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Perforation of Hollow Viscus and MDCT

Pictorial Essay

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Abstract

Perforation of hollow viscus or GIT is common in clinical practice. Plain radiograph, ultrasound and fluoroscopy have limited value in its evaluation. MDCT is the gold standard for localisation of the site of perforation. Pattern of air collection depends on the site of perforation. In oesophageal perforation air outlines mediastinum, lesser curvature, or liver. Peptic ulcer perforation commonly occurs in gastric antrum. Collection of free air occurs at midline, along falciform ligament and ligament teres. In small bowel perforations, escaped air is too small to be appreciated even on MDCT making diagnosis difficult. Air may be noted in mesenteric folds, anterior surface of liver in mid abdomen. Ascending, transverse and, descending colonic perforations can present with air in right anterior pararenal space, lesser sac and left anterior pararenal space, respectively. Location of free air/ fluid, bowel wall thickening, discontinuity and adjacent stranding can help in predicting the site of perforation on MDCT.

Keywords: Gastrointestinal tract; Perforation; MDCT

Introduction

Perforation of hollow viscus or GIT is common in clinical practice presenting as acute abdomen. Accurate and early diagnosis is important as the mortality is high despite advanced treatment protocols. Sometimes diagnosis may be difficult if there is no or very minimal extraluminal air. In such situations critical analysis of images is important to reach a diagnosis. Wide variety of entities such as inflammatory bowel disease like Crohn's disease, Ulcerative colitis, neoplastic diseases, trauma, post- intervention like endoscopy/ colonoscopy, post-operative and FB ingestionare various causes of perforation. Thispictorial essay and literature review will highlight the key imaging features for diagnosis and to localise the site of perforation.

Investigations

Plain radiograph remains the basic investigation for demonstrating the free air and FB if radio-opaque (Figure 1). An erect chest radiograph is the most sensitive tool for detection of free intra-peritoneal gas. However, localisation of site of perforation is difficult. MDCT is the gold standard for diagnosis and localisation of the site of perforation with accuracy from 82-90% [1]. Certain technical modifications are to be done in evaluation of these cases. Unless there is any contraindication, both oral and IV contrast are to be performed. Water soluble contrasts do not cause inflammatory reaction if extravasated. They get rapidly absorbed. Entire abdomen and pelvic scans are mandatory and for oesophagus or pharynx entire chest to be scanned. Assessment in both bone window and lung window in addition to normal are needed (Figure 1) for better

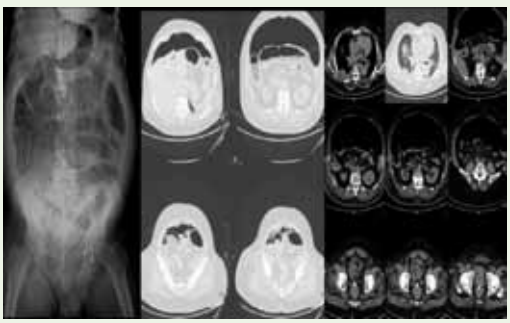

Figure 1: 75-year-old male: Large amount of free air in centre of abdomen in the radiograph and confirmed on CT both in soft tissue and bone window in a case of sigmoid perforation.

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demonstration of air, FB. Multiplanar reconstructions are essential to localise extraluminal air/area of discontinuity with high accuracy [as high as 82 to 90%] in detecting extraluminal gas and to localise the site of perforation [1]. It is also necessary to differentiate contained perforation from free perforation as the later has to be managed by immediate surgery.

Ultrasonography (USG) is not the primary modality of choice. However, it can detect air in peritoneal cavity. The presence of free fluid can also be detected. Fluoroscopy can detect water-soluble contrast leak from perforated site and can confirm the diagnosis when there are equivocal findings on CT.

