Chronic Mesenteric Ischemia: 20 Year Experience of Open Surgical Treatment

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WHAT THIS PAPER ADDS
This study is the first to include a large sample of patients presenting exclusively with chronic mesenteric ischemia, with a median follow up longer than 5 years. This department has great experience in the field of chronic mesenteric ischemia, and care was always taken to get the optimal follow up for this specific population. Here the experience is reported and the actual long-term good results for open surgery in the modern era are demonstrated.

Objectives: Both open surgery (OS) and endovascular surgery (ES) have been proposed for the treatment of symptomatic chronic mesenteric ischaemia (CMI). OS was considered the gold standard but ES is increasingly proposed as the first option. The aim was to report long-term outcomes associated with OS in patients suffering CMI in the modern era in order to help in choose between the two techniques.

Materials and methods: A retrospective single centre analysis of all consecutive digestive artery revascularizations performed for CMI between January 2003 and December 2012 was carried out. Primary outcomes were 30 day mortality and morbidity, and secondary outcomes were survival, primary patency (PP), secondary patency (SP), and freedom from digestive symptoms, depending on the completeness of the revascularization performed.

Results: Eighty-six revascularizations were performed. Median follow up was 6.9 years (range 0.3–20.0). The 30 day mortality and morbidity rates were respectively 3.5% and 13.9%. Ten year survival was 88% for complete revascularization (CR) and 76% for incomplete revascularization (IR) \((p = .54)\). The PP was 84% at 10 years for CR and 87% respectively for IR \((p = .51)\). The 10 year SP was 92% for CR and 93% for IR \((p = .63)\). Freedom from digestive symptoms was influenced by the completeness of revascularization: 79% for CR versus 65% for IR at 10 years \((p = .04)\).

Conclusions: OS for CMI, especially complete revascularization, provides lasting results despite high morbidity.

INTRODUCTION
Chronic mesenteric ischaemia (CMI) secondary to arterial insufficiency was first recognized and described by Chienne \(^1\) in 1869, followed by Councilman \(^2\) in 1894 with the anatomical description of the celiac trunk (CT) and superior mesenteric artery (SMA) occlusions. The recognition of abdominal angina as a vascular disease representing a precursor to fatal intestinal vascular occlusion was made by Dunphy in 1936. \(^3\) In 1957 Mikkelson \(^4\) was the first to propose a surgical treatment for occlusive lesions of the SMA. One year later, Shaw and Maynard \(^5\) described the first surgical thromboendarterectomy of the SMA proving its effectiveness in relieving the symptoms associated with CMI. However, the clinical manifestations of CMI can remain poor owing to the extensive collateral development of digestive arteries, but if intestinal blood flow is unable to supply physiological gastrointestinal demands, mesenteric ischemia will occur. If preventive treatment in asymptomatic patients is controversial, treatment of symptomatic CMI is widely accepted in order to prevent acute mesenteric ischemia (AMI), which may cause bowel infarction and death. Open surgery (OS) techniques and options are endarterectomy, re-implantation, and aorto-mesenteric and/or celiac bypass grafting. OS is effective but associated with relatively high peri-operative mortality and morbidity rates, ranging from 1% to 17% for mortality, and from 2% to 33% for morbidity. \(^6\)–\(^8\) If OS mesenteric revascularization has been the primary method of treatment for CMI, endovascular surgery (ES) has rapidly
risen as a valuable option and is now being used more often than surgery in the United States. Comparisons between OS revascularizations and ES for visceral arterial occlusive disease have been published, but large series studying long-term outcomes associated with OS revascularization are still missing. The purpose of this report was to review the 20 year experience from a single institution of OS treatment of patients with CMI, depending on the completeness of the revascularization.

