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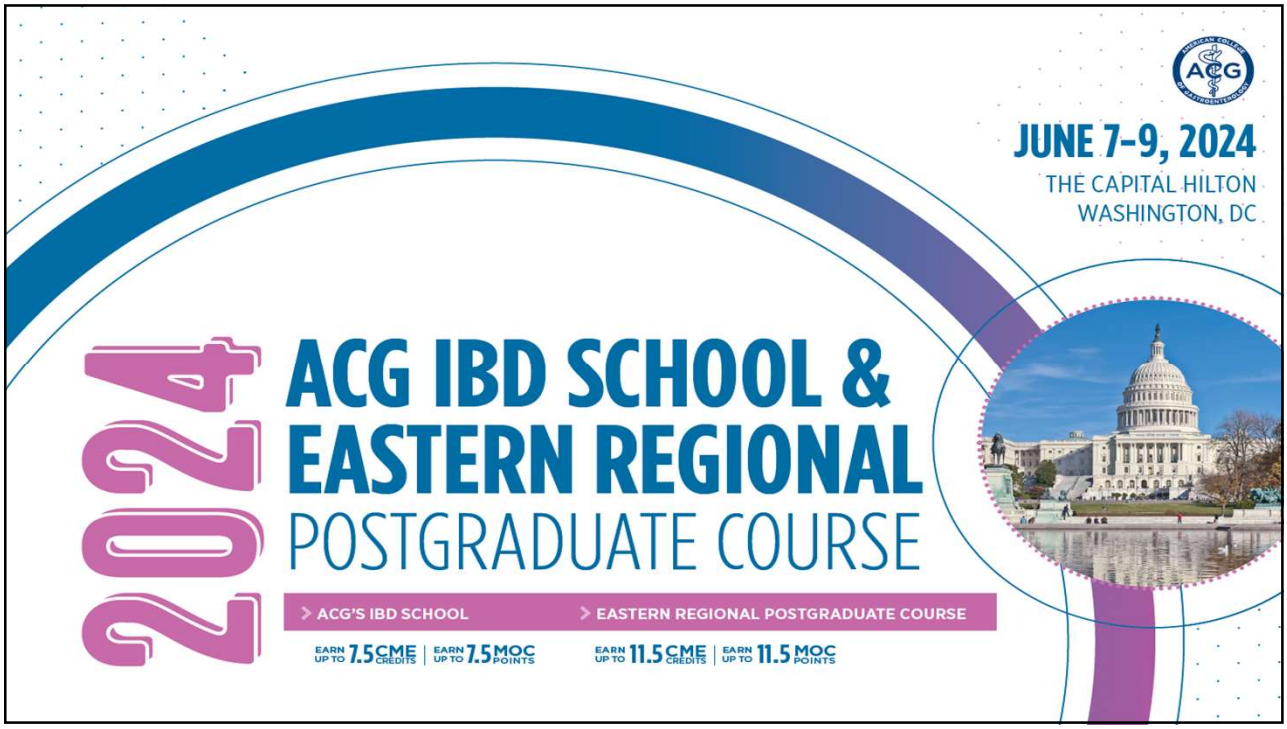
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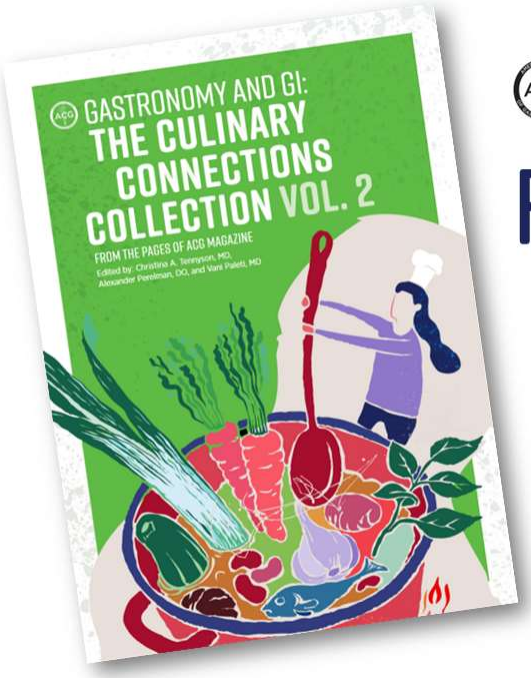


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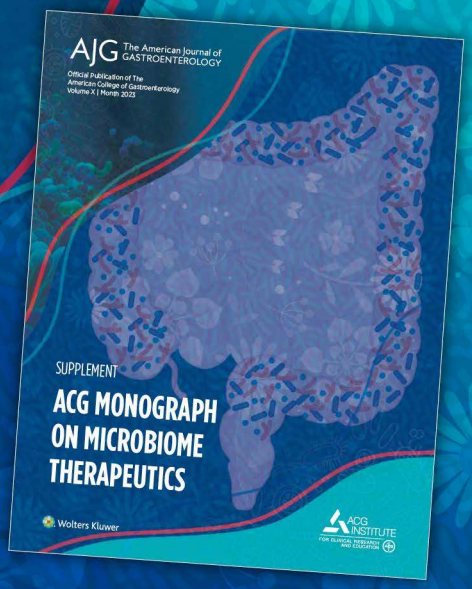


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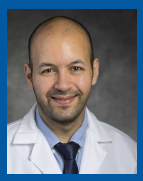
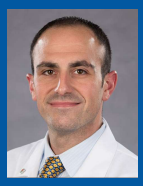


**Week 8 – Thursday, February 22, 2024**
Interpretation and Therapeutic Implications of Physiologic Testing in the Management of Esophageal Disorders
Faculty: Dustin A. Carlson, MD, MSCI
Moderator: Fady Haddad, MD
At Noon and 8pm Eastern




