Retroperitoneal Colon Perforation with Review of Retroperitoneal Anatomic Relationships: Case Series with Review of Literature

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Abstract

We present two cases of iatrogenic retroperitoneal perforation involving the ascending and descending colon. The unique imaging findings in these two cases demonstrate potential routes of communication for air originating in the retroperitoneum. In context of these cases, we review the clinical presentation, management, and anatomic features of retroperitoneal perforation. Along with clinical history, an understanding of retroperitoneal anatomic relationships can aid radiologists in identifying the origin of perforation.

Keywords

- retroperitoneal perforation
- pneumoretroperitoneum
- computed tomography
- radiograph
- retroperitoneal anatomy

Introduction

We present two similar cases of iatrogenic posterior retroperitoneal perforation of the colon: the first involving the ascending colon and the second involving the descending colon. The computed tomography (CT) imaging findings of these cases provide an opportunity to discuss retroperitoneal anatomic relationships and imaging features that distinguish this entity from intraperitoneal perforation. The imaging findings of these retroperitoneal colonic perforations are sufficiently characteristic that specific diagnoses can be suggested, including differentiation from retroperitoneal duodenal perforation. To our knowledge, demonstration of retroperitoneal perforation of the ascending and descending colon has not been previously reported together.

Case Reports

Case 1: Ascending Colon Perforation

A 40-year-old man presented to the emergency department with acute right lower quadrant abdominal and flank pain, which worsened throughout the day after screening colonoscopy. He also had one episode of emesis and denied any bowel movements or flatus since the procedure.

During the colonoscopy, a 7 mm polyp was removed from the mid-ascending colon with a hot snare. An additional small polyp was removed from the proximal ascending colon.

Upon admission, laboratory workup was significant for leukocytosis (white blood cell count of $12 \times 10^3/\mu L$). The scout film from an abdominal CT scan showed free air in the right side of the abdomen, limited superiorly by the liver (►**Fig. 1**). The CT images demonstrated the right retroperitoneal free air in the region of the bare area of the liver (►**Fig. 2A**); porta hepatis and perinephric space, surrounding the upper pole of the kidney and the right adrenal gland (►**Fig. 2B**); anterior and posterior pararenal spaces, as well as extension to the inferior vena cava (IVC; ►**Fig. 2C**); and posterior to the ascending colon (►**Fig. 2D**).

The patient was taken to the operating room for a robotic-assisted laparoscopic right hemicolectomy. A primary anastomosis was performed. Fibropurulent exudate was seen over the gallbladder and hepatic flexure.

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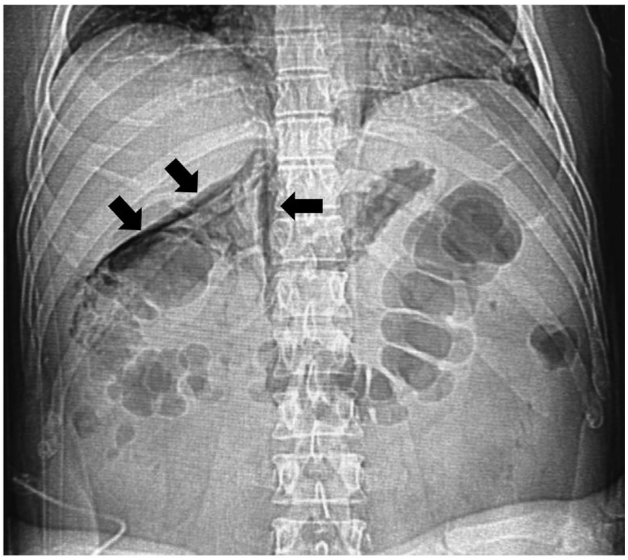

Fig. 1 Abdominal radiograph of a patient with right colonic perforation shows free air in the right side of the abdomen (black arrows), limited superiorly by the liver.

