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Case Report

Use of novel photon – counting detector CT for diagnosis of bowel infarction ☆

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ABSTRACT

A 75 year old male with a history of thoraco-abdominal surgery presented with acute onset epigastric pain. CT of the abdomen and pelvis with contrast performed on a novel photon-counting detector CT demonstrated dilated loops of small bowel herniating into the thoracic cavity through a defect in the left hemidiaphragm. On conventional CT reconstructions, the bowel wall demonstrated a thin rim of hyper-density which could have been interpreted as normal mucosal enhancement in viable bowel. However, spectral-imaging data including the iodine map revealed a complete lack of enhancement within the herniated loops of bowel compatible with infarction. With the added diagnostic information, the patient was taken rapidly to surgery for small bowel resection, with good outcome.

Introduction

Bowel infarction is the terminal stage of the clinical presentation of acute mesenteric ischemia, which refers to vascular compromise of portions of the bowel. Causes include numerous etiologies of both arterial and venous compromise but are often most severe in patients with prior surgery due to the altered anatomy. Imaging is often depended upon for rapid diagnosis as clinical findings including physical exam and laboratory abnormalities can be nonspecific at initial presentation. If not definitely addressed in the acute setting, it can progress rapidly and in cases of delayed diagnosis mortality rates can be as high as 30%-70% [1]. Conventional contrast-enhanced CT has almost universally become the imaging modality of choice due to ready availability and perceived

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Fig. 1 – Herniated loops of small bowel (arrow) into the thoracic cavity on contrast enhanced CT.

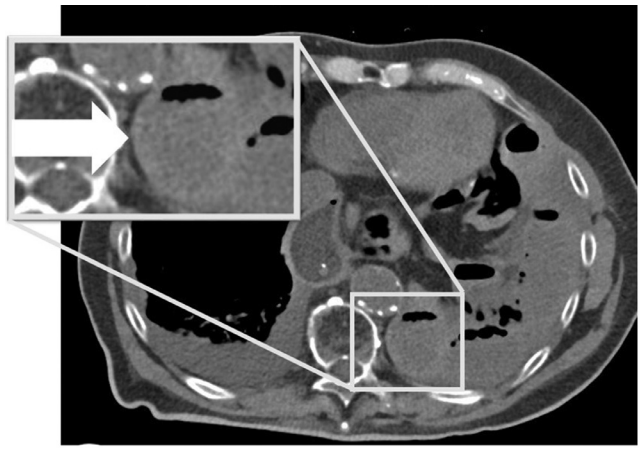

Fig. 2 – Virtual non-contrast image showing hyper-dense material in the bowel wall, likely hemorrhage in the submucosa (white arrow).

accuracy. However, the subtlety of positive image findings may go underappreciated and can lead to unnecessary delay or even misdiagnosis. Photon-counting detector CT (PC-CT) uses new energy resolving x-ray detectors which allow for higher contrast to noise ratio, improved spatial resolution and optimized spectral imaging [2]. In clinical scenarios it can reveal the presence or absence of faint intravenous iodinated contrast to improve reader confidence in detecting subtle bowel wall enhancement. In this first published report, we describe the imaging findings of bowel ischemia/infarction taking advantage of reconstructions of PC-CT data.

Case

A 75 year old male with history of esophagectomy 10 years prior presented with acute onset epigastric abdominal pain. The patient experienced acute onset radiating left upper quadrant and chest pain with obstipation and numerous episodes of vomiting.

On physical exam the patient was diaphoretic and tachycardic on 4L nasal canula. There was guarding in the upper abdomen. Laboratory results obtained in the ED revealed a Lactate of 3.0mmol/L, an estimated GFR of > 60 and WBC 11. An NG tube was placed and a contrast enhanced CT was performed on a Siemens Photon Counting CT. The patient was emergently taken to the operating room for robotically assisted reduction of paraoesophageal hernia w/ repair and small bowel resection. Pertinent hx esophageal cancer s/p

