Abdominal Radiology (2023) 48:2969–2977
https://doi.org/10.1007/s00261-022-03705-z

SPECIAL SECTION: ILEAL POUCHES

Continent ileostomies: what the radiologist needs to know

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Received: 28 September 2022 / Revised: 5 October 2022 / Accepted: 6 October 2022 / Published online: 9 November 2022

Abstract
Continent ileostomies are performed in patients who are not candidates for or do not want a traditional *J*-pouch after total colectomy. In these cases, patients may opt for a type of continent ileostomy instead of an end ileostomy. The most common types of continent ileostomies include the Kock (*K*) pouch, *S*-pouch and Barnett Continent Intestinal Reservoir. The normal fluoroscopic and CT appearance of these types of continent ileostomies are reviewed. CT provides better evaluation of the proximal small bowel and pouch for inflammatory bowel disease, while fluoroscopy is superior in evaluating the nipple valve. Common complications of these types of continent ileostomies are discussed including slipped nipple valve, pouch inflammation, fistulas, and polyps. Radiologist should be familiar with the different types of continent ileostomies that exist and their common complications.

Keywords Continent · Ileostomy · Crohn's · Pouch · Computed tomography · Fluoroscopy · Koch

Introduction

Historically, patients with diseases requiring proctocolectomy received an end ileostomy with external bag appliance and no control of the excretion process. In the late 1960's, Dr. Kock described a continent ileostomy allowing patients control over the timing of bowel elimination and omitting the external appliance as well. It was called the Kock pouch (*K*-pouch) [1]. A continent one-way valve was created from intussuscepted ileum which allowed intermittent drainage of an ileal pouch through the anterior abdominal wall. Throughout the years, there have been different adaptions of this procedure with the eventual creation of the ileal-J pouch.

While the Ileal *J*-pouch has become the procedure of choice following proctocolectomy for ulcerative colitis and familial adenomatous polyposis (FAP), there remains a select group of patients that will need to consider a continent ileostomy. Common indications include those with impaired anal sphincter function or short mesentery rendering a tension free ileal pouch-anal anastomosis (IPAA) impossible. Additional indications include patients with refractory pouchitis and/or *J*-pouch complications who do not want a pouch revision but still would like to maintain continence. Other patients who may consider a continent ileostomy are those with severe pelvic floor dysfunction that impairs their quality of life, or patients dissatisfied at having more than 8 bowel movements a day with a typical *J*-pouch.

Radiologists may be asked to evaluate both newly created and existing continent ileostomies and should be familiar with the different configurations that exist, including the normal appearance of these pouches and common complications that can occur. The purpose of this pictorial essay is to familiarize radiologists with the normal fluoroscopic and CT appearance of continent ileostomies and provide examples of common complications.

Types of continent ileostomies

Since the initial *K*-pouch operation, several modifications have been developed, with the most common being the Barnett continent intestinal reservoir (BCIR) and the S pouch. These pouch configurations are important for the radiologist to understand and recognize as they provide a helpful roadmap to colorectal surgeons when complications arise, and pouch revisions are needed.

The *K*-pouch procedure is performed by creating a reservoir from the ileum. The ileum is opened longitudinally

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and sutured into a *U*-shaped limb. The limb is then folded vertically to create the reservoir. Intussuscepting the efferent ileal loop retrograde into the pouch creates a one-way nipple valve that prevents reservoir contents from entering the stoma (Fig. 1). In total, a *K*-pouch requires approximately 60 cm of functioning ileum to create to the pouch [2]. Patients are required to intubate the nipple valve and drain the *K*-pouch several times a day using a semirigid catheter.

The Barnett Continent Intestinal Reservoir or BCIR procedure utilizes an intestinal collar to help support and reinforce the nipple valve [3]. Like the *K*-pouch, the BCIR also utilizes a *U*-shaped ileal pouch and a similar nipple valve created but from intussuscepting the afferent limb that is divided/transected about 15 cm away from the pouch. The bowel upstream is anastomosed to the pouch to allow gastrointestinal flow into the pouch. The pouch inlet limb is then wrapped around this valve to provide more stabilization of the valve and prevent its slippage (Fig. 2).

The *S*-pouch is a 3-limb pouch in which three adjacent loops of ileum are used to construct the ileal reservoir. The efferent limb is used to create a nipple valve like the *K*-pouch. The *S*-pouch is then closed vertically, as in a *K*-pouch. The valve and the pouch inlet are in opposite orientation from one another, making the procedure technically easier and reducing injury of the pouch during intubation (Fig. 3) [4].