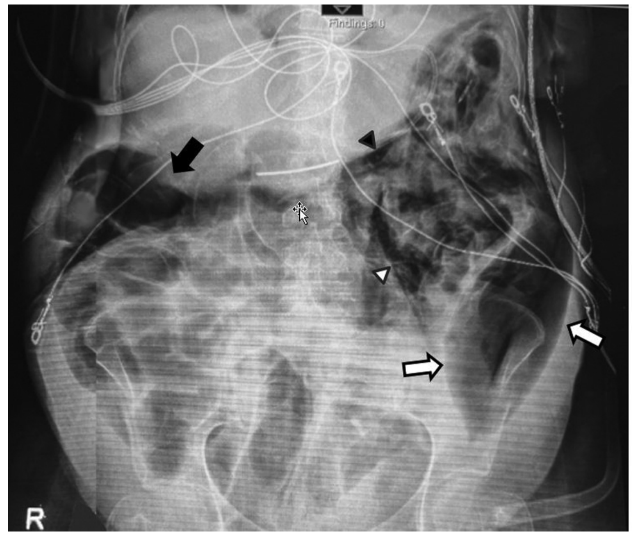

Fig. 3 Abdominal radiograph of a patient with left colonic perforation shows free air in the right upper quadrant (black arrow), left upper quadrant (black arrowhead), and left lower quadrant, outlining the left psoas muscle (white arrowhead), and bowel wall within the left paracolic gutter (white arrows).

Case 2: Descending Colon Perforation

A 66-year-old woman, whose hospital course was complicated by hematochezia in the setting of supratherapeutic heparin anticoagulation, underwent colonoscopy. A polypectomy was performed for an incidentally found sigmoid polyp. Thereafter, the patient developed increasing abdominal distension, prompting an abdominal radiograph, which showed free air in the right upper quadrant, left upper quadrant, and left lower quadrant, outlining the left psoas muscle and bowel wall (►**Fig. 3**). A subsequent CT scan of the abdomen showed a large volume of free air, predominantly within the left retroperitoneum, surrounding the descending colon and left posterior pararenal space (►**Fig. 4A**). The air was noted to reach the midline at the aortic bifurcation but did not extend across to the right retroperitoneum (►**Fig. 4B**). However, a