MATERIALS AND METHODS

A retrospective analysis of all consecutive patients operated on for digestive revascularization for CMI between January 1993 and December 2012 was performed. Inclusion criteria were patients presenting at least two of the following digestive symptoms: typical chronic postprandial abdominal pain, weight loss, a fear of food (because of pain), meals split into smaller portions (food fear with meal splitting), digestive troubles (diarrhoea, nausea, or vomiting), and the presence of a significant diameter stenosis of at least 70% in one or more digestive artery, CT, SMA, or inferior mesenteric artery (IMA) on duplex scan examination, confirmed by pre-operative radiological imaging: arteriography or computed tomography angiography.

Exclusion criteria were incidental digestive artery stenosis without symptoms, treatment of any digestive artery in combination with another aortic procedure without CMI symptoms, and AMI.

During this period, the policy of the team concerning CMI was always the same: OS was carried out, except in patients that were considered too high risk. In fact, surgical risk was always defined pre-operatively according to the guidelines for the peri-operative cardiac management in non-cardiac surgery of the European Society of Anaesthesiology. High risk patients were thus defined as patients with three or more serious comorbidities, including chronic obstructive pulmonary disease, weight loss, a fear of food, age >75 years, and active tobacco use. Cardiac, renal, and cerebrovascular comorbidities were present in 50 (58%), 21 (24%), and seven (8%) patients respectively.

The following pre-operative parameters were recorded: demographic data, cardiovascular risk factors (diabetes, hypertension, dyslipidaemia, tobacco use), comorbidities (a history of myocardial infarction, coronary bypass, or stenting corresponding to cardiac comorbidity, a creatinine clearance less than 30 mL/min for renal comorbidity, and a history of stroke or previous carotid endarterectomy for cerebral comorbidity), and blood albumin level.

An angiographic score was assigned, regardless of pre-operative angiography imaging, to evaluate the digestive arterial system in each patient: for each digestive artery (CT, SMA, IMA), occlusion was rated 0, a stenosis greater than 70% was rated 1, a stenosis between 50% and 70% was rated 2, a stenosis of less than 50% was rated 3, and a normal artery was rated 4. This score was developed in order to have an objective and easily quantified value for each patient.

Surgical procedures performed were listed, including the type of revascularization done: complete or incomplete. Thirty day mortality and morbidity were recorded. Morbidity was defined as surgery related morbidity (graft thrombosis, haemorrhagic complication, operative site infection) or systemic morbidity (renal, pulmonary, cardiac, or neurologic failures).

Patients were reviewed in the outpatient clinic at 30 days and at 6 months, and annually thereafter. Ultrasound monitoring was performed in each case, and a CT scan when ultrasound examination was non-contributory. Survival, primary patency, secondary patency, and freedom from digestive symptoms were analysed according to the completeness of the revascularization.

Statistical analysis was performed using GraphPad Prism under the supervision of the University Statistics Department. Non-normally distributed data are presented as median (MED) and interquartile range (IQR). Kaplan–Meier analysis and log-rank test were used to compare survival, primary patency, secondary patency, and freedom from digestive symptoms rates. The chosen significance level was 5% (p < .05).

RESULTS

Population

Eighty-six patients, 52 men and 34 women (sex ratio 1.53), with median age 62 (IQR 56–75) years were included. During the same period 31 revascularizations considered as preventive (completed for asymptomatic patients presenting at least 2 lesions regardless of the Mikkelsen rule, or completed during aortobifemoral bypasses done for occlusive disease), 39 endovascular procedures performed in patients with poor clinical status, and 36 procedures performed for AMI were excluded.

Median follow up was 6.9 (range 0.3–20.0) years. No patients dropped out the study. Cardiovascular risk factors were diabetes mellitus in 22 patients (26%), hypertension in 72 patients (84%), dyslipidaemia in 48 patients (56%), and active tobacco use in 42 patients (49%). Cardiac, renal, and cerebral comorbidities were present in 50 (58%), 21 (24%), and seven (8%) patients respectively.

