Imaging of Bowel Ischemia

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Disclosures

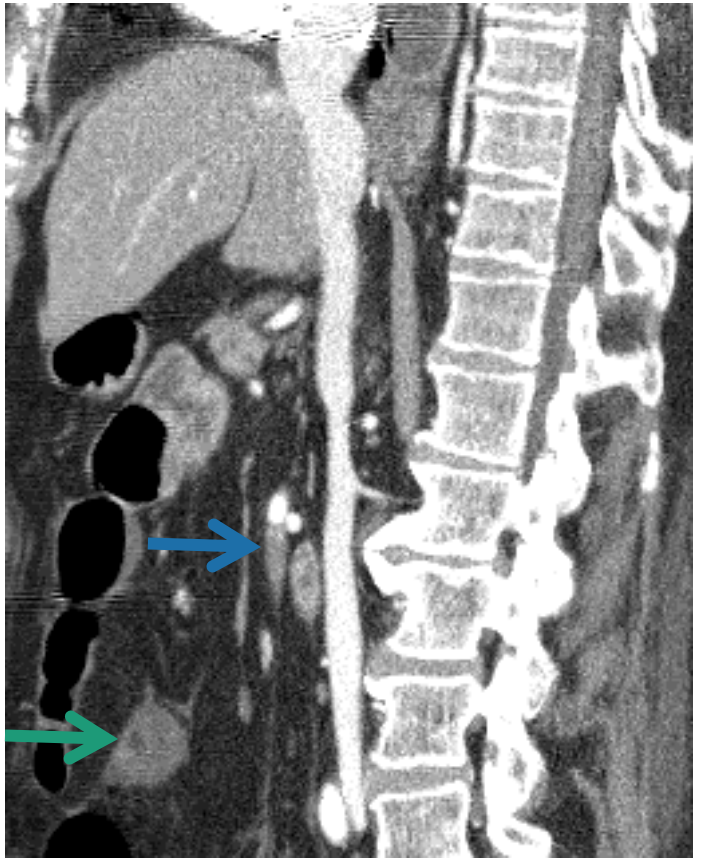
None

Learning Objectives

- Understand **types and etiopathogenesis** of bowel ischemia
- Recognize imaging manifestations with special emphasis on **early diagnosis and differentials**
- Learn **management principles** relevant to imaging

Acute Intestinal Ischemia

- Mesenteric vascular insufficiency
- Complex disorder
  - Self limited to transmural
  - Occlusive to non-occlusive
  - Segmental vs diffuse



Epidemiology

- 0.1% hospital patients
- 1% of hospital admissions
- High mortality
- Increased occurrence in,
  - Elderly
  - Cardiac **(atrial fibrillation)**

Types: Etiology

Thrombo-embolism

Non-occlusive causes

Bowel obstruction

Neoplasms

Vasculitis

Trauma

Inflammatory conditions

Others

Acute vs. Chronic

Arterial Vs. Venous

Clinical Features

- 50-70 years
- **Abdominal pain out of proportion to physical exam**
- Classic triad of abdominal pain, hematochezia, and fever in only 1/3rd patients

Laboratory Findings

- **Elevated lactic acid levels**, leukocytosis, and anion-gap
- No simple screening test

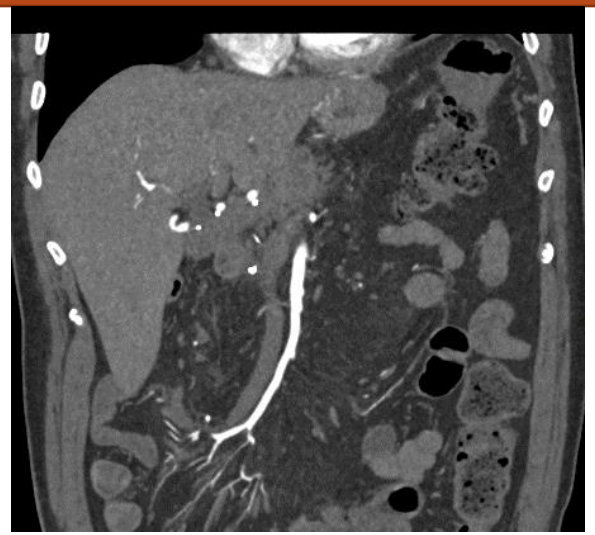
Role of Imaging

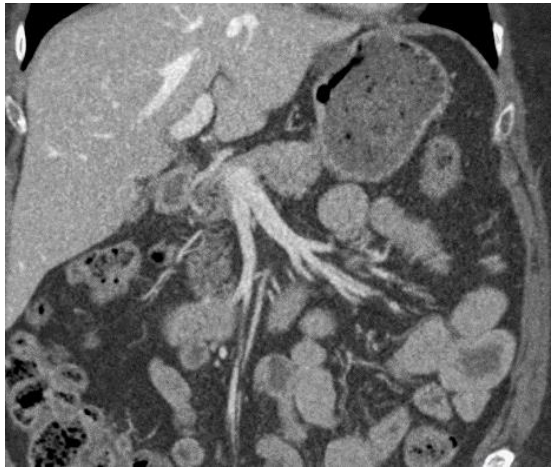
- Challenging to diagnose clinically
- Untreated = 100% mortality
- Early detection and guide management
- Complications
- ***AMI underdiagnosed in CT of acute abdomen if no clinical suspicion***

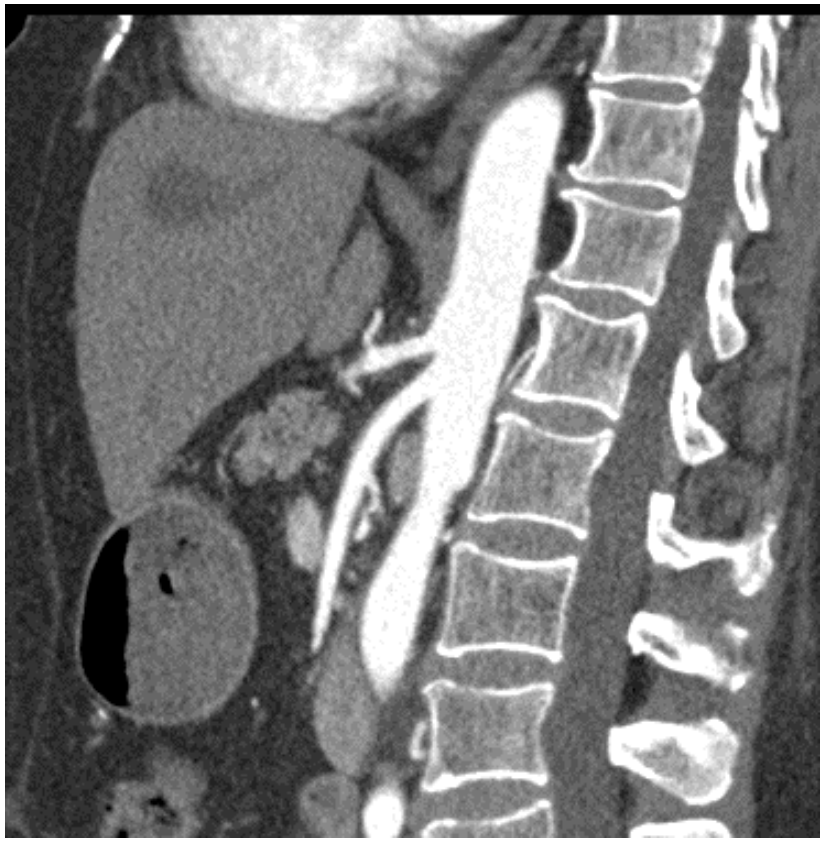
CT Protocol

- No oral contrast
- Iohexol 350
- 100 to 200 mL of contrast followed by 30 to 50 mL saline at 5 to 6 mL/sec depending on weight
- Phases- Arterial and Portal venous
- **Bolus tracking:** Threshold 150 HU

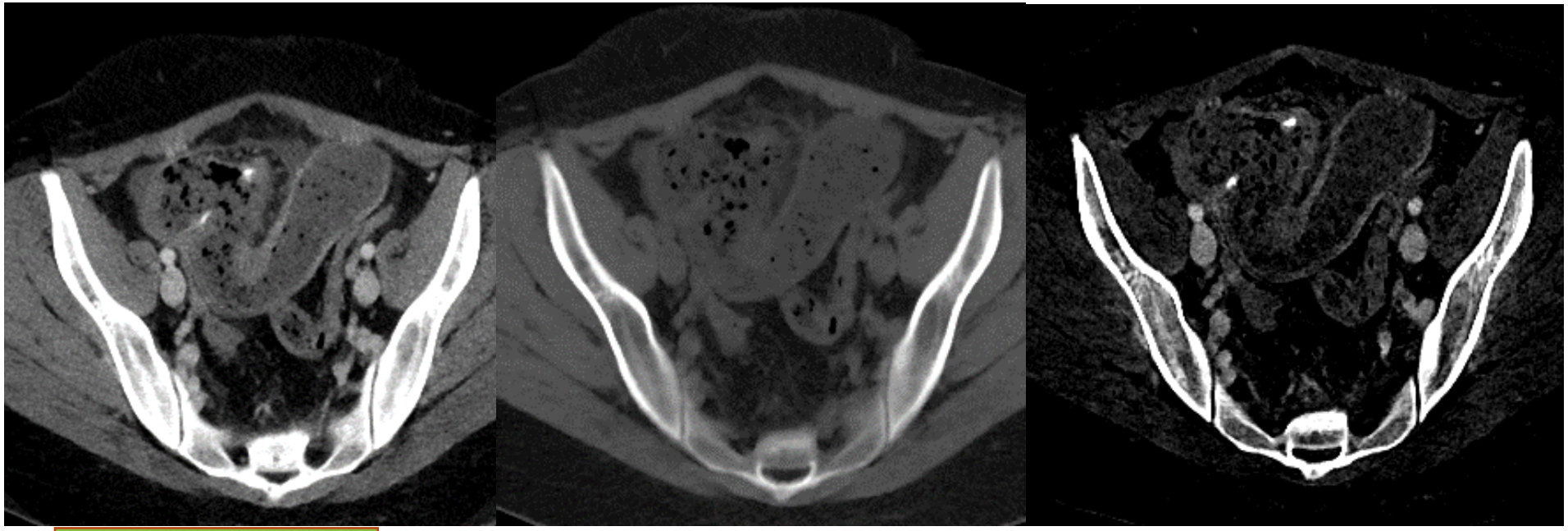
CT Protocol: Reformats







Dual Energy CT

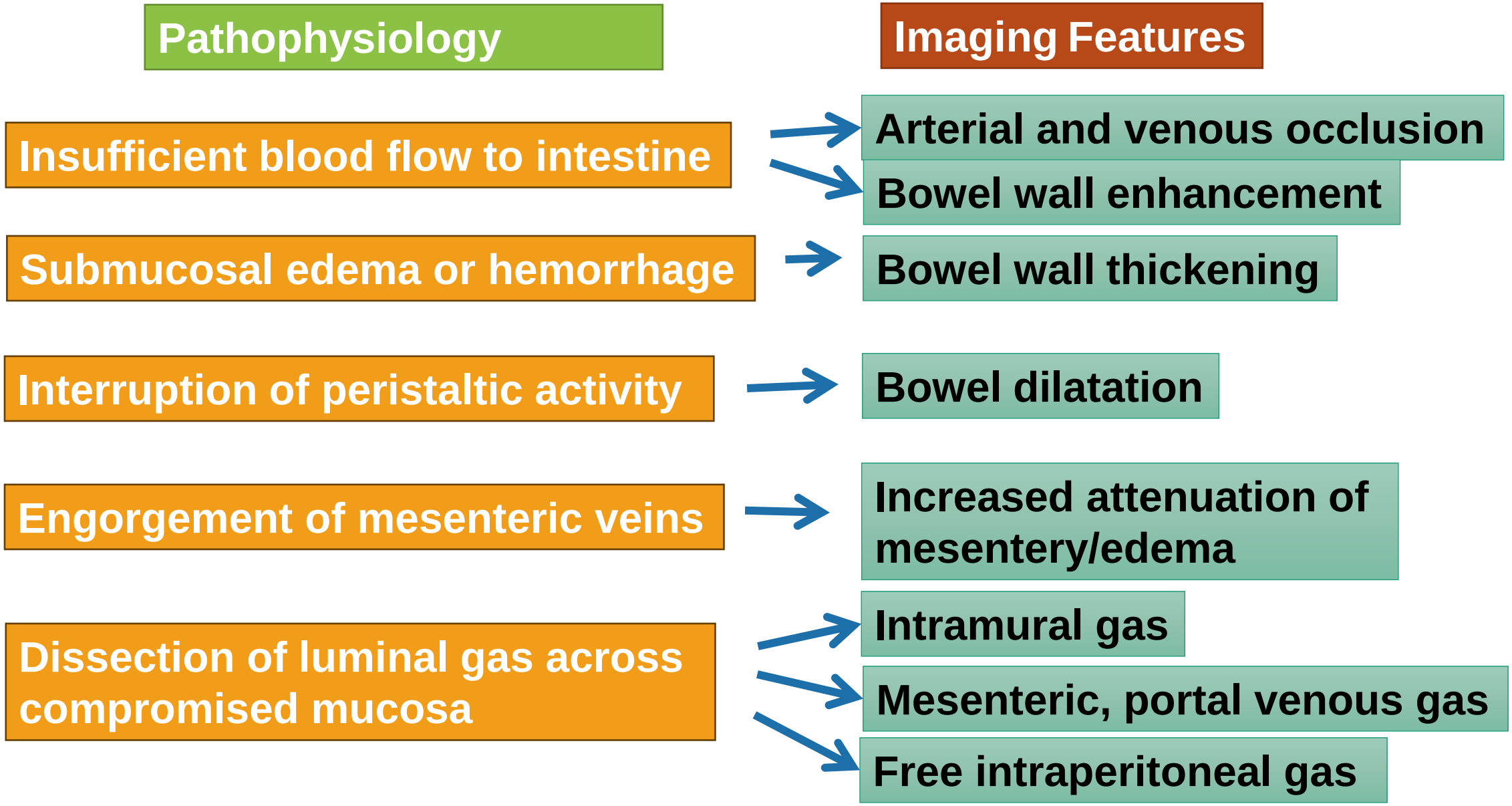


Mono 50 keV

Virtual non-contrast

Iodine map

- Improves conspicuity of ischemic bowel
- Increases attenuation difference between perfused and non-perfused bowel
- Detection of bowel wall hemorrhage


Pathophysiology
Imaging Features
Insufficient blood flow to intestine
Arterial and venous occlusion
Bowel wall enhancement
Submucosal edema or hemorrhage
Bowel wall thickening
Interruption of peristaltic activity
Bowel dilatation
Engorgement of mesenteric veins
Increased attenuation of mesentery/edema
Dissection of luminal gas across compromised mucosa
Intramural gas
Mesenteric, portal venous gas
Free intraperitoneal gas

