Chronic mesenteric ischemia

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INTRODUCTION

Mesenteric ischemia is caused by a reduction in intestinal blood flow and is classified as acute (sudden onset of intestinal hypoperfusion) or chronic depending on the time course of symptoms. Chronic mesenteric ischemia, also called intestinal angina, refers to episodic or constant hypoperfusion of the small intestine that can occur, typically in patients with multivessel mesenteric stenosis or occlusion.

The clinical features, diagnosis, and management of chronic mesenteric ischemia will be reviewed here. The diagnosis and management of acute mesenteric ischemia, including acute-on-chronic ischemia (usually related to sudden thrombotic occlusion of an already stenotic mesenteric vessel), and colonic ischemia are reviewed separately. (See "Overview of intestinal ischemia in adults" and "Acute mesenteric arterial occlusion" and "Colonic ischemia".)

ETIOLOGY AND ASSOCIATIONS

The majority of cases of chronic mesenteric ischemia are caused by atherosclerotic narrowing of the origins of the celiac or superior mesenteric arteries [1,2]. Atherosclerosis of the mesenteric vessels is fairly common; however, clinical manifestations as a consequence of mesenteric arterial disease are rare [3,4]. Up to 18 percent of individuals over 65 in the general population have significant stenosis of the celiac or superior mesenteric artery without any known prior symptoms [3,5,6]. In one autopsy series, 29 of 120 individuals showed atherosclerotic disease within 2 cm of the origins of the celiac or mesenteric arteries, and 18 of 120 had at least two stenotic vessels; only one patient had evidence of bowel necrosis [7]. The occurrence of disease was strongly associated with aging and correlated with atherosclerotic disease of cerebral arteries at the skull base. In a study of 184 asymptomatic patients, the prevalence of celiac or superior mesenteric artery stenosis or occlusion was 18 percent for those over 65 using duplex ultrasound [6]. Single-vessel disease was more common in the celiac artery compared with the superior mesenteric artery (81 versus 19 percent). A population-based study found a similar prevalence of 17.5 percent among 870 patients over 65 [3]. Multivariate analysis identified renal artery stenosis and high-density lipoprotein >40 mg/dL as significantly associated with celiac or mesenteric artery stenosis or occlusion.

Rare causes of chronic mesenteric ischemia include median arcuate ligament syndrome (compression of the celiac artery from the median arcuate ligament of the diaphragm), fibromuscular dysplasia, aortic or mesenteric artery dissection, vasculitis (polyarteritis nodosum, Takayasu's disease [8]), and retroperitoneal fibrosis [9]. Advanced endografts (eg, fenestrated) can cause partial obstruction of the visceral vessels during endovascular aortic repair. (See "Celiac artery compression syndrome" and "Clinical manifestations and diagnosis of fibromuscular dysplasia" and "Overview of gastrointestinal manifestations of vasculitis" and "Clinical features and diagnosis of acute aortic dissection" and "Spontaneous mesenteric arterial dissection" and "Complications of endovascular abdominal aortic repair" and "Clinical manifestations and diagnosis of retroperitoneal fibrosis".)

CLINICAL FEATURES

History — Most patients with atherosclerotic mesenteric vascular disease do not exhibit symptoms, because a large collateral network can form to compensate for reduced flow (figure 1). In one review of 270 patients with occlusive disease of one or more splanchnic vessels, 61 (60 percent) had no symptoms [10]. In a study of 82 patients identified on arteriography to have a 50 percent stenosis in at least one mesenteric artery, 4 of 15 patients with significant three-vessel disease developed mesenteric ischemia during follow-up [4]. One of these had no abdominal complaints prior to an acute presentation resulting in necrosis of the entire gut. The three others each developed typical symptoms of chronic mesenteric ischemia at 7, 24, and 24 months, respectively.

Patients who manifest symptoms of chronic mesenteric ischemia are typically over the age of 60 and are three times more likely to be female rather than male [4,11]. The typical patient has a history of smoking (58 percent in one study [12]), and approximately one half of patients have a history of coronary heart disease, cerebrovascular disease, or lower extremity peripheral artery disease [12,13].

Symptoms — Symptoms of chronic mesenteric ischemia manifest as recurrent episodes of acute abdominal pain after eating, which has also been referred to as "intestinal angina." Patients classically complain of dull, crampy, postprandial epigastric pain, usually within the first hour after eating. The pain usually subsides over the course of the next two hours. Two explanations are proposed for the timing of symptoms. One suggests that pain arises from a mismatch between splanchnic blood flow and intestinal metabolic demand, while the other suggests that small intestinal hypoperfusion results from blood being shunted to the stomach [14]. The latter explanation is probably more consistent with the typical temporal pattern. (See "Overview of intestinal ischemia in adults", section on 'Physiology and mechanisms of ischemia'.)

The pain can be variable in intensity and location and may occasionally radiate to the back. The severity of the pain is greater following larger meals with high fat content [15]. The association of abdominal pain with eating leads patients to avoid eating (food fear), and they typically lose weight [16]. A survey of 270 patients identified four clinical factors associated with chronic mesenteric ischemia (weight loss, postprandial pain, adapted eating pattern, diarrhea); the probability of chronic mesenteric ischemia was 60 percent if all were present versus 13 percent if none was present [10]. Approximately one third of patients have less typical symptoms including nausea, vomiting, early satiety, or even lower gastrointestinal bleeding, which is likely a consequence of foregut ischemia (ischemic gastropathy) from celiac artery insufficiency [14].

Symptoms can be progressive and may lead to acute mesenteric ischemia (acute-on-chronic mesenteric ischemia) from thrombus formation [4]. Such patients have a much higher morbidity and mortality compared with patients with only chronic symptoms. (See "Acute mesenteric arterial occlusion".)

Physical examination — Physical findings are usually nonspecific except that findings consistent with weight loss are present in approximately 80 percent of patients, which is attributed to the development of a food aversion due to the anticipation of postprandial pain. Abdominal examination reveals an epigastric bruit in approximately 50 percent of patients.

DIAGNOSIS

A high index of clinical suspicion is important for making a timely diagnosis of chronic mesenteric ischemia, which is often delayed as patients are often first evaluated for other etiologies (especially malignancy) as an explanation for weight loss. The average delay from the beginning of symptoms to diagnosis or treatment was 10.7 months in one review [17] and 15 months in another [2]. (See 'Differential diagnosis' below.)

