

◆ ENDOVASCULAR THERAPY REVIEWS ◆

Management of Chronic Mesenteric Ischemia. The Role of Endovascular Therapy

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Chronic mesenteric ischemia is an uncommon disorder manifested most commonly as abdominal pain. Surgical revascularization has traditionally been the treatment of choice. Endovascular management of this entity was originally attempted as an alternative for high-risk patients. Improvements in stent technology, refinement in technique, and increased efficiency of antiplatelet regimens have, over time, increased the popularity of this minimally invasive approach. We present a review of the available series on endovascular treatment of chronic mesenteric ischemia, with emphasis on short- and long-term outcome and morbidity and mortality results. Principles of operative technique and controversial issues and topics of interest are also discussed.

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Chronic mesenteric ischemia (CMI) is an uncommon disease that accounts for <2% of the revascularization operations for atherosclerotic lesions. It generally presents in patients over 60 years of age, is 3 times more frequent in women, and has been recognized as an entity since 1936.¹ Autopsy studies have demonstrated splanchnic atherosclerosis as the underlying cause in 35% to 70% of cases.² More unusual etiologies include fibromuscular dysplasia, nodose panarteritis, arteritis, and median arcuate ligament (MAL) syndrome.³ CMI is related to a lack of blood supply in the splanchnic region and is caused by disease in one or more visceral arteries: the celiac trunk (CT), the superior mesenteric artery (SMA), or the inferior mesenteric artery (IMA). Symptoms are thought to occur when 2 of the 3 visceral vessels are affected⁴; however, in as many as 9% of cases, only a single vessel is involved (SMA in 5% and celiac trunk in 4%).³

Treatment of symptomatic CMI is necessary to prevent the development of acute mesenteric ischemia, which may cause bowel infarction and death. Classical surgical management involves endarterectomy or surgical bypass. The perioperative mortality (0%–17%) and morbidity (15%–33%) associated with surgical intervention are relatively high.^{4–7} To minimize morbidity, endovascular intervention has been suggested as an alternative. The first successful percutaneous angioplasty of the SMA was reported in 1980.⁸ Since then, several authors have presented the results from mesenteric angioplasty and/or stenting in small series, with variable success rates. Therefore, at present there is not enough evidence to conclusively define the role of the endovascular approach in the treatment of CMI.

In this article, we summarize available data on clinical results for mesenteric endovascular interventions. Indications, technique, complications, and controversial topics are also discussed.

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CLINICAL PRESENTATION, DIAGNOSIS, AND INDICATIONS FOR TREATMENT

Clinical manifestations of mesenteric ischemia are uncommon owing to the extensive collateral development of the mesenteric arcades; however, if intestinal blood flow is unable to meet the physiological gastrointestinal demands, mesenteric insufficiency will occur. The classical symptoms include "food fear," postprandial abdominal pain, and weight loss. Persistent nausea and occasionally diarrhea may coexist. Diagnosis remains challenging, and most of the patients will undergo an extensive and expensive gastrointestinal tract workup for the above symptoms prior to referral to a vascular service. Several noninvasive diagnostic techniques have been evaluated, including provocative balloon tonometry,⁹ pre- and postprandial duplex sonography,¹⁰ magnetic resonance angiography (MRA),¹¹ and computed tomographic angiography.¹² Moneta et al.¹³ evaluated the use of duplex ultrasound in the diagnosis of mesenteric occlusive disease in a blinded prospective study. A peak systolic velocity in the SMA >275 cm/s correlated to a sensitivity of 92%, specificity of 96%, and an overall accuracy of 96% for detecting $>70\%$ stenosis. The same authors found sensitivity and specificity of 87% and 82%, respectively, with an accuracy of 82% in predicting $>70\%$ celiac trunk stenosis. Other criteria have also been utilized, including peak systolic velocity (PSV) >200 cm/s and end-diastolic velocity (EDV) >55 cm/s for the diagnosis of significant stenosis ($>50\%$) of the celiac artery, as well as PSV >300 cm/s and EDV >45 cm/s for the diagnosis of significant stenosis of the SMA.¹⁴ Digital subtraction angiography, however, remains the most accurate modality to evaluate the degree of stenosis in the mesenteric vessels.⁵

