The splanchnic circulation is the largest regional circulation at rest and receives about 30% of the cardiac output. Intestinal ischemia is generally the result of vascular occlusion by thrombi, embolisms or by non occlusive processes.

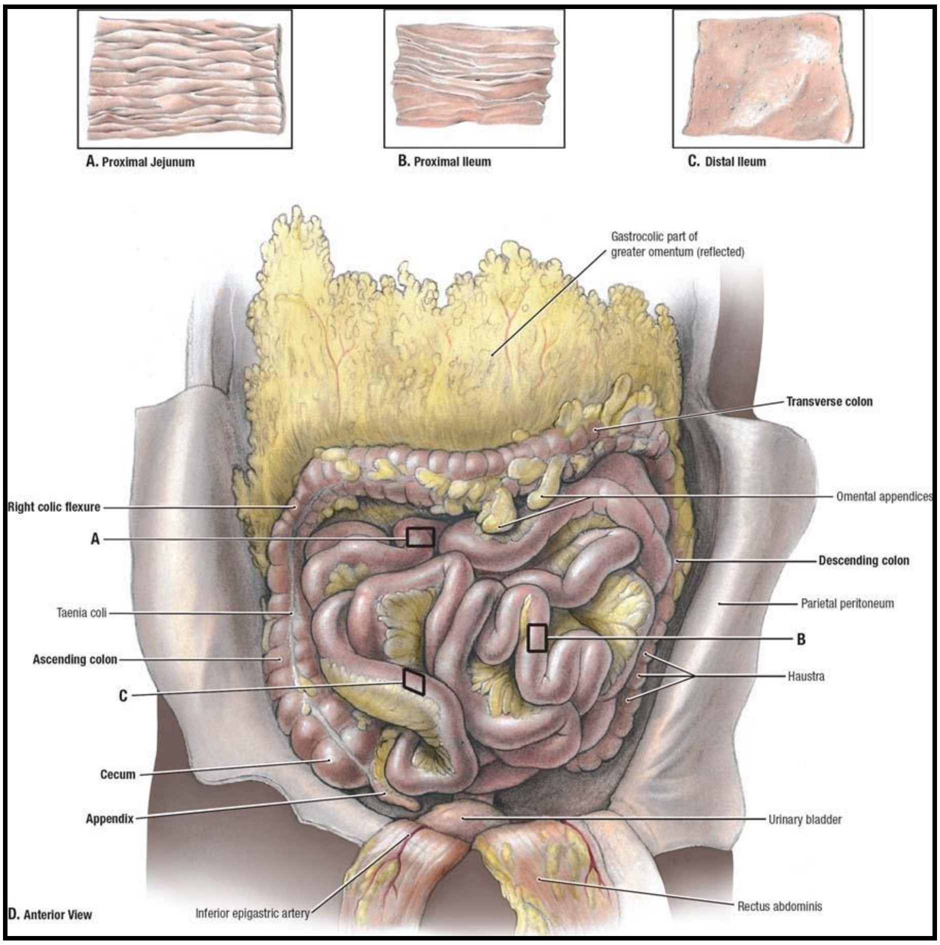
Ischemic bowel disease is a common but a complex disorder with various primary causes and clinical presentations and high mortality.

Computed tomography (CT) became a powerful tool in the management of mesenteric ischemia with the introduction of multidetector technology, as it provides direct visualization of the mesenteric vasculature, intestines and mesentery.

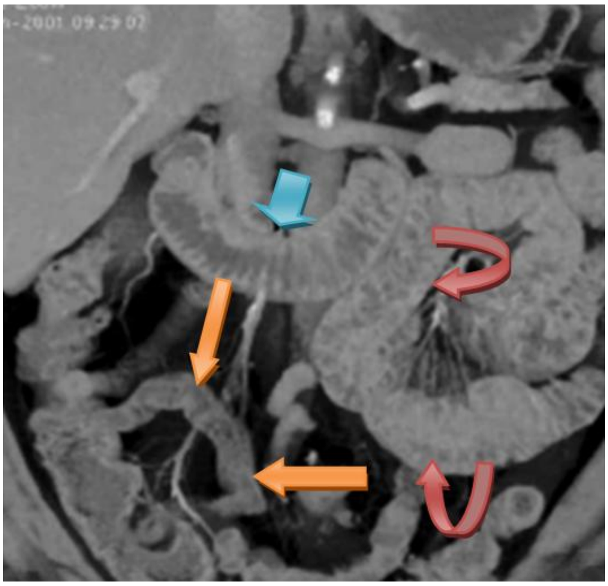
Aim Of The Work

The aim of this work is to define the role of MDCT in cases of bowel ischemia with a trial to document the value of its recent advances in understanding the diagnosis of this complex and heterogeneous entity.

