CLINICAL REVIEW

Mesenteric Artery Stenting for Chronic Mesenteric Ischemia

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Abstract

Chronic mesenteric ischemia (CMI), or abdominal angina, is a rare disorder accounting for less than 5% of all intestinal ischemic events, and in more than 90% of instances is caused by atherosclerosis.1–4 CMI has the potential to worsen and develop into acute intestinal ischemia with bowel infarction.1 Therefore, treatment of symptomatic CMI is necessary to prevent acute mesenteric ischemia, which may cause bowel infarction and death.2

Until recently, open revascularization has been the method of choice for therapy of patients with CMI. However, the rate of major complications is relatively high.5,3 As an alternative to open surgical revascularization, PTA was introduced by Furrer et al in 1980. Since then, several studies have presented the results of angioplasty and/or stenting in the treatment of CMI, with a periprocedural mortality rate of 0 to 13%, and complication rate of 0–25%. The technical success rate of PTA is 90–100%.2–6

Introduction

CMI is caused by atherosclerosis in more than 90% of the cases. Nonatheromatous conditions include: median arcuate ligament compression syndrome (compression of celiac artery by diaphragmatic crus), Takayasu arteritis, dysplastic lesions, thromboangiitis obliterans, and radiation-induced vascular injury.1–4 The disease generally presents in patients over 60 years and the incidence is three times higher in women.3 Approximately half of the patients with CMI have significant coronary artery disease and peripheral vascular disease.3,2

The usual cause of the patient symptoms is usually intermittent transient episodes of inadequate intestinal blood supply due to increased metabolic demands at digestion. Symptoms commonly include: “food fear,” postprandial pain, nausea, diarrhea, and weight loss.

CMI involving the celiac arterial distribution may result in disorders such as gastroparesis, gastric ulceration, and gallbladder dyskinesia.1,3,5

Physical examination is usually unremarkable, except pain that is out of proportion to the physical exam findings. An epigastric arterial bruit can be heard, but, unfortunately, in less than 50% of patients with arterial stenosis.7,1

Since there is no reliable test available to establish the presence of CMI, the diagnosis must be based on accurate medical history and exclusion of other gastrointestinal causes.

Diagnostic Tools

Duplex ultrasound has proven to be an accurate screening tool for detecting significant stenosis in mesenteric arteries, with 90% accuracy in identifying significant proximal SMA stenosis and 80% accuracy for celiac trunk lesions. Peak systolic velocity of greater than 200 cm/s and end-diastolic velocity exceeding 55 cm/s have been shown to have high correlation with celiac artery stenosis. Lesions of proximal SMA are highly likely when peak systolic velocity is greater than 275 cm/s; however, end-diastolic velocity greater than 45 cm/s is more specific.1,5,3

Tonometry of gastrointestinal tract has the unique potential to detect ischemia, irrespective of flow or metabolism. Tonometry is based on association of mucosal ischemia with increased gastrointestinal PCO2, which can be measured using a balloon-tipped catheter, which is attached to a modified carbonogram.1

Magnetic resonance angiography (MRA) is a valuable tool for diagnosing CMI. Coronal three-dimensional MRA images have been shown by several studies to provide high-resolution mesenteric angiograms in greater than 90% of SMA, 75–90% of celiac artery and 25% of IMA vessels. In a study by Sreenarasimhaiah, contrast-enhanced MRA had 100% sensitivity for stenosis of celiac artery and SMA, compared to angiography.1

Multislice computed tomography is usually used for pretreatment evaluation of celiac trunk and superior mesenteric artery (SMA) stenosis, if the patient’s renal function is adequate. This confirms the presence of arterial disease and also allows for optimal planning in terms of approach, determination of vessel...
dimension, and point of reconstitution in cases of total arterial occlusion. 2,3
Biplanar selective splanchnic angiography is still the gold standard for evaluation of vascular anatomy and degree of stenosis. 7,1

Splanchnic artery anatomy. In order to understand the pathophysiology of CMI, it is necessary to review the anatomy of splanchnic circulation. Three major aortic branches provide the gastrointestinal blood supply: celiac artery (CA), superior mesenteric artery (SMA), and inferior mesenteric arteries (IMA).

The CA divides into three branches: the splenic artery, common hepatic artery, and left gastric artery. The celiac artery supplies the stomach, proximal duodenum, liver, and spleen.

