

Non-traumatic adult acute abdomen with high-attenuation lesions or materials in the gastrointestinal tract on unenhanced computed tomography

INTRODUCTION

Computed tomography (CT) is a useful tool for acute abdomen because it facilitates an accurate and reproducible diagnosis. Acute abdomen has various causes, and unenhanced CT can provide a diagnosis in some cases based on characteristic high-attenuation lesions in the gastrointestinal tract that may represent urgent or clinically unimportant conditions. CT contrast is determined by differences in X-ray absorption between structurally distinct components, and the CT number differs depending on the sizes or atomic numbers and molecular densities of the main components.^[1] Therefore, lesions or materials in the gastrointestinal tract can present with high attenuation on unenhanced CT – for example, stones, food, faeces, foreign bodies, haemorrhage, and drugs. Abdominal radiographs are widely used for acute abdomen; however, some lesions and materials are difficult to visualise on radiographs because of the low sensitivity. Although contrast-enhanced CT is an invaluable tool, unenhanced CT can provide additional information in some emergency situations; hence, the purpose of this article is to describe typical CT findings with high-attenuation lesions in the gastrointestinal tract.

STONES

Gallstone ileus

Gallstone ileus is a rare complication of gallstone disease that accounts for 1% to 4% of all mechanical small-bowel obstructions.^[2,3] Gallstone ileus is a bowel obstruction caused by gallstone impaction; therefore, the word ‘ileus’ is not appropriate because it is not a paralytic ileus. Gastric

obstruction caused by duodenal gallstone impaction is called Bouveret’s syndrome and is exceedingly rare. Gallstones cause chronic inflammation that spreads to the surrounding organs and may lead to a fistula to the bowel. In 85% of cases, bilioenteric fistula occurs between the gall bladder and the duodenum.^[2] Although rare, bilioenteric fistulas can also be caused by gall bladder malignancies. The clinical presentations of gallstone ileus are similar to those of other small-bowel obstructions and may include abdominal pain, abdominal distention, nausea, and vomiting.

CT is the most useful imaging modality for the diagnosis of gallstone ileus because it has high sensitivity (90%–93%) and specificity (100%).^[2] The typical findings of gallstone ileus are dilated small-bowel loops with ectopic gallstones and pneumobilia. Unenhanced CT is more useful for the evaluation of ectopic gallstones than contrast-enhanced CT because it yields a higher contrast between the stones and the surrounding structures [Figure 1]. Most ectopic gallstones show high attenuation with distinct patterns on CT, such as whole, part, or rim attenuation [Figure 1].^[2] Bilioenteric fistulas can be visualised on contrast-enhanced CT, and thin-slice CT and multi-planar reconstruction are helpful [Figure 1c]. Surgical management is required for most patients.

Bezoars and enteroliths

Stones of the gastrointestinal tract are called bezoars or enteroliths, depending on where they are formed, and they can cause ulcers or small-bowel obstructions. A bezoar is an indigestible mass formed by the reaction of ingested food

