

Judging the J pouch: a pictorial review

Shannon P. Sheedy ¹, David J. Bartlett ¹, Amy L. Lightner,² Steven W. Trenkner,¹ David H. Bruining,³ Jeff L. Fidler ¹, Wendaline M. VanBuren,¹ Christine O. Menias,⁴ Joshua D. Reber ¹ and Joel G. Fletcher¹

¹Department of Radiology, Mayo Clinic, 200 First Street SW, Rochester, MN 55905, USA

²Department of Surgery, Division of Colon and Rectal Surgery, Mayo Clinic, Rochester, MN, USA

³Division of Gastroenterology and Hepatology, Mayo Clinic, Rochester, MN, USA

⁴Department of Radiology, Mayo Clinic, Scottsdale, AZ, USA

Abstract

Restorative total proctocolectomy with ileal pouch-anal anastomosis is the surgery of choice for patients with medically refractory ulcerative colitis, ulcerative colitis with high-grade dysplasia or multi-focal low-grade dysplasia, and for patients with familial adenomatous polyposis. The natural history of the surgery is favorable, and patients generally experience improved quality of life and acceptable long-term functional outcome. However, some patients experience significant long-term morbidity from early and/or late pouch-related complications. When complications arise, radiologists must understand the advantages and disadvantages of the various imaging modalities that can be used to assess the pouch. Radiologist familiarity with the surgical technique, pouch anatomy, and imaging appearance of the various potential early and late complications will help facilitate appropriate clinical and surgical decision-making. This review provides an anatomic-based imaging review of the pouch and pouch-related complications, including numerous illustrative fluoroscopic and cross-sectional imaging examples.

Key words: J pouch—Ileoanal anastomosis—Ileal pouch-anal anastomosis—Proctocolectomy—Enterography—Ulcerative colitis

Since the late 1970s, total proctocolectomy with ileal pouch-anal anastomosis (IPAA) has been the operation of choice for patients with medically refractory ulcerative colitis (UC) or ulcerative colitis with high-grade dysplasia/multi-focal low-grade dysplasia, and in patients with familial adenomatous polyposis (FAP). The surgery is generally discouraged in patients with Crohn's colitis because of high rates of complications, pouch dysfunction, and recurrence in the small bowel used to create the pouch. Patients may undergo the surgery for a diagnosis of ulcerative colitis or indeterminate colitis and later be found to have Crohn's disease [1, 2].

Proctocolectomy with IPAA removes all of the diseased and at-risk tissue (aside from a short rectal cuff) while providing restoration of gastrointestinal continuity and preservation of the anal sphincters to maintain fecal continence. Patients generally experience improved quality of life and acceptable long-term functional outcome [3]. Unfortunately, some patients experience significant long-term morbidity from early and/or late pouch-related complications [3–6]. Early complications include anastomotic or staple margin leaks and dehiscence, pelvic sepsis, abscess, mesenteric and portal vein thrombosis, and small bowel obstruction. Late complications include pouchitis, strictures, obstruction, fistula development, dysplasia, and malignancy. These complications may lead to poor pouch function, incontinence, and pouch failure that require pouch revision or excision with creation of a permanent ileostomy.

Radiologists must be familiar with the surgical technique and pouch anatomy to understand, identify, and characterize complications seen on imaging and to guide clinical and therapeutic decision-making. In this review, we propose a systematic, anatomic-based approach to the evaluation of the IPAA that can be adopted in clinical practice and used in conjunction with a dedicated

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Correspondence to: Shannon P. Sheedy; email: Sheedy.Shannon@mayo.edu

structured report template used at our institution (Online Appendix A). We also provide numerous illustrative examples of pouch-related complications.

Surgical technique

Variation exists in the construction of the IPAA, and this variation has implications for deciphering post-operative complications on radiology studies. After the completion proctectomy, the small bowel mesentery is mobilized to the root of the superior mesenteric artery, and the ileocolic artery divided at its origin to provide sufficient mesenteric length to perform a tension-free anastomosis. The pouch is then constructed using the distal 30–40 cm of ileum, most commonly in a J configuration measuring 12–15 cm from apex to top of the blind limb, or pouch

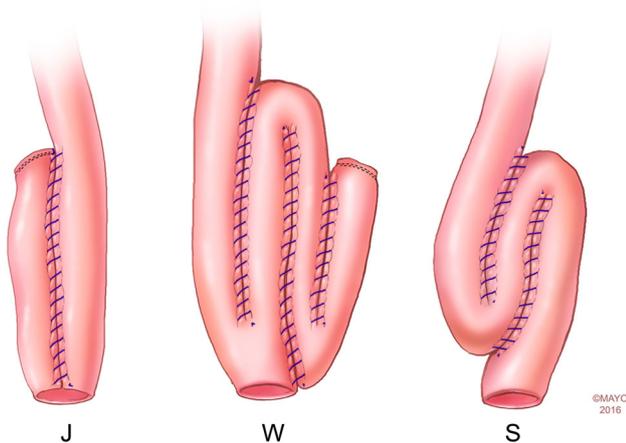


Fig. 1. J, W, and S pouch anatomical configurations. Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved.

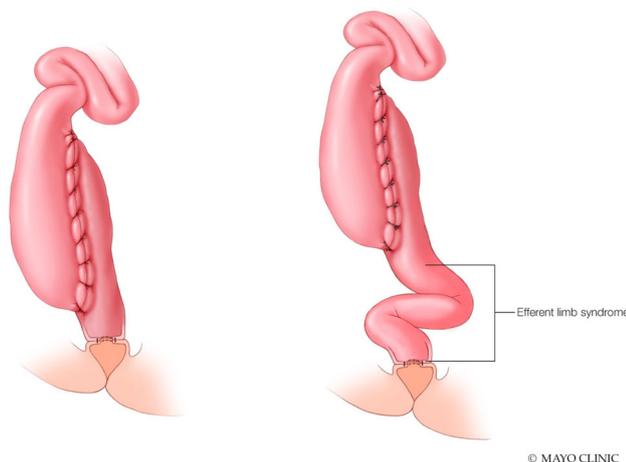


Fig. 2. Efferent limb syndrome in a S pouch where the outflow tract gets kinked making it difficult to evacuate the pouch. Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved.

appendage. A J pouch is most often constructed using two firings of a linear stapler and stapling across the blind end of the pouch [7]. The W or S configuration pouches are rarely used today due to comparative ease of J pouch construction and increased potential for efferent limb syndrome with an S pouch [8–10] (Figs. 1, 2).

As the pouch is brought into the pelvis for the anastomosis, the small bowel mesentery may be placed anteriorly or posteriorly. It is most often placed in a posterior orientation to prevent twisting of the mesentery which can result in relative ischemia to the pouch, and to provide a buffer between the pouch and sacrum should any posterior anastomotic leaks occur. On occasion, the surgeon may lay the pouch in the pelvis with the mesentery anteriorly to gain an additional 1–2 cm of reach, if needed. Because many surgeons will perform a close rectal dissection during the proctectomy rather than a total mesorectal excision, the superior rectal artery and residual mesorectal fat may also be present in addition to the small bowel mesentery.

The last step in an IPAA is construction of the anastomosis. In certain situations (e.g., low rectal cancer in UC or FAP, or extensive distal rectum polyp burden in FAP), a mucosectomy, with complete removal of at-risk rectal mucosa, is performed with a hand-sewn anastomosis at the dentate line due to the concern for the potential malignancy (Fig. 3). However, a stapled anastomosis is now the preferred operative technique due to ease of construction, improved bowel function, and no difference in rates of development of rectal cuff or pouch

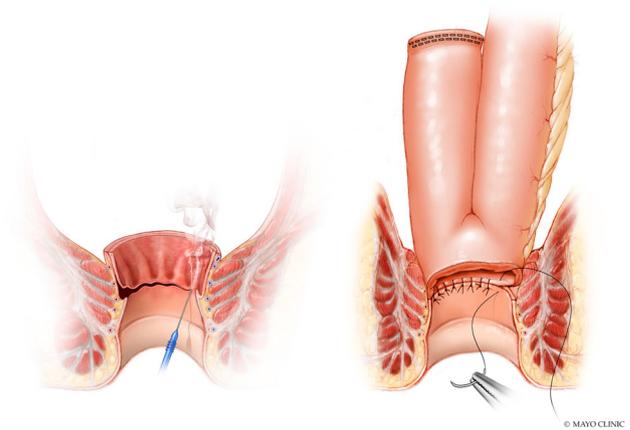


Fig. 3. In certain situations (e.g., low rectal cancer in UC or FAP, or extensive distal rectum polyp burden in FAP), a mucosectomy, with complete removal of at-risk rectal mucosa, is performed. The mucosa is lifted off the submucosa with the use of needle tip electrocautery and the pouch brought down into the anal canal. A two-layer hand-sewn anastomosis is performed at the dentate line, approximating the rectal mucosa. Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved.

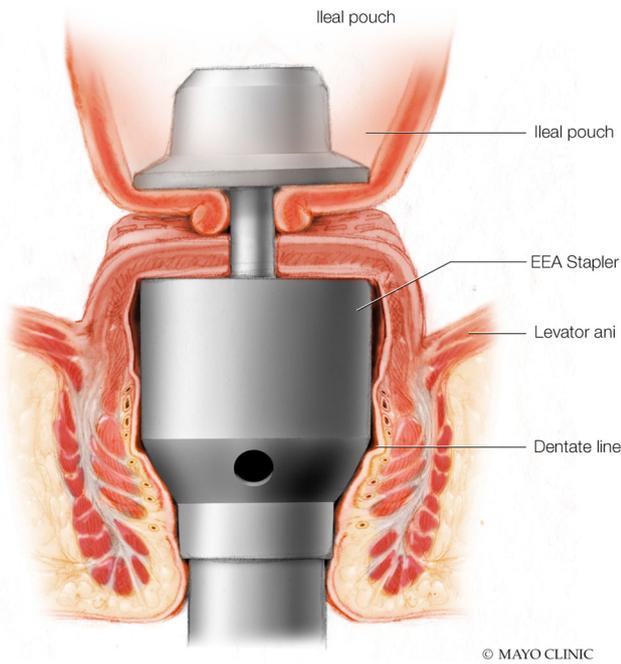


Fig. 4. An EEA 29-mm circular stapler is used to perform an end-to-end stapled ileal pouch-anal anastomosis between the pouch and top of the anal canal. Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved.

malignancies [11] (Fig. 4). The stapled technique is intended to occur at the anorectal ring, or the insertion of the levator ani, which leaves a “rectal cuff” extending from the dentate line to the anastomosis. This location minimizes risk of injury to the anal sphincter complex and preserves the anal transition zone, which plays an important role in maintaining fecal continence as it preserves patients’ ability to distinguish between gas, liquid, and solid stool [12]. (Fig. 5)

Imaging modalities

Fluoroscopic enema

In our practice, a retrograde water-soluble contrast enema is routinely performed two to three months after surgery, prior to closure of the diverting loop ileostomy, to (a) evaluate for leaks, sinus tracts, or fistulas; (b) assess for patency of the ileoanal anastomosis; (c) ensure integrity of the pouch; and (d) evaluate for obstruction between the anus and loop ileostomy. Antegrade studies are more difficult and of lesser quality [13]. If a leak is detected, ileostomy take down may be delayed and follow-up contrast enemas are performed to assess for closure.