Imaging features of hollow viscus perforation

There are many direct and indirect signs of perforation. Free extraluminal air has been regarded as major finding of perforation [2]. CT is sensitive to detect free extraluminal air (localise whether it is intra or extra peritoneal location) (Figure2A,2B,Figure 3). Air collection depends on site of perforation. Direct visualisation of discontinuity of bowel wall is another direct sign and it indicates exact site of perforation. Discontinuity is a hypodense cleft running perpendicular to bowel wall on CT [3] (Figure 4). However, the cleft is demonstrated on CT in less than 50% of cases [2]. Multiplanar reconstruction is essential as axial images may not be demonstrated. Other signs to localise site may include air collection at the site of injury (Figure 5), extravasation of contrast (Figure 5), wall thickening, fat standings in adjacent mesentery, fluid collection (Figures 6-8) and localised phlegmon and abscess are other features. CT has an accuracy of 82-90% in detection of exact site of perforation [1]. There are certain imaging features specific to site and etiology of perforations. Pneumoperitoneum is common after abdominal surgery. It resolves in 3-6 days after surgery and may persist as long as 24 days. Persistent or increasing free air and or as cites postoperatively indicate iatrogenic perforation.

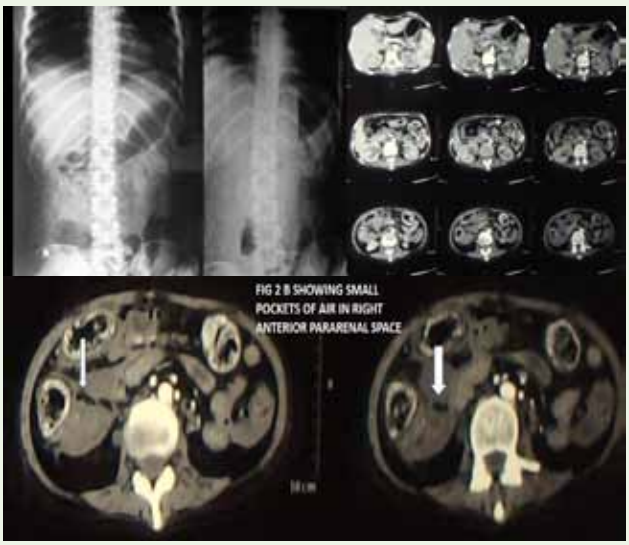

Figure 2 A,B: Duodenal perforation showing pockets of free air in right anterior pararenal space in 23-year-old female (2B is magnified view to show free air).

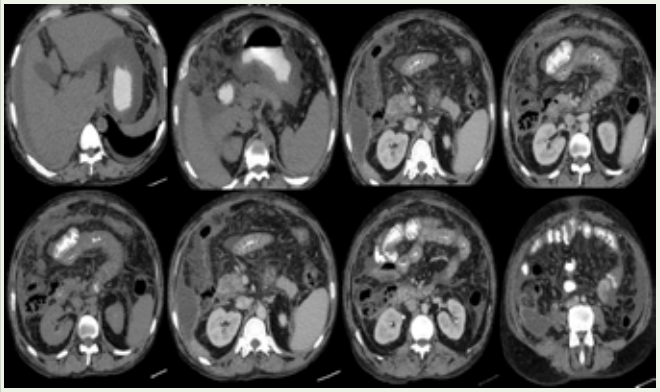

Figure 3: A case of duodenal perforation in 48-year -old male.

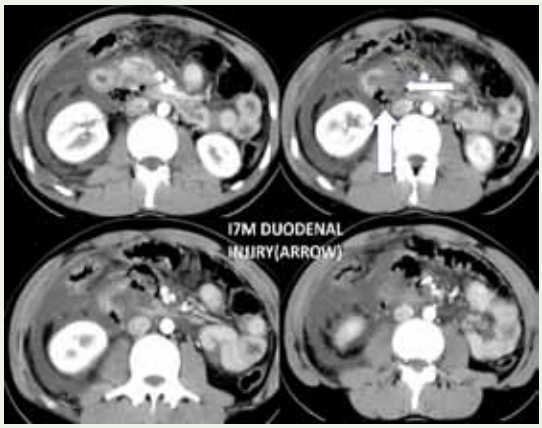

Figure 4: Duodenal discontinuity shown by transverse arrow and free air shown by vertical arrow in a 17-year-old male with road traffic accident.