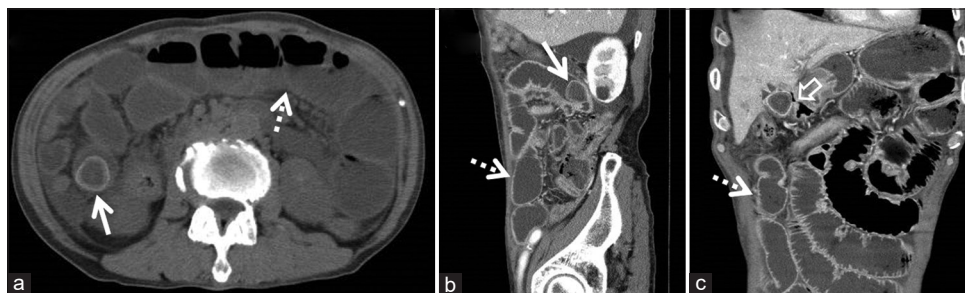


Figure 1: Gallstone ileus in a 67-year-old man with abdominal distension and pain. He had a history of gall bladder carcinoma and liver metastasis with invasion into the perihilar bile duct. (a) Unenhanced, (b) contrast-enhanced sagittal plane, and (c) coronal plane computed tomography (CT) demonstrate dilated small-bowel loops with air-fluid level (dotted arrows). A peripheral high-attenuation mass suggestive of an ectopic gallstone in the right lower abdomen causing obstruction is observed (arrows). It is easier to detect the stone on unenhanced CT (a) than post-contrast CT (b). A fistula between the gall bladder and the small bowel is clearly observed on the coronal image (open arrow). The gallstone is thought to have migrated into the small bowel through the fistula.

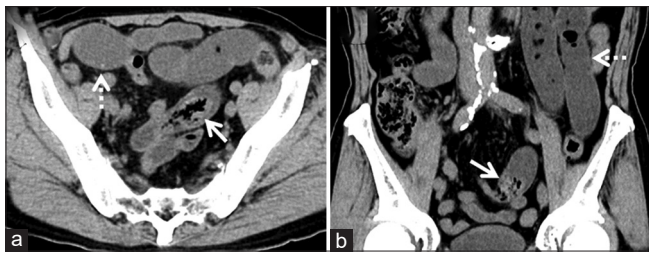


Figure 2: Small-bowel obstruction caused by a phytobezoar in an 85-year-old man with abdominal pain and nausea. He regularly consumed high amounts of persimmons in autumn. (a) Axial and (b) coronal unenhanced computed tomography demonstrating dilated small-bowel loops (dotted arrows). A peripheral high-attenuation ovoid mass containing air bubbles causes obstruction in the ileum (arrows).

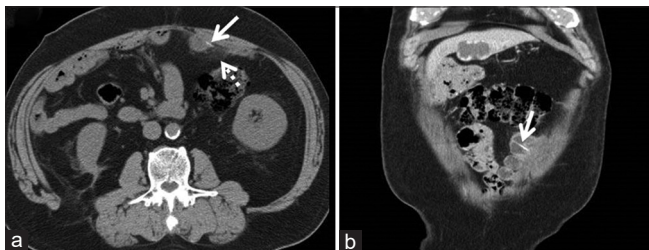


Figure 4: A case of ingested fish bone complicated by small-bowel perforation in a 66-year-old man with lower-abdominal pain. (a) Unenhanced and (b) contrast-enhanced coronal computed tomography demonstrate a linear hyperattenuating substance in the small bowel, suggestive of an ingested fish bone (arrow), with associated surrounding fat infiltration, suggestive of inflammation (dotted arrow). The images clearly show that the fish bone has penetrated the intestinal wall.

or foreign bodies with gastric juice and mucus. Bezoars are classified according to their composition: that is, phytobezoars (plant materials such as fibres, fruit remnants, and vegetable skins) [Figure 2], trichobezoars (ingested hair), pharmacobezoars (medications), and lactobezoars (milk protein in milk-fed babies); phytobezoars are the most common type.^[4] Bezoars account for 0.4% to 4.8% of mechanical small-bowel obstructions.^[4]

For the formation of enteroliths, mechanical factors such as stenosis, diverticula, or surgical enteroanastomoses are required [Figure 3].^[3] The reported prevalence of enterolithiasis in selected populations varies widely from 0.3% to 10%.^[3]

Bezoars and enteroliths show various attenuations on CT depending on their components. CT has high sensitivity (up to 90%) for the diagnosis of bezoars and enteroliths.^[4] They are demonstrated as round or ovoid masses with air bubbles and a mottled appearance^[4] [Figures 2 and 3]. They may resemble the small-bowel faeces observed in about 8% of cases with small-bowel obstruction. Faeces tends to occupy a longer segment compared to a bezoar.^[4]

There are several treatment options available for bezoars and enteroliths, such as dissolution with various compounds, endoscopic removal, laparotomy, and laparoscopic surgery.^[3,4]



Figure 3: Enteroliths in a 72-year-old woman with abdominal distension. She had a history of choledochojejunostomy. Unenhanced computed tomography demonstrates a high-attenuation ovoid mass containing air bubbles in the jejunum near the anastomosis (arrow).

