

Imaging of Mesenteric Ischemia
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
1. Acosta S, Wadman M, Syk I, Elmstahl S, Ekberg O. Epidemiology and prognostic factors in acute superior mesenteric artery occlusion. J Gastrointest Surg. 2010; 14(4):628-635.	Observational-Dx	1970 and 1982 (n = 270), 1987 to 1996 (n = 135), and 2000 and 2006 (n = 100)	To examine trends in incidence and mortality of acute superior mesenteric artery occlusion(SMA) and evaluate prognostic factors in recent years.	The overall incidence rate decreased from 8.6 to 5.4/100,000 person years and the autopsy rate from 87% to 25% over time. A higher serum creatinine level was associated with a lower probability of undergoing multi-detector row CT with intravenous contrast (MDCTiv) (p = 0.006). Not performing a MDCTiv (odds ratio 4.0; 95% confidence interval [1.0-16.0]) remained as independent prognostic factor for in-hospital mortality. General and vascular surgeons collaborated in 25 out of 61 patients that underwent an intervention, of which 21 (84%) (p < 0.001) survived. A close collaboration between radiologists and general and vascular surgeons seems to be most important to lower the mortality in patients with acute SMA occlusion.	4
2. Herbert GS, Steele SR. Acute and chronic mesenteric ischemia. Surg Clin North Am. 2007; 87(5):1115-1134, ix.	Review/Other-Dx	N/A	To review the various etiologies, presentation, and diagnosis of different types of mesenteric ischemia.	No results stated in abstract.	4
3. Kassahun WT, Schulz T, Richter O, Hauss J. Unchanged high mortality rates from acute occlusive intestinal ischemia: six year review. Langenbecks Arch Surg. 2008;393(2):163-171	Review/Other-Tx	126 patients	To evaluate our experience in treating acute occlusive intestinal ischemia with a view to expand the cumulative information in the literature.	Of the 60 patients with primary thrombotic vascular event, 20 patients had embolism and 19 patients arterial thrombosis. In 21 patients, mesenteric venous thrombosis was the etiology of AII. The median age was 73 years (range, 43-96). Higher ASA classification, age >70 years, late presentation, and high serum lactate levels were predictors of adverse outcome. The overall death rate was 60% (36/60), which was within the range of that observed in the published series.	4

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EVIDENCE TABLE**

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<p>4. Schoots IG, Koffeman GI, Legemate DA, Levi M, van Gulik TM. Systematic review of survival after acute mesenteric ischaemia according to disease aetiology. Br J Surg. 2004;91(1):17-27</p>	<p>Review/Other-Tx</p>	<p>45 studies; 3692 patients</p>	<p>To analyse the published data on survival following acute mesenteric ischaemia over the past four decades in relation to disease aetiology and mode of treatment.</p>	<p>Quantitative analysis of data derived from 45 observational studies containing 3692 patients with acute mesenteric ischaemia showed that the prognosis after acute mesenteric venous thrombosis is better than that following acute arterial mesenteric ischaemia; the prognosis after mesenteric arterial embolism is better than that after arterial thrombosis or non-occlusive ischaemia; the mortality rate following surgical treatment of arterial embolism and venous thrombosis (54.1 and 32.1 per cent respectively) is less than that after surgery for arterial thrombosis and non-occlusive ischaemia (77.4 and 72.7 per cent respectively); and the overall survival after acute mesenteric ischaemia has improved over the past four decades.</p>	<p>4</p>

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5. Sreenarasimhaiah J. Chronic mesenteric ischemia. <i>Best Pract Res Clin Gastroenterol.</i> 2005; 19(2):283-295.	Review/Other-Dx	N/A	To outline the salient clinical features, diagnostic testing, and medical or surgical management of this unusual cause of abdominal pain.	Chronic mesenteric ischemia is an unusual but important cause of abdominal pain and accounts for 5% of all intestinal ischemic events. Among its many causes, atherosclerotic occlusion or severe stenosis is the most common. This disorder has an indolent course that results in extensive collateral vascular formation. Thus, symptoms occur when at least two of the three main splanchnic vessels are affected. Intestinal angina, weight loss, and sitophobia are common clinical features. Diagnosis can often be made by noninvasive methods such as computerised axial tomographic angiography, magnetic resonance angiography, and duplex ultrasonography as well as by invasive catheter angiography. Therapy of chronic mesenteric ischemia depends on the extent and location of vascular disease. Alternatives to traditional surgical bypass are becoming more common including embolectomy, thrombolysis, and percutaneous angioplasty with vascular stenting. Early intervention is vital as the natural course of this illness can be debilitating.	4
6. Angle JF, Nida BA, Matsumoto AH. Managing mesenteric vasculitis. <i>Tech Vasc Interv Radiol.</i> 2015;18(1):38-42	Review/Other-Tx	N/A	No study objective stated.	No results stated in abstract	4
7. Gumus H, Gumus M, Tekbas G, et al. Clinical and multidetector computed tomography findings of patients with median arcuate ligament syndrome. <i>Clin Imaging.</i> 2012;36(5):522-525	Review/Other-Tx	744 patients: 363 males; 381 females	To present the clinical and multidetector computed tomography (MDCT) findings of patients who were diagnosed with the median arcuate ligament (MAL) syndrome on MDCT retrospectively.	Twenty-one patients were shown to have MAL syndrome. Of 21 patients, 18 with MAL syndrome were asymptomatic. Three patients had some symptoms. On MDCT angiography, proximal narrowing of the arteries was observed in 21 patients.	4

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<p>8. Min SI, Yoon KC, Min SK, et al. Current strategy for the treatment of symptomatic spontaneous isolated dissection of superior mesenteric artery. <i>J Vasc Surg.</i> 2011;54(2):461-466.</p>	<p>Observational-Tx</p>	<p>14 patients</p>	<p>To present our experience in the treatment of symptomatic spontaneous isolated dissection of superior mesenteric artery.</p>	<p>The median age of the study subjects was 59 years (range, 50-75 years). The median follow-up time was 27.5 months (range, 2-64 months). Treatment included conservative management without the use of anticoagulation in seven patients, ES in six, and necrotic bowel resection in one. Four patients with severe compression of the true lumen or large dissecting aneurysm underwent ES as a primary treatment. ES was additionally performed in two patients in whom initial conservative treatment failed (increasing dissecting aneurysm at 7-day follow-up CT scan in one and a reappearance of abdominal pain after resuming diet in the other). The median fasting time was significantly shorter in patients with primary ES (2.5 days) than in those managed conservatively (8.0 days). No complications associated with the SID_SMA or ES were developed. The patency of stents was demonstrated on follow-up CT scans up to 60 months (range, 1-60 months).</p>	<p>2</p>

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9. Woodhams R, Nishimaki H, Fujii K, Kakita S, Hayakawa K. Usefulness of multidetector-row CT (MDCT) for the diagnosis of non-occlusive mesenteric ischemia (NOMI): assessment of morphology and diameter of the superior mesenteric artery (SMA) on multi-planar reconstructed (MPR) images. <i>Eur J Radiol.</i> 2010; 76(1):96-102.	Observational-Dx	4 patients; 13 controls	To assess the efficacy of multidetector-row CT (MDCT) for the diagnosis of non-occlusive mesenteric ischemia (NOMI) by analyzing morphology and diameter of superior mesenteric artery (SMA). Authors also assessed whether MDCT was as useful as angiography for the diagnosis of NOMI.	Multi-planar reconstructed (MPR) images of all NOMI cases showed irregular narrowing of the SMA, spasm of the arcades of SMA, and poor demonstration of intramural vessels. MPR images of two patients who had angiography were concordant with their angiograms. The mean diameter of SMA of NOMI patients was 3.4±1.1mm, which was statistically smaller than that of 13 control patients, 6.0±1.5mm (P<0.05, Wilcoxon rank sum tests). Angiography has been recognized essential for the diagnosis of NOMI. Study shows the possibility of MDCT to be an equivalently useful modality compared to angiography for the diagnosis of NOMI by interpreting morphologic appearance and diameter of SMA. Introduction of MDCT in the decision tree of NOMI treatment may bring the benefit of prompt diagnosis and subsequent early and efficient initiation of therapy, which may improve the mortality.	3
10. Al-Thani H, El-Mabrok J, El-Menyar A, et al. Clinical presentation and outcome of mesenteric vein thrombosis: a single-center experience. <i>Angiology.</i> 2015;66(3):249-256.	Review/Other-Tx	35 patients	To evaluate the etiology, clinical presentation, management, and outcome of MVT in Qatar.	The risk of MVT was significantly high among males who smoked and females of Arab ethnicity. The main manifestations of MVT were abdominal distension and vomiting. The major etiological factors included deficiency in protein C and S, homocysteinemia, and prior abdominal surgery. Computed tomography (CT) findings were helpful in 80% of the patients. Bowel resection with primary anastomosis was performed in 25 (71%) patients. The overall mortality rate was 17%. High index of suspicion, detection of risk factors, CT imaging, and timely intervention are essential for better prognosis.	4