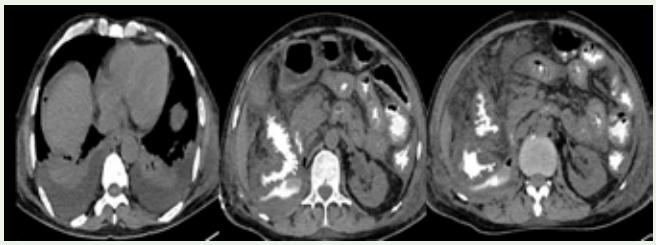

Figure 5: 24-year-old male: Post nephrectomy had ileal perforation as evidenced by direct contrast leak from ileal loop to right renal fossa.

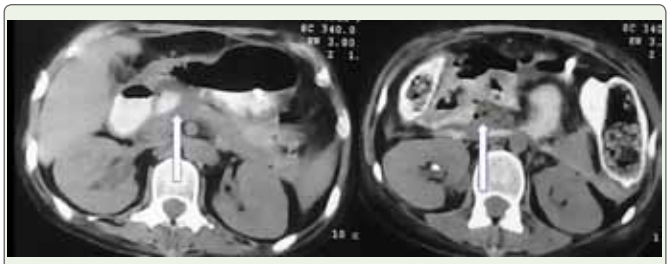

Figure 6: 26-year-old-female: A case of SLE had duodenal perforation. Accumulation of contrast and air leak seen in pancreaticoduodenal fossa.

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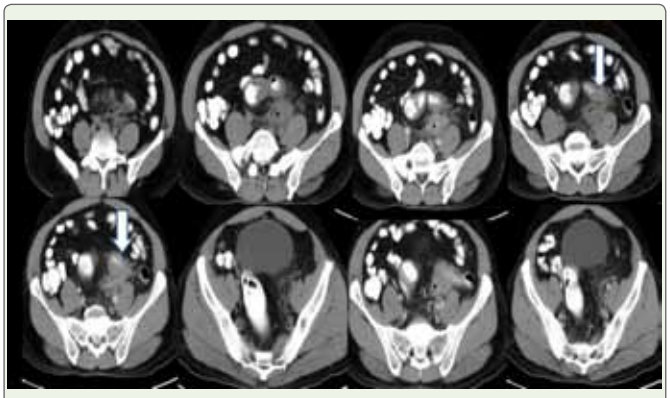

Figure 7: A case of perforation of sigmoid diverticulitis showing free air, fluid adjacent to thickened sigmoid wall(arrow).

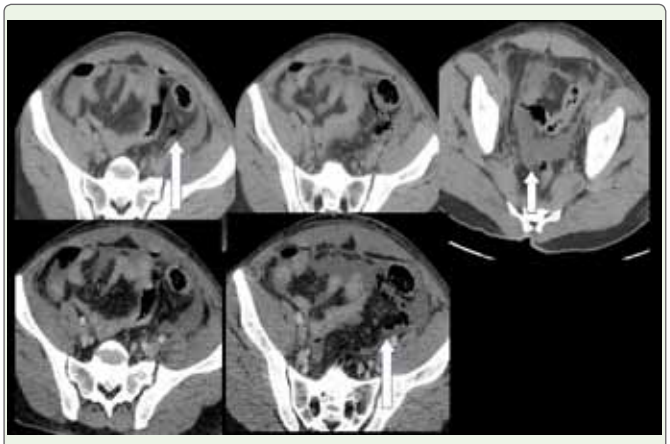

Figure 8: Wall thickening of sigmoid colon with adjacent free air and free fluid in 39-year-old male.