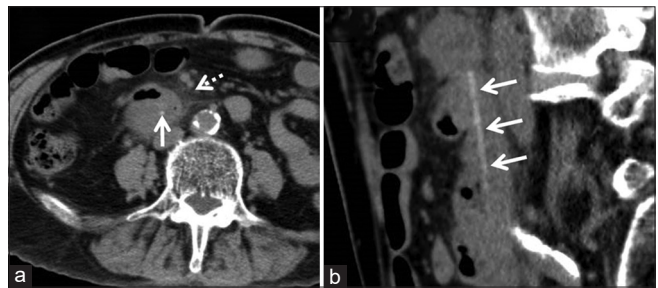


Figure 5: Wooden toothpick ingestion in a 73-year-old man with no symptoms. Preoperative screening computed tomography ((a) axial, (b) oblique sagittal planes) for tongue cancer demonstrated by chance a linear hyperattenuating substance in the small bowel similar to an ingested fish bone (arrow), with associated bowel wall thickening and surrounding fat infiltration, suggestive of inflammation (dotted arrow). Surgery was performed, and a wooden toothpick was excised. A history of toothpick ingestion about 2 months earlier was revealed in the post-operative interview.

FOOD-RELATED LESIONS

Fish bones

Accidentally ingested fish bones are common foreign bodies, especially in Asia, where fish is served whole, with the bones, as food. The complications vary, ranging from mild inflammatory changes to abscess formation, viscus perforation, intestinal obstruction, and bleeding. Common CT findings of fish bone ingestion include a linear hyperattenuating substance and surrounding fat stranding [Figure 4].^[5] Objects with sharp and pointed ends, such as toothpicks, sewing needles, hairpins, and wires, are included in the differential diagnosis. Wooden toothpicks may sometimes mimic fish bones [Figure 5]. Toothpicks are completely linear, whereas fish bones are

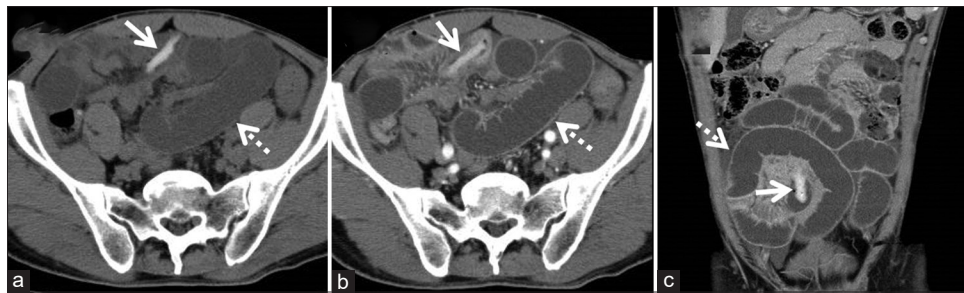


Figure 6: Intestinal food bolus impaction caused by a rice cake in a 54-year-old man with abdominal pain. He had consumed rice cakes 2 days earlier and had a habit of swallowing rice cakes. (a) Unenhanced, (b) contrast-enhanced axial, and (c) coronal computed tomography demonstrating dilated small-bowel loops (dotted arrows). A flat, high-attenuation object (163 HU) in the small bowel causing obstruction is observed (arrows).



Figure 7: Faecal impaction in a 38-year-old woman with abdominal pain. She had a history of chronic constipation. Unenhanced computed tomography demonstrates a dilated colon with air-fluid levels (a, dotted arrow). High-attenuation faeces is observed, causing obstruction in the sigmoid colon (b and c, arrows).