The failure to identify a specific etiology in patients with otherwise unexplained chronic abdominal pain, weight loss, and food aversion should suggest chronic mesenteric ischemia [15,18]. The diagnosis is supported by the imaging that demonstrates high-grade stenosis or occlusion of two or more mesenteric vessels (image 1) [19]. Patients with stenosis in only one of the three mesenteric arteries do not typically exhibit symptoms; however, a complete occlusion of a single artery may be the cause of intestinal angina in approximately 5 percent of patients, particularly in association with prior gastrointestinal surgery that has disrupted the collateral circulation (figure 1) [20].

Vascular imaging — Demonstration of stenosis of the major mesenteric vessels is a requirement for a diagnosis of chronic mesenteric ischemia. Calcification of mesenteric vessels seen on plain abdominal films (often obtained in an initial evaluation) may be a clue to the diagnosis of mesenteric atherosclerosis but is not specific. For patients with suggestive symptoms, we agree with the American College of Radiology consensus opinion that recommends computed tomography (CT) of the abdomen with intravenous contrast (ie, CT angiography [CTA]) as the initial imaging study, since it reliably identifies or excludes the presence of atherosclerotic vascular disease as the most likely etiology and simultaneously rules out other abdominal pathologies as the source of symptoms [21-24]. Conventional arteriography is indicated for diagnostic confirmation when the results of noninvasive testing are equivocal, and for therapeutic intervention when clinically appropriate.

When available, CT angiography is the preferred initial diagnostic imaging modality as it allows for rapid and accurate three-dimensional renderings of the intestinal vasculature and bowel timed to coincide with peak arterial or venous enhancement. The study should be performed with intravenous contrast, as well as a neutral oral contrast (barium or water) to better evaluate the bowel wall.

CT angiography has sensitivities and specificities exceeding 90 percent for the diagnosis of chronic mesenteric ischemia due to atherosclerosis [25-28]. High-grade mesenteric vascular stenoses in at least two major vessels (celiac, superior mesenteric, or inferior mesenteric) must be established. Evidence for collateral formation to compensate for the reduced main arterial flow is typically present (figure 1) [1]. Contrast-enhanced magnetic resonance angiography (MRA) is also highly sensitive for detecting arterial stenoses at the origins of the celiac or mesenteric arteries; however, the technique is much less reliable for detecting more distal lesions. Quantification of postprandial flow on MR angiography may prove useful as a diagnostic modality. Noncontrast MR angiography may be a useful alternative to CT angiography in patients who cannot tolerate an intravenous contrast load [29]. (See 'Functional studies' below.)

Duplex ultrasonography of the mesenteric vessels has also been advocated as a reasonably accurate screening modality for the detection of high-grade celiac and superior mesenteric artery stenosis [15,30]. For patients who are initially seen in an office setting, a duplex ultrasound is a reasonable first study. Sensitivity exceeding 90 percent has been reported in patients with more than a 50 percent stenosis of the superior mesenteric or celiac arteries. Velocity criteria are given in the table (table 1) [30-33]. (See "Noninvasive diagnosis of arterial disease", section on 'Specific anatomic sites'.)

Because the negative predictive value of duplex ultrasonography approaches 99 percent, it is justifiable to pursue other etiologies of abdominal pain after a negative study [30]. However, the number of patients who have been studied using this technique is limited, and technical considerations, including the expertise of the examiner, large body habitus, intraintestinal gas, and prior abdominal surgery, should be considered in assessing the results [34,35]. Duplex ultrasound can also be used to diagnose the median arcuate ligament syndrome [36]. (See "Celiac artery compression syndrome", section on 'Diagnosis'.)

Functional studies — A possible role for tonometry, spectroscopic oximetry, and MR flow for the diagnosis of chronic mesenteric ischemia has been suggested, but the clinical usefulness of these studies, which are still under investigation, has not been adequately established [25,37-43].

Tonometry uses an intraluminal catheter to measure the intestinal pH in the jejunum after a test meal. Intramural acidosis that correlates with abdominal pain may be a good marker of tissue ischemia [37-41]. A visible light spectroscopy oximeter can also be used to objectively measure mucosal saturations during endoscopy to diagnose mesenteric ischemia [42]. In one study, abnormally low proximal small bowel mucosal oxygen saturations resolved after successful percutaneous intervention. Larger studies are needed to validate these findings. Lastly, MR venography can be used to measure the increase in superior mesenteric vein blood flow following a meal. In one study, the postprandial increase was significantly reduced in patients with chronic mesenteric ischemia compared with that in healthy controls (64 versus 206 percent) [43].

DIFFERENTIAL DIAGNOSIS

There are many causes of chronic abdominal pain and of weight loss in adults. The constellation of progressive abdominal pain and weight loss, particularly in older adult patients, frequently prompts an evaluation to rule out other conditions such as malignancy, chronic cholecystitis, chronic pancreatitis, or peptic ulcer disease. If a patient presents with symptoms suggestive of chronic mesenteric ischemia but has not had significant weight loss, an alternative diagnosis (eg, functional bowel disorder) is more likely [16]. (See "Evaluation of the adult with abdominal pain" and "Causes of abdominal pain in adults" and "Approach to the patient with unintentional weight loss".)

Food aversion and weight loss may also be a sign of an eating disorder. (See "Eating disorders: Overview of epidemiology, clinical features, and diagnosis".)

MANAGEMENT

Conservative care — In general, patients with an incidental diagnosis of mesenteric occlusive disease who do not have overt clinical manifestations are managed with smoking cessation and secondary prevention measures to limit the progression of atherosclerotic disease [2,19]. Interestingly, compared with patients with a typical risk profile for peripheral artery disease, 376 patients with chronic mesenteric ischemia were more likely be female, have lower incidences of hypertension and hypercholesterolemia, and have a lower than expected incidence of obesity and diabetes [12]. Reduced caloric intake, related to the postprandial pain, likely explains the observed differences. (See "Overview of the prevention of cardiovascular disease events in those with established disease (secondary prevention) or at high risk".)

