Revascularization of acute mesenteric ischemia after creation of a dedicated multidisciplinary center

Arnaud Roussel, MD,[a] Yves Castier, MD, PhD,[a] Alexandre Nuzzo, MD,[b] Quentin Pellenc, MD,[a] Annie Sibert, MD,[c] Yves Panis, MD, PhD,[d] Yoram Bouhnik, MD, PhD,[b] and Olivier Corcos, MD,[b]
Paris, France

Objective: **Arterial acute mesenteric ischemia (AAMI) is a vascular and gastroenterologic emergency, most often surgical, still associated with a poor prognosis and frequent short bowel syndrome in survivors. We report the results of revascularization in AAMI patients after the creation of an intestinal stroke center.**
Methods: **Since July 2009, we developed a multimodal and multidisciplinary management for AMI, focusing on intestinal viability and involving gastroenterologists, vascular and abdominal surgeons, radiologists, and intensive care specialists. This management was the first step to the creation of an intestinal stroke center, based on the stroke unit model. All patients received: (1) a specific medical protocol; (2) endovascular and/or open surgical revascularization whenever possible; and/or (3) resection of non-viable small bowel. We aimed to study survival, morbidity, type of revascularization, and bowel resection in patients who benefited from arterial revascularization in our intestinal stroke center.**
Results: **Eighty-three patients with AMI were prospectively enrolled in the intestinal stroke center. Among them, 29 patients with AAMI underwent revascularization. The mean age was 50.2 ± 12 years, with 41% of male gender. The mean follow-up was 22.7 ± 19 months. Overall 2-year survival was 89.2%, and 30-day operative mortality was 6.9%. Surgical revascularization included bypass grafting (65%), endarterectomy with patch angioplasty (21%) ± retrograde open mesenteric stenting of the superior mesenteric artery (7%), and endovascular revascularization as first stage procedure (38%). The 2-year primary patency rate of open revascularization was 88%. The rate and the median length of bowel resected were 24% and 43 cm (range, 36-49 cm), respectively.**
Conclusions: **In our experience, revascularization of AAMI patients as part of a multidisciplinary and multimodal management leads to encouraging results. Vascular surgeons have a central role in a dedicated intestinal stroke center. (J Vasc Surg 2015;62:1251-6.)**

Acute mesenteric ischemia (AMI) accounts for about 0.1% of hospital admissions, and mortality remains high with a rate ranging from 30% to 80%.[1-6] In this emergency setting, rapid restoration of blood flow with endovascular or surgical revascularization is recommended but often difficult to coordinate with early diagnostic, intensive care management and gastrointestinal surgery.[7] In most cases, large intestinal resections are required, and the outcome for most AMI survivors is marked by short-bowel syndrome (SBS), permanent intestinal failure, long-term parenteral nutrition (PN), and sometimes intestinal transplantation.[8] These poor outcomes are the result of a late recognition and an incomplete treatment.[9,10]

From the Department of Vascular and Thoracic Surgery,[a] Department of Gastroenterology, Inflammatory Bowel Diseases, Nutritional Support, and Intestinal Transplantation,[b] Department of Radiology,[c] and Department of Colorectal Surgery and Intestinal Transplantation,[d] Groupe Hospitalier Universitaire Paris Nord Val de Seine, Faculté de médicine Denis Diderot.

Author conflict of interest: none.

Correspondence: Arnaud Roussel, MD, Department of Vascular and Thoracic Surgery, Bichat Hospital, 46 rue Henri Huchard, 75018 Paris, France (e-mail: arnaudkiem.roussel@gmail.com).

The editors and reviewers of this article have no relevant financial relationships to disclose per the JVS policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.
0741-5214

http://dx.doi.org/10.1016/j.jvs.2015.06.204

AMI has a complex and progressive pathophysiology, explaining the inevitable clinical outcome of undertreated patients, from acute abdominal pain to extensive bowel necrosis, multi-organ failure, and death.[11] Therefore, considering this pathophysiology, we hypothesized in a previous preliminary study that a multidisciplinary and multimodal management (M^3 protocol) could improve AMI prognosis and survival.[12] On the design of organized stroke units involving multidisciplinary teams,[13,14] we created the first intestinal stroke center (ISC) in July 2009 dedicated to AMI. Our program combined three therapeutic approaches: (1) prevention of multi-organ failure with a multimodal medical treatment; (2) removal of necrotic small bowel; and (3) revascularization of viable intestine. The preliminary results of a pilot study showed the feasibility of M^3 protocol in AMI with a decrease of both rate and length of bowel resection and an improvement in survival.[15] The aim of the present study was to assess the results of revascularization for arterial AMI (AAMI) in our ISC.