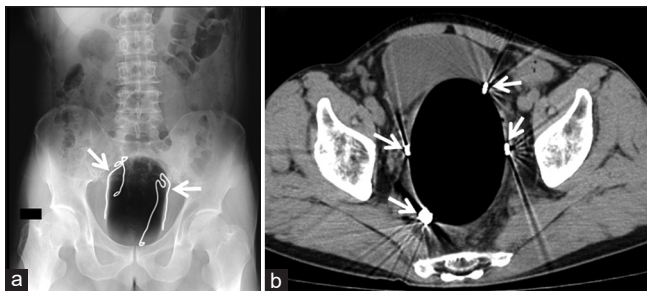


Figure 8: Retained rectal foreign body in a 60-year-old man with lower-abdominal pain. After inserting the bottle through the anus, he was unable to remove the bottle and visited our emergency department. (a) Abdominal radiograph and (b) unenhanced computed tomography demonstrate the low-attenuation bottle with linear metallic attenuation materials in the rectum (arrows). A plastic bottle (5 cm in diameter and 10 cm in length) with metallic wires was removed transanally under lumbar paralysis.

slightly curvilinear. Moreover, although wooden toothpicks show high attenuation, their level of attenuation is lower than that of fish bones. Surgery is required for intestinal perforation caused by fish bones or their mimickers.

Intestinal food bolus impaction

Some foods may show high attenuation. This should be kept in mind to avoid a misdiagnosis such as haemorrhage or foreign body. Small-bowel obstruction caused by food bolus is rare and accounts for 0.3% to 4% of all cases.^[6] The most common site of obstruction is the terminal ileum. This is a result of stasis of the intestinal contents in proximity to the ileocaecal valve, where the calibre is relatively small. The attenuation on CT varies depending

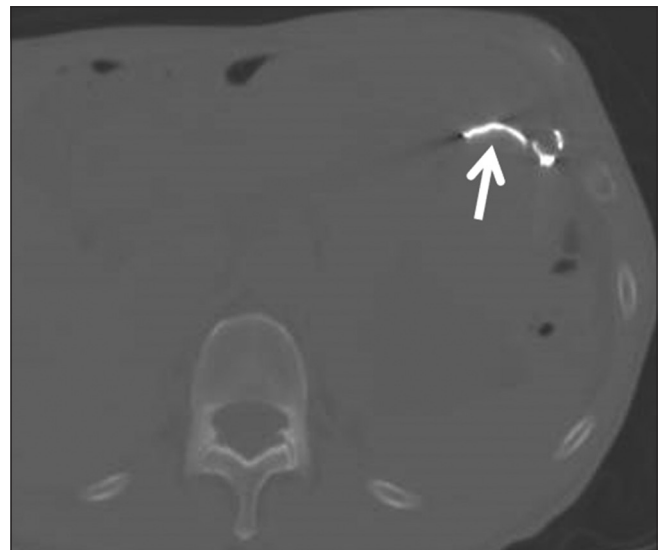


Figure 9: Metallic dental prosthesis ingestion in a 64-year-old man with no symptoms. Unenhanced computed tomography demonstrates an object with extremely high attenuation in the stomach (arrow).

on the type of food, but rice cakes and noodles show uniform high attenuation [Figure 6]. Rice cakes are a traditional food in Asia, especially Japan. CT is the most useful imaging modality for the diagnosis of retained rice cakes, clearly demonstrating the flat shape of the high-attenuation objects^[6,7] [Figure 6]. Furthermore, the CT number is useful for distinguishing rice cakes from other foods because its CT number (120–206 HU) is significantly higher than that of other foods.^[7] Most reported cases of small-bowel obstruction caused by rice cakes did not require surgery.^[6]

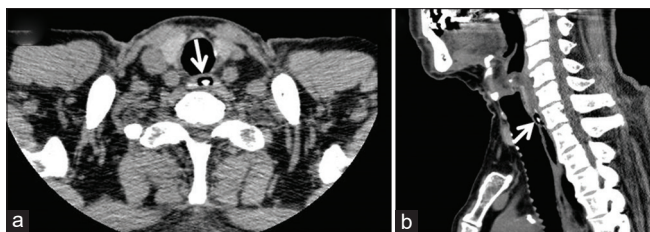


Figure 10: Press-through package ingestion in a 90-year-old man with neck discomfort. (a) Axial and (b) sagittal unenhanced computed tomography demonstrate a high-attenuation oval-shaped material with surrounding air bubbles and a linear high-attenuation material (arrows), suggesting ingested press-through package in the cervical oesophagus.