Contrast enemas are performed after ileostomy closure to evaluate pouch dysfunction, in the acute setting if a leak is suspected but not identified on cross-sectional

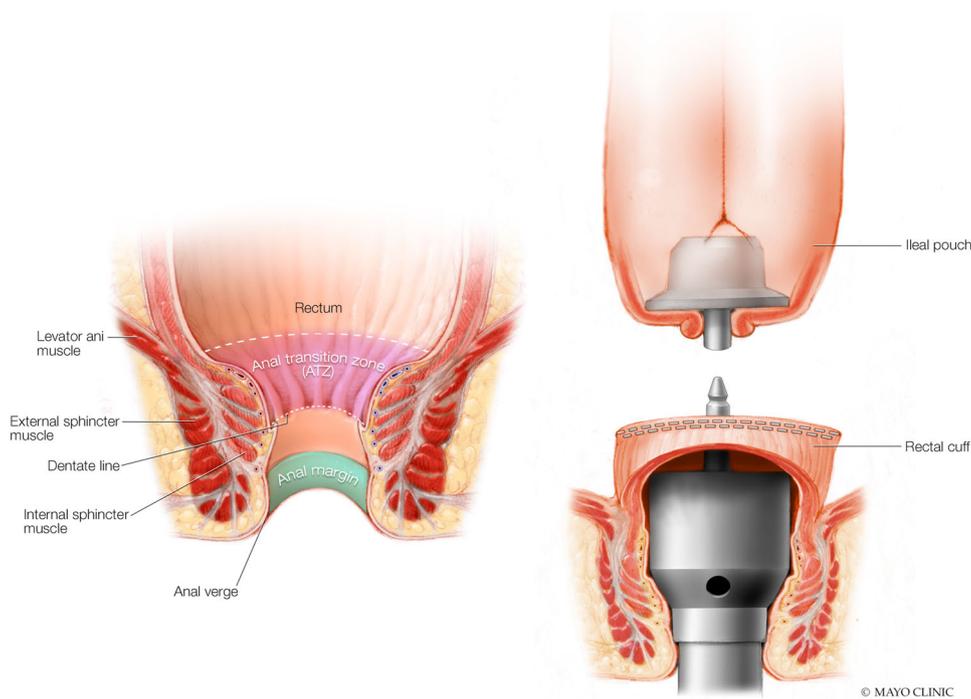


Fig. 5. Care should be taken to avoid catching the sphincter complex in the stapler because that can lead to chronic anal pain. Therefore, transection of the rectum is performed just

above the anorectal ring. Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved.

imaging, and to confirm or refute suspected bowel obstruction seen on CT or MRI (Fig. 6). Functional dilation of the distal ileum can occur without obstruction, and retrograde fluoroscopic examination easily differentiates a fixed narrowing from collapse, which may be mistaken for a stricture on cross-sectional imaging.

A scout film with the overhead tube helps identify opacities that may be confused for a leak and shows the

staple lines (especially helpful for an ileostomy takedown site). A small, flexible catheter that does not have a balloon should be used (e.g., Junior Flexi-Tip or smaller 14 Fr Pediatric Flexi-Tip; E-Z-EM, Inc.), with tip placed just inferior to the anastomosis. The pre-ileostomy takedown studies and any study for suspected leak are performed with water-soluble contrast. Barium is utilized in post-ileostomy takedown studies, especially when obstruction is suspected.

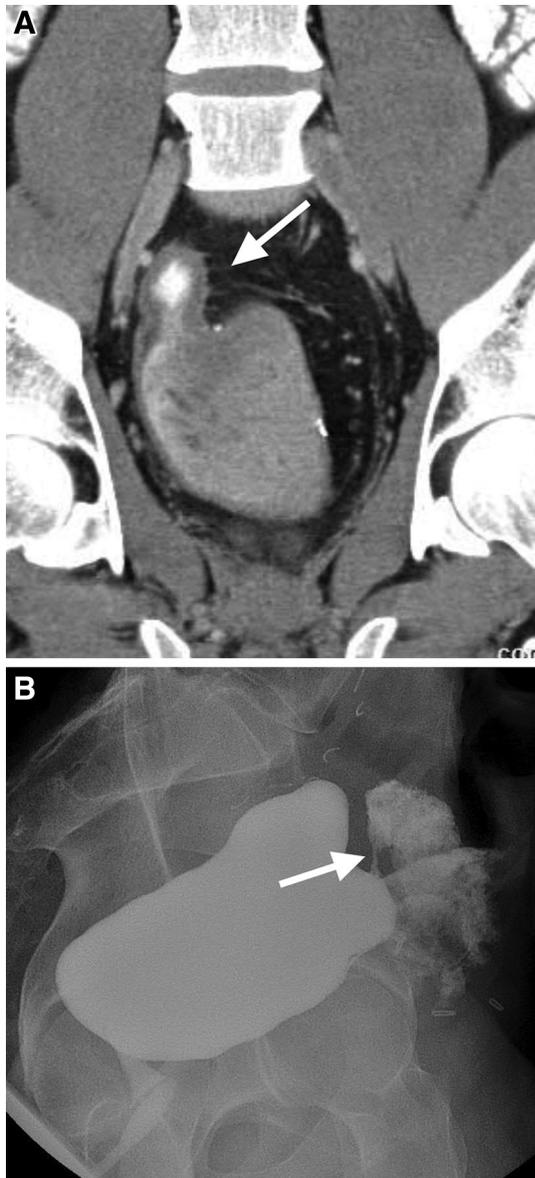


Fig. 6. Water-soluble contrast enema to evaluate potential prepouch ileum abnormality seen on CT. A 51-year-old male post ileal pouch-anal anastomosis for ulcerative colitis presents with intermittent symptoms of bowel obstruction. **A** Coronal CT image demonstrates short segment of wall thickening and luminal narrowing of the prepouch ileum with edema in the perienteric fat (arrow). **B** Water-soluble contrast enema confirms a focal tight stricture (arrow).

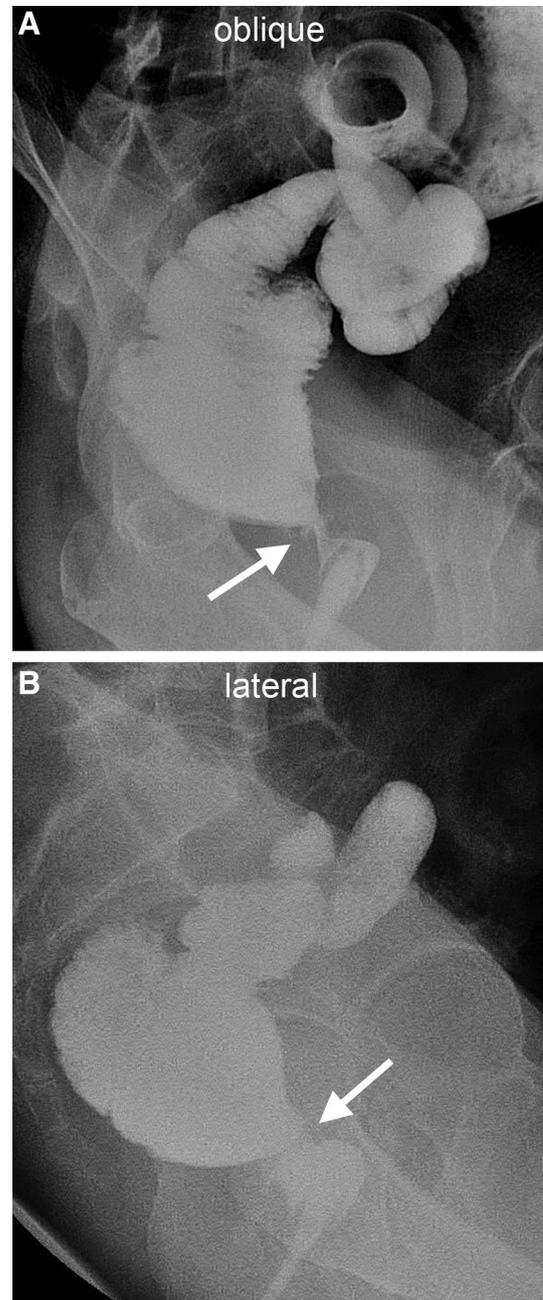
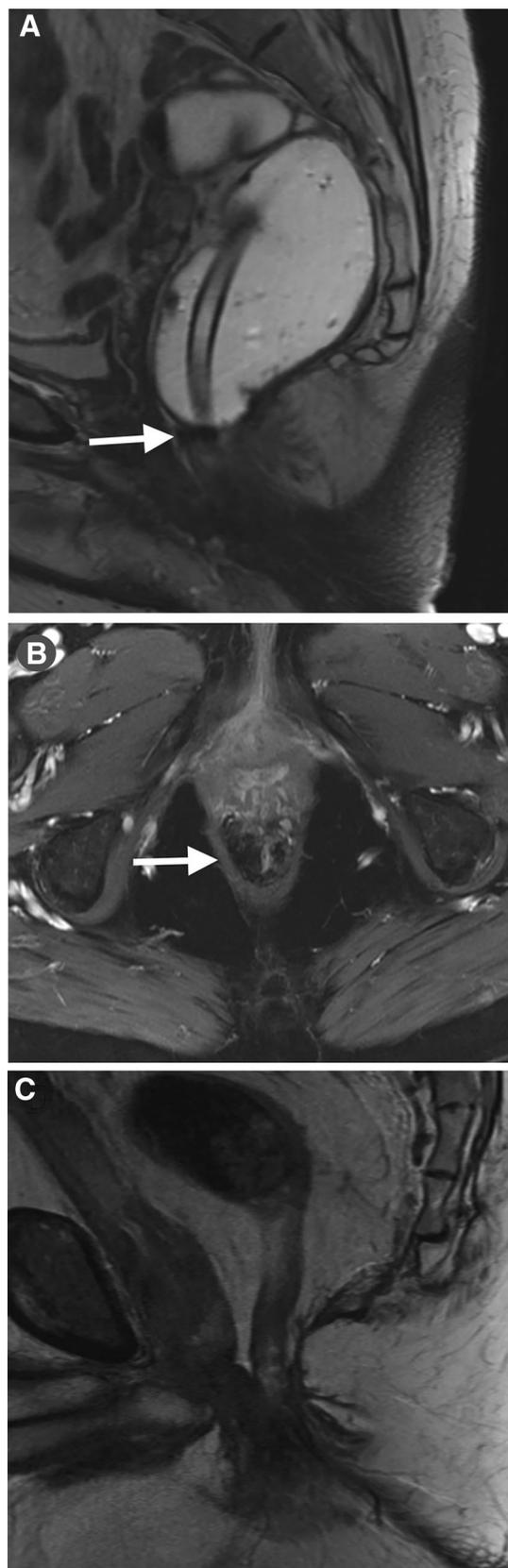


Fig. 7. Anastomotic stricture. Tight anastomotic stricture is better appreciated on the oblique **A** fluoroscopic image. The stricture is less well laid out and is partially obscured by overlying bony anatomy on the lateral projection (**B**).



◀**Fig. 8.** Hand-sewn vs. stapled IPAA technique. **A** Sagittal T2-weighted image demonstrates the low T2 signal intensity ring of the stapled anastomosis (arrow). **B** Axial post-contrast gradient echo image shows magnetic susceptibility artifact related to the stapled anastomosis (arrow). **C** Sagittal T2-weighted image is from a patient with a hand-sewn anastomosis which is less readily apparent on imaging.

Spot films should be obtained at full pouch distension. Oblique images of the anal anastomosis with no contrast flowing into the pouch, with no overlying pelvic bones, are particularly helpful (Fig. 7). A lateral image of the anastomosis is required, as most leaks track posteriorly toward the sacrum, but some track anteriorly toward the vagina or prostate gland/penile bulb. If the catheter tip is above the anastomosis (e.g., a low anal anastomosis), the enema tip should be pulled into the anus so contrast under gravity pressure tests the anastomosis.