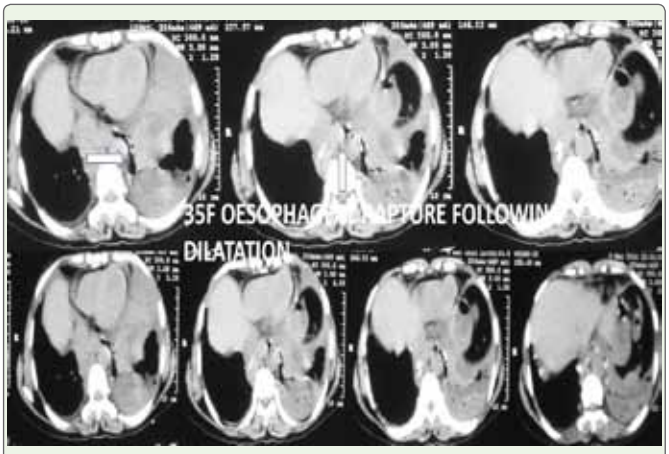

Figure 9: A 35-tear-old female had perforation during oesophageal dilatation. The discontinuity and the track are outlined by air. There is also left pleural effusion.

Site specific imaging features

Oesophageal rupture is catastrophic as it leads to mediastinitis and sepsis very quickly. Mortality is as high as 13.3% and after 24 hours it still increases [4]. Common cause of oesophageal perforation is iatrogenic like stenting, dilatation of strictures and sometimes during endoscopy, post-operative. Other includes trauma, FB ingestion, corrosive poisoning, and neoplastic conditions. Spontaneous rupture known as Boerhaave syndrome may be a clinical emergency. Lack of serosal layer makes the oesophagus and poor arterial supply causes more susceptible to injury as compared to rest of the GIT. In oesophageal perforation air seen outlining mediastinum, along lesser curvature or it may outline the liver and stomach. Extravasation of oral contrast, pleural, pericardial effusion, and fluid in mediastinum (Figure 9) are other features. Pleural effusion usually occurs on left side. Subcutaneous emphysema of chest wall and neck are common. Thickening of oesophageal wall is also observed like in other parts of GIT.

Among various causes peptic ulcer disease is major cause of gastric perforation followed by necrotic/ulcerated malignancies, iatrogenic injury (Figure 10) and trauma. Peptic ulcer perforation commonly occurs in gastric antrum. Collection of free air occurs at midline. Along Falciform ligament (called Falciform ligament sign,) and along ligament Teres (ligament Teres sign). It may also be observed in lesser sac. There may be large amount of air and sometimes it collects along mesenteric leaves. Air in supra-mesocolic compartments indicates gastro-duodenal perforation, gas in lesser sac indicates posterior gastric wall perforation, gas along falciform ligament, hepatic fissure, and ligament Teres indicates intra-peritoneal rupture of gastro-duodenal segment. Hence location or air is important in deciding site of perforation. Traumatic gastric injury is suspected when there is air in splenic location and left lobe of liver injury is suspected if the air is located in diaphragmatic areas in cases of RTA. MDCT can recognise the injury tract.

Duodenal perforation mostly due to peptic ulcer disease, complication of endoscopic procedure (Figure 11A) or due to trauma (Figure 11B), malignant, inflammatory, and ischaemic causes. Duodenal perforation may be pre-bulbar or post- bulbar. CT features of duodenal perforation are extraluminal air or pneumo-peritoneum. Air collection depends on site of perforation. If it is bulbar free air collects in midline, along Falciform ligament or ligament Teres. Post bulbar perforation causes air to collect in left anterior pararenal space. Traumatic injury /perforation occurs in vertical and horizontal part of duodenum as this is the site of firm attachment in retroperitoneum. Acute angles of first and second part of duodenum, acute angle of third and fourth part of duodenum, and compression against vertebra predispose for occurrence of perforation (Figure 4,6 and Figure 11B). Air collects in retroperitoneum (anterior pararenal space). Diagnosis is delayed as it is retroperitoneal structure and signs are difficult to be elicited. Peritonitis develop once the duodenal contents are extravasated into peritoneal cavity. The early diagnosis is crucial for prompt management.