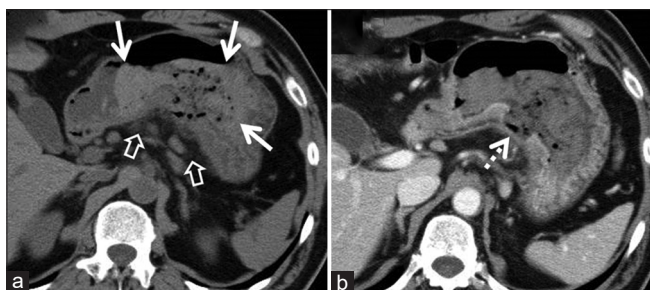


Figure 12: Haemorrhagic gastric ulcer in a 60-year-old man with melena. (a) Unenhanced and (b) contrast-enhanced computed tomography demonstrate high-attenuating material (56 HU), suggesting haematoma in the stomach (arrows). Deep gastric ulcer is demonstrated as focal discontinuity of the mucosal hyperenhancement (dotted arrow) with surrounding fat stranding (open arrows).

Faecal impaction

Faecal impaction is defined as a large mass of compacted faeces at any intestinal level that cannot be evacuated spontaneously.^[8] Faecal impaction is thought to be a consequence of chronic constipation, and it can cause large-bowel obstruction, ischaemia, and perforation.^[8,9] Faecal impaction can occur at any age, although it is common in the elderly population. Several other risk factors have been reported, including inadequate fibre intake, lack of mobility, spinal cord injuries, and neuropsychiatric diseases.^[8,9] The prevalence of faecal impaction in adults has been estimated as 0.7% to 8.8%.^[9] Faecal impaction presents as a high-attenuation mass with air bubbles in the colon or rectum [Figure 7]. When it causes large-bowel obstruction, proximal colonic or small-bowel dilation is observed [Figure 7a]. Treatment options include manual disimpaction, evacuation of the colon with enemas or suppositories, and endoscopic fragmentation.^[8,9] If there are severe abdominal symptoms or life-threatening complications, including large-bowel perforation or ischaemia, surgery may be needed.

FOREIGN BODIES

The ingestion of foreign bodies mainly occurs in the paediatric population, elderly population, and psychiatric and neurological patients.^[10] Foreign bodies that pass through the oesophagus into the stomach and pylorus are automatically excreted in



Figure 11: Press-through package (sheet only) ingestion in a 71-year-old woman with no symptoms. Unenhanced computed tomography demonstrates a linear high-attenuation material (arrow), suggesting an ingested sheet of a press-through package in the lower oesophagus. Ingested fish bone is also a possibility in the absence of typical history.

80% to 98% of cases, whereas only 1% of cases will cause serious complications, including intestinal obstruction and perforation.^[10] Common foreign bodies are press-through packages (PTPs) and dental prostheses in adults.^[10] The insertion of foreign bodies into the anus and rectum is another cause of acute abdomen [Figure 8]. CT attenuations of foreign bodies can differ: some materials are difficult to detect on CT, whereas foreign bodies made of metal can be easily identified because of their extremely high attenuation [Figure 9]. PTPs that consist of lids coated with a heat-sealed material on an aluminium sheet and a dome of vinyl chloride are widely used to enclose tablets because of their cleanliness, hermetic seal, ease of handling, and robustness.^[11] Because of their sharp corners, ingested PTPs represent a potential risk for gastrointestinal bleeding, mediastinitis, intestinal perforation, and obstruction.^[11] PTPs show characteristic findings on CT – that is, high-attenuation oval-shaped materials representing the tablet with surrounding air bubbles in the plastic dome and a linear high-attenuation material on the base representing the sheet^[11,12] [Figure 10]. If only the aluminium sheet is ingested, it may present as a linear high-attenuation material and mimic a fish bone [Figure 11]. Endoscopic removal should be performed in cases involving PTPs in the oesophagus or stomach; therefore, it is important to correctly diagnose the location of the PTP.^[11]

Drug-related conditions, such as body packing and tablets taken in a drug overdose, can also cause acute abdomen, and these can be easily diagnosed by unenhanced CT.