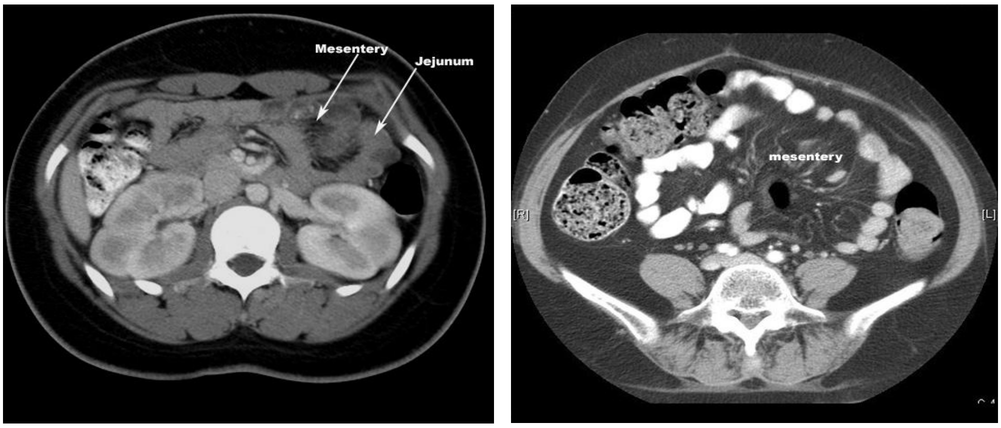
Anatomy



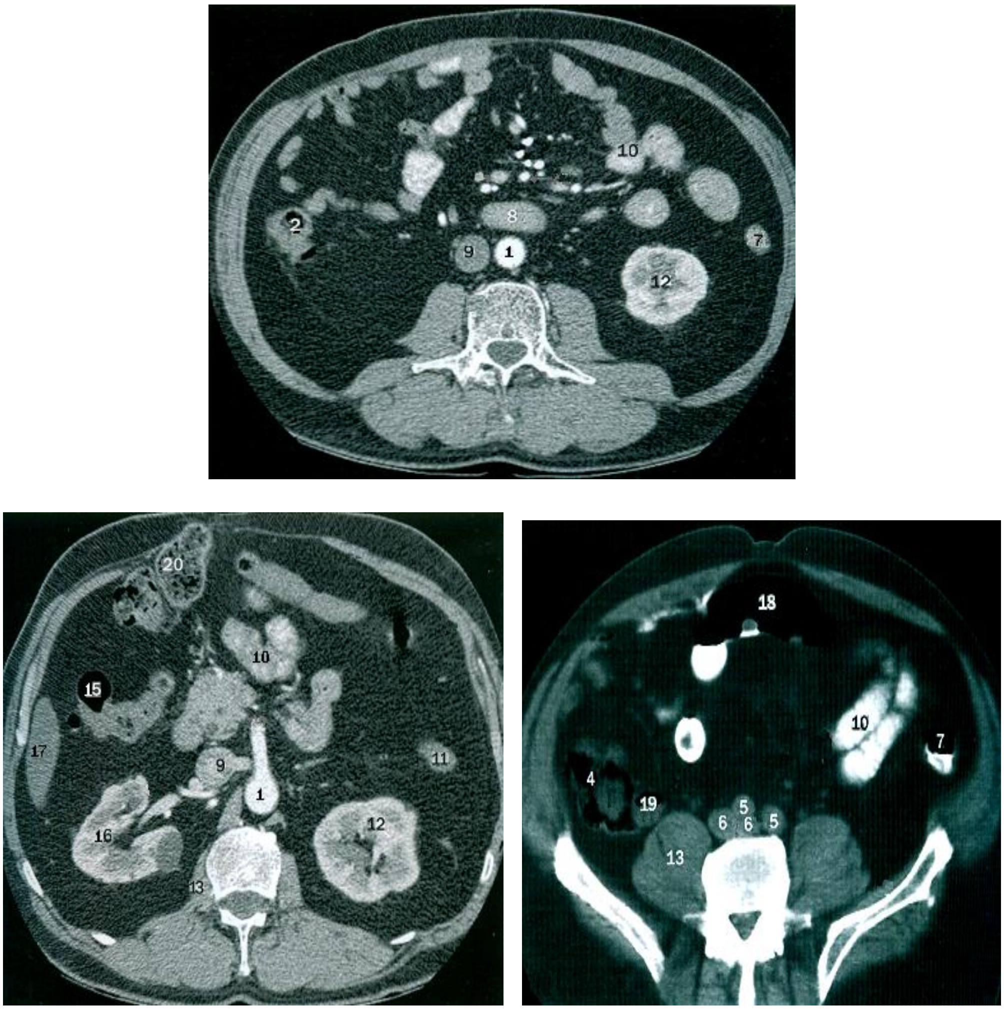
A. Proximal jejunum. The circular folds are tall, closely packed, and commonly branched. B. Proximal ileum. The circular folds are low and becoming sparse. The caliber of the gut is reduced, and the wall is thinner. C. Distal ileum. Circular folds are absent, and solitary lymph nodules stud the wall. D. Intestines in situ, greater omentum reflected. The ileum is reflected to expose the appendix. The appendix usually lies posterior to the cecum (retrocecal) or, as in this case, projects over the pelvic brim