Computed tomography

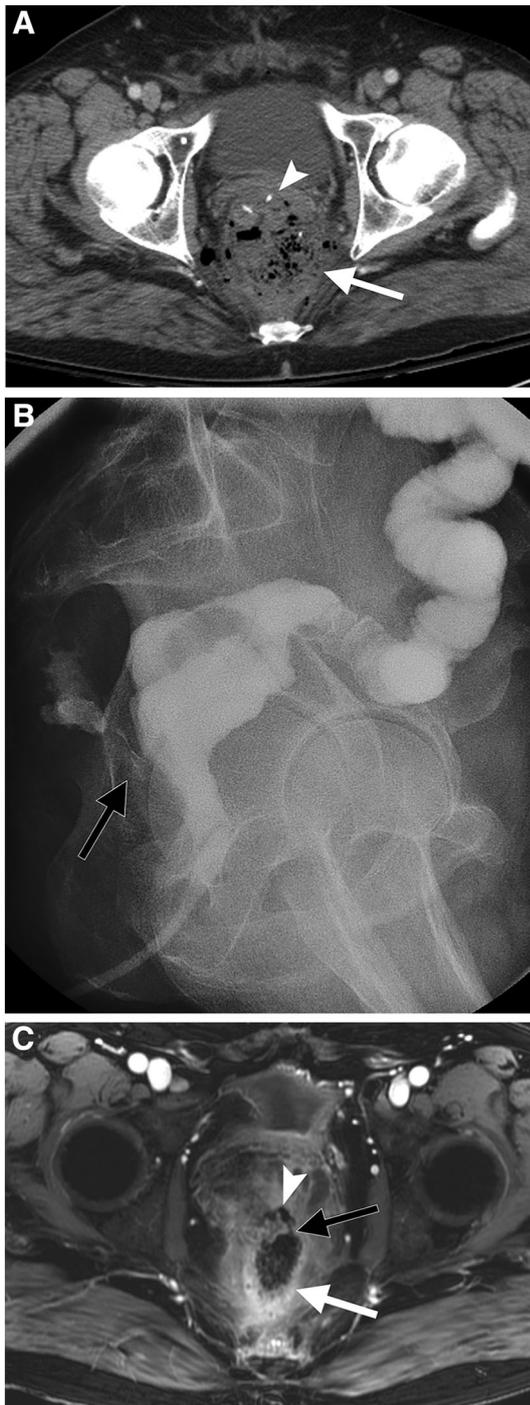
CT is the first-line imaging approach for patients with IPAA presenting acutely with pain, with symptoms of bowel obstruction, and when septic complications are suspected. Unlike the contrast enema, CT demonstrates both luminal and extraluminal structures in multiple planes and is thus better able to identify peripouch inflammatory processes [14]. Sagittal images are particularly helpful to identify the ileoanal anastomosis and to better evaluate the presacral space and sacrum.

In the acute setting, if a leak, dehiscence, or sepsis is suspected, retrograde administration of water-soluble contrast material (e.g., iohexol 300, 30 mL diluted in 300 mL warm tap water) should be considered. Extraluminal contrast material, air, or fluid should be carefully interrogated for a source and proximity to the anal anastomosis and blind end.

Magnetic resonance imaging

In our practice, pelvic MRI is preferred in lower acuity situations in the setting of chronic and/or recurrent pouchitis and for suspected pouch-related fistulas that present or persist outside of the early (6 month) post-operative period. Owing to its superior soft tissue contrast resolution and anatomic detail, MRI has a higher sensitivity for subtle fistulas than pouchography or CT [14].

When assessing the pouch and pouch-related complications, the dedicated perianal fistula pelvic MRI protocol is performed on either a 1.5 or 3.0 T magnet, but is carried more superiorly to include the entire pouch



◀**Fig. 9.** Chronic posterior anastomotic leak. A 60-year-old male with medically refractory chronic ulcerative colitis. **A** Axial CT image performed in the early post-operative period demonstrates a presacral abscess (arrow) between the pouch and sacrum (notice metallic surgical clips, arrowhead). Patient was treated with a percutaneous drain. Two years later, the patient returned with sacral pain and CT showed a similar, but smaller presacral collection (not shown). **B** A water-soluble contrast enema shows a persistent posterior leak (black arrow) arising from the ileoanal anastomosis and extending posteriorly to a presacral collection. **C** Post-contrast axial MR image (performed to assess for osteomyelitis) demonstrates peripherally enhancing fluid collection/chronic abscess (white arrow) with persistent posterior anastomotic leak (black arrow). Notice the susceptibility artifact from the metallic surgical clips confirming disruption at the level of the anastomosis (arrowhead). Patient ultimately underwent pouch excision and permanent ileostomy.

because of the high prevalence of strictures at the anastomosis, but can be considered for anal sphincter evaluation. Alternatively, insertion of a small flexible catheter into the anus can help straighten any distortions or asymmetry in the anal canal resulting from repeated anal dilatations or fistulizing disease, and provides adequate assessment of anal sphincter integrity.

The key images of the fistula protocol include small field of view multiplanar T2-weighted fast spin-echo sequences without and with fat saturation. Straight axial and coronal images through the pelvis are obtained unless there is concern for an anal or vaginal fistula, in which case the images are oriented in orthogonal planes relative to the anus or rectovaginal septum depending on the site of suspicion. T2-weighted sagittal fast spin-echo images are critical to identify the rectal cuff, anastomosis, and presacral space. Fat-saturated images serve to increase conspicuity of inflammation, edema, and fluid whereas the nonfat-saturated images provide more anatomic detail and allow for better characterization and classification of fistulas. Diffusion-weighted images may also be considered and can serve as an adjunct to T2-weighted images to identify active inflammation, but in our experience are not imperative.

Granulation tissue and pus in fistulas will be hyperintense on T2-weighted images, with increasing intensity in more severely inflamed tracts. Post-contrast images help identify any ring enhancing abscess or undrained sepsis within fistulas or sinus tracts. Chronic or partially healed fistulas may be quite subtle with less intense T2 signal hyperintensity and less avid contrast enhancement. This protocol provides excellent assessment of the pouch and peripouch anatomy.

(iliac crests through perineum/upper thigh) in the field of view. No patient preparation is required, and endovaginal gel or retrograde administration of contrast material into the pouch may be considered at the discretion of the radiologist, depending on the clinical scenario. An endoanal probe is not used unless specifically requested

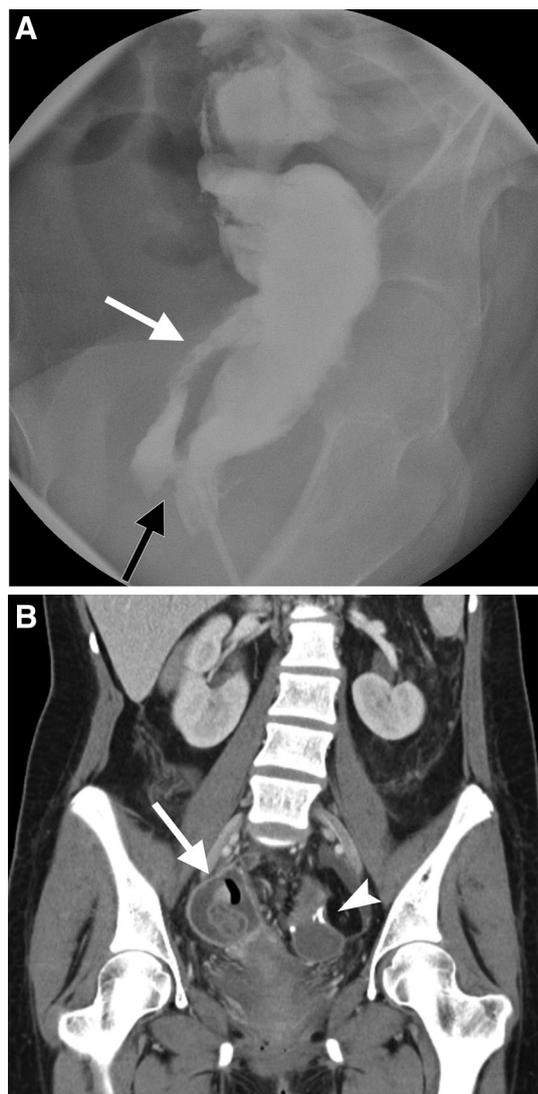


Fig. 10. Anterior anastomotic leak. A 14-year-old status post ileal pouch-anal anastomosis for juvenile polyposis syndrome and ulcerative colitis. The patient was readmitted to hospital shortly after discharge with diarrhea, intractable vomiting, and abdominal pain. **A** Right posterior oblique pouchogram image demonstrates a leak arising anteriorly from the ileoanal anastomosis (black arrow) and tracking to the right of midline in the cephalad direction (white arrow). **B** Coronal CT image demonstrates a fluid collection and extraluminal gas about the right ovary (arrow). Notice the top of the pouch indicated by the radiodense staples (arrowhead). This patient required laparoscopic-assisted peritoneal washout with creation of a diverting loop ileostomy to allow the anastomotic leak to heal.

MRI dynamic defecating pouchogram can also be performed following retrograde contrast material administration to evaluate anatomic and functional complications of IPAA, including pouch prolapse or pelvic floor dyssynergy.

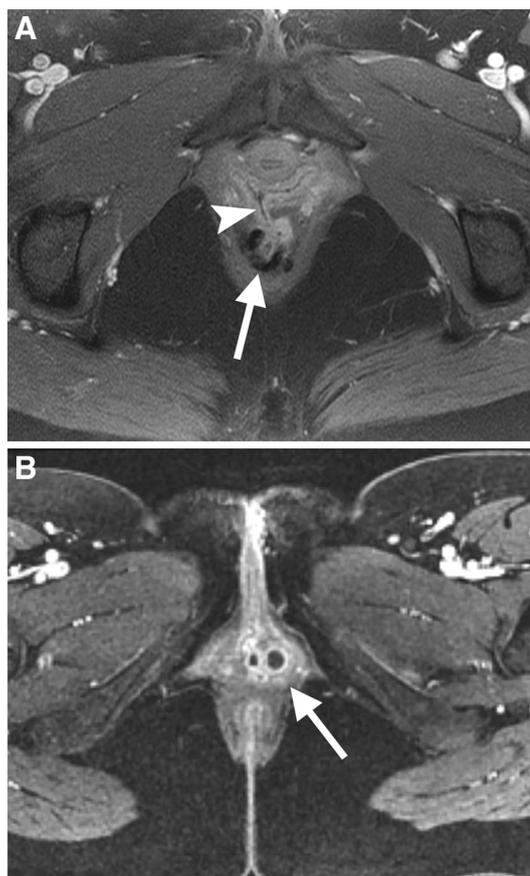


Fig. 11. Pouch-vaginal fistula with ano-perineal sinus tract and abscesses. A 35-year-old female developed feculent vaginal discharge and perineal pain many years post IPAA for ulcerative colitis. **A** Axial post-contrast MR image demonstrates an anovaginal fistula (arrowhead) arising from the stapled ileoanal anastomosis (arrow). **B** Axial post-contrast image more caudally demonstrates a low anterior, transsphincteric, branching ano-perineal sinus tract terminating in small labial abscesses (arrow). Patient was initially treated with incision and drainage of the labial abscesses and placement of a seton in the fistula, but because of persistent symptoms has now been recommended to have either pouch excision or interposition tissue flap placed between the anus and vagina.

CT or MR enterography

MR or CT enterography is generally performed to evaluate the proximal small bowel for imaging findings of active inflammatory Crohn's disease, and these procedures have been well described [15–17]. The fluid challenge also helps identify transition points related to strictures and other causes of obstruction. Desmoid tumors associated with FAP [18] and extraluminal findings associated with inflammatory bowel disease (for example, mesenteric vein thrombosis/occlusion, changes of primary sclerosing cholangitis, avascular necrosis of femoral heads) will also be evident at enterography.



Fig. 12. Rectal cuff. Sagittal post-contrast MR image demonstrating measurement of the rectal cuff from the anastomosis to the top of the surgical anal canal/anorectal junction (double headed arrow).

Ultimately, CT, MRI, and contrast enema offer complementary information on disorders of the pouch and the chosen method(s) of investigation should vary depending on the timing relative to surgery and the clinical situation.

Systematic approach to evaluation of the ileal pouch-anal anastomosis

Ileoanal anastomosis

The stapled anastomosis can be identified on fluoroscopy and CT by locating the metallic clips and on MRI as a hypointense metallic ring artifacts on all sequences (Fig. 8). The hand-sewn anastomosis is more difficult to identify on imaging.

The presence of peripouch fluid should provoke a methodical search for a pouch-related leak, dehiscence, or fistula. These complications frequently develop at the anal anastomosis but other susceptible sites include the over-sewn pouch appendage (or blind end) and, less commonly, the parallel suture lines along the lateral margins of the ileal reservoir. Early in the post-operative setting, leaks are often identified at routine fluoroscopy and may require delay of the takedown. Dehiscence or leak arising within six months of surgery is likely to represent a post-operative complication, with potential sequela of a sinus tract, fistula, and/or abscess.