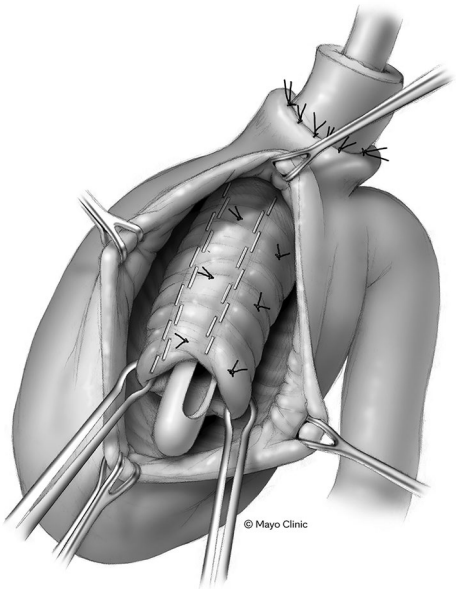

Fig. 1 Schematic detailing the anatomy and surgical technique in creating a Kock (*K*) pouch. The *K*-pouch procedure is performed by creating a reservoir from the ileum, which is opened longitudinally and sutured into a *U*-shaped limb. The limb is then folded vertically to create the reservoir. A nipple valve is created by intussuscepting the efferent ileal loop retrograde into the pouch. This nipple acts as a one-way valve preventing reservoir contents from entering the stoma. From: Dozois R & Dosois EJ. Chapter 125: The Continent Ileostomy. In: Fischer JE, editor. Mastery of Surgery, 5th Edition. Philadelphia: Lippincott, Williams & Wilkins, 2006, P 1396, used with permission of Mayo Foundation for Medical Education and Research, all rights reserved

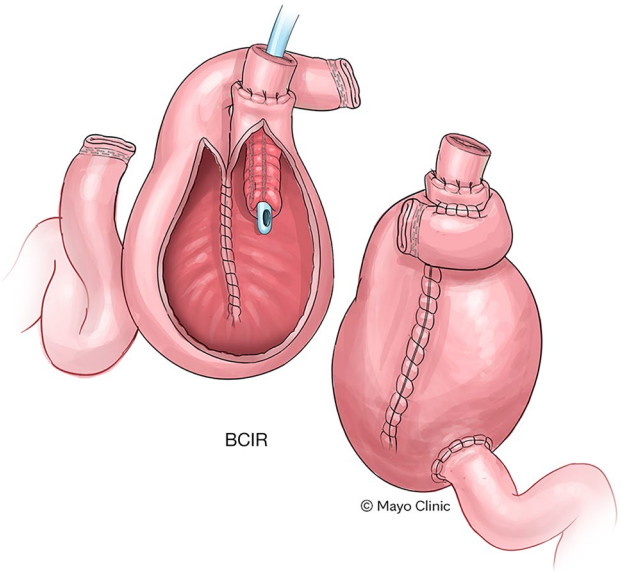

Fig. 2 Barnett continent intestinal reservoir (BCIR). The BCIR utilizes a *U*-shaped ileal pouch and a nipple valve created from intussuscepting the efferent limb. The pouch inlet is then wrapped around the nipple valve to help provide more valve stabilization and prevent nipple valve slippage. This intestinal collar therefore helps to support and reinforce the nipple valve. Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved

Imaging technique

Both CT and fluoroscopy evaluations of the continent ileostomies can provide valuable information.

Double contrast pouchogram

At our institution, the double contrast exam is preferred. The empty pouch is typically intubated by the patient, if they are able, using a semirigid catheter commonly supplied by the patient. The patient intubates their stoma either in supine or standing position. If the patient is unable to intubate their stoma, the radiologist may attempt to intubate the pouch with the patient in either position. Contrast is injected through the stoma to outline the nipple tract. The catheter can often be manipulated through the visible subcutaneous tract and the nipple valve under fluoroscopic guidance. Viewing the stoma and nipple tract in profile is helpful to identify redundancy and kinking of the tract. This is usually best done with the patient in the lateral position. If the pouch cannot be intubated, further assistance may be required by the colorectal surgeon or via endoscopic intubation.

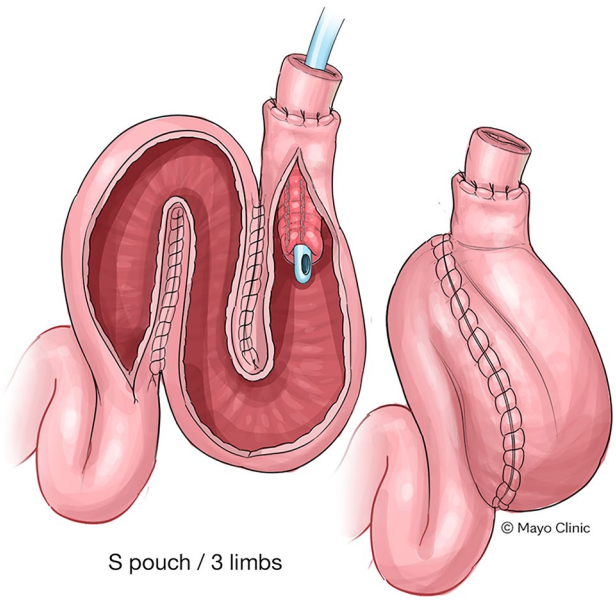

Fig. 3 *S*-pouch. The *S*-pouch is a 3-limbed pouch in which three adjacent loops of ileum are used to construct the ileal reservoir. The efferent limb is used to create a nipple valve (not shown). The pouch is then closed horizontally. The valve and the pre-pouch ileum are in opposite orientation from one another. Used with permission of Mayo Foundation for Medical Education and Research, all rights reserved