Coronal volume rendered contrast enhanced MSCT image using water as oral contrast demonstrates the duodenum (short arrow) and jejunum (curved arrow). A few distal ileal loops also are identified (long arrows)

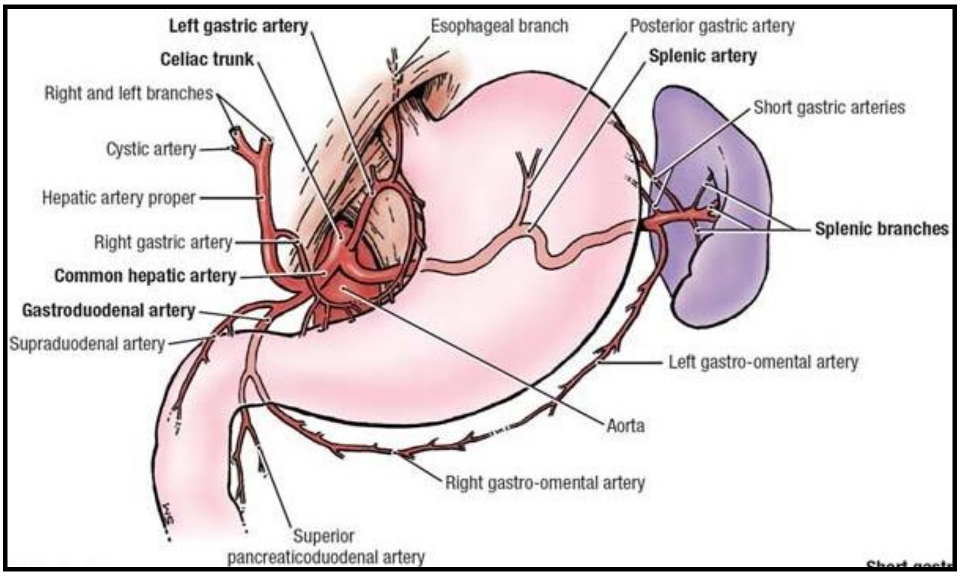


(A&B): Transverse CT images of normal CT appearance of the mesentery of jejunum and ileum



Axial CT images through the abdomen and pelvis **2**.Ascending colon **4**. Caecum **7**. Descending colon**10**. Jejunum **11**. Left colic (splenic) flexure **15**. Right colic (hepatic) flexure **18**. Sigmoid colon **19**. Terminal ileum **20**. Transverse colon

Vascular supply of the bowel



Branches of celiac trunk

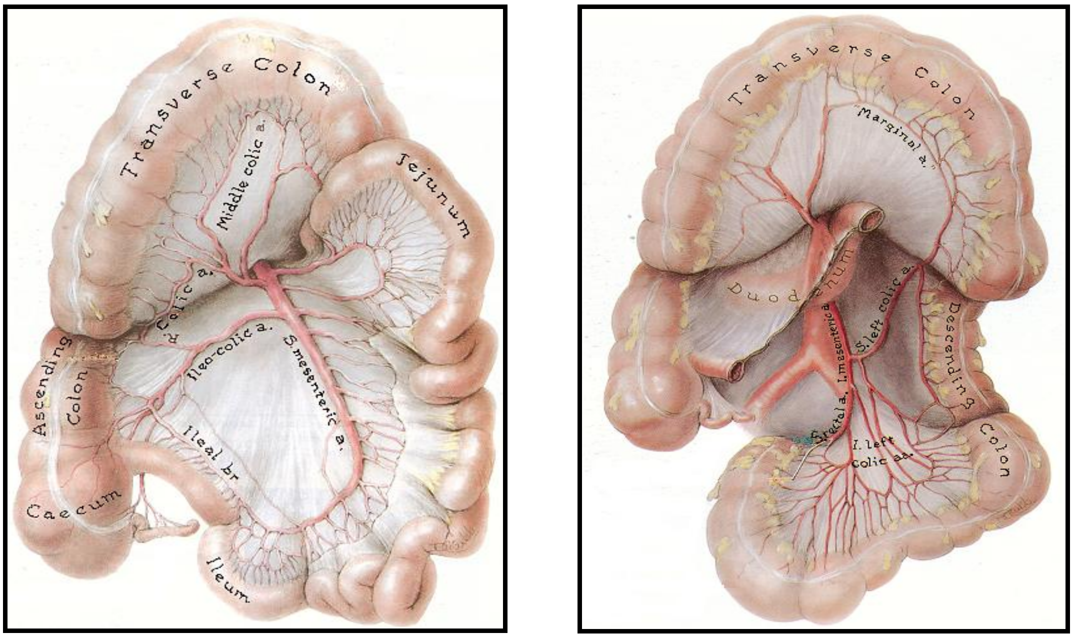
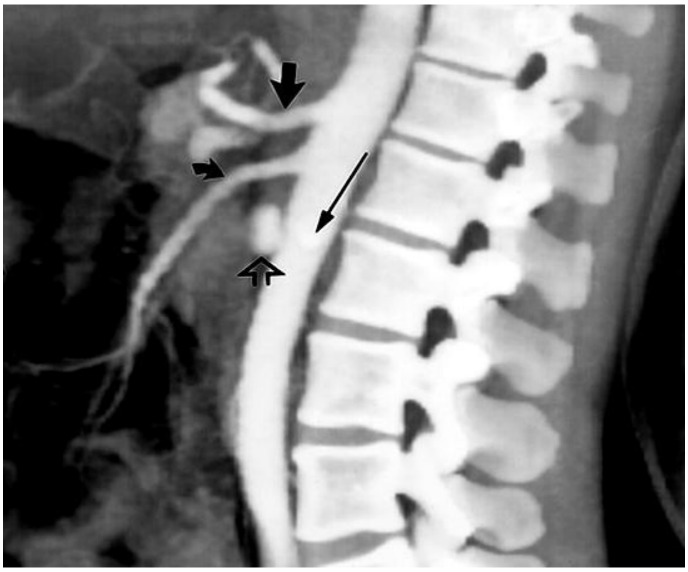
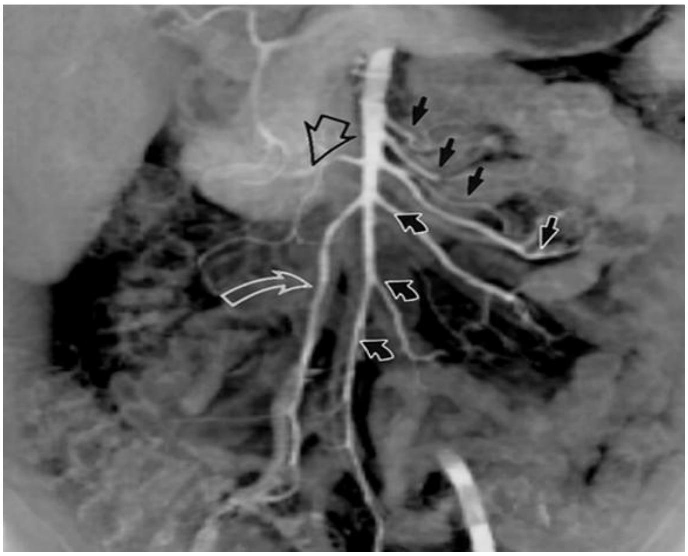