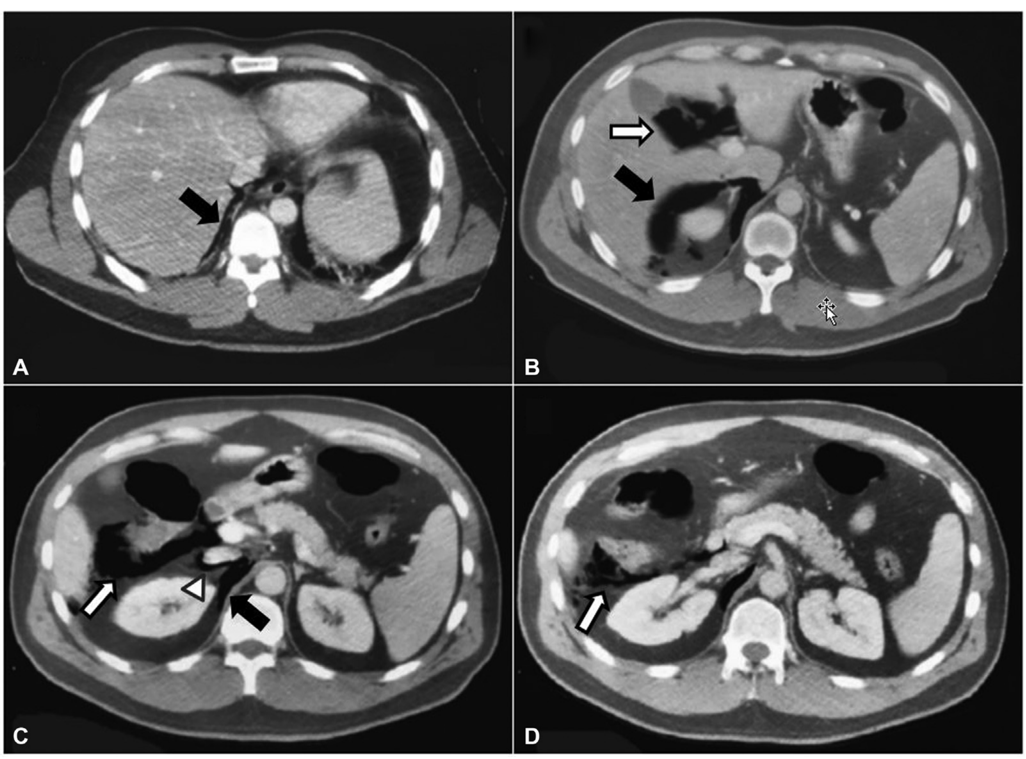

Fig. 2 Abdominal computed tomography for patient with right colonic perforation shows free air in the (**A**) region of the bare area of the liver (black arrow), (**B**) porta hepatis (white arrow) and perinephric space (black arrow), (**C**) anterior (white arrow) and posterior (black arrow) pararenal spaces, as well as extension to the inferior vena cava (white arrowhead), and (**D**) posterior to the ascending colon (white arrow).