Imaging Features

Mural	Extra-Mural
Bowel wall thickening	Arterial or venous occlusion
Bowel dilatation/ileus	Fat stranding, fluid and hemorrhage
Target or halo	Mesenteric gas
Abnormal enhancement	Portal venous gas
Hemorrhage	Gastric ileus
Pneumotosis	

Practical Etiological Categorization - Acute Mesenteric Ischemia

Acute mesenteric ischemia

Arterial

Occlusive

Non-occlusive

Embolism

Mesenteric arterial occlusive ds

Venous

Special Scenarios

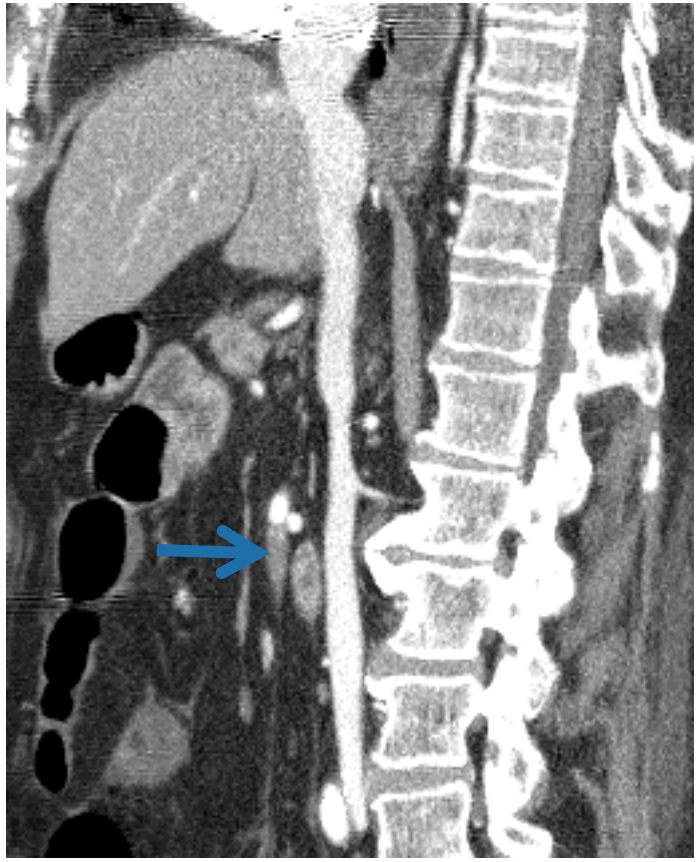
Occlusive Arterial Mesenteric Ischemia

- Thromboembolic occlusion- 60 to 70%
- Emboli lodge in SMA
- Wide caliber and narrow take off from aorta
  - **3 to 10 cm from origin**
  - Distal to middle colic
  - 15% lodge at origin
- Look at heart

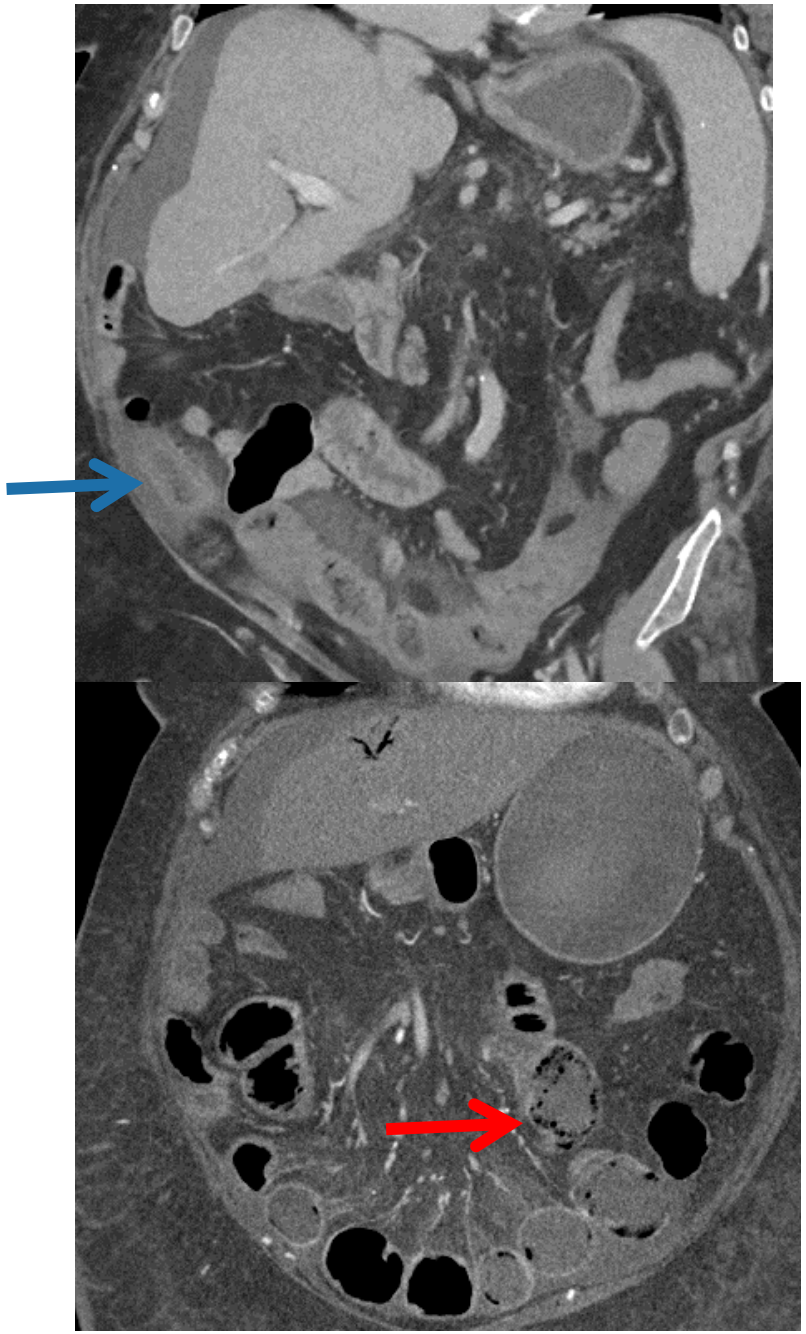
Acute SMA embolism

Highly Specific SMA Embolism

- 3 to 10 cm beyond origin distal to origin of middle colic artery
- Aortic thrombus

