

Multicenter study of retrograde open mesenteric artery stenting through laparotomy for treatment of acute and chronic mesenteric ischemia

Gustavo S. Oderich, MD,^a Rodrigo Macedo, MD, MSc,^a David H. Stone, MD,^b Edward Y. Woo, MD,^c Jean M. Panneton, MD,^d Timothy Resch, MD, PhD,^e Nuno V. Dias, MD, PhD,^e Björn Sonesson, MD, PhD,^e Marc L. Schermerhorn, MD,^f Jason T. Lee, MD,^g Manju Kalra, MBBS,^a Randall R. DeMartino, MD, MSc,^a Giuliano de A. Sandri, MD,^a and Emanuel J. Ramos Tenorio, MD, PhD,^a on behalf of the Low Frequency Vascular Disease Research Consortium Investigators, Rochester, Minn; Lebanon, NH; Washington, D.C.; Norfolk, Va; Malmö, Sweden; Boston, Mass; and Palo Alto, Calif

ABSTRACT

Objective: Retrograde open mesenteric stenting (ROMS) through laparotomy was introduced as an alternative to surgical bypass in patients with acute mesenteric ischemia (AMI). The purpose of this study was to evaluate the indications and outcomes of ROMS for treatment of AMI and chronic mesenteric ischemia.

Methods: We reviewed the clinical data and outcomes of all consecutive patients treated by ROMS in seven academic centers from 2001 to 2013. ROMS was performed through laparotomy with retrograde access into the target mesenteric artery and stent placement using a retrograde or antegrade approach. End points were early (<30 days) and late mortality, morbidity, patency rates, and freedom from symptom recurrence and reintervention.

Results: There were 54 patients, 13 male and 41 female, with a mean age of 72 ± 11 years. Indications for ROMS were AMI in 44 patients (81%) and subacute-on-chronic mesenteric ischemia with flush mesenteric occlusion in 10 patients (19%). A total of 56 target mesenteric vessels were stented, including 52 superior mesenteric arteries and 4 celiac axis lesions, with a mean treatment length of 42 ± 26 mm. Retrograde mesenteric access was used in all patients, but 16 patients also required a simultaneous antegrade brachial approach. The retrograde puncture was closed primarily in 34 patients and with patch angioplasty in 17 patients; 1 patient had manual compression. Bowel resection was needed in 29 patients (66%) with AMI because of perforation or gangrene. Technical success was achieved in all (98%) except one patient for whom ROMS failed, who was treated by bypass. Early mortality was 45% (20/44) for AMI and 10% (1/10) for subacute-on-chronic mesenteric ischemia ($P = .04$). Early morbidity was 73% for AMI and 50% for subacute-on-chronic mesenteric ischemia ($P = .27$). Patient survival for the entire cohort was $43\% \pm 9\%$ at 2 years. Primary patency and secondary patency at 2 years were $76\% \pm 8\%$ and $90\% \pm 8\%$, respectively. Freedom from symptom recurrence and freedom from reinterventions were $72\% \pm 8\%$ and $74\% \pm 8\%$ at the same interval.

Conclusions: ROMS offers an alternative to bypass or percutaneous stenting in patients with AMI who require abdominal exploration and in those who have flush mesenteric occlusions and have failed to respond to or are considered unsuitable for stenting by a percutaneous approach. Despite high technical success, mortality remains elevated in patients with AMI. Patency rates and freedom from symptom recurrence and reinterventions are comparable to the results achieved with stenting using percutaneous technique. (J Vasc Surg 2018;■:1-11.)

Treatment of mesenteric artery disease has evolved. Significant developments in diagnostic imaging, surgical and endovascular techniques, and medical therapy have resulted in increasing recognition and improved outcomes. The management of acute mesenteric ischemia (AMI) remains challenging because of delay in diagnosis,

which results in advanced bowel gangrene and high rates of morbidity and mortality.¹ Embolism of cardiac origin as a cause of acute ischemia has declined because of widespread treatment of cardiac arrhythmias and ischemic cardiomyopathy with anticoagulant therapy. Conversely, in situ thrombosis of chronic mesenteric

From the Advanced Endovascular Aortic Research Program, Division of Vascular and Endovascular Surgery, Mayo Clinic, Rochester^a; the Section of Vascular Surgery, Dartmouth-Hitchcock Medical Center, Lebanon^b; the Department of Vascular Surgery, MedStar Health, Washington, D.C.^c; the Division of Vascular Surgery, Eastern Virginia Medical School, Norfolk^d; the Department of Thoracic Surgery and Vascular Disease, Vascular Centre, Skane University Hospital, Malmö^e; the Division of Vascular and Endovascular Surgery, Department of Surgery, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston^f; and the Division of Vascular Surgery, Stanford University Medical Center, Palo Alto.^g

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Additional material for this article may be found online at www.jvascsurg.org. Correspondence: Gustavo S. Oderich, MD, Gonda Vascular Center, Mayo Clinic, 200 First St SW, Rochester, MN 55905 (e-mail: oderich.gustavo@mayo.edu).