Secondary prevention in patients with atherosclerotic disease typically includes antiplatelet therapy, which also has a role in the treatment of patients with spontaneous mesenteric artery dissection [44]. (See "Overview of the prevention of cardiovascular disease events in those with established disease (secondary prevention) or at high risk", section on 'Antiplatelet therapy' and "Spontaneous mesenteric arterial dissection", section on 'Antithrombotic therapy'.)

Systemic anticoagulation is indicated in the setting of acute thrombus (ie, acute-on-chronic mesenteric ischemia). (See "Overview of intestinal ischemia in adults", section on 'Anticoagulation' and "Acute mesenteric arterial occlusion".)

In the absence of symptoms, there is little role for prophylactic intervention. An exception may be in patients with atherosclerotic occlusive disease of the mesenteric vessels who require aortic reconstruction for other indications (aneurysm, aortoiliac occlusive disease) or extensive foregut surgery (eg, pancreaticoduodenectomy), but such a decision depends on other factors as well. (See "Endovascular repair of abdominal aortic aneurysm", section on 'Anatomic considerations'.)

Nutritional assessment and support — Due to the often delayed diagnosis, patients may exhibit significant weight loss (eg, body mass index [BMI] <18.5, albumin <3.0). Thus, nutritional status should be evaluated in all patients [45,46]. The severity of nutritional deficiency has a bearing on the approach to treatment [47]. A number of preoperative factors are associated with poorer long-term survival, including BMI >25, smoking, hypertension, chronic kidney disease, and widespread atherosclerosis [48]. (See "Overview of perioperative nutritional support", section on 'Consequences of malnutrition in surgical patients' and "Overview of perioperative nutritional support", section on 'Nutritional assessment in the surgical patient' and "Overview of perioperative nutritional support", section on 'Preoperative nutritional support' and "Clinical assessment and monitoring of nutritional support in adult surgical patients", section on 'Initial assessment of nutritional status'.)

Revascularization — The indication for revascularization (open or endovascular) is the presence of symptoms, including abdominal pain and weight loss, in the setting of documented severe splanchnic artery stenoses. The aim of intervention is to prevent future bowel infarction [2]. For patients with acute symptoms (ie, acute-on-chronic mesenteric ischemia), revascularization options in the acute setting are discussed separately. (See "Acute mesenteric arterial occlusion", section on 'Management'.)

Options for revascularization include open surgical reconstruction and percutaneous transluminal angioplasty (PTA) with or without placement of a stent (bare or covered). Traditionally, open surgical revascularization, which is durable, was the standard and only available treatment. As catheter-based techniques improved, percutaneous angioplasty, with or without stenting, was offered initially to those who were not candidates for surgery due to the presence of multiple and severe comorbidities, and later as a primary therapy, but has evolved to become the preferred initial therapy. In practice, in patients with severe renal impairment for whom intravenous radiocontrast may be contraindicated, a surgical rather than percutaneous intervention may need to be considered, provided the patient has an acceptable risk for surgery. An alternative method may be to use carbon dioxide (CO_2) as a contrast agent, but this may cause severe cramping. Another option is to guide intervention using intravascular ultrasound (IVUS).

The extent of revascularization (number of vessels revascularized) may depend upon the approach chosen, but this varies from institution to institution [49,50]. In a systematic review comparing approaches, significantly more mesenteric vessels were revascularized with open surgery compared with the endovascular approach [2]. The celiac artery was more often treated with open surgery, typically in conjunction with superior mesenteric artery revascularization. Although not commonly revascularized in isolation, the inferior mesenteric artery may be the only suitable vessel [51]. In some cases, advanced percutaneous techniques, such as crossing total occlusions, may be attempted to avoid an open surgical approach [52-55]. In the setting of acute mesenteric ischemia, isolated revascularization of the superior mesenteric artery is more commonly performed either using an open or hybrid approach [56]. (See "Acute mesenteric arterial occlusion".)

Open surgery — Open surgical techniques for mesenteric revascularization include aortomesenteric and/or celiac bypass grafting, endarterectomy [57-59], and mesenteric reimplantation. For patients deemed to be candidates for open surgery, the choice of procedure depends primarily upon the presenting anatomy [11,60].

The most common surgical procedure for elective multivessel mesenteric revascularization is an antegrade aorto-mesenteric/aorto-celiac bypass [2,61,62]. Retrograde bypass from the infrarenal aorta and iliac arteries has also been described [63]. The distal thoracic aorta can also serve as inflow [64].

Multiple observational studies have described the long-term results of surgical revascularization for chronic mesenteric ischemia [65-76]. Although surgical endarterectomy appears to have better long-term symptom relief compared with open mesenteric bypass, the procedure is more complex, and the number of patients who are candidates for this procedure is limited (younger, focal disease of the suprarenal aorta) [75]. Following open surgical bypass, primary graft patency rates at five years range from 57 to 69 percent [65,71,74]. Among survivors, the rates of freedom-from-recurrence at 5 and 10 years are approximately 80 and 60 percent, respectively [74,75]. Long-term patency rates may be influenced by the completeness of surgical revascularization [76]. In a review of 86 patients, primary patency rates were 84 percent for complete revascularization and 87 percent for incomplete revascularization. At 10 year follow-up, the secondary patency rates were similar (92 and 93 percent), but more patients undergoing complete compared with incomplete revascularization were free from gastrointestinal symptoms (79 versus 65 percent).

For mesenteric bypass, conduit choices include Dacron, expanded polytetrafluoroethylene (ePTFE), and vein (saphenous vein, femoral vein) [77]. Vein is used in the setting of bowel contamination [56]. In one observational study using the American College of Surgeons database, the outcomes of 156 patients who underwent mesenteric revascularization were evaluated [78]. Patients revascularized using a vein graft had higher rates of short-term complications such as graft failure, bowel resection, and infectious complications, and an increased need for emergent surgery, compared with those who had a prosthetic graft. Mortality was also significantly higher among those who had a vein graft (16 versus 5 percent). Higher morbidity and mortality were felt to be more likely related to patient factors, such as the extent of bowel ischemia at the time of operation, and not necessarily the type of conduit that was used.