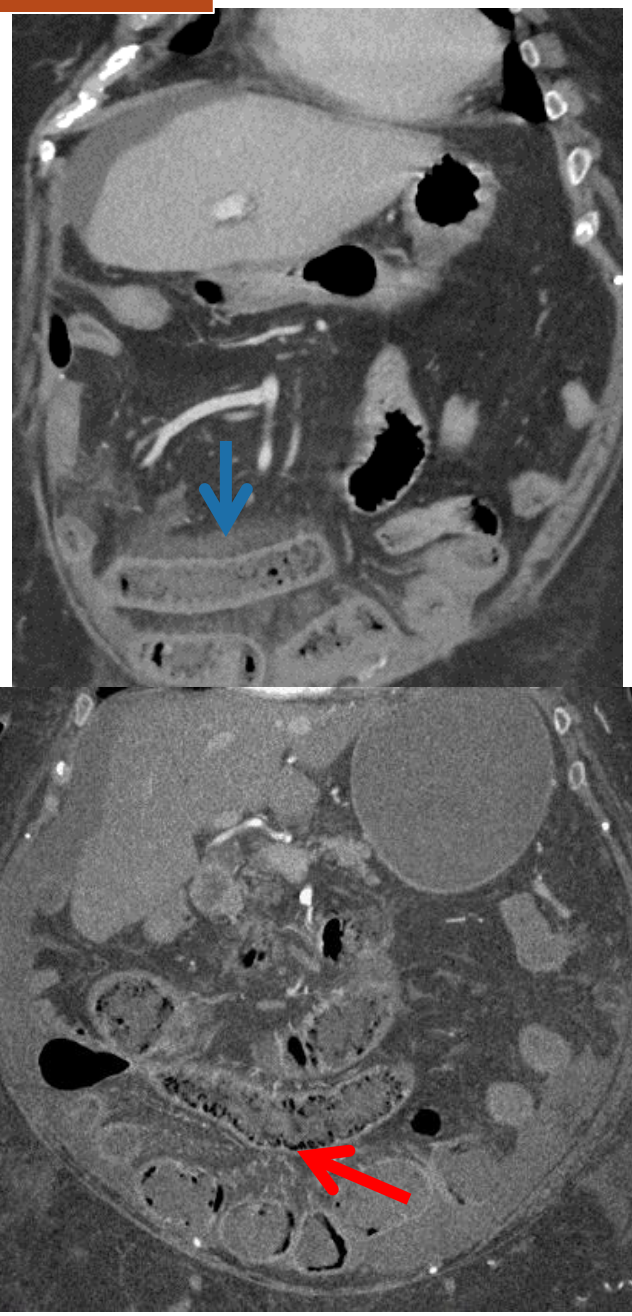


73/ f with abdominal pain, diarrhea and hematochezia



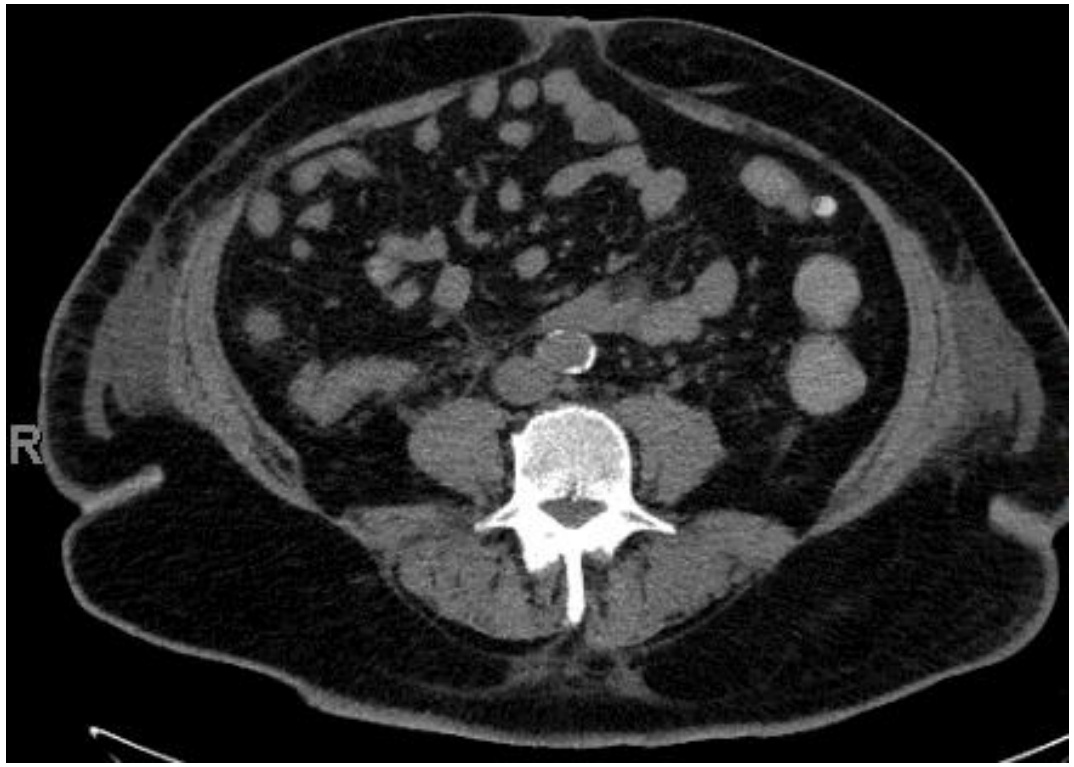
Partial

Full-thickness



Early

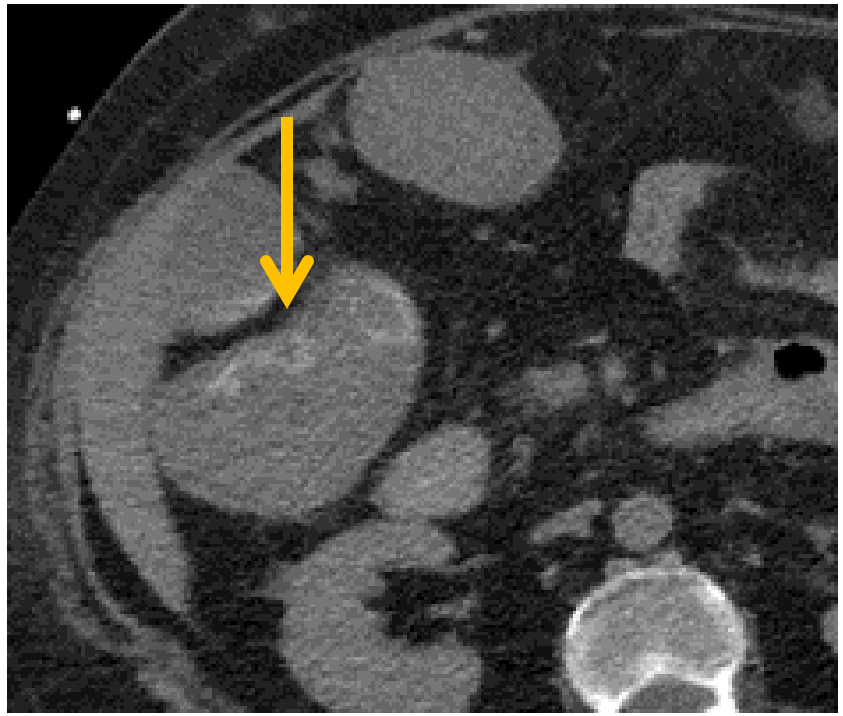
4 days later

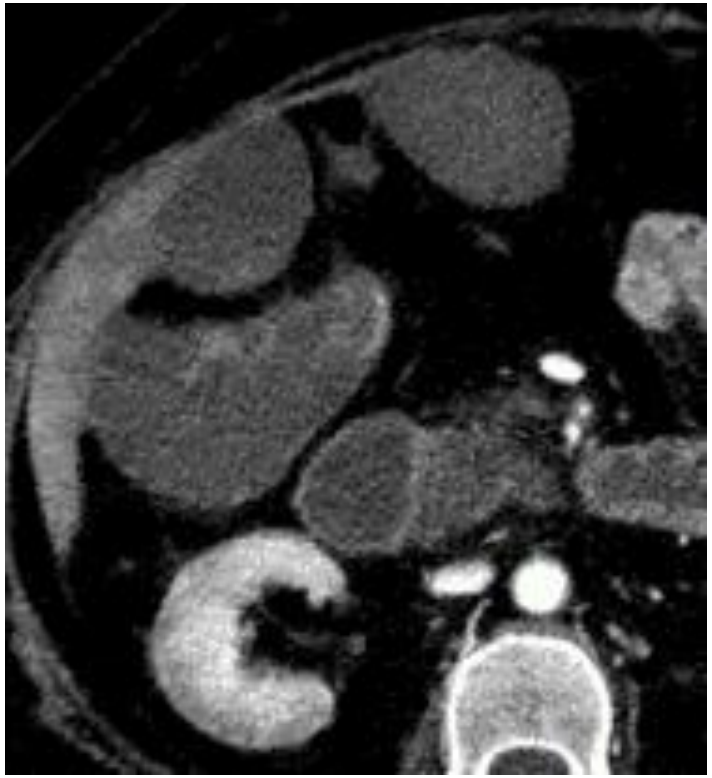


Normal

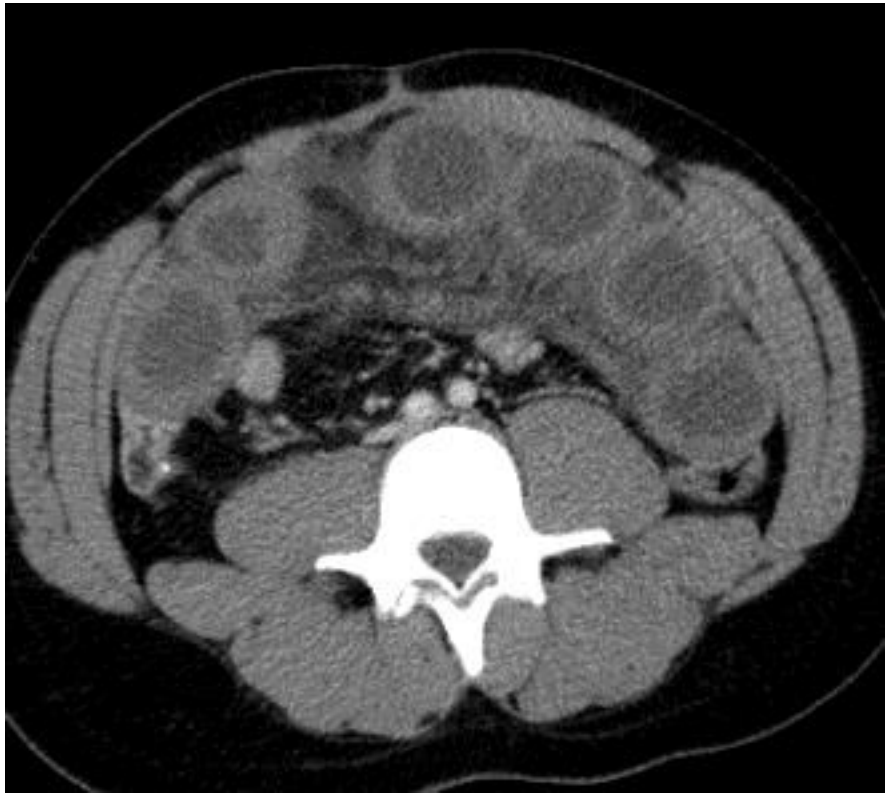
Hypotonic mildly dilated aperistaltic ischemic bowel after 5 days

Bowel wall hemorrhage

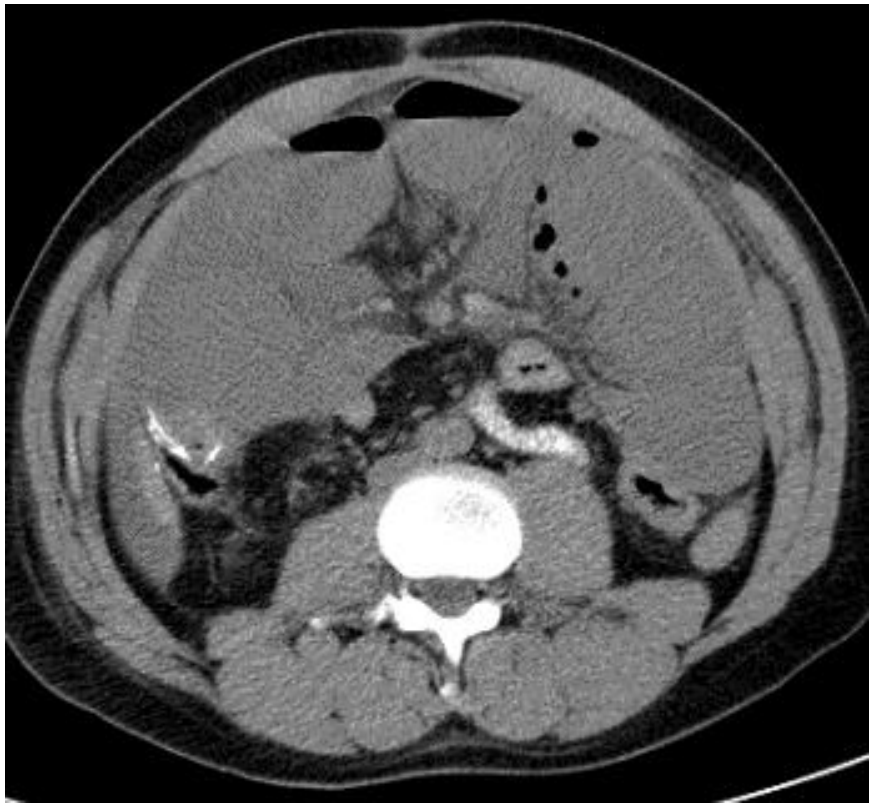




Closed loop obstruction causing ischemia: initial bowel thickening followed by thinning and necrosis

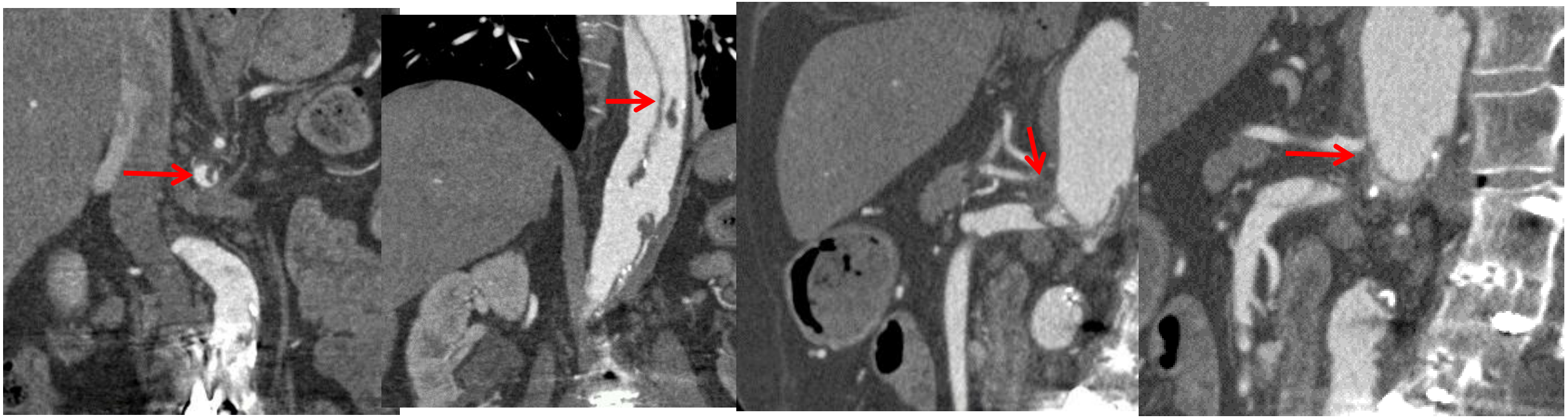


Initial



Several days later

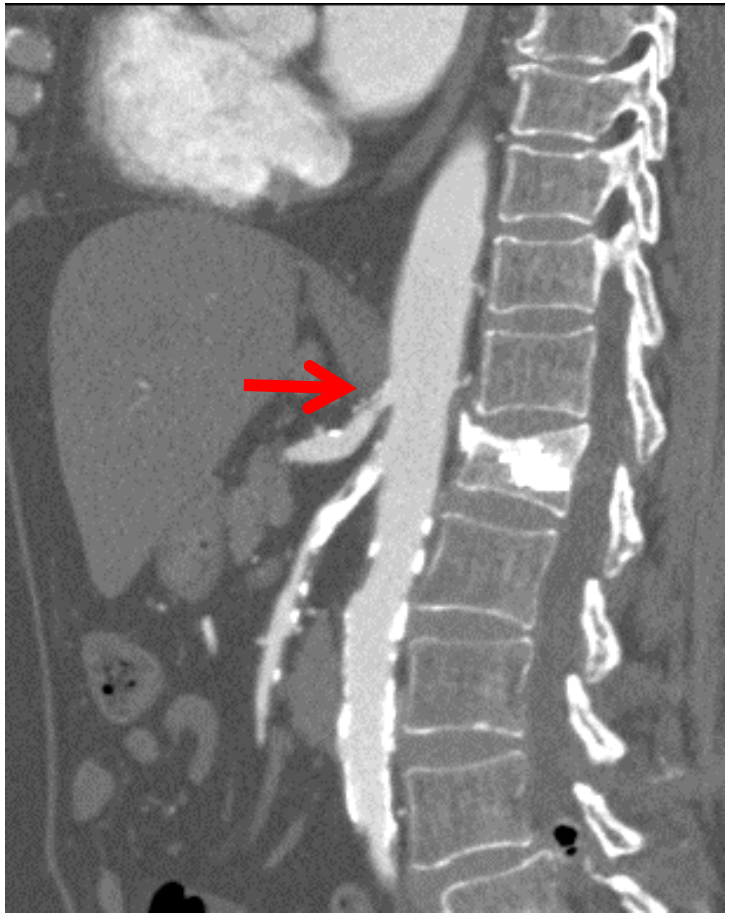
Aortic dissection →Ischemia



- **3-5% have SMA occlusion**
- **Aortic repair followed by visceral revascularization**

Chronic Atherosclerotic Occlusive Disease

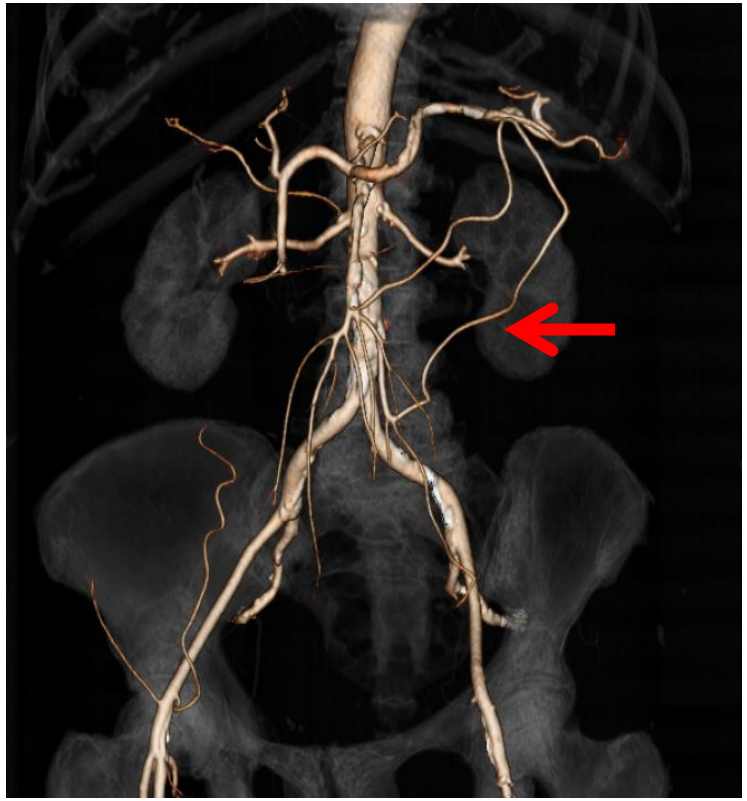
- 25% of AMI
- **Affects origin**
- Direct extension of atherosclerotic disease



Critical stenosis SMA

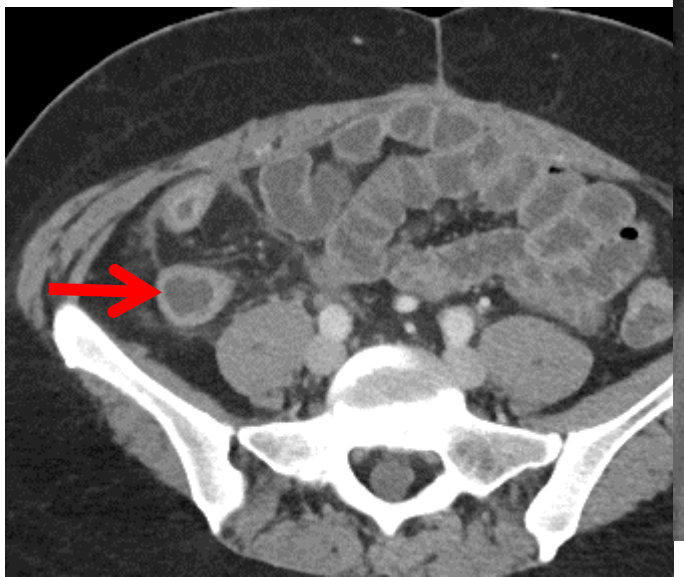
Usually compensated with collaterals

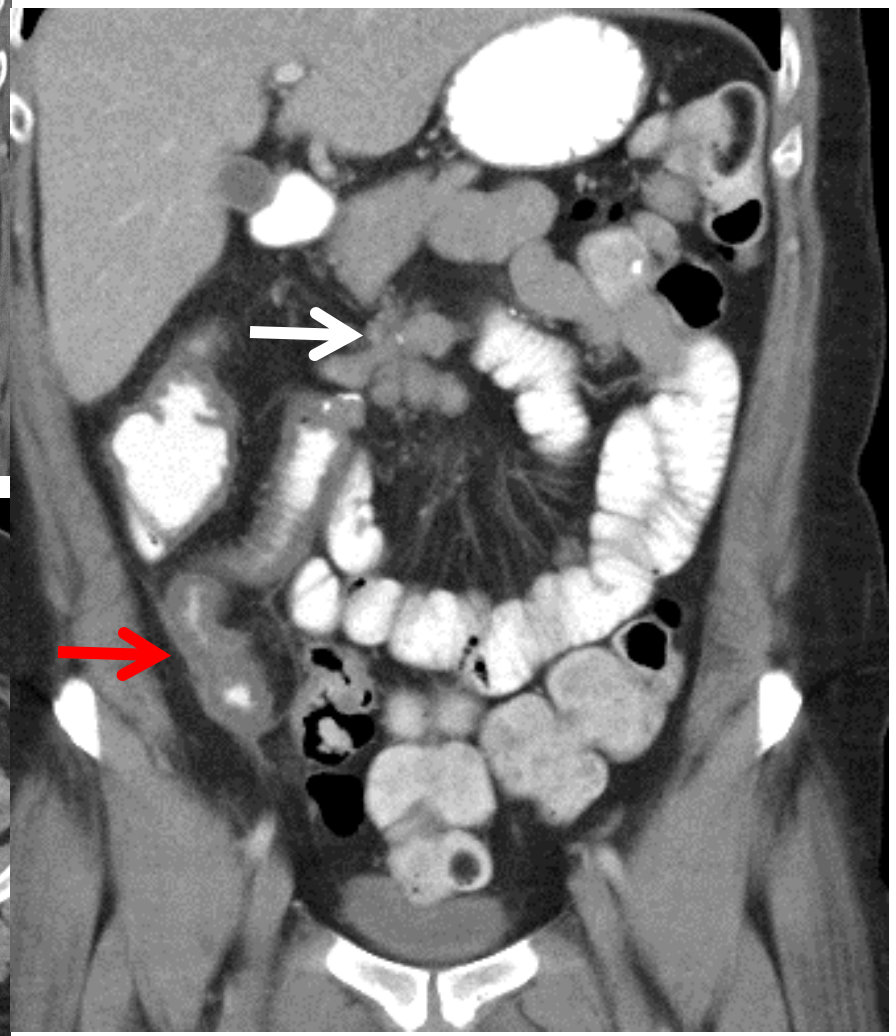
Peripancreatic collaterals between celiac and SMA



Arc of Riolan

49/F Ileal carcinoid with resection

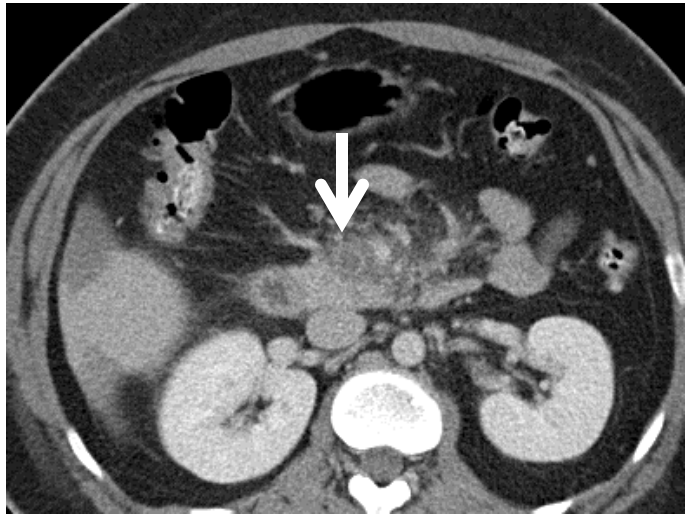




Chronic ischemic stricture with partial bowel obstruction

Mesenteric Venous Occlusion

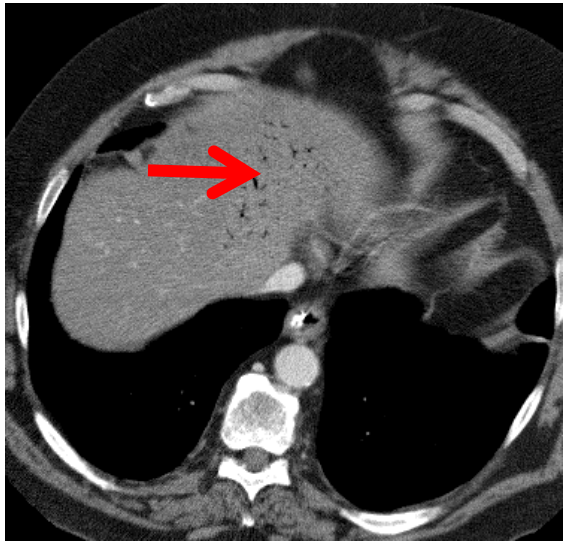
- 5-10% of ABI
- Primary
- Secondary
  - Hypercoagulable states
  - Cirrhosis
  - Polycythemia and Sickle cell
  - Bariatric surgery

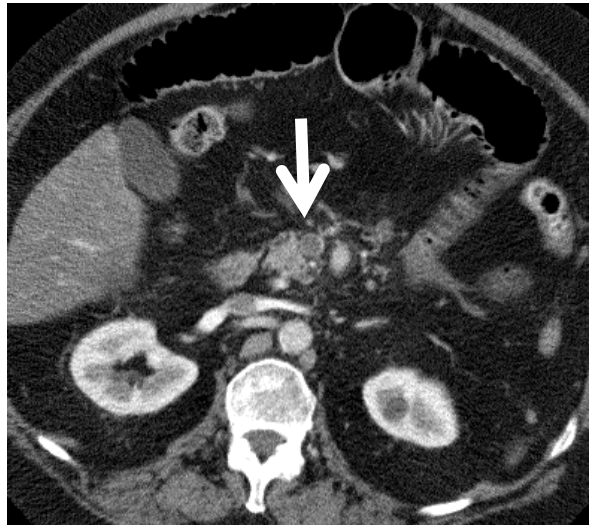


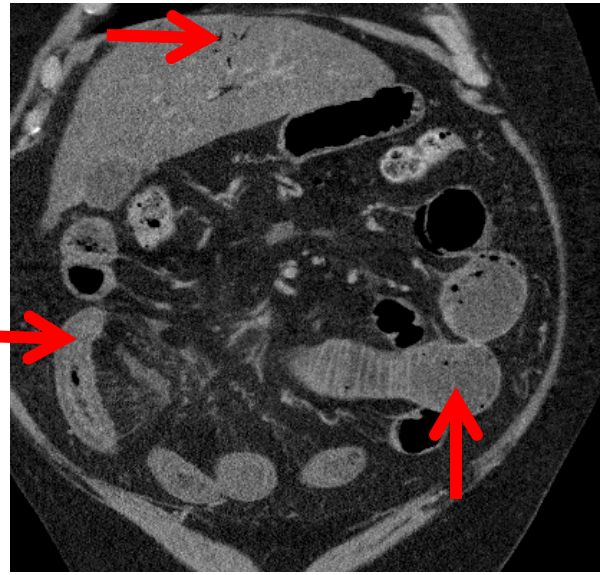
Acute Mesenteric Venous Occlusion

64/M abdominal pain, nausea and vomiting

Acute superior mesenteric vein thrombosis with pneumotosis and edema of proximal small bowel and portal venous gas

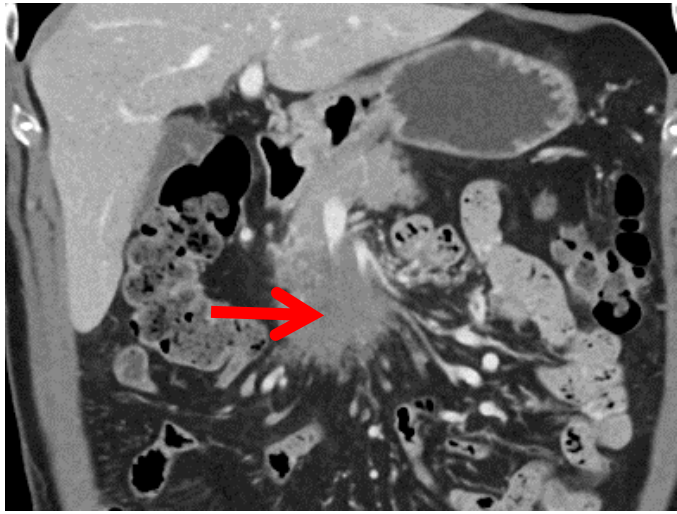






Secondary Venous Occlusion

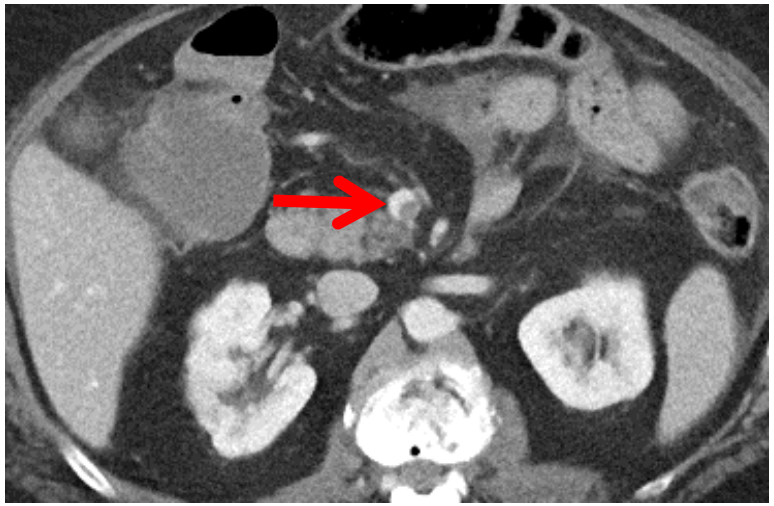
- Neoplastic infiltrative lesions
  - ➢Carcinoid, desmoid, pancreas cancer
- Inflammatory and infectious diseases
  - ➢Diverticulitis, appendicitis, pancreatitis

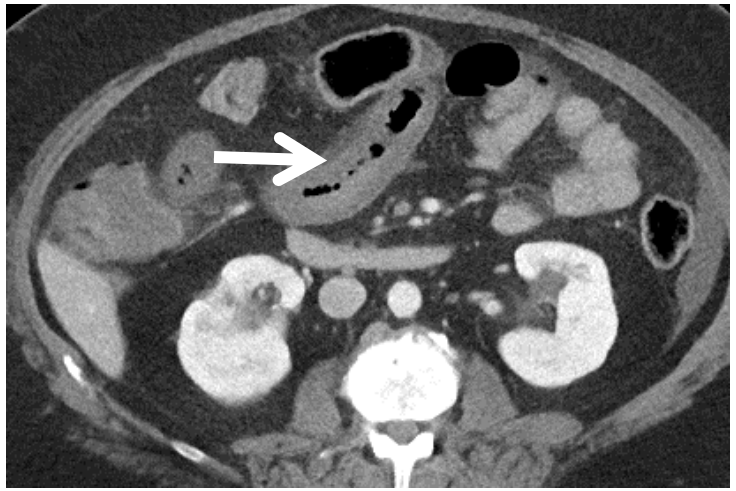


Pancreas cancer

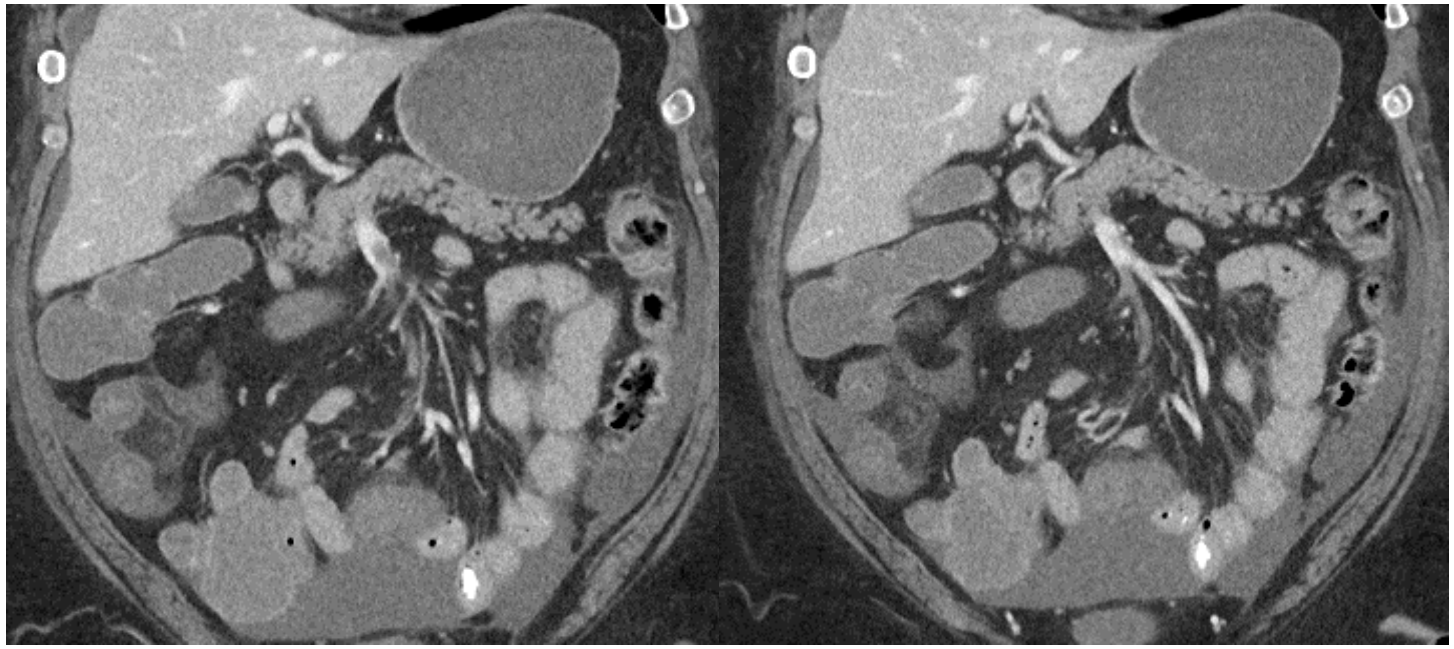
Acute pancreatitis

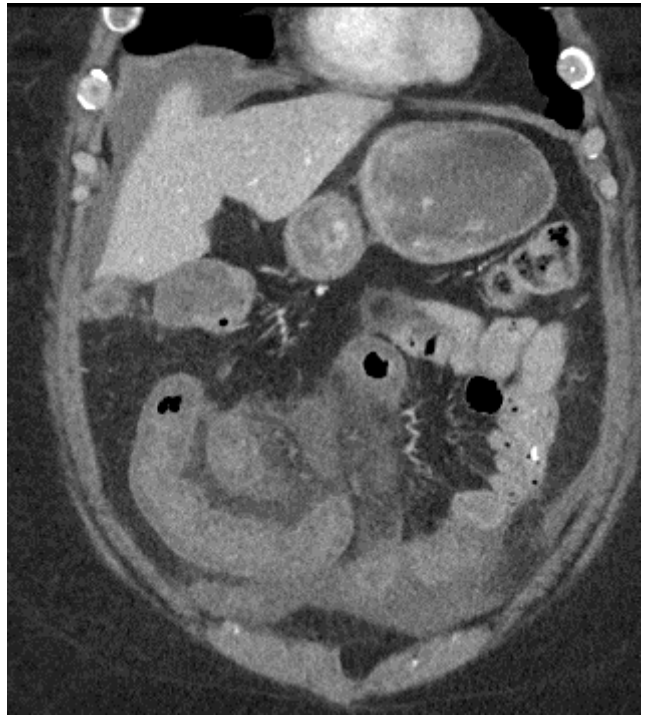
49/m severe abdominal discomfort and rectal bleeding 2 months status post surgery





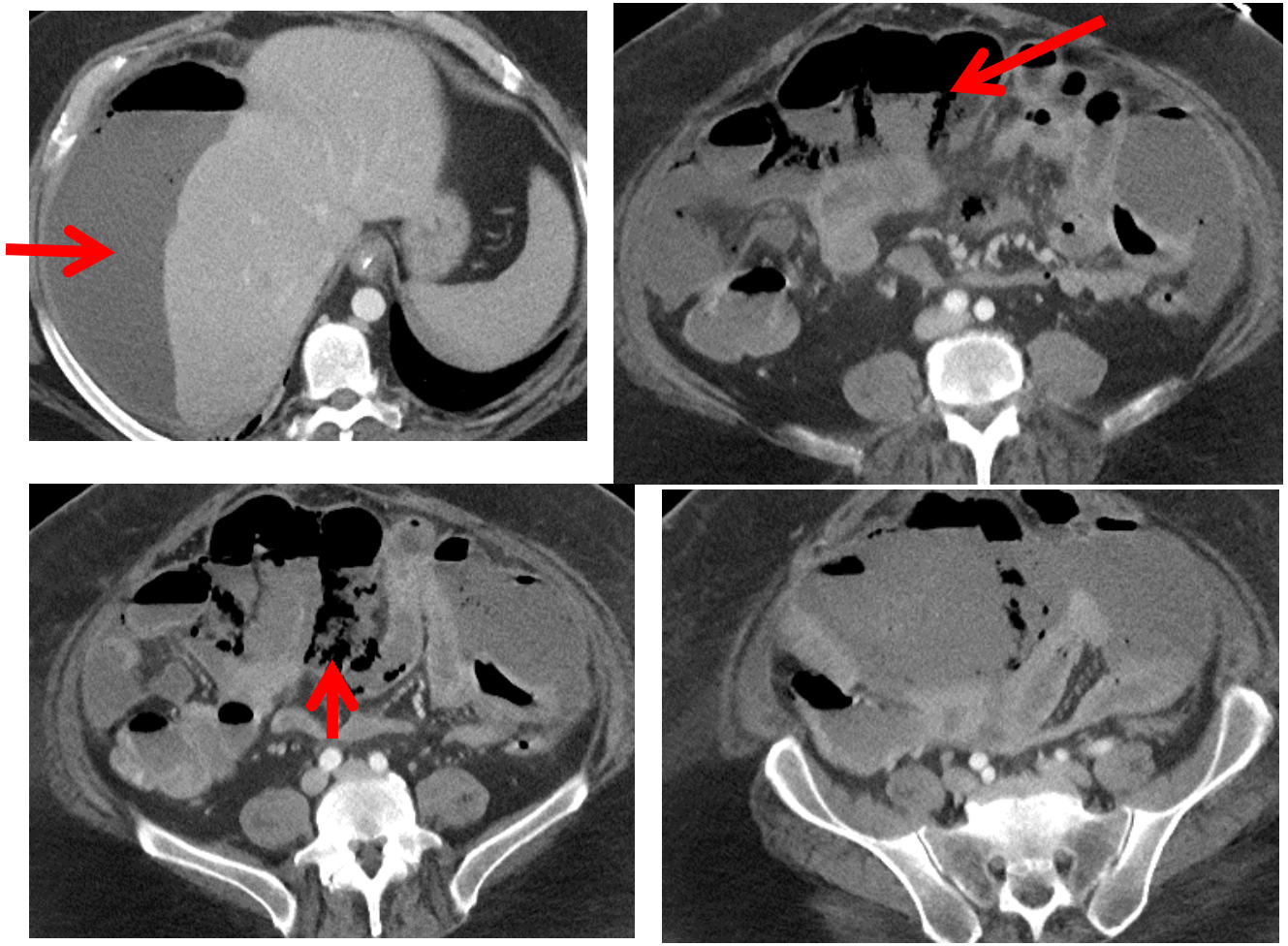
Lactate: 6mmol/l

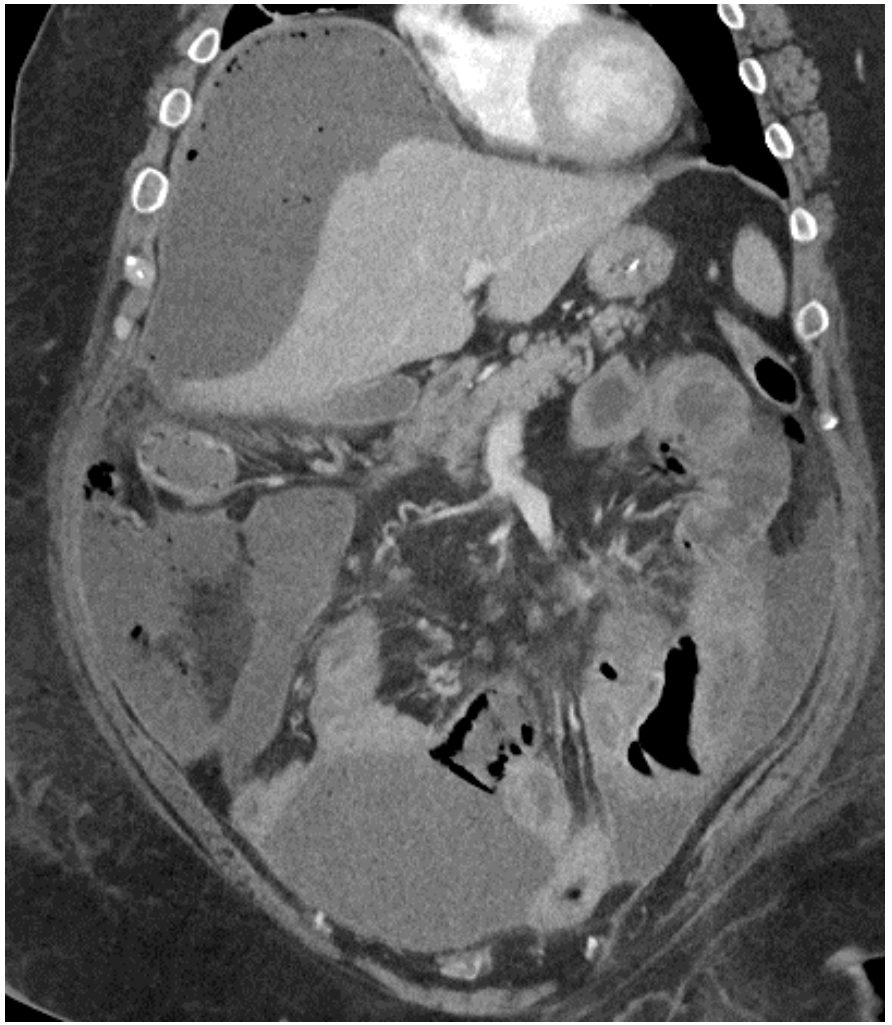




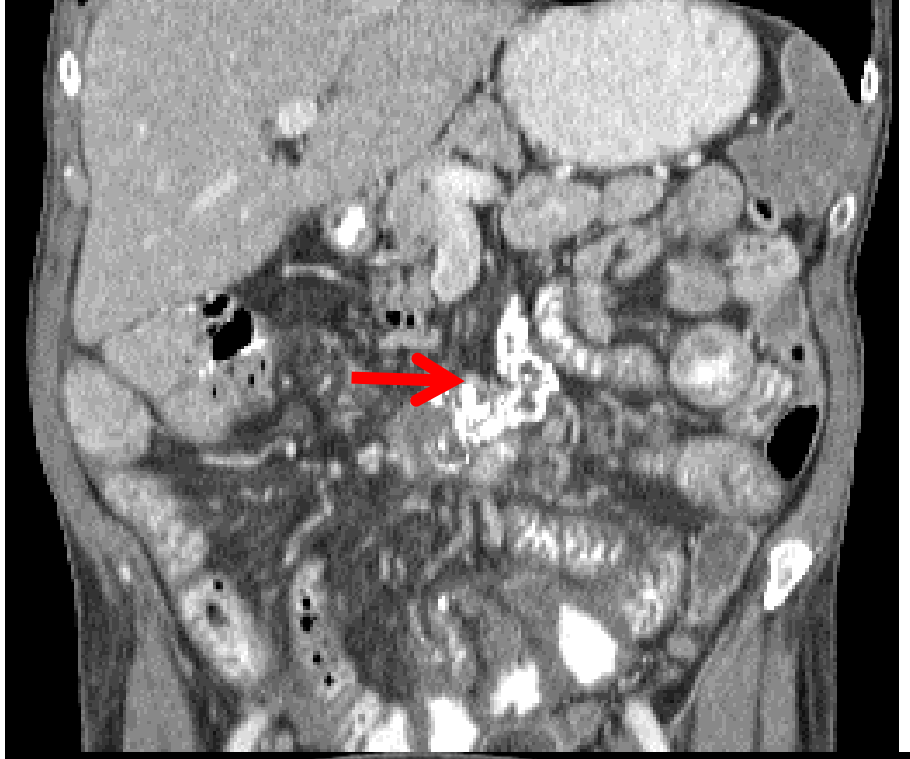
Lactate: 6mmol/l (Reference Range: 0.6 - 2.3 mmol/L)

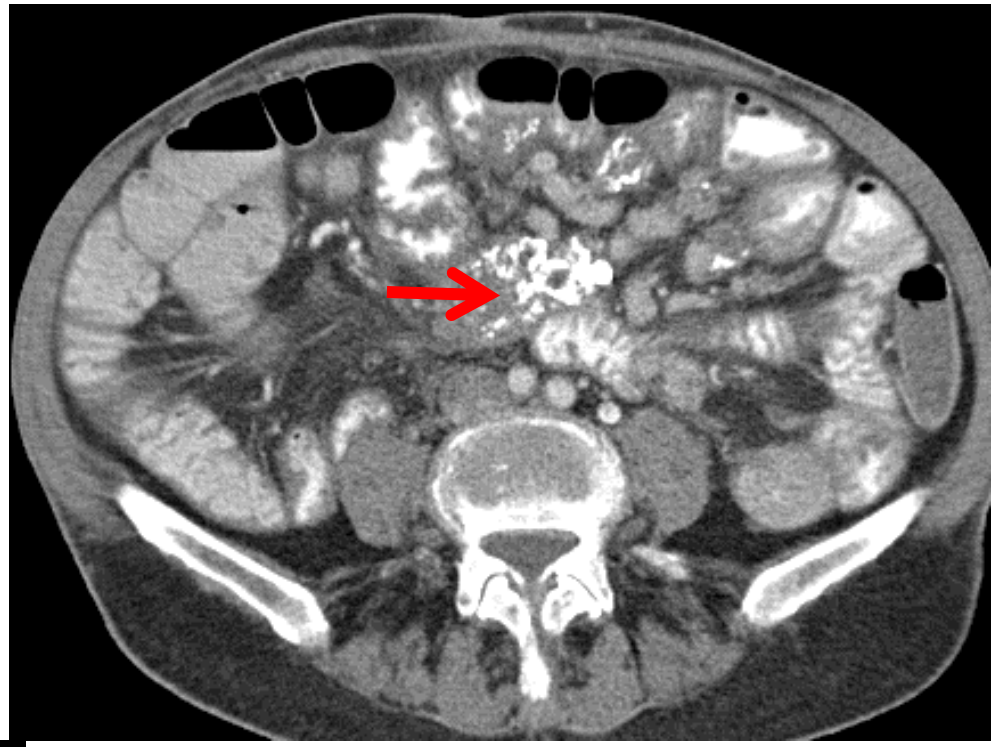
2 weeks later





1. Small bowel necrosis
2. Superior mesenteric vein thrombus
3. Intraabdominal sepsis

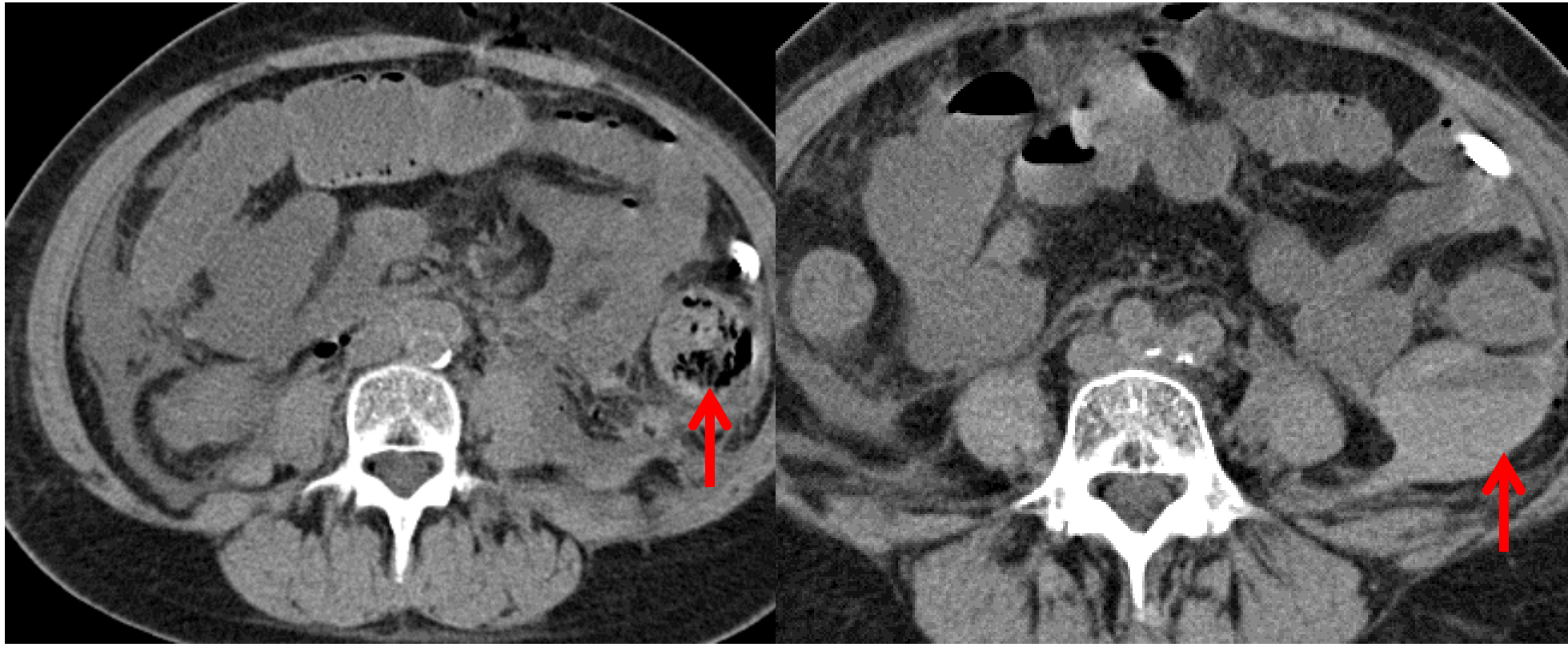




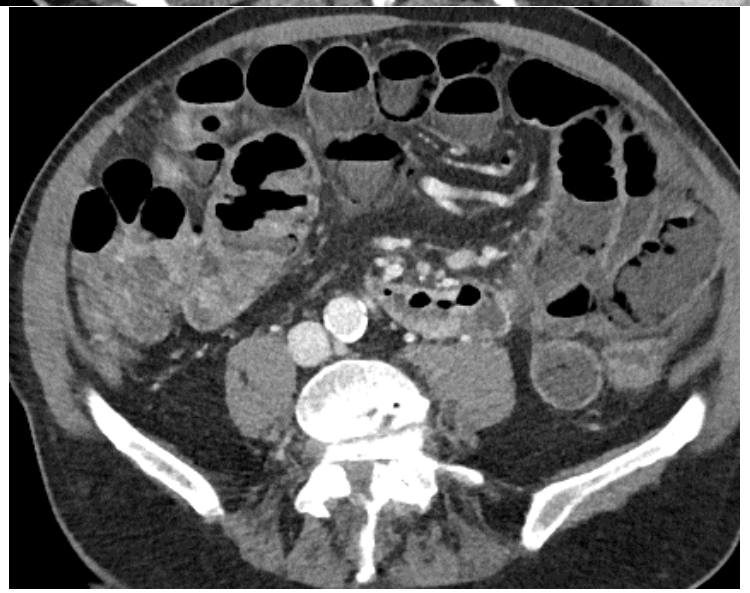
Chronic mesenteric venous occlusion due to sclerosing mesenteritis

Low Flow State Ischemia (NOMI)

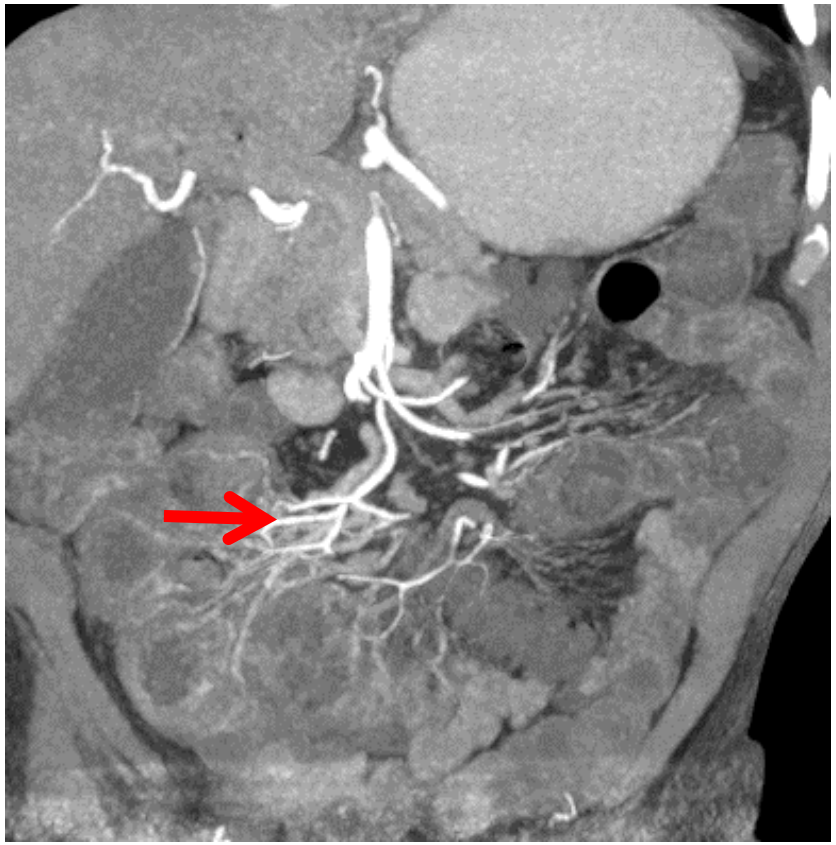
- 10-15%
- Non-occlusive
- Elderly patients
- **Dehydration**
- **ICU setting**
- Mesenteric vasoconstriction
- High mortality



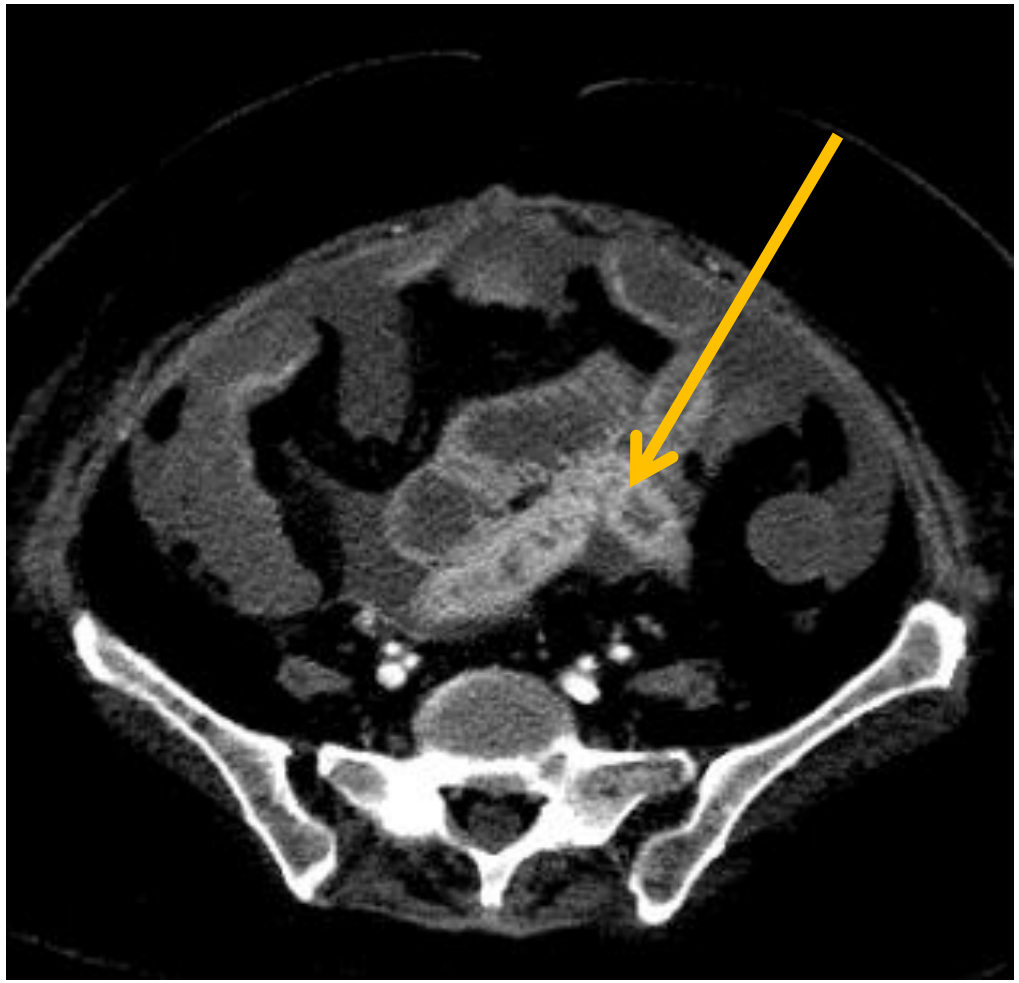
80/M with diarrhea, abdominal pain



Hypoperfusion associated vasoconstriction

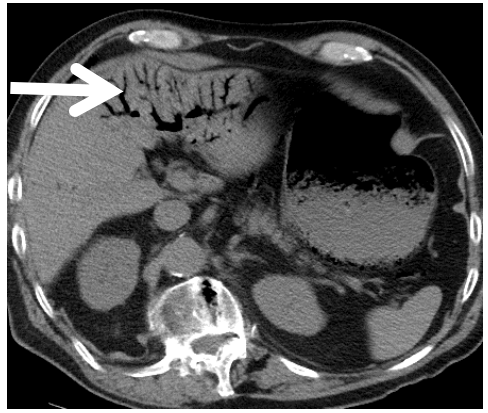


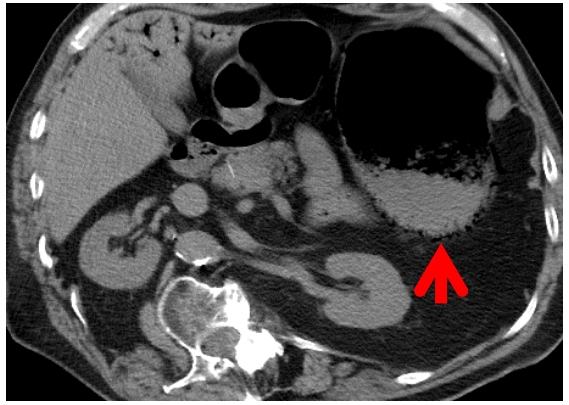
Increased enhancement of ischemic bowel loop probably due to reperfusion

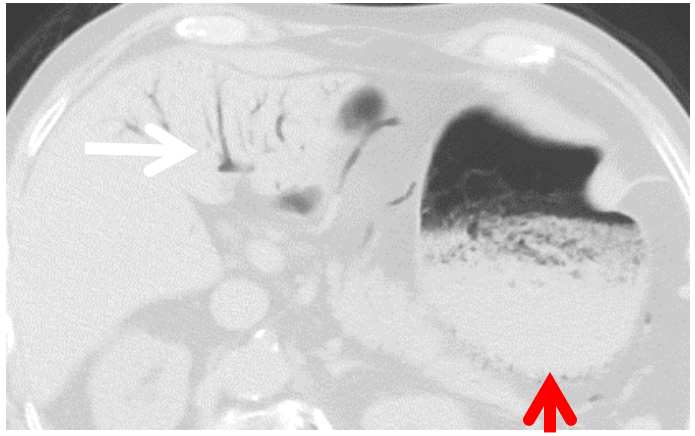


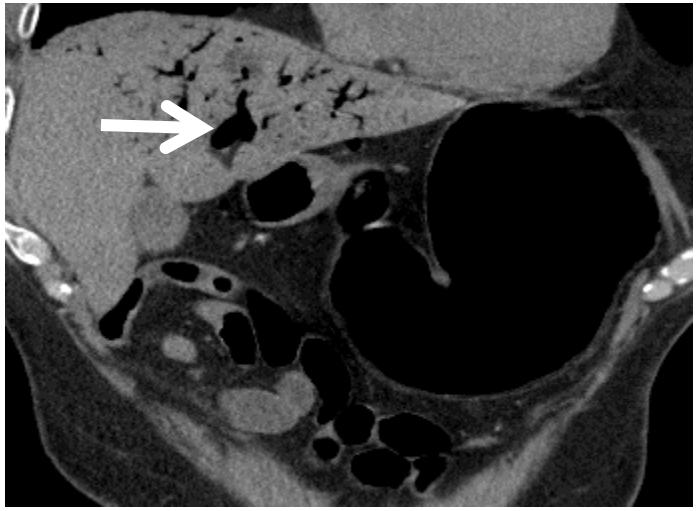
78/M total proctocolectomy, end ileostomy, high stoma output

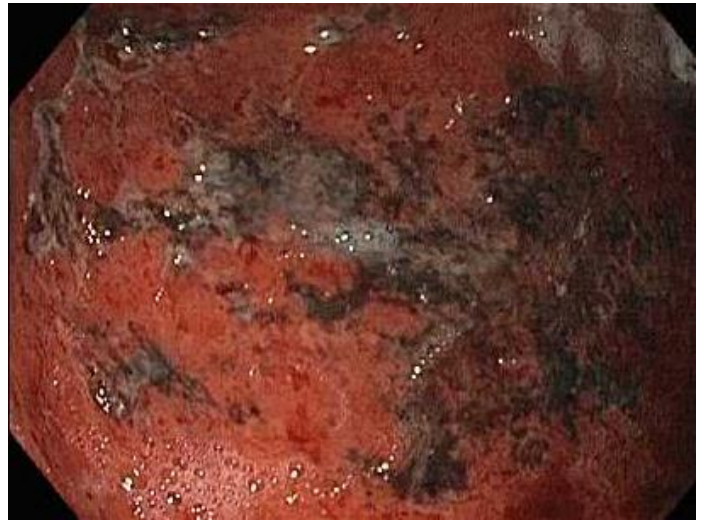
Gastric hypoperfusion resulting in ischemia due to dehydration









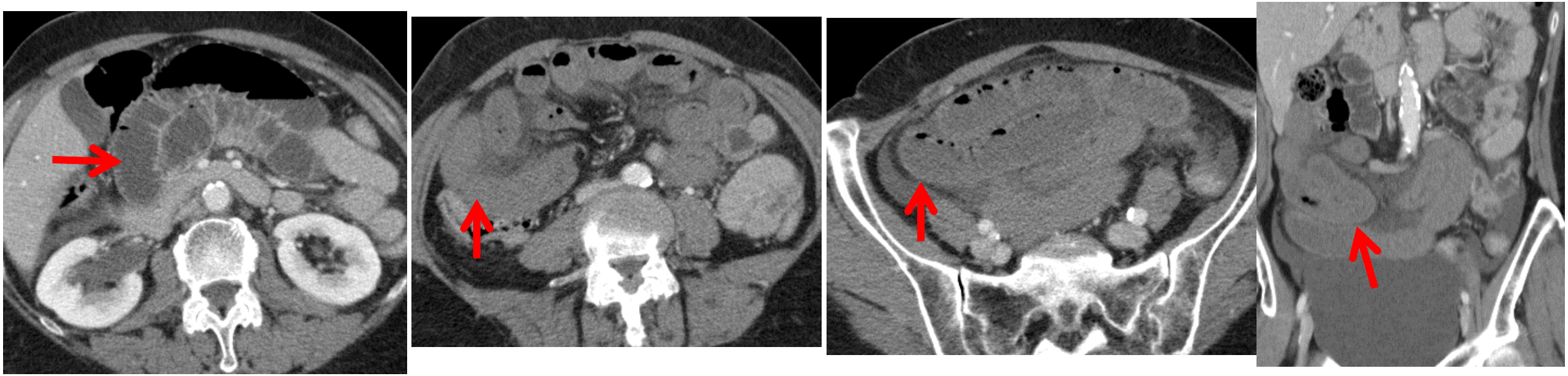


Special Scenarios

Closed Loop Obstruction with Ischemia

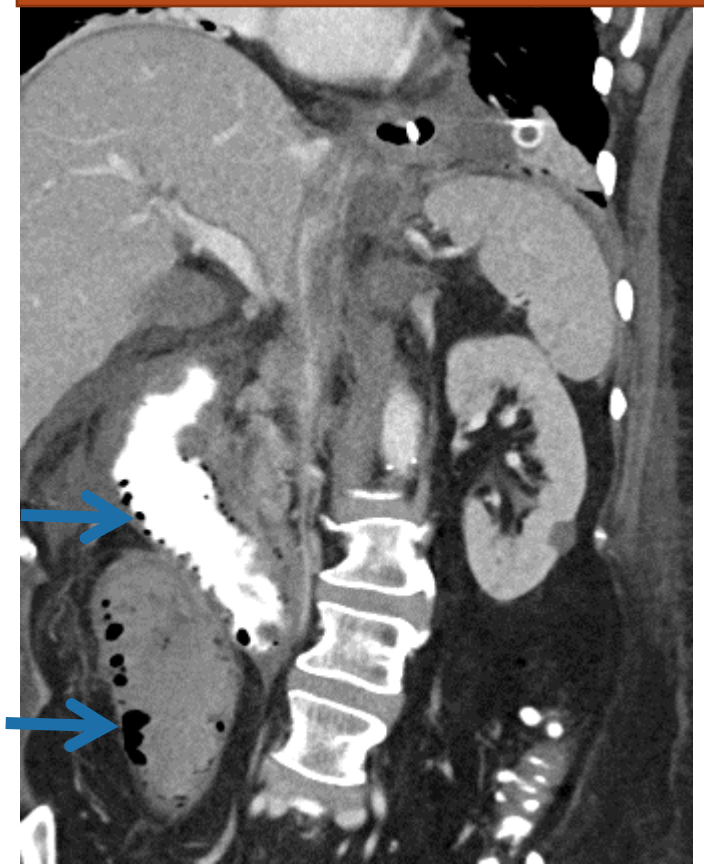
- 60 to 80% have bowel ischemia or necrosis
- Predicting ischemia in bowel obstruction challenging
- High attenuation of bowel wall, intraperitoneal air, reduced enhancement of mesenteric arteries/bowel, and small-bowel feces signs show high specificity

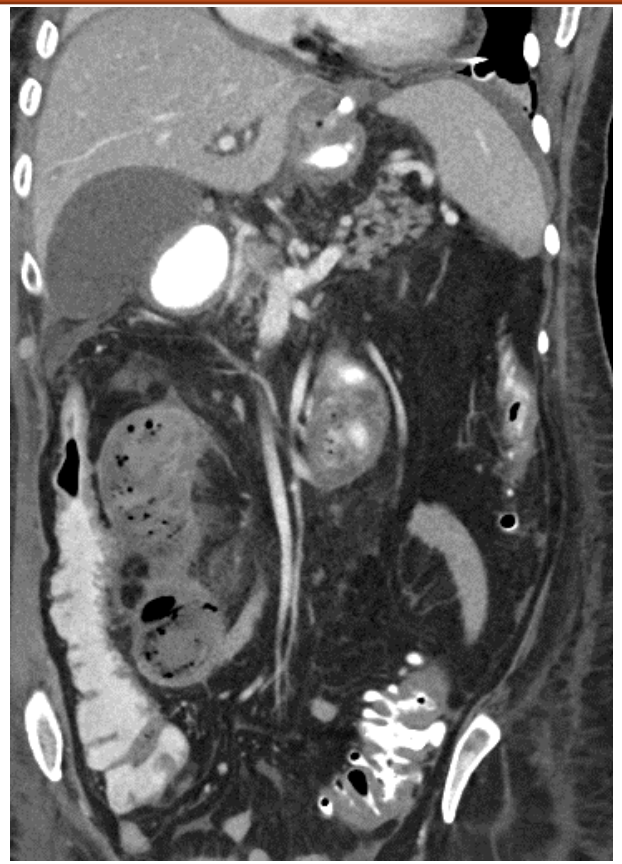
69/f with sudden onset acute abdominal pain



Adhesive band with concomitant volvulus causing bowel hemorrhage & ischemia

Post-procedural Ischemia

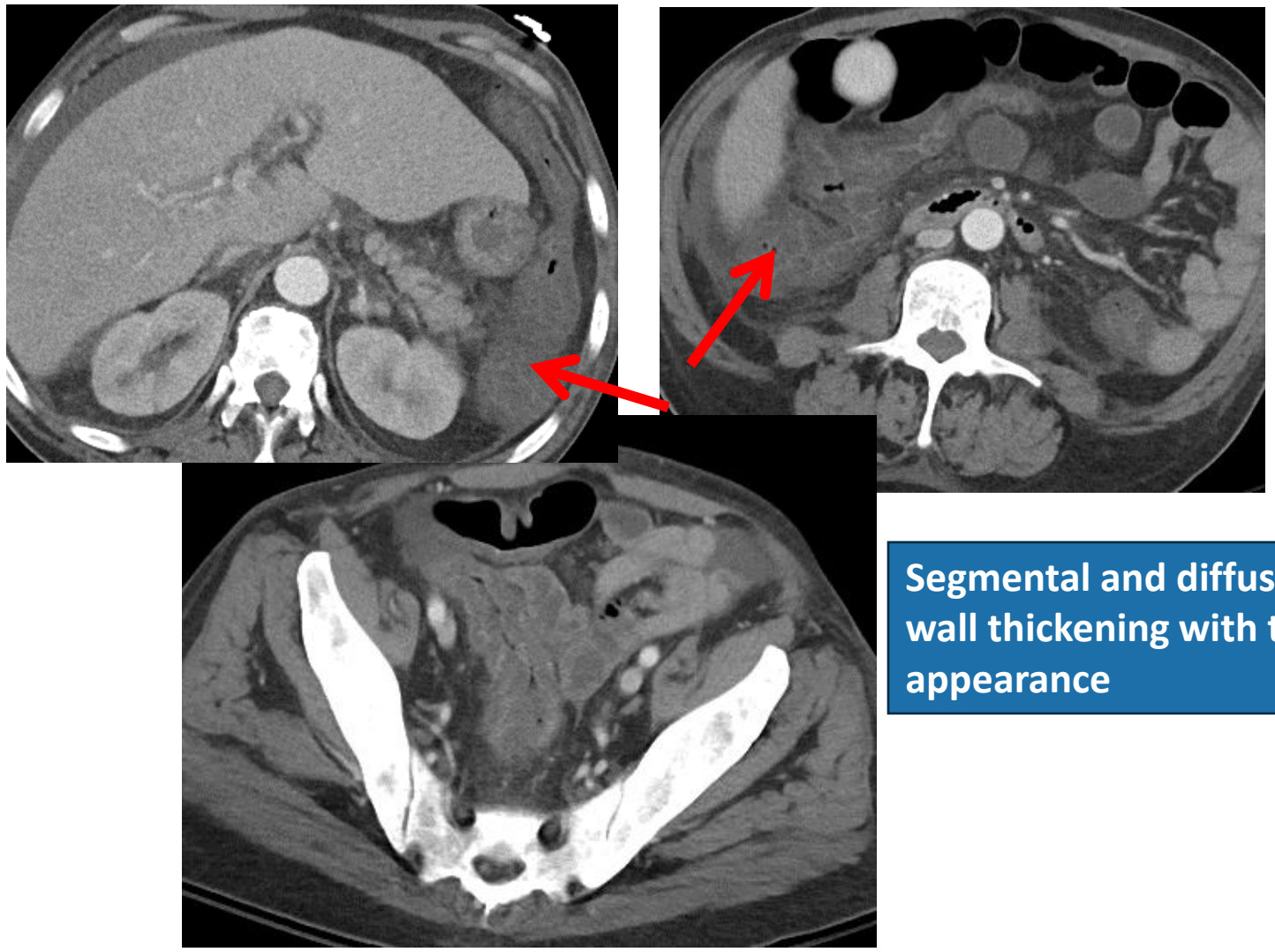




Unexplained abdominal pain after any invasive procedure should lead to suspicion and investigation of AMI

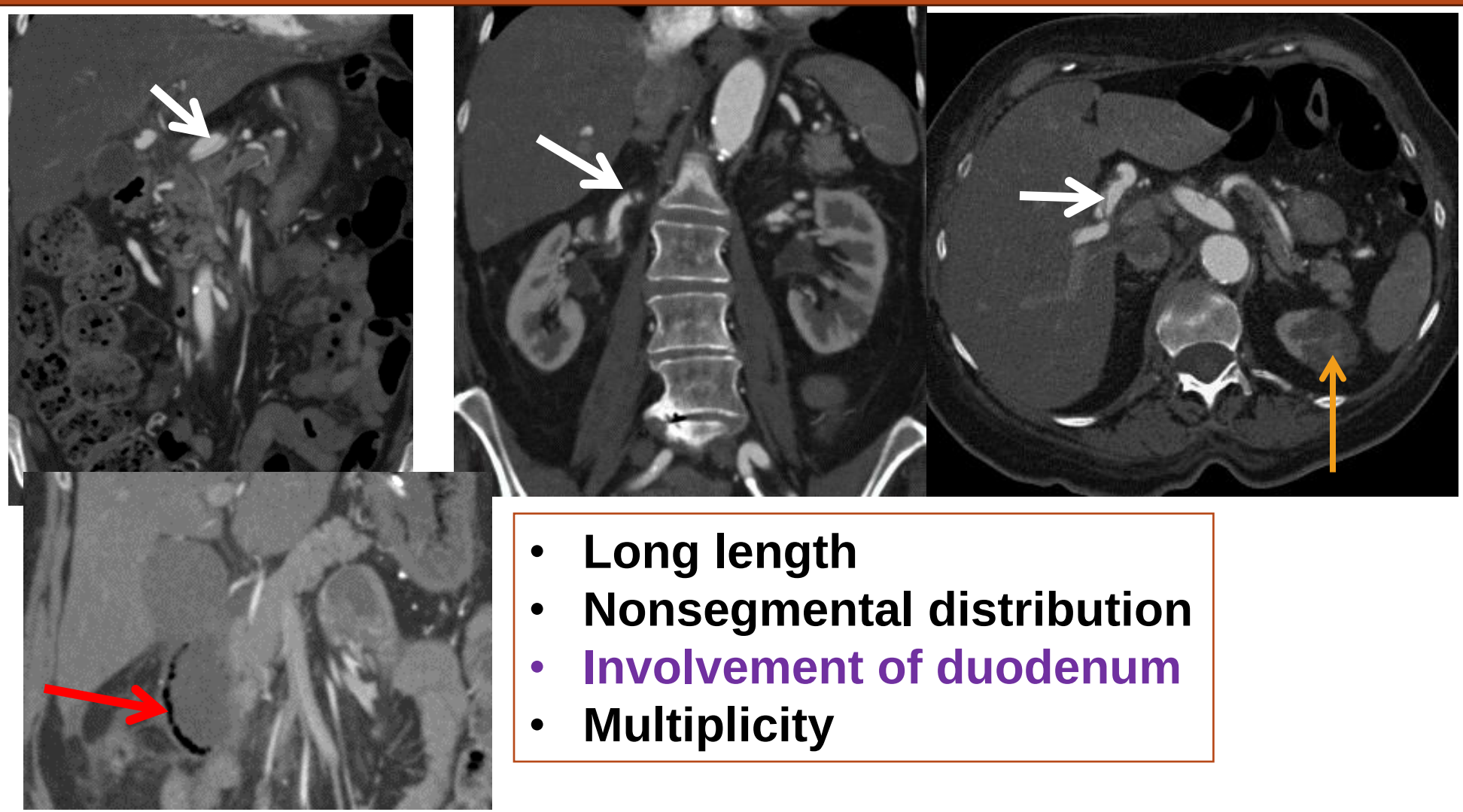
Acute gastrointestinal vaso-occlusive ischemia in sickle cell disease

- Acute abdominal crisis
- Micro-occlusion of post-capillary venules
- Colonic involvement
- Renal insufficiency



Segmental and diffuse bowel wall thickening with target appearance

Vasculitis: Poly Arteritis Nodosa (PAN)

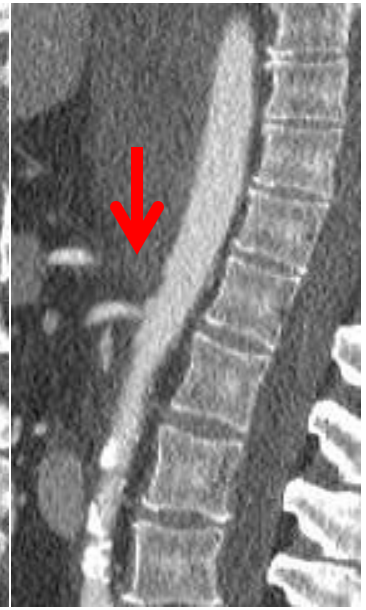
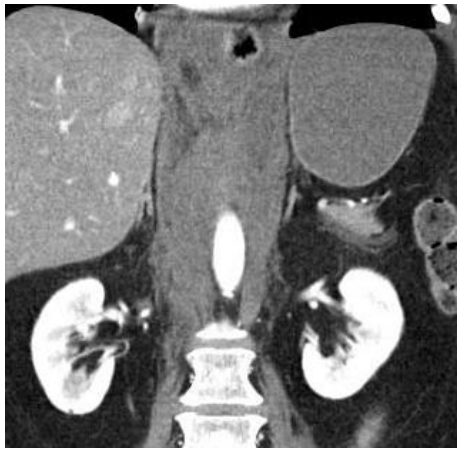


- **Long length**
- **Nonsegmental distribution**
- **Involvement of duodenum**
- **Multiplicity**

Trauma: Celiac Artery Transection

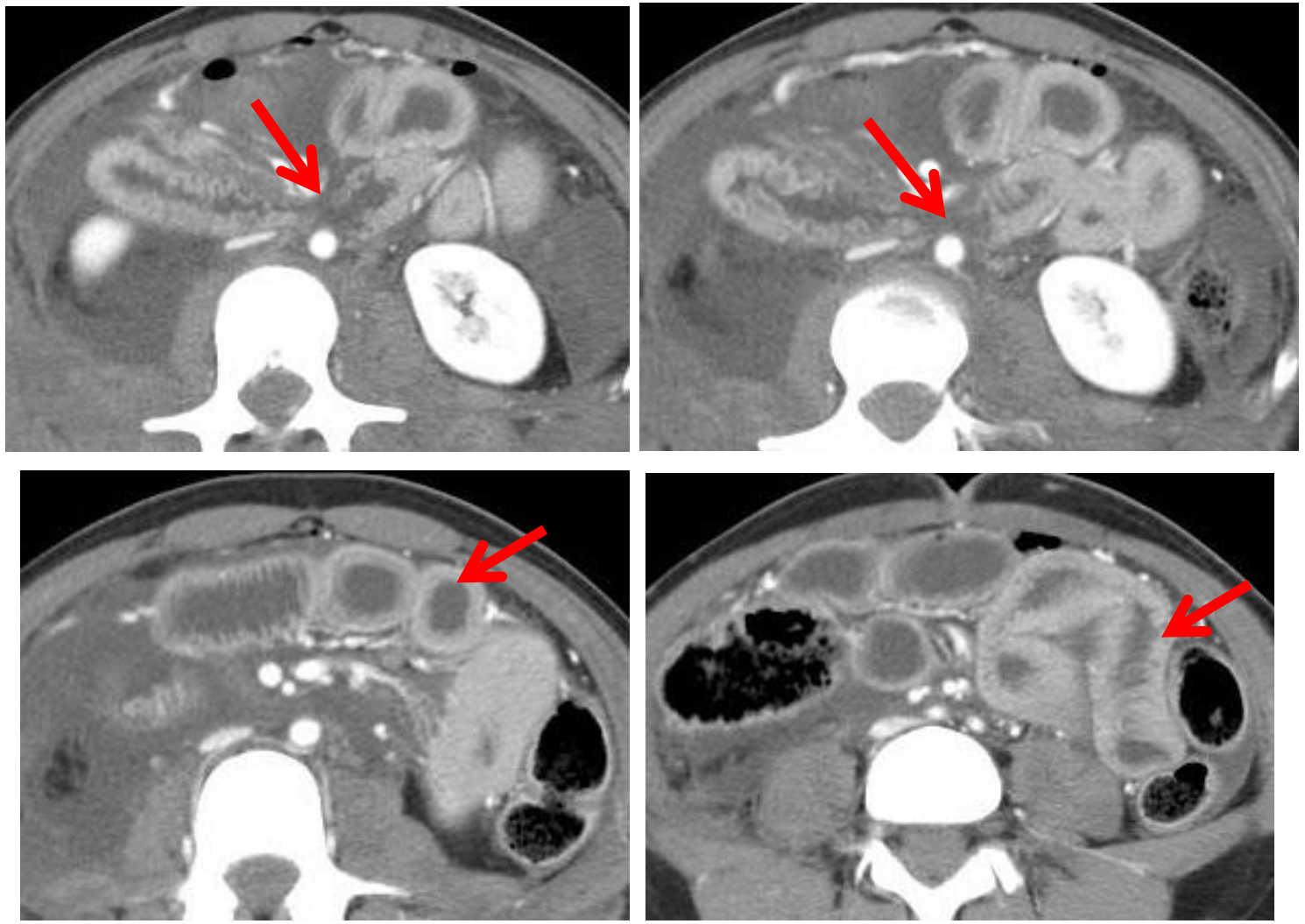




- **Direct damage to major vessels**
- **Extensive hemoperitoneum**

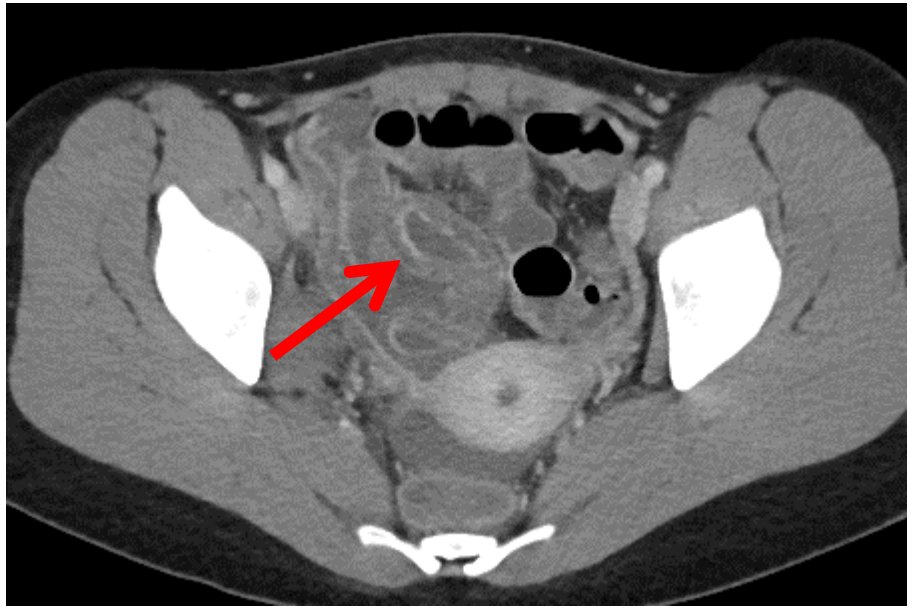
Trauma: Jejunal Avulsion at Ligament of Treitz



- **Focal deprivation of blood supply secondary to tear in mesenteric attachment contributes to development of posttraumatic ischemia**
- **Leads to ischemic stricture**

Radiation Associated

18/F Ewing sarcoma, radiation, abdominal pain

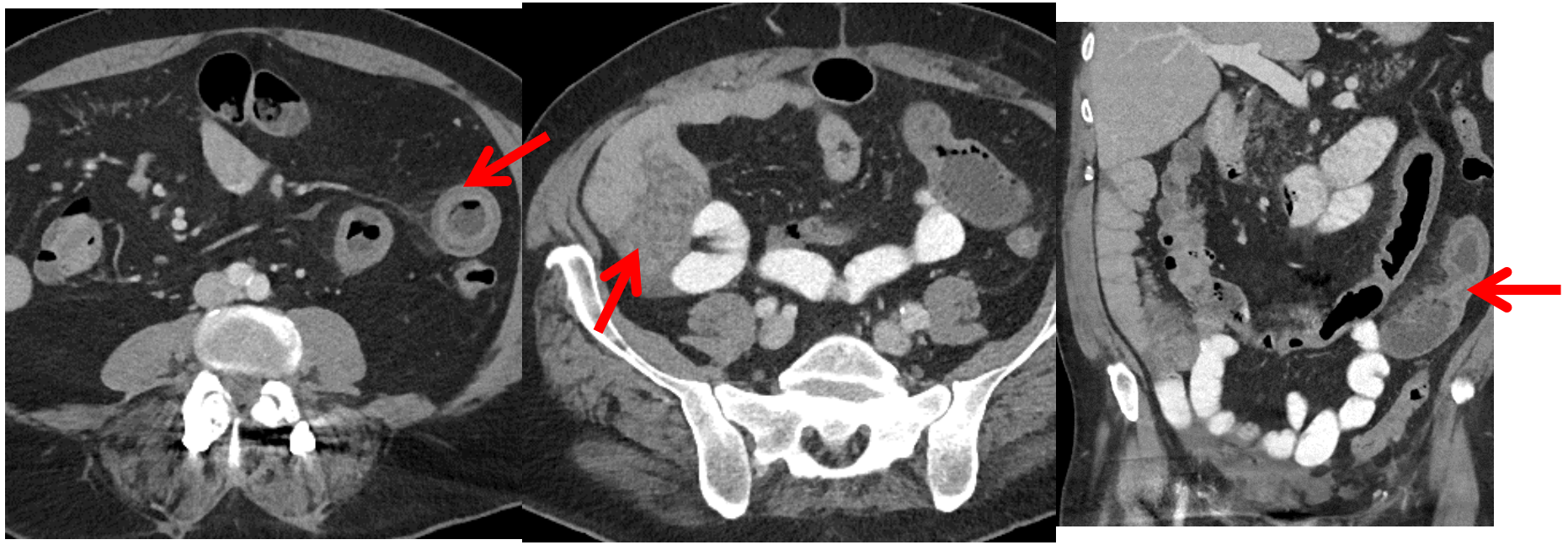


- **≥4,500 cGy radiation**
- **Bowel changes confined to radiation port**
- **May complicate with stricture or fistula formation**

Pitfalls

Mimickers	CT Findings
Vasculitis	Occlusion of vessels
Inflammatory, infectious or malignant processes	Bowel wall thickening
IBD, Radiation, GVHD, Nutrition	Bowel wall enhancement
Ileus, pseudo-obstruction	Bowel dilatation
Air trapped between the bowel wall and residual fluid, benign causes of pneumotosis	Pneumotosis and portal venous gas

Acute exacerbation of celiac disease

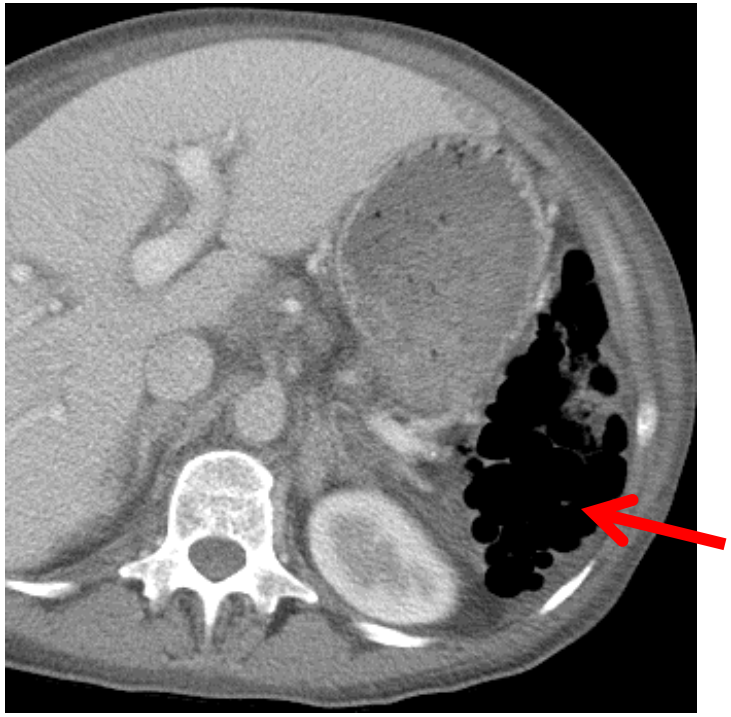


Bowel wall thickening and edema

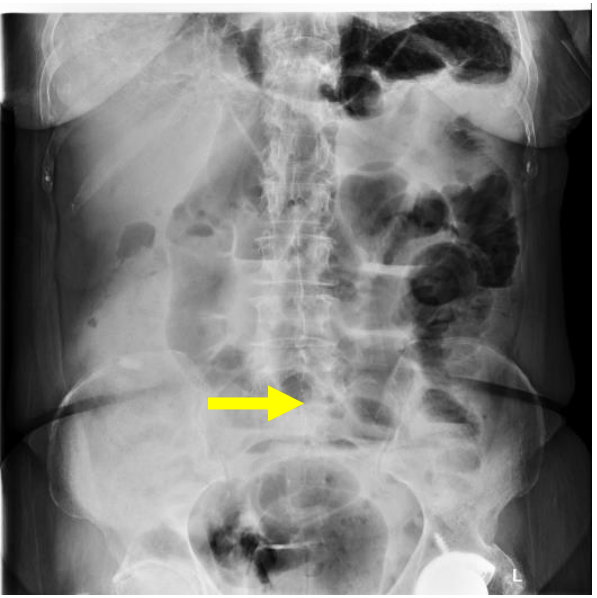
- **Infectious/inflammatory/ischemic**
- **ACE-inhibitor related angioedema**
- **Hypoproteinemia**

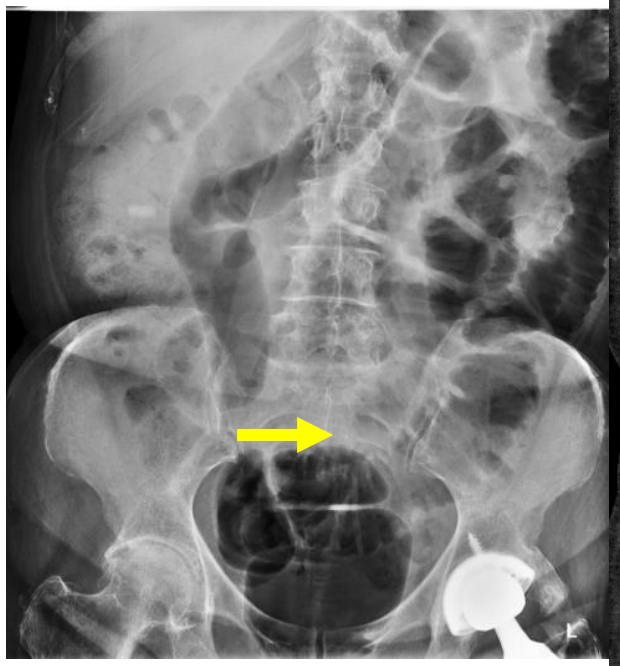
55/m Acute on chronic nausea, vomiting, and abdominal pain

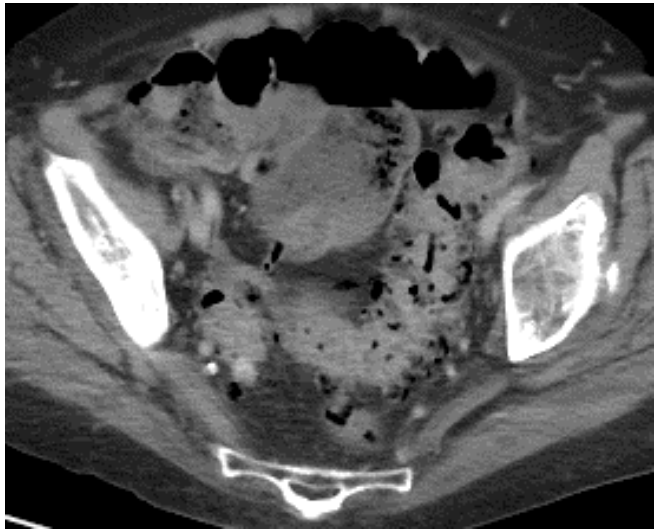
Pneumatosis cystoides intestinalis



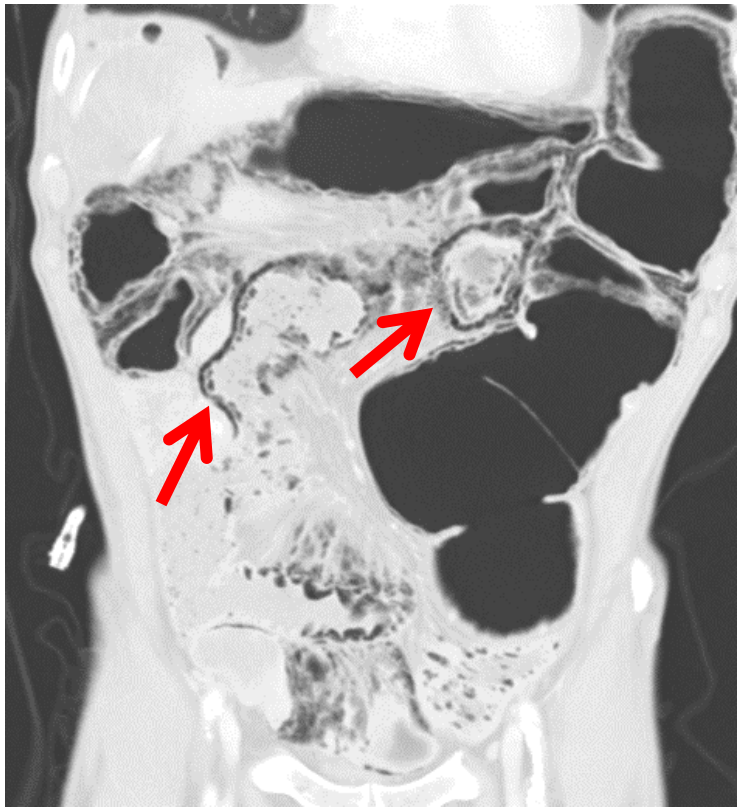
Benign pneumatosis of Scleroderma







J-tube associated pneumatosis



Treatment

Endovascular procedure

Open surgery

Intraoperative retrograde revascularization

Anticoagulation

Vasodilators

Underlying cause

Clinical presentation, preoperative comorbidity, and life expectancy

Conclusion

- CT is diagnostic test of choice for detecting AMI
- Evaluation of arteries and veins leading to and from diseased bowel can reveal etiology of bowel ischemia
- Important to distinguish from other mimickers
- **Treatment of underlying etiology improves outcomes**