With the patient in the supine position, 60 ml of high-density barium is injected into the pouch under fluoroscopic guidance. Next, the patient is asked to barrel roll one or two times on the fluoroscopic table to thoroughly coat the walls of the pouch. A clamp is applied to the intubation catheter to prevent the tube from slipping into the ileal reservoir during rolling. Any residual barium is then aspirated via the catheter. Repositioning of the patient and the catheter may be required to successfully empty the pouch. After most of the barium has been aspirated, air is injected into the pouch until the pouch is insufflated (80–160 ml typically).

Image acquisition is obtained in multiple projections so that the entire pouch is documented. The radiographic images should include views of the nipple valve in profile and the pouch inlet as well as the pre-pouch ileum if opacified. Once the entire pouch has been thoroughly evaluated, images are obtained as contrast material (high-density barium) is injected through the catheter while being slowly retracted. This is helpful in evaluating for stomal fistulas and other tract abnormalities.

CT technique

CT imaging of patients with a continent ileostomy can be done multiple ways. An intravenous contrast-enhanced single portal venous phase CT exam can provide adequate information about the pouch if it is distended with fluid contents. At our institution, we have adopted a monophasic CT enterography technique. Patients are asked to drink 3 bottles of neutral oral contrast at 45, 30, and 15 min before the CT scan. A single monophasic CT enterography exam is performed with IV contrast material (patients do not empty their pouches before the exam). Table 1 lists the standard IV contrast dosing used at our institution. Coronal, sagittal, and axial CT images are created. The enterography technique is anticipated to provide consistent pouch distention, better visualization of the proximal small bowel, and optimal mucosal enhancement of the pouch. The pouch is not routinely intubated for the CT scan; however, if patients have difficulty intubating their stoma, the CT scan can be performed with the catheter in place. Figure 4 illustrates a normal CT appearance of a *K*-pouch.

Normal pouch appearance

At fluoroscopy, continent ileostomies can vary in size depending on the frequency of pouch emptying and the amount of pouch accommodation. A typical pouch is approximately 160–175 ml at the time of maturation 4 weeks after surgery. The pouch mucosa should be smooth without nodularity or fold thickening. The ileal mucosal fold pattern should be maintained. Additionally, it is important to remember that the nipple valve extends into or inside the pouch and represents a normal filling defect (Fig. 5).

When the nipple valve is evaluated in profile, it should appear symmetric on either side of the catheter and protrude into the pouch approximately 4–6 cm; however, this can vary due to patient abdominal wall width and body habitus (Fig. 6) [5]. The pre-pouch ileum should be of normal caliber and mucosal pattern.

Table 1 Standard IV contrast dosing for monophasic enterography study

IV contrast dosing				
Body weight	< 64 kg	64–109 kg	110–136 kg	> 136 kg
IV contrast	Iohexol 300	Iohexol 300	Iohexol 300	Iohexol 300
Contrast protocol (Glomerular filtration rate (GFR) greater than 30 mL/min)	100 mL followed by 50 mL 0.9% NaCl at 4 mL/sec	140 mL followed by 50 mL 0.9% NaCl at 4 mL/sec	200 mL followed by 50 mL 0.9% NaCl at 4 mL/sec	200 mL followed by 50 mL 0.9% NaCl at 5 mL/sec

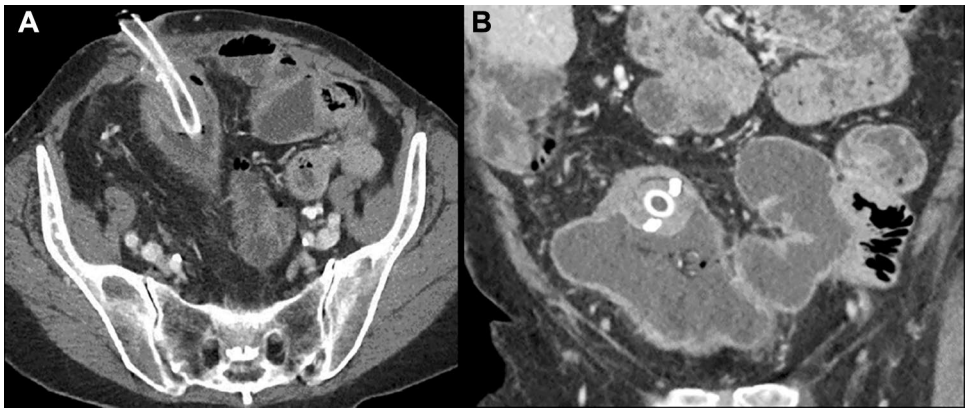

Fig. 4 Normal CT Enterography appearance of the Kock (*K*) pouch. **a** Axial CT Enterography demonstrates an intubated *K*-pouch with normal appearance of the nipple valve. **b** Coronal CTE showing normal appearance of the pouch without inflammatory changes