Angioplasty and stenting — Mesenteric angioplasty and stenting has become a first-line therapy for patients with chronic mesenteric ischemia (image 2). Stenting the superior mesenteric or celiac artery has high technical and early clinical success rates. Technical success is defined as residual stenoses of less than 50 percent after treatment. Most authors have reported technical success rates of greater than 80 percent, and relief of abdominal pain occurs in 75 to 100 percent of patients, with one half of patients experiencing weight gain [20,79-105].

Following angioplasty/stenting, restenosis and recurrent symptoms occur in 17 to 50 percent of patients within the first year. Recurrence rates in the higher range are typically those for angioplasty without stenting. Angioplasty alone is associated with high rates of restenosis, which can usually be managed effectively with repeat intervention [79,106]. Primary stent placement may help prevent restenosis compared with angioplasty alone (image 3) [83-87,107,108]. The use of covered stents has also been tried and may further reduce the rate of reintervention compared with bare metal stents among those undergoing primary intervention or reintervention for chronic mesenteric ischemia.

However, covered stents may be associated with an increased risk of sudden occlusion [93,106]. (See 'Open versus endovascular' below.)

Periprocedural complications during mesenteric angioplasty and stenting include embolization, perforation, thrombosis, and dissection. In a retrospective review, these occurred in 7 percent of patients [109]. Five of 11 patients with complications required open conversion. Access site complications are more frequently seen with a brachial arterial access, but the elevated risk may be justified by the geometric advantage of approaching the superior mesenteric artery from above.

Open versus endovascular — Multiple reviews of observational studies have compared open with endovascular revascularization for chronic mesenteric ischemia [17,110-130], but there have been no large trials directly comparing angioplasty with or without stenting with surgical revascularization. The decision to perform one or the other is generally based upon the patient's life expectancy, nutritional status, and medical comorbidities, as well as the number and severity of diseased vessels and the ability to access the vessels via endovascular means [112-114]. Based upon observational studies and expert opinion, we suggest an attempt at endovascular treatment as the first-line therapy, provided it is technically feasible [2,17]. This is based primarily on the lower risk of periprocedural morbidity and mortality. Although open reconstruction has superior primary and secondary patency and a lower rate of symptomatic recurrence, long-term assisted patency rates and overall survival appear similar. Primary, primary-assisted, and secondary graft patency rates for open surgical antegrade mesenteric bypass are excellent at 69, 94, and 100 percent, respectively [71]. For patients deemed good risk for open surgery, particularly those with a long life expectancy, some advocate open surgical revascularization as the initial approach [11]. The ability to offer endovascular or open treatment depends on the availability of experienced vascular surgeons or vascular interventionalists.

A systematic review identified eight observational studies with 569 patients who underwent open or endovascular revascularization for chronic mesenteric ischemia [127]. A pooled analysis showed no significant difference in perioperative (30 day) mortality between the groups. The endovascular group had a significantly lower rate of in-hospital complications but a significantly higher recurrence rate within three years of revascularization compared with the open group. The three-year cumulative survival rates were not significantly different.

- One of the early reviews found that one third of patients in the angioplasty group had restenosis within an average of 10 months, compared with no recurrences in the surgical patients at an average follow-up period of 35 months [129].

- Cumulative restenosis and mortality rates at three years were found in another report to be similar between the treatment approaches, but more patients undergoing angioplasty had recurrent symptoms of intestinal angina (34 versus 13 percent) [117].

- A later retrospective review of 161 patients found similar results [130]. Among the endovascular patients, 27 developed restenosis and required open repair. Compared with successful endovascular revascularization, patients with failed endovascular revascularization requiring subsequent open repair had significantly higher rates of aortic occlusive disease (86 versus 49 percent), long lesions ≥2 cm on arteriography (57 versus 12 percent), and lesions that were close to the mesenteric takeoff. Perioperative mortality was significantly higher in the endovascular failure group (15 versus 2 percent).

FOLLOW-UP

Following mesenteric revascularization, a diet can be initiated with evidence of return of bowel activity in those undergoing open surgery, and more immediately following endovascular procedures. However, after open revascularization, the recovery period can be prolonged, with one report citing a mean postoperative length of stay of 32 days [71].

Malnourished patients undergoing surgery may not be able to meet their nutritional requirements in the perioperative period and should receive postoperative nutritional support. (See "Overview of perioperative nutritional support", section on 'Postoperative nutritional support'.)

Patients with atherosclerosis of mesenteric vessels should receive standard treatment to reduce risk for future cardiovascular events, including treatment of hypercholesterolemia, hypertension, diabetes, smoking cessation therapy, and antiplatelet therapy [131]. (See "Overview of lower extremity peripheral artery disease", section on 'Risk factor modification'.)

Recurrent stenosis — Following open or endovascular treatment for chronic mesenteric ischemia, routine follow-up is important to identify recurrent symptoms and restenosis. Many vascular specialists use duplex ultrasonography to monitor patency following revascularization, but the study chosen (duplex, computed tomographic [CT] angiography, magnetic resonance [MR] angiography) often depends upon institutional resources and local expertise [132-134]. The initial follow-up study should be obtained once the patient has recovered to establish a baseline for future comparison. Thereafter, following stenting, duplex should be obtained at three- to six-month intervals. The interval between studies can be increased if velocities and waveforms remain stable. For mesenteric bypass, annual follow-up is usually adequate in the absence of symptoms.

On duplex ultrasound, in-stent stenosis is suggested by a significant increase from the baseline peak systolic velocity (PSV), or when the PSV approaches 500 cm/s. These PSV values differ from those used to establish stenosis in native vessels (table 1). Any abnormalities identified on ultrasound should be confirmed using CT or MR angiography prior to proceeding with any reintervention.

Recurrent stenosis occurs in 5 to 15 percent of patients and is higher for endovascular compared with open surgery. Recurrent symptoms are usually associated with restenosis [83,96]. Whether following endovascular or open surgery, recurrent symptoms from restenosis can often be successfully managed with repeat angioplasty/stenting (image 4). However, for recurrence following initial percutaneous intervention, some clinicians will proceed directly to open surgical bypass, provided the patient is a reasonable surgical candidate.