Fig. 13. Cuffitis with stricture and associated fistulas. **A** ▶ 16-year-old male, status post IPAA for inflammatory bowel disease, presents with perineal pain and nocturnal stool leakage. **A** Sagittal T2 MR image demonstrates a relatively long rectal cuff with wall thickening and T2 hyperintensity, consistent with cuffitis (white arrow). Notice the dilated and stool filled pouch above the level of the strictured cuff (black arrow). **B** Axial T2-weighted image with fat saturation shows an extrasphincteric fistula arising from the inflamed rectal cuff (arrow). **C** Axial T2-weighted image with fat saturation slightly more caudally shows a second anterior midline fistula arising from the anus (arrow) and extending toward the base of penis (arrowhead, **A**). Pouchoscopy showed severely inflamed 5-cm cuff. The pouch was dilated and stool filled but appeared healthy.

Anastomotic leaks commonly arise posteriorly and course along the top of the levator plate and into the presacral space [19] (Fig. 9). Chronic presacral collections may cause periostitis, seen as anterior sacral cortical thickening, or osteomyelitis with bone marrow edema, cortical bone loss, bony erosions, endosteal scalloping, and hyperenhancement. MRI is most sensitive and specific for osteomyelitis [20]. Anterior leaks are less common but can occur (Fig. 10). Pouch sinuses, small confined leaks that may not be clinically evident, occur in 2–8% of patients; these often heal with conservative, nonoperative management [21, 22].

The pooled incidence of fistulas in IPAA patients in a large meta-analysis was 4.5% (3.5–5.7%) [23]. Anastomotic fistulas may involve other bowel, anus, vagina, urethra, bladder, or perineum. Fluoroscopy cannot accurately determine the relationship of a tract to the anal sphincter complex and this relationship has important management implications, as preservation of the anal sphincter complex is required to maintain fecal continence. CT often identifies inflammatory tracts peripouch abscesses; however, MRI is superior at detection and differentiating chronic fibrotic tracts from active inflammatory tracts.

Pouch-vaginal fistula is a unique complication resulting from inadvertently catching the vagina in the staple device, from post-operative leak/dehiscence, or from unsuspected Crohn's disease. It is a cause of considerable morbidity and is one of the more common causes of pouch failure [24] (Fig. 11). These can be missed on fluoroscopic studies if the catheter is at or above the level of the fistula. MRI is the modality of choice for suspected vaginal fistula, and filling the vagina with gel and angling the axial MRI plane relative to the anovaginal septum may facilitate visualization. These fistulas can arise several years after the surgery because of slow erosion by the staples, and thus they often have a subtle, chronic appearance on MRI, with less T2 signal

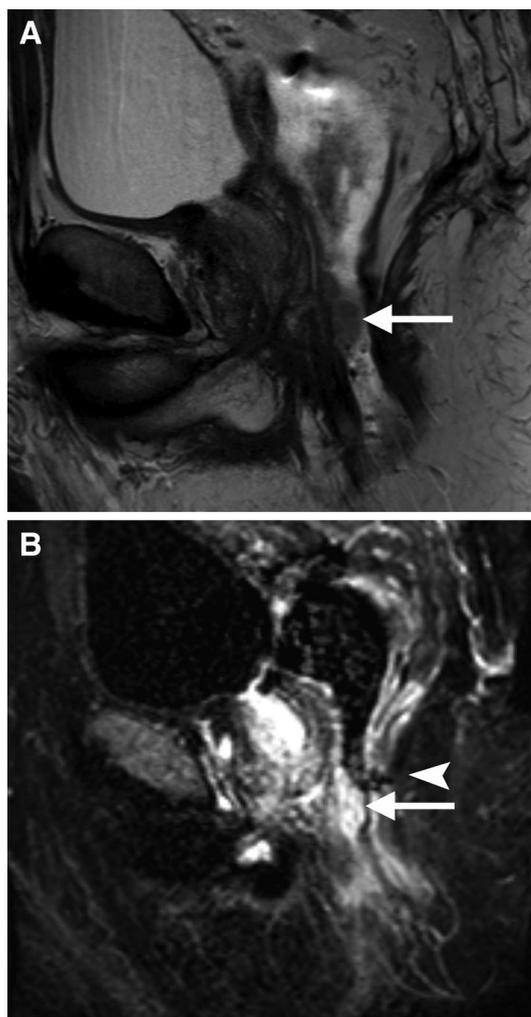
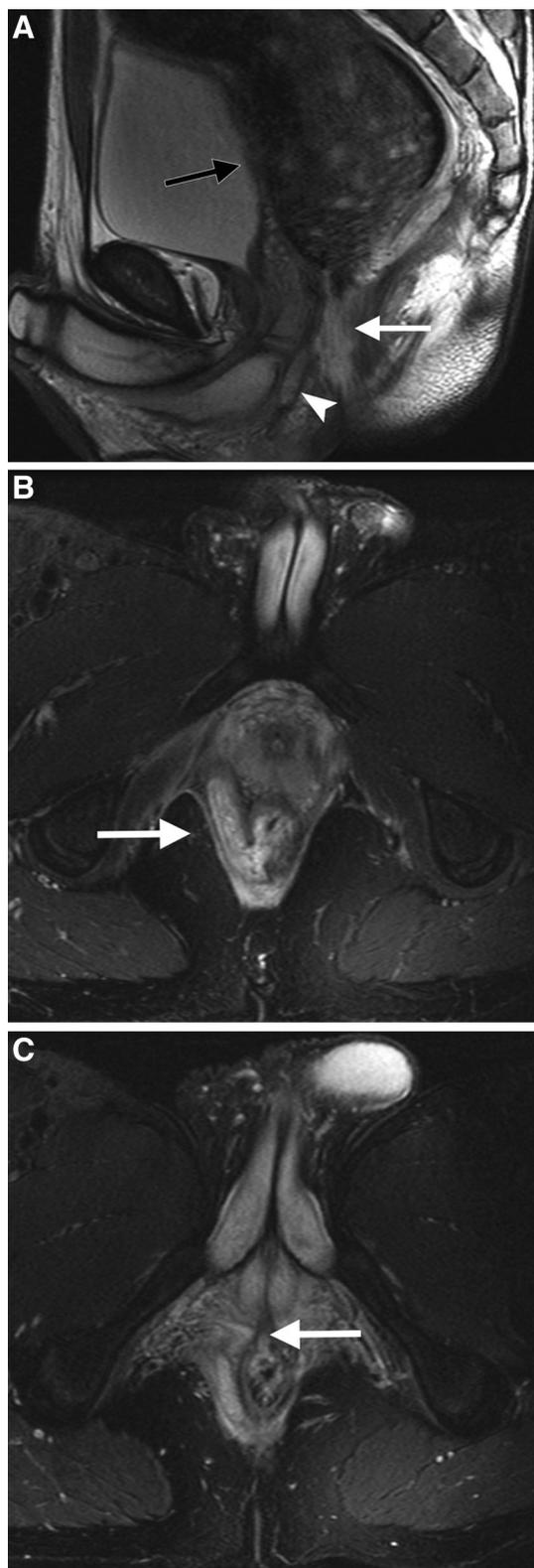


Fig. 14. Primary adenocarcinoma in the anal transition zone/rectal cuff. A 76-year-old male with IPAA for chronic ulcerative colitis has a history of multiple pouch complications, including recurrent polyps, and now presents with pain and hematochezia. Anorectal examination revealed nodularity in the anal canal. **A** Sagittal T2-weighted and **B** sagittal post-contrast subtraction MR images demonstrate an intermediate T2 signal intensity, enhancing polypoid mass (white arrows) arising from the rectal cuff (arrowhead, **B**). Biopsy revealed adenocarcinoma.

hyperintensity and less avid contrast enhancement than other fistulas.

Strictures develop in more than 10% of IPAA patients, most commonly at the anal canal and anastomo-

sis, and often take months to develop [21, 23]. Anastomotic strictures develop from ischemia, chronic dehiscence or leakage, or inflammation with subsequent fibrosis and are visualized at retrograde contrast enema (Fig. 7), but may not be apparent on cross-sectional imaging. They may be web-like and amenable to manual or endoscopic dilatation; however, repeated dilatations risk exacerbating pre-existing inflammation and can result in fistulas and contribute to pouch failure [25].

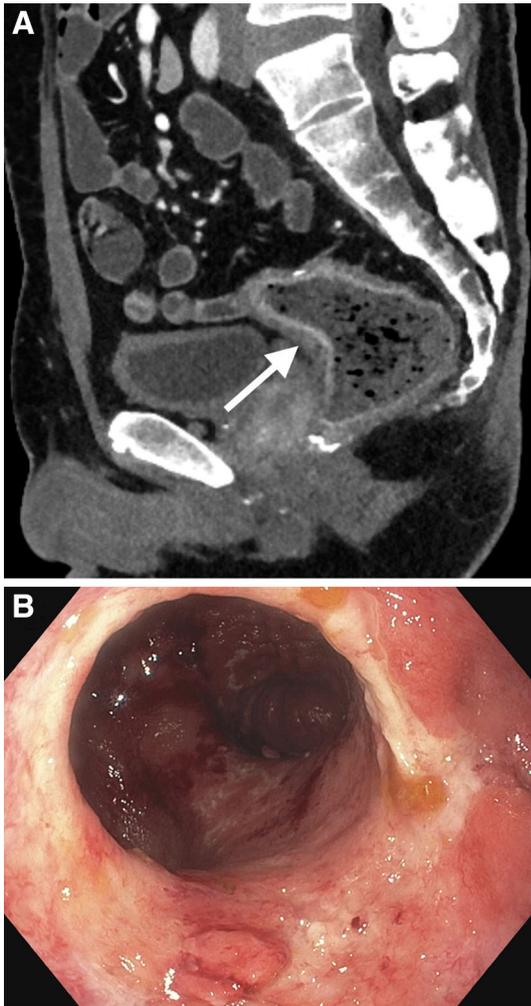


Fig. 15. Pouchitis. A 51-year-old female, status post ileoanal pouch procedure for chronic ulcerative colitis, presents with pain. **A** Sagittal CT image demonstrates symmetric thickening of the pouch wall with striated hyperenhancement (arrow). Endoscopic image **B** shows ulceration, edema, and friability, corresponding with the inflammation seen on CT. Biopsies confirmed chronic pouchitis. In the absence of penetrating complications, cross-sectional imaging findings of pouchitis and Crohn's disease of the pouch can be identical. Patient responded well to antibiotic medical management.

Rectal cuff

The length of the rectal cuff should be provided whenever the stapled technique has been performed. Ideally, the entire rectal cuff, including the anal transition zone, is less than 2 cm with the ileoanal anastomosis just above the anal sphincter complex. However, because of technical challenges at the time of surgery, extra cuff length is not uncommon. The length is best assessed in the sagittal plane on cross-sectional imaging, measured from the anastomosis to the anorectal junction (Fig. 12). No

Fig. 16. Small bowel obstruction secondary to Crohn's disease of the pouch and prepouch ileum. A 20-year-old male with IPAA several years ago for diagnosis of ulcerative colitis presents with recurrent episodes of severe abdominal pain, bloating and decrease in bowel frequency. **A** and **B** Axial contrast-enhanced CT images from superior to inferior demonstrate multiple segments of actively inflamed small bowel, including the prepouch ileum (**A**, arrows) and the proximal pouch (**B**, arrow). There was also active inflammation down near the ileoanal anastomosis (not shown). Notice the inflammatory pseudopolyp in the proximal pouch (**B**, arrowhead). Same day fluoroscopic pouchogram (**C**) demonstrates three strictures. The first is located at the ileoanal anastomosis (black arrow), the second is within the pouch (white arrow), and the third is located more proximally in the prepouch ileum (arrowhead) and causes complete obstruction. No contrast could be advanced past this point despite good distention of the pouch. The patient responded well to medical management for Crohn's disease.

measurable rectal cuff remains when the hand-sewn anastomosis is created at the dentate line.

The rectal cuff predisposes to recurrent inflammation, particularly in patients with inflammatory bowel disease. This variant of ulcerative proctitis, or "cuffitis," causes urgency and blood in stools and develops in approximately 2–6% of UC patients' stapled IPAA [8, 21]. Fistulas may develop (Fig. 13), and there is often concomitant pouchitis.