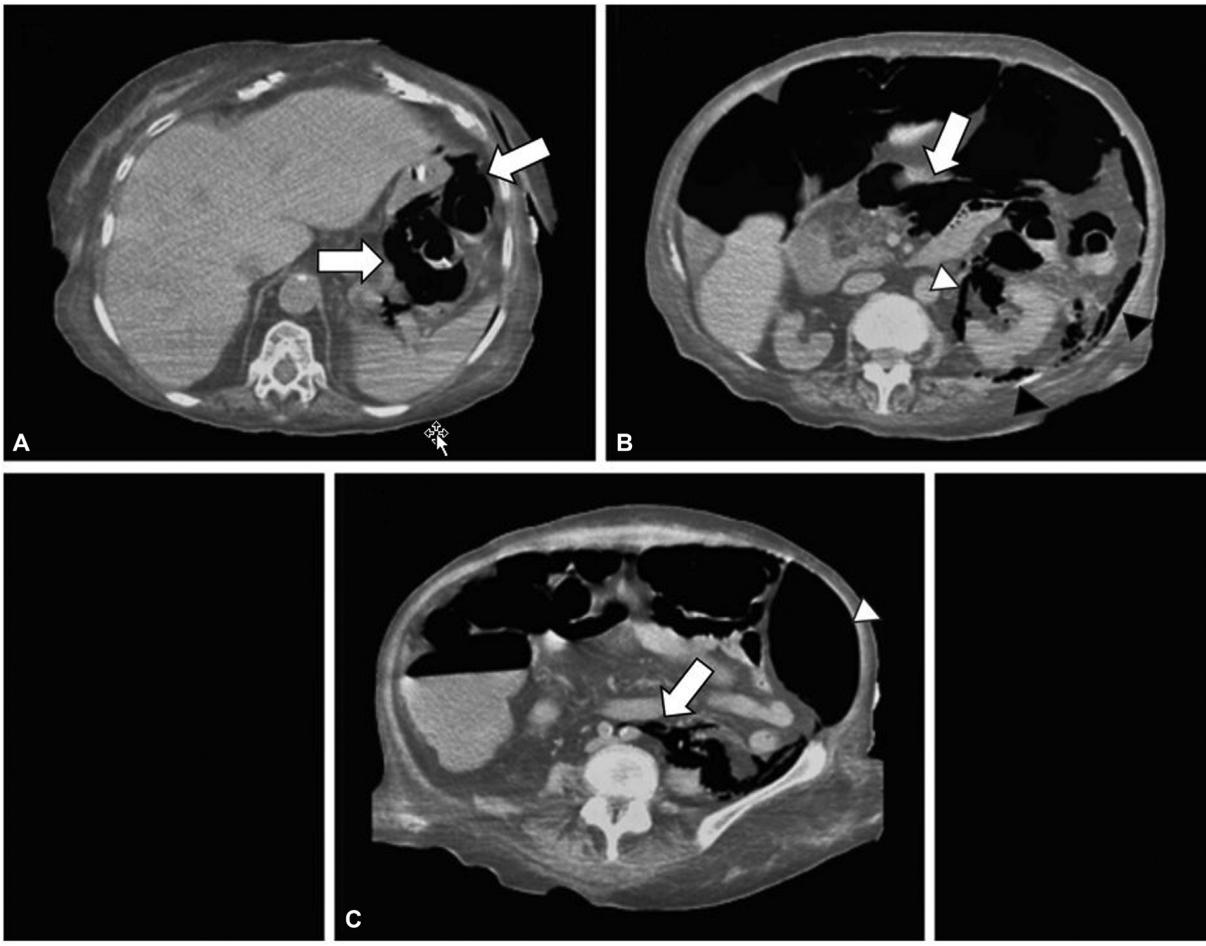

Fig. 4 Abdominal computed tomography for a patient with left colonic perforation shows large-volume free air (**A**) predominantly within the left retroperitoneum, surrounding the descending colon (white arrows). More inferiorly (**B**), air is seen in the left anterior pararenal space (white arrowheads) and left posterior pararenal space (black arrowheads). (**C**) A small amount of air dissects into the peritoneal cavity in the region of the fourth portion of duodenum ventral to the ligament of Treitz (white arrow), leading to free intraperitoneal air including the region of the splenic flexure (white arrowhead). Air extends toward the midline at the aortic bifurcation but does not extend across to the right retroperitoneum (white arrow).

small amount of air dissected into the peritoneal cavity in the region of the fourth portion of duodenum ventral to the ligament of Treitz, leading to pneumoperitoneum in the region of the hepatic flexure, transverse colon, and splenic flexure.

Discussion

Causes

In both cases, the colonic perforation was determined to be the result of iatrogenic injury from colonoscopy. The underlying mechanism of perforation is thought to be due to excess pneumatic pressure from insufflation, mechanical pressure from colonoscope, or improper therapeutic technique during polypectomy and electrocautery.[1]

Iatrogenic colonic perforation as a result of colonoscopy, although rare, can be seen in up to 0.03 to 0.8% of colonoscopy procedures with an associated mortality rate of up to 25%.[2] A higher rate of colonic perforation is noted for therapeutic (as opposed to diagnostic) colonoscopy.[3] The cecum is the second most common site of iatrogenic colon perforation, likely due to its thinner muscular layer and larger diameter, second only to the sigmoid.[2]

Among noniatrogenic causes, diverticular disease, ulcerative colitis, and colorectal cancer are common causes.[4,5] Other less common causes include ischemia, trauma, or toxic megacolon.[4] Peptic ulcer disease can additionally result in pneumoretroperitoneum from duodenal perforation.[6]

Clinical Features

After routine colonoscopy, patients may experience crampy abdominal pain due to retained air in the bowel. Those with extraperitoneal colonic perforation may also experience subcutaneous emphysema of the neck, face, or upper chest followed by abdominal pain and dyspnea. Patients may also be asymptomatic. Signs of intraperitoneal colonic perforation, however, may experience rebound tenderness, abdominal rigidity, fever, leukocytosis, and tachycardia as a result of peritoneal irritation.[2] Colonic perforations that are confined to retroperitoneal spaces usually present with subtle symptomatology.[7] Extraluminal gas contained within the right retroperitoneal compartment may be seen with retroperitoneal perforation of the ascending colon, as well as duodenal perforation.