The SMA arises from the aorta very close to the CA at approximately 1 cm caudally. SMA branches include middle, right, and ileocolic arteries, as well as jejunal and ileal arteries. The SMA and its branches supply the distal duodenum, small bowel, and proximal colon up to splenic flexure of colon.

The IMA arises 3–5 cm above the aortic bifurcation. IMA branches include left colic, marginal, and sigmoid arteries, which supply the region from the splenic flexure until the superior portion of the rectum.

In between these vessels, there is a large collateral network that protects against the effects of stenosis in one of the main branches. Therefore, mesenteric ischemia is thought to occur when at least two of the three visceral vessels are affected. 2,3,5

Therapeutic Options for Patients with CMI
There are basically two approaches for the treatment of CMI: surgery and endovascular recanalization.

Endovascular recanalization includes percutaneous transluminal angioplasty (PTA) with or without stent placement of one or more mesenteric arteries. 3

Treatment of symptomatic CMI is necessary to prevent acute mesenteric ischemia, which may cause bowel infarction and death. 5 Asymptomatic disease does not constitute an indication for treatment, although prophylactic treatment may be necessary in cases of planned abdominal surgery because of probable loss of collaterals during surgery. 2

Classic surgery includes procedures such as endarterectomy, aortomesenteric and/or celiac bypass grafting. However, the perioperative mortality can be high, reaching 17% and the major complications rate is high, ranging between 15 and 35%. 3,5

As an alternative to open surgical revascularization, Furrer et al introduced PTA in 1980. Since then, several studies have presented the results of angioplasty, and/or stenting in the treatment of CMI. The overall periprocedural mortality rate of the endovascular approach is between 0 and 13% and the complication rate is between 0 and 25%. 2,4 The technical success rate of the endovascular approach is 90–100%. 2,4

Table 1 provides a representative overview of the published literature on PTA with and without stenting of mesenteric arteries.
The lateral aortogram is essential to view the anterior oblique (30˚), and lateral angiogram (90˚), if high-quality CTA is not available, an aortogram in the AP position is usually done. Some authors recommend obtaining a right anterior oblique (30˚), left anterior oblique (30˚), and lateral angiogram (90˚), routinely. The lateral aortogram is essential to view the SMA and celiac origins.

After the initial aortogram and depending on the size of the stent/balloon intended for use, a long, 33-cm preshaped sheath with inner diameter of 5 or 6 Fr is inserted.

A reverse curve catheter, such as a Sos-Omni or Simmons-1 is typically necessary to select the stenosed artery. A cobra catheter can be used if the artery is not severely narrowed.

Selective angiogram of the SMA or CA is then obtained. After the stenosis is identified, the lesion is traversed with an appropriate guidewire. The choice of the guidewire varies. Some groups prefer the 0.035" wires/balloon/stent solution, while others prefer the 0.014" system. The intervention is done in a projection that demonstrates the vessel origin in profile.

The current low profile, highly maneuverable balloon-and-stent technology, along with preshaped introducers, has made the interventional approach from femoral artery easier.

After traversing the lesion, predilatation with a 3 or 4 mm diameter low profile angioplasty balloon is sometimes necessary, and then the proper stent can be deployed.

All patients should receive heparin (3000–7000 IU) intraprocedurally, unless there is an absolute contraindication.

### Important Technical Considerations

Treatment of a single-vessel stenosis is important when the stenosis is significant.

In occluded SMA and stenosed CA, the CA should be treated first. In case of a double- or triple-vessel disease, the SMA should be the primary target for treatment.

If two of three vessels are occluded with stenosis of the third, treatment of the narrowed artery usually relieves the symptoms. However, absolute care must be

#### Table 1.

<table>
<thead>
<tr>
<th>Study</th>
<th>No. of patients</th>
<th>Technical success, %</th>
<th>Complication rate, %</th>
<th>Mortality rate, %</th>
<th>Clinical success, %</th>
<th>Primary patency, %</th>
<th>Mean follow-up months</th>
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Mesenteric Artery Stenting

taken not to compromise this artery, which may lead to acute intestinal ischemia.