In addition to strictures, pouch outlet obstruction, or "effluent limb syndrome," can rarely be the result of acute angulation or torsion of an excessively long rectal cuff (a longer cuff may result in increased pouch mobility). Patients may present with dyschezia, abdominal pain, distension, constipation, or a sense of incomplete evacuation [8]. Torsion can result in pouchitis, ulceration, and necrosis and requires surgical consultation with consideration for reduction of the torsion. Excessive rectal cuff length may need to be excised and pouch pexy, revision, or excision may be considered [8, 26–28].

Patients with polyposis syndromes are at risk of developing polyps in any residual rectal mucosa [29] or the pouch. In a study by Tajika, et. al., adenomatous polyps developed in up to 2/3 of FAP patients in the ileal pouch and in all patients with residual rectal mucosa [30]. Inflammatory pseudopolyps can develop in patients with IBD. Although rare, dysplasia or malignancy can arise in the anal transition zone (even mucosectomy may fail to entirely remove all of the rectal mucosa and thus does not guarantee to eliminate the possibility of neoplasia) or rectal cuff [25, 31] (Fig. 14).

Ileal pouch

The process of pouch adaptation continues for up to a year following surgery. During this time, the pouch in-

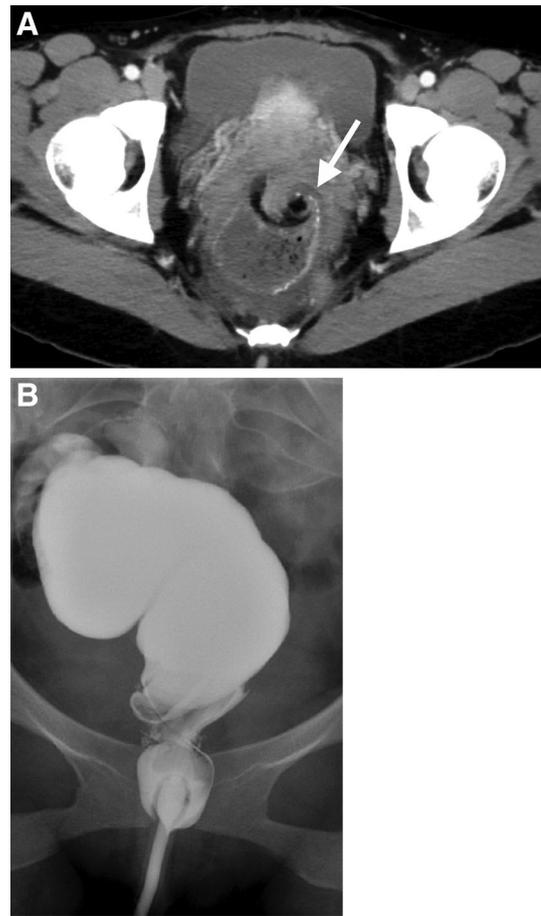
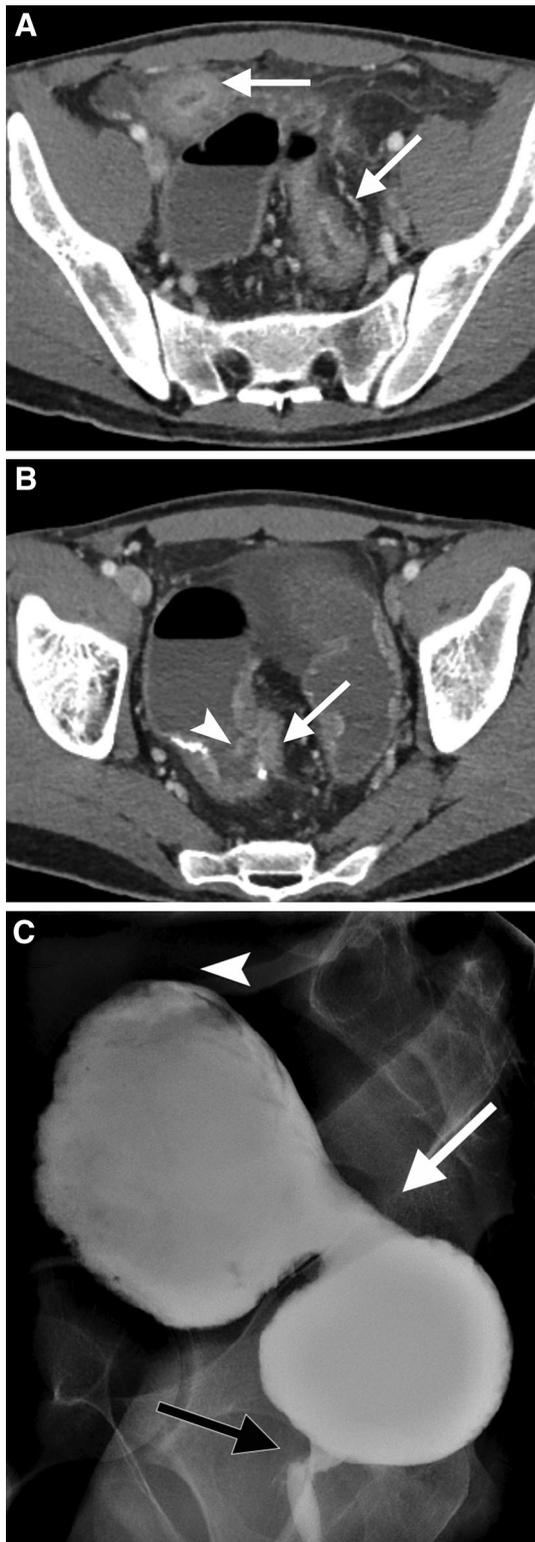


Fig. 17. Pouch torsion. A 31-year-old female with IPAA for ulcerative colitis 11 years ago presents with 4-day history of constipation, nausea, vomiting, and abdominal pain. **A** Axial CT image demonstrates a twist of the pouch (arrow) deep in the pelvis, proximal to the ileoanal anastomosis. The prepouch ileum was markedly dilated (not shown). **B** Fluoroscopic enema also shows the twist in the distal pouch with dilated upper pouch. Exploratory laparotomy revealed an internal hernia with pouch torsion through a mesenteric defect.

studies have demonstrated the transformation of ileal pouch mucosa into colonic mucosa [32]. In some patients, likely as a result of this post-operative adaptation, the ileal pouch and prepouch ileum dilate, lose their normal small bowel folds, and develop deep indentations that appear similar to rectal valves (pseudo valves of Houston) [32].

Pouchitis is a poorly understood, complex inflammatory condition with multiple contributing etiologies, occurring in more than 25% of patients post IPAA [23]. It is more commonly in patients with UC than with FAP, and the incidence increases with duration of follow-up [4, 33]. Pouchitis can be defined as idiopathic (hypothesized to be at least in part related to intestinal flora disequilibrium) or secondary, for example, to ischemia or infection. Initial acute episodes usually respond to

creases its capacity to be able to serve as a reservoir. As such, the normal pouch is often more distended than typical small bowel, but marked dilatation should raise the suspicion of stricturing of the cuff, anastomosis, or anal canal. During this adaptive process, histopathologic

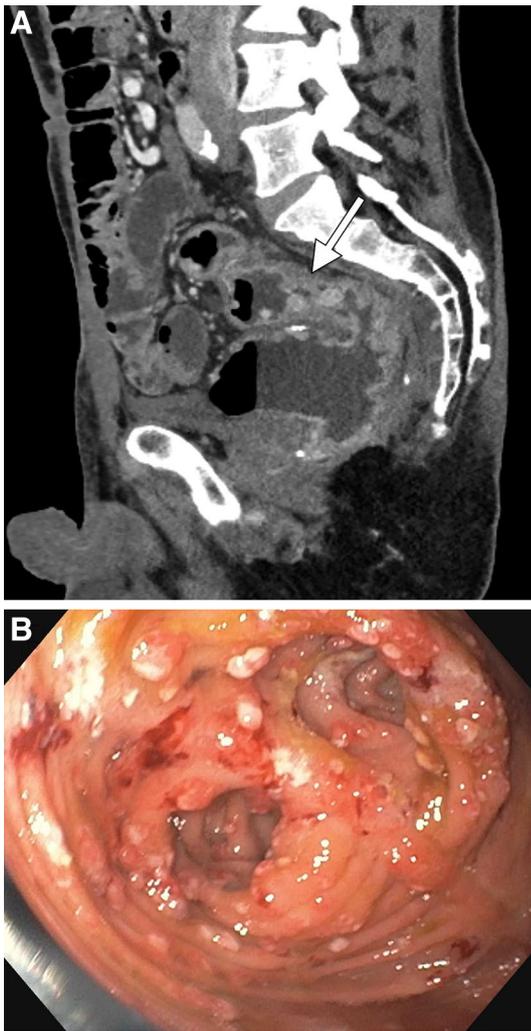


Fig. 18. Pouch polyps. **A** 59-year-old male with IPAA performed for familial adenomatous polyposis syndrome. He returns every six months for pouchoscopy and polyp excision. **A** Sagittal CT enterography image demonstrates numerous subcentimeter polyps in the pouch and in the prepouch ileum (arrow). **B** Endoscopy image demonstrates diffuse polyposis, ulceration, and friability of the pouch.

antibiotic therapy; however over time, a subset of patients become antibiotic dependent or develop chronic antibiotic refractory disease, a common cause of pouch failure [21, 34]. Because of the varied presentation, clinical course, and potential overlap with other inflammatory disorders of the pouch, the diagnosis of pouchitis can be challenging and relies on combined assessment with clinical, endoscopic, and histologic findings. Radiologic investigations often ensue because symptoms raise concern for septic complications.

Endoscopically, pouchitis is seen as nonspecific inflammation with mucosal edema and erythema, friability, erosions, and superficial ulcerations [35] (Fig. 15). Histologically, it is characterized by acute and chronic inflammation with villous atrophy, and crypt

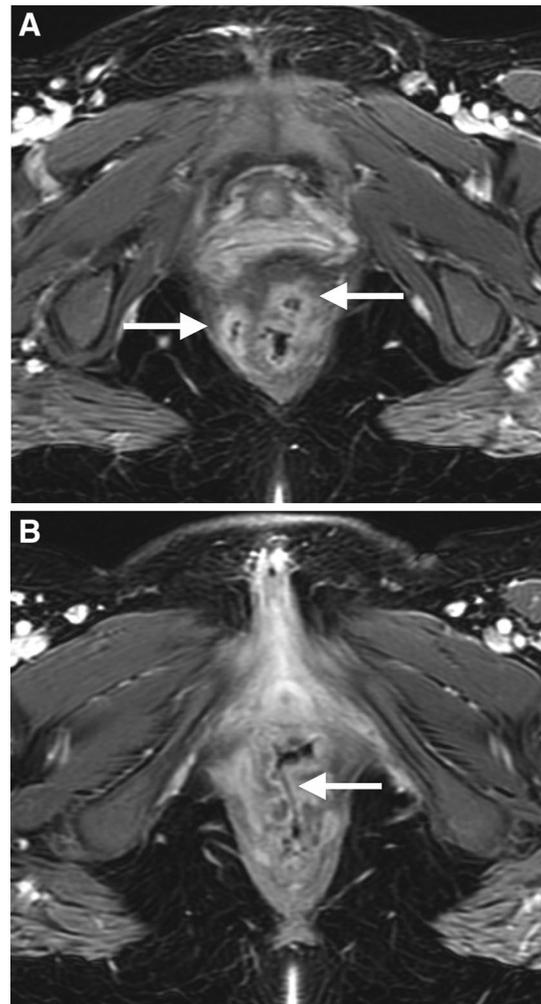
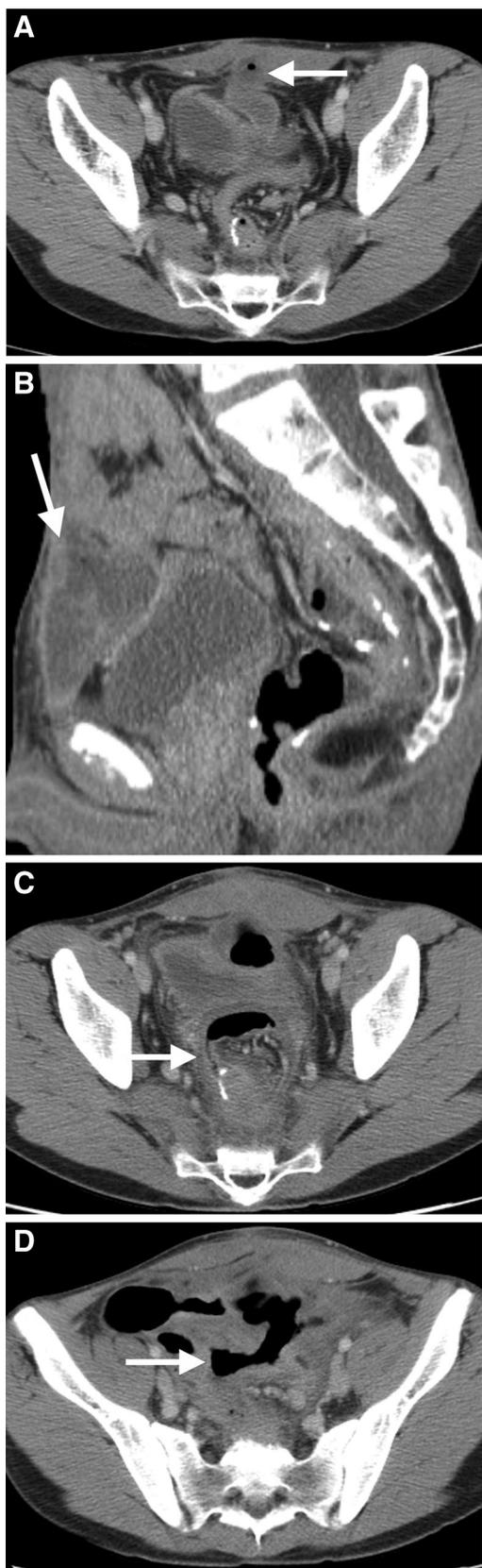