Imaging of Mesenteric Ischemia
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11. Kumar S, Sarr MG, Kamath PS. Mesenteric venous thrombosis. <i>N Engl J Med.</i> 2001;345(23):1683-1688	Review/Other-Tx	N/A	No abstract available	No abstract available	4
12. Cangemi JR, Picco MF. Intestinal ischemia in the elderly. <i>Gastroenterol Clin North Am.</i> 2009; 38(3):527-540.	Review/Other-Dx	N/A	To review the clinical spectrum of mesenteric ischemia in the elderly with particular emphasis on the varied presentations, evaluation, and management of ischemic disorders of the intestines.	Angiography remains the gold standard in AMI, allowing for diagnostic and therapeutic measures to address this condition. It has a high sensitivity (74% to 100%) and specificity (100%) with few complications. MDCTA is emerging as a new technology that may serve as an excellent alternative to angiography. Duplex ultrasonography with B-mode ultrasonography and Doppler waveform analysis serves as an excellent noninvasive means of accurately detecting mesenteric stenosis in chronic mesenteric ischemia. It has a specificity of 92% to 100% for severe stenosis of the celiac or SMA but sensitivity is less at 70% to 89%.	4
13. Karkkainen JM, Lehtimäki TT, Manninen H, Paajanen H. Acute Mesenteric Ischemia Is a More Common Cause than Expected of Acute Abdomen in the Elderly. <i>J Gastrointest Surg.</i> 19(8):1407-14, 2015 Aug.	Review/Other-Dx	N/A	To utilize acute appendicitis, ruptured abdominal aortic aneurysm, acute pancreatitis, and acute cholecystitis as reference diagnoses, and the age-specific incidence rates were calculated.	The in-hospital incidence rates of AMI, acute obstructive mesenteric ischemia, and non-obstructive mesenteric ischemia were 7.3, 4.5, and 2.0/100,000/year, respectively. AMI was more common than ruptured abdominal aortic aneurysm, and the age-specific incidence of AMI was higher than the incidence of acute appendicitis in patients over age 75 years with acute abdomen. During the follow-up, the age-adjusted risk of death was 1.8 times higher in AMI survivors than in survivors of acute cholecystitis.	4

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14. Lehtimäki TT, Karkkainen JM, Saari P, Manninen H, Paaajanen H, Vanninen R. Detecting acute mesenteric ischemia in CT of the acute abdomen is dependent on clinical suspicion: Review of 95 consecutive patients. <i>Eur J Radiol.</i> 2015;84(12):2444-2453	Observational-Dx	95 patients with 97 AMI events	To evaluate the ability of emergency room radiologists to detect acute mesenteric ischemia (AMI) from computed tomography (CT) images in patients with acute abdominal pain and to identify factors affecting radiologists' performance in the CT interpretation and patient outcome.	The referring clinician had suspected AMI in 30 (31%) cases prior to imaging. The crucial findings of AMI had been stated in 97% of the radiology reports if the clinician had mentioned AMI suspicion in the referral; if not, the corresponding rate was 81% (p=0.04). Patients without suspicion of AMI prior to CT were more prone to undergo bowel resection. CT protocol was optimal for AMI (with contrast enhancement in arterial and venous phases) in only 34 (35%) cases. Intestinal findings were more difficult to detect than vascular findings. Vascular findings were retrospectively detectable in 92% of cases with embolism and 100% in ASVD and MVT. Some evidence of intestinal abnormality was retrospectively found in the CT findings in 92%, 100%, 100% and 67% of cases with embolism, ASVD, NOMI and MVT, respectively.	2

Imaging of Mesenteric Ischemia
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15. Cudnik MT, Darbha S, Jones J, Macedo J, Stockton SW, Hiestand BC. The diagnosis of acute mesenteric ischemia: A systematic review and meta-analysis. Acad Emerg Med. 2013;20(11):1087-1100	Meta-analysis	23 studies	To determine diagnostic test characteristics of patient symptoms, objective signs, laboratory studies, and diagnostic modalities to help rule in or out the diagnosis of acute mesenteric ischemia in the ED.	The literature search identified 1,149 potentially relevant studies, of which 23 were included in the final analysis. The quality of the diagnostic studies was highly variable. A total of 1,970 patients were included in the combined population of all included studies. The prevalence of acute mesenteric ischemia ranged from 8% to 60%. There was a pooled sensitivity for l-lactate of 86% (95% confidence interval [CI] = 73% to 94%) and a pooled specificity of 44% (95% CI = 32% to 55%). There was a pooled sensitivity for D-dimer of 96% (95% CI = 89% to 99%) and a pooled specificity of 40% (95% CI = 33% to 47%). For computed tomography (CT), we found a pooled sensitivity of 94% (95% CI = 90% to 97%) and specificity of 95% (95% CI = 93% to 97%). The positive likelihood ratio (+LR) for a positive CT was 17.5 (95% CI = 5.99 to 51.29), and the negative likelihood ratio (-LR) was 0.09 (95% CI = 0.05 to 0.17). The pooled operative mortality rate for mesenteric ischemia was 47% (95% CI = 40% to 54%). Given these findings, the test threshold of 2.1% (below this pretest probability, do not test further) and a treatment threshold of 74% (above this pretest probability, proceed to surgical management) were calculated.	Good
16. Lyon C, Clark DC. Diagnosis of acute abdominal pain in older patients. Am Fam Physician. 2006; 74(9):1537-1544.	Review/Other-Dx	N/A	To review diagnosis of acute abdominal pain older patients.	In older patients with appendicitis, the initial diagnosis is correct only one half of the time, and there are increased rates of perforation and mortality when compared with younger patients. Different imaging studies are recommended depending on the condition.	4

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17. Gans SL, Stoker J, Boermeester MA. Plain abdominal radiography in acute abdominal pain; past, present, and future. <i>Int J Gen Med.</i> 2012;5:525-533	Review/Other-Dx	N/A	No results stated in abstract	No results stated in abstract	4
18. Oldenburg WA, Lau LL, Rodenberg TJ, Edmonds HJ, Burger CD. Acute mesenteric ischemia: a clinical review. <i>Arch Intern Med.</i> 2004;164(10):1054-1062	Review/Other-Tx	N/A	No results stated in abstract	No results stated in abstract	4
19. Wolf EL, Sprayregen S, Bakal CW. Radiology in intestinal ischemia. Plain film, contrast, and other imaging studies. <i>Surg Clin North Am.</i> 1992; 72(1):107-124.	Review/Other-Dx	N/A	To review the role of plain film, contrast, and other imaging studies in the diagnosis of intestinal ischemia.	The barium enema is the most useful radiographic examination in the diagnosis of colonic ischemia, and a double-contrast study will show abnormalities in almost all cases. When AMI is suspected, angiography should be performed, but CT, US, and, perhaps, MR imaging may contribute to the diagnosis.	4
20. Angelelli G, Scardapane A, Memeo M, Stabile Ianora AA, Rotondo A. Acute bowel ischemia: CT findings. <i>Eur J Radiol.</i> 2004; 50(1):37-47.	Review/Other-Dx	N/A	To review the aetiological and pathophysiological aspects as well as a broad spectrum of CT findings of acute bowel ischemia.	In recent years CT has proved to be a valid diagnostic tool in the evaluation of patients with acute abdominal syndrome and in the visualization of early signs of bowel ischemia.	4