Clinically, left colonic perforation may present with peritoneal signs, particularly in the presence of abscess or feculent peritonitis.[4] On imaging, the origin of perforation may be traced to left colon in the presence of left-sided, but not right-sided, pneumoretroperitoneum. In the absence of peritoneal signs, diagnosis of perforation into the retroperitoneal space can often be delayed.[4,8] An anatomic connection between the soft tissue of the neck, mediastinum, and retroperitoneum known as the visceral space exists.[8] More specifically, the deep cervical fascia, which is continuous with the pericardium, encloses and follows the esophagus into the retroperitoneal soft tissue.[9] As such, pneumoretroperitoneum from colonic perforation can result in pneumomediastinum and pneumothorax manifesting as subcutaneous emphysema and dyspnea.[4,8,10,11] In isolated retroperitoneal perforation, subcutaneous emphysema is often the earliest clinical manifestation.[2]

In rare cases, the spread of infection through fascial planes and psoas muscle can result in necrotizing fasciitis, lower extremity cellulitis, and thrombophlebitis (preference for left side), inguinal abscess, pneumoscrotum, and hip/buttock pain.[2,4,8,12,13] In some cases, pneumoretroperitoneum can extend into the intraperitoneal space, leading to distension as noted in case 2.

Management

Management of colonic perforation can be conservative or surgical depending on the clinical stability of the patient as well as extent of involvement. Isolated retroperitoneal perforation in clinically stable patients may often be treated conservatively.[2] Tiwari et al reported that 75% of isolated retroperitoneal perforations were treated conservatively, while 60% of combined intra- and retroperitoneal perforation required surgical intervention. While small, localized perforations (i.e., during polypectomy) can seal off with adhesions from pericolic fat and omentum, larger perforations on the antimesenteric wall require surgical management due to potential for contamination and low likelihood of natural healing.[9] Surgical management includes Hartmann procedure, colostomy, colectomy, segmental resection and anastomosis with or without ileostomy, and surgical debridement.[2,4] Conservative approaches include endoscopic closure, bowel rest with close observation, and intravenous antibiotics.[2,9] It has been reported that endoluminal repair using clips may be employed for perforation closure. Endoscopic clipping may be considered for small perforations, which may provide mucosal and submucosal healing, thus preventing peritoneal fecal contamination.[14] Laparoscopic surgery with oversewing of the perforation or a small tangential resection may also be performed.

Retroperitoneal Anatomic Relationships

The radiologic–anatomic relationships of the retroperitoneum have been well demonstrated since the first detailed description by Meyers and Kazam in *Dynamic Radiology of the Abdomen: Normal and Pathologic Anatomy* published in 1976.[15] This landmark textbook is currently in its 6th edition. The reader is also referred to several early articles in which retroperitoneal anatomic relationships were further described.[16–18]

More recent articles relating to retroperitoneal anatomy provide excellent reviews of current knowledge and understanding.[19] In summary, the key anatomic points include (1) the retroperitoneum is defined as the space between the parietal peritoneum anteriorly and the transversalis fascia posteriorly; (2) bilaterally, the retroperitoneum is divided primarily into three major compartments comprised of the perinephric space and the surrounding anterior and posterior pararenal spaces; (3) the perinephric spaces, which are shaped as inverted cones, extend to the iliac fascia in the pelvis; (4) important boundaries of the retroperitoneum include Gerota's fascia anteriorly, which fuses with the Zuckerkandl's fascia posteriorly to form the lateral lateroconal fascia; (5) medial fascial connections on the right side extend to periureteral connective tissue and duodenal attachments; (6) medial fascial connections on the left side extend to the periaortocaval connective tissue; and (7) the anterior retroperitoneal fascia on the right side attaches superiorly to the diaphragms and coronary ligament of the liver, thus forming the bare area of the liver.

