can be in a radial (Fig. 8A and B) or circumferential fashion (Fig. 9A and B). Patients with CD-associated distal pouches or anastomotic strictures and those with pouch strictures from fecal diversion are considered as better candidates for needle-knife stricturotomy than for EBD, because needle-knife stricturotomy is less invasive and traumatic in the area with friable mucosa from underlying diseases.

The authors believe that endoscopic stricturotomy with a needle-knife in a semicircumferential or full-circumferential fashion may be more effective than needle-knife therapy done in a radial fashion for a shorter stricture (<2 cm). Needle-knife stricturotomy done in a radial fashion may be more applicable for a longer stricture (>2 cm). Occasionally, the senior author (B. S.) uses endoscopic electrocauterization with or without preceding EBD to treat long, refractory strictures.

To avoid areas of intense vascularity, probe-based Doppler US may be used. The procedure involves the use of a probe to delineate areas of less vascularity and subsequent use of a needle-knife with the setting of ERCP Endocut (ERBE USA, Marietta, Ga) to dissect unremitting fibrotic tissue.\(^{47}\) After the procedure, patients are closely monitored for signs of excessive bleeding and abdominal pain. From the author’s (B. S.) own experience, needle-knife stricturotomy in experienced hands may be more effective than through-the-scope balloon dilation in refractory fibrotic strictures with an acceptable risk for adverse events. Future randomized studies are needed to directly compare EBD and needle-knife stricturotomy in ileal pouch and other GI strictures.

**Bougie dilation**

Minor strictures can be dilated by the patient using a finger or a bougie dilator. The bougie dilator is lubricated and then inserted through the anus into the anastomosis with a stricture and held for at least 10 seconds.\(^{47}\) Bougie dilation is often performed in patients with a short and/or mild anastomotic stricture in a surgical clinic, and it can be done in patients with a long and/or tight stricture under general anesthesia. There is no clear consensus on the size of the dilator or duration and frequency of dilation. However, the majority of these patients eventually may need either endoscopic or surgical therapy.

**Stent placement**

The role of stent placement in small-bowel CD strictures is still under debate, because of the high risk of adverse events like migration, impaction, and perforation.\(^{48,49}\) There was a reported case with a stricture at the proximal afferent limb in which a stent was placed, preventing the patient from having surgery for 8 years.\(^{50}\) We recently used a self-expandable covered metal stent...
to treat a long, angulated, EBD-refractory pouch inlet stricture. The procedure was performed with the placement of a guidewire through the operating channel of an ultrathin endoscope. A 10-cm long, 18-mm stent was placed without the need of fluoroscopic guidance. Two weeks later, we found that the stent had migrated into the pouch body, causing increased bowel frequency and urgency, and we noticed more patency of the stricture (Fig. 10A and B). The biodegradable stent may be an option, although it has not been studied in patients with ileal pouches. Given the lack of substantial data and possible associated adverse events, stent placement is not routinely recommended in the management of ileal pouch strictures.

**EBD in patients with underlying fistulas**

EBD is not contraindicated for anastomotic strictures in patients with perianal fistulas. However, EBD in the area may be avoided in a patient’s distal pouch or anastomotic stricture and nearby pouch-vagina fistula. In the latter situation, endoscopic stricturotomy with a needle-knife targeting the posterior aspect of the stricture may be performed safely. Whether EBD can be performed safely in patients with fistulas and concurrent strictures at the inlet or afferent limb depends on the distance between the fistula and stricture. In the authors’ experience, EBD may be performed if a fistula is far away from the stricture (>5 cm), with a lower risk for perforation resulting from unintentional disruption of the enterocutaneous fistula track.

**SURGICAL THERAPY**

The final modality available in the armamentarium for ileal pouch strictures is surgery. The surgical techniques used for ileal pouch strictures include bowel resection and anastomosis, stricturoplasty, pouch redo, and diverting ileostomy. However, given the invasive nature, postoperative adverse events, and cost, surgery is reserved as the last resort after failure of medical and endoscopic therapies.

**Resection and anastomosis**

Recurrent and persistent ileal pouch strictures that are refractory to medical and endoscopic therapies are managed by surgical resection by using an end-to-end
anastomosis stapler or a stapler cutter or by pouch advancement.\(^{51,52}\) One case series of 3 patients with complex anastomotic strictures reported a transanal technique that used pouch advancement and neoleonan anastomosis.\(^{51}\) Another study of 128 patients with 15 anastomotic strictures reported a new technique of placing circumferential sutures through the stricture ring to induce necrosis of the strictured areas.\(^{52}\) We recommend this technique for short strictures and pouch advancement for long strictures.