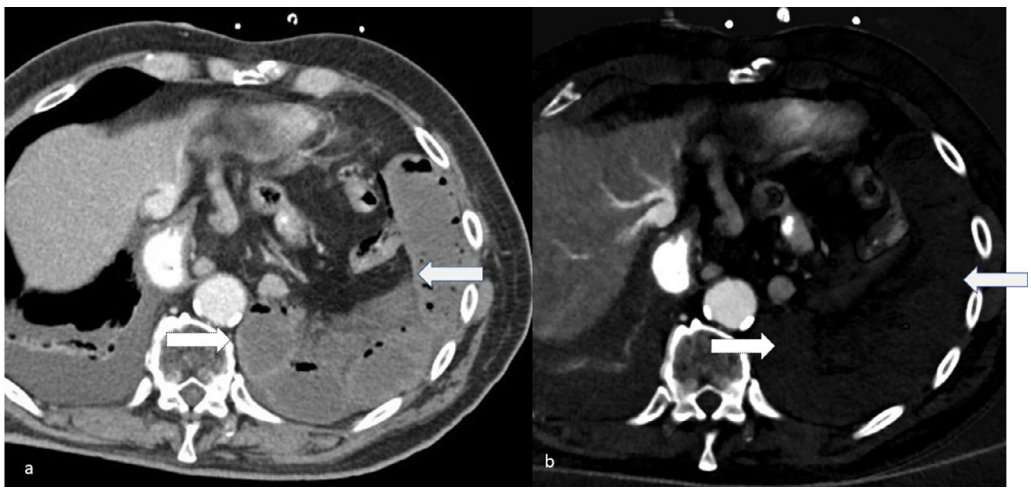

Fig. 3 – Conventional CT reconstructions (A), the bowel wall demonstrated a thin rim of hyper-density (white arrows) which could have been interpreted as normal mucosal enhancement in viable bowel. However, spectral-imaging data including the iodine map (B) revealed a complete lack of enhancement within the herniated loops of bowel compatible with infarction.

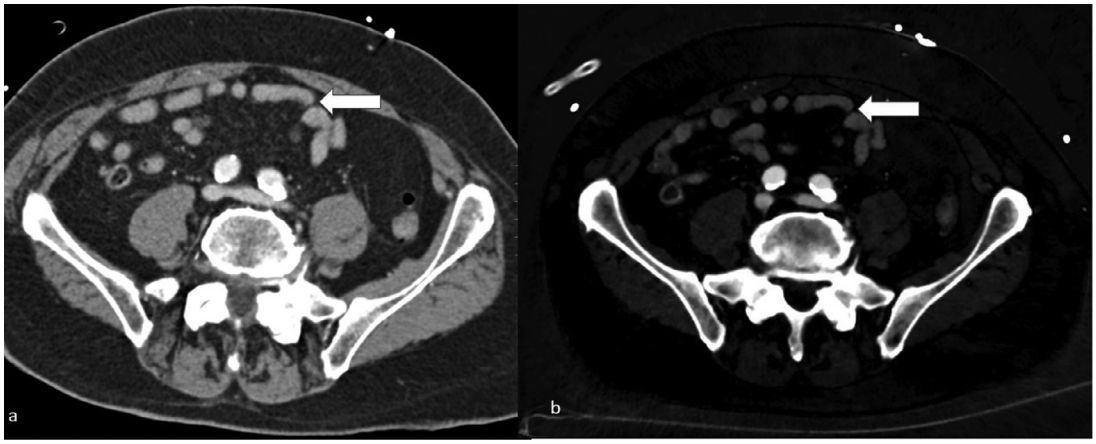

Fig. 4 – In a slice lower down in the same patient, normal small bowel enhancement (arrows) on contrast enhanced CT (A) and iodine map (B).

trans-hiatal esophagectomy, SLE. Patient presents to CVICU after initial stay in ART PACU. He received volume resuscitation and was able to be weaned off vasopressors prior to arrival. Patient underwent thoracotomy diaphragmatic hernia repair with approximately 3 feet of necrotic small bowel was removed. The patient was originally recovered in the ICU with minimal vasopressor requirement where he made a prompt recovery.

Imaging

CT of the abdomen and pelvis with contrast performed on PC-CT demonstrated multiple dilated loops of bowel herniating into the thoracic cavity through a defect in the left hemidiaphragm, see Fig. 1. There is a thin rim of increased density within the wall of the herniated bowel loops. Although this finding could have been interpreted as representing mucosal enhancement (suggesting no ischemia) the possibility of hemorrhage within the submucosa was also considered (suggestive of infarcted bowel) but could not be determined with conventional CT reconstructions. Spectral imaging data from the PC-CT was assesses. First, a virtual non-contrast image revealed the hyper-dense material in the bowel wall (likely hemorrhage in the submucosa). See Fig. 2. Next, a dedicated Iodine map revealed a complete lack of iodine within the loops of bowel compatible with non-perfused bowel (small bowel infarction). See Fig. 3. Please compare with iodine in normal bowel in the lower small bowel in Fig. 4.

Pathology

Gross pathology demonstrates the resected portion of bowel demonstrating a black discoloration and mottled appearance consistent with necrosis. Pathology reported the free edges of the specimen were viable. The bowel totaled 72 cm in length and averaged 6 cm in diameter. Microscopic evaluation confirmed complete bowel necrosis with hemorrhagic blood products throughout all bowel layers and sloughing of the mucosa Fig. 5.

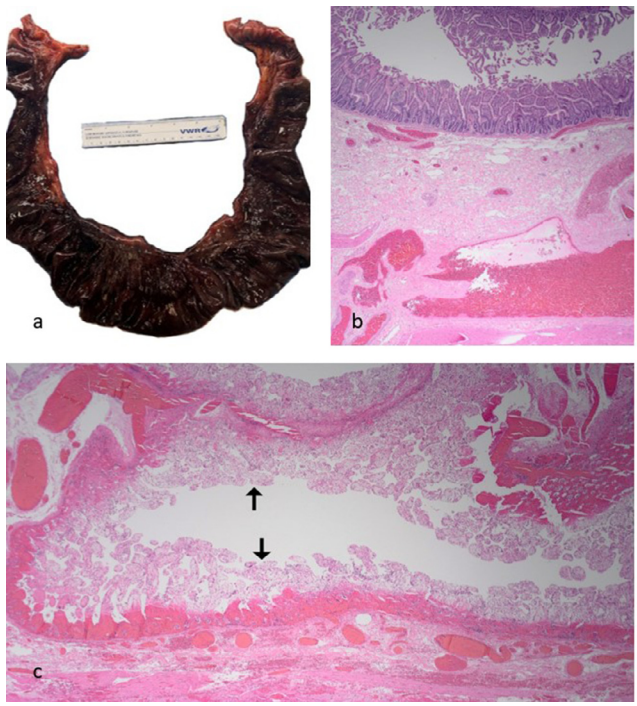

Fig. 5 – Gross pathology (A) demonstrates the resected portion of bowel which appear edematous and mottled with black coloration. Pathology reported the free edges of the specimen were viable. Microscopic evaluation (b&c) confirmed complete bowel necrosis with hemorrhagic blood products throughout all bowel layers and sloughing of the mucosa, (black arrows denote dead mucosa).

Discussion

The clinical presentation of bowel infarction can vary with the underlying cause but severe abdominal pain disproportionate

to exam which does not respond to analgesics is typical. The infarcted bowel sequence of events begins with necrosis of the bowel wall, then bacterial proliferation, followed by extraluminal air (pneumatosis intestinalis and portal venous gas), finally leading to sepsis and multiorgan failure [1]. Although the treatment will vary depending on the severity and cause of ischemia, in general, the treatment is often surgical.

Historically catheter angiography was the gold standard for imaging of suspected bowel ischemia. In recent years, CT has largely replaced conventional angiography due to rapid access and accuracy. On CT imaging, ischemic segments of bowel are often found to have a different density and enhancement compared to non-ischemic segments [3]. Specifically, spectral imaging allows a better delineation of the iodine content of the bowel wall than conventional CT [4]. Photon counting CT differs from Dual energy/source conventional CT in that it utilizes a different x-ray detection method allowing for improved contrast-to-noise ratio compared to Dual energy and Dual source CT [5]. We believe this case report can further exemplify the potential added value of Photon-counting detector CT by improving visualization of the bowel wall and mesenteric vasculature, revealing intramural hemorrhage, and quantifying the degree of ischemia/infarction.

Patient Consent

Patient Consent was obtained.

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