If both CA and SMA are stenotic with occlusion of IMA, it is better to start with the one determined to be technically easier.4

Ostial atherosclerotic lesions are the major cause of mesenteric stenoses or occlusions. For this reason, balloon-expandable are preferred over the self-expandable stents.2

CA stenting should be done carefully. It is important first to exclude the presence of extrinsic compressing factors like compression by the median arcuate liga-

ment. This patient population is usually younger, and the approach for treatment is different.

Therefore, when this condition is suspected, it is important to rule out dynamic compression of CA by obtaining inspiration and expiration lateral aortogram. Stent choice in CA compression is important. It is advisable not to use the balloon-expandable stents, except for a pure atherosclerotic lesion. If there is any suspicion of extrinsic compression, it is better to treat surgically2 or using a self-expanding nitinol stent, as it has memory and can stand repetitive compression stresses.5

Contraindications to intervention in mesenteric ischemia.
1. Suspected acute bowel ischemia (it is controversial);
2. Bowel necrosis;
3. Extrinsic compression as the cause of stenosis;
4. Presence of extensive disease involving the origin of major secondary branches (open surgery is better suited);
5. Visual angiographic evidence of intraluminal thrombus (increased risk of plaque fragmenta-
tion and distal embolization);
6. Cardiac source of emboli;
7. History of bleeding diathesis or coagulopathy4,10,11

Post-Procedural Care

In our institution, the patient receives IV heparin continuously for 24 hours, with targeted partial thromboplastin time of 60 to 80 after the procedure. If stenting is planned, 300 mg clopidogrel are given to the patient during the procedure. The anti-platelet regimen with clopi-
dogrel (75 mg PO daily) should continue for at least 3 months, unless there is a contraindication for use. A daily dose of 100 mg oral salicylic acid is prescribed for life.2,3

Careful symptomatic and noninvasive imaging follow up for signs of recurrent disease is mandatory.2 Follow up duplex surveillance studies can be obtained in 1, 3, and 6 months, initially, and every 6 months thereafter.3

Results

Technical success of the procedure is high, ranging from 80–100%. With improved techniques and equipment, a higher success rate is noted in recent studies.2,3 Table 1 provides a representative overview of published literature on PTA with and without stenting.

Symptomatic improvement has been reported in up to 95% of treated patients. Five to 20% of patients in referenced literature experienced no symptomatic relief immediately after the procedure, indicating that symp-
toms were probably due to etiologies other than bowel ischemia, which indicated the importance of appropriate patient selection.2 Primary patency (sustained pri-
mary clinical benefit due to favorable clinical outcome without need for further intervention) has been report-
ed to be between 40 and 80%, but with the primary assisted patency (requirement of re-intervention), it may increase up to 100%.4 Interventions in the celiac artery appear to be associated with more symptomatic recurrences, possibly due to the presence of arcuate ligament syndrome.

The complication rate is low, ranging between 0–25% and mostly related to access site complications.2,3

Razavi et al.4 noted that probable causes of restenosis might be occluded or stenotic lesions longer than 3 cm and final stent diameter of < 5 mm.

Discussion

The CMI is a rare gastrointestinal disorder with an incidence of 1 in 100,000.3 If CMI is left untreated, it can progress to acute ischemia and intestinal infarction. The treatment has been surgical revascularization by various methods. Recent studies have suggested an increased role for endovascular management of occlusive mesenteric vascular disease.

The overall outcome of an endovascular approach in the treatment of CMI compares favorably to surgery. Although some have advocated that surgery is a better option for those with CMI who are fit for surgery; lower perioperative mortality and morbidity for the endovascular approach, especially with a low-profile (0.014-in) system and a high technical success rate of catheter-based techniques have made this approach the first line of therapy for CMI, especially in high-risk patients. Throughout all currently available reports, investigators proclaim that patients at low operative risk should be treated by surgical revascularization, and that patients at a higher risk should be referred to intervention with or without stenting.

Landis et al.11 hypothesize that stenting of mesenteric arteries offers more structural support to the arterial wall against elastic recoil when compared to PTA alone. A review of the literature shows a better patency rate for stented mesenteric arteries compared to balloonning alone.11

In summary, stenting of mesenteric arteries is a safe and effective method for the treatment of patients with CMI. With the recent improvement of the endovascular equipment and technical skills,
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endovascular revascularization of mesenteric stenoses can be a minimally invasive alternative to surgery.

References
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