Perforation from traumatic injuries occurs predominantly in the descending and horizontal segments of theduodenum, mostly by blunt trauma in children and by penetrating trauma in adults, and cause pneumo-retro-peritoneum in the anterior pararenal space [8]. CT is helpful in distinguishing a duodenal hematoma from Gastroduodenal Perforation from traumatic injuries occurs

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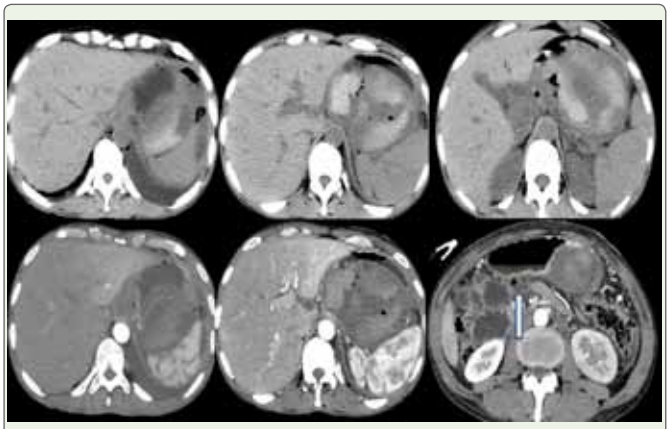

Figure 10: A 31-year-old male had pancreatitis and fluid collection. Pig tail drainage was tried and there was rent in stomach. Hematoma was visualised in gastric wall and free air in lesser sac.

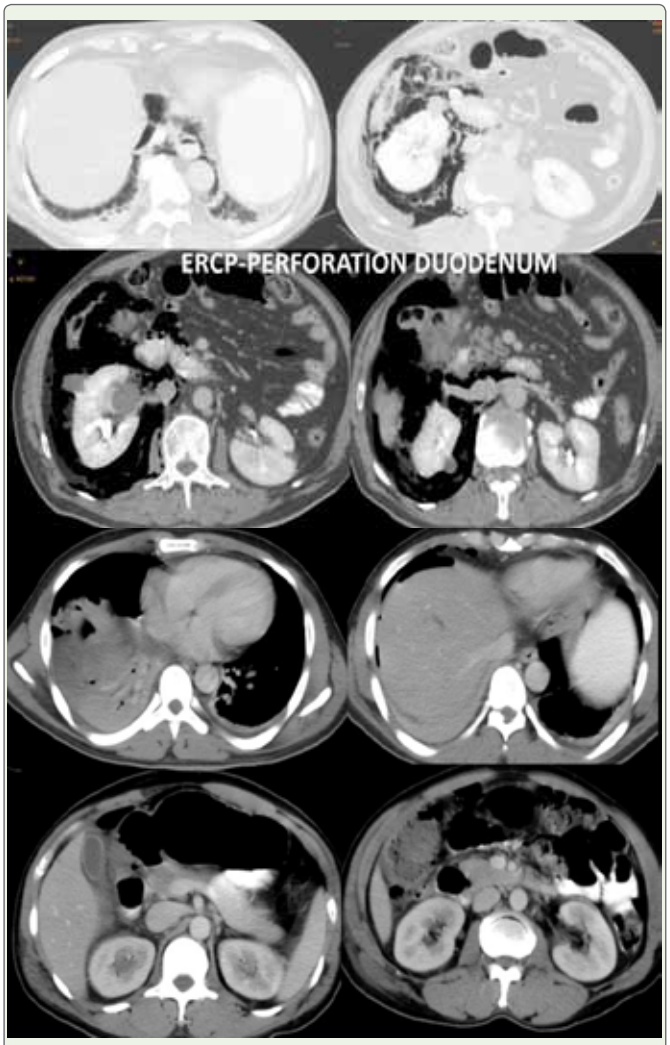

Figure 11: Perforation occurred during ERCP in an elderly person
A: shows extensive free air in anterior pararenal space, perinephric space due to duodenal perforation.
B. Air in anterior pararenal space and under right dome in a case of duodenal injury.