The goals of revascularization in patients with symptomatic CMI are to improve symptoms and nutritional status and prevent intestinal infarction.⁷ Prophylactic mesenteric revascularization is rarely performed in the asymptomatic patient undergoing an aortic procedure for other indications.⁶ However, the natural history of untreated chronic

mesenteric ischemia may justify revascularization in some asymptomatic patients, if the operative risks are acceptable,¹⁵ since the first clinical presentation may be acute mesenteric ischemia in as many as 50% of the patients.^{16,17}

Technique

Both the brachial and femoral approaches have been utilized in mesenteric angioplasty and stenting. The former appears to have a slight advantage in cases of acute angulation at the mesenteric vessel origin off the aorta. A 6-F sheath is inserted via the access vessel. If the brachial artery has been accessed, then early heparinization is advised to prevent thrombosis at the sheath insertion site. A pigtail catheter is advanced through the sheath into the abdominal aorta, and a diagnostic arteriogram is performed, first in the anterior-posterior direction to assess the SMA and celiac branches, and then on a lateral plane to assess the arterial orifices and confirm the presence and severity of stenosis. The pigtail is subsequently exchanged for a selective catheter. Our preference is to use the Cobra 2 catheter (Boston Scientific, Natick, MA, USA) during the femoral access and an angled multipurpose catheter in the event of the brachial approach. The catheter is navigated in the abdominal aorta and engages the target vessel, either celiac or SMA. If not already given, heparin should be administered at that point. The lesion can then be crossed with a 0.035-inch hydrophilic guidewire. Alternatively, a 0.014-inch wire can be used if one plans to place an embolus protection device. A 6- or 7-F sheath is then placed just proximal to the lesion and the balloon and/or stent is brought through the sheath. Arteriography through the sheath is obtained to pinpoint the stenosis, and the angioplasty or stent placement follows. Alternatively, a no-touch technique has been described and can be used if the origin of the target vessel is very calcified or ulcerated. According to this, the guide catheter is positioned in the aorta and is maintained straight by means of a 0.035-inch wire that keeps the catheter from engaging the takeoff of the target vessel. A 0.014-inch wire is then

inserted in the guiding catheter, the 0.035-inch wire is removed, and the lesion is crossed with the finer 0.014-inch wire.⁵ The guiding catheter can at this point be advanced to engage the lesion and the intervention follows. After the procedure and if a stent has been deployed, the patient stays on clopidogrel for at least 4 weeks.

The question of primary versus selective stenting has not been resolved. It appears to be a general consensus that an unsatisfactory result after angioplasty alone as evidenced by residual stenosis >30% or a >15-mmHg pressure gradient across the lesion, calcified ostial or high-grade eccentric stenoses, chronic occlusions, or the presence of dissection after angioplasty all constitute indications for stent placement. Balloon-expandable stents that offer precise placement are favored by most authors. Placement with 1- to 2-mm protrusion into the aortic lumen is advised. Postdilatation is performed, and depending on the angiographic result, the pressure gradient across the lesion may be measured. Placement of cerebral protection devices was not performed during the early days of mesenteric endovascular interventions, but embolization was an infrequent complication. In contrast, vasospasm secondary to wire manipulation is rather common, and intra-arterial nitroglycerin or papaverine infusion has been advocated.

