Percutaneous transluminal angioplasty and stenting as first-choice treatment in patients with chronic mesenteric ischemia

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Purpose: Open revascularization in patients with chronic mesenteric ischemia (CMI) is considered the gold standard. Percutaneous transluminal angioplasty and stenting (PTAS) is often reserved for patients not suitable for open revascularization. In our institute, endovascular revascularization is the first-choice treatment. The purpose of this study was to report the technical and clinical success rates after endovascular revascularization as the first-choice treatment in a series of 51 consecutive patients with CMI at a single tertiary vascular referral center.

Methods: A retrospective review was performed of all consecutive patients with CMI who underwent PTAS from July 2001 to July 2008. Only symptomatic patients treated for atherosclerotic CMI were included. Patency was evaluated using computed tomography angiography (CTA). Kaplan-Meier curves were used to calculate patency rates of the treated mesenteric arteries.

Results: Sixty mesenteric arteries (30 celiac trunks, 24 superior mesenteric, and 6 inferior mesenteric arteries) were treated in 51 patients (26 men). Major morbidity was 4%. After dissection of the superior mesenteric artery (n = 1) and brachial artery (n = 1), respectively, both patients underwent endarterectomy and patch plasty. In three arteries, the lesion could not be crossed endovascularly and they were deemed immediate intention-to-treat failures. The initial technical success rate was 93%. No 30-day mortality was observed. Median follow-up was 25 months. During follow-up, 2 patients died from intestinal ischemia. Complete symptom relief was achieved in 78% of patients. Primary 1- and 2-year patency rates were 86% ± 5% and 60% ± 9%, respectively; primary-assisted patency rates were 88% ± 5% and 79% ± 7%, respectively. During follow-up, 6 patients underwent open revascularization due to failure of PTAS.

Conclusion: The initial technical success rate of PTAS as first-choice treatment of CMI is >90%. The 2-year primary patency rate dropped to 60%, but symptomatic in-stent stenoses could often be treated successfully with renewed endovascular techniques. Including one conversion, 14% of patients needed open revascularization during follow-up. (J Vasc Surg 2010;51:386-91.)
Clinical success was defined as technical success in at least one artery with sufficient collateral circulation and the resolution of symptoms and weight gain at least 3 months after the procedure, or both. PTAS was considered the first-choice treatment in all patients. If the endovascular treatment failed, a visceral bypass was considered. All patients were prescribed aspirin (100 mg daily) after the procedure. In addition, clopidogrel was prescribed for 1 month after stent placement in all patients.

Regular follow-up consisted of anamnesis and physical examination after 3 months and yearly thereafter. If the patient had complete symptom relief, no additional imaging was performed. In December 2008, all patients were interviewed and invited for a physical examination and CTA.

**Statistical analysis.** Measured values are reported as mean ± 1 SD or median (range), as appropriate. Technical success and patency rates were based on a per-artery analysis. Clinical success was based on a per-patient analysis. Kaplan-Meier curves were used to estimate patency and success rates. They were presented as percent ± SEM. Pearson’s $\chi^2$ test was used to determine differences between groups. Significance was established at $P < .05$.

Analysis was performed using SPSS 15.0 software (SPSS Inc, Chicago, Ill).

**RESULTS**

**Technical success.** A total of 69 patients with suspected CMI underwent DSA. PTAS was not performed in 18 patients. In 6 patients, compression of the celiac artery by the arcuate ligament was observed. In the other patients, either a significant stenosis was not assessed, or abundant collateral circulation to the diseased artery was observed. Sixty mesenteric arteries (30 celiac, 24 superior mesenteric, and 6 inferior mesenteric arteries) were treated in 51 patients (26 men). Mean age was 64 ± 11 years. In 14 of the 51 patients, complete occlusion of the SMA was observed. In 11 of 14 patients, a stenosis in the celiac trunk was successfully treated by PTAS, and the SMA was left untreated. In 2 patients, the IMA was treated successfully. In the remaining patient, both the celiac trunk and SMA were occluded, and recanalization of both arteries was only successful for the SMA. All other treated vessels contained a hemodynamically significant stenosis (>70%). All patients underwent PTAS using short balloon-expandable stents with a median length of 14 mm (8-24 mm). Median stent diameter placed in the celiac trunk was 6 mm (5-7 mm); in the SMA, 6 mm (4.5-7 mm); and in the IMA, 5 mm (4-6 mm). In 3 patients, the obstruction (1 occlusion, 2 stenoses) in the celiac trunk could not be crossed endovascularly, and they were deemed immediate intention-to-treat failures. In all of the patients with an initial failure, a second mesenteric artery was successfully treated by PTAS during the same procedure. A fourth intention-to-treat failure was registered after dissection of the SMA occurred that could not be restored endovascularly. This patient underwent endarterectomy and patch plasty of the dissected artery. The initial technical success rate was 93% (56 of 60 arteries).
In addition to the dissection of the SMA, resulting in the only initial conversion, another major complication was observed in a second patient. Dissection at the access site developed, and this patient underwent endarterectomy and patch plasty of the brachial artery. In 3 other patients, a hematoma was observed at the transfemoral access site without need for surgical intervention. This resulted in a major complication rate of 4% (2 of 51 procedures). The 30-day mortality rate was 0%.

