St. James's Hospital
DEPARTMENT OF RADIOLOGY

Acute Mesenteric Ischaemia: Tips and Tricks for Early CT Diagnosis

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Learning Objectives

1. To outline the optimal CT protocol and patient preparation for patients with suspected mesenteric ischaemia
2. To describe the CT findings associated with mesenteric ischaemia in order to improve detection of this condition at a potentially treatable stage

Background

- Acute mesenteric ischaemia (AMI) arises from occlusive or non-occlusive aetiologies that result in decreased blood flow to the gastrointestinal tract
- Rapid diagnosis is essential to reduce patient morbidity and mortality and requires a strong clinical suspicion, usually combined with CT imaging
- Many of the CT findings are non-specific and can therefore mimic other intestinal pathologies

Imaging Findings Or Procedure Details

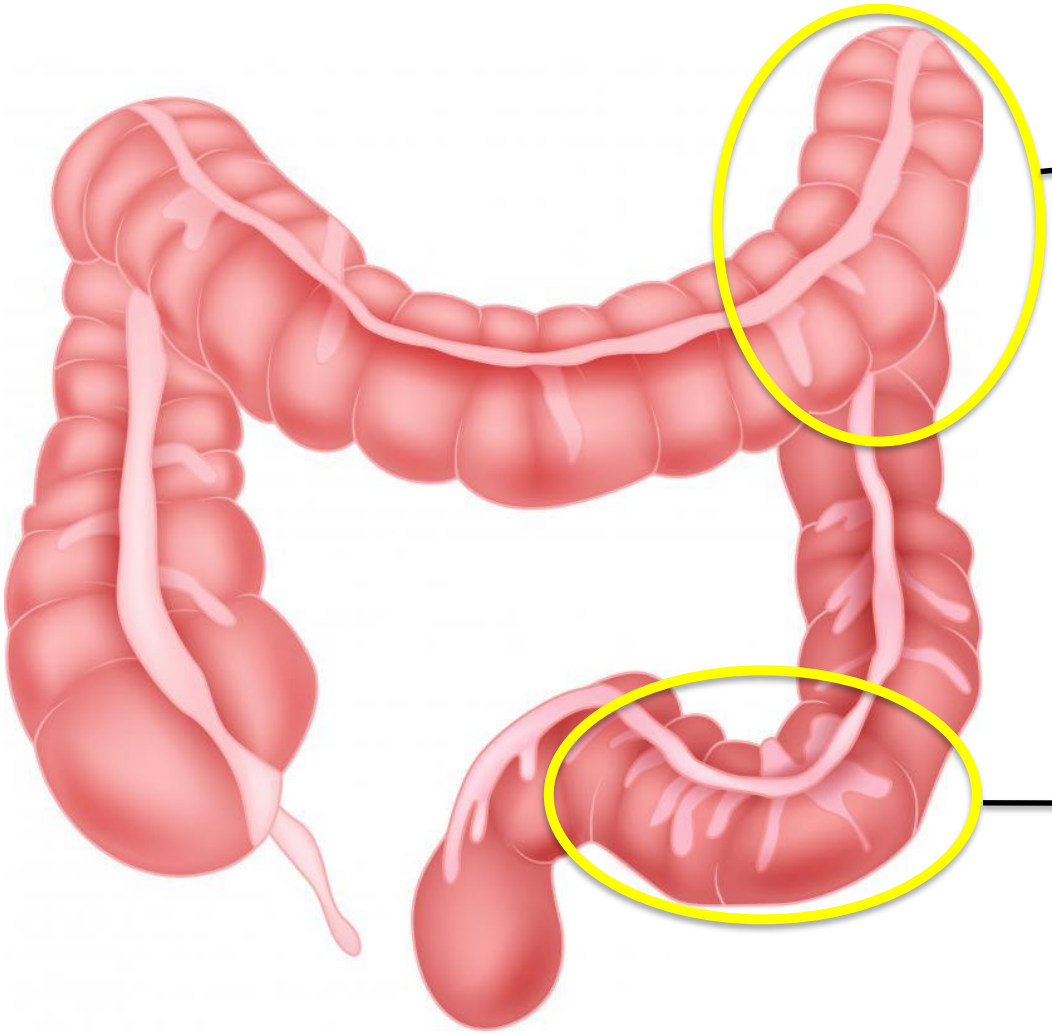
AMI can occur via one of four mechanisms:

	Mechanism	Risk Factors
1	**Arterial embolus**	Atrial fibrillation, Aortic aneurysm, Valvular heart disease, Endocarditis
2	**Arterial thrombosis**	Atherosclerosis
3	**Venous thrombosis**	Hypercoaguable states, Localised inflammation (eg Pancreatitis), Multi-organ failure, Oestrogen use
4	**Non-occlusive ischaemia**	Hypovolaemia/Low-flow states (eg sepsis, cardiopulmonary bypass) or Splanchnic vasoconstriction (eg inotropes)

Common sites of AMI

Mechanism	Most common site
Arterial embolus	Distal to middle colic artery of SMA – distal jejunum, ileum and ascending colon
Arterial thrombosis	Origin of SMA – small bowel and proximal colon
Venous thrombosis	Ileum and jejunum
Non-occlusive ischaemia	SMA territory – small bowel and proximal colon Watershed areas

Watershed areas, supplied by the distal branches of major arteries, are most vulnerable to ischaemia from low flow states as they have the fewest vascular collaterals



Griffiths' point
Superior mesenteric artery (middle colic artery) and inferior mesenteric artery (left colic artery)

Sudeck's point
Inferior mesenteric artery (superior rectal artery) and Internal iliac artery (middle and inferior rectal artery)

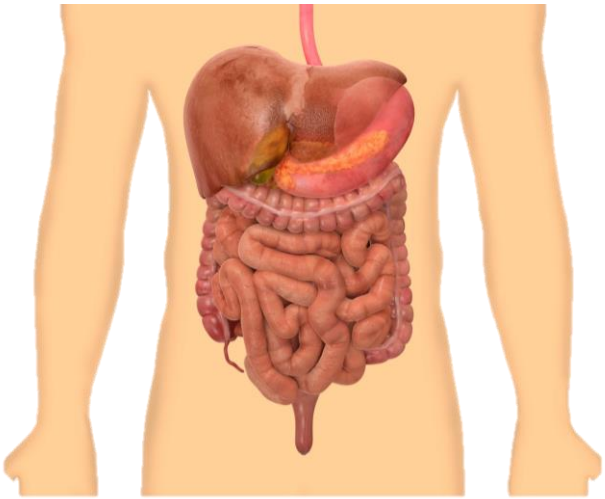
Patient Presentation

Symptoms:

- Most common: severe abdominal pain out of proportion to examination findings
- Nausea and vomiting
- Diarrhoea
- Blood per rectum

Signs:

- Fever
- Tachycardia
- Soft abdomen with little or no tenderness
- Peritonitis (when necrosis occurs)
- Septic shock followed by death



CT Protocol

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- IV bolus of 100 mL iodinated contrast (350 mg/mL) at 4 ml/s
  - Arterial phase triggered when density of 100 HU reached in the abdominal aorta (Fig. 1)
  - Portal venous phase (70 seconds)
  - A non-contrast is not absolutely necessary for diagnosis
- Neutral luminal contrast (water)
  - Oral positive contrast renders assessment of bowel wall enhancement and thickness difficult
- Scan range from diaphragm to proximal femurs

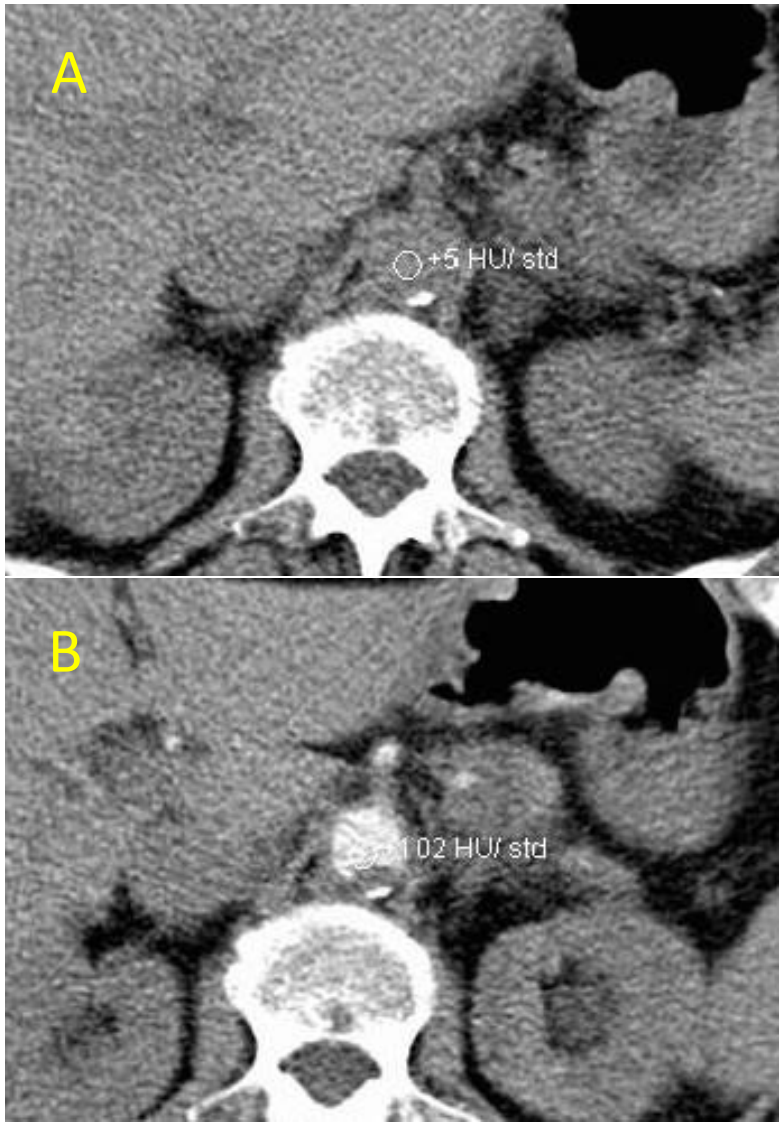

Figure 1. *(A) Region of interest placed in upper abdominal aorta. (B) Arterial phase triggered when Hounsfield units exceed 100*

Pathophysiology

- The insult begins at the mucosa and extends out through the submucosa and muscularis externa, ending at the serosa
- Severity ranges from mucosal to mural ischaemia and finally to transmural necrosis
- The CT findings of AMI can therefore vary widely depending on the duration of symptoms, the cause and its location

CT Findings in Mesenteric Ischaemia
Bowel wall thickening
Bowel dilatation
Ascites and mesenteric oedema
Abnormal enhancement
Pneumatosis intestinalis
Portomesenteric venous gas
Arterial embolus or venous thrombus
Pneumoperitoneum

Bowel wall thickening

- Most common yet least specific finding, secondary to oedema or haemorrhage
- Degree of thickening does not correlate with severity
- Normal bowel wall thickness <3mm

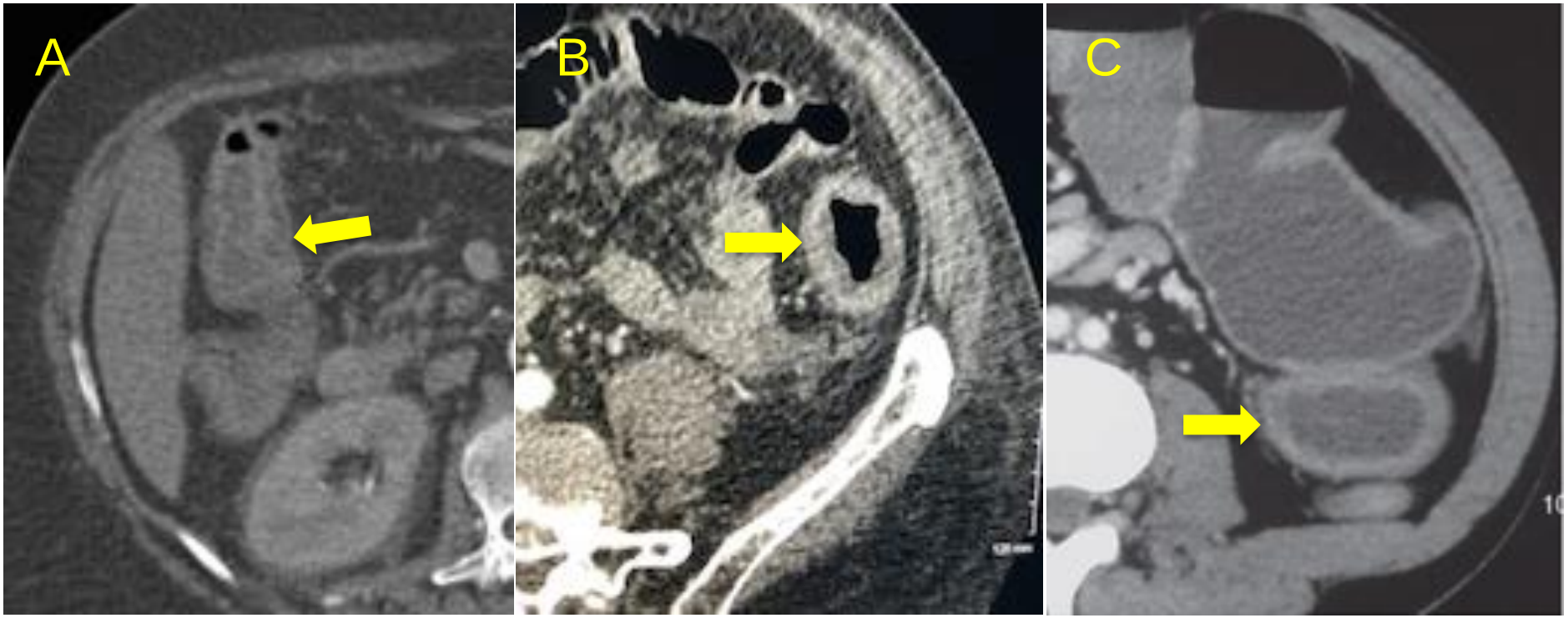

***Figure 2**. Axial arterial phase CT images showing diffuse mural thickening of (A) the hepatic flexure in a patient with an SMA thrombus, (B+C) the descending colon in patients with ischaemic colitis.*

Bowel Dilation

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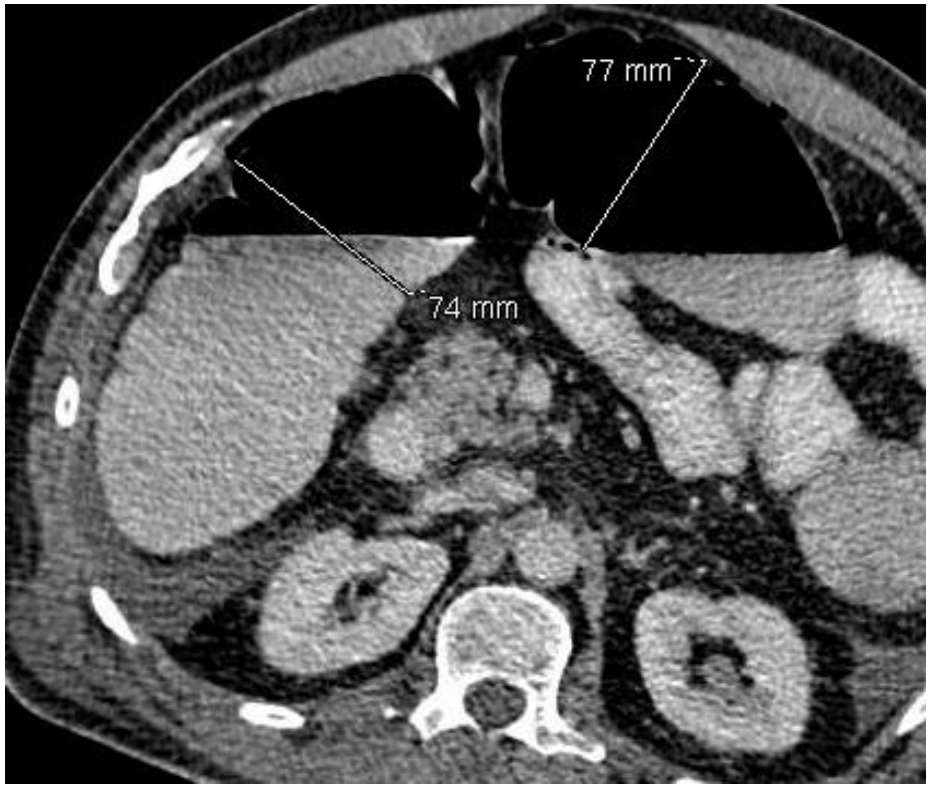
- Dilation occurs due to interruption of normal bowel peristalsis
- Increased intestinal secretions results in fluid distension of the bowel, usually in venous thrombosis or strangulating obstruction
- In patients with arterial occlusion, fluid distension is rare



Normal bowel calibre:
Small bowel ≤ 3cm
Caecum ≤ 9cm
Rest of large bowel ≤ 6cm

Figure 3. *Portal venous CT showing air and fluid dilatation of the transverse colon in a patient with ischaemia and high inotropic requirements post prolonged cardiothoracic surgery.*

Ascites and small bowel mesentery oedema

- Free intraperitoneal fluid occurs secondary to raised mesenteric venous pressure and subsequent transudation of fluid into the mesentery and peritoneal cavity

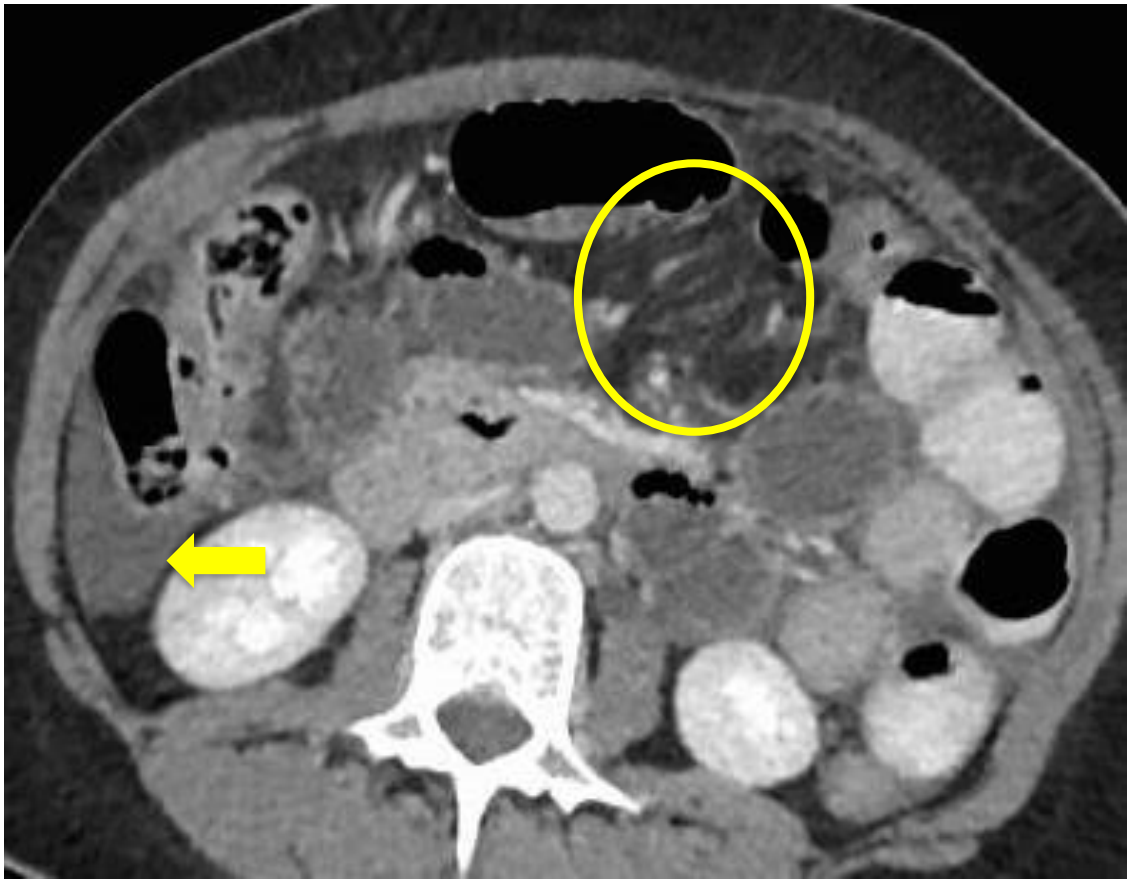


***Figure 4**. Free fluid (arrow) and oedema of the small bowel mesentery (circle) in a patient with ischaemic small bowel secondary to adhesional obstruction.*

Abnormal Enhancement

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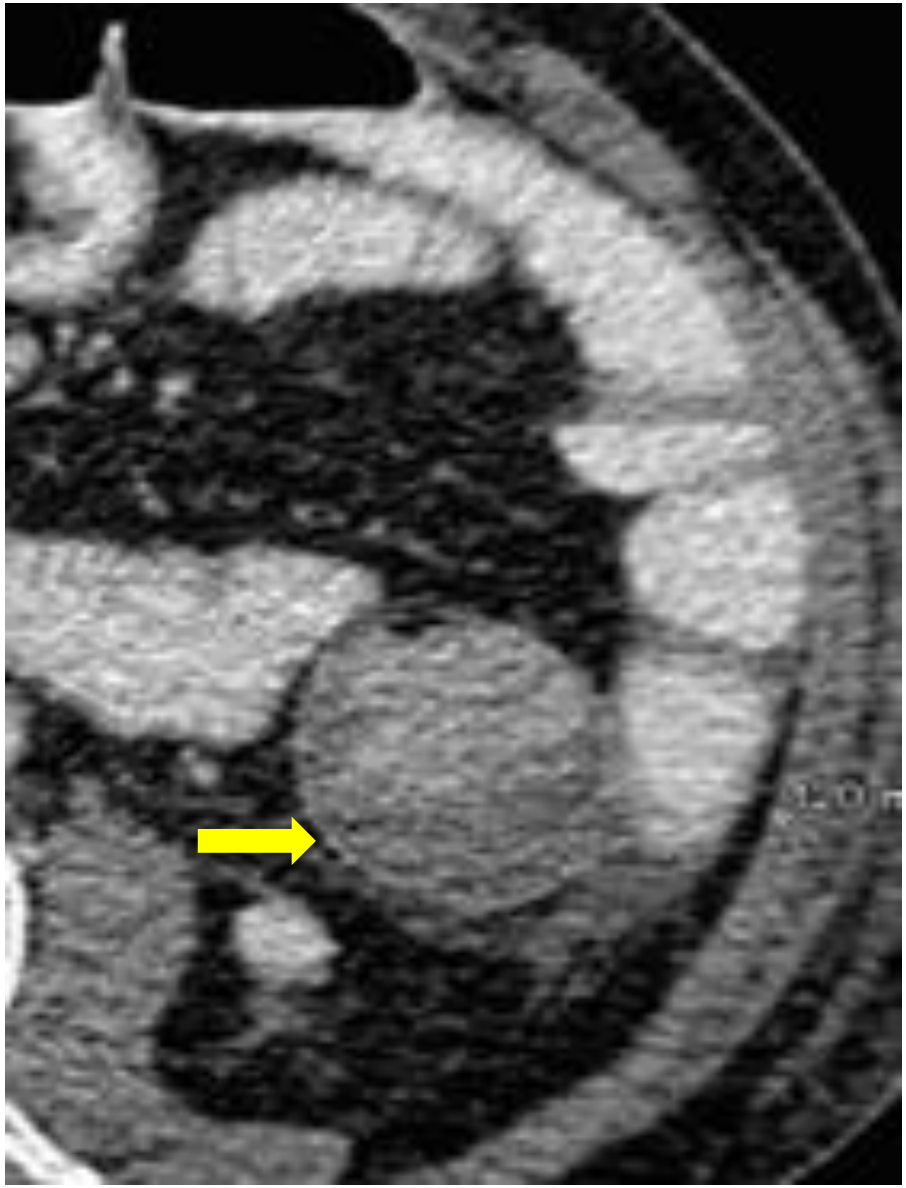

- Bowel wall enhancement should ideally be assessed on both pre and post contrast images
- On non-contrast images
  - Bowel wall hypoattenuation indicates bowel wall oedema
  - Hyperattenuation is caused by intramural haemorrhage and haemorrhagic infarction
- On contrast-enhanced CT, absent or reduced contrast enhancement of the bowel wall is highly specific for AMI

***Figure 5**. Portal venous phase CT demonstrates abnormal hypoenhancement of the descending colon in a patient with colonic ischaemia post cardiac arrest and prolonged ICU admission.*

Pneumatosis Intestinalis

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- Locules of air within the bowel wall indicates transmural bowel ischaemia and is a late and prognostically negative finding
- Pneumatosis intestinalis is not specific of ischaemia and may occur in a range of benign scenarios. However when identified, ischaemia must be excluded

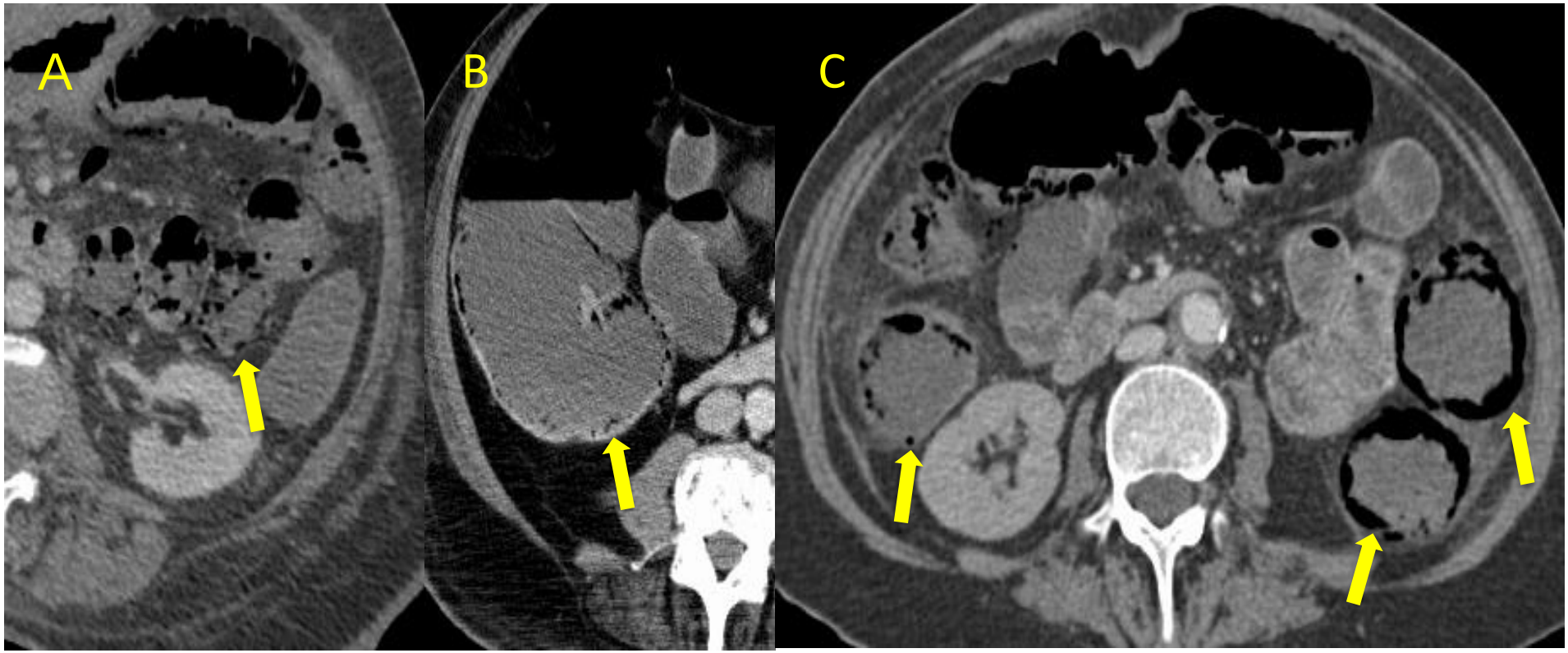

Figure 6. *Varying severity of pneumatosis intestinalis of (A) the jejunum, (B) the caecum and ascending colon and (C) the ascending and descending colon in patients with ischaemia of various causes.*

Portomesenteric venous gas

- Air in the mesenteric or portal veins, when accompanied by pneumatosis intestinalis, is highly specific for mesenteric ischaemia and indicates transmural infarction
- Associated with a poor prognosis and high mortality rates

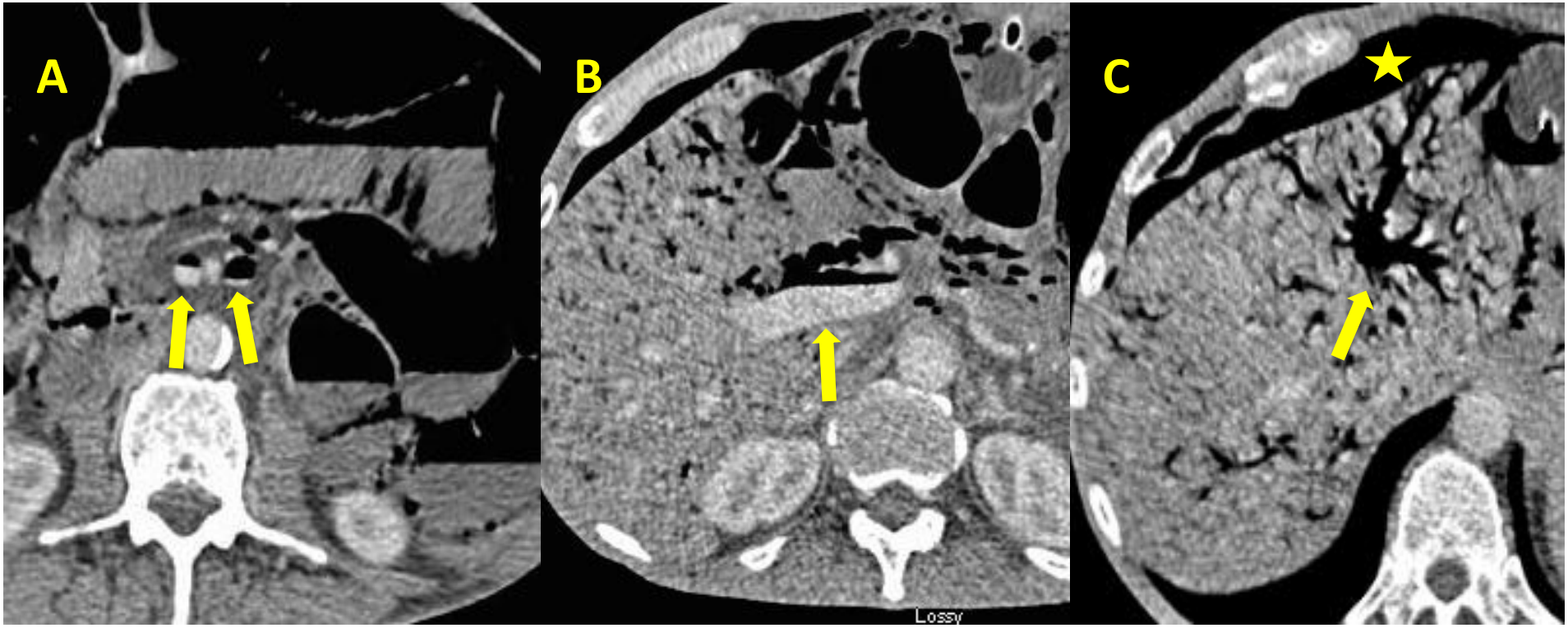

Figure 7. *Portomesenteric venous gas on portal venous phase CT abdomen. (A) Air within the superior (left) and inferior (right) mesenteric veins. (B) Air within the main portal vein. (C) Air in the biliary tree with a pneumoperitoneum (*).*

Arterial Embolus

- Arterial phase CT demonstrates a luminal filling defect or complete lack of opacification of the artery, if the embolus is occlusive
- Approximately 15% are at the origin of the SMA with 50% immediately distal to the origin of the middle colic artery
- Acute SMA occlusion carries a mortality of 75-90%

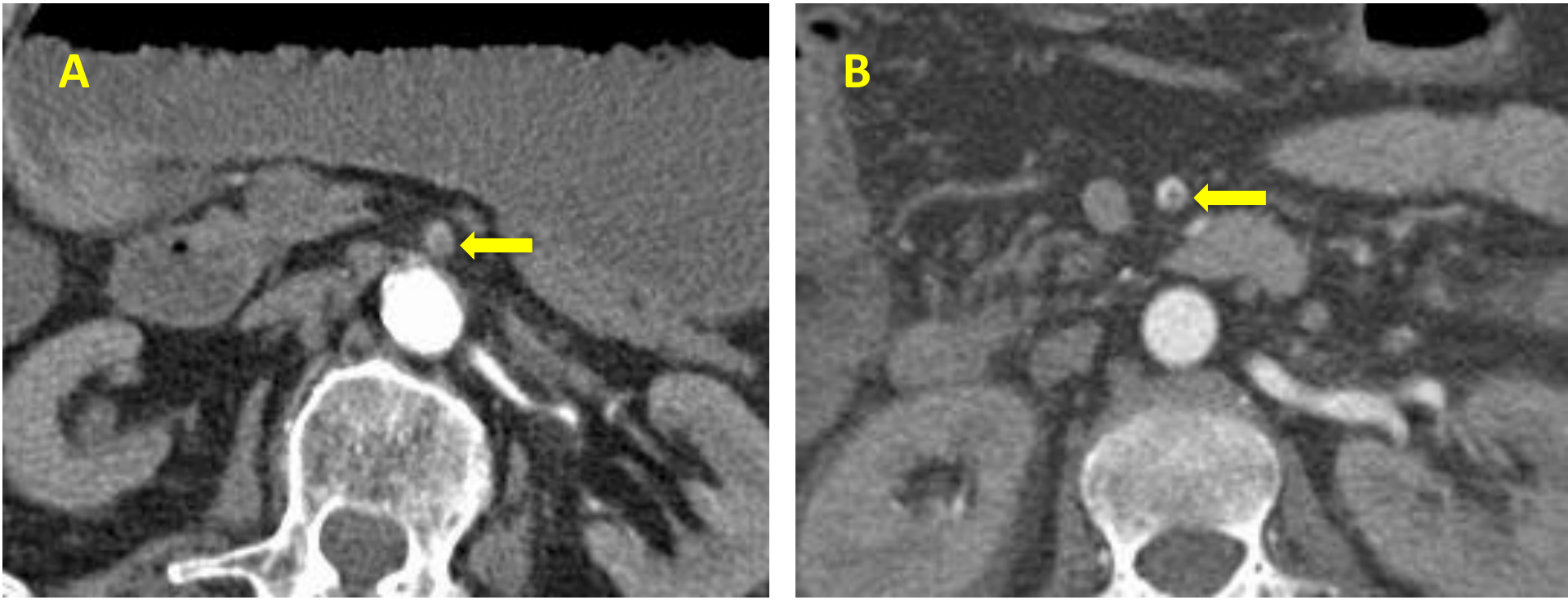

Figure 8. *Arterial phase images demonstrating filling defects in the SMA consistent with emboli.*

Our Tips and Tricks

- Avoid the use of iodinated oral contrast
- Most common finding, but least specific is thickening of the bowel wall – typically between 8-9mm
- Check for emboli elsewhere in the arterial tree, such as in the heart – raises suspicion for acute embolus
- Venous thrombosis causes venous congestion and therefore CT is more likely to show bowel wall thickening, mucosal hyperenhancement and mesenteric oedema
- Non-occlusive mesenteric ischaemia has no typical CT features. Clinical history is important in this subgroup – it's almost exclusively seen in critically ill patients requiring inotropes

Conclusions

- Imaging findings of early acute mesenteric ischaemia can closely mimic other gastrointestinal causes of an acute abdomen
- A high clinical suspicion and the correct CT protocol followed by a methodical search for both intra and extraintestinal features of mesenteric ischaemia are essential for it's prompt diagnosis

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