Complications

Access complications are by far the most common and can take the form of either hemorrhage or thrombosis. The former is common in femoral and high brachial or axillary approaches. Bleeding into the axillary sheath has the potential to permanently compromise nerve function; therefore, early diagnosis and prompt evacuation are essential to minimize morbidity. Careful technique that involves an ultrasound-guided stick using a micropuncture needle is of paramount importance in order to prevent this complication. Thrombosis occurs almost exclusively in the brachial artery that is small in size and can be totally occluded by interventional sheaths. Rapid heparinization after sheath insertion is usually an adequate preventive measure. The

status of the radial and ulnar circulation should be documented preoperatively, and any evidence of compromise after the completion of the endovascular procedure should be aggressively treated with thromboembolism of the brachial artery to avoid permanent ischemic sequelae.

Entering a subintimal plane while trying to cross a high-grade stenosis or occlusion causes dissection, which necessitates stent placement to avoid distal propagation and arterial occlusion. If re-entry to the true lumen and successful wire advancement through the lesion are not possible, then conversion to an open operation may be necessary. Bowel ischemia is a related but infrequent complication that develops in cases of underestimated dissection after percutaneous transluminal angioplasty (PTA) or as a result of distal embolization after crossing long occlusions. If intestinal malperfusion is suspected intraoperatively and confirmed angiographically, then standard catheter-based salvage techniques are available and should be implemented immediately. When these are not successful, or if abdominal symptoms from presumed intestinal ischemia have been established, abdominal exploration with bowel inspection and thromboembolism is indicated. Other complications that are common to all the endovascular procedures, such as renal failure and anaphylactic reaction, may also infrequently occur.

LITERATURE REVIEW OF CLINICAL RESULTS

To analyze short- and long-term outcomes of endovascular intervention for CMI, we identified relevant studies through a MEDLINE search of the English-language literature performed using keyword combinations, such as "mesenteric ischemia," "balloon angioplasty," "mesenteric stenting," and "intestinal angina." Secondary publications were identified through manual journal review and cross-referencing to ensure that all the relevant studies were included. Because of an inherent bias in reporting only successful outcomes, case reports were not included in our review. For the same reason, only series with 5 or more patients were used for data analysis.

Information collected from each study included the number and demographic characteristics of patients, technical success, clinical success (early after the intervention and late during follow-up), restenosis rates, need for re-intervention, and morbidity and mortality rates. In all the studies, technical success was defined as <30% residual stenosis or <15 mmHg gradient across the lesion. Most authors followed their patients clinically. Mesenteric duplex scanning was used occasionally, whereas angiography was reserved for patients with recurrent symptoms or evidence of restenosis on follow-up duplex evaluation.

As expected, a heterogeneous patient population emerged, with differences in technique and procedural protocols among different authors. Additionally, as endovascular technology improved over time, some authors adopted different techniques to incorporate smaller profile systems and more evolved stents. Despite these limitations, useful conclusions can be drawn, especially with reference to short- and long-term outcomes, morbidity, and mortality.

Averages were calculated for the endpoints of technical success, early and late symptomatic relief, complications, mortality, restenosis rate, and incidence of repeat PTA and/or stenting. Rates for restenosis and late clinical success, the latter defined as freedom from recurrent symptoms during follow-up, were both calculated based on the actual number of patients for whom follow-up was available. Morbidity and mortality rates were available for the first 30 days after the intervention. Deaths that occurred during this timeframe were taken into account even if they were not directly related to the intervention.

After 1998, intravascular stent placement was utilized with increasing frequency, generating 3 subgroups of studies; in the first, PTA was the only form of treatment; in the second, PTA was mainly employed, whereas stenting was used selectively; in the third, all the patients had primary stent placement. Outcomes among these 3 subgroups were compared for all the endpoints mentioned above. Unfortunately, it was not possible to extract individual patient data from the second group of studies that would allow direct

comparison of patients who had PTA alone to those who had stenting alone. The chi-square test was used to assess statistical significance in differences of outcomes between the 2 groups.

General Characteristics

Sixteen studies^{3-7,18-28} on endovascular management of chronic mesenteric ischemia were identified (Table 1). They included 328 patients with a mean age of 68 years (range 40-89). Patients had classic symptoms of mesenteric ischemia, including postprandial abdominal pain, weight loss, nausea, and diarrhea. Angiographic confirmation of the lesions was achieved with biplanar arteriography that was routinely performed preoperatively.