Fig. 19. Complex perianal fistulizing disease and inflammatory pseudopolyp after IPAA for IBD. A 26-year-old female with history of severe fistulizing perianal Crohn's disease after IPAA. **A** and **B** Axial post-contrast MR images demonstrate multiple perianal sinus tracts (**A**, arrows) and an anovaginal fistula with indwelling seton (**B**, arrow). This patient also had wall thickening and hyperenhancement of the pouch from pouchitis as well as the enhancing pouch polyp (not shown).

distortion or hyperplasia [35]. The severity of clinical symptoms does not correlate with the objective evidence of inflammation on endoscopy or histology [36, 37]. Pouchography may be normal or may demonstrate spicules, fold thickening, or spasm [38]. Cross-sectional imaging demonstrates both mural and extramural manifestations of pouchitis, including nonspecific circumferential wall thickening, edema, and hyperenhancement; peripouch vascular engorgement, edema, and inflammatory change; and prominent reactive peripouch lymph nodes (Fig. 15). Backwash ileitis may be present in the prepouch neoterminal ileum. A normal pelvic MRI is a good predictor of negative pouch disease at endoscopy and histology [39]. Additionally, enterography has been

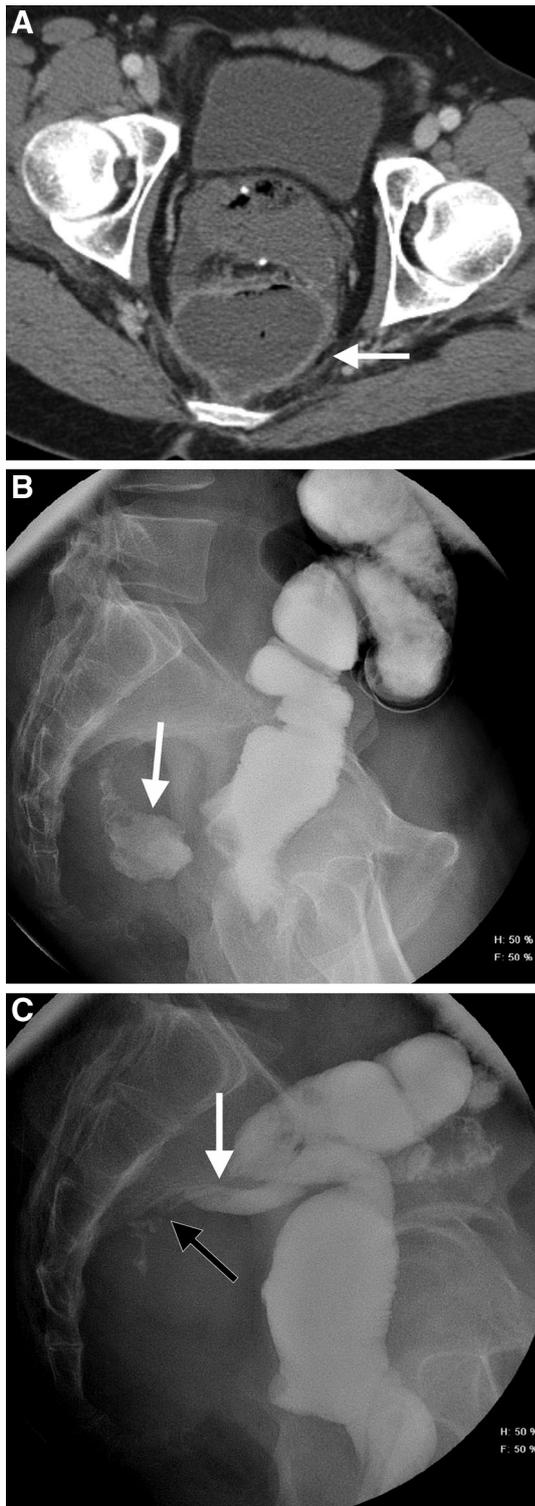


◀**Fig. 20.** Chronic leak from pouch appendage mistaken for Crohn's disease. A 23-year-old male underwent ileal pouch-anal anastomosis for ulcerative colitis. Early post-operative course was complicated by post-operative leaks and abscesses necessitating multiple surgeries. Three years later, he presents from an outside institution with a suspected diagnosis of Crohn's disease because of an enterocutaneous fistula (**A**, arrow) and pelvic abscess (**B**, arrow). Review of an older, early post-operative CT (**C** and **D**, axial images) revealed a leak from the pouch appendage (**C**, arrow) (notice high-density staple line at the blind end of the pouch) and an air filled cavity in the small bowel mesentery (**D**, arrow). In retrospect, after studying multiple interval CT exams, it was evident that the pouch appendage leak never healed and that the current enterocutaneous fistula and abscesses were the result of a chronic pouch appendage leak rather than Crohn's disease.

found to positively correlate with findings of pouch inflammation at endoscopy and histopathology [40]. Patients with irritable pouch disease (IPD), a diagnosis of exclusion, may present with similar symptoms but do not meet the criteria for pouchitis on the pouch disease activity index (PDAI), a quantitative score combining clinical, endoscopic, and histologic features [41].

Pouch inlet and mid-pouch strictures are less common and more challenging to treat than strictures at the anastomosis. They occur secondary to recurrent pouch inflammation, nonsteroidal anti-inflammatory treatment, or Crohn's disease [42]. Other findings that may suggest Crohn's disease of the pouch rather than pouchitis include asymmetric and patchy rather than uniform inflammatory changes, penetrating/fistulizing complications (in the pouch or anus), peripouch fibrofatty proliferation, concomitant proximal small bowel disease (Fig. 16), and persistence despite antibiotic therapy. Ischemic pouchitis occurs with torsion (Fig. 17) or when the length of the mesentery is inadequate, resulting in tension, and may also reveal asymmetric inflammation at endoscopy and histology [43]. Anterior positioning of the pouch mesentery during anastomosis may allow the pouch a few extra centimeters to complete the reach to the anastomosis, but if seen on imaging can also suggest torsion if it was originally placed posteriorly at surgery. Subsequent surgeries after pouch construction and portal vein thrombosis are additional risk factors for ischemic pouchitis [43].

Pouch polyps develop in many patients with FAP following IPAA [44] (Fig. 18), and inflammatory pseudopolyps may develop in IBD patients (Fig. 19). Because of the risk of dysplasia, polyps in FAP patients are removed, and those that are bleeding, atypical in appearance, or greater than a centimeter will at least be biopsied



◀**Fig. 21.** Pouch appendage leak. A 28-year-old male with medically refractory ulcerative colitis, status post IPAA with diverting loop ileostomy. He presents with fevers, abdominal bloating, nausea and vomiting, and high stool output with dehydration. **A** Axial CT image reveals a large presacral abscess (arrow). **B** and **C** Subsequent fluoroscopic pouchogram also demonstrates the presacral collection (**B**, arrow) and also better demonstrates the leak (**C**, black arrow) originating from the blind end of pouch/pouch appendage (**C**, white arrow). This patient underwent percutaneous drainage of the presacral abscess, but eventually because of persistent leak required oversewing of the pouch appendage.

Pouch appendage

In the commonly performed J pouch, the pouch appendage is the over-sewn blind limb of the jejunum that is usually not fully incorporated into the pouch reservoir and can be identified by the surgical staple line at its terminus. The length of the pouch appendage is variable. A long pouch may fill with debris or be a cause of bacterial overgrowth. Other potential complications of the pouch appendage include Crohn's disease, stricture formation, or rarely torsion in long limbs. In our experience, the pouch appendage is frequently overlooked as a source of leak or dehiscence by inexperienced radiologists unfamiliar with the surgical technique and anatomy (Fig. 20). Similar to anastomotic leaks, pouch appendage leaks tend to course posteriorly and often terminate in a presacral fluid collection (Fig. 21). Inexperienced fluoroscopists may confuse the pouch appendage with a leak, but the pouch appendage should have visible small bowel folds (Fig. 22) and should fill and contract whereas a leak will not.

Prepouch ileum

Small bowel obstruction is one of the most common complications of IPAA, with an incidence of 11.4% (95% CI 9.1–14.1) from pooled meta-analysis data [23]. Typical causes include post-operative or post-inflammatory adhesions, strictures, internal hernias, and bowel torsion or volvulus.

Obstruction commonly occurs at the ileostomy closure site. A less common cause of obstruction of the prepouch ileum is termed “afferent limb syndrome” and develops as a result of acute angulation, torsion, or prolapse of the afferent limb at the pouch inlet [46] (Fig. 23). A combined radiologic and endoscopic assessment is often required to establish the diagnosis and many patients with afferent limb syndrome require endoscopic or surgical intervention [46]. Most other obstructive episodes respond to conservative management, but approximately 25% will require an operation [21]. If the small bowel is dilated and obstruction is suspected, the radiologist should record the location and cause of the obstruction if evident, the degree of dilata-

in IBD patients. Pouch malignancy, usually adenocarcinoma, is rare with a reported prevalence of 1.2% in IPAA patients [45]. Preoperative colorectal neoplasia and primary sclerosing cholangitis are risk factors for developing pouch malignancy [45].

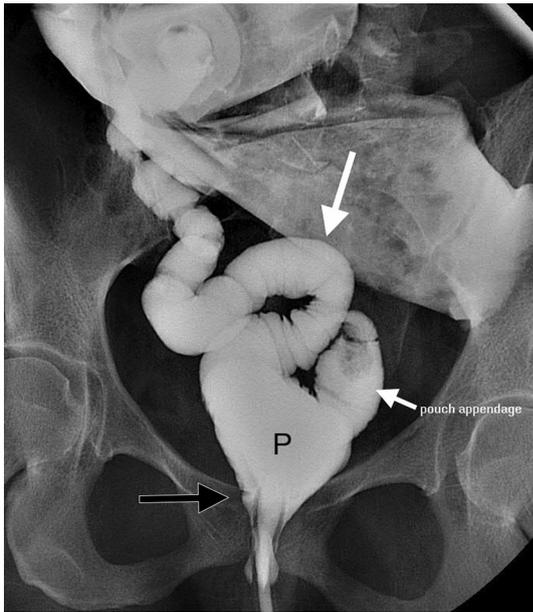


Fig. 22. Normal J pouch anatomy. Fluoroscopic image of a normal ileal pouch, including the prepouch ileum or “afferent limb” (longer white arrow), the pouch (“P”), the pouch appendage or “blind end” (shorter white arrow), the ileoanal anastomosis (black arrow), and the enema tip through the anal canal. Notice the visible small bowel folds in the pouch appendage.