Median follow-up was 25 months. In 39 of 51 patients (76%), anatomic follow-up was obtained. Primary 1-year and 2-year patency rates were 86% ± 5% and 60% ± 9%, respectively, and assisted primary patency rates were 88% ± 5% and 79% ± 7% (Fig 1).

**Clinical success.** Patients presented predominantly with postprandial pain and weight loss (Table I). Successful PTAS of a second mesenteric artery in patients with an intention-to-treat failure eventually resulted in clinical success in these patients. Technical failure of PTAS resulted in clinical failure in 1 patient who required conversion after dissection of the SMA. Ten other patients did not have complete symptom relief after 3 months, resulting in an initial clinical success rate of 78% ± 6% (Fig 2). In 6 patients, two visceral arteries were treated successfully, resulting in initial clinical success (after 3 months) in all patients. After successful treatment of only one visceral artery, initial clinical success was observed in 34 of 45 patients (P = .171).

Twenty patients suffered from two-vessel disease and 24 from three-vessel disease. Seven patients suffered from single-vessel disease in the absence of collateral circulation to the diseased artery on DSA (Table II). In 5 of 7 patients, the celiac trunk was treated, and the SMA was treated in 2 patients. Four of 7 patients presented with typical postprandial pain in combination with weight loss. After PTAS, 3 of 7 patients were asymptomatic, and 1 had only partial improvement. In 3 patients, persistent complaints were observed. In 2 patients, symptom relief was obtained by treatment of *Helicobacter pylori* (n = 1) and *Clostridium difficile* infection (n = 1), respectively. In the remaining patient, PTAS treatment of the CA was technically successful, but her nausea and vomiting complaints did not improve. The patient died of pneumonia 4 months later. After PTAS in patients suffering from two-vessel disease, 5 of 20 patients did not have complete symptom relief. Three patients had only partial improvement. One patient underwent an SMA bypass, and another patient underwent an endarterectomy of SMA due to dissection. After PTAS in patients suffering from three-vessel disease, 2 patients did not have complete symptom relief. One patient had partial improvement, and the other patient underwent an SMA bypass (Fig 2). The difference in symptom relief after PTAS in patients with single- and multi-vessel disease was statistically significant (P = .014).

During a median follow-up of 25 months, symptoms relapsed in 13 of the 40 patients with initial complete symptom relief. Relapse of symptoms was observed only in patients with multi-vessel disease. In 12 of 13 patients with symptom relapse, CTA showed restenosis of the treated mesenteric artery. Five patients underwent successful percutaneous transluminal angioplasty (PTA) of an in-stent stenosis. The other 8 patients had mild symptoms and were monitored without renewed intervention. In another 6 patients, significant restenosis was identified in the treated mesenteric artery without symptom relapse. Two patients died during follow-up of intestinal ischemia. Both patients had withdrawn from follow-up and presented with acute mesenteric ischemia. Twelve patients died of causes not related to the CMI, of which 6 were cardiovascular deaths. During follow-up, recurrence of symptoms after treatment of two visceral arteries was similar to treatment of one visceral artery (P = .962). The primary 1-year and 2-year

### Table I. Comorbidity and presenting symptoms in 51 patients with chronic mesenteric ischemia

<table>
<thead>
<tr>
<th>Factor</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>26</td>
<td>51</td>
</tr>
<tr>
<td>Smoking</td>
<td>29</td>
<td>57</td>
</tr>
<tr>
<td>Hypertension</td>
<td>37</td>
<td>73</td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
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<td>63</td>
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<tr>
<td>Diabetes</td>
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<td>12</td>
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<td>Renal disease</td>
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</tr>
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<td>CAD</td>
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<td>45</td>
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<tr>
<td>COPD</td>
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</tr>
<tr>
<td>Previous vascular surgery</td>
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<td>39</td>
</tr>
<tr>
<td>Postprandial abdominal pain</td>
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<td>92</td>
</tr>
<tr>
<td>Weight loss</td>
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<td>63</td>
</tr>
<tr>
<td>Diarrhea</td>
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<td>24</td>
</tr>
<tr>
<td>Intestinal ulcer</td>
<td>6</td>
<td>12</td>
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CAD, Coronary artery disease; COPD, chronic obstructive pulmonary disease.