Figure 13: Diverticular bleeding in a 55-year-old man with haematochezia and tachycardia. (a) Unenhanced computed tomography (CT) demonstrates high-attenuating material (40 HU) suggesting haematoma in the transverse colon (arrow). (b) Contrast-enhanced CT demonstrates extravasation of contrast medium (open arrow) from a diverticulum (dotted arrow) in the ascending colon. (c) Digital subtraction angiography demonstrates extravasated contrast medium from branches of the ileocaecal artery (arrowhead). The bleeding did not stop following urgent endoscopic clipping. Hence, coil embolisation was performed.



Figure 14: A 67-year-old man on dialysis. Unenhanced computed tomography showing material with extremely high attenuation, suggesting retained lanthanum carbonate in the colon (arrows).

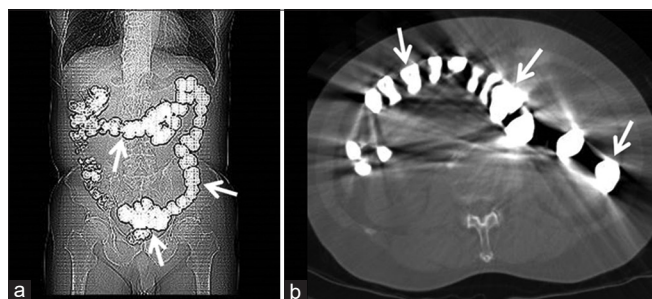


Figure 15: A 73-year-old man who underwent a gastrointestinal series the day before computed tomography (CT). (a) Scout image and (b) unenhanced CT demonstrate material with extremely high attenuation, suggesting retained barium in the entire colon (arrows).

BLOOD

Active bleeding – a life-threatening condition – may show moderately high attenuation; thus, care must be taken that it is not overlooked. There are various causes of gastrointestinal bleeding, but haemorrhagic gastric ulcer and diverticular bleeding are common.

Haemorrhagic gastric ulcer

Peptic ulcer disease is the development of gastric or

duodenal mucosal defects that penetrate the muscularis mucosa. It is a major global health problem and is caused by *Helicobacter pylori* infection and the widespread use of non-steroidal anti-inflammatory drugs.^[13] The spectrum of peptic ulcer disease ranges from relatively self-limiting to life-threatening conditions, including perforation, obstruction, and haemorrhage. Endoscopy is the reference standard for the diagnosis of haemorrhagic gastric ulcers; however, CT can be useful in patients with suspected gastrointestinal bleeding. On CT, the haemorrhage shows a hyperattenuating clot (30–70 HU), and the clot of highest attenuation is generally found near the bleeding site^[13] [Figure 12]. A high-attenuation clot is easier to detect on unenhanced CT than on contrast-enhanced CT because the contrast between the clot and the surrounding structure is greater on unenhanced CT. Hyperattenuating materials such as residual contrast medium or medications, surgical material, or foreign bodies can mimic or obscure bleeding.^[13] Deep gastric ulcers can be identified as focal discontinuities of the mucosal hyperenhancement with surrounding fat stranding^[13] [Figure 12]. Endoscopic haemostasis is the first-line therapy for active bleeding. When endoscopic haemostasis cannot be achieved, transcatheter arterial embolisation may be helpful.^[13]