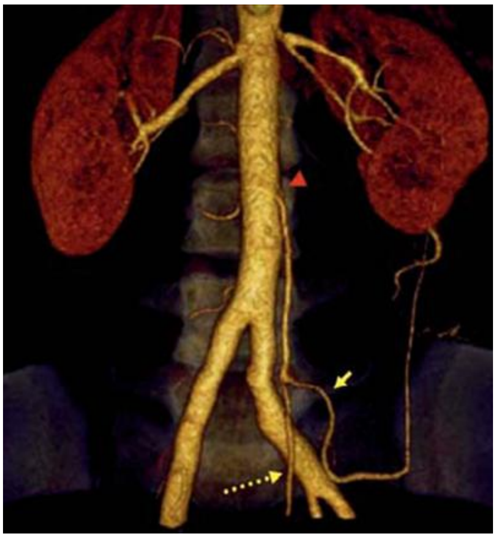
Diagram shows distribution of the superior (A) and inferior (B) mesenteric arteries to the intestine



Sagittal 3D multi-detector row CT scan demonstrates the normal anatomy of the celiac axis (thick solid arrow) and SMA (curved arrow). The SMA courses over the left renal vein (open arrow). The origin of the left renal artery is also visualized (thin solid arrow)

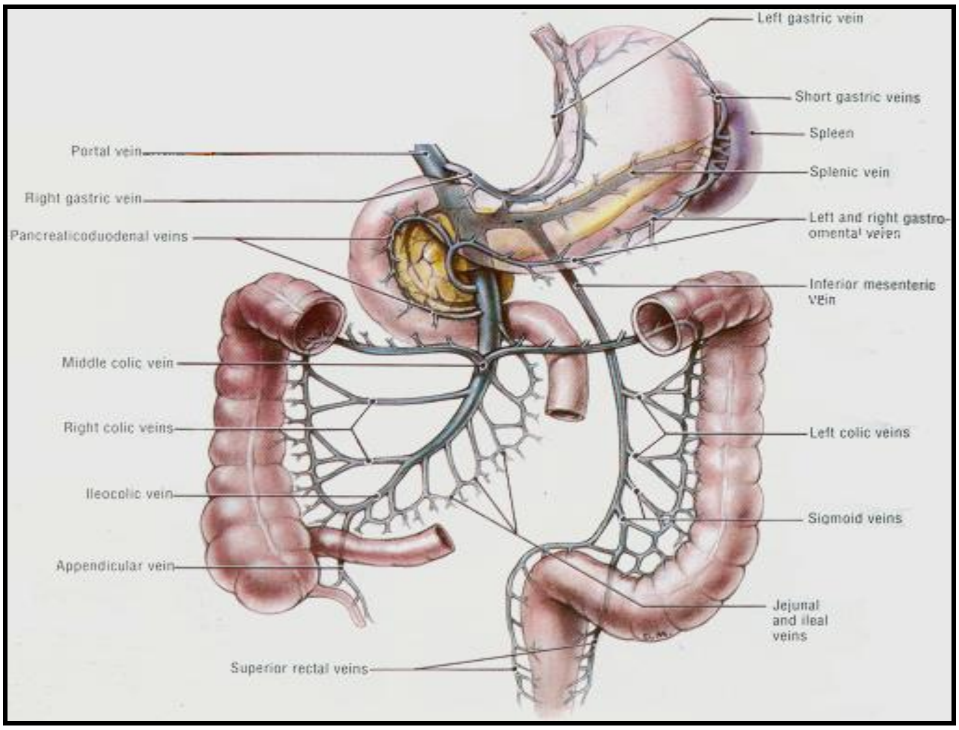


Coronal 3D multi-detector row CT scan demonstrates the normal anatomy and branching pattern of the SMA. The jejunal branches (straight solid arrows) and ileal branches (curved solid arrows) are well visualized. The ileocolic branch of the SMA arises from the right side of the vessel (curved open arrow). The middle colic artery is also identified (straight open arrow)

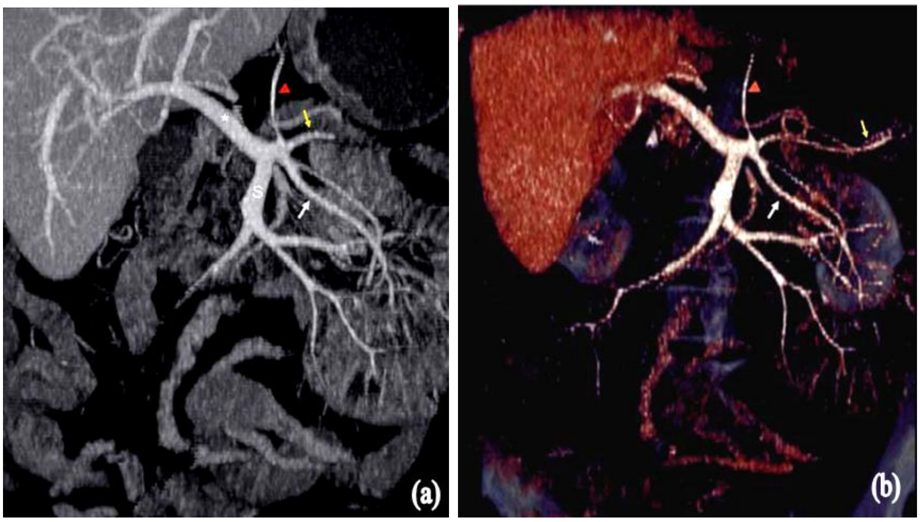


Coronal 3-D VR of IMA (arrowhead) with left colic artery (short arrow) and superior rectal artery (dashed arrow**)**