*Weight loss was defined as at least 5 kg in a period <6 months.

**Fig 1.** Kaplan-Meier primary (interrupted line) and assisted primary patency (continuous line) rates of 60 mesenteric arteries treated by percutaneous transluminal angioplasty.
Clinical success rates were 70% ± 7% and 56% ± 8%, respectively, and assisted primary clinical success rates were 72% ± 6% and 68% ± 7% (Fig 3).

PTAS failed during follow-up in 6 patients, and they underwent open revascularization. The first 2 patients underwent successful PTAS of a stenosed celiac trunk, and the occluded SMA was left untreated. When symptoms did not resolve after 1 month, a common iliac artery SMA bypass was performed, as mentioned above. The third patient underwent PTAS of a stenosed celiac trunk. The occluded SMA and stenosed IMA were left untreated. A DSA showed scant collateral circulation. Although symptoms resolved, a common iliac artery SMA bypass was performed. The fourth patient underwent PTAS of the celiac trunk, but the occluded SMA was left untreated. After 2 years, successful PTA of an in-stent stenosis in the celiac trunk was performed. Postprandial pain and weight loss returned 9 months later, and open revascularization was performed using an antegrade bifurcated bypass to the hepatic artery and SMA. The fifth patient underwent successful PTAS of a stenosed SMA, but endovascular treatment of the stenosis in the celiac trunk failed. The occluded IMA was left untreated. Restenosis of the SMA occurred after 25 months and was treated by PTA. Although technically successful, postprandial pain and weight loss did not resolve, and open revascularization was performed using an antegrade bifurcated bypass to the hepatic artery and SMA. The sixth patient underwent recanalization and stent placement of a totally occluded SMA, but recanalization of the totally occluded celiac trunk failed. Four years after PTAS, the patient presented with acute mesenteric ischemia due to occlusion of the recanalized SMA. Open revascularization consisting of a retrograde SMA bypass was performed; unfortunately, the patient died the first day after surgery. All bypasses were anastomosed distally from the stent, and this was not associated with technical difficulties.

### DISCUSSION

Endovascular treatment as first-choice treatment for patients with CMI appears to be a safe therapy with initial technical and clinical success rates similar to open revascularization. During midterm follow-up, substantial recurrence of symptoms has been observed. In the current series, we have treated unselected patients endovascularly.

#### Table II.

<table>
<thead>
<tr>
<th>Number of diseased visceral arteries</th>
<th>Patients Complete symptom relief</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>24</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
</tr>
</tbody>
</table>

PTAS, Percutaneous transluminal angioplasty and stenting.

#### Fig 2.

Clinical success in 51 patients treated for chronic mesenteric ischemia (CMI) by percutaneous transluminal angioplasty and stenting (PTAS).

#### Fig 3.

Kaplan-Meier primary (interrupted line) and assisted primary clinical success (continuous line) rates in 51 patients with chronic mesenteric ischemia treated by percutaneous transluminal angioplasty.
also including young and fit patients. Therefore, the results of this series might be better for comparison with the findings after open revascularization, since PTAS has often been reserved for patients unfit for open revascularization.

Open revascularization is associated with substantial morbidity and mortality. Reported morbidity ranges from 12% to 33%.17,18 Two major complications (4%) were observed in our series, and no patients died as a result of PTAS. In a series from a nationwide database in the United States, more than 5500 patients were treated for CMI. The mortality rate of 3.7% after PTAS was significantly lower than the 13% after bypass.4 In the largest recent series from specialized centers, the mortality rate after open revascularization ranges from 2% to 15%.1,3,6,7

The initial technical success rate in our series was 93%. Seven patients (14%) eventually underwent open revascularization after PTAS failure. In only 1 patient did PTAS have to be converted immediately to endarterectomy due to dissection of the treated artery. Three other patients underwent open revascularization within 3 months after PTAS. During follow-up, 3 more patients underwent open revascularization after late failure of PTAS.