**Pouch redo**

Persistent strictures may lead to pouch failure resulting in pouch excision or pouch redo or conversion to continent ileostomy. Few studies have reported on the long-term outcomes of pouch salvage surgery in patients with IPAA adverse events including ileal pouch strictures. One study of 101 patients with IPAA adverse events including 22 anastomotic strictures reported pouch redo to be associated with improved patient satisfaction and quality of life, although pouch failure occurred more frequently in the revised IPAA.\(^{53}\) In another study of 51 patients who underwent IPAA with septic adverse events, fecal diversion at the time of revision did not seem to improve healing rates.\(^{54}\)

There are no large published studies that specifically addressed pouch strictures with redo pouch surgery. One study including 3707 patients who underwent IPAA reported that 19 (5.2%) of those patients developed an early anastomotic stricture, with 415 (11.2%) experiencing a late stricture during a median follow-up of 84 months. However, only 5 patients (0.1%) required either excision or reconstruction.\(^{16}\) In a separate study of 64 patients who underwent continent ileostomy after a failed IPAA, strictures were reported to be the cause of pouch failure in 14 (21.9%) of those patients.\(^{55}\) However, a recent study from the Cleveland Clinic including 502 patients who underwent redo pouch surgery from 1983 to 2014, ileal pouch stricture was not found to be a risk factor for pouch failure.\(^{56}\)

**Stricturoplasty**

Stricturoplasty has been studied extensively in patients with strictureing CD of the small bowel.\(^{57,58}\) Approximately 15 types of stricturoplasty techniques have been described in the literature. However, only few studies have addressed the role of stricturoplasty in patients with ileal pouch strictures (Table 4). A published report on a 33-year-old female patient with a long, tight, mid-pouch stricture 9 years after pouch construction who failed medical therapy revealed that repeat imaging of the pouch demonstrated a wider pouch lumen 1 year after stricturoplasty.\(^{59}\) Subsequently, our group investigated a larger patient population and compared stricturoplasty (\(N = 16\)) and EBD (\(N = 151\)). Patients in both the groups had comparable overall pouch survival and stricture-free survival rates. However, the time interval between the endoscopic or surgical procedure and stricture recurrence or pouch failure was longer in the stricturoplasty group than that in the endoscopic dilation group (\(P < .001\)).\(^{60}\) The surgery-free curves for both approaches merged at 3 years from the inception treatment. There was no difference in the procedure-related adverse events between the 2 groups. Both EBD and stricturoplasty have advantages and disadvantages. Although EBD is less invasive, easy to perform, and safe in experienced hands, patients need to be treated repeatedly. In contrast, stricturoplasty is more invasive and more decisive. We believe that needle-knife stricturotomy has an efficacy and safety profile in between EBD and stricturoplasty. Thus the relative ease, safety, efficacy and the anticipated outcome need to be considered for individual cases before appropriate treatment strategies are recommended for patients with ileal pouch strictures.

**Bypass surgery**

There are no published studies on bypass surgery for pouch strictures in the literature. Bypass of the obstructed segment from the distal ileum to the pouch has been attempted in patients with afferent limb syndrome, which is defined as distal small-bowel obstruction caused by an acute angulation, prolapse, or intussusception of the afferent limb at the junction to the pouch. In a study of 567 patients who underwent IPAA, of whom 122 experienced obstructive symptoms and 6 were attributed to afferent limb syndrome, the obstruction was successfully bypassed by side-to-side anastomosis of the afferent limb to the pouch (enteroenterostomy) in 5 of 6 patients.\(^{27}\)
Also, other surgical techniques such as resection of the angulated bowel, pexy of the pouch, pouch excision with end ileostomy, and mobilization of the pouch with small-bowel fixation has been successfully used in those patients. Our group also has performed bypass surgery successfully in a few patients who underwent IPAA with multiple long and/or angulated strictures in the inlet and afferent limb (unpublished data).