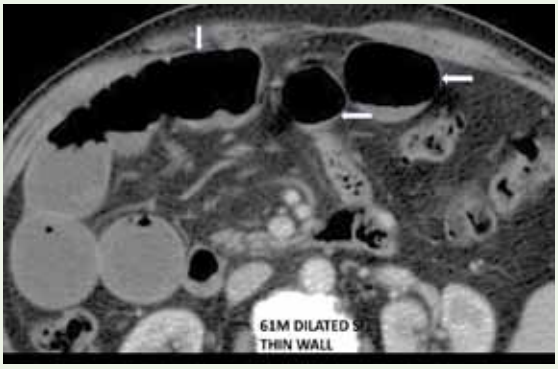

Figure 12: Dilated thin-walled small bowel with small pocket of free air in mesentery in a 61-year-old male: Showing bowel infarct. Note: small pocket of air in mesentery.

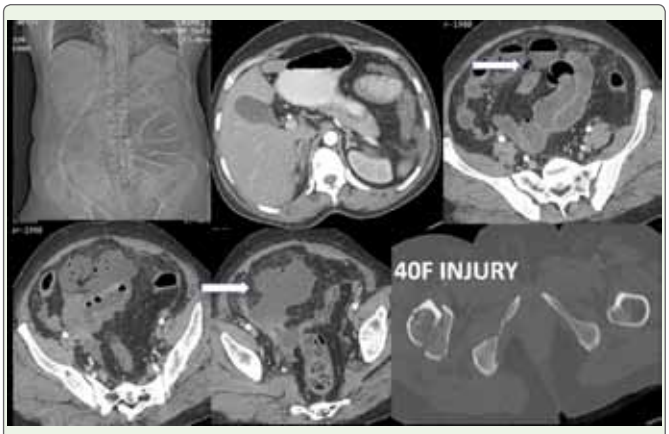

Figure 13: Small intestinal perforation having large interloop fluid and small pockets of air in a 40-year-old female.

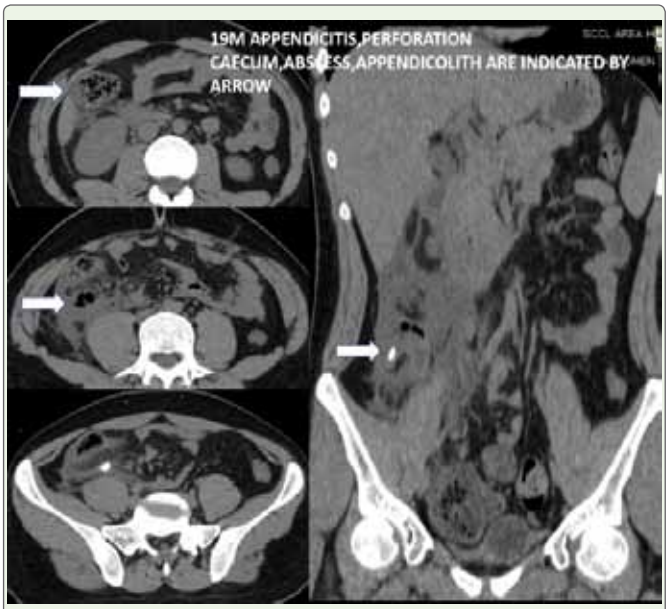

Figure 14: Small intestinal perforation having large interloop fluid and small pockets of air in a 40-year-old female.