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21. Wadman M, Syk I, Elmstahl B, Ekberg O, Elmstahl S. Abdominal plain film findings in acute ischemic bowel disease differ with age. <i>Acta Radiol</i> 2006; 47(3):238-243.	Observational-Dx	134 patients with AIBD; 89 patients examined radiographically	To evaluate whether elderly patients with acute ischemic bowel disease (AIBD) present different radiographic findings on admission compared to younger patients and whether the radiographic findings correlate to clinical findings.	In 89%, the plain film displayed pathologic signs. Bowel dilatation was more common in the elderly. Of 68 patients aged = 71 years, 19 (28%) had colon gas/fluid levels with/without colon dilatation, and of 19 patients > 84 years 16 (84%) had small-bowel dilatation. Of 20 patients aged < 71 years, 1 (5%) had colon gas/fluid levels with/without colon dilatation, and 11 (55%) small-bowel dilatation (P < 0.05; P < 0.05). Gasless abdomen was more common in the younger age group, noted in 5 of 20 (25%) patients aged < 71 years, compared to 2 of 68 (3%) patients aged = 71 years (P = 0.001). Of the patients with diarrhea, 13 of 33 (40%) had colon gas/fluid levels with/without colon dilatation compared to 2 of 29 (7%) without (P = 0.003). In the elderly (= 71 years), 48 of 53 (91%) patients with bowel dilatation on plain film died, compared to 11 out of 16 (69%) without this finding (P < 0.05). Abdominal plain film findings differed with age. Bowel dilatation was more frequent in the elderly with AIBD, whereas gasless abdomen was more common in younger patients. The radiographic findings were associated with clinical symptoms and mortality	3
22. American College of Radiology. ACR-NASCI-SIR-SPR Practice Parameter for the Performance and Interpretation of Body Computed Tomography Angiography (CTA). Available at: https://www.acr.org/-/media/ACR/Files/Practice-Parameters/body-cta.pdf	Review/Other-Dx	N/A	Guidance document to promote the safe and effective use of diagnostic and therapeutic radiology by describing specific training, skills and techniques.	N/A	4

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23. Barmase M, Kang M, Wig J, Kochhar R, Gupta R, Khandelwal N. Role of multidetector CT angiography in the evaluation of suspected mesenteric ischemia. <i>Eur J Radiol.</i> 2011;80(3):e582-587	Observational-Dx	31 patients	To assess the role of multidetector CT angiography (MDCTA) in the diagnosis of acute mesenteric ischemia (AMI) and to compare the diagnostic utility of axial images with reconstructed images.	AMI was correctly diagnosed in all 16 patients on MDCTA (100% sensitivity and specificity) of whom nine patients underwent surgical exploration. Three patients expired before surgery and the remaining 5 patients were proven based on positive clinical and laboratory findings. Mesenteric arterial occlusion was seen in 7 patients while 5 patients had portomesenteric venous thrombosis. Reconstructed images using minimum intensity projection, volume rendering and multiplanar volume reconstruction were found to perform better for the detection of vascular abnormalities and improved the diagnostic confidence of both radiologists in the evaluation of bowel and mesenteric abnormalities.	1
24. Horton KM, Fishman EK. Multidetector CT angiography in the diagnosis of mesenteric ischemia. <i>Radiol Clin North Am.</i> 2007; 45(2):275-288.	Review/Other-Dx	N/A	To review contrast administration and image acquisition protocols, the anatomy of the mesenteric vasculature, the etiology of acute and chronic mesenteric ischemia, and CT findings diagnostic for these conditions.	MDCT is an ideal tool for the diagnosis of acute and chronic mesenteric ischemia. Advanced CT scanners and expertise in 3D imaging are becoming increasingly widespread, opening the door to new opportunities and challenges in the evaluation of patients suspected of having mesenteric ischemia.	4

Imaging of Mesenteric Ischemia
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25. Kirkpatrick ID, Kroeker MA, Greenberg HM. Biphasic CT with mesenteric CT angiography in the evaluation of acute mesenteric ischemia: initial experience. <i>Radiology</i> . 2003; 229(1):91-98.	Observational-Dx	62 patients	To evaluate the sensitivity and specificity of biphasic CT with mesenteric CT angiography in the diagnosis of acute mesenteric ischemia (AMI).	AMI was diagnosed in 26 patients. The CT angiogram depicted arterial disease in eight patients and altered care in five. A finding of any one of pneumatosis intestinalis, venous gas, superior mesenteric artery occlusion, celiac and inferior mesenteric artery occlusion with distal SMA disease, or arterial embolism was 100% specific but only 73% sensitive. Alternatively, a finding of bowel wall thickening in addition to focal lack of bowel wall enhancement, solid organ infarction, or venous thrombosis was 50% sensitive and 94% specific. By using either of these criteria for the diagnosis, a sensitivity of 96% and a specificity of 94% can be achieved. Biphasic CT with mesenteric CT angiography is effective in the diagnosis of AMI.	2
26. Shih MC, Angle JF, Leung DA, et al. CTA and MRA in mesenteric ischemia: part 2, Normal findings and complications after surgical and endovascular treatment. <i>AJR</i> . 2007; 188(2):462-471.	Review/Other-Dx	N/A	To review the normal appearance of surgical and endovascular treatments of mesenteric ischemia and their complications as seen on CTA and contrast-enhanced MRA.	CTA is a technique that is well suited for assessing the normal and complicated appearances after mesenteric ischemia treatment. According to the authors, the ability to visualize the lumen of metallic stents, the higher spatial resolution, and the much faster acquisition times on modern MDCT scanners make CTA superior to contrast-enhanced MRA in this setting.	4
27. Turkbey B, Akpınar E, Cil B, Karcaaltincaba M, Akhan O. Utility of multidetector CT in an emergency setting in acute mesenteric ischemia. <i>Diagn Interv Radiol</i> . 2009; 15(4):256-261.	Review/Other-Dx	N/A	To review utility of MDCT in an emergency setting in AMI.	Besides conventional diagnostic imaging modalities contrast enhanced MDCTA enables fast and detailed evaluation of the mesenteric circulation and abdominal viscera which provides accurate and rapid diagnosis in the emergency room.	4
28. White CJ. Chronic mesenteric ischemia: diagnosis and management. <i>Prog Cardiovasc Dis</i> . 2011;54(1):36-40	Review/Other-Dx	N/A	No results stated in abstract	No results stated in abstract	4

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29. Schaefer PJ, Pfarr J, Trentmann J, et al. Comparison of noninvasive imaging modalities for stenosis grading in mesenteric arteries. <i>Rofo</i> . 2013;185(7):628-634.	Experimental-Dx	52 patients	To prospectively analyze duplex sonography, CTA, and MRA with respect to stenosis grading of the celiac trunk (TC) and the superior mesenteric artery (SMA), with DSA as the reference.	The mean image quality was 3.8 +/- 0.7, 3.1 +/- 1.0, 4.4 +/- 0.7, and 3.8 +/- 0.9 for DSA, duplex sonography, CTA, and MRA, respectively. For both TC and SMA, stenosis grading reached a significant level of correlation between each noninvasive modality with DSA (p < 0.001, each). The weighted Cohen's kappa for duplex sonography/CTA/MRA was 0.94/0.93/0.74, respectively, for the TC and 0.64/0.91/0.56, respectively, for the SMA. Highest sensitivity/specificity/NPV/PPV/accuracy were found for CTA with 100%/95%/85%/100%/96% for the TC and with na/98%/na/100%/98%, respectively, for the SMA.	1
30. Raman SP, Fishman EK. Computed Tomography Angiography of the Small Bowel and Mesentery. <i>Radiol Clin North Am</i> . 2016;54(1):87-100	Review/Other-Dx	N/A	To detail the MDCT imaging findings of several small bowel vascular and inflammatory disorders.	No results stated in abstract	4

Imaging of Mesenteric Ischemia
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31. Aschoff AJ, Stuber G, Becker BW, et al. Evaluation of acute mesenteric ischemia: accuracy of biphasic mesenteric multi-detector CT angiography. <i>Abdom Imaging</i> . 2009;34(3):345-357	Observational-Tx	79 patients	To explore the accuracy of multi-detector row helical CT (MDCT), using a biphasic mesenteric angiography protocol for evaluation of acute mesenteric ischemia (AMI).	In total, 79 consecutive patients with clinical signs of AMI underwent contrast enhanced 16- or 40-channel MDCT. MDCT findings were correlated with surgery, endoscopy and clinical outcome. Sensitivity, specificity, and positive and negative predictive values were calculated using the patients in which AMI had been excluded as a control group. In 28 patients the final diagnosis was AMI. In 27 patients (96.4%) MDCT correctly diagnosed AMI (specificity of 97.9%). A sensitivity of 93%, specificity of 100%, and positive and negative predictive values of 100% and 94%, respectively were achieved for the CT findings of visceral artery occlusion, intestinal pneumatosis, portomesenteric venous gas or bowel wall thickening in combination with either portomesenteric thrombosis or solid organ infarction.	3
32. Wasnik A, Kaza RK, Al-Hawary MM, Liu PS, Platt JF. Multidetector CT imaging in mesenteric ischemia--pearls and pitfalls. <i>Emerg Radiol</i> . 2011;18(2):145-156	Review/Other-Dx	N/A	No results stated in abstract	No results stated in abstract	4
33. Hagspiel KD, Flors L, Hanley M, Norton PT. Computed tomography angiography and magnetic resonance angiography imaging of the mesenteric vasculature. [Review]. <i>Tech Vasc Interv Radiol</i> . 18(1):2-13, 2015 Mar.	Review/Other-Dx	N/A	To provide an introduction to the CTA and MRA imaging protocol to study the mesenteric vasculature, the imaging findings in patients presenting with acute and chronic mesenteric ischemia and visceral aneurysms, and the value of these imaging techniques for therapy planning and follow-up.	No results stated in abstract	4