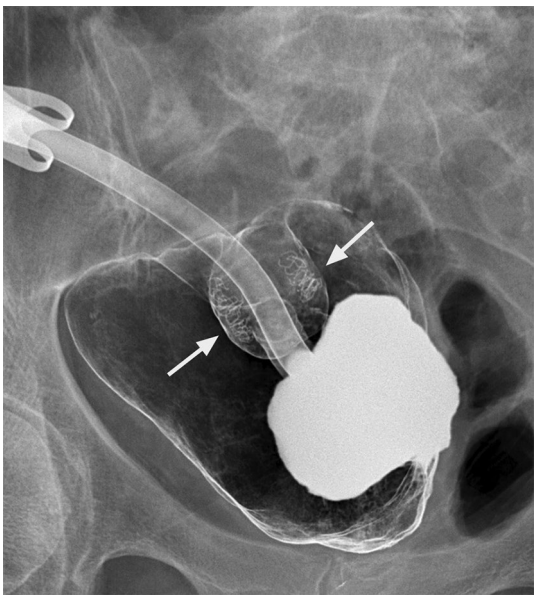

Fig. 5 Normal double contrast fluoroscopic appearance of the Kock (*K*) pouch. The air distended pouch is normal in size with smooth mucosal walls. Barium outlines the mucosa of the nipple valve (arrows) which protrudes into the pouch

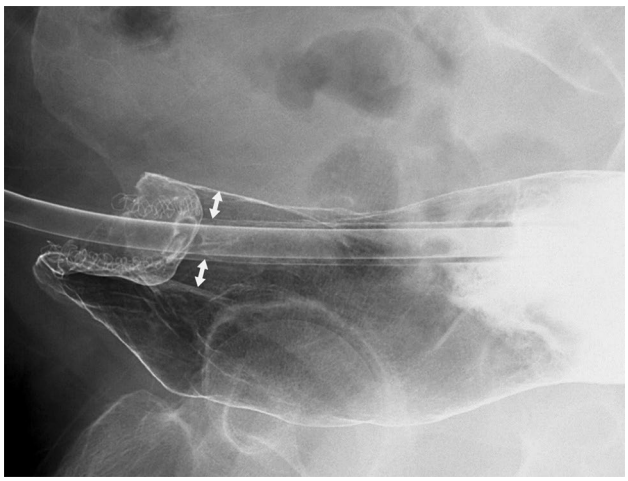

Fig. 6 Normal double contrast appearance of the nipple valve in profile. The nipple protrudes into the pouch and demonstrates symmetry on either side of the catheter (arrows). Normal nipple length is approximately 4–6 inches

Both the pouch and nipple valve should be evaluated by CT. The pouch should be evaluated for normal mucosal enhancement, wall thickening, and pre-pouch ileal inflammation. Any intra-pouch findings like enteroliths, polyps, or masses should be reported. While the positioning of the nipple valve is more difficult to appreciate at CT, other complications such a fistulas or inflammation can be assessed using multiplanar images. The tract between the nipple valve and the stoma should be inspected for fistula and redundancy.

At both fluoroscopy and CT, it is important to evaluate the orientation of the pouch inlet tract/pre-pouch ileum in relation to the nipple valve. This can be helpful in differentiating the various types of continent ileostomies. The *S*-pouch will have the pouch inlet and the nipple valve situated opposite one another (Fig. 7a). A BCIR will have a similar pouch inlet and nipple valve orientation to a *K*-pouch but should demonstrate the pre-pouch ileum wrapping around nipple valve (Fig. 7b). A *K*-pouch will have the pouch inlet and nipple valves near one another (Fig. 7c). No matter the type of continent ileostomy, it is important to remember that the normal nipple valve should extend inside the pouch several centimeters.

Complications

A meta-analysis comparing different types of ileal pouches (including J, S, and K pouches) found that there were no appreciable differences in the perioperative complications between them [6]. Complication rates have been reported in 20–44% of patients. [6–8] The most common complications include peristomal fistula, slipped nipple valve causing inability to intubate the pouch, intra-pouch enteroliths, and

Fig. 7 The different cross-sectional appearances of an *S*-pouch, Barnett continent intestinal reservoir (BCIR), and Kock (*K*) pouch. **a** *S*-pouch showing that the nipple valve (arrowhead) and pouch inlet (arrow) are opposite the pouch from each other rather than in closer proximity as would be expected with a *K*-pouch. **b** Axial CT image demonstrating the appearance of a BCIR procedure. The nipple valve can be seen exiting at the level of the skin (arrowhead). The pouch inlet limb is seen looping around the nipple valve (arrows). **c** *K*-pouch with catheter exiting the nipple valve (arrowhead). The pouch inlet can be seen near the nipple valve (arrow)

development of a recurrent Crohn's phenotype involving the pouch and the pre-pouch ileum.