**Week 9 – Thursday, February 29, 2024**
Exocrine and Endocrine Complications of Pancreatitis
Faculty: Jodie A. Barkin, MD, FACG
Moderator: Tara Keihanian, MD, MPH
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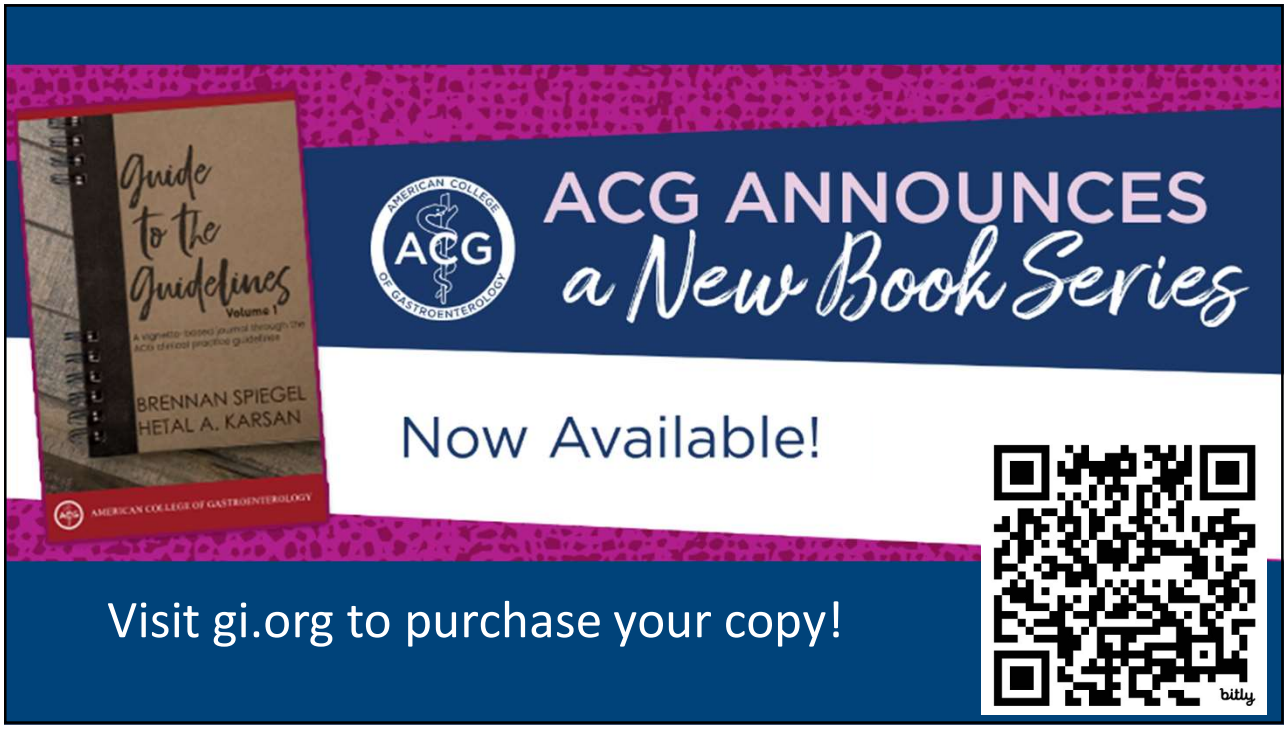


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# Disclosures

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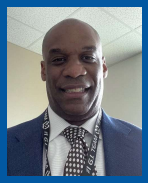

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# A New Organ: The Mesentery and Mesenteric Diseases

Monjur Ahmed, MD, FACG
Professor of Medicine
Thomas Jefferson University, Philadelphia

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# Learning Objectives

- Anatomical and functional aspects of mesentery.
- Different mesenteric diseases.
- Epidemiology, clinical aspects, diagnostic tools and management.

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# Introduction

- Mesentery - 79$^{th}$ organ in human body.
- The organ in which all abdominal digestive organs develop.
- First described in 1508 by Leonardo da Vinci.
- In 1885, Sir Frederick Treves presented mesentery as fragmented structure between small bowel and large bowel.
- Discovered as a new organ by Professor of Surgery J. Calvin Coffey at the University Hospital Limerick, Ireland in 2017.

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# Mesentery - anatomy

- A single, substantive and continuous organ that attaches the intestine to the posterior abdominal wall.
- It extends from the duodenojejunal flexure to the rectum.
- The organ is a double fold of peritoneum containing two layers continuous with both parietal and visceral peritoneum.
- The two layers are separated by loose connective tissue.
- It contains blood and lymph vessels, nerves, lymph nodes, and fat.

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# Anatomical division

- Mesentery proper or small intestinal mesentery – SMA.
- Right mesolcolon – right colic artery.
- Transverse mesocolon – middle colic artery.
- Left mesocolon – left colic artery.
- Mesosigmoid – sigmoid arteries.
- Mesoappendix – appendicular artery.
- Mesorectum – superior rectal artery.

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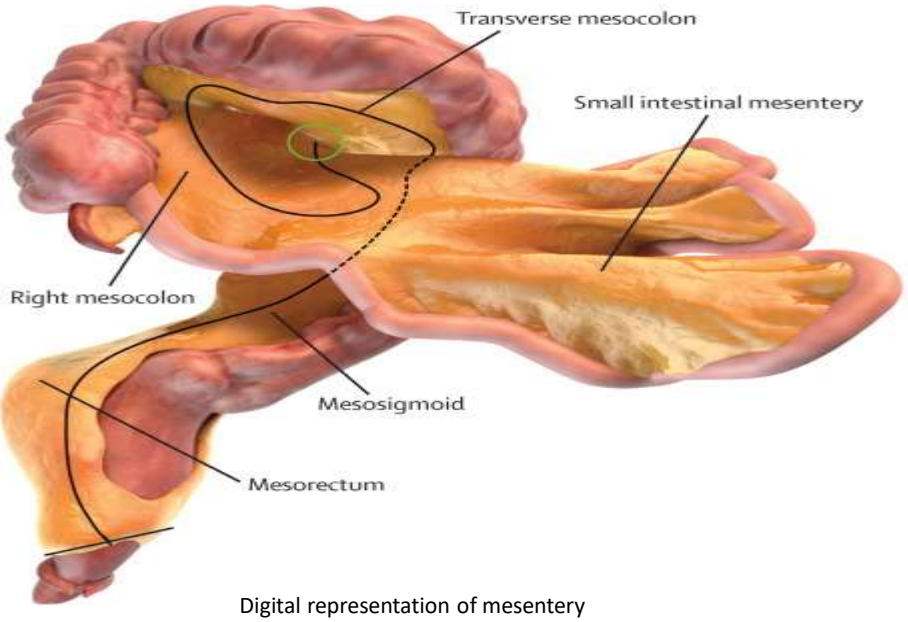