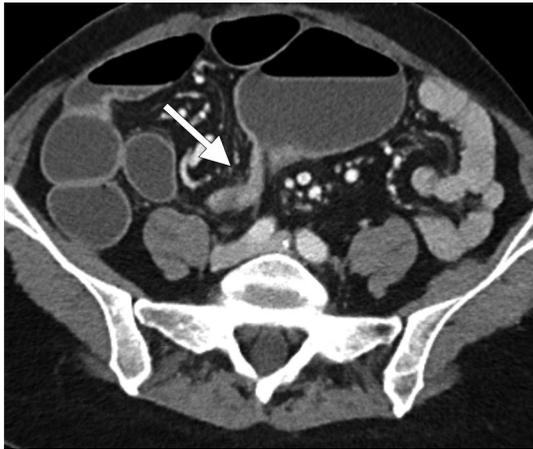


Fig. 23. Afferent limb syndrome, torsion just above pouch. A 57-year-old female with ileal pouch-anal anastomosis performed over 20 years ago for ulcerative colitis presents acutely with nausea, vomiting, and abdominal pain. Axial CT image demonstrates dilated, fluid filled loops of small bowel in the abdomen. To the right of midline and just proximal to the pouch, there is a transition point and swirling of the small bowel mesentery (arrow), consistent with prepouch torsion.

tion (diameter of bowel lumen in centimeters), and whether a retrograde enema might be useful to confirm the presence of obstruction or to sort the etiology out.

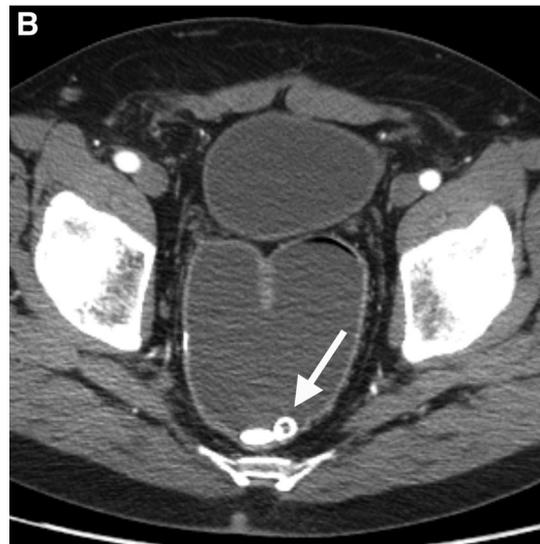
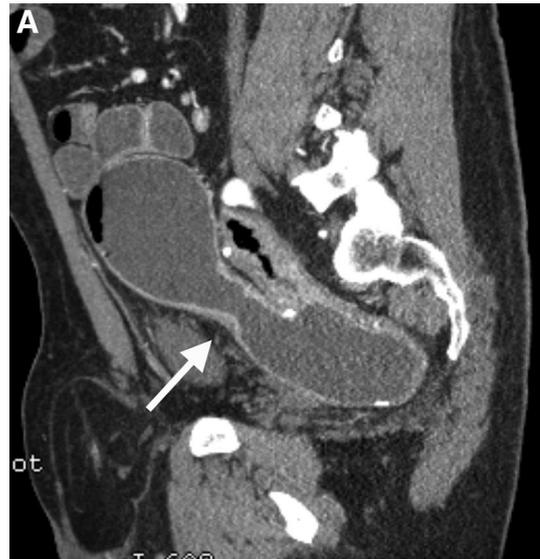


Fig. 24. Backwash ileitis. A 31-year-old female with IPAA for chronic ulcerative colitis. **A** Sagittal CT enterography image shows short segment of symmetrical mucosal hyperenhancement with bowel wall thickening involving the immediate prepouch neoterminal ileum (arrow). Both endoscopy and pathology favored backwash ileitis. The patient had a longstanding anastomotic stricture (not shown) requiring repeated dilatations that was thought to be contributing to the backwash ileitis. **(B, axial CT)** Notice the enteroliths (arrow) within the upstream dilated bowel.

Backwash ileitis of the prepouch ileum can be difficult to differentiate from Crohn’s disease. Nonspecific backwash ileitis is associated with pouchitis and appears as nonspecific, symmetric inflammation isolated to the neoterminal ileum (Fig. 24). Crohn’s disease of the small bowel should be considered if there is asymmetric or patchy inflammation, skip areas of active inflammation, involvement of more proximal small bowel, or any penetrating complications (Fig. 25). However, Crohn’s

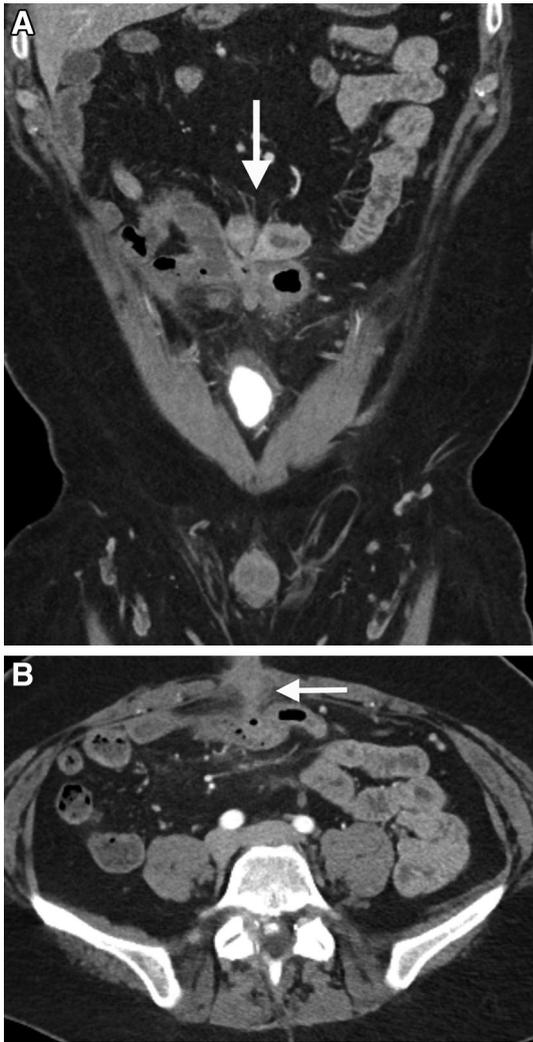


Fig. 25. Crohn's disease of the prepouch ileum with penetrating complications. **A** Coronal CT image shows inflammatory strictures in the prepouch ileum with associated stellate, interloop fistula complex resulting in tethering of adjacent ileal loops (arrow). **B** Axial image near umbilicus in same patient shows an enterocutaneous fistula (arrow). Crohn's disease of the pouch may be distinguished from backwash ileitis by the presence of asymmetric and patchy inflammation, multisegmental involvement, and penetrating complications.

inflammation can be symmetric, particularly when concomitant strictures are present.

Anus

The anal sphincter complex must be closely inspected in all patients with IPAA. The sphincter is particularly well seen on the dedicated pelvic MRI where the scan plane can be specifically angled relative to the anal canal if there is a suspicion of anal or perianal disease [47].

The sphincter should be assessed for sinus tracts, fistulas (Fig. 26), horseshoe ramifications, and global or

Fig. 26. Cuffitis with stricture and perianal fistulizing disease after IPAA. A 48-year-old male presents for follow-up of post-operative diagnosis of Crohn's disease of the neoterminal ileum and pouch. **A** Axial post-contrast MR image demonstrates marked enhancement and thickening of the inflamed rectal cuff and surrounding tissue (arrow). **B** Axial T2-weighted image slightly more inferiorly shows a midline anterior anourethral fistula involving the upper anal canal (arrow). **C** Sagittal CT imaging does not demonstrate the anal canal anatomy as well, but demonstrates a long rectal cuff with active inflammation and stricture (longer white arrow) and the enhancing anourethral fistula (shorter white arrow). Also note active proximal small bowel inflammation from Crohn's disease (arrowhead).

focal atrophy, seen as thinning or fatty marbling, and for scarring, which will be seen as marked T2 hypointense signal.

For ease and clarity of communication, anal fistulas should be described consistently; in our institution, we use the Parks classification scheme to describe external fistulas, and internal fistulas are described based on the organs of involvement. A simple perianal fistula is a linear, nonbranching inflammatory tract, whereas a complex fistula has branching ramifications and/or associated abscess. An abscess is defined as any ring enhancing fluid collection associated with a blind ending sinus tract or fistula.

As previously mentioned, in the setting of IPAA, fistulas and sinus tracts will more often arise from the ileoanal anastomosis, but when they arise from the anal canal away from the anastomosis or are complex, Crohn's disease should be considered (Fig. 19).

Anal stricture can occur secondary to active inflammation or fibrosis. Malignancy can occur within chronic perianal fistulas but is rare, and can occur in the anus.

Mesentery and mesenteric vessels

Mesenteric/portal venous thrombosis (MVT/PVT) is a frequent complication of inflammatory bowel disease [48] and is also a frequent early complication post IPAA, reportedly occurring in up to 6–45% of patients during the early post-operative period [49–52]. The hypercoagulable state of IBD, heightened inflammation in the presence of early post-operative sepsis, and dehydration secondary to diarrhea or surgery all likely contribute. It is also theorized that mobilization and manipulation of mesenteric vessels may result in endothelial stretch injury post IPAA [51, 52].

Patients may be asymptomatic or may present with abdominal pain, fever, nausea, or vomiting [52]. Acute/subacute thrombus presents as an occlusive or nonocclusive filling defect, or as a lack of flow void on



MRI, and the affected vein(s) may be abnormally distended (Fig. 27). With portal vein thrombus, peripheral wedge-shaped perfusion anomalies may be seen in the

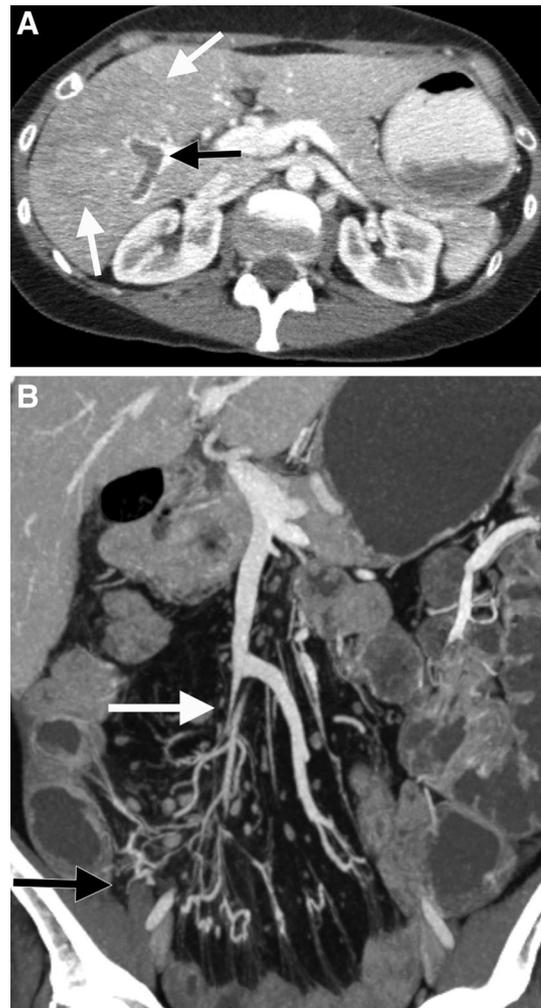
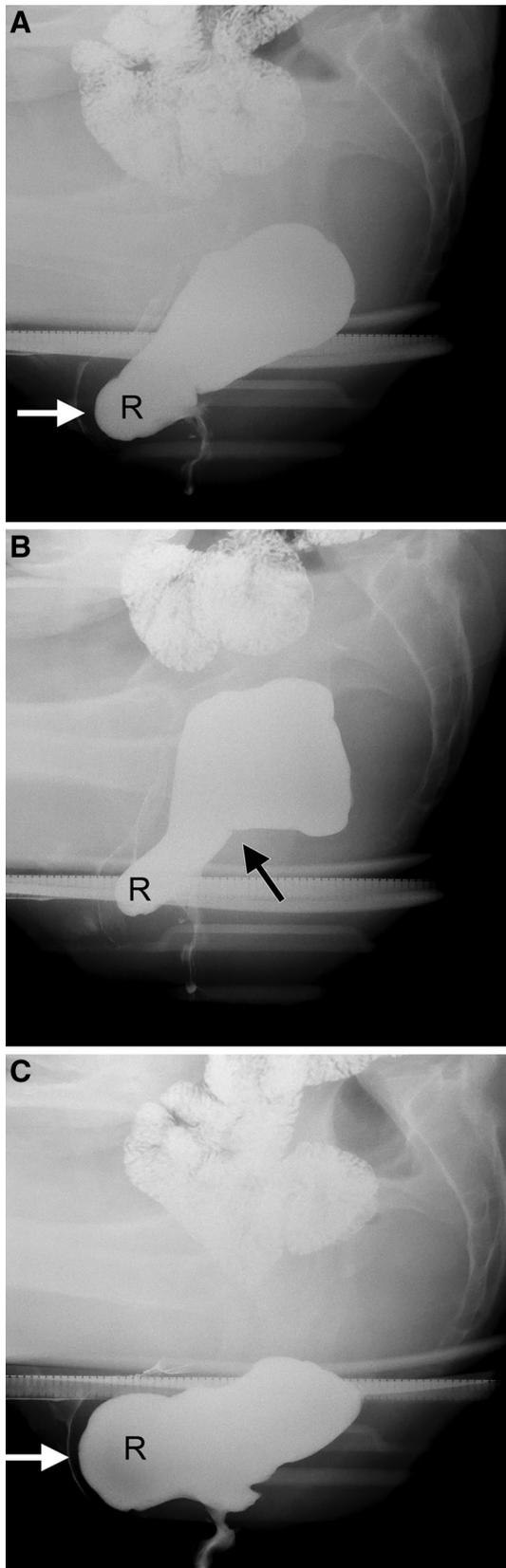