Diverticular bleeding

The prevalence of colonic diverticular disease has been increasing as a result of the increase in the elderly population. Colonic diverticula are the most common cause of life-threatening lower gastrointestinal bleeding. Spontaneous bleeding is common in the diverticula of the ascending colon.^[14] Colonoscopy is the reference standard for the diagnosis of diverticular bleeding; however, CT may be selected as the first diagnostic modality because of its accessibility. On CT, haemorrhage is seen as a hyperattenuating clot [Figure 13a], and diverticula are seen as small outpouchings of the colonic wall. Extravasated contrast medium in the colonic lumen on contrast-enhanced CT indicates active bleeding with high specificity (91.2%), although sensitivity is low (57.6%)^[14] [Figure 13]. Colonoscopy is a useful option for the treatment of diverticular bleeding.^[14] When endoscopic

haemostasis cannot be achieved, transcatheter arterial embolisation is the next treatment option.^[14]

MIMICKERS

Lanthanum [Figure 14] and barium [Figure 15] show extremely high attenuation on CT because of their high atomic numbers (57 and 56, respectively).^[1] They can resemble foreign bodies or haematoma in the gastrointestinal tract on CT; moreover, they can make the CT evaluation difficult because of their high attenuation and beam-hardening artefacts.^[1]

DUAL-ENERGY CT

Dual-energy CT has been adopted for evaluation of the acute abdomen. With modern dual-energy scanners, we can obtain both virtual non-enhanced and enhanced images from one Post-contrast scan. Creating virtual non-enhanced images in the evaluation of acute abdomen substantially reduces radiation doses by eliminating true non-enhanced images. Moreover, dual-energy CT is capable of reducing metallic artefacts, improving the evaluation of abdominopelvic organs.^[15]

CONCLUSION

Unenhanced CT can play a crucial role in diagnosing acute abdomen with characteristic high-attenuation lesions or materials in the gastrointestinal tract. These conditions are often urgent; therefore, familiarity with their characteristic radiological features is essential for accurate diagnosis.

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Conflicts of interest

There are no conflicts of interest.

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SMC CATEGORY 3B CME PROGRAMMEOnline Quiz: <https://www.sma.org.sg/cme-programme>**Deadline for submission: 6 pm, 18 November 2022.**

| Question | True | False |
|--|------|-------|
| 1. Regarding gallstone ileus: | | |
| (a) Bilioenteric fistulas between the gall bladder and duodenum are the most common pathway. | | |
| (b) Gallstone ileus is a paralytic ileus caused by a gallstone. | | |
| (c) Computed tomography (CT) has high sensitivity but low specificity for the evaluation of ectopic gallstones. | | |
| (d) Most ectopic gallstones show high attenuation on CT. | | |
| 2. Regarding food-related lesions: | | |
| (a) Fish bones are completely linear. | | |
| (b) Wooden toothpicks show higher CT number than fish bones. | | |
| (c) Rice cakes show higher CT number than other foods. | | |
| (d) The most common site of obstruction caused by food bolus is the proximal jejunum. | | |
| 3. Regarding foreign bodies: | | |
| (a) Metal foreign bodies can be easily identified because of their extremely high attenuation. | | |
| (b) Press-through packages (PTPs) show high-attenuation oval-shaped materials with surrounding air bubbles and a linear high-attenuation material on CT. | | |
| (c) Most cases of foreign body ingestion cause serious complications. | | |
| (d) If only the aluminium sheet of PTPs is ingested, it may mimic a fish bone | | |
| 4. Regarding haemorrhage and active bleeding: | | |
| (a) Gastric ulcers cannot be identified on CT. | | |
| (b) Extravasated contrast medium in the colonic lumen on contrast-enhanced CT indicates active diverticular bleeding with high sensitivity. | | |
| (c) The highest attenuation clot is generally found near the bleeding site on CT. | | |
| (d) Transcatheter arterial embolisation is a treatment option for active diverticular bleeding. | | |
| 5. Regarding bezoars and enteroliths: | | |
| (a) Trichobezoars are the most common type. | | |
| (b) Bezoars tend to appear in a long segment compared to faeces. | | |
| (c) Surgical enteroanastomoses are not related to the formation of enteroliths. | | |
| (d) Bezoars and enteroliths are seen as round or ovoid masses with air bubbles on CT. | | |