Enteroliths

Enteroliths are a common finding in a continent ileostomy pouch secondary to pooling and stasis of enteric contents. Figure 8 depicts both the fluoroscopic and CT appearance of enteroliths within continent ileostomy pouches.

Slipped nipple

Nipple valve complication rates with continent ileostomies are approximately 30% and often increase over time [8, 9]. Nipple slippage or valve prolapse can be either partial or complete. Common symptoms of a slipped or prolapsed nipple valve include difficulty intubating the pouch. A recent study by Ecker found that 33% of complications were associated with the nipple valve. Of those, intubation problems and nipple slippage both accounted for 19% of complications. [10]

The radiologic findings of a slipped nipple include loss of the nipple symmetry when viewing the nipple valve en face (Fig. 9). Additionally, a tortuous or non-linear course of the catheter and nipple valve should raise concern for a slipped valve. Fluoroscopy is the easiest method for evaluating the nipple valve and its orientation. However, in more dramatic cases this can also be detected with CT (Fig. 9). At CT the nipple valve should follow a relatively straight course and should protrude into the pouch. Retraction of the nipple valve outside of the pouch or its excessive angulation suggests slippage. Complete valve prolapse occurs when there is separation of the valve from the anterior abdominal wall. Detection of this complication is crucial because it typically requires surgical correction.

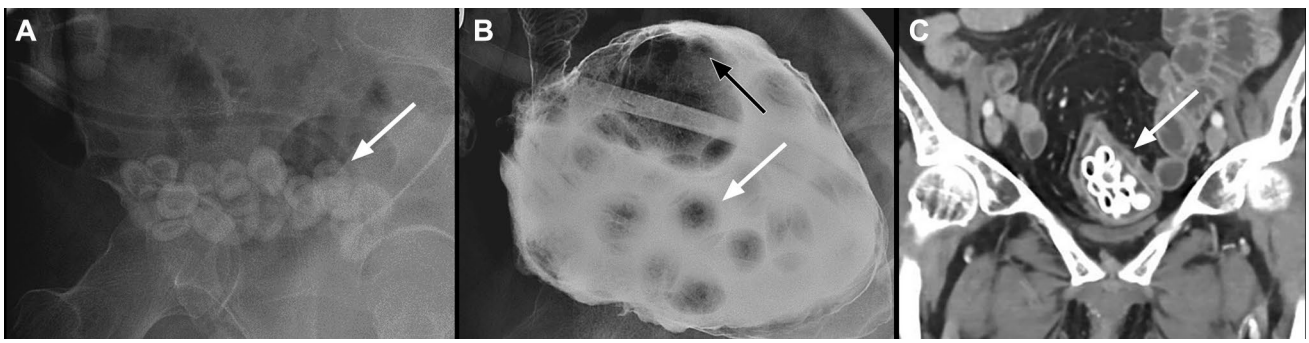

Fig. 8 Fluoroscopic and CT images of pouch enteroliths. **a** A scout radiograph demonstrates multiple round calcifications projecting over the pelvis. **b** A single contrast view of the Kock (*K*) pouch demonstrates multiple round filling defects representing stones (white arrow). The larger filling defect with a catheter running through it represents the normal nipple valve (black arrow). **c** Coronal CT image demonstrating multiple enteroliths within a *K*-pouch (arrow)

Fig. 9 A 69-year-old female who received both a CT of the pelvis and a pouchogram due to inability to easily intubate the stoma. **a** Axial CT image demonstrates a malpositioned nipple valve (arrow) extending medial to the pouch. Normally the nipple valve should be within the pouch. **b** A single contrast pouchogram demonstrates an abnormal and tortuous course of the catheter and contrast material. There is sharp angulation at the nipple valve (arrow). These findings are consistent with a slipped nipple valve

Fistulas

A fistula can develop at the valve any time after surgery and has been reported in up to 25% of patients [8]. Fistulas can occur at the nipple valve, the afferent limb, or at the pouch. When occurring at the base of the valve, fistulas can lead to symptoms of incontinence. Risk factors for fistula include the use of mesh at surgery to strengthen the pouch, Crohn's phenotype, and repeated forceful intubation of the nipple valve. Surgical revision is usually required when this occurs and is one of the major causes for overall pouch excision in these patients.

At fluoroscopy, the barium-coated pouch should be distended fully with air to opacify any fistulous tracts involving the pouch. To evaluate the pre-pouch ileum for a fistula, contrast should be refluxed into the pouch inlet and pre-pouch ileum when possible. A pouch or pre-pouch fistula should raise concern for development of a Crohn's phenotype (Fig. 10).

Fistula development at the base of the nipple can occur secondary to trauma from forceful cannulation or secondary to surgical technique. Abnormal accumulation of contrast material along the subcutaneous or nipple valve tract is a red flag for a sinus tract or fistula (Fig. 11).