Digital representation of mesentery

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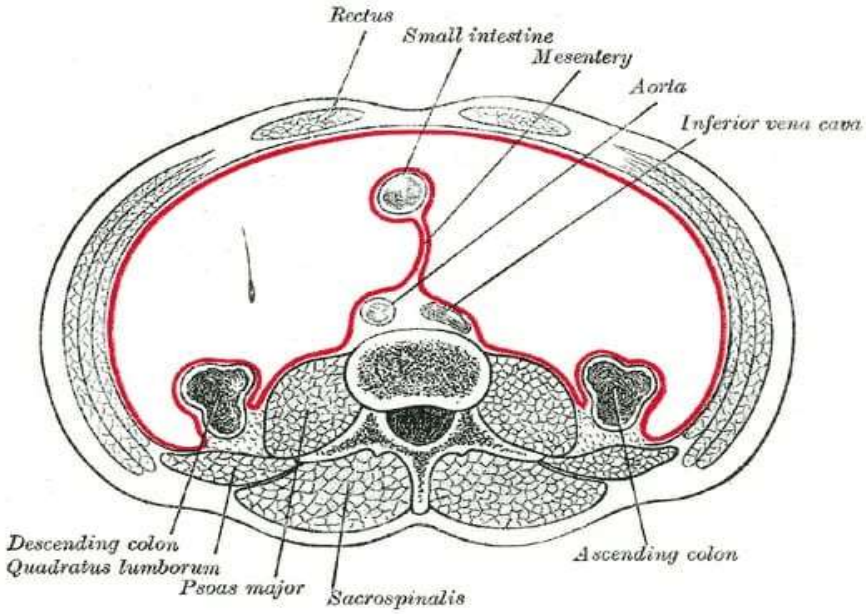


Schematic representation of mesentery

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## Functional Aspects of Mesentery

- Mechanical: Attaches the intestine to the posterior abdominal wall, maintaining conformation in different postures, and preventing the intestine from collapsing into the pelvis.
- Lympho-vascular communication: between the intestine and rest of the body.
- Immune hemostasis: Mesenteric lymph nodes (MLNs) can trap live intestinal bacteria and viruses, and regulate migration of T cells, B cells, dendritic cells and natural killer cells to intestinal mucosa.
- Food allergy and tolerance: MLNs as part of gut associated lymphoid tissue (GALT) respond to food allergens and play an important role in inducing tolerance to food proteins.
- Storage of fat: Mesentery stores fat which can be used in different metabolic and nutritional needs. Mesenteric fat is connected to serosa and muscularis propria directly, acts as a gate of communication between the intestine and other systems of the body.
- Secretion of CRP: Mesenteric adipocytes can secrete C-reactive protein (CRP) in response to local inflammation and bacterial translocation to mesenteric fat.

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- Mesenteropathy: when the mesentery or its contents get involved in a benign or malignant disease.
- Primary mesenteropathy: Disease originating in the mesentery with or without involvement of other organs.
- Secondary mesenteropathy: Disease originating in other organs with subsequent progression and involvement of the mesentery.
- Indeterminant mesenteropathy: when it remains unclear whether the disease originated from the mesentery or outside

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**Mesenteropathies:**

1. **Non-vascular mesenteropathies:**

- Mesenteric defect
- Inflammatory mesenteric diseases: mesenteric adenitis, mesenteric panniculitis.
- Mesenteric fibrosis.
- Mesenteric adiposity.
- Mesenteric cyst.
- Mesenteric volvulus.
- Mesenteric hematoma.
- Mesenteric neoplasms.
- Heterotopic mesenteric ossification

2. **Vascular mesenteropathy** – Ischemic Bowel Disease.

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**Mesenteric defect**

- Congenital or acquired – 2 to 3 cm defect – internal hernia.
- Abdominal pain, intestinal obstruction.
- More common in pediatrics than adults.
- Challenging to diagnose preoperatively.
- CT may show transition point but not the defect.
- Rx – reduction of hernia and closure of the defect.

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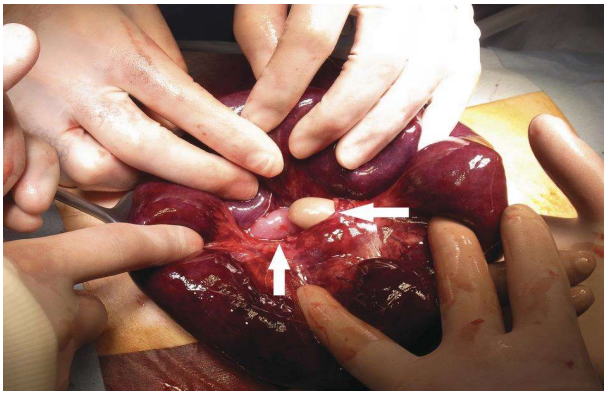

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# Mesenteric adenitis

- Non-specific inflammation of a cluster of 3 or more mesenteric lymph nodes in the RLQ of abdomen - (8 mm or more in short axis in at least one on imaging).
- Exact incidence unknown but 20% of patients going to the OR for appendectomy.
- Primary mesenteric adenitis – without underlying intra-abdominal inflammatory process.
- Non-specific mesenteric adenitis - more common in children, adolescents and age >64.
- RLQ pain and tenderness, fever, leucocytosis, ↑CRP.
- Treatment: supportive care with IV hydration and NSAID.
- Secondary mesenteric adenitis – appendicitis, diverticulitis, pancreatitis, IBD, PID