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34. Klar E, Rahmanian PB, Bucker A, Hauenstein K, Jauch KW, Luther B. Acute mesenteric ischemia: a vascular emergency. Dtsch Arztebl Int. 2012;109(14):249-256.	Review/Other-Dx	N/A	To improve outcomes of cases of Mesenteric ischemia by recognizing the disease as a vascular emergency that requires rapid and efficient clinical evaluation and treatment.	If non-occlusive mesenteric ischemia is suspected, angiography should be performed, with the option of intraarterial pharmacotherapy to induce local vasodilation. Endovascular techniques have become increasingly important in the treatment of arterial occlusion. Embolic central mesenteric artery occlusion requires surgical treatment; surgery is also needed in case of peritonitis. Portal-vein thrombosis can be treated by local thrombolysis through a transhepatically placed catheter. This should be done within 3 to 4 weeks of the event to prevent later complications of portal hypertension.	4
35. Ofer A, Abadi S, Nitecki S, et al. Multidetector CT angiography in the evaluation of acute mesenteric ischemia. Eur Radiol. 2009;19(1):24-30.	Review/Other-Dx	91 patients	To determine the accuracy of multidetector row CT angiography in the diagnosis of acute mesenteric ischemia.	Mesenteric ischemia was diagnosed in 18 patients, 14 of them were of the thromboembolic type and four from the nonocclusive type. Positive CTA findings were confirmed by surgery in 13 patients and by clinical follow-up in three cases. Other reasons for abdominal pain were diagnosed by CT in 38 patients out of the remaining 74. There were two false positive and two false negative CT results, resulting in an overall accuracy of 95.6%.	4

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36. Chen YC, Huang TY, Chen RC, et al. Comparison of Ischemic and Nonischemic Bowel Segments in Patients With Mesenteric Ischemia: Multidetector Row Computed Tomography Findings and Measurement of Bowel Wall Attenuation Changes. <i>Mayo Clin Proc.</i> 2016;91(3):316-328	Observational-Dx	69 patients: 35 men; 34 women	To describe multidetector row computed tomography (MDCT) findings and to compare the enhancing ratio of ischemic and nonischemic bowel wall segments in patients with mesenteric ischemia.	The most common origin of ischemia was the mesenteric artery (45 of the 69 patients [65.2%]), but only 5 patients (7.2%) had evidence of arterial thrombus on MDCT. The quantitative MDCT measurements indicated that the ischemic bowel segments had significantly less bowel wall attenuation than the nonischemic bowel segments on the arterial phase (28.58±9.28 vs 58.97±12.50; P<.001) and the portal venous phase (33.93±11.16 vs 76.25±13.56; P<.001). The enhancing ratio on the arterial phase (cutoff, 0.32 or less; sensitivity, 89.9%; specificity, 98.6%) and the ERv (cutoff, 0.81 or less; sensitivity, 95.7%; specificity, 98.6%) predicted bowel ischemia. The most common MDCT findings in ischemic bowel were thickened bowel wall in 59 patients (85.5%), mesenteric fatty stranding in 57 (82.6%), and decreased bowel wall enhancement in 56 (81.2%). All quantitative measurements reached moderate to substantial agreement (0.399-0.601).	2
37. Acosta S, Bjornsson S, Ekberg O, Resch T. CT angiography followed by endovascular intervention for acute superior mesenteric artery occlusion does not increase risk of contrast-induced renal failure. <i>Eur J Vasc Endovasc Surg.</i> 2010;39(6):726-730.	Observational-Tx	55 patients	To study the development of postoperative permanent renal failure due to contrast-induced nephropathy.	Preoperative renal insufficiency was found in 52%; advanced state in one patient. Creatinine was lower (p = 0.018) at discharge (median: 71 micromol L(-1)), compared to admission (median: 76 micromol L(-1)), in the 32 survivors exposed to repeated iodinated contrast media (median: 54.7 g iodine). No patient died due to renal failure or needed dialysis after endovascular intervention. Endovascular intervention was associated with a higher survival rate (p = 0.001).	3
38. Clair DG, Beach JM. Mesenteric Ischemia. <i>N Engl J Med.</i> 2016;374(10):959-968.	Review/Other-Dx	N/A	No abstract available	No abstract available	4

**Imaging of Mesenteric Ischemia
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
<p>39. Menke J. Diagnostic accuracy of multidetector CT in acute mesenteric ischemia: systematic review and meta-analysis. <i>Radiology</i>. 2010;256(1):93-101.</p>	<p>Meta-analysis</p>	<p>6 studies</p>	<p>To use meta-analysis to determine the diagnostic accuracy of contrast agent-enhanced MDCT in primary acute mesenteric ischemia. Surgery or clinical outcome used as the reference standard.</p>	<p>Three studies were prospective, and three were retrospective. All studies were of high quality. The CT scanners used in the included studies had between 4 and 40 rows. The between-study heterogeneity was low to moderate. Overall, acute mesenteric ischemia was found in 142/619 studied cases. The meta-analysis showed a pooled sensitivity of 93.3% (95% CI: 82.8%, 97.6%) and a pooled specificity of 95.9% (95% CI: 91.2%, 98.2%). On the basis of a thorough clinical examination, contrast-enhanced MDCT allows the diagnosis of primary AMI with high sensitivity and specificity. Thus, it may be used as the first-line imaging method.</p>	<p>Good</p>

Imaging of Mesenteric Ischemia
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
40. Wadman M, Block T, Ekberg O, Syk I, Elmstahl S, Acosta S. Impact of MDCT with intravenous contrast on the survival in patients with acute superior mesenteric artery occlusion. <i>Emerg Radiol.</i> 2010;17(3):171-178.	Observational-Dx	36: 29 women; 7 men	To analyze multi-detector computerised tomography with intravenous contrast enhancement (MDCTiv) and how it may improve diagnostic accuracy and survival.	In all, 24 (67%) of the 36 patients were correctly diagnosed by MDCTiv at first evaluation. Clinical suspicion of intestinal ischemia followed by a distinct inquiry for intestinal ischemia was associated with trend for a higher rate of correct radiological diagnosis, 18 of 23 (78%), at first evaluation (0.06) but without affecting in-hospital survival ($p = 0.27$). At re-evaluation, SMA occlusion was found in all cases with MDCTiv, whereas intestinal findings were present in half. In-hospital mortality rate was 42% for patients who underwent MDCTiv, which was significantly lower compared to 90% for the ten patients examined with plain MDCT ($p = 0.007$) and 71% for patients not examined with MDCTiv or plain MDCT ($p = 0.031$). Patients that underwent plain MDCT had higher levels of creatinine compared to those examined with MDCTiv ($p = 0.005$). Patients who underwent intestinal revascularisation, endovascular or open, had higher survival rate ($p = 0.001$).	2

Imaging of Mesenteric Ischemia
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
41. Yikilmaz A, Karahan OI, Senol S, Tuna IS, Akyildiz HY. Value of multislice computed tomography in the diagnosis of acute mesenteric ischemia. <i>Eur J Radiol.</i> 2011;80(2):297-302.	Observational-Dx	200 patients	To define the value of multislice CT in the diagnosis of acute abdominal pain.	94 patients (47%) underwent surgery for AMI or for other causes of acute abdominal pain. 106 patients (53%) were followed conservatively according to clinical, radiologic and laboratory findings. Of the 94 patients who underwent surgery, 49 (25%) were found to have AMI. All of these 49 patients with a proven AMI diagnosis were diagnosed with CT. In the other 45 patients who underwent surgery, CT findings were negative for AMI. None of the patients, who were followed conservatively, were eventually diagnosed as having AMI except 1 patient. This patient was unfit for surgery although his clinical and radiologic findings were consistent with AMI and died in 3 days. The sensitivity and specificity values of CT for the detection of AMI were calculated to be 100% for each.	3
42. Schieda N, Fasih N, Shabana W. Triphasic CT in the diagnosis of acute mesenteric ischaemia. <i>Eur Radiol.</i> 2013;23(7):1891-1900.	Observational-Dx	218 patients	To evaluate the yield of each phase in a triphasic CT protocol used to diagnose acute mesenteric ischaemia (AMI).	The sensitivity and specificity of submucosal haemorrhage were 10 % and 98 %. Interobserver variability was poor (kappa = 0.17). All true-positive cases had other CT findings of AMI (n = 4). There was no difference in the assessment of bowel enhancement between readers (P < 0.05). There was no difference between readers (P < 0.05) and interobserver variability was moderate to good when diagnosing arterial abnormalities without CTA. Sample size was small and errors occurred when using only the portal venous phase for this purpose.	2