Typical chronic postprandial abdominal pain was present in 73 patients (85%), weight loss in 66 patients (77%), food fear with meal splitting in 54 (63%) and diarrhea, nausea or vomiting in 48 patients (56%). Mean weight loss was 13.6 kg (median 10.0, interquartile range [IQR] 7.0–12.5). Malnutrition was present in 50 patients (58%), with associated hypoalbuminaemia and body mass index <19 kg/m².
**Digestive arterial system**

All patients had a pre-operative arteriogram. Numbers of pathological digestive arteries were one in six patients (7%), two in 68 patients (79%), and three in 12 patients (14%), with a mean number of 2.14 (median 2, IQR 1–3). The CT was involved in 72 patients (84%), SMA in 82 patients (95%), and IMA in 28 patients (33%). Mean angiographic score was 4.1 (median 4, IQR 3–5).

**Type of revascularization**

The number of treated arteries was one in 49 patients (57%), and two in 37 patients (43%), with a mean number of 1.43 (MED 1/IQR 1–2).

Revascularization was complete in 46 cases (53%), and anterograde in 79 cases (92%). Comparison of pre-operative characteristics of patients who underwent complete revascularization and patients who underwent incomplete revascularization showed no difference (Table 1).

All revascularizations are described in Table 2. In nine cases (10%), an associated aortic reconstruction was done simultaneously: two aorto-aortic bypasses, one aorto-bi-iliac bypass, and six aorto-bifemoral bypasses. All bypasses were done using polyethylene terephthalate grafts.

Anterograde revascularizations were 31 aorta to proper hepatic and SMA bypass (36%), an aorto-hepatic bypass in four cases (5%), an aorto-SMA bypass in 26 cases (30%), a SMA direct re-implantation in 13 cases (15%), a SMA and IMA re-implantation in four cases (5%), and a transaortic SMA endarterectomy in one case (1%).

**Table 1. Pre-operative characteristics of patients.**

<table>
<thead>
<tr>
<th>Total number = 86</th>
<th>Complete revascularization</th>
<th>Incomplete revascularization</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographics data</td>
<td></td>
<td></td>
<td>----</td>
</tr>
<tr>
<td>Mean age</td>
<td>62</td>
<td>60</td>
<td>.98</td>
</tr>
<tr>
<td>Male gender</td>
<td>27 (58.7%)</td>
<td>25 (62.5%)</td>
<td>.72</td>
</tr>
<tr>
<td>Cardiovascular risk factors</td>
<td></td>
<td></td>
<td>----</td>
</tr>
<tr>
<td>Diabetes</td>
<td>13 (28.3%)</td>
<td>9 (22.5%)</td>
<td>.54</td>
</tr>
<tr>
<td>Hypertension</td>
<td>37 (80.4%)</td>
<td>35 (87.5%)</td>
<td>.38</td>
</tr>
<tr>
<td>Dyslipidaemia</td>
<td>23 (50.0%)</td>
<td>25 (62.5%)</td>
<td>.24</td>
</tr>
<tr>
<td>Tobacco addiction</td>
<td>22 (47.8%)</td>
<td>20 (50.0%)</td>
<td>.84</td>
</tr>
<tr>
<td>Comorbidities</td>
<td></td>
<td></td>
<td>----</td>
</tr>
<tr>
<td>Cardiac</td>
<td>28 (60.9%)</td>
<td>22 (55.0%)</td>
<td>.58</td>
</tr>
<tr>
<td>Renal</td>
<td>11 (23.9%)</td>
<td>10 (25.0%)</td>
<td>.91</td>
</tr>
<tr>
<td>Cerebral</td>
<td>5 (10.9%)</td>
<td>2 (5.0%)</td>
<td>.32</td>
</tr>
<tr>
<td>Symptoms</td>
<td></td>
<td></td>
<td>----</td>
</tr>
<tr>
<td>Typical abdominal pain</td>
<td>38 (82.6%)</td>
<td>35 (87.5%)</td>
<td>.53</td>
</tr>
<tr>
<td>Weight loss</td>
<td>36 (78.3%)</td>
<td>30 (75.0%)</td>
<td>.72</td>
</tr>
<tr>
<td>Food fear</td>
<td>26 (56.5%)</td>
<td>28 (70.0%)</td>
<td>.19</td>
</tr>
<tr>
<td>Digestive troubles</td>
<td>28 (60.9%)</td>
<td>20 (50.0%)</td>
<td>.31</td>
</tr>
<tr>
<td>Malnutrition</td>
<td>26 (56.5%)</td>
<td>24 (60.0%)</td>
<td>.74</td>
</tr>
<tr>
<td>Mean angiographic score</td>
<td>4.2</td>
<td>4.0</td>
<td>.83</td>
</tr>
</tbody>
</table>