METHODS

Study design. In this open label study, patients who underwent revascularization for occlusive AAMI were consecutively enrolled and data prospectively collected between July 2009 and December 2014. The study protocol was in accordance with good clinical practice according to the 1975 Declaration of Helsinki guidelines. Authorization

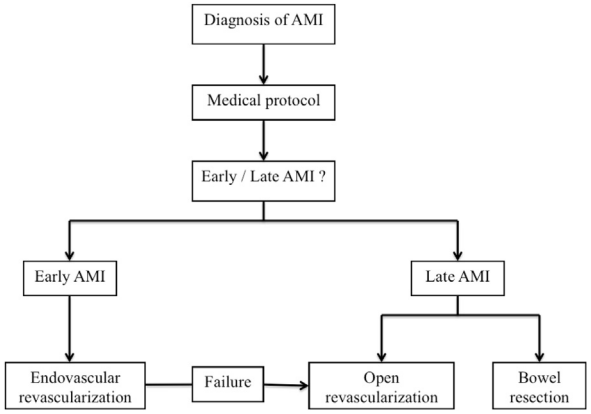

Fig 1. Algorithm of arterial acute mesenteric ischemia (*AAMI*) management in the intestinal stroke center. *AMI,* Acute mesenteric ischemia.

Table I. Common and additional medical protocol in acute mesenteric ischemia (AMI)

Mandatory medical protocol	Blood volume resuscitation
	Mean arterial pressure >65 mm Hg
	Urine output >0.5 mL · kg^{-1} · h^{-1}
	Curative unfractionated heparin therapy
	Anti-Xa target: 0.4-0.8
	Oral digestive decontamination
	PO gentamicin 80 mg/d
	PO metronidazole 1.5 g/d
	IV proton pump inhibitors
	IV pantoprazole, 80 mg/d
	Oxygen therapy
	Food resting
	PN if prolonged >5 days
Conditional medical protocol	IV aspirin 100 mg/d
	If arterial thrombosis or revascularization
	IV piperacillin-tazobactam 12 g/d
	If SIRS or organ failure
	Upper gastrointestinal aspiration
	If ileus
	Blood transfusion
	If hemoglobin level <9 g/dL

IV, Intravenous; *PN,* parenteral nutrition; *PO,* per os; *SIRS,* systemic inflammatory response syndrome.

from the Institutional Review Board was obtained prior to study start, and all patients gave informed consent.

Inclusion criteria. In the absence of specific biomarkers, AAMI was defined as already described by the presence of an intestinal ischemic injury related to at least one splanchno-mesenteric artery occlusion.[16] Patients presenting with AMI secondary to mesenteric venous thrombosis, nonocclusive arterial hypoperfusion, left-sided colon ischemia, chronic mesenteric ischemia, and aortic dissections complicated by visceral ischemia were excluded.

Collection of data. For all included patients, specific demographics and atherosclerotic risk factors were collected. Preoperative clinical presentation and preoperative radiographic findings with the number of vessels occluded were recorded. The classification of etiology (thrombotic or embolic) was based on multidisciplinary interpretation of the clinical presentation, the computed tomography (CT) scan, and operative findings. As already described, early AMI was defined in the absence of organ failure, increased blood lactate levels, and pneumoperitoneum/peritonitis/necrosis on CT scan. Late AMI was considered in the presence of at least one of the aforementioned criteria.[15] Histologic confirmation of acute ischemic damage was obtained from all resected small bowel specimens. Two-year survival, 30-day mortality, postoperative morbidity, rate, and length of intestinal resection were analyzed.

Principles of the M^3 protocol: the ISC. The organization of the ISC was based on the stroke unit model. This center, available 24 hours a day, 7 days a week, and located at Groupe Hospitalier Universitaire Paris Nord Val de Seine, Paris VII University, associates the departments of gastroenterology, vascular and digestive surgery, radiology, and intensive care. The organization and cross-communication within the ISC have been previously described.[15] All patients treated in the ISC were clinically and radiographically evaluated by a multidisciplinary team at presentation. CT scan was interpreted by a radiologist, a gastroenterologist, a digestive surgeon, and a vascular surgeon to evaluate the severity of intestinal injury, the mechanism of ischemia, and the alternatives for revascularization. The M^3 protocol combines a medical protocol and a simple decisional algorithm (Fig 1). After admission, all patients received the multimodal medical protocol since July 2009 (Table I). Endovascular revascularization included a combination of angioplasty, stenting, thromboaspiration, and/or thrombolysis of digestive arterial stenosis or emboli, depending on the mechanism of ischemia, the length of the vascular occlusion, and the appearance of the underlying and distal arteries. If endovascular treatment failed or did not immediately improve clinical and biological conditions, and in all cases of late AMI, patients then were treated by surgical revascularization, associated if necessary with intestinal resection (Fig 1). The surgical team always included both digestive and vascular surgeons. Surgical revascularization was performed through a midline laparotomy and consisted of an evaluation of small bowel viability and revascularization of the superior mesenteric artery (SMA) or coeliac trunk, followed by resection of non-viable small bowel. Open revascularization included endarterectomy with patch angioplasty ± retrograde stenting of the SMA and bypass grafting. A second look intervention was considered if the patient's condition did not improve after 48 hours in intensive care or according to the surgeon's perioperative interpretation. In patients who underwent intestinal resection, a temporary stoma was always performed, and patients received PN until surgical rehabilitation.

Statistical analysis. Values were expressed as mean (standard deviation), median (interquartile range) or percentage, as appropriate. Data were obtained at the final follow-up visit for surviving patients. Overall survival