Outcomes of treatment for restenosis following open surgery were evaluated in one case-control study [92]. Among 47 patients with recurrent symptoms, repeat open surgery was performed in 28 patients, and endovascular intervention was performed in 19 patients. Repeat operation or endovascular intervention for recurrent symptoms had similar mortality, recurrence, and reintervention rates. Morbidity was significantly higher for repeat surgery compared with endovascular treatment (63 versus 16 percent). Compared with the index surgical revascularization, repeat surgery was associated with similar morbidity and mortality but lower primary patency (66 versus 94 percent). Primary and secondary patency rates at one year were 61 and 92 percent for repeat open surgery, and 77 and 100 percent for endovascular treatment.

MORBIDITY AND MORTALITY

Perioperative mortality among patients with chronic mesenteric ischemia ranges from 0 to 16 percent but can be as high as 50 percent for those patients who develop acute symptoms [4,65,71,72,74,116,135,136].

A systematic review evaluated outcomes of studies performed from 2000 to 2009 and reported more than 1000 patients treated for chronic mesenteric ischemia [2]. Patients were treated using an endovascular approach in 18 studies and by open surgery in 16 studies, and in 9, both approaches were used. Morbidity was higher for open surgical revascularization, while restenosis was higher for endovascular revascularization. (See 'Recurrent stenosis' above.)

- Open surgical revascularization:

  Mortality: 4.4 percent
  Morbidity: 16 percent
  Restenosis: 7 percent

- Endovascular revascularization:

- Mortality: 5.6 percent
- Morbidity: 11 percent
- Restenosis: 34 percent

Following mesenteric revascularization, late deaths are less likely to be related to mesenteric ischemia compared with other causes. In a retrospective review, 144 of 343 patients died during the follow-up period (median follow-up 96 months) [137]. Long-term patient survival was not influenced by type of arterial reconstruction (open, endovascular). Cardiac disease was the most common cause (35 percent), followed by cancer (15 percent), pulmonary complications (13 percent), mesenteric ischemia (11 percent), and other or unidentifiable causes (10 percent). Independent predictors of any cause mortality included age >80 years, diabetes, chronic kidney disease stage IV or V, and home oxygen. Mesenteric-related death was associated with diabetes and chronic kidney disease stage IV or V.

SOCIETY GUIDELINE LINKS

Links to society and government-sponsored guidelines from selected countries and regions around the world are provided separately. (See "Society guideline links: Occlusive carotid, aortic, mesenteric, and peripheral atherosclerotic disease".)

INFORMATION FOR PATIENTS

UpToDate offers two types of patient education materials, "The Basics" and "Beyond the Basics." The Basics patient education pieces are written in plain language, at the 5th to 6th grade reading level, and they answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials. Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are written at the 10th to 12th grade reading level and are best for patients who want in-depth information and are comfortable with some medical jargon.

Here are the patient education articles that are relevant to this topic. We encourage you to print or e-mail these topics to your patients. (You can also locate patient education articles on a variety of subjects by searching on "patient info" and the keyword(s) of interest.)

- Basics topic (see "Patient education: Ischemic bowel disease (The Basics)")

SUMMARY AND RECOMMENDATIONS

- Chronic mesenteric ischemia (also called intestinal angina) refers to episodic or constant intestinal hypoperfusion and is usually due to mesenteric atherosclerotic disease. (See 'Introduction' above.)

- Patients classically complain of dull, crampy, postprandial epigastric pain, usually within the first hour after eating. The pain can be of variable intensity and location and may occasionally radiate to the back. The severity of the pain is increased after larger meals with high fat content. The pain usually subsides over the course of the next two hours. Symptoms are often progressive and may culminate in acute mesenteric ischemia (acute-on-chronic mesenteric ischemia) from thrombus formation. (See 'Clinical features' above.)

- The diagnosis of chronic mesenteric ischemia is supported by the demonstration of high-grade stenoses usually in multiple mesenteric vessels, in patients with unexplained chronic abdominal pain, weight loss, and food aversion. A high clinical index of suspicion is crucial to making the diagnosis. (See 'Diagnosis' above.)

- For patients diagnosed with chronic mesenteric ischemia, the indication for revascularization is the presence of symptoms, including abdominal pain and weight loss. The aim of intervention is to prevent future bowel infarction. Therapeutic options include open surgical and endovascular revascularization. Provided an endovascular approach is technically feasible, we attempt angioplasty with or without stenting as the initial treatment, rather than using an open surgical approach. Although percutaneous revascularization is associated with a higher rate of restenosis, recurrent symptoms from restenosis can often be successfully managed with repeat angioplasty/stenting. (See 'Management' above and 'Recurrent stenosis' above.)

