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Case Report

Use of dual energy CT to identify gastrointestinal anastomotic leak by assessment of percutaneous drain contents ☆,☆☆

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ABSTRACT

Anastomotic leakage is a feared complication of many different types of gastrointestinal surgery. It is important to identify patients with leaks early because sepsis may develop quickly. Suspected leaks are typically confirmed by either fluoroscopy or computed tomography with oral contrast. This article presents a novel method to confirm the presence of a gastrointestinal anastomotic leak when standard imaging and clinical presentation are ambiguous.

Introduction

Gastrointestinal (GI) anastomotic leakage refers to the escape of luminal contents due to a defect in the bowel wall at the site of anastomosis. The incidence of leaks varies by the type of procedure being performed, but for bariatric surgeries that involve the small intestine, post-operative leaks occur between 0.5% and 2.5% [1]. The prognosis of a patient with a GI anastomotic leak worsens considerably. The 30-day mortality rate is over 3-fold greater for post-operative patients with leaks compared to those without [2]. For patients that remain hemodynamically stable, GI anastomotic leaks are often confirmed radiographically prior to determining treatment, either by fluoroscopy or CT with oral contrast [3,4]. Occasionally, conventional imaging and patient presentation may remain inconclusive. Here we present a case of a duodenal anastomotic leak with ambiguous imaging that was confirmed with ex-vivo dual energy CT imaging of the contents of the patient's surgical drain.

Case report

A 61-year-old female patient with a recent history of a cholecystectomy presented to an outside hospital with 2 weeks of abdominal pain, distention, and bilious emesis concerning for

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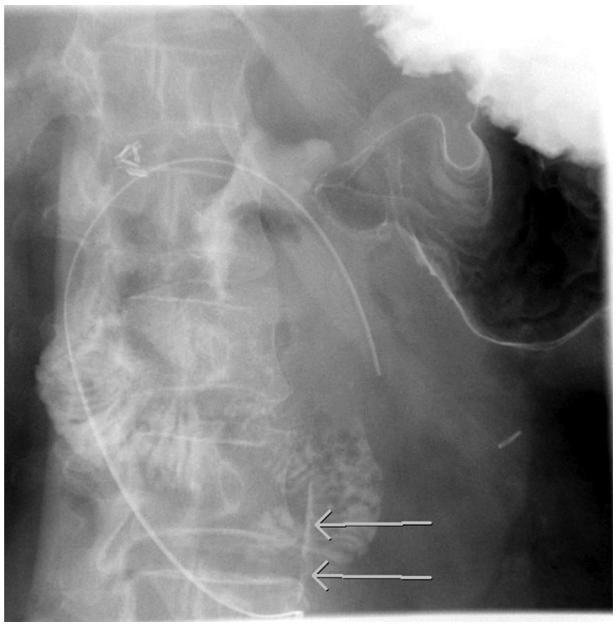

Fig. 1 – Fluoroscopic image from an upper gastrointestinal series demonstrating a small focus of possible extraluminal contrast adjacent to the duodenojejunostomy site (white arrows), potentially representing a leak.

small bowel obstruction. Upon admission, a CT scan of her abdomen demonstrated a dilated stomach and proximal duodenum, increasing suspicion of duodenal obstruction. Magnetic resonance cholangiopancreatography confirmed focal narrowing of the second duodenal segment, and esophagogastroduodenoscopy revealed an acquired, benign-appearing, intrinsic severe stenosis.

The patient was subsequently transferred to our hospital for further work-up and management. An upper endoscopic ultrasound was performed revealing a circumferential plaque in the duodenal wall in the area of stenosis, and a biopsy demonstrated duodenal adenocarcinoma. The patient opted for surgical resection of the lesion, and duodenectomy with anastomosis was performed without any immediate complications. A percutaneous drainage catheter was placed with a negative pressure bulb was placed to facilitate healing.

On post-operative day 3, the patient reported worsening abdominal pain despite multimodal pain management and stable vitals, and there was continued serosanguinous output from the surgical drain. An upper gastrointestinal fluoroscopy series with iodinated oral contrast was ordered (Fig. 1). Contrast was noted adjacent to the anastomosis. It was unclear whether the contrast represented a leak or post-surgical changes, so a dual energy CT abdomen/pelvis without IV contrast was performed 90 minutes after the fluoroscopy to further evaluate.