Venous drainage

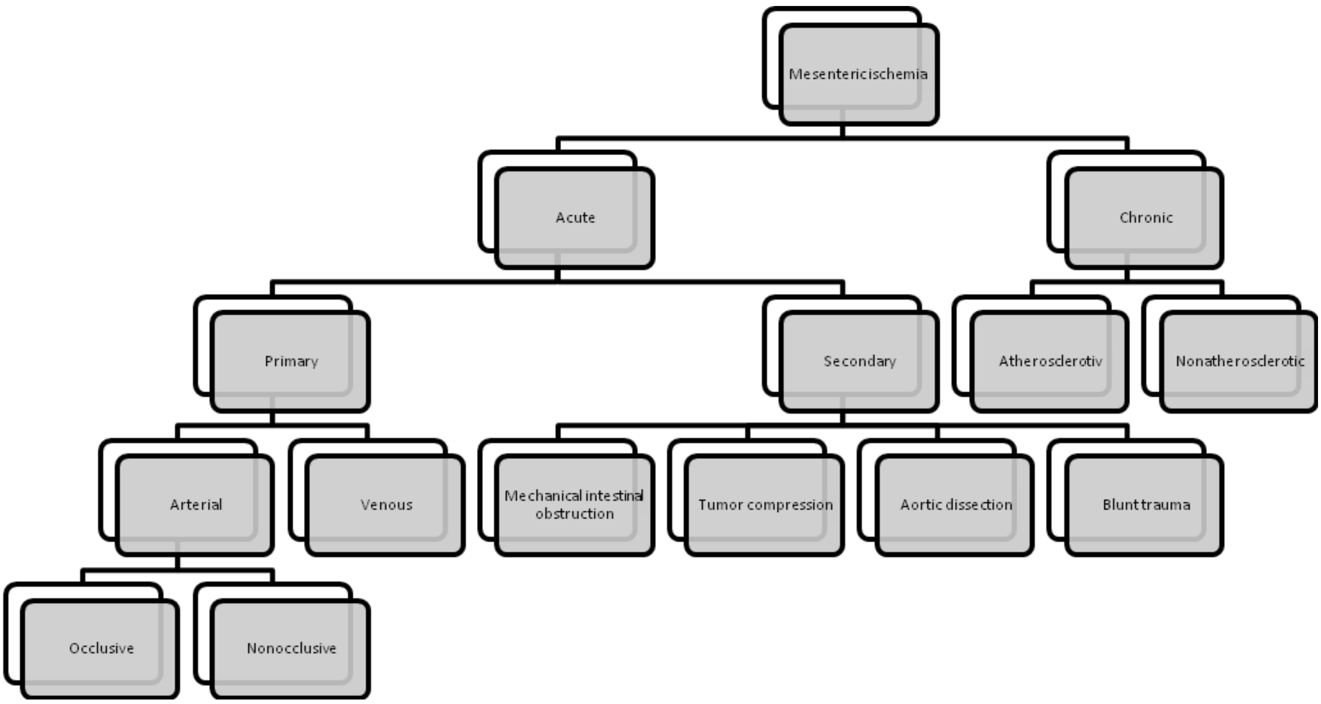


Veins corresponding with the arteries drain to the superior and inferior mesenteric veins. Inferior mesenteric vein drains to splenic vein which unites with superior mesenteric vein to form the portal vein.



(a, b): Normal portal venous system. Coronal volume rendering (VR) showing main portal vein (*), splenic vein (upper arrow), and superior mesenteric vein (SMV) (S) joining at the portal confluence. The inferior mesenteric vein (IMV) (lower arrow) and the gastroepiploic vein (arrowhead) can drain into the splenic vein

Mesenteric ischemia can be classified according to the onset into Acute mesenteric ischemia and chronic mesenteric ischemia.



Technique

The developments in CT since its introduction can be considered as attempts to provide faster acquisition times, better spatial resolution, and shorter computer reconstruction times. The recent advent of multiple row detector helical scanners has the capability to produce 3D images that approach the ideal of a true "3D radiographs".

Technique:

A) CT Technique:

CT images are obtained from the dome of the liver to the level of the perineum to cover the entire course of the intestine. With MDCT scanners, a collimation of 0.5-2.5mm and a detector pitch of 1.0-2.0 are used. Images with a 5- to 7-mm section thickness are usually constructed for image interpretation; however, thinner sections of contiguous 1-2mm should also be constructed for multiplanar image reformations and CT angiography. Sagittal images are helpful in assessing the origin of the mesenteric arteries and their variations.