At CT, fistulas involving the pouch, the pouch inlet or pre-pouch ileum will look like penetrating Crohn's phenotype seen in other parts of the small bowel and colon. A fistula from the pouch to the skin or other part of the nipple may be difficult to detect given that the nipple tract is not routinely injected with contrast, and scanning plane obliquity (without multiplanar reformatted views at various angles) makes en face evaluation difficult. A rim enhancing or air-filled tract between the base of the nipple and the nipple tract would suggest a fistula (Fig. 12). Contrast material can be administered via a catheter while simultaneously removing the tube in patients with a high clinical suspicion of fistula. Immediate CT scan would be necessary after contrast injection.

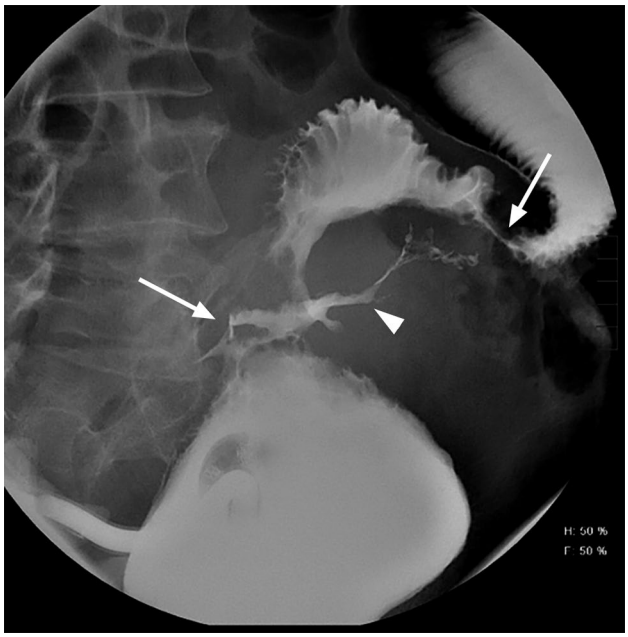

Fig. 10 Single contrast fluoroscopic image of the Kock (*K*) pouch and pre-pouch ileum. There are skip lesions with stricturing in the pre-pouch ileum (arrows), as well as a complex fistula extending anteriorly at the level of the proximal pre-pouch ileum (arrowhead)

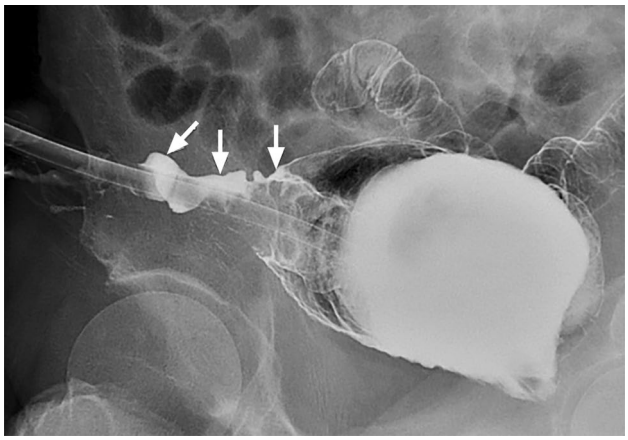

Fig. 11 Double contrast fluoroscopic image of the Kock (*K*) pouch and nipple tract. There is an abnormal fistulous tract that opacifies with contrast between the proximal *K*-pouch and the nipple tract (arrows)

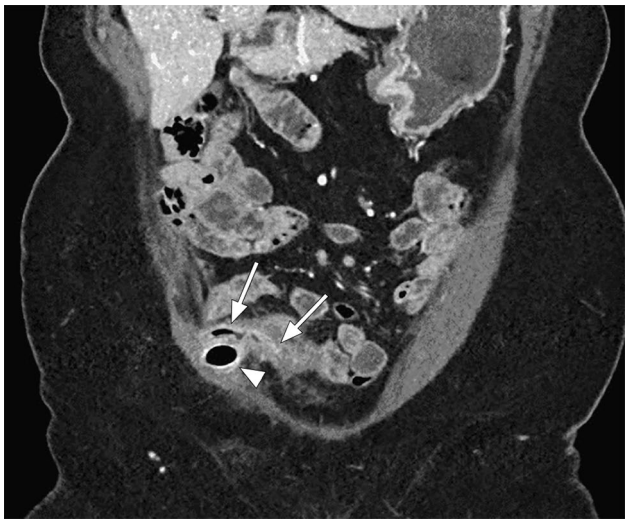

Fig. 12 Coronal CT image demonstrating an air containing fistula tract (arrows) along the nipple tract (arrowhead) in a patient with a Barnett continent intestinal reservoir

Inflammation

Pouchitis is inflammation of the pouch often accompanied by bacterial overgrowth [8]. The frequency of *K*-pouchitis is between 26 and 29% [8] for all types of *K*-pouch patients. Patients present with increased pouch output, abdominal pain, bloating, and possibly bloody stool output. Recurrent pouchitis can be a cause for pouch removal, but it is initially treated with antibiotics or other anti-inflammatory drugs. Patients with Crohn's phenotype are generally not candidates for a continent ileostomy as they have a 4.5 × greater risk of pouch failure compared to patients with FAP or ulcerative colitis [8]. These patients can also develop pouchitis and other typical changes seen with Crohn's phenotype, increasing the risk of pouch failure.