Imaging of Mesenteric Ischemia
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
43. Blachar A, Barnes S, Adam SZ, et al. Radiologists' performance in the diagnosis of acute intestinal ischemia, using MDCT and specific CT findings, using a variety of CT protocols. <i>Emerg Radiol.</i> 2011;18(5):385-394.	Observational-Dx	47 Patients	To evaluate the performance of radiologists in the diagnosis of acute intestinal ischemia using specific multi-detector CT findings.	The sensitivity, specificity, and accuracy for diagnosing bowel ischemia were 89%, 67%, and 79% for the abdominal imager; 83%, 67%, and 76% for the general radiologist; and 66%, 83%, and 74% for the senior resident, respectively. The calculated kappa value for inter-observer agreement regarding the presence of bowel ischemia was 0.79. CT findings that significantly distinguished bowel ischemia from other bowel pathologies were decreased or absent bowel wall enhancement, filling defect in the superior mesenteric artery, small bowel pneumatosis, and gas in the portal veins or superior mesenteric vein. For most of these signs, there was good inter-observer agreement.	2
44. Gaa J, Laub G, Edelman RR, Georgi M. [First clinical results of ultrafast, contrast-enhanced 2-phase 3D-angiography of the abdomen]. <i>Rofo.</i> 1998;169(2):135-139	Review/Other-Dx	125 patients	To assess the utility of breath-hold abdominal ultrafast three-dimensional (3D) gadolinium-enhanced dual-phase magnetic resonance angiography (MRA). Note: Manuscript is in German language. Statistics primarily descriptive (%).	119 (95%) of 125 MRA's were of good or excellent quality. The sensitivity in the detection of renal artery stenoses as well as stenoses of the celiac trunk and the superior mesenteric artery was 100%. Accessory renal arteries (n = 9) and replaced hepatic arteries (n = 4) were reliably detected by MRA. In 24 (71%) of 34 cases MR-angiographic delineation of the spleno-portal system and hepatic veins was superior compared to conventional angiography.	4
45. Gilfeather M, Holland GA, Siegelman ES, et al. Gadolinium-enhanced ultrafast three-dimensional spoiled gradient-echo MR imaging of the abdominal aorta and visceral and iliac vessels. <i>Radiographics.</i> 1997;17(2):423-432.	Review/Other-Dx	N/A	No results stated in abstract	No results stated in abstract	4

Imaging of Mesenteric Ischemia
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
46. Holland GA, Dougherty L, Carpenter JP, et al. Breath-hold ultrafast three-dimensional gadolinium-enhanced MR angiography of the aorta and the renal and other visceral abdominal arteries. <i>AJR Am J Roentgenol.</i> 1996;166(4):971-981	Observational-Dx	63; age from 14 to 88	To develop and show the efficacy of a breath-hold ultrafast three-dimensional (3D) spoiled gradient-echo (SPGR) gadolinium-enhanced MR angiographic technique for imaging the aorta and the renal and other visceral arteries of the abdomen; and to compare breath-hold ultrafast 3D SPGR with two-dimensional (2D) time-of-flight (TOF) and non-breath-hold ultrafast 3D SPGR in the same patients.	Breath-hold ultrafast 3D SPGR correctly identified 31 of 31 stenoses of the renal artery for a sensitivity, specificity, and accuracy of 100%. Two-dimensional TOF detected 23 of 31 renal artery stenoses for a sensitivity, specificity, and accuracy of 74%, 98%, and 87% respectively. Breath-hold ultrafast 3D SPGR underestimated two renal arteries as having severe ostial stenoses that were graded correctly by 2D TOF and by angiography as occlusions. Eight of nine (89%) accessory renal arteries were correctly identified with breath-hold ultrafast 3D SPGR: Two-dimensional TOF identified six of nine (67%). Breath-hold ultrafast 3D SPGR identified one accessory and two reconstituted renal arteries missed by 2D TOF and conventional contrast angiography that were confirmed at surgery. Ultrafast 3D SPGR and 2D TOF correctly identified 20 of 20 celiac, superior mesenteric, and inferior mesenteric artery ostial stenoses or occlusions for a sensitivity, specificity, and accuracy of 100%. Three Riolan's arcs were correctly identified by breath-hold 3D SPGR but were missed by 2D TOF: Forty of the 63 patients did not have conventional contrast angiography and were managed surgically (n = 9) or medically (n = 31) based on the results of the MR angiograms and clinical data. Breath-hold ultrafast 3D SPGR MR angiography correctly identified and graded 48 of 51 renal, celiac, superior mesenteric, and inferior mesenteric artery stenoses or occlusions. Two-dimensional TOF MR angiography correctly identified and graded 45 of 51 renal, celiac, superior mesenteric, and inferior mesenteric artery	2

Imaging of Mesenteric Ischemia
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
				stenoses and occlusions.	
47. Meaney JF, Prince MR, Nostrant TT, Stanley JC. Gadolinium-enhanced MR angiography of visceral arteries in patients with suspected chronic mesenteric ischemia. <i>J Magn Reson Imaging</i> . 1997; 7(1):171-176.	Observational-Dx	14 patients had MR imaging findings available	To evaluate accuracy of dynamic gadolinium-enhanced MRA of the celiac, superior, and inferior mesenteric arteries in patients with suspected mesenteric ischemia compared with catheter angiography or surgery.	Overall sensitivity and specificity were 100% and 95%, respectively, compared with catheter angiography and surgery. The two errors were caused by overgrading the severity of IMA disease. 3D gadolinium-enhanced MRA can accurately demonstrate the origins of the celiac artery and SMA and is useful in evaluation of patients with suspected mesenteric ischemia.	3
48. Shetty AS, Mellnick VM, Raptis C, Loch R, Owen J, Bhalla S. Limited utility of MRA for acute bowel ischemia after portal venous phase CT. <i>Abdom Imaging</i> . 2015;40(8):3020-3028.	Observational-Dx	32 patients	To compare the concordance of CT and magnetic resonance angiography (MRA) for acute bowel ischemia.	Ten cases of bowel ischemia were confirmed by endoscopy and/or surgical pathology. CT correctly identified bowel findings in all cases. Intraobserver agreement between CT and MRA for all vessels was 0.68 and 0.63, highest for the superior mesenteric artery. Interobserver agreement was 0.74 for MRA and 0.78 for CT. Vascular findings were only directly mentioned in 10 of 32 CT reports (and 7 of 10 cases with confirmed bowel ischemia). MRA only detected two additional or alternative diagnoses.	2
49. Boley SJ, Sprayregan S, Siegelman SS, Veith FJ. Initial results from an aggressive roentgenological and surgical approach to acute mesenteric ischemia. <i>Surgery</i> . 1977;82(6):848-855.	Experimental-Dx	50 patients	To apply an earlier and more liberal use of angiography in patients at risk and the intra-arterial infusion of papaverine for the relief of superior mesenteric artery (SMA) vasoconstriction in both nonocclusive and occlusive forms of AMI	Of the first 50 patients managed by this approach, 35 (70%) had AMI demonstrated by SMA angiography, Nineteen (54%) of these 35 patients survived, including nine of 15 patients with nonocclusive mesenteric ischemia, seven of 16 with SMA embolus, two of three patients with SMA thrombosis, and the one patient with mesenteric venous thrombosis. Seventeen of the 19 survivors lost no bowel or had excision of less than 3 feet of small intestine.	3