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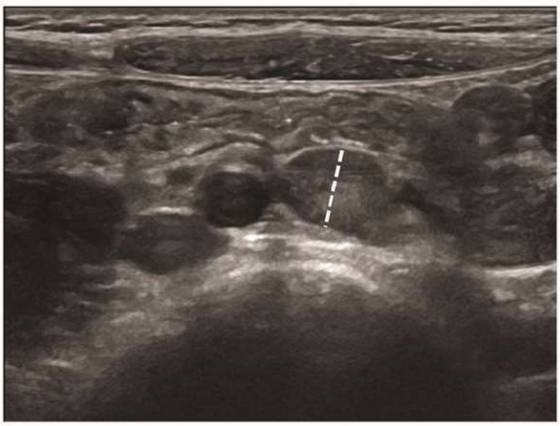

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# Mesenteric panniculitis

- Idiopathic benign chronic non-specific inflammation and fibrosis of adipose tissue of mesentery proper.
- Histologic progression: mesenteric lipodystrophy – mesenteric panniculitis – sclerosing mesenteritis or retractile mesenteritis.
- Age: 6$^{th}$ and 7$^{th}$ decade of life, M:F >2:1.
- Asymptomatic - up to 40%. Vague abdominal pain, vomiting, early satiety, alteration of bowel habit, anorexia, weight loss, tender palpable mass in central abdomen.
- Lab: mild leukocytosis, ↑CRP, ↑ESR.
- CT – a hyperdense, inhomogeneous, well defined solid mass at the root of the mesentery. Hyperattenuating thin soft tissue encasing the mass (pseudocapsule) in 50% of cases. Hypoattenuating normal fat tissue around encased vessels (halo sign) in 75% of cases.

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# Mesenteric panniculitis (MP)

- Routine tissue diagnosis is not required.
- In equivocal cases – CT-guided biopsy, laparoscopy, laparotomy.
- In oncology patients – PET/CT .
- No symptom – no treatment. “watch and wait” approach.
- Symptomatic patients – Prednisone 20 to 40 mg per day tapering over 8 to 12 weeks - currently considered as first line agent - effective in 75% of cases.
- Steroid non-responders – colchicine, tamoxifen, pentoxifylline, anti-TNF, LDN (4.5 mg nightly for 12 weeks).
- Role of surgery – complicated MP with mass effect on small bowel or lymphovascular obstruction.

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# Mesenteric panniculitis associations

- Acute pancreatitis.
- Trauma, surgery.
- Chronic infections: histoplasmosis, TB, syphilis, Whipple's disease.
- Neoplasms: lymphoma, NET, colon, renal and prostate cancers.
- Autoimmune diseases.
- Sarcoidosis.
- IgG4 related diseases.
- Fibrosclerotic diseases – Sjogren's syndrome, Riedel thyroiditis, retroperitoneal fibrosis, sclerosing pancreatitis, primary sclerosing cholangitis.

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# Mesenteric fibrosis (MF)

- Mesenteric panniculitis - fibrosis.
- Jejunoileal neuroendocrine tumor with locoregional lymph node metastasis. Secretion of profibrotic factors – EGF, FGF-2, FGF $\mathcal{B}$, TGF $\mathcal{B}$ and $\propto$ - desmoplastic reaction.
- Presentation: Asymptomatic.
- Abdominal pain – small bowel or transverse colon obstruction due to adhesion or small bowel ischemia due to SMA or SMV due to encasement.
- Abdominal distension – due to transudative (SMV occlusion) or chylous ascites (lymphatic obstruction).
- Lower GI bleed – small bowel varices.
- Malabsorptive diarrhea – venous stasis.
- Diagnosis – CT (contrast enhanced or multi-detector) – soft tissue mass "wheel spoke" or stellate pattern". *68Ga-PET-CT–CT should also be done to identify the primary NET and its lymph node metastasis.*
- Treatment: surgical resection of MF only in symptomatic patients.

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# Mesenteric fibrosis

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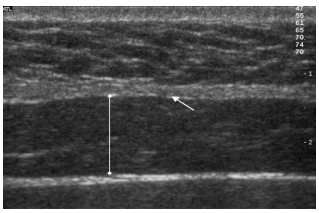
# Mesenteric adiposity

- ↑Mesenteric fat - ↑ FFA influx into hepatocytes – metabolites of FFA (long-chain acyl CoAs and diacylglycerol) relocate cytoplasmic protein kinase Cs to the membrane. Protein kinase Cs then phosphorylate intracellular portion of insulin receptors – insulin resistance.
- Mesenteric fat thickness ≥ 1 cm – an independent determinant of metabolic syndrome (sensitivity 70% and specificity 75%), DM, accelerated atherosclerosis, cardiovascular diseases, obstructive sleep apnea and steatotic liver disease.



Liu et al. - International journal of Obesity 2003.

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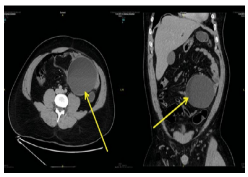
# Mesenteric cysts



- Rare benign condition – 1 in 100,000 to 250,000 hospital admissions.
- Any age. Slight female predominance.
- Generally single, but can be unilocular or multilocular with septations.
- Size may vary from few mm to giant size (20 to 30 cm).
- 60% seen in the mesentery proper.
- Content can be serous or chylous.
- Etiopathogenesis – unknown, proliferation of ectopic lymphatics, degeneration of lymph node, continued growth of congenitally malformed lymphatic tissue.
- Asymptomatic. Abdominal pain, n/v, altered bowel habit, abdominal mass.
- Acute abdomen – infection, intestinal obstruction, volvulus, torsion, rupture, bleeding, shock.
- Diagnosis - US, CT, MRI.
- Treatment: complete surgical excision of symptomatic mesenteric cysts by laparoscopy or laparotomy.