At fluoroscopy, pouchitis is best viewed with a double contrast technique so that the mucosa of the pouch can be adequately evaluated. Mucosal fold thickening and nodularity are the most common findings of pouchitis at fluoroscopy (Fig. 13).

At CT, inner wall hyperenhancement (often asymmetric in Crohn's phenotype disease) and wall thickening are suggestive of pouchitis. In more severe Crohn's phenotype cases, stricturing and penetrating disease can also occur involving the pouch and/or the pre-pouch ileum (Figs. 13, 14).

Polyps

Polyps within the pouches are commonly encountered. Patients with Crohn's phenotype disease can develop inflammatory polyps within the pouch and in the pre-pouch ileum. Additionally, continent ileostomies have been performed for patients with FAP. Careful scrutiny of the pouch for polyps is important in this population as adenomas harbor an increased risk of subsequent cancer. Double contrast fluoroscopic images will demonstrate a round filling defect protruding into the pouch. This may or may not be associated with findings of pouchitis (Fig. 15a). With contrast-enhanced CT, an enhancing soft tissue nodule protruding into the pouch lumen is typically seen (Fig. 15b); however, small sessile polyps can carpet the entire pouch in patients with FAP and may mimic diffuse wall thickening with mild irregularity. Polyps can be differentiated from residual small bowel contents since polyps will enhance following IV contrast administration.

Summary

For patients who wish to maintain continence, continent ileostomies are an alternative if a standard *J*-pouch has failed or is not appropriate. These pouches can be adequately evaluated with both CT and fluoroscopy. CT provides better evaluation of the proximal small bowel and pouch for inflammatory bowel disease, while fluoroscopy is superior in evaluating the nipple valve. Patients at our institution with continent ileostomies are routinely evaluated with

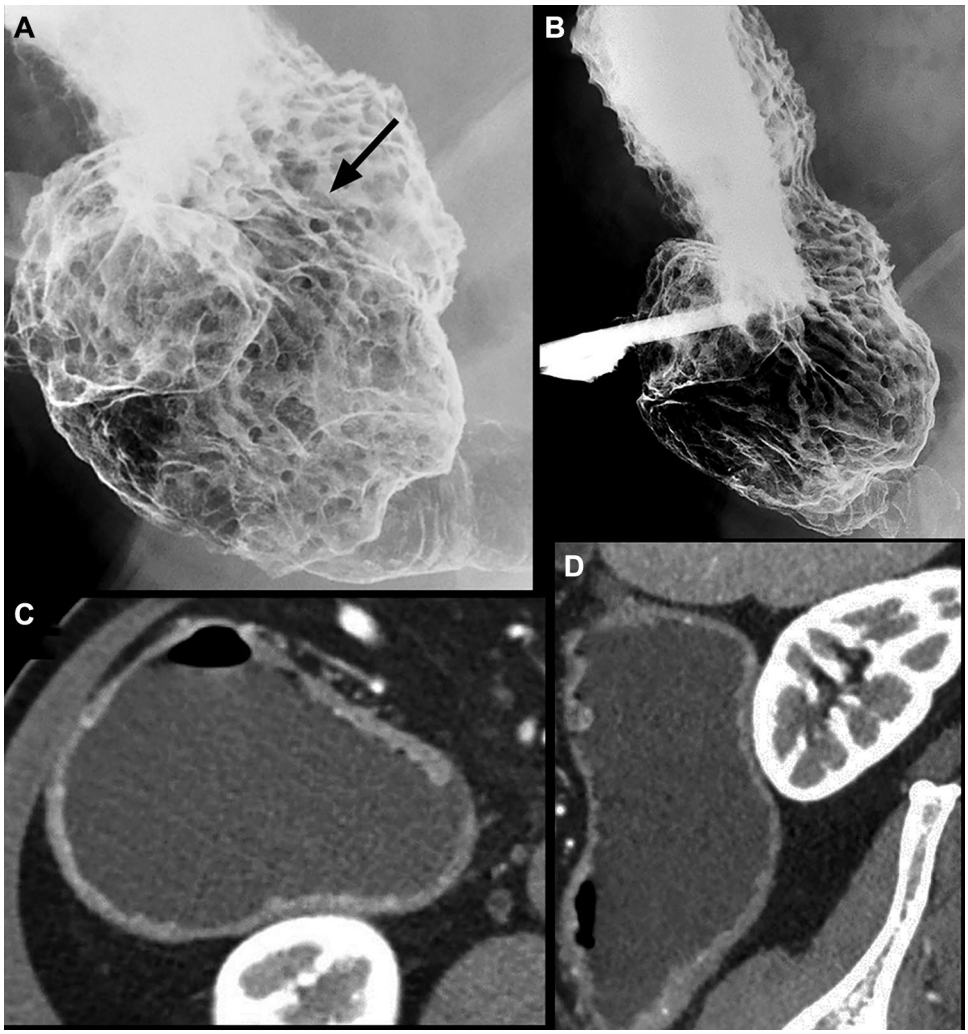

Fig. 13 Fluoroscopic and CT imaging finding of pouchitis involving a *K*-pouch. **a**, **b** Double contrast fluoroscopic images demonstrating fold thickening and nodularity (arrow) of the Kock (*K*) pouch most consistent with pouchitis. **c**, **d** axial and sagittal contrast-enhanced CT images, respectively, that illustrate wall thickening and enhancement of the *K*-pouch consistent with pouchitis