Cumulative Data

Endovascular intervention was successful in 300 (91%) of 328 patients. Among the patients who had a technical failure, 15 were ultimately diagnosed with MAL syndrome and underwent successful surgical treatment. Symptomatic relief immediately after completion of the procedure was evident in 269 patients (early clinical success rate of 82%). Follow-up was available for 292 patients over an average period of 26 months (range 1-73). Symptomatic relief without re-intervention was maintained in 220 (75%) of these patients. Further intervention at that point led to much higher assisted primary and secondary patency rates; however, variability in the way these rates were reported in the different studies does not allow for pooling of the data. Restenosis was diagnosed in 84 (28%) of 292 patients for whom follow-up was available. This led to a total of 79 repeat interventions, either angioplasty or both angioplasty and stenting (27% re-intervention rate). Complications were noted in 30 (9%) patients, including infection, access site thrombosis or hematoma requiring intervention, dissection requiring either stent placement or conversion to an open operation, and distal embolism. The 30-day mortality was 3% (11 patients).

TABLE 1
Outcomes of Recent Series of Endovascular Treatment for Chronic Mesenteric Ischemia

Author	N	Success (Technical/Clinical/ Late Clinical)	Complications	30-day Mortality	Restenosis	Number of Patients/Mean Follow-up, mo	Repeat PTA
Schaefer, 2006 ²⁴	19	18/19/15	0	2	4	18/17	1
Silva, 2006 ²⁶	59	57/50/42	2	0	20	52/38	13
Lim, 2005 ²¹	8	7/7/4	2	0	2	8/52	2
Brown, 2005 ²⁸	14	13/14/6	0	0	8	14/13	8
Landis, 2005 ²⁰	29	28/26/19	4	2	10	29/28	10
Van Wanroij, 2004 ²⁷	27	25/22/18	3	0	6	25/19	NA
AbuRahma, 2003 ⁵	22	21/21/11	0	0	7	18/26	5
Pietura, 2002 ²³	6	6/6/4	0	0	0	6/N/A	0
Matsumoto, 2002 ¹⁸	33	27/29/24	5	0	5	29/38	6
Kasirajan, 2001 ⁶	28	28/NA/17	5	3	5	19/24	19
Sheeran, 1999 ²⁵	12	11/11/10	0	1	2	12/15	2
Nyman, 1998 ²²	5	4/5/4	2	0	3	5/24	3
Maspes, 1998 ³	23	20/20/18	2	0	4	21/27	4
Allen, 1996 ⁴	19	18/18/15	2	1	3	18/28	2
Rose, 1995 ⁷	8	3/7/4	2	1	2	6/9	1
Hallisey, 1995 ¹⁹	16	14/14/9	1	1	3	12/28	3
Totals	328	300 (91%)/ 269 (82%)/ 220 (75%)	30 (9%)	11 (3%)	84 (28%)	292/26	79 (27%)

PTA: percutaneous transluminal angioplasty.

Group Data Analysis

The studies were grouped as previously discussed into those that included patients who were treated with PTA only (PTA group, 66 patients), those treated with primary stenting (stent group, 134 patients), and those treated with PTA and selective stent (PTA + stent group, 128 patients). It was unclear whether in the last group of studies the decision to place a stent was based on PTA failure, operator's preference, device availability, or lesion characteristics.

As can be seen in Table 2, technical success was highest in the stent group (95%, $p=0.007$). Complications were more frequent in the PTA group, a finding that may reflect a learning curve effect, since most of the PTA patients were identified in studies prior to 1998. Surprisingly, restenosis throughout the follow-up period was more likely to occur in the stent group (35% versus 21%, $p=0.05$). No significant differences for the other endpoints were noted.