Imaging of Mesenteric Ischemia
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
50. Boos S. [Angiography of the mesenteric artery 1976 to 1991. A change in the indications during mesenteric circulatory disorders?]. <i>Radiologe</i> . 1992;32(4):154-157.	Review/Other-Dx	N/A	To study the lowering of acute vascular mesenteric insufficiency by performing consistent angiographic examination.	Article written in a language other than English	4
51. Bottger T, Schafer W, Weber W, Junginger T. [Value of preoperative diagnosis in mesenteric vascular occlusion. A prospective study]. <i>Langenbecks Arch Chir</i> . 1990;375(5):278-282.	Review/Other-Dx	46 patients	To study the value of preoperative diagnostics in cases of acute mesenteric vascular occlusion.	Seventeen patients had an arterial thrombosis, 17 a venous thrombosis, 10 had an emboli and 2 patients suffered from a non-occlusive mesenteric infarction. All patients had leucocytosis with an average of 21,000/nl; serum lactate was increased in 91.4% and phosphate was increased in 36.4%. In 82.6% of the cases loops of the small bowel were seen on the X-ray of the abdomen, but in none of the patients an acute mesenteric vascular occlusion was suspected based on the X-ray alone. In 5 of the 46 cases the occlusion could be seen sonographically. The angiography had a sensitivity of 77%.	4
52. Clark RA, Gallant TE. Acute mesenteric ischemia: angiographic spectrum. <i>AJR Am J Roentgenol</i> . 1984;142(3):555-562.	Review/Other-Dx	56 patients	To study fifty-six patients, selected by clinical criteria, that underwent angiography for suspected acute mesenteric ischemia.	Twenty-nine patients subsequently did not have mesenteric ischemia and had negative arteriograms. Twenty-seven patients had mesenteric ischemia: arterial thrombosis (three), arterial embolus (seven), venous thrombosis (five), vasculitis with thrombosis (one), and nonocclusive ischemia (11). Of these 27 patients, 12 (44%) received intraarterial vasodilator infusions. Overall, 13 (48%) of the 27 patients survived their hospitalization, including five (45%) of 11 with nonocclusive ischemia.	4

Imaging of Mesenteric Ischemia
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
53. Czerny M, Trubel W, Claeys L, et al. [Acute mesenteric ischemia]. Zentralbl Chir. 1997;122(7):538-544.	Review/Other-Dx	145 patients	To describe the development of the various procedures of diagnostic assessment and treatment between 1970 and 1996, to show the influence on survival and to define recent standards. Article written in a language other than English	In most cases AMI was caused by arterial embolism (64.1%, n = 93) followed by arterial thrombosis (27.6%, n= 40). Venous thrombosis (3.5%, n = 5) and non-occlusive AMI (4.8%, n = 7) were rare events. Serum lactate level has been determined routinely in all patients having been admitted with acute abdomen since 1984 and turned out to be positive in 81.2% (mean value 9.81 (3.21-22.3) mmol/l). Abdominal x-ray gave only in some individual cases special hints to the advanced intestinal gangrene. Abdominal sonography led to the correct diagnostic assessment in 52 patients (= 35.8%). Angiography was in 92% conclusive for the diagnosis. Abdominal CT led to establish the correct diagnosis in > 80%. Our series with revascularisation (thrombectomy/embolectomy or bypass) has resulted in 73.8% patient survival with intestine having been maintained in the most favourable cases.	4
54. Kaufman SL, Harrington DP, Siegelman SS. Superior mesenteric artery embolization: an angiographic emergency. Radiology. 1977;124(3):625-630.	Review/Other-Dx	N/A	To study eleven cases of superior mesenteric artery embolization.	The extent of bowel necrosis was found to be related to two major factors: the site of occlusion and the elapsed time between the onset of symptoms and definitive therapy. Angiography, available on an emergency basis, provides a definitive diagnosis which can only be suspected by other means. Therapy instituted within 24 hours of the onset of symptoms in all cases resulted in a mortality of only 9% attributable to intestinal infarction.	4

Imaging of Mesenteric Ischemia
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
55. Marston A, Clarke JM, Garcia Garcia J, Miller AL. Intestinal function and intestinal blood supply: a 20 year surgical study. Gut. 1985;26(7):656-666.	Experimental-Tx	100 patients	To analyze the experience of The Middlesex Hospital in the investigation and management of chronic intestinal arterial occlusion (IAO) over a 20 year period.	No relation was found between intestinal performance and the degree of potential ischaemia suggested by angiography. Twenty two patients underwent reconstruction of the coeliac axis and mesenteric arteries, with three perioperative deaths. The remainder were followed for periods ranging between six months and 10 years. Of these, 15 are asymptomatic, one is unchanged, and one is subjectively worse. T	4
56. Stoney RJ, Cunningham CG. Acute mesenteric ischemia. Surgery. 1993;114(3):489-490.	Review/Other-Tx	N/A	Not stated.	No results stated in abstract	4
57. Brandt LJ, Boley SJ. AGA technical review on intestinal ischemia. American Gastrointestinal Association. Gastroenterology. 2000; 118(5):954-968.	Review/Other-Dx	N/A	To provide a technical review of intestinal ischemia.	N/A	4

**Imaging of Mesenteric Ischemia
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
<p>58. Beaulieu RJ, Arnaoutakis KD, Abularrage CJ, Efron DT, Schneider E, Black JH, 3rd. Comparison of open and endovascular treatment of acute mesenteric ischemia. <i>J Vasc Surg.</i> 2014;59(1):159-164</p>	<p>Observational-Tx</p>	<p>N/A</p>	<p>Not stated</p>	<p>Of 23,744 patients presenting with AMI, 4665 underwent interventional treatment from 2005 through 2009. Of these patients, 57.1% were female, and the mean age was 70.5 years. A total of 679 patients underwent vascular intervention; 514 (75.7%) underwent open surgery and 165 (24.3%) underwent endovascular treatment overall during the study period. The proportion of patients undergoing endovascular repair increased from 11.9% of patients in 2005 to 30.0% in 2009. Severity of comorbidities, as measured by the Charlson index, did not differ significantly between the treatment groups. Mortality was significantly more commonly associated with open revascularization compared with endovascular intervention (39.3% vs 24.9%; P = .01). Length of stay was also significantly longer in the patient group undergoing open revascularization (12.9 vs 17.1 days; P = .006). During the study time period, 14.4% of patients undergoing endovascular procedures required bowel resection compared with 33.4% for open revascularization (P < .001). Endovascular repair was also less commonly associated with requirement for TPN support (13.7% vs 24.4%; P = .025).</p>	<p>3</p>

Imaging of Mesenteric Ischemia
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
59. Cai W, Li X, Shu C, et al. Comparison of clinical outcomes of endovascular versus open revascularization for chronic mesenteric ischemia: a meta-analysis. <i>Ann Vasc Surg.</i> 2015;29(5):934-940	Meta-analysis	8 studies	To compare the clinical outcomes of endovascular versus open revascularization for chronic mesenteric ischemia (CMI).	Eight studies were analyzed by meta-analysis method, cumulative 569 cases were included. Endovascular treatments were performed in 209 cases, and open repairs were performed in 360 cases. Meta-analysis showed that there was no difference in 30-day mortality and 3-year cumulative survival rate between the endovascular group and the open group (P = 0.55 and P = 0.56); compared with the open revascularization group, the endovascular revascularization group resulted in significantly lower rate of in-hospital complication (P = 0.002), while recurrence rate within 3 years after revascularization was significantly greater in the endovascular revascularization group (P < 0.00001).	Good

**Imaging of Mesenteric Ischemia
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
60. Ryer EJ, Kalra M, Oderich GS, et al. Revascularization for acute mesenteric ischemia. J Vasc Surg. 2012;55(6):1682-1689	Observational-Tx	93 patients	To evaluate our experience with AMI over the last 2 decades to evaluate changes in management and assess current outcomes.	Over the last 2 decades, 93 patients with AMI underwent emergency arterial revascularization. Forty-five patients were treated during the 1990s and 48 during the 2000s. The majority of these patients were transferred from outside facilities. Patient demographics and risk factors were similar between the 2 decades with the exception that the more contemporary patients were significantly older (65.1 +/- 14 vs 71.3 +/- 14; P = .04). Etiology remained constant between the groups with in situ thrombosis being the most common followed by arterial embolus. The majority of patients were treated with open revascularization. Endovascular therapy alone or as a hybrid procedure was used in 11 total patients, eight of which were treated in the last 10 years. The use of second-look laparotomy was much more liberal in the last decade (80% vs 48%; P = .003) Thirty-day mortality was 27% in the 1990s and 17% during the 2000s (P = 0.28). Major adverse events occurred in 47% of patients with no difference between decades. There was no significant difference in outcomes between open and endovascular revascularization. On univariate analysis, elevated SVS comorbidity score, congestive heart failure, and chronic kidney disease predicted early death, while a history of chronic mesenteric ischemia appeared protective. On multivariate analysis, no factor independently predicted perioperative mortality. Bowel resection and cerebrovascular disease predicted postoperative morbidity, while advanced age and connective tissue disease predicted long-term mortality.	2