Acquisition of both unenhanced and contrast- enhanced CT scans is always necessary. The use of 0.75-mm overlapping slices and a reconstruction interval of 0.5mm produce a volume data set that is ideal for 3D imaging.

The thin slices are used for 3D imaging, and the thick slices are used for review of other organs. 120 kilovolts (kV) and 270 effective milliamperes (mAs) are usually adequate

For contrast-enhanced CT, 100-150mL of iodinated contrast material is administered with a power injector at a rate of 2-5mL/s, and scanning starts with delay times of 30 and 60sec for dual acquisition and 40-50sec for single acquisition.

By using multi-detector row CT of the entire abdomen, demonstration of an arterial (25-30sec) after initiation of injection and a portal venous (60sec) phase of enhancement can be easily achieved, and data sets from the arterial phase of enhancement may be used for various types of post-processing.

B) Computed Tomographic Angiography

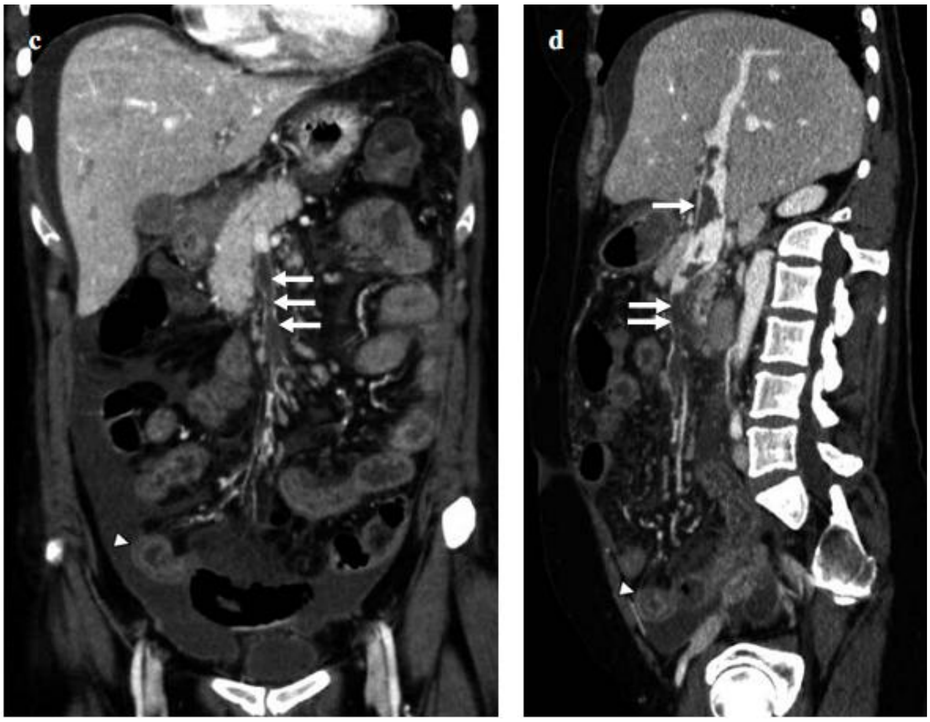
It is a new minimally invasive method for the volumetric display of contrast filled vessels.With spiral CT, the data acquisition can be achieved during one breath-hold, which gives the certainty that small lesions won't be missed due to breathing motion.