Comparing the PTA and PTA + stent groups, technical success was more common in the latter, but the difference did not reach statistical significance (92% versus 83%,

$p=0.06$). Clinical relief, morbidity and mortality, as well as restenosis rates were similar between these 2 groups. Finally, looking at the stent and PTA + stent groups, complications were more frequent in the PTA + stent group (15% versus 3%, $p=0.0006$). There were no significant differences for all the other variables under study.

Despite the heterogeneity of the populations and variability in technique, review of these results underscores a number of important points. First, the endovascular approach is safe and can be performed with minimal morbidity and mortality. Second, stent placement is associated with a higher immediate technical success rate, although the long-term restenosis rate seems to be similar to that of PTA. Based on this finding, a selective use of stenting for highly calcified lesions, or those with significant stenosis, seems to be appropriate. Last, after a successful endovascular procedure, roughly 1 of 3 patients will need some sort of re-intervention. This, however, is well tolerated and not associated with substantial morbidity. Overall, the long-term patency is inferior to that of an open surgical intervention, but the lower

TABLE 2
Comparison of Outcomes Among Studies in Which Authors Used Stent Only, PTA Only,
or PTA + Selective Stenting

	PTA (n=66)	Stent (n=134)	PTA+Stent (n=128)	p (PTA vs. Stent)	p (PTA vs. PTA+Stent)	p (Stent vs. PTA+Stent)
Patients in follow-up	57	122	113			
Technical success	55 (83%)	127 (95%)	118 (92%)	0.007	0.06	0.39
Symptomatic relief	59 (89%)	122 (91%)	115 (90%)	0.70	0.92	0.74
Late symptomatic relief	46 (81%)	88 (72%)	86 (76%)	0.49	0.49	0.48
Complications	7 (11%)	4 (3%)	19 (15%)	0.02	0.49	0.0006
Mortality	3 (5%)	3 (2%)	5 (4%)	0.36	0.83	0.43
Restenosis	12 (21%)	43 (35%)	29 (26%)	0.05	0.50	0.11

PTA: percutaneous transluminal angioplasty.

morbidity makes the endovascular approach a very reasonable alternative for the high-risk patient.

TOPICS OF INTEREST

Acute Mesenteric Ischemia

The role of endovascular therapy in acute mesenteric ischemia (AMI) remains controversial. In cases of AMI, assessment of intestinal viability is crucial and can be achieved only with abdominal exploration and direct bowel inspection. That point aside, it is worth mentioning that endovascular treatment is an appropriate alternative for the occasional patient who is a prohibitive operative risk and does not have frank peritoneal signs on physical examination, as well as for those patients who have a contaminated peritoneal cavity and lack an autogenous conduit for the performance of a mesenteric or celiac bypass. Along these lines, Boley et al.²⁹ used arteriography and subsequent catheter-based interventions or transcatheter vasodilator therapy as the initial or sole therapy of AMI. Catheter-directed thrombolysis,^{30,31} as well as percutaneous angioplasty,³² have also been used with good results in the treatment of acute mesenteric embolism. Demirpolat et al.³³ reported 3 patients with increasing abdominal pain but without peritoneal find-

ings who were treated percutaneously with good outcome. Lastly, Lim and colleagues^{21,34} have reported the use of an endovascular approach in surgically unfit patients with good result. All these authors emphasized the importance of performing endovascular treatment in the absence of peritoneal signs and only when bowel viability can be assessed either clinically or with imaging techniques.

Technical Issues

The use of embolic protection dramatically improved the outcome of endovascular procedures in the carotid territory. Only one study, however, mentions routine use of a protection device for mesenteric intervention.²⁸ It appears that in the early years of mesenteric stenting the possibility of embolism was less of a concern for a number of reasons. First, the vast anastomotic network among mesenteric branches renders microembolism less threatening of a problem. In addition, if a clinically significant embolic event occurs, aspiration or thrombolytic techniques can address the complication with minimal morbidity. Surgical intervention with embolectomy remains a final option for cases unable to be salvaged with endovascular means. It is expected, however, that the refinement of cerebral protection devices will

encourage their use in visceral endovascular interventions.