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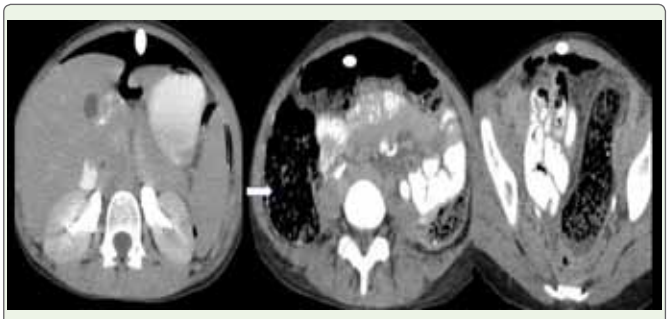

Figure 15: A 16-year-old female with SLE with colonic perforation. Air is under anterior abdominal wall along ligament teres.

predominantly in the descending and horizontal segments of the duodenum, mostly by blunt trauma in children and by penetrating trauma in adults, and cause pneumo-retro-peritoneum in the anterior pararenal space [8]. CT is helpful in distinguishing a duodenal hematoma from perforation. Small bowel perforation is usually caused by peptic ulcer disease, trauma, FB, iatrogenic, inflammatory conditions, infarcts, or neoplasia. Usually, the escaped air is too small to be appreciated even on MDCT. Air may be noted in mesenteric folds, anterior surface of liver in mid abdomen (Figure 12). Blunt injury of SI may be indicated by small air bubble in mesentery, extravasation of oral contrast (Figure 5), bowel wall thickening, mural discontinuity, moderate to large volume of peritoneal fluid and mesenteric infiltration. In penetrating trauma leakage of oral contrast is more specific than only demonstration of free air. Since many times, the free air is too subtle to be recognised attention must be paid to localised interloop collection of extraluminal fluid between fluid filled loops [5]. Hence CT diagnosis of small intestinal injury is challenging as there are no specific signs. Combination of bowel wall thickening, bowel wall discontinuity are accurate indicators, Mesenteric fat stranding and moderate to large volume of intraperitoneal fluid in absence of solid organ injury suggest small intestinal injury [1] (Figure 13). FB perforation common to occur at less fixed segments and with acute angulations like ileum, IC junctionor rectosigmoid regions. CT signs may be free air, bowel wall thickening, adjacent fat infiltration and identification of FB [6, 7]. Anastomotic leak is identified by contrast extravasation. Strangulated bowel indicates infarction. The diagnostic findings are intestinal wall thickening, mural hypoperfusion, pneumatosis intestinalis, gas in portal vein and pneumoperitoneum. Inflammatory bowel disease and neoplastic condition can be diagnosed on CT. Transmural Crohn's disease may lead to contained perforation due to presence of adhesions between the loops. Subsequent phlegmon and abscess formation with localised peritonitis may develop.

Perforation can be a complication of appendicitis. Usually, small amount of air not more than 1 to 2ml may be seen (8). Extraluminal air, extraluminal appendicolith, abscess, phlegmon and defect in the wall are diagnostic features of appendiceal perforation (Figure 14).

In colonic perforation air is detected in mesenteric folds, retroperitoneum (Figure 14). In ascending colonic perforation air is seen in right anterior pararenal space, Perforation of descending colon shows air in left anterior pararenal space, sigmoid colon in left anterior pararenal space, rectal in anterior and posterior pararenal spaces and transverse colon in lesser sac. Air leak may be large in colonic perforation (Figure 1 and 15). Malignant lesion, diverticulitis (Figure 7 and 8), trauma and ischemia are common causes of perforation on left side colon. Inflammatory bowel disease (Figure 15), diverticulitis, penetrating trauma are the aetiologies on right side colon. Caecum is perforated in bowel obstruction. Iatrogenic injury is common in rectum and sigmoid colon.

Conclusion

Familiarity with specific features like free air, free fluid, bowel wall thickening, discontinuity and adjacent mesenteric stranding can help us in predicting the site of perforation on MDCT.

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