**Imaging of Mesenteric Ischemia
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
<p>61. Schermerhorn ML, Giles KA, Hamdan AD, Wyers MC, Pomposelli FB. Mesenteric revascularization: management and outcomes in the United States, 1988-2006. J Vasc Surg. 2009;50(2):341-348 e341.</p>	<p>Review/Other-Tx</p>	<p>6,342 PTA/S and 16,071 open surgical repairs</p>	<p>To evaluate trends in management of CMI and AMI using surgery or PTA/S between 1988 and 2006 and used a national hospital administrative database to compare in hospital outcomes in the most recent years.</p>	<p>From 1988 to 2006, there were 6,342 PTA/S and 16,071 open surgical repairs overall. PTA/S increased steadily, surpassing all surgery for CMI in 2002. PTA/S for AMI has also increased and surpassed bypass in 2002 but has not surpassed all surgical procedures for AMI even in 2006. The mortality rate was lower after PTA/S than after bypass for CMI (3.7% vs 13%, P<.01) and AMI (16% vs 28%, P<.01). Bowel resection was more common after bypass than PTA/S for CMI (7% vs 3%, P<.01). This subgroup showed an increased in-hospital mortality rate for both repair types (54% and 25%, respectively).</p>	<p>4</p>

**Imaging of Mesenteric Ischemia
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
<p>62. Tallarita T, Oderich GS, Macedo TA, et al. Reinterventions for stent restenosis in patients treated for atherosclerotic mesenteric artery disease. J Vasc Surg. 2011;54(5):1422-1429 e1421</p>	<p>Observational-Tx</p>	<p>30 patients</p>	<p>To review the outcomes of patients treated for mesenteric artery in-stent restenosis (MAISR).</p>	<p>There were 30 patients (25 female and five male; mean age, 69 +/- 14 years) treated with reintervention for MAISR. Twenty-four patients presented with recurrent symptoms (21 chronic, three acute), and six had asymptomatic preocclusive lesions. Twenty-six patients (87%) underwent redo endovascular revascularization (rER) with stent placement in 17 (13 bare metal and four covered) or percutaneous transluminal angioplasty (PTA) in nine. The other four patients (13%) had open bypass, one for acute ischemia. There was one death (3%) in a patient treated with redo stenting for acute mesenteric ischemia. Seven patients (27%) treated by rER developed complications, including access site problems in four patients, and distal embolization with bowel ischemia, congestive heart failure and stent thrombosis in one each. Symptom improvement was noted in 22 of the 24 symptomatic patients (92%). After a mean follow-up of 29 +/- 12 months, 15 patients (50%) developed a second restenosis, and seven (23%) required other reintervention. Rates of symptom recurrence, restenosis, and reinterventions were 0/4, 0/4, and 0/4 for covered stents, 2/9, 3/9, and 2/9 for PTA, 5/13, 8/13, and 5/13 for bare metal stents, and 1/4, 4/4, and 0/4 for open bypass. For all patients, freedom from recurrent symptoms, restenosis, and reinterventions were 70% +/- 10%, 60% +/- 10% and 50% +/-10% at 2 years. For patients treated by rER, secondary patency rates were 72 +/- 12 at the same interval.</p>	<p>2</p>

Imaging of Mesenteric Ischemia
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
63. AbuRahma AF, Stone PA, Srivastava M, et al. Mesenteric/cealic duplex ultrasound interpretation criteria revisited. <i>J Vasc Surg.</i> 2012;55(2):428-436 e426; discussion 435-426	Observational-Dx	153 patients	To study the largest number of mesenteric duplex/angiography correlations reported to date for the diagnosis of SMA/CA stenosis	For SMA (151 arteries: 84 with $\geq 50\%$ stenosis [54 of which had $\geq 70\%$ stenosis] based on angiography): the PSV threshold that provided the highest overall accuracy (OA) for detecting $\geq 50\%$ SMA stenosis was ≥ 295 cm/s (sensitivity [sens.] 87%, specificity [spec.] 89%, and OA 88%); and for detecting $\geq 70\%$ SMA, it was ≥ 400 cm/s (sens. 72%, spec. 93%, and OA 85%). The EDV threshold that provided the highest OA for detecting $\geq 50\%$ stenosis was ≥ 45 cm/s (sens. 79%, spec. 79%, and OA 79%); and for $\geq 70\%$ stenosis was ≥ 70 cm/s (sens. 65%, spec. 95%, and OA 84%). ROC analysis showed that PSV was better than EDV and SMA/aortic PSV ratio for $\geq 50\%$ stenosis of SMA ($P = .003$ and $P = .0005$). For celiac arteries (150 arteries: 105 with $\geq 50\%$ stenosis [62 of which had $\geq 70\%$ stenosis]): the PSV threshold that provided the highest OA for $\geq 50\%$ stenosis was ≥ 240 cm/s (sens. 87, spec. 83%, and OA 86%); and for $\geq 70\%$ stenosis was ≥ 320 cm/s (sens. 80%, spec. 89%, and OA 85%). The EDV threshold that provided the highest OA for $\geq 50\%$ stenosis was ≥ 40 cm/s (sens. 84%, spec. 48%, and OA 73%); and for $\geq 70\%$ stenosis was ≥ 100 cm/s (sens. 58%, spec. 91%, and OA 77%). ROC analysis showed that PSV was better than EDV and SMA/aortic PSV ratio for $\geq 50\%$ stenosis of CA ($P < .0001$ and $P = .0410$.)	2
64. Moneta GL. Screening for mesenteric vascular insufficiency and follow-up of mesenteric artery bypass procedures. <i>Semin Vasc Surg.</i> 2001;14(3):186-192	Review/Other-Dx	N/A	No results stated in abstract	No results stated in abstract	4

Imaging of Mesenteric Ischemia
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
65. Martinez JP, Hogan GJ. Mesenteric ischemia. <i>Emerg Med Clin North Am.</i> 2004;22(4):909-928	Review/Other-Dx	N/A	No results stated in abstract	No results stated in abstract	4
66. Schoots IG, Levi MM, Reekers JA, Lameris JS, van Gulik TM. Thrombolytic therapy for acute superior mesenteric artery occlusion. <i>J Vasc Interv Radiol.</i> 2005;16(3):317-329.	Review/Other-Tx	48 patients	To perform a systematic analysis of literature to evaluate thrombolytic therapy for acute SMA occlusion as an alternative or adjunctive treatment modality to surgical therapy and to provide current knowledge for timely and informed decisions regarding treatment of AMI.	Technically feasible but few reports found. Insufficient data to judge safety and effectiveness. Thrombolytic therapy can be effective relatively quickly, may obviate surgery, and has the potential to resolve the clot completely. In some cases it can be used as an alternative or neo-adjunctive treatment modality to surgery.	4
67. Harki J, Vergouwe Y, Spoor JA, et al. Diagnostic Accuracy of the Combination of Clinical Symptoms and CT or MR Angiography in Patients With Chronic Gastrointestinal Ischemia. <i>J Clin Gastroenterol.</i> 2016:[E-pub ahead of print]	Observational-Tx	436 patients	To establish an accurate prediction model for CGI, based on clinical symptoms and radiologic evaluation of the amount of stenosis in the celiac artery (CA) and superior mesenteric artery (SMA) by means of computed tomography-angiography or magnetic resonance (MR)-angiography.	CGI was present in 171/436 (39%) patients (67 y; range, 54 to 74 y; 27% male). Strongest predictors for CGI were female gender [odds ratio (OR)=1.44; 95% confidence interval (CI), 0.85-2.43], weight loss (OR=1.63, 95% CI, 0.98-2.72), concomitant cardiovascular disease (OR=1.70, 95% CI, 1.04-2.78), duration of symptoms (OR=0.88, 95% CI, 0.79-0.99), and stenosis of CA and SMA (50% to 70% stenosis CA: OR=1.33, 95% CI, 0.56-3.19; >70% stenosis CA: OR=5.79, 95% CI, 3.42-9.81; 50% to 70% stenosis SMA: OR=3.21, 95% CI, 0.81-12.74; >70% stenosis SMA: OR=4.39, 95% CI, 2.30-8.41). A model based on clinical symptoms alone showed limited discriminative ability for diagnosing CGI (c-statistic 0.62). Adding radiologic imaging of the mesenteric arteries improved the discriminative ability (c-statistic 0.79).	3
68. Sun MY, Maykel JA. Ischemic colitis. <i>Clin Colon Rectal Surg.</i> 2007;20(1):5-12.	Review/Other-Tx	N/A	To enable the reader to summarize the management of ischemic colitis.	No results stated in abstract	4