Fig. 27. Portal and mesenteric vein thrombus (PVT/MVT) after ileal pouch-anal anastomosis. A 36-year-old female post IPAA for medically refractory chronic ulcerative presented with presacral pain and was found on CT to have a presacral abscess. **A** Axial CT image of the abdomen also demonstrated extensive nonocclusive intraluminal thrombus involving both the right and left portal veins (black arrows), with associated geographic regions of altered hepatic parenchymal enhancement, particularly in the right hepatic lobe (white arrows). **B** Coronal maximum intensity projection (MIP) image in a different patient demonstrates chronic occlusion of the mesenteric vein (white arrow) with prominent marginal collateral veins (black arrow). A high index of suspicion is critical as early anticoagulation must be instituted to avoid subsequent complications.

liver (Fig. 27). At this early stage, thrombus may respond to anticoagulation therapy without long-term sequela on pouch function [51]. Alternatively, the vein(s) may retract as the thrombus resolves, resulting in chronic mesenteric vein occlusion which is often best observed on



◀**Fig. 28.** Pseudoanterior rectocele. Fluoroscopic defecography demonstrates marked weakness of the anterior wall of the ileal pouch with a large anterior rectocele-like out-pouching resulting in poor pouch emptying. **A** At rest, there is anterior protrusion of the anterior wall of the ileal pouch, with an appearance similar to a rectocele (labeled “R”), and pooching into the posterior wall of the vagina (white arrow). **B** With squeeze, there is appropriate elevation of the pelvic floor and the expected prominent impression from the puborectalis muscle (black arrow). **C** With evacuation, there is appropriate descent of the pelvic floor. The anterior wall of the ileal pouch continues to protrude anteriorly and fills with more contrast material (arrow). Stenotic anal anastomosis also impedes emptying.

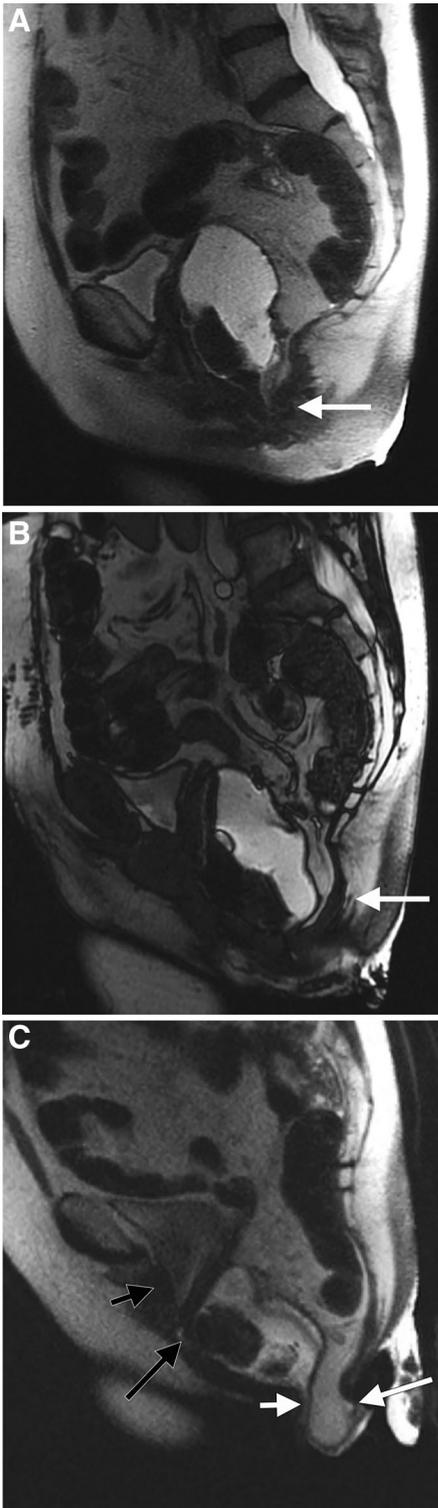
coronal MIP imaging (Fig. 27). With chronic occlusion, peripheral collateral veins or small bowel varices may develop (Fig. 27).

The mesenteric vessels should be tracked along their length down into the peripouch fat to identify any twisting or suggestion of torsion. Torsion may also be suggested in pouchitis patients when the mesenteric fat is unexpectedly located anterior to the pouch but it was placed posteriorly at surgery. Twisting of the longitudinal staple lines along the length of the pouch may provide another clue. However, many times the torsion is not specifically appreciated on imaging.

Functional imaging

Large variations exist in pouch emptying and functional outcome [53]. Patients experiencing obstructed defecation, anal seepage, dyschezia, pain with defecation, or overt external prolapse of tissue may be suspected of having an evacuation disorder and can be studied with either fluoroscopic or MR defecography, typically as an adjunct to ano-pouch manometry. MRI provides not only functional information but also allows a more complete assessment of the pouch, peripouch anatomy, anal sphincters, and levator plate.

Defecography studies may reveal pouch intussusception, anterior pouchocele (Fig. 28), pouch prolapse (Fig. 29), or dyssynergic defecation (Fig. 30). Pouch prolapse is a rarely reported complication following IPAA with a reported incidence of < 1% [54], with tension and stretch from the small bowel mesentery likely being a protective factor. Radiologists should determine whether the prolapse is limited to the mucosa, which can typically be managed with stool bulking agents and biofeedback, or full thickness prolapse, which more often requires definitive surgery with pouch pexy, revision, or excision [54, 55]. Histopathology of excised pouch tissue after prolapse may demonstrate changes similar to those



◀Fig. 29. Pouch prolapse. MRI dynamic defecography images show excessive descent of the pelvic floor with low position of anorectal junction at rest (A, arrow) and further descent with simulated defecation (B), resulting in vertically oriented levator plate (B, arrow). (C) On static post-evacuation image, there is extra-anal prolapse of a peritoneocele containing peripouch fat (C, long white arrow) and posterior pouch wall (C, short white arrow). Post-evacuation also shows anterior displacement of the pouch into the vagina like a rectocele (long black arrow) and a cystocele (short black arrow).

Pouch failure

A small proportion (2–5%) of IPAA patients do not achieve a functioning pouch at 12 months post IPAA or lose long-term functional outcome and ultimately require pouch revision or excision with permanent end ileostomy [21, 23, 57]. Refractory pouchitis and sequelae of post-operative pelvic sepsis are the most common reasons for pouch failure [21, 58]. Crohn's disease is also an independent risk factor [21, 59, 60]. Younger Crohn's patients, those with pouch-vaginal fistula or other fistulizing disease or sepsis, those who are smokers, and those who require immunomodulator therapy or biologics are particularly at risk [58]. Potential mechanical causes of pouch failure include excessively long rectal cuff, afferent limb syndrome, long pouch-associated stricture, or pouch prolapse or torsion [21, 58].

Summary

Restorative total proctocolectomy with ileal pouch-anal anastomosis is the procedure of choice in patients with unremitting ulcerative colitis, ulcerative colitis with high-grade dysplasia/multi-focal low-grade dysplasia, and familial adenomatous polyposis, with the goal of removing at-risk tissue. While long-term outcomes are generally favorable, patients can potentially experience a myriad of early and late pouch-related complications. Radiologists must understand the surgical technique and pouch anatomy, must be familiar with the potential complications, and must recognize the advantages and pitfalls of the various imaging modalities when assessing patients with an IPAA. We provide a systematic, anatomic-based imaging review of the pouch and related complications and we offer a sample of a dedicated structured report template that can be used in clinical practice. Radiologist familiarity with and recognition of the various complications following IPAA will serve to guide appropriate and timely medical and surgical management.

seen with solitary rectal ulceration in the setting of rectal prolapse [54]. Dyssynergic defecation is more common in patients with chronic pouchitis and may be an underestimated complication of IPAA [56].

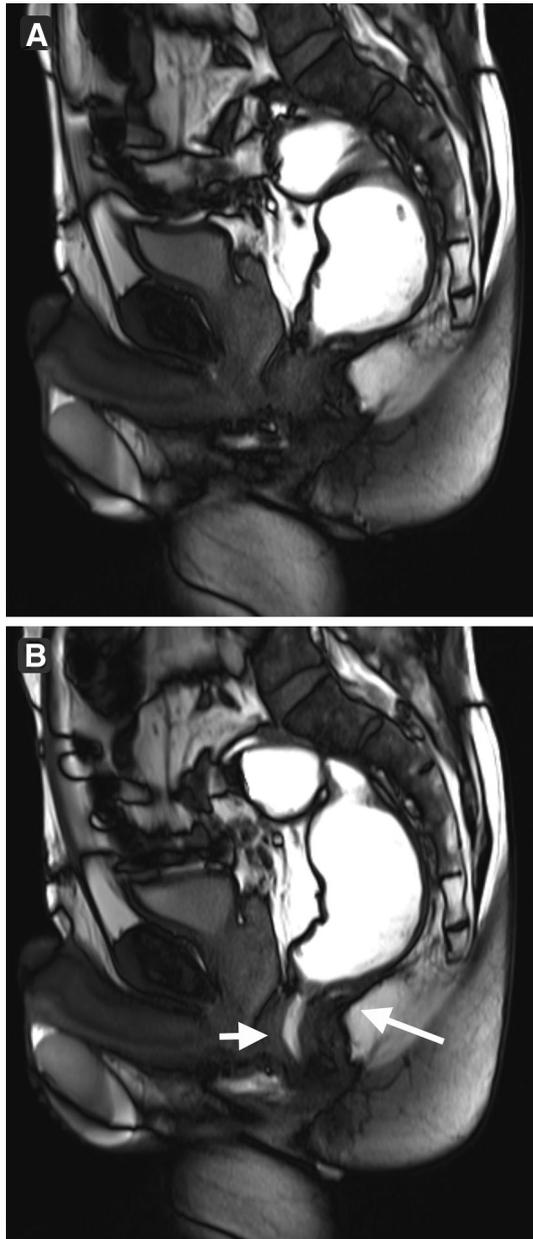


Fig. 30. Dyssynergic defecation of the pouch. A 57-year-old male with IPAA performed for refractory ulcerative colitis. **A** Sagittal image at rest during MR defecating proctogram. **B** Sagittal image during simulated defecation shows lack of relaxation of the puborectalis muscle (long arrow), minimal change in the anorectal angle, minimal distension of the anal canal (short arrow), and poor evacuation.

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Compliance with ethical standards

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Conflict of interest The authors have no conflicts of interest to declare

Ethical approval This article does not contain any studies with human participants performed by any of the authors.

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