The rationale for an optimal CT angiography protocol in evaluating patients with suspected mesenteric ischemia depends on fast, high-resolution CT performed during the arterial phase of vascular enhancement. To obtain this result in the abdominal region.

Three-dimensional Reformatting Techniques

A) Multiplanar reformatting (MPR):

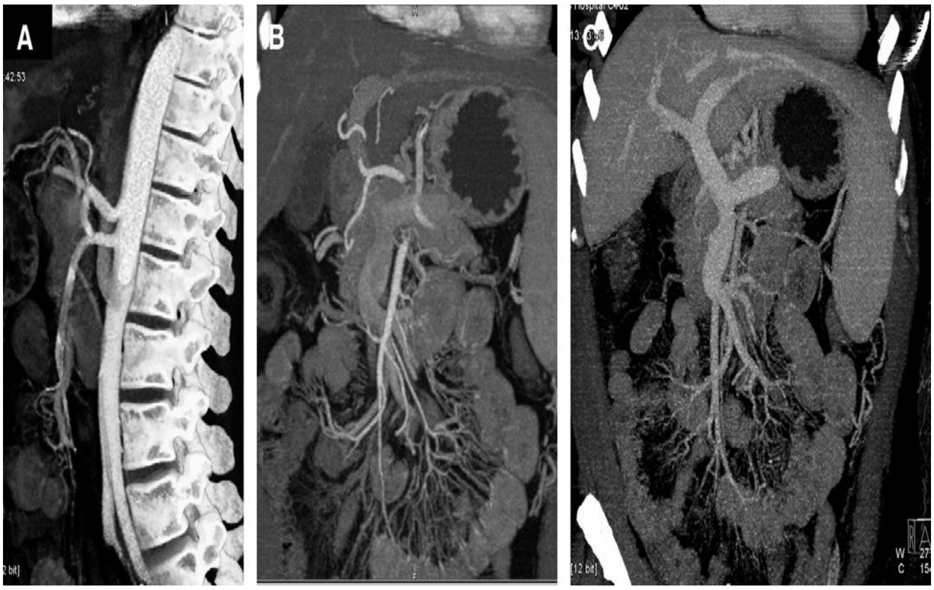
Sagittal, coronal, and curved multiplanar reformatted images and CT angiograms may be very helpful in identifying the site,level, and/or cause of bowel ischemia



(a-d) venous bowel infarction. a,b Thrombosis of the superior mesenteric vein (SMV, arrow). Layered thickening of small bowel loops (arrows). Ascites (asterisk). c, d SMV thrombosis and partial thrombosis of the portal vein (arrows) are better evaluated with MPR. Layered thickening of a small-bowel loop (arrowhead)

b) Volume Rendering:

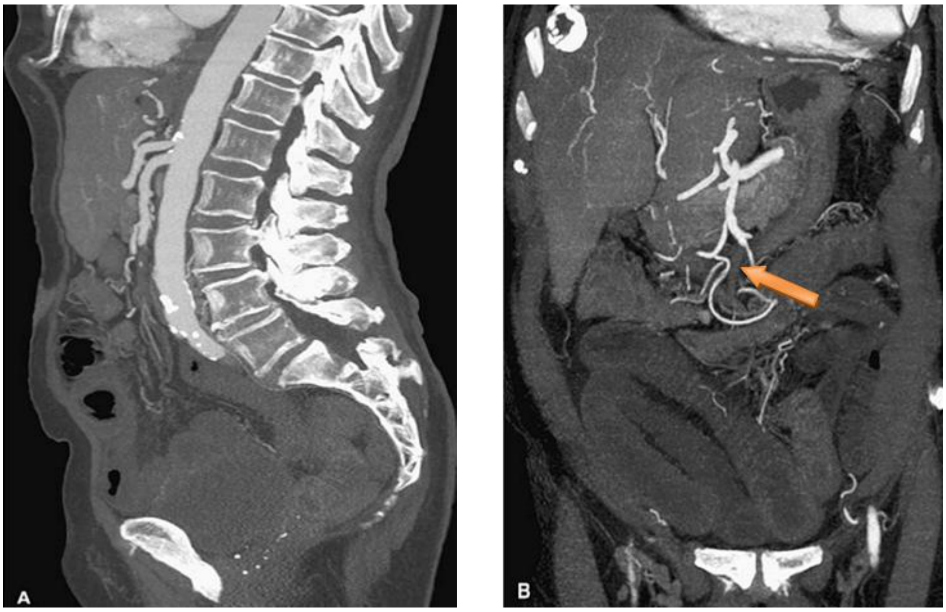
Volume rendering is the most advanced and computer-intensive rendering algorithm available For example, parameters can be applied to the volume set to affect the appearance of the small intestine so that related anatomy and disease are optimally demonstrated. These parameters include window width and level, attenuation, and brightness which can be adjusted interactively by the user. The major advantage of volume rendering is its capacity to accurately display the vessels as well as its adjacent structures.