The presence of total occlusion implies a technically more demanding procedure, but it does not constitute a contraindication for endovascular intervention. Only a few attempts to cross occlusions were seen in the early studies, and Kasirajan et al.⁶ noted that it was more common for their group to use an open procedure to treat patients with occluded vessels. A major concern at the time was the potential for plaque fragmentation, with subsequent distal embolization. This, however, has not been confirmed by authors who crossed and treated occluded mesenteric vessels.²² The length of the occlusion correlates with plaque burden and seems to be an important predictor of the likelihood for distal embolization; however, given the few patients studied, this has not been statistically confirmed. Low-profile systems and evolving expertise have now made successful treatment of occluded vessels feasible; Landis et al.²⁰ treated 9 patients who had mesenteric occlusion and reported 100% technical success, clinical success, and primary 1-year patency.

As a principle, treatment of SMA lesions needs to take precedence over treatment of lesions in the celiac axis or the IMA. Even this rule, however, has an exception. In a study by Matsumoto et al.,¹⁸ 4 patients with occluded SMA had only their IMAs treated and remained asymptomatic in long-term follow-up. A patent meandering artery can assure collateral circulation in the event of a difficult-to-treat SMA occlusion. The feeding vessel of such important collateral should be visualized in detail, and any stenotic lesions found should be treated aggressively.

Surveillance

This is a daunting task since duplex ultrasonography is the only noninvasive surveillance modality available for follow-up after mesenteric endovascular intervention. However, its role is debatable, and there have been reports²¹ in which ultrasound velocities did not correlate with angiographic findings. Following a patient only clinically is also inadequate since it is well documented that

symptomatology does not necessarily translate into vessel patency.³⁵ Limiting factors that affect the accuracy of mesenteric Doppler ultrasound include operator experience, as well as individual patient factors (tortuous vessels, bowel gas, body habitus, and fasting status). Moneta³⁶ described the use of mesenteric duplex ultrasound in graft surveillance following open mesenteric revascularization. A Doppler ultrasound is performed to establish a baseline that serves as a point of reference for future comparison. Firm guidelines, however, are not yet available. Extrapolating from this experience, one could use a similar approach to monitor patients after endovascular intervention.²¹

Comparison of Endovascular With Open Surgical Technique

Surgical intervention for mesenteric occlusive disease has traditionally been the treatment of choice. The number of vessels revascularized has often been reported to influence the long-term outcome. However, it has been noted that revascularization of the SMA is of paramount importance and provides optimal long-term symptomatic relief, even if revascularization of other compromised arteries is not possible.^{6,37,38} Open surgical techniques (SMA endarterectomy or aortomesenteric or celiac bypass grafting) have achieved an immediate clinical success that approaches 100%, surgical mortality rates from 0% to 17%, and operative morbidity rates that range from 19% to 54% in a number of different series.^{2,6,7,13,35,37,39-44} The median hospital stay has been reported to be 14 days.³⁹ Recently, 2 reports of surgical revascularization for chronic mesenteric ischemia revealed 5-year survival rates of 61% to 64% and a 9-year assisted primary graft patency rate of 79%.^{40,41} However, overall patency rates as high as 93% have been reported.²²

In comparison to the above historical results and based on the data from our review, mesenteric angioplasty and stenting demonstrate slightly inferior technical and clinical success rates. Long-term patency rates appear to also be superior with the open technique. There is a general consen-

sus, however, that the endovascular approach is associated with lower morbidity and mortality rates. Our finding of mean morbidity and mortality rates of 9% and 3%, respectively, was in agreement with this assumption. Historically, open surgical repair of chronic mesenteric occlusion is associated with mean morbidity of 29% (range 19%–54%) and a mean 30-day mortality of 7% (range 0%–17%).⁶ There is no randomized study comparing open versus endovascular intervention, and given the rarity of this condition, structuring such a study would be a challenging task. The consensus expressed by the studies under review, which also represents our personal bias, is to reserve endovascular intervention for the high-risk and older patients or for the individual patient with unclear symptomatology and questionable diagnosis.

Primary Versus Selective Stenting

Indications for primary stent placement in the series we studied included calcified ostial stenoses, high-grade eccentric stenoses, chronic occlusions, significant residual stenosis, or the presence of dissection after angioplasty. The question of a more liberal approach in stent placement, especially after the encouraging results from their application in other vascular territories, remains unanswered. A bias appears in more recent studies and favors primary stent placement. Our review indicates higher technical success rates when stenting is utilized primarily. Some authors suggest that using PTA results in inferior clinical and technical success.²⁰ At the same time, caution is advised since the rate of restenosis in the long term appears to be higher with stents. Improvements in stent technology and more effective pharmacological strategies against intimal hyperplasia will likely remedy this problem in the near future. Drug-eluting stents have revolutionized the management of coronary syndromes and are expected to soon be used in the peripheral arterial circulation,^{45,46} but they were absent during the early experience of mesenteric stenting. In addition, practices representing standard of care for stent placement today, such as perioperative heparini-

zation and antiplatelet therapy, were not routinely used in some of the series under review. Their broad application has the potential to substantially improve the outcome after stenting.

Salvage Procedure

Although not as durable as the open intervention, the endovascular approach can be a valuable tool for the patient who is too malnourished to undergo a surgical procedure. Interval stenting may allow the patient to regain some weight and optimize his/her nutritional status to minimize the risk of postoperative complications.⁴⁷ If the mesenteric vessel restenoses or occludes, an open intervention can then be offered in a relatively optimized patient. Concerns that stent placement may complicate an open bypass have not been substantiated.²⁸ Patients who remain high risk should be followed closely; in the event of restenosis, a repeat angioplasty or stent placement can again ameliorate their symptoms.

Median Arcuate Ligament Syndrome

The MAL syndrome results from compression of the celiac artery by the median arcuate ligament. Compression by the adjacent sympathetic plexus may also contribute to the celiac axis compression. Most patients are asymptomatic. Symptoms, when present, mimic the clinical picture of chronic mesenteric ischemia. Because of the extrinsic nature of the lesion, angioplasty or stenting in these patients is associated with high failure rates and is not recommended by most authors.^{18,22} The typical angiographic finding is that of a non-ostial, eccentric, anterior and superior lesion of the celiac artery that becomes more pronounced during deep expiration.⁴⁸ The endovascular approach can be of benefit in the occasional patient with unclear symptomatology for whom relief of symptoms after PTA or stenting predicts a good response to operative intervention and for the high-risk, malnourished patient who will not be able to tolerate an open surgical procedure.

Conclusion

Endovascular management of patients with chronic mesenteric ischemia offers a number of significant advantages to the traditional open techniques of revascularization. It is associated with shorter hospital stay and low morbidity and mortality rates. Perioperative use of heparin, postoperative administration of antiplatelet agents, more liberal use of stents, improvement in the skill level, and more careful patient selection, with increased awareness of the MAL syndrome, all have the potential to improve the technical and short- and long-term clinical success rates. Routine follow-up with duplex could detect a recurrent stenosis at an early stage, resulting in a timely re-intervention and ultimately prolonged patency.

Data on efficacy of endovascular treatment for CMI are limited and are presented in only a retrospective manner. As a synopsis of these retrospective studies, our review is bound to their individual limitations. Given the lack of randomization, bias in patient selection is likely, with the sicker patients receiving endovascular treatment. There was an expected intra-institutional variability in treatment protocols and skill level. Follow-up has been problematic, and most of the patients were re-evaluated because of new onset of symptoms, associated with significant restenosis or occlusion. A prospective randomized trial will be necessary to definitively address the role of an open versus endovascular approach in the management of patients with CMI.

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