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lesions has become the most frequent cause of AMI in contemporary series, affecting >50% of patients.^{2,3} Treatment goals in patients with acute in situ mesenteric thrombosis are control of peritoneal contamination, resection of necrotic bowel, mesenteric revascularization, and restoration of bowel continuity if needed.

Endovascular therapy has gained widespread applicability in the treatment of mesenteric lesions, and technologic improvements, such as embolic protection devices, smaller profile stents, and thrombolytic therapy, have allowed safer treatment of acute lesions. In patients with acute ischemia, catheterization of flush occlusions can be difficult or time-consuming. The term *retrograde open mesenteric stenting* (ROMS) was coined to describe hybrid mesenteric revascularization using midline laparotomy to directly expose the mesenteric artery for retrograde endovascular access. The purpose of this study was to evaluate the indications and outcomes of ROMS for treatment of mesenteric artery disease in a multicenter experience.

METHODS

The study was approved by the Institutional Review Board of each participating center. All patients consented for participation in the research study. The clinical data and outcomes of all consecutive patients treated by ROMS from 2001 to 2013 were retrospectively reviewed using a standardized database. ROMS was indicated selectively at the discretion of the treating physician in patients with AMI who needed a laparotomy for treatment of perforated or gangrenous bowel and in those who were considered not suitable for percutaneous stenting because of flush mesenteric occlusions. Diagnosis of mesenteric ischemia was based on clinical presentation and physical examination with supporting imaging consistent with severe mesenteric artery occlusive disease. Subacute-on-chronic mesenteric ischemia was defined as deterioration of symptoms of chronic mesenteric ischemia (CMI) during a 2- to 4-week period.

Demographics, clinical characteristics, and radiologic and procedural data were obtained from medical records. The early postprocedure period was defined as occurring within the first 30 days postoperatively or within the hospital stay if it was longer than 30 days. Late follow-up was obtained from medical records and correspondence with the patient or referral physician. Technical success was defined by the ability to complete ROMS using either retrograde or antegrade access to the mesenteric artery with successful stent placement and <30% residual stenosis on completion angiography. Primary patency was defined as uninterrupted patency with no additional procedures needed.^{4,5} Primary assisted patency was defined as revision of the revascularization method to prevent impending occlusion or progression of stenosis.^{4,5} Secondary patency was

ARTICLE HIGHLIGHTS

- **Type of Research:** Retrospective, multicenter, cohort study
- **Take Home Message:** Retrograde open mesenteric stenting through laparotomy for acute and chronic mesenteric ischemia in 54 patients resulted in 98% technical success, early mortality rates of 45% (acute mesenteric ischemia) and 10% (chronic mesenteric ischemia), 2-year primary patency of 76%, and freedom from symptom recurrence and reintervention in 72%.
- **Recommendation:** This study suggests that retrograde open mesenteric stenting is an appropriate alternative for patients with mesenteric ischemia requiring a laparotomy.

defined as restored patency after occlusion by thrombectomy, thrombolysis, or transluminal angioplasty or stenosis or occlusion treated by open surgical reconstruction.^{4,5} Clinical success was defined as relief or improvement of presenting symptoms. Recommended follow-up consisted of clinical examination and duplex ultrasound every 6 months during the first year and annually thereafter.

Technique. The technique of ROMS has been reported elsewhere.⁶ ROMS was performed under general endotracheal anesthesia using midline laparotomy. Abdominal exploration was carried out to evaluate gangrenous or perforated bowel and other potential causes of acute abdominal pain. Frank gangrene or perforation was treated expeditiously by stapled resection of the gangrenous bowel to control contamination. Ischemic bowel with borderline findings indicating potential viability was not resected and was reassessed after revascularization. If there was frank gangrene, the mesenteric vessels in the adjacent mesentery were ligated or stapled before restoration of blood flow.

The superior mesenteric artery (SMA) was the main target vessel treated by ROMS (Fig 1). Exposure was facilitated by cranial retraction of the transverse mesocolon and exposure of the root of the mesentery, which was reflected to the right side of the abdomen. The SMA was directly palpated for calcifications or was evaluated by hand-held Doppler flowmeter. The mesentery was opened longitudinally on top of the SMA up to the inferior edge of the transverse mesocolon with careful attention to avoid injury to the pancreas. The SMA and multiple jejunal branches were dissected free and controlled with Silastic vessel loops. After intravenous administration of heparin (60-80 units/kg), the SMA was accessed in a retrograde fashion using a 0.018-inch micropuncture kit, which was exchanged for a 0.035-inch guidewire and a 6F or 7F sheath. Limited retrograde

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