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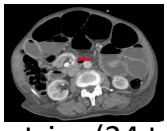
# Mesenteric volvulus



- Occurs due to twisting of a loop of intestine around its supporting mesentery and blood vessels.
- Leads to acute, subacute or chronic strangulating intestinal obstruction.
- Can occur in small intestine (SIMV) or colon (CMV).
- SIMV - more common in children and young adults
- SIMV - more common in Asia, Africa and Middle Eastern countries (24 to 60/100,000 population) than western countries (1.7 to 5.7/100,000 population).
- Precipitating factors – adhesion, bands, stromal tumors, Meckel's diverticulum, malrotation.
- CT – "Whirl sign" (a swirling of vessels in the mesenteric root) – 50% of cases.
- Treatment –devolvulation, resection, anastomosis, Rx of underlying cause.

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# Colonic volvulus

- 5% of all cases of intestinal obstruction.
- 10-15% of all cases of colonic obstruction in USA, 20 -50% in “volvulus belt.”
- Sigmoid colon – 80%, cecum - 15%, transverse colon – 3% and splenic flexure – 2%.
- Sigmoid volvulus - counterclockwise torsion around its mesenteric axis.
- Sigmoid volvulus – elderly males, black race, chronic constipation with chronic laxative use, neuropsychiatric disorders, neuroleptic medications, megacolon, high fiber intake with overloading of sigmoid colon.
- Plain X-ray: markedly distended ahaustral sigmoid colon like a coffee bean.
- CT – disproportionately dilated sigmoid colon with closed loop obstruction.
- Treatment: stabilization, NGT, colonoscopy with devolvulation.
- Surgery: signs of peritonitis or pneumoperitoneum on imaging, blackish or gangrenous mucosa during colonoscopy or unsuccessful colonoscopy.

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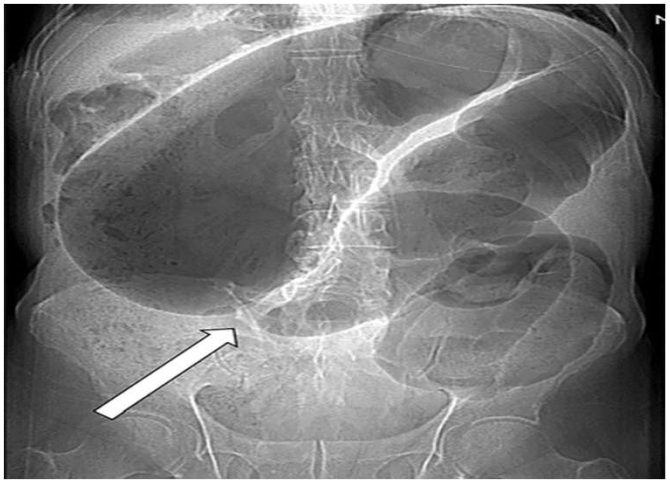
# Sigmoid volvulus



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# Cecal volvulus

- Type 1: clockwise twisting of cecum along its long axis. Cecum is located in RLQ.
- Type 2 (most common): Twisting of a part of the cecum and a part of the terminal ileum in a counterclockwise direction.
- Type 3 (cecal bascule): cecum is folded upwards without axial twisting

- Common in young females.
- Abdominal pain, distension, nausea, vomiting.
- X-ray - distended cecum from RLQ to LUQ and dilated small bowel with air-fluid level.
- CT– distal colonic decompression, >10 cm cecal distension, cecal apex in LUQ, ileocecal twist, transition point and “whirl sign”.
- Treatment – surgery within 24 to 72 hours after diagnosis.

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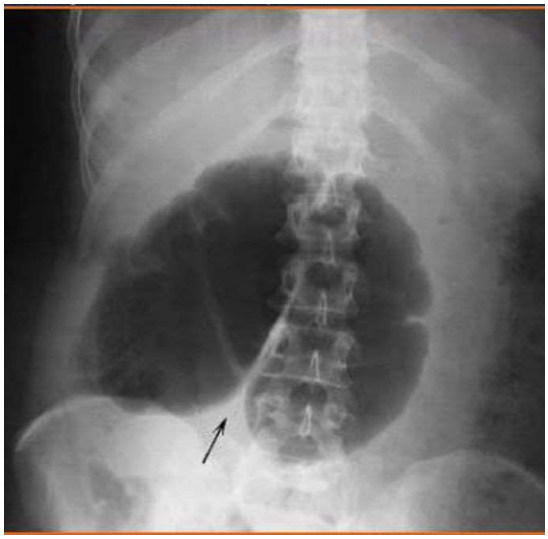
# Cecal volvulus



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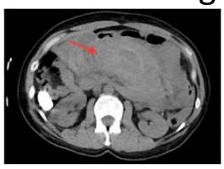
# Mesenteric hematoma

- Occurs due to bleeding from peripheral mesenteric vessels.
- Caused by trauma, surgery, rupture of mesenteric aneurysm, pancreatitis, anti-coagulation, vasculitis and collagen vascular diseases.
- Presentation – asymptomatic or abdominal pain, nausea.
- Diagnosis – contrast enhanced CT or MRI.
- Conservative treatment if asymptomatic or no sign of active bleeding.
- Selective angiography and emblotherapy in case of active bleeding.
- Surgical intervention in case of sizeable symptomatic hematoma, continued bleeding, complicated mesenteric hematoma and diagnostic difficulty.



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# Heterotopic mesenteric ossification (HMO)

- A very rare condition characterized by calcification and reactive bone formation at the base of the mesentery.
- Precipitating factors: trauma, surgery, stab wound, gunshot wound.
- Pathogenesis – trauma – inflammatory cells infiltration – release of calcium - ↑ phospholipase activity - ↑ FFA – binding of calcium to FFA.
- "Seeding" of osteoprogenitor cells into the mesentery during trauma or surgery
- Presentation: asymptomatic – abdominal pain – small bowel obstruction.
- Diagnosis - CT imaging or intraoperatively.
- Treatment – complete excision of symptomatic HMO.

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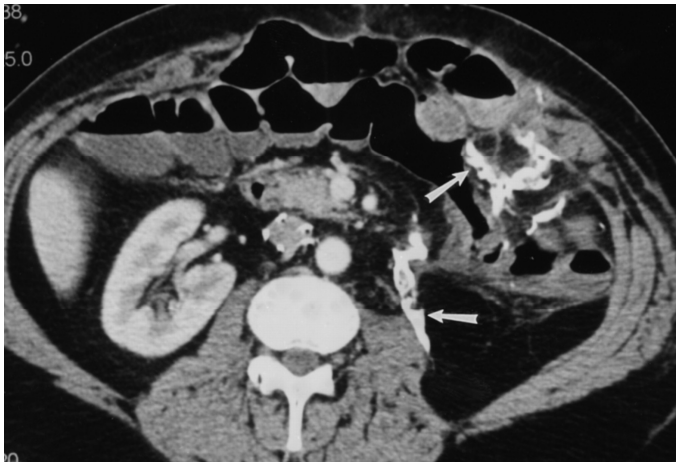
# HMO



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# Mesenteric neoplasms

- Primary: mesenteric lymphoma, mesenteric lymphangioma, mesenteric leiomyosarcoma, mesenteric desmoid tumor, mesenteric neuroendocrine tumor, mesenteric GIST.
- Secondary: carcinomatosis, sarcomatosis, lymphomatosis.

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# Mesenteric vascular diseases

- Acute mesenteric ischemia
- Chronic mesenteric ischemia
- Colonic ischemia

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# Acute mesenteric ischemia (AMI)

- Incidence: 0.09 to 0.2% of all acute surgical admissions.
- Embolic mesenteric ischemia (40-50%) – due to SMA embolism.
- Thrombotic mesenteric ischemia (15-25%) – due to SMA thrombosis.
- Venous mesenteric ischemia (5-15%) - due to thrombosis of SMV or rarely IMV.
- Non-occlusive mesenteric ischemia (5-15%) – due to mesenteric vasoconstriction associated with systemic hypotension.

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## Presentation of AMI

- Sudden onset of sharp, severe abdominal pain with nausea & vomiting.
- Pain is out of proportion to physical sign.
- Abdomen is soft, non-tender with hyperactive bowel sound – early phase.
- Bloody diarrhea, fever, shock - late phase (within 12 hours of onset).
- Rebound tenderness (Blumberg's sign), rigidity, guarding with hypoactive or absent bowel sound.

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## Investigations of AMI

- Lab tests: Leukocytosis, lactic acidosis, positive D-dimer test.
- Imaging: CTA (First line investigation), DUS, Plain X-ray abdomen.
- Traditional/catheter-based mesenteric angiogram – 2$^{nd}$ line modality.

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## Treatment of AMI

- Resuscitation – crystalloid infusion up to 100 ml/kg. If still hypotensive, pressors – Dobutamine, low dose dopamine, milrinone.
- NGT and antibiotics.
- Multidisciplinary approach: IR, general surgery, and vascular surgery consult.
- Revascularization – Percutaneous endovascular vs surgical.

  -- Thrombectomy, embolectomy.

  -- Intra-arterial Papaverine infusion or alprostadil infusion during catheter-based mesenteric angiogram.
- Resection of infarcted bowel.
- Second look laparotomy or laparoscopy 24 to 48 hours after restoration of mesenteric blood flow.
- Anti-coagulation for venous mesenteric ischemia. Other approaches for extensive thrombosis: surgical thrombectomy, direct thrombolysis, percutaneous transhepatic or transjugular catheter-directed thrombectomy/thrombolysis.

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## Prognosis of AMI

- AMI - pooled in-hospital short term mortality - 59.6%, mid/long term mortality 68.2%
- Non-occlusive mesenteric ischemia – 58.4%.
- Acute mesenteric venous thrombosis – 24.6%%.
- Revascularized occlusive arterial AMI – short term mortality – 33.9%

Tamme et al. BMJ Open. October 2022.

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## Chronic mesenteric ischemia

- Prevalence: 2-3 *per* 100000 persons *per* year. <5% of all cases of mesenteric ischemia.
- Generally, two of three major blood vessels (CA, SMA, IMA) need to be stenotic to produce ischemic symptoms.
- Mostly seen in patients older than 60 years and 3 times more common in females
- Presentation: Classic triad of post-prandial abdominal pain, sitophobia, and weight loss - 16 to 20% of patients.
- Dx – CTA (Ist line investigation), MRA, DUS, catheter-based angiography.
- Tx– Percutaneous endovascular treatment – now considered as first line treatment (angioplasty with or without stent placement) vs open surgical revascularization (antegrade aorto-mesenteric or aorto-celiac bypass graft, retrograde bypass graft from infrarenal aorta and iliac arteries to distal SMA, endarterectomy and reimplantation of SMA directly into the infra-renal aorta.
- Prognosis – revascularization significantly improves quality of life.

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## Colonic ischemia (CI)

- Prevalence: 22.9/100000 persons per year from 2005-2009.
- Frequency: 1 in 1000 hospital admissions.
- Risk factors: DM,HTN, HLD, CAD, AFIB, CKD, IBS-C, COPD, thrombophilia, constipation inducing medications, illicit drugs (amphetamine, cocaine), surgery involving IMA- AAA surgery, vasculitis, radiation, amyloidosis, fibromuscular dysplasia, colonic obstruction.

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# Pathogenesis of colonic ischemia

- Sudden but transient reduction in blood flow to the colon due to non-occlusive causes -95% of cases.
- Thought to be due to localized non-occlusive ischemia secondary to small-vessel disease (Type I disease).
- Rarely, episodes of non-occlusive ischemia secondary to systemic hypotension are identified (Type II disease).
- Occlusive ischemia due to atheromatous emboli or vasculitis affects short segment of the colon.
- CI can affect any part of the colon, but the left colon is involved in two-third of cases.
- Segmental involvement of the colon is commonly observed, particularly the splenic flexure, the descending colon and the sigmoid colon – commonest sites.
- Isolated right colon ischemia can occur in about 10% of cases. > CRF on HD, hypotension, sepsis. mass forming lesion, ↑ surgery, 5 x morbidity, 2 x mortality.

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# Presentation of CI

- Sudden onset of mild to moderate cramping pain over left lower quadrant of the abdomen or hypogastrium.
- Urgency to defecate followed by hematochezia within 24 h.
- Bleeding is not severe enough to require blood transfusion.
- Patients with right colon ischemia usually present with hypogastric pain rather than hematochezia.
- Physical examination may reveal mild to moderate tenderness over the left lower quadrant or over the involved segment.

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## Clinical course of CI

- Patients feel better with resolution of abdominal pain and hematochezia in few days time.
- Persistent symptoms more than few days may indicate development of chronic CI *i.e.* chronic ulcerative IC or ischemic colonic stricture.
- Gangrenous colitis or fulminant pancolitis is generally recognized by marked abdominal tenderness, rebound tenderness, hypotension or shock.

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## Investigations of CI

- Leucocytosis, lactic acidosis, hypoalbuminemia, elevated LDH, CPK and amylase may suggest colonic infarction.
- Plain X-ray abdomen is normal in most of the time but rarely it may show ‘thumbprinting’ due to submucosal edema/hemorrhage, pneumatosis linearis due to necrosis of the colon wall, portal venous gas, colonic ileus or pneumoperitoneum due to perforation.
- CT abdomen and pelvis with oral and intravenous contrast is the imaging study of choice to evaluate CI.
- Multiphasic CTA should be done in case of suspected RSCI or when the diagnosis of AMI needs to be ruled out.

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# Investigations of CI

- Colonoscopy with biopsy within 48 h is the next step to conform the diagnosis of CI.
- In non-gangrenous IC, colonoscopy may show a highly specific sign like a single linear ulcer running longitudinally along the antimesenteric colonic wall (colon single-strap sign) or non-specific signs like segmental erythema, fragile and edematous colon mucosa, scattered hemorrhagic erosions, scattered petechial hemorrhages with pale areas, bluish hemorrhagic nodules due to submucosal hemorrhage and sometimes mass-like lesions mimicking malignancy.
- In gangrenous IC, colon mucosa will appear as black or gray-green.
- Histology is nonspecific most of the time. It may show focal crypt drop out, lamina propria and submucosal hemorrhage and edema, hemosiderin laden macrophages in the submucosa, fibrin thrombi in capillaries with infiltration of neutrophils, erosion and granulation tissue hyperplasia.

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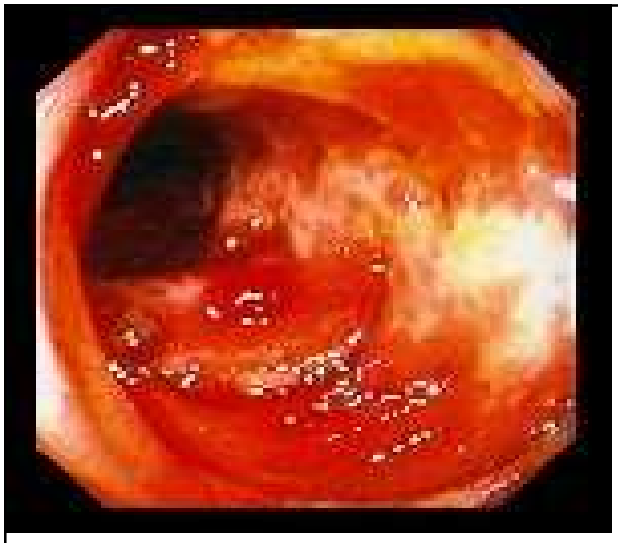
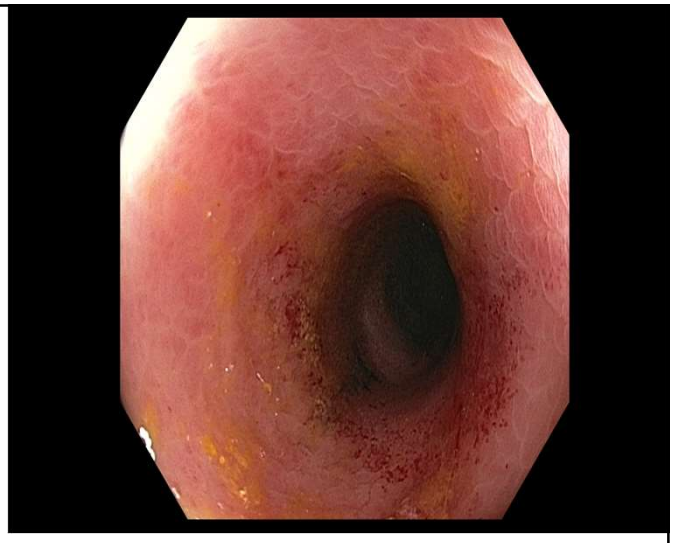


Colon single-strap sign



Ischemic colon stricture

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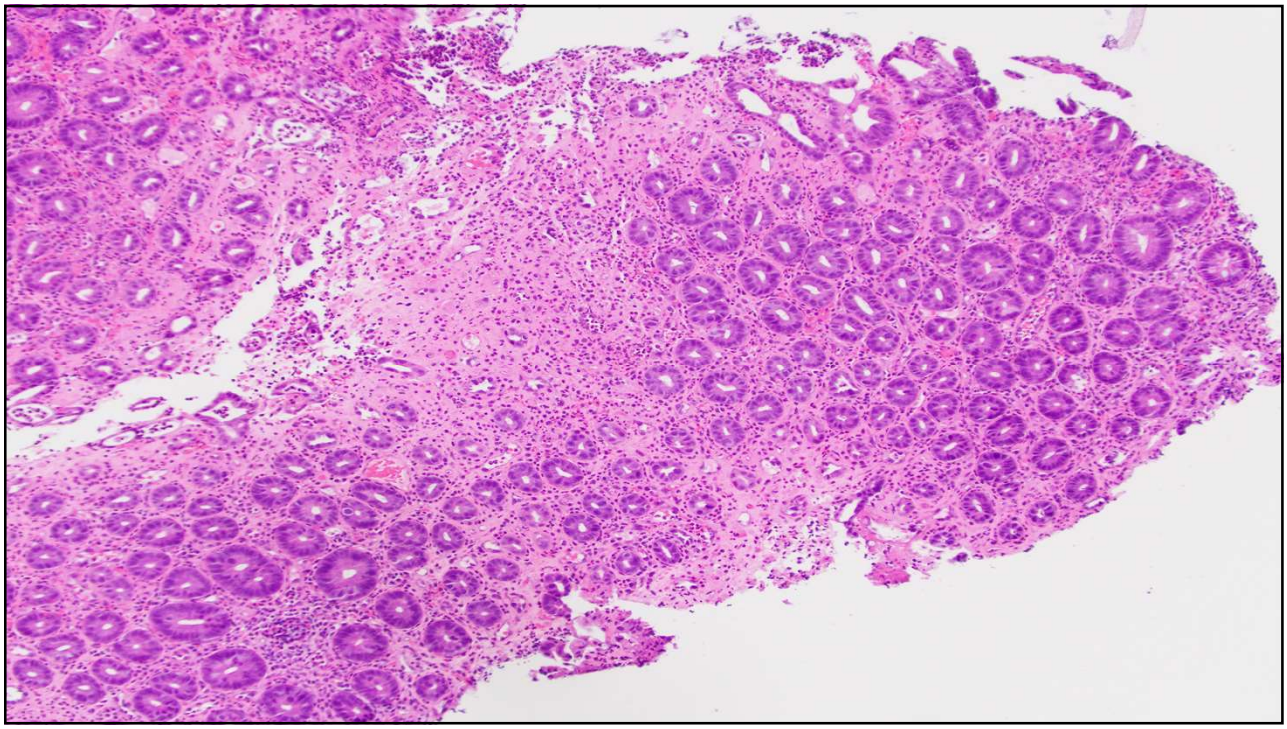

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## Risk factors associated with poor outcome

- Male sex
- Abdominal pain without rectal bleeding
- Tachycardia (heart rate > 100/min)
- Hypotension (systolic blood pressure < 90 mmHg)
- Leukocytosis (white blood cell count > 15000/cmm
- Anemia (hemoglobin < 12 gm/dL)
- Hyponatremia (< 136 meq/L)
- Azotemia (blood urea nitrogen > 20 mg/dL
- High serum LDH level (> 350 units/L)
- Colonic mucosal ulceration identified colonoscopically

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## Severity of CI

- Mild CI: Typical symptoms with left sided colitis. No risk factor associated with poor outcome.
- Moderate CI: Up to 3 risk factors associated with poor outcome.
- Severe CI: More than 3 risk factors associated with poor outcome or any of the following: (1) Signs of peritonitis on physical examination; (2) Pneumoperitoneum, portal venous gas or pneumatosis on imaging; or (3) Gangrenous colitis on colonoscopy.

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## Management of CI

- Mild CI - bowel rest, IV fluid, NGT placement if there is ileus. Precipitating factors like hypotension or cardiac arrythmia should be treated. Avoid vasospastic medications.
- Moderate CI - Antibiotics plus surgery consult.
- Severe CI – ICU monitoring plus emergent surgery consult. Patients with gangrenous colitis or colonic perforation – surgical exploration for colectomy.
- Elective surgery - segmental colonic resection with primary anastomosis in patients with chronic CI with diarrhea and ischemic colonic stricture with obstruction.

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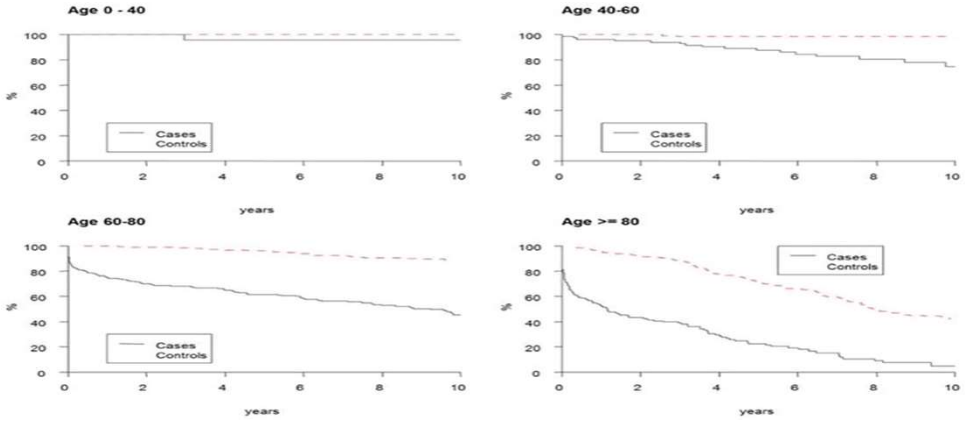
# Prognosis of CI

Overall, 5-year survival – about 69%.

Severity of CI, age and comorbidities are important factors.




Overall survival in Omstead County 1976– 2009.

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# Summary

- Mesentery – discovered as a new organ in 2017. Has distinct anatomy, physiology and different disease states.
- Mesenteric non-vascular diseases can be benign or malignant, mostly diagnosed by cross-sectional imaging.
- Mesenteric vascular diseases have different types of presentations: acute to chronic, mild to moderate to severe life threatening.
- Diagnostic modalities include labs, imaging, and colonoscopy with bx.
- Treatment modalities include conservative treatment, percutaneous endovascular revascularization, surgical revascularization, anticoagulation, surgical resection of infarcted/ischemic bowel.
- Prognosis varies – excellent to grave.

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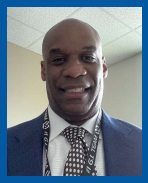
# Questions

Monjur Ahmed, MD, FACG



Christian S. Jackson, MD, FACG

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