**Surgical fecal diversion**

Permanent ileostomy is constructed in 2 clinical settings: (1) permanent Brooke ileostomy after colectomy in patients who elect not to have an ileal pouch for personal or technical reasons, and (2) ileostomy after pouch failure in those with initial restorative proctocolectomy. The long-term outcome of patients with permanent ileostomy related to pouch failure from various adverse events has not been studied adequately. One case-control study of 123 patients including 57 with a primary ileostomy (ie, stoma created after colectomy for ulcerative colitis) and 66 with a secondary ileostomy (ie, stoma created after pouch failure) after pouch failure reported an increased risk of CD in patients with a secondary ileostomy. Furthermore, postoperative intestinal strictures were more common in the secondary ileostomy group than in the primary ileostomy group (55% vs 1.2%; \( P < .01 \)). Also, patients with secondary ileostomy experienced postoperative small-bowel obstruction more frequently (48.5% vs 8.8%; \( P < .0001 \)) than the primary ileostomy group.

As mentioned earlier, the long-term fecal diversion with the pouch body remaining in situ can lead to distal pouch strictures or even a completely sealed pouch outlet (Fig. 10A and B).

**SUMMARY, RECOMMENDATIONS, AND FUTURE DIRECTIONS**

Studies including patients with strictureing CD of the small bowel have suggested a possible role of medical...
therapy for the inflammatory component of strictures (Table 5). Future studies should investigate the role of immunomodulator and anti-TNF biologics for the inflammatory type of ileal pouch strictures.\textsuperscript{63,64} Newer diagnostic modalities to differentiate the inflammatory from the fibrotic type are needed to aid in medical therapy. However, once fibrosis ensues, medical therapy may not be effective. The mechanical nature of ileal pouch strictures is amenable to endoscopic therapy. Varying definitions of technical and long-term success, differences in balloon sizes, concurrent use of immunomodulators and biologic therapy and the retrospective nature of the studies have led to differences in reported technical success and long-term outcomes in EBD-related studies. A growing number of patients with pouch strictures have been treated with endoscopic stricturotomy, especially with needle-knife stricturotomy. Needle-knife stricturotomy appears to be more effective and maybe safer in treating pouch strictures than EBD, in experienced hands. The ultimate nonsurgical treatment of ileal pouch strictures may be a combination of EBD and/or needle-knife stricturotomy along with disease-modifying drugs. Future studies are needed to answer the ideal settings, the optimal duration and pressure of inflation, the optimal number of dilations per session, elective versus serial scheduled dilations of EBD, and the candidacy for needle-knife stricturotomy. The role of stricture resection and anastomosis and stricturoplasty in treatment should be further investigated in those patients. EBD, needle-knife stricturotomy, and stricturoplasty may be considered complementary techniques to save the pouch. Furthermore, pouch revision would be the last option, which should be avoided in patients with a known diagnosis of CD of the pouch. Prospective studies are needed to directly compare the efficacy and safety of EBD, needle-knife stricturotomy, and surgery for the treatment of pouch strictures. There are technical issues in the use of stents for pouch strictures. Finally, future studies are needed to find markers necessary to differentiate strictures secondary to CD versus those that are ischemia-related to help guide appropriate management. We proposed a management algorithm for pouch strictures (Fig. 11).

REFERENCES


1. Risk factors for pouch strictures include
   a. NSAID use
   b. Pelvic sepsis after pouch construction
   c. Backwash ileitis
   d. Anastomotic tension on the pouch
   c. Ischemia

True or False

2. Refractory gastroesophageal reflux disorder could be a presentation of ileal pouch stricture

3. Endoscopic therapy of pouch strictures should be avoided in patients on high-dose corticosteroid therapy

4. Pouch strictures that are >4-5cm in length are best managed by surgical therapy

5. Stent placement for pouch strictures is controversial and carries a high risk of migration, impaction and perforation

6. Enemas are sufficient to prepare a pouch for endoscopic therapy

7. Pouch-anal anastomosis in female patients should be dilated to a maximum of 18mm to minimize risk of pouch-vaginal fistulae

8. Outlet strictures do better with endoscopic balloon dilation compared to needle knife therapy

9. Endoscopic balloon dilation of Koch pouch strictures is usually not effective and is not recommended

10. Strictures most amenable to endoscopic balloon dilation are short, straight fibrotic strictures

11. NSAID-associated strictures rarely resolve after stopping NSAID

12. The benefit of medical therapy for the treatment of pouch strictures is controversial, may be most helpful in the group with adjacent inflamed bowel mucosa

13. The majority of patients who are successfully dilated with endoscopic balloon dilation will require repeat dilations in the future