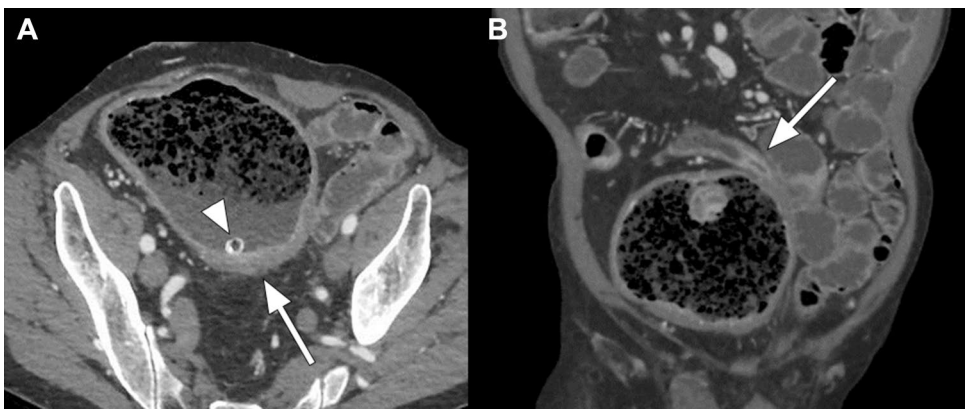

Fig. 14 Pouchitis and recurrent Crohn's phenotype disease. **a** Contrast-enhanced axial CT image of a 78-year-old male with thickening and mild enhancement of the pouch (arrow). A small stone is noted within the pouch (arrowhead). **b** Contrast-enhanced coronal CT image of the same patient demonstrates pre-pouch ileitis with inner wall hyperenhancement and luminal narrowing consistent with recurrent Crohn's phenotype disease (arrow)

both a dedicated CT enterography and fluoroscopic pouchogram. Radiologists should be familiar with the normal and abnormal appearance of the continent ileostomy at CT and fluoroscopy, and they should be able to recognize common complications.

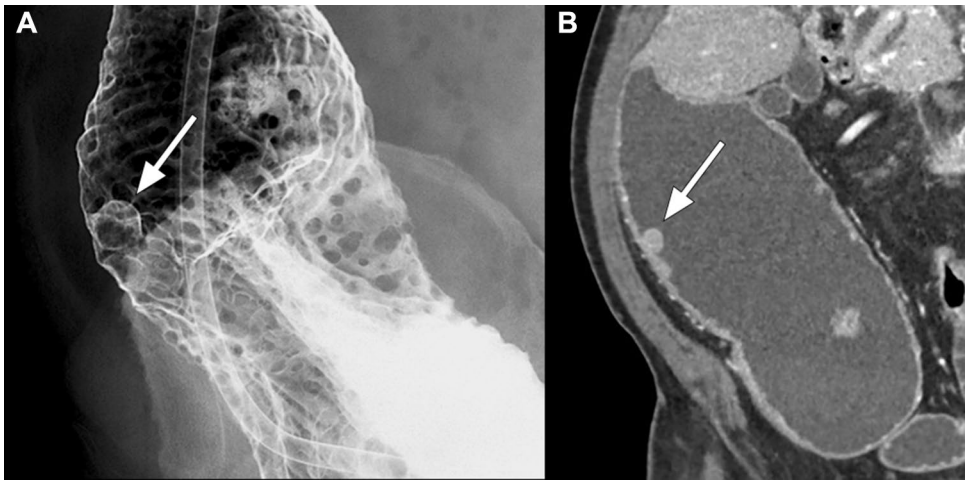

Fig. 15 Fluoroscopic and CT finding of pouch polyps**. a** Double contrast fluoroscopic image demonstrates a rounded filling defect protruding into the pouch (arrow) consistent with an adenomatous polyp in a patient with known familial adenomatous polyposis. **b** A sagittal contrast-enhanced CT image in the same patient shows an enhancing nodule along the anterior pouch wall protruding into the pouch lumen (arrow)

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00261-022-03705-z.

Acknowledgements The authors acknowledge the assistance of Desiree Lanzino Ph.D., Lucy Bahn Ph.D. and Sonia Watson Ph.D. in editing the manuscript.

Funding None.

Availability to data/materials Not applicable.

Code availability Not applicable.

Declarations

Conflict of interest The authors have no conflict of interest to declare.

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