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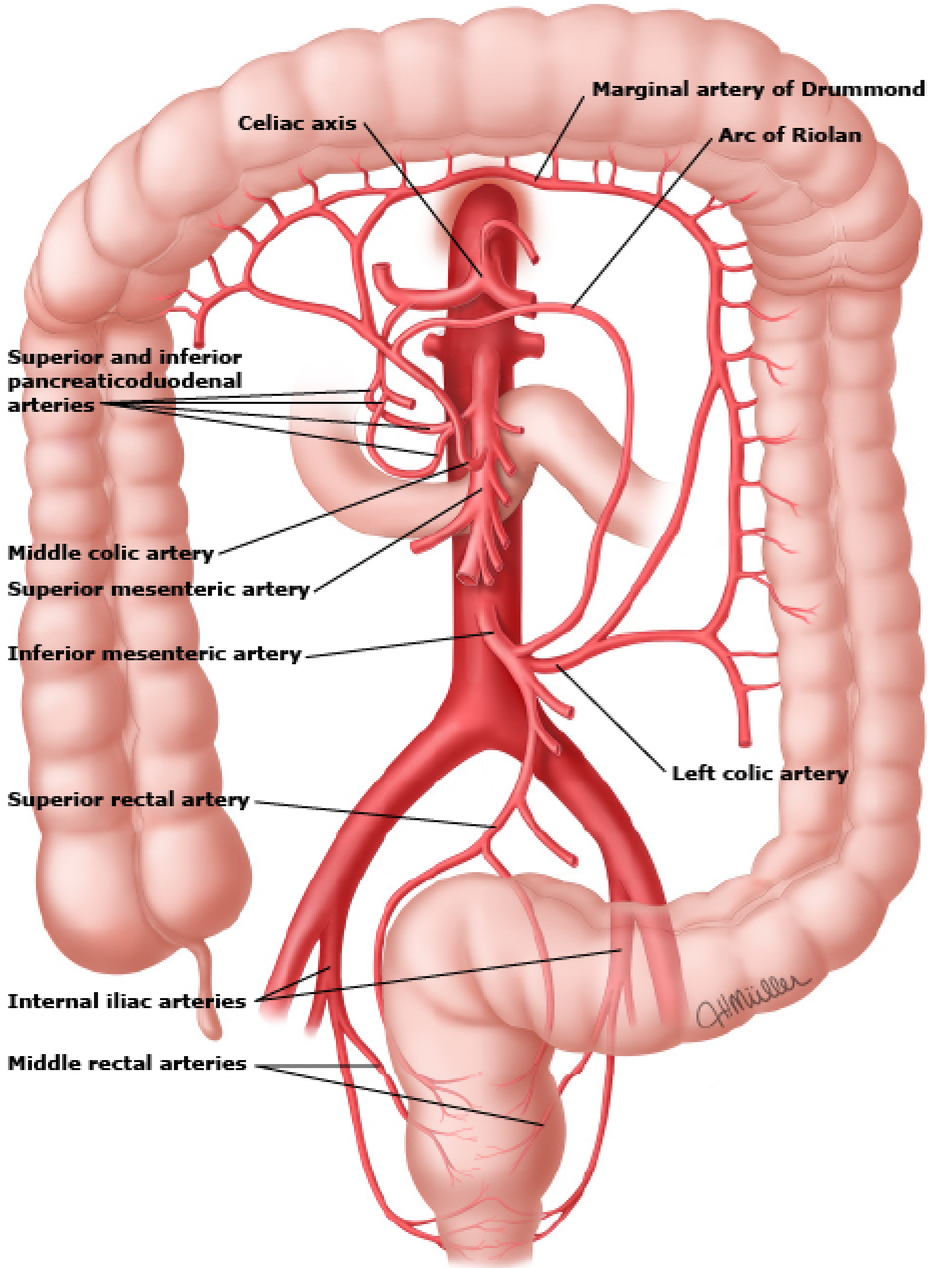
Topic 2563 Version 22.0

GRAPHICS

Collateral circulation to the intestines

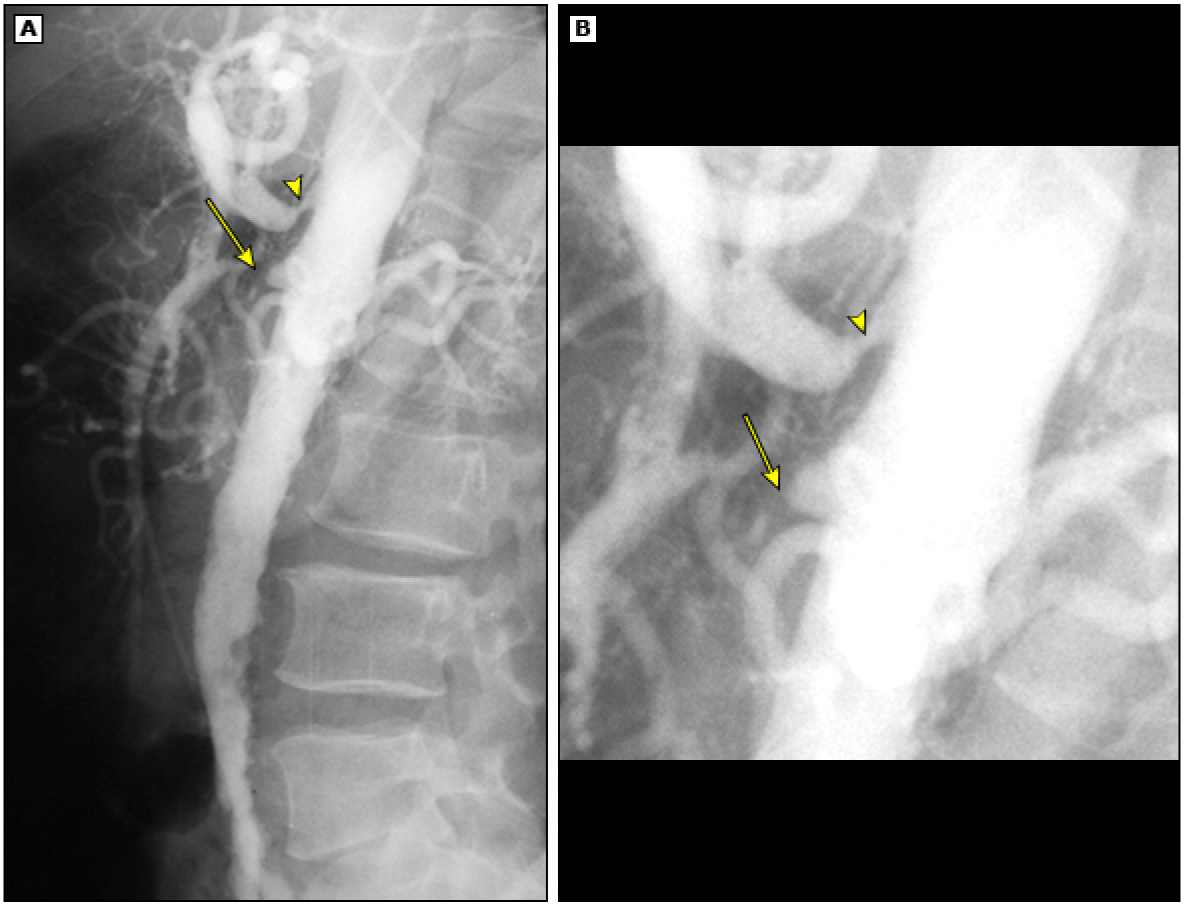


An abundant collateral blood supply exists between the SMA and IMA and the IMA and internal iliac arteries. The arcades of the SMA and IMA interconnect at the base and border of the mesentery. The connection at the base of the mesentery is called the arc of Riolan, whereas the connection along the mesenteric border is known as the marginal artery of Drummond. Ischemic damage to the rectum is rare since the rectum has a dual blood supply from the IMA and iliac arteries. Collateral flow between the IMA and iliac arteries occurs via the superior and middle/inferior rectal vessels. Despite the presence of collaterals, the colon circulation has two watershed areas that are vulnerable to ischemia during systemic hypotension: the narrow terminal branches of the SMA supply the splenic flexure, and the narrow terminal branches of the IMA supply the rectosigmoid junction.