**Table 2. Type of revascularization.**

<table>
<thead>
<tr>
<th>Total number = 86</th>
<th>Digestive revascularization alone n = 77</th>
<th>Associated aortic reconstruction n = 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aorto-hepatic and − SMA bypass</td>
<td>32 (37%)</td>
<td>None</td>
</tr>
<tr>
<td>Aorto-hepatic bypass</td>
<td>4 (5%)</td>
<td>None</td>
</tr>
<tr>
<td>Aorto-SMA bypass</td>
<td>27 (31%)</td>
<td>5 (6%)</td>
</tr>
<tr>
<td>SMA direct reimplantation</td>
<td>7 (8%)</td>
<td>None</td>
</tr>
<tr>
<td>SMA indirect reimplantation</td>
<td>6 (7%)</td>
<td>None</td>
</tr>
<tr>
<td>SMA and IMA reimplantation</td>
<td>None</td>
<td>4 (5%)</td>
</tr>
<tr>
<td>Transaortic endarterectomy</td>
<td>1 (1%)</td>
<td>None</td>
</tr>
</tbody>
</table>

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

Retrograde bypasses were four aorto-SMA bypasses (5%), two aorto-SMA bypasses associated with aorto-bifemoral bypasses (2%), and one bifurcated aorta to proper hepatic and SMA bypass (1%). All these bypasses were retrograde bypasses due to heavy calcifications of the celiac part of the aorta, without possibility of clamping.

**Thirty day mortality and morbidity**

Three patients (3.5%) died during the initial post-operative period: two from heart failure on days 3 and 5, and one from septic shock on day 21. Post-operative morbidity was 13.9%, and consisted of one respiratory failure requiring prolonged intubation and ventilation, two temporary acute renal failures, one surgical site infection, three parietal hematoma, two acute coronary syndromes, and three graft thromboses. Mortality and morbidity were not influenced by the completeness of revascularization.

**Late results**

Survival, primary patency, and secondary patency were not influenced by the completeness of the revascularization. Survival rate was 92.1% at 5 years and 87.9% at 10 years for complete revascularization, and 83.2% and 76.3% respectively for incomplete revascularization (Fig. 1). The primary patency rate was 88.2% at 5 years and 84.4% at 10 years for complete revascularization, and 88.1% at 5 and 10 years for incomplete revascularization (Fig. 2). The secondary patency rate was 93.6% at 5 and 10 years for complete revascularization; and 93.7% for incomplete revascularization (Fig. 3).

Freedom from digestive symptoms was influenced by the completeness of the revascularization. Freedom from digestive symptoms rate was 84.3% at 5 years and 80.3% at 10 years for complete revascularization, and 68.9% and 65.7% respectively for incomplete revascularization (p = .04) (Fig. 4).
OS for CMI provides lasting long-term results, especially when performing complete and anterograde revascularization. It has long been known that the natural history of patients with symptomatic chronic mesenteric ischemia is not favourable because it carries significant morbidity and the risk of mortality from acute mesenteric ischemia, which justifies mandatory revascularization. Open surgical procedures were first described for CMI, but have become proportionally much less commonly used than endovascular procedures. In fact, since 2005, angioplasty and stenting of the CT and the SMA have surpassed the number of open surgical procedures, especially as endovascular techniques have made considerable progress, including the recent use of covered stents. The question is: Is there still a room for OS in CMI?