Although endarterectomy and antegrade and retrograde bypasses are associated with significant rates of morbidity and mortality, open revascularization provides durable symptom relief. After open revascularization, excellent long-term clinical success rates up to 92% after 5 years have been reported.1,2,6,7 It has been considered the standard for many years. In a review of 292 patients treated by PTAS, symptom relief without reintervention was maintained in 75% of these patients.15 In our current series, symptoms with varying severity had occurred in 13 of 40 patients after a median follow-up of 25 months. The 2-year primary clinical success rate had dropped to 56%. However, the symptomatic restenoses in most patients could again be treated endovascularly, resulting in a 2-year primary-assisted clinical success rate of 68%. It appears that the results after endovascular revascularization are not as durable as after open revascularization.

A critical point in treating patients with CMI—both open and endovascularly—is adequate diagnostic studies. Imaging studies to identify the presence of mesenteric artery obstructive disease include DUS, MRA, CTA, and DSA. CMI is suspected in patients with at least two mesenteric arteries demonstrating a hemodynamically significant stenosis or occlusion. Single-vessel disease without collaterals may also lead to symptomatic CMI. Treatment of asymptomatic patients with a significant celiac trunk or SMA stenosis has not been recommended. The presence of an asymptomatic mesenteric artery stenosis is not associated with death or adverse cardiologic events, and these patients do not develop chronic intestinal ischemia or intestinal infarction.19 Only asymptomatic patients with significant three-vessel arterial disease should be considered for prophylactic mesenteric arterial revascularization.20 Symptoms can be nonspecific, and typical symptoms are not always the result of mesenteric ischemia.

Failure of symptom relief after successful PTAS or open revascularization might result from an incorrect diagnosis. In our series, at least 3 patients with an incorrect diagnosis underwent PTAS. Two patients did not obtain symptom relief before eradication therapy for Helicobacter pylori and Clostridium difficile. In the third patient, a proper explanation for the nausea, vomiting, and chronic diarrhea not responding to PTAS was never found.

Gastric exercise tonometry is a functional test that can be used as an addition to anatomic imaging.10 In our series, the clinical outcome after treatment of patients with single-vessel disease was disappointing and significantly worse compared to patients with multi-vessel disease. Especially in these patients, a functional test could have additional value to identify gastrointestinal ischemia. In a series of 95 patients treated for CMI, 84% had durable and complete symptom relief after surgical revascularization or endovascular stent placement. Prior to the revascularization, 85% of patients had abnormal results on gastric exercise tonometry. Of the patients with a single-vessel stenosis, 38 of 50 were free from symptoms, compared with 32 of 35 with multiple-vessel stenoses (P = .086).2 This test was used in only 3 of our patients but seems to have additional value in selected patients.

In this retrospective series, morbidity and mortality rates after endovascular revascularization as first-choice treatment in patients with CMI are low compared with reported outcomes after open revascularization. The initial technical success rate of PTAS was >90%. The 2-year primary patency and clinical success rate is only reasonable, and in-stent stenoses can often be treated successfully with repeated endovascular techniques. Although one initial conversion was observed, only 14% of patients needed open revascularization during midterm follow-up. Therefore, we believe PTAS can be the first-choice treatment in patients with CMI, while open revascularization is reserved for patients in which PTAS fails.

AUTHOR CONTRIBUTIONS
Conception and design: BF, JM, FM, JV
Analysis and interpretation: BF, HR, ML, JB, JV
Data collection: BF, HR, JM, SK
Writing the article: BF, HR, JV
Critical revision of the article: BF, HR, JM, ML, SK, FM, JB, JV
Final approval of the article: BF, HR, JM, ML, SK, FM, JB, JV
Statistical analysis: BF, JV
Obtained funding: Not applicable
Overall responsibility: BF

REFERENCES

INVITED COMMENTARY

Ahmed Abou-Zamzam, Jr., MD, Loma Linda, Calif

Fiocle et al report 51 patients treated with percutaneous angioplasty and stenting (PTAS) for chronic mesenteric ischemia (CMI), reflecting the authors’ transition towards a PTAS-first approach to CMI. They report very acceptable primary patency, reflecting the authors’ transition towards a PTAS-first approach to CMI.1-3 The question is whether PTAS is a reasonable first-line therapy based on the data, or because surgeons now perform PTAS. From a patient perspective, however, less may be better.

Major morbidity was only 4%. But what is the cost? The authors, unfortunately, do not provide this information. With a 2-year primary patency of only 60%, repeat interventions may be the norm. Within the current health care environment, this is an excellent opportunity for comparative-effectiveness research.

REFERENCES