Imaging of Mesenteric Ischemia
EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
69. Karkkainen JM, Saari P, Kettunen HP, et al. Interpretation of Abdominal CT Findings in Patients Who Develop Acute on Chronic Mesenteric Ischemia. <i>J Gastrointest Surg.</i> 2016;20(4):791-802.	Observational-Dx	47 patients	To study whether ischemia-specific computed tomography (CT) findings are consistently detectable in patients who develop acute on chronic mesenteric ischemia (AOCMI), whereas absent in chronic mesenteric ischemia (CMI).	Two observers had substantial agreement ($k=0.66$) that two thirds of AOCMI patients showed ischemia-specific CT findings (decreased bowel wall enhancement, pneumatosis, or thrombotic SMA clot); the third observer agreed only fairly regarding pneumatosis and thrombosis ($k=0.3-0.4$). All observers had substantial agreement ($k=0.65-0.71$) that most patients with AOCMI had unspecific intestinal findings such as mesenteric fat stranding in up to 96%, bowel lumen dilatation in 93%, and bowel wall thickening in 70%, while only few patients with CMI had such findings (due to chronic ischemic colitis) ($P<0.001$).	2
70. Laissy JP, Trillaud H, Douek P. MR angiography: noninvasive vascular imaging of the abdomen. <i>Abdom Imaging.</i> 2002; 27(5):488-506.	Review/Other-Dx	N/A	To review role of MRA in imaging the abdomen.	MRA is as accurate as DSA in the diagnosis of portal vein diseases. AMI is an emergency in which CT is the most appropriate imaging modality. Conversely, chronic mesenteric ischemia is best examined with contrast-enhanced MRA, which is almost as accurate as DSA. Contrast-enhanced MRA is superior to DSA for the simultaneous exploration of the aorta, renal arteries, and iliac arteries, thereby providing a panoramic view of abdominal vascular involvement. MRA can be coupled with measurements of flow. With this functional approach, MRA is the only modality that can completely assess vascular diseases of the abdomen.	4

**Imaging of Mesenteric Ischemia
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
71. Steinmetz E, Tatou E, Favier-Blavoux C, et al. Endovascular treatment as first choice in chronic intestinal ischemia. <i>Ann Vasc Surg.</i> 2002; 16(6):693-699.	Review/Other-Dx	19 consecutive patients	To define the place of endovascular treatment in chronic intestinal ischemia (CII).	Stenoses were significant in the single superior mesenteric artery (SMA) in 2 patients and in two arteries in 17 patients, including the celiac artery (CA) and SMA (n = 13), CA and inferior mesenteric artery (IMA) (n = 1), and SMA and IMA (n = 3). Balloon angioplasty was performed in only one of the arteries in each patient, 15 times in the SMA and 4 times in the CA. In 7 patients, angioplasty required stenting because of recoil (n = 5) or dissection (n = 1). In one patient the lesion was stented primarily, because of adjacent thrombus on the stenosis.	4
72. Hagspiel KD, Angle JF, Spinosa DJ, Matsumoto AH. Mesenteric ischemia: angiography and endovascular interventions. In: Long W, Peterson GJ, Jacobs DL, eds. <i>Intestinal ischemia disorders: pathophysiology and management.</i> St. Louis, MO: Quality Medical Publishing; 1999:105-154.	Review/Other-Dx	N/A	Book chapter.	N/A	4

**Imaging of Mesenteric Ischemia
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
73. Arthurs ZM, Titus J, Bannazadeh M, et al. A comparison of endovascular revascularization with traditional therapy for the treatment of acute mesenteric ischemia. <i>J Vasc Surg.</i> 2011;53(3):698-704; discussion 704-695.	Observational-Tx	70 patients	To evaluate the effect of endovascular therapy on outcomes for the treatment of AMI.	70 consecutive patients were identified with AMI (mean age, 64 +/- 13 years). Etiology of mesenteric ischemia was 65% thrombotic and 35% embolic occlusions. Endovascular revascularization was the preferred treatment (81%) vs operative therapy (19%). Successful endovascular treatment was achieved in 87%. Endovascular therapy required laparotomy in 69% vs traditional therapy in 100% (P<.05), with a median 52-cm necrotic bowel resected (interquartile range, 11–140 cm) vs 160 cm (interquartile range, 90–250 cm; P<.05), respectively. Acute renal failure and pulmonary failure occurred less frequently with endovascular therapy (27% vs 50%; P<.05 and 27% vs 64%; P<.05). Successful endovascular treatment resulted in a mortality rate of 36% compared with 50% (P<.05) with traditional therapy, whereas the mortality rate for endovascular failures was 50%. Endovascular therapy was associated with improved mortality in thrombotic AMI (odds ratio, 0.10; 95% CI, 0.10-0.76; P<.05).	2
74. Di Minno MN, Milone F, Milone M, et al. Endovascular Thrombolysis in Acute Mesenteric Vein Thrombosis: a 3-year follow-up with the rate of short and long-term sequelae in 32 patients. <i>Thromb Res.</i> 2010;126(4):295-298.	Experimental-Tx	32 patients	To perform a 3-year follow-up with the rate of short and long-term sequelae in patients with endovascular thrombolysis in acute MVT.	An early endovascular thrombolytic treatment in MVT will improve the patency of the mesenteric-portal system and to protect from the development of short (bowel resection) and long-term (portal hypertension) sequelae in subjects with contraindications to surgery.	1

**Imaging of Mesenteric Ischemia
EVIDENCE TABLE**

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
75. Zacharias N, Eghbalieh SD, Chang BB, et al. Chronic mesenteric ischemia outcome analysis and predictors of endovascular failure. <i>J Vasc Surg.</i> 2016;63(6):1582-1587	Observational-Tx	116 patients	To identify predictors of endovascular failure.	There were 116 patients who were first treated with ER (72%) and 45 patients with OR (28%). Overall mortality was 6.8% (11/161). Among the ER patients, 27 developed restenosis and required OR (23%). Patients treated with ER were older (73 vs 66 years; P = .014), had similar comorbidities, and had higher rate of short lesions (≤ 2 cm) on preoperative angiograms (23% vs 47%; P = .004). Primary patency at 3 years was higher in the OR group compared with the ER group (91% vs 74%; P = .018). Long-term survival rates were higher in the ER group (95% vs 78%; P = .003). Hospital length of stay and intensive care unit length of stay were shorter in the ER group (<math><.001</math>). Perioperative mortality (30-day) was not statistically significant between the groups (5.2% vs 11%; P = .165). A subgroup analysis was performed between the patients with successful ER and failure of ER requiring OR. Patients with failure of ER had significantly higher rates of aortic occlusive disease (86% vs 49%; P = .005) and long lesions >math>\geq 2</math> cm on angiography (57% vs 12%; P < .001) that were close to the mesenteric takeoff. Perioperative mortality was higher in the ER failure group (15% vs 2%; P = .009).	2
76. American College of Radiology. ACR Appropriateness Criteria® Radiation Dose Assessment Introduction. Available at: https://www.acr.org/-/media/ACR/Files/Appropriateness-Criteria/RadiationDoseAssessmentIntro.pdf .	Review/Other-Dx	N/A	Guidance document on exposure of patients to ionizing radiation.	No results stated in abstract.	4

Evidence Table Key

Study Quality Category Definitions

- *Category 1* The study is well-designed and accounts for common biases.
- *Category 2* The study is moderately well-designed and accounts for most common biases.
- *Category 3* There are important study design limitations.
- *Category 4* The study is not useful as primary evidence. The article may not be a clinical study or the study design is invalid, or conclusions are based on expert consensus. For example:
 - a. The study does not meet the criteria for or is not a hypothesis-based clinical study (e.g., a book chapter or case report or case series description);
 - b. The study may synthesize and draw conclusions about several studies such as a literature review article or book chapter but is not primary evidence;
 - c. The study is an expert opinion or consensus document.
- Meta-analysis
 - a. *Good quality* – the study design, methods, analysis, and results are valid and the conclusion is supported.
 - b. *Inadequate quality* – the study design, analysis, and results lack the methodological rigor to be considered a good meta-analysis study.

Abbreviations Key

Dx = Diagnostic

Tx = Treatment