(A) Sagittal volume-rendered 3D CTA demonstrates the normal anatomy of the celiac axis and SMA. The origin and proximal segment of these vessels is best appreciated in the sagittal projection. (B) Coronal volumerendered 3D CTA demonstrates the normal branching pattern of the SMA. Distal branches of the SMA are visualized best in the coronal projection using either volume rendering or MIP. (C) Coronal MIP image demonstrates the normal anatomy of the mesenteric veins

C) Maximum Intensity Projection:

MIP is a simple algorithm that displays the brightest voxel along computer-generated rays in a specified orientation. MIP can be a valuable tool for visualizing distal branches of vessels; however, spatial relationships are lost .MIP recons-tructions are easy and fast to obtain, but they are subject to artifacts caused by vascular calcification, venous visualization, and the potential for less accurate estimation of stenosis with increasing slab thickness



(A) Sagittal MIP reconstruction of arterial phase MDCT obtained in an 86-year old patient with lactate acidosis reveals an occlusion of the SMA. (B) Coronal MIP reconstruction also shows SMA occlusion (arrow). The patient underwent embolectomy and small bowel resection. Note the small bowel wall dilatation in the right lower quadrant. One month later, the patient suffered from acute mesenteric ischemia again and died of multi-organ failure during her hospital stay

d) Shaded Surface Display:

Voxels within the thresholds are displayed, whereas voxels outside the thresholds are excluded. Because only the surface is displayed, there is considerable artifact, noise, and loss of mural detail

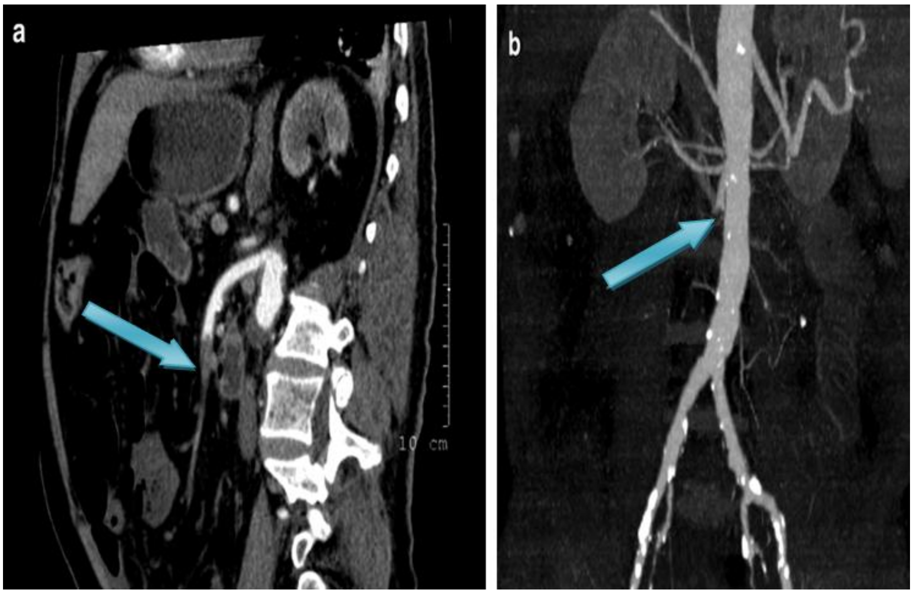
A B

46-year-old man. Digital subtraction angiography (**A**) and surface shaded display 3D reconstruction image of CT angiography (**B**) of superior mesenteric artery (SMA) show occlusion of middle colic artery and several jejunal branches. One jejunal branch has tubular aneurysm (*arrow*)

CT Findings in Acute Bowel Ischemia:

Acute bowel ischemia provides various morphologic and attenuation abnormalities on CT images in the bowel wall, mesenteric vessels, and mesentery**.**

a)Acute Mesenteric Arterial Occlusion:



CTA of a 76-year-old man with 24 h of progressive abdominal pain and atrial fibrillation with suspected acute mesenteric ischemia. a and b MPR and MIP reformation showing complete occlusion of the SMA main trunk (arrow). At laparotomy intestinal ischemia was encountered with necrosis of the terminal ileum and right colon