The unique imaging features from our cases demonstrate potential routes of communication for air originating in the retroperitoneum:

1. *Decompression through interfascial planes*. Spread of air and/or fluid within the retroperitoneum has been described as occurring between interfascial decompression planes.[18,19] The interfascial planes of the renal fascia are defined as a single multilaminated structure, which contains potential spaces, including the combined interfascial planes, as well as the retromesenteric, retrorenal, and lateroconal fascia.[20] Dissection of gas and fluid into these tissue planes on the right side has been most commonly described following retroperitoneal duodenal perforation due to blunt abdominal trauma, peptic ulcer disease, and endoscopic sphincterotomy.[6] Retroperitoneal perforation of the ascending colon should be considered in the differential diagnosis of right retroperitoneal gas and fluid, considering the multidirectional nature of retroperitoneal communication. Case 1 demonstrates a distribution of retroperitoneal gas similar to that found with duodenal perforation. However, perforation of the ascending colon appears to result in a larger volume of air than duodenal perforation. With knowledge of prior endoscopic procedure, that is, early endoscopic retrograde cholangiopancreatography and papillotomy versus endoscopic colonic biopsy, the etiology of right retroperitoneal perforation may be surmised.
2. *Communication into extraperitoneal spaces.* Retroperitoneal air may communicate with extraperitoneal spaces.[6] The right retromesenteric plane may be seen to extend to the bare area of the liver (►**Fig. 2A**), as well as the right

inferior coronary ligament. There may be communication with the liver hilum through the subperitoneal space of the hepatoduodenal ligament (►**Fig. 2B**). In case 2, the left retromesenteric plane and the left perirenal space extend to the dome of the diaphragm, where they connect with the left subdiaphragmatic extraperitoneal space (►**Fig. 4A**).

3. *Communication between the right and left retroperitoneum*. A theoretical pathway for communication between the compartments of the right and left retroperitoneal regions, known as the "Kneeland channel," extends within the connective tissue, in front of the aorta and IVC, referred to as the anterior interfascial (retromesenteric) plane. Hemorrhage from abdominal aortic aneurysm rupture has been demonstrated to extend through this region.[18] However, there is a relative barrier to communication to the opposite side due to a medial fascial connection to the periaortocaval connective tissue. In the two cases of colonic perforation presented herein, retroperitoneal air extended as far as the aorta but did not extend to the opposite side, confirming the relative barrier to flow (►**Figs. 2C** and **4B**).
4. *Communication with intraperitoneal space*. Case 2 introduces the topic of potential sites of communication between the left retroperitoneum and the peritoneal cavity. It is generally felt that the anterior pararenal space does not directly communicate with the peritoneal cavity. Of the eight cases of duodenal perforation reported by Yagan et al, only one case demonstrated free intraperitoneal air, and in that case, intraperitoneal air could be explained by concomitant gastric antral biopsies and pancreatic fine-needle aspiration biopsy during endoscopy.[6] Tiwari et al reported a case of combined intraperitoneal and extraperitoneal perforation; however, the colonoscopic biopsy was from the transverse colon.[2] Dodds et al had postulated that the anterior pararenal space is a component of the intraperitoneal space and that the posterior extension of the anterior pararenal space might be related to an intraperitoneal extension.[16] This concept has not generally been endorsed by others and a study with retroperitoneal contrast injection of cadavers has not demonstrated such communication.[17] The case of left-sided retroperitoneal colon perforation presented here, however, shows intraperitoneal extension of air, thus reopening the possibility of retroperitoneal–intraperitoneal communication, at least on the left side.

Conclusion

We presented two cases of iatrogenic retroperitoneal perforation involving the ascending and descending colon. The imaging findings demonstrate potential routes of communication for air originating in the retroperitoneum: 1) decompression through interfascial planes; 2) communication into the extraperitoneal space via subperitoneal space of the hepatoduodenal ligament on the right and diaphragmatic dome on the left; 3) transit between the right and left retroperitoneal spaces via the Kneeland channel, although with relative barrier to flow; and 4) communication into the intraperitoneal space via shared peritoneal extensions. Along with clinical history, an understanding of these retroperitoneal anatomic relationships can aid radiologists in identifying the origin of perforation.

Conflict of Interest
None declared.

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