A common criticism of prior studies comparing endovascular versus open surgery for CMI treatment is the lack of risk stratified analysis, because it can introduce selection bias, given that open surgery is preferred in lower risk patients, and that endovascular surgery is preferred in higher risk patients. Based on the best available evidence, endovascular surgery has reduced early mortality and morbidity compared with OS, but is associated with higher rates of re-stenosis and re-intervention. In fact, the type of revascularization has not been shown to affect survival, but comparative analysis is always limited by selection bias favouring OS for lower risk patients and endovascular revascularization for high risk patients. Tallarita et al. showed by using propensity score matched comparisons that 5 year patient survival was not influenced by the type of revascularization (open or endovascular surgery). Thus, given that late patient survival is not influenced by the type of revascularization, treatment selection should be based on factors that may affect the durability of the procedure, such as the anatomical characteristics of the lesion. Oderich et al. reported that rates of restenosis were higher among patients treated for heavily calcified or >30 mm occlusions. However, the evidence between OS or endovascular revascularization for CMI is still based on the preference and experience of the individual interventionalist. Properly designed and well executed studies are scarce. Consequently, the best available level of evidence is 2b. A large randomized study would be required, but is quite impossible due to the low number of patients potentially suitable for both techniques. However, based on the decreased complication rates and rapid recovery from endovascular revascularizations, a reasonable endovascular approach in
patients with short stenoses of the involved vessels, in which angioplasty and stent placement would not compromise the landing site for a possible future open bypass graft can be proposed. OS should still be the preferred approach in patients at low risk for aortic operations who present with complex occlusive disease of their mesenteric vessels (occlusion, long stenosis), or in patients in whom placement of a stent would compromise subsequent bypass grafting. The purpose was not to compare endovascular versus open surgery results, but to evaluate the long-term results of OS, especially depending on the completeness of the revascularization. The current study is the first to include a large sample of patients presenting with CMI, with a median follow up longer than 5 years.

In the authors’ experience, OS provides long-term lasting results, especially long-term freedom from digestive symptoms when performing complete revascularization. Several studies evaluating open surgical repair for CMI have reported symptom improvement in 90–100% of patients. However, while there is no question about the durability of OS in chronic mesenteric ischemia, controversy continues to surround whether single or multiple vessel revascularizations are recommended. Some authors have already emphasized that complete revascularization is necessary when possible: if both the CT and the SMA are involved in the disease process, both arteries should be reconstructed to ensure a good long term prognosis, with lower risk of recurrence. Other authors advocate a SMA only approach, which seem as good as multi-vasel targeting in many aspects, and showed that symptom recurrence after open repair only occurs when both limb of a bifurcated graft fail or when a single graft to the SMA became stenotic. In the authors’ experience, complete revascularization provides positive impact on long-term freedom of digestive symptoms.

However, OS is still associated with significant morbidity (5–30%) and mortality (3–12%). The initial results are similar to those found in the literature, with acceptable morbidity and mortality rates. In the authors’ experience, morbidity or mortality were not influenced by the completeness of the revascularization. In fact, morbidity and mortality in CMI patients are in part related to the weight loss and malnutrition in these patients, which are predictors of increased morbidity and mortality after major surgery. This draws attention to the necessity for pre-operative care in these fragile patients, with the use of adequate parenteral nutrition.

However, this study has severe limitations. First, it is a retrospective study performed at a single institution, generating bias linked to a retrospective data collection, even though several data were collected prospectively. The long study period is also a severe limitation, because during these decades there has been significant progress in medical therapy and surgical techniques that may have affected outcomes, but the unknown or probably low incidence of CMI makes the retrospective nature mandatory. Furthermore, the study population was selected for OS based on fitness, whereas endovascular centres present data on all patients, fit or not. This is also an important limitation of the study.

However, the durability and efficacy of open surgical repair in CMI are convincing over time, despite high morbidity, which justifies the use of OS in CMI. Therefore, complete surgical revascularization remains the treatment of choice for fit patients.

CONFLICT OF INTEREST
None.

FUNDING
None.

REFERENCES