SMA: superior mesenteric artery; IMA: inferior mesenteric artery.

Graphic 89911 Version 5.0

3 vessel mesenteric disease on aortography



A lateral aortogram (A) shows severe stenosis of the celiac axis (arrowhead), occlusion of the SMA (arrow), and nonvisualization of the IMA. Image B is a magnified view and shows severe stenosis of the celiac axis (arrowhead) and occlusion of the SMA (arrow).

SMA: superior mesenteric artery; IMA: inferior mesenteric artery.

Graphic 93265 Version 2.0

Validated criteria for stenosis in visceral vessels

Artery	Percent of stenosis	Criteria
Superior mesenteric artery	≥70 percent	Peak systolic velocity >275 cm/s
Celiac artery	≥70 percent	Peak systolic velocity >200 cm/s
Renal artery	≥60 percent	Renal aortic ratio >3.5 (PSV in renal artery/PSV in adjacent aorta)
Renal artery	≥80 percent	Renal aortic ratio >3.5 and renal artery end diastolic velocity ≥150 cm/s

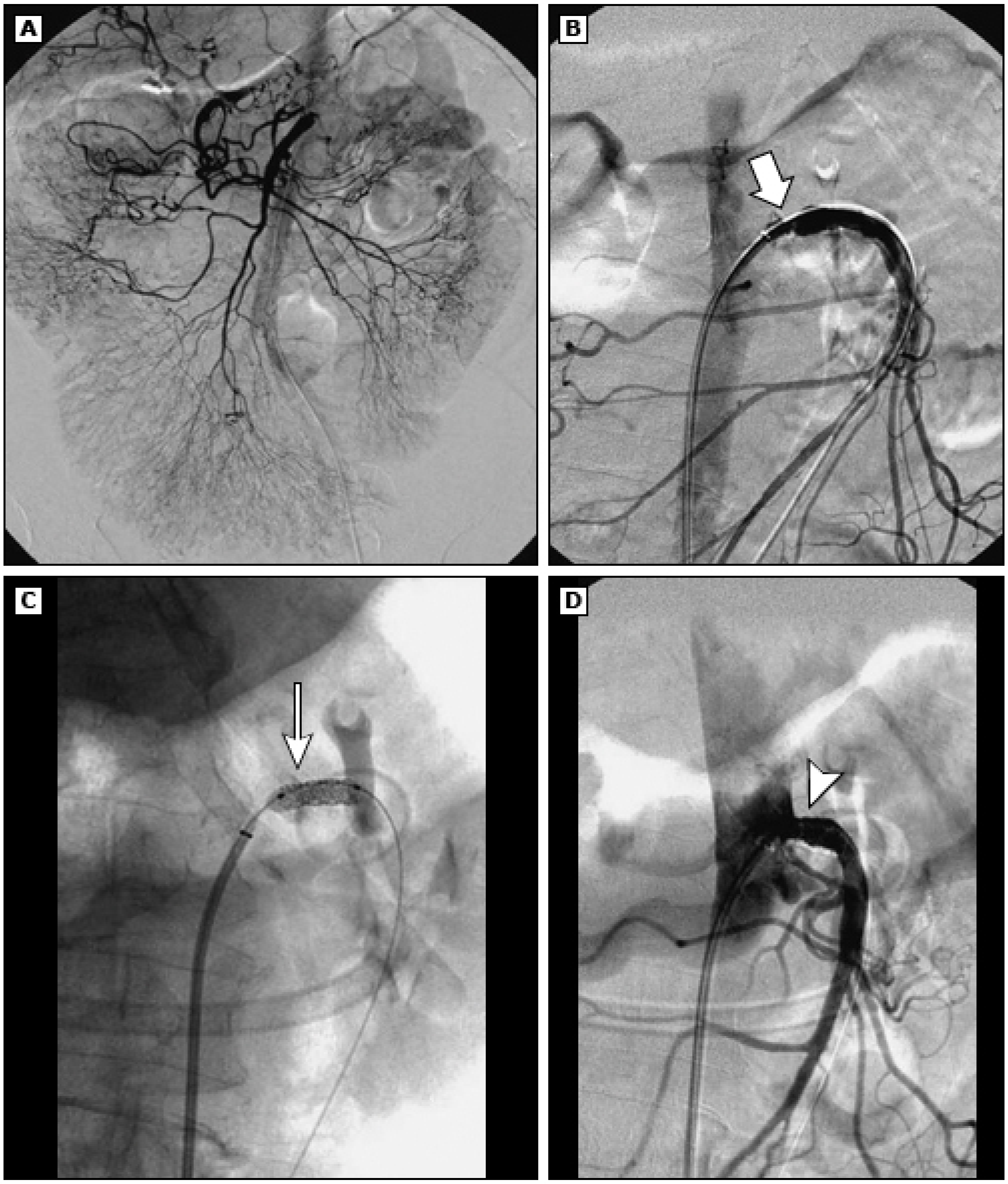
Data from:

1. *Moneta GL, Lee RW, Yeager RA, et al. Mesenteric duplex scanning: a blinded prospective study. J Vasc Surg 1993; 17:79.*
2. *Gentile AT, Moneta GL, Lee RW, et al. Usefulness of fasting and postprandial duplex ultrasound examinations for predicting high-grade superior mesenteric artery stenosis. Am J Surg 1995; 169:476.*
3. *Moneta GL. Screening for mesenteric vascular insufficiency and follow-up of mesenteric artery bypass procedures. Semin Vasc Surg 2001; 14:186.*

Courtesy of Dr. Erica Mitchell.

Graphic 76874 Version 4.0

Superior mesenteric arterty angioplasty and stent

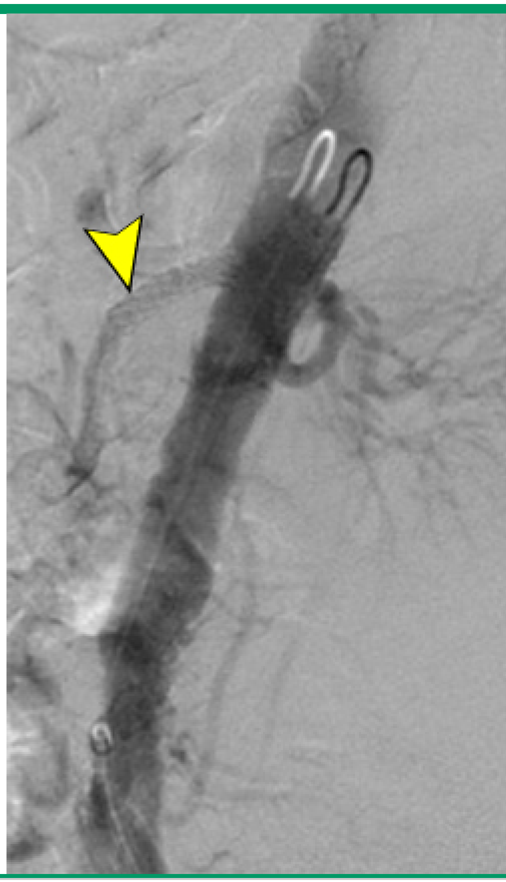


The arteriogram (A) shows filling of the jejunal, ileal, ileocolic, right colic, and middle colic arteries. There is a small amount of retrograde filling of the celiac axis via the pancreaticoduodenal arcade. The stenosis of the SMA is not visible on this view. A steep right anterior oblique view of the SMA (B) shows a short segment stenosis of the proximal SMA at its origin (thick white arrow). A stent has been positioned in the proximal SMA (C) in the region of the stenosis (thin white arrow) and expanded using a balloon. A selective SMA arteriogram (D) postangioplasty shows significant improvement in the severity of the stenosis following stent placement (white arrowhead).

SMA: superior mesenteric artery.

Graphic 86512 Version 2.0

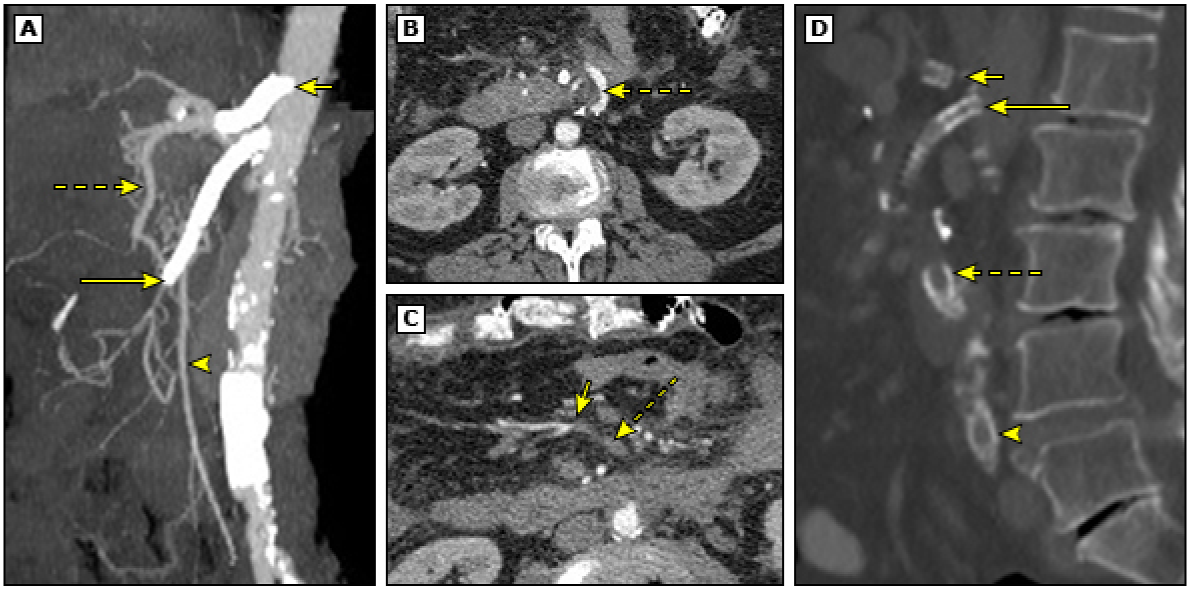
Superior mesenteric artery stent



Aortogram in the lateral projection. The arrow head shows the superior mesenteric artery (SMA) which contains a deployed stent and no evidence of stenosis.

Graphic 50488 Version 9.0

Stented mesenteric bypass graft



A CTA of the abdominal aorta (A) in sagittal projection shows a patent celiac axis stent (short arrow), with collateral supply (dashed arrow), bypassing an occluded SMA stent (arrow) to the distal SMA (arrowhead). The IMA is occluded. Image B shows a subsequently placed aortomesenteric graft (dashed arrow). Image C shows occlusion of the graft (dashed arrow) with distal reconstitution (short arrow). Image D is a sagittal reconstruction without contrast and shows stents in the aortomesenteric graft, in the celiac axis (short arrow), SMA (arrow), and common iliac artery (arrowhead).

CT: computed tomography; CTA: computed tomography angiography; SMA: superior mesenteric artery; IMA: inferior mesenteric artery.

Graphic 91717 Version 2.0

Contributor Disclosures

David A Tendler, MD Equity Ownership/Stock Options (Spouse): Amgen, Inc,; Cisco Systems, Inc.; General Electric Company; International Business Machines Corp.; Johnson and Johnson; Medtronic (Covidien); Merck; Pfizer Inc.; Procter & Gamble Company; Walmart. **J Thomas Lamont, MD** Nothing to disclose **John F Eidt, MD** Nothing to disclose **Joseph L Mills, Sr, MD** Grant/Research/Clinical Trial Support: Voyager Trial [Peripheral artery disease (Rivoxaraban)]. Consultant/Advisory Boards: Innomed [Peripheral artery disease (Femoral artery stent)]. Equity Ownership/Stock Options: NangioTx [Peripheral artery disease (Self-assembling nanotubules)]. Other Financial Interest: Elsevier; Rutherford [Vascular surgery (Rutherford and Comprehensive Vascular and Endovascular Surgery textbooks)]. **Lillian S Kao, MD, MS** Nothing to disclose **Kathryn A Collins, MD, PhD, FACS** Nothing to disclose

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Conflict of interest policy