An initial interpretation of the conventional CT found no obvious contrast leak, but the contents of the tubing appeared hyper-attenuating (Figs. 2A and 3A). The differential diagnosis of the finding was either: a) a combination of the CT attenuation from the tube material and beam hardening artifact from the barium impregnated strip present on the tube or b) iodinated contrast within the tube which would indicate a leak. However, using the iodine overlay reconstruction from the dual energy CT, it was apparent that the tube contained iodine and was not simply associated with the barium strip, suggesting an anastomotic leak (Figs. 2B and 3B). In order further confirm the presence of an anastomotic leak, the contents of the surgical drain were placed in a syringe and rescanned in the CT (next to a syringe of normal saline as a control) (Fig. 4). This image reveals the drain contents measuring 68 Hounsfield units (HU) compared to the saline (29 HU), confirming the fluid is in fact hyper-attenuating and not simply a result of beam-hardening artifact from the barium impregnated tubing. Due to the small volume of the leak and the patient's hemodynamically stable vital signs, the surgery team opted to watch the patient closely and continue total parenteral nutrition to allow the leak to heal itself rather than operate. A follow-up CT abdomen/pelvis on post-operative day 5 confirmed the resolution of the leak and the patient's pain subsided. The patient was discharged several days later.

Discussion

This case demonstrates the utility of dual energy CT for the detection of an anastomotic leak after small bowel resection in patients with ambiguous clinical and fluoroscopic presentation. It is useful to view the contents of surgical drainage tubes using an iodine overlay, which eliminates artifact from the barium strip present within most surgical drainage tubes. The visualization of the syringe with the drainage contents compared to the syringe with the saline was further proof that the contents of the drainage contained contrast and that the density of the tube on routine CT was not due to the tube itself or artifact from the barium strip. This confirmatory step would not need to be performed in future imaging studies.

Normal saline was used as the control to the drainage contents because normal saline has similar attenuation to unenhanced, un-clotted blood. Normal saline on our CT imaging had a density of 29 HU, while uncoagulated, unenhanced blood in a patient with a normal hematocrit has a density around 40 HU [5]. However, it is important to note that the exact density of flowing blood on CT varies linearly with hemoglobin levels [6]. The density of the serosanguinous contents of the surgical drain was 68 HU, increased by the iodinated contrast from the anastomotic leak. Coagulated blood could have densities this high, depending on the age of the coagulation, but the drain contents as seen by the attending radiologist and surgery team was mostly serous, making a density as high as 68 HU unlikely in the absence of contrast.

The typical presentation of a GI anastomotic leak includes worsening abdominal pain, abdominal rigidity, tachycardia and fever, similar to intestinal perforation [7]. Our patient's vitals remained stable throughout their post-operative recovery. The concern for a leak was due to the worsening abdominal pain on post-operative day 3. The relatively mild symptoms of our patient further support that the leak was presumably small and hence difficult to detect on imaging. Another possible explanation of the ambiguous imaging was the timing of oral contrast dosing in our patient. Due to an unknown delay,

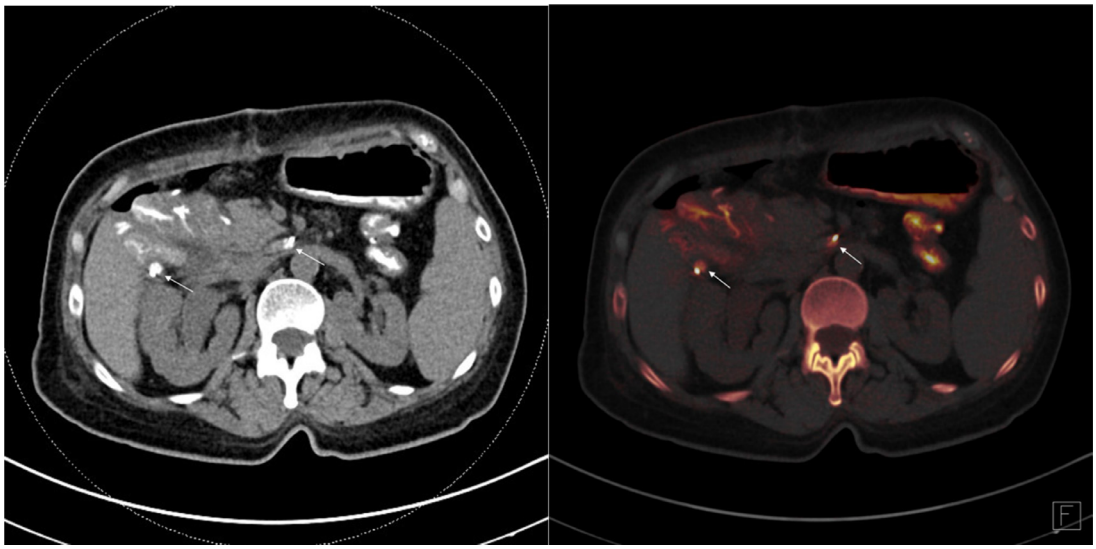

Fig. 2 – (A) (left) Axial slice of a dual energy CT abdomen/pelvis without IV contrast but with oral iodinated contrast demonstrating no clear presence of anastomotic leak. It was initially unclear whether the high-attenuation inside the transverse slice of tubing (white arrows) represents beam-hardening artifact from the barium strip or if it was due to iodinated contrast leakage. (B) (right) Iodine overlay reconstruction of Fig. 2A (where red is color coded to the multi-energy spectrum of iodine) demonstrating material in the surgical drain tubing contents contain iodinated contrast (white arrows) in the absence of a clear anastomotic leak source. Potentially this iodine source may have been remnant from the earlier fluoroscopic study that had had time to collect in the drain.

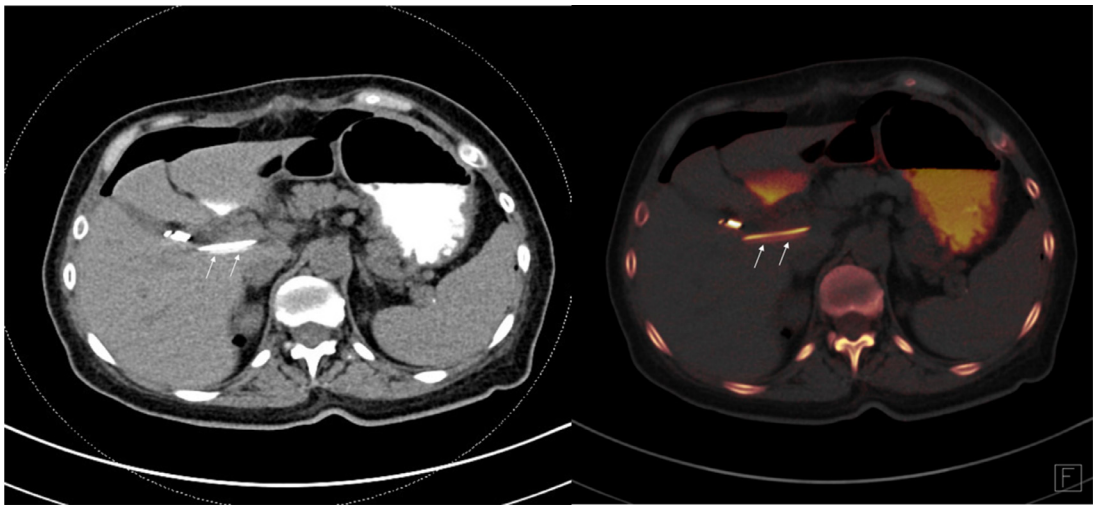

Fig. 3 – (A): (left) Axial slice of a dual energy CT abdomen/pelvis without IV contrast but with oral iodinated contrast demonstrating no clear presence of anastomotic leak. The white arrows point to a longitudinal slice of the tubing, again demonstrating that the hyper-attenuation within the tube looks similar to artifact from the Barium strip. (B): (right) Iodine overlay reconstruction of Fig. 3A demonstrating attenuation of the surgical drain tubing contents clearly eccentric from the barium strip (white arrows).

the patient received the oral contrast over 2 hours prior to the upper GI series, and the non-contrast CT abdomen/pelvis was taken an hour later. The oral contrast seen in the CT was the remnants of the oral dosing given 3 hours prior for the upper GI series. This delay in timing may explain why the majority of the leaked contrast appears to have been captured by the surgical drain.

The first-line imaging for the detection of anastomotic leaks is an upper GI series with barium or iodinated oral contrast [3]. In the past, many institutions performed upper GI series on all bariatric surgical patients with bariatric surgeries involving small bowel anastomoses [3]. However, today many institutions, including ours, only image with clinical suspicion. CT with oral contrast is increasingly being used to iden-

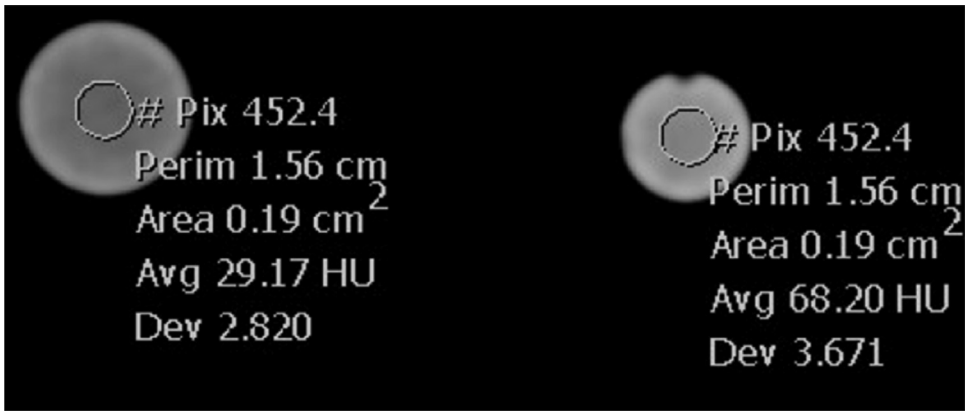

Fig. 4 – CT axial images of a syringe filled with saline (left) and a syringe filled with the serosanguinous output of surgical drainage (68 HU), which is over twice as dense as the saline (29 HU).

tify leaks, and it has been shown to have a negative predicative value of between 97 and 100% in patients with low clinical suspicion [3]. Patients with high clinical suspicion for a leak, are typically taken back to the OR for direct visualization of the anastomosis, via either laparoscopy or open surgery. Intraoperatively, methylene blue can be injected proximal to the anastomotic site to for leak detection [8].

Treatment of a GI anastomotic leak varies based on presentation and imaging findings. For mild presentations with small leaks, such as in our case, treatment may consist of careful observation, a negative pressure drainage catheter, parenteral nutrition, and antibiotics to allow a small leak to heal non-surgically [9]. Other alternative approaches to surgery include endoscopic placement of stents, clips, and fibrin glue depending on the anastomosis location [10]. If the patient becomes hemodynamically unstable, emergent take back to the operating room to irrigate and control contamination and for surgical repair.

Conclusion

This case demonstrates the use of dual energy CT with iodinated oral contrast to diagnose a gastrointestinal anastomotic leak in patients with an ambiguous clinical presentation and imaging. By examining the contents of the percutaneous negative pressure drainage catheter with dual energy CT, an iodine overlay reconstruction can confirm the presence of a suspected leak.

Patient consent

The authors received written permission from the patient allowing them to publish anything about her case that could be useful to others.

REFERENCES

[1] Verhoeff K, Mocanu V, Jogiat U, Forbes H, Switzer NJ, Birch DW, et al. Patient selection and 30-day outcomes of SADI-S compared to RYGB: a retrospective cohort study of 47,375 patients. Obes Surg 2022;32(7):1–8. doi:10.1007/s11695-022-06068-y.

[2] Turrentine FE, Denlinger CE, Simpson VB, Garwood RA, Guerlain S, Agrawal A, et al. Morbidity, mortality, cost, and survival estimates of gastrointestinal anastomotic leaks. J Am Coll Surg 2015;220(2):195–206. doi:10.1016/j.jamcollsurg.2014.11.002.

[3] Doraiswamy A, Rasmussen JJ, Pierce J, Fuller W, Ali MR. The utility of routine postoperative upper GI series following laparoscopic gastric bypass. Surg Endosc 2007;21(12):2159–62. doi:10.1007/s00464-007-9314-9.

[4] Kalff MC, de Raaff CAL, de Vries CEE, Coblijn UK, Willink MT, Fauquenot-Nollen JMB, et al. Diagnostic value of computed tomography for detecting anastomotic or staple line leakage after bariatric surgery. Surg Obes Relat Dis 2018;14(9):1310–16. doi:10.1016/j.soard.2018.05.007.

[5] Del Marmol O, Coulier B. Black" and "White" blood on unenhanced CT. J Belg Soc Radiol 2019;103(1):16. doi:10.5334/jbsr.1733.

[6] Black DF, Rad AE, Gray LA, Campeau NG, Kallmes DF. Cerebral venous sinus density on noncontrast CT correlates with hematocrit. AJNR Am J Neuroradiol 2011;32(7):1354–7. doi:10.3174/ajnr.A2504.

[7] Hyman N, Manchester TL, Osler T, Burns B, Cataldo PA. Anastomotic leaks after intestinal anastomosis: it's later than you think. Ann Surg 2007;245(2):254–8. doi:10.1097/01.sla.0000225083.27182.85.

[8] White S, Han SH, Lewis C, Patel K, McEvoy B, Kadell B, et al. Selective approach to use of upper gastroesophageal imaging study after laparoscopic Roux-en-Y gastric bypass. Surg Obes Relat Dis 2008;4(2):122–5. doi:10.1016/j.soard.2007.10.007.

[9] Marshall JS, Srivastava A, Gupta SK, Rossi TR, DeBord JR. Roux-en-Y gastric bypass leak complications. Arch Surg 2003;138(5):520–3 discussion 523-4. doi:10.1001/archsurg.138.5.520.

[10] Merrifield BF, Lautz D, Thompson CC. Endoscopic repair of gastric leaks after Roux-en-Y gastric bypass: a less invasive approach. Gastrointest Endosc 2006;63(4):710–14. doi:10.1016/j.gie.2005.11.018.