



Results of retrograde open mesenteric stenting for acute thrombotic mesenteric ischemia

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Abstract

Objective

Acute mesenteric ischemia (AMI) is an emergent event with a high mortality rate; survivors have high rates of intestinal failure. Restoration of blood flow using endovascular or surgical revascularization is associated with better outcome in terms of survival rate and intestinal resection. Retrograde open mesenteric stenting (ROMS), which is a hybrid technique, combines two benefits: prompt blood flow restoration with an endovascular approach and inspection and resection of the small bowel. The aim of the study was to assess the results of ROMS in thrombotic AMI in a retrospective multicenter study.

Methods

We retrospectively enrolled all consecutive patients who underwent ROMS revascularization for occlusive thrombotic AMI in three participating tertiary care centers between November 2012 and March 2017.

Results

Twenty-five patients (14 men and 11 women; mean age, 64.9 ± 11.6 years) were included. In two patients, ROMS was not possible because of failure of re-entry in the aortic lumen (technical success, 92%). One patient required revascularization of two visceral arteries and underwent an aortohepatic bypass. Five patients (20%) underwent endarterectomy and patch angioplasty of the superior mesenteric artery before retrograde stenting. Thirteen patients (52%) required bowel or colon resection (11 patients required both resections) during the initial procedure with a mean length of small bowel resection of 52 ± 87 cm. The 30-day operative mortality rate was 25%, and the overall 1-year survival rate was 65%. The 1-year primary patency rate was 92%. In one patient, postoperative imaging at 1 month showed stent migration in the aortic bifurcation.

Conclusions

ROMS for thrombotic AMI has a high technical success rate and a high midterm primary patency rate. It could be an alternative procedure to retrograde superior mesenteric artery bypass for patients when percutaneous endovascular revascularization is not indicated or has failed.

Keywords: Acute mesenteric ischemia; Superior mesenteric artery; Retrograde open mesenteric stenting

Article Highlights

- **Type of Research:** Multicenter retrospective cohort study
- **Take Home MessageKey Findings:** Retrograde open mesenteric stenting in 25 patients with acute mesenteric ischemia who were not candidates for percutaneous stenting resulted in a 30-day operative mortality of 25%, primary 1-year stent patency of 92%, and overall survival at 1 year of 65%.
- **RecommendationTake Home Message:** This study suggests that retrograde open mesenteric stenting is a reasonable procedure for selected patients with acute mesenteric ischemia not amenable to percutaneous stenting.

Acute mesenteric ischemia (AMI) is an emergent event with a high mortality rate; survivors have high rates of intestinal failure secondary to short bowel syndrome requiring parenteral nutrition.¹⁻³ Restoration of blood flow using endovascular or surgical revascularization is associated with better outcome in terms of survival rate and intestinal resection.⁴⁻⁷

During the last decade, percutaneous endovascular revascularization (PER) for AMI has increased significantly and is currently considered the first option with acceptable outcomes for acute thrombotic mesenteric ischemia.^{8,9} Moreover, PER could be used as a bridge to an open revascularization under better clinical conditions. Unfortunately, PER of the superior mesenteric artery (SMA) is sometimes unattainable because of extensive atherosclerosis of the aortic wall and origin of the SMA.⁷ Furthermore, in most cases of AMI, intestinal inspection and resection of nonviable bowel are required through laparotomy. Thus, retrograde open mesenteric stenting (ROMS), which is a hybrid technique, combines the benefits of both techniques: prompt blood flow restoration with an endovascular approach and inspection and resection of the small bowel. This technique was first described in 2004 by Milner et al,¹⁰ but to date only one series has included >10 cases.⁷

The aim of this study was to assess the results of ROMS in occlusive AMI in a retrospective multicenter study.

Methods

Study design and inclusion criteria

We retrospectively enrolled all consecutive patients who underwent ROMS revascularization for occlusive AMI in three participating tertiary care centers between November 2012 and March 2017. In the absence of specific biomarkers, AMI was defined, as previously described, by the presence of an intestinal ischemic injury related to at least significant stenosis or occlusion of the SMA confirmed on a contrast-enhanced computed tomography (CT) scan.^{5,6} ROMS was performed in three circumstances of AMI: with significant stenosis or occlusion of the SMA deemed unsuitable for PER; with failure of PER; and for patients requiring emergent abdominal exploration.

The study protocol was in accordance with good clinical practice according to the 1975 Declaration of Helsinki guidelines. Authorization from the Institutional Review Board of all centers was obtained before the study start. Informed consent of the patients was obtained for the study.

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. Histologic confirmation of acute

ischemic damage was obtained from all resected small bowel specimens. The 1-year survival, 30-day mortality, postoperative morbidity rate, length of intestinal resection, and 1-year primary patency rate were analyzed.

ROMS technique

ROMS was performed through a midline laparotomy. The SMA was exposed and controlled inferior to the transverse colon mesentery, and the patient was fully heparinized (50 units/kg). When required, an endarterectomy with patch angioplasty of the SMA using the saphenous vein was performed before retrograde stenting. Otherwise, the SMA was punctured distal to the occlusion, a short 0.035-inch wire was introduced, and a 6F or 7F sheath was placed in a retrograde fashion. Hand-injected retrograde lateral angiography was performed, and a 0.035-inch guidewire was used to cross the lesion (the type of guidewire and catheter depended on the center's practices). A 6-mm or 7-mm stent was placed retrograde in the SMA origin. The type of stent depended on the center. The proximal stent edge was intended to protrude into the aortic lumen. When required, the stent was extended distally with a self-expandable stent. Completion angiography was performed to assess inflow before sheath removal and closure of the SMA with Prolene 6-0. A re-entry catheter system was not used in this series.

Postoperative course and follow-up

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 performed and patients received parenteral nutrition until surgical rehabilitation.

Revascularization patency was assessed with mesenteric artery duplex ultrasound or CT scan at 1 month and 6 months postoperatively and yearly thereafter. All patients received at least an antiplatelet treatment.

Statistical analysis

Values were expressed as mean (\pm standard deviation) for continuous variables and as percentage for categorical variables. Data were obtained at the final follow-up visit for surviving patients. Overall survival (time from admission in ourthe tertiary care center until death, regardless of cause) and primary patency rate were estimated by the Kaplan-Meier method. All analyses were performed using R version 3.2.1 (R Foundation for Statistical Computing, Vienna, Austria).

Results

During the study period, 25 patients (14 men and 11 women; mean age, 64.9 \pm 11.6 years) were included. Relevant demographic characteristics and comorbid medical conditions are summarized in [Table I](#). In all patients, ROMS was the initial treatment. At initial admission, 22 patients (88%) presented with abdominal pain. The three remaining patients were diagnosed under mechanical ventilation in the intensive care unit on the CT scan. Other common symptoms on presentation included vomiting or nausea (28%) and diarrhea (16%). Frequent laboratory findings included leukocytosis (mean, 15,719 \pm 9490 \times 10⁶/L) and an elevated lactate level (mean, 3.1 \pm 2.9 mmol/L; [Table I](#)). All patients had a preoperative CT scan. Significant splanchnic-mesenteric artery stenosis or occlusion concerned three vessels, two vessels, or a single vessel in 28%, 28%, and 44%, respectively.

Table I Demographic data and preoperative characteristics of the patients

Characteristics	Patients (N = 25)
Age, years	64.9 \pm 11.6
Male	14 (56)
Comorbidity	
Hypertension	22 (88)
Smoking	15 (60)
Diabetes mellitus	10 (40)
Dyslipidemia	19 (76)
Coronary artery disease	13 (52)
Atrial fibrillation	7 (28)
Peripheral artery disease	15 (60)
Renal insufficiency with dialysis	3 (12)

Hypercoagulable disorder	3 (12)
ASA score	3 ± 0.45
Clinical presentation	
Abdominal pain	22 (88)
Emesis or nausea	7 (28)
Diarrhea	4 (16)
Peritonitis signs	11 (44)
Laboratory values at presentation	
White blood cell count, ×10 ⁶ /L	15,719 ± 9490
Creatinine concentration, μmol/L	127 ± 107
Lactate concentration, mmol/L	3.1 ± 2.9
Hepatic cytolysis	5 (20)
Metabolic acidosis	10 (40)
Preoperative imaging	
Signs of intestinal ischemic injury	18 (72)
Infrarenal aorta or iliac artery disease	15 (60)

ASA, American Society of Anesthesiologists.

Categorical variables are presented as number (%). Continuous variables are presented as mean ± standard deviation.

ROMS was indicated as the first treatment option for 23 patients (92%) and for recurrent SMA stenosis or occlusion after PER in 2two patients; of these 2two patients, one patient required emergent intestinal resection through laparotomy and the second patient showed a worsening of the SMA disease deemed unsuitable for a second PER attempt. In 23 patients (92%), the SMA was the only vessel treated. One patient underwent an aortohepatic bypass with an autogenous vein during the same procedure as ROMS because of the poor quality of the SMA and its branch outflow after revascularization despite ROMS patency. A second patient required an angioplasty stenting of the celiac artery because of persistent hepatic insufficiency and gastric ischemia despite ROMS patency. In two patients, ROMS was chosen as the first treatment option but was not possible because of failure of re-entry in the aortic lumen. These two patients underwent retrograde mesenteric bypass with favorable outcome but were not included in the analysis. Therefore, technical success was achieved in 25 of 27 patients (92%).

Three patients (12%) received more than one stent in the SMA, one patient because of a distal dissection of the SMA and two patients to enhance the congruence of the stent in the SMA curvature because of stent kinking during the initial procedure. The type and characteristics of stents used in all patients with successful ROMS are summarized in Table II. Five patients (20%) underwent endarterectomy and patch angioplasty of the SMA before retrograde stenting (Fig 1).

Table II Vascular and intestinal technical characteristics	
Characteristics	Patients (N = 25)
Type of stent	
Covered stent	18 (67)
Bare-metal stent	4 (15)
Nitinol stent	5 (18)
Length of stent, mm	36.5 ± 13.3
Stent diameter, mm	6.7 ± 0.6

Patch angioplasty	10 (40)
Endarterectomy	5 (20)
Additional vascular procedure	1 (4)
Intestinal resection	13 (52)
Length of bowel, cm	52 ± 87
Colon	6 (24)
Second look	9 (36)

Categorical variables are presented as number (%). Continuous variables are presented as mean ± standard deviation.



Fig 1 **A**, Sagittal view of preoperative computed tomography (CT) scan showing a total occlusion of the superior mesenteric artery (SMA). **B**, Sagittal view of postoperative CT scan after revascularization combining endarterectomy with patch angioplasty and the retrograde open mesenteric stentin (ROMS) technique.

Thirteen patients (52%) required bowel or colon resection (11 patients required both resections) during the initial procedure with a mean length of small bowel resection of 52 ± 87 cm. When required, the two stages of the operation (vascular and intestinal) were performed in the same way: revascularization of the SMA and intestinal resection. In nine patients, a second-look laparotomy was needed, and six patients required additional bowel resection. Among these six patients, two patients did not undergo intestinal resection during the initial intervention. The rate of weaning from parenteral nutrition was 56%. The rate of intestinal continuity restoration was 27.3% with an average time of 3.9 ± 1.6 months. The mean length of intensive care unit stay was 13 ± 25 days.

The mean follow-up time was 10 ± 11 months. The 30-day operative mortality rate was 25%, the overall 1-year survival rate was 65%, and the 1-year reintervention-free survival (including all types of interventions related to ROMS) was 58% (Fig 2). Causes of death are summarized in Table III. The 1-year primary patency rate of the SMA was 92%. In one patient, postoperative imaging at 6 months showed an intrastent occlusion. As the patient was asymptomatic, a wait-and-see management was chosen, without adverse events. No causes of stent thrombosis were identified. In a second patient, postoperative imaging at 1 month showed stent migration in the aortic bifurcation. The SMA was patent with no significant stenosis. This patient underwent an additional procedure to squeeze the stent against the aortic wall using the kissing stent technique. This patient remained asymptomatic, and a wait-and-see management plan was chosen.

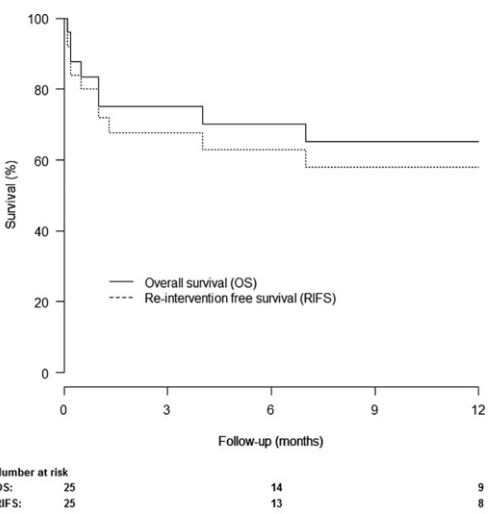


Fig 2 Overall survival (OS) and reintervention-free survival (RIFS) rates in patients undergoing retrograde open mesenteric stenting (ROMS) for acute mesenteric ischemia (AMI) using Kaplan-Meier analysis.

Table III Postoperative outcomes and mortality rates	
Results	Patients (N = 25)
Follow-up, months, mean ± SD	10 ± 11
Length of stay in ICU, days, mean ± SD	13 ± 25
Restoration of intestinal continuity	5 (42.38%)
Parenteral nutrition weaning	14 (56%)
1-Year primary patency rate	94.2%
30-Day survival rate	75.1%
1-Year survival rate	65.1%
Cause of in-hospital death	
Multiorgan failure	3
Septic shock	1
Hemorrhagic shock	1
Pneumonia	1
Acute ischemic stroke	1

ICU, Intensive care unit; SD, standard deviation.

Discussion

To our knowledge, this report is the largest series about ROMS reported in the literature to date. The literature about ROMS is rare, and series including more than five patients for AMI are summarized in [Table IV](#). In our series, the 1-year primary patency rate was 94.2%. Blauw et al⁷ reported a primary patency rate of 83%, a primary assisted patency rate of 91%, and a secondary patency rate of 100% [at 12 months](#). In the series comparing endovascular and open surgery for AMI, the primary patency rate of PER remains

under-reported.¹⁴ In their study, Blauw et al reported the use of a short 6- or 7-mm balloon-expandable stent (Express; Boston Scientific, Marlborough, Mass) to perform ROMS. In our series, most of the ROMS techniques were performed using a balloon-expandable covered stent (67%; Atrium Advanta V12 [Maquet, Orléans, France] or Lifestream [Bard, Karlsruhe, Germany]). This practice relies partly on the study reported by Oderich et al¹⁵ comparing covered stents and bare-metal stents for the treatment of chronic atherosclerotic mesenteric arterial disease. In this nonrandomized study, covered stents were associated with higher freedom from restenosis and better primary patency rate at 3 years compared with bare-metal stents (92% vs 53% and 92% vs 52%, respectively). In this study, one patient showed a stent migration on the 1-month postoperative CT scan. This patient had undergone an endarterectomy with patch angioplasty, and a 6-mm balloon-expandable stent had been used. This stent was probably undersized compared with the enlargement of the artery secondary to the angioplasty. Furthermore, this technical complication might also be explained by the initial experience of the surgeons and the quality imaging in the sagittal view with the classic fluoroscopic C-arm unit, particularly in obese patients. With common use of the new-generation flat-panel detector and wide emergence of the hybrid operating room, this complication should be avoided.

Table IV Review of the English-language literature for retrograde open mesenteric stenting (ROMS) including more than five patients in the setting of acute occlusive mesenteric ischemia

Authors	Year	No. of patients	Primary patency	Mortality	Follow-up, months
Wyers et al ¹¹	2007	6	50%	4 patients	13 ± 7
Pisimisis et al ¹²	2011	7	—	—	—
Blauw et al ⁷	2014	15	83%	20%	12
Chen et al ¹³	2015	6	100%	17%	12
Present series	2017	25	91%	35%	10 ± 11

ROMS was first reported in 2004 by Milner et al,¹⁰ who described the technique in a patient with bowel ischemia. Since then, few studies about ROMS with more than six patients have been reported in the setting of AMI. Wyers et al¹¹ reported the use of the ROMS technique in six patients because of previously failed PER. After a mean follow-up period of 13 months, the mortality and patency rates were both 50%. Moyes et al¹⁶ reported a series of four cases of ROMS in patients with AMI with an in-hospital mortality rate of 25%. The first significant series was reported by Blauw et al,⁷ which included 15 patients undergoing ROMS for AMI. Among them, 11 patients were directly treated with ROMS as the first treatment and **4**four patients after a failed PER. The 30-day mortality and primary patency rates were 20% and 92%, respectively. At 12 months, the mortality rate was still 20% and the primary patency rate was 83%. In our series of 25 patients, the 30-day mortality rate was 25%. At 12 months, the mortality rate was 35% and the primary patency rate was **9****4**2%. The higher mortality rate in our series might be explained by a larger number of patients requiring intestinal resection (52% vs 20% in the series of Blauw et al) and a more severe clinical condition of the patients.

During the last decade, PER has become the first treatment in the setting of AMI, and recent reports demonstrated a decreased mortality rate for patients undergoing PER compared with open surgery. In a recent meta-analysis assessing the best revascularization strategy for acute occlusive arterial mesenteric ischemia, Salsano et al¹⁷ reported a reduced risk of in-hospital mortality for patients treated with PER and also a benefit impact on risk of bowel resection and second-look laparotomy. Nevertheless, PER is not possible in nearly 20% of patients with AMI because of extensive aortic wall and SMA origin atherosclerosis.⁷ Furthermore, in most cases of AMI, intestinal inspection and resection of nonviable bowel are required through laparotomy. Under these circumstances, ROMS might be a useful technique that allows prompt blood flow restoration with an endovascular approach and inspection and resection of nonviable small bowel.

This technique has several benefits. It avoids vascular reconstruction and use of a prosthetic graft under septic circumstances. In this series, most procedures (67%) were performed using a covered stent even in the setting of a contaminated field or peritonitis without graft infection during follow-up. Moreover, no stent infections have been reported in the literature of ROMS technique. It prevents distal embolization in comparison with PER. This technique can also benefit patients presenting with bowel necrosis and with no available autogenous conduit or patent donor vessel to perform a retrograde bypass. Moreover, the ROMS technique avoids the risk of autogenous or allogeneic graft kink during retrograde bypass revascularization. Finally, the ROMS technique may also be a useful technique in the setting of other clinical or surgical situations, such as symptomatic dissection of the SMA described by Mitsuoka et al,¹⁸ or if the SMA ostium is covered during placement of a fenestrated stent graft as reported by Sonesson et al.¹⁹

This study has a number of important limitations. First, just a small number of patients is included, given the relatively infrequent occurrence of AMI. Second, the ROMS technique and particularly the surgical practices are heterogeneous according to the center and the type of stent used for revascularization. Thus, no guidelines or advice concerning the type of stent that should be used for ROMS can be asserted. A randomized trial for the type of stent would be required but challenging, given the relatively infrequent occurrence and acute presentation of AMI.

Conclusions

The ROMS technique could be an alternative procedure to retrograde SMA bypass in the setting of acute thrombotic mesenteric ischemia for patients deemed unsuitable for PER or in cases of PER failure. This technique should be part of the multimodal management and treatment of AMI, which remains a devastating event.

Author contributions

Conception and design: AR, OGB, PL, MC, YC

Analysis and interpretation: AR, QP, OC, YC

Data collection: AR, NDS, RC, TB

Writing the article: AR, YC

Critical revision of the article: NDS, RC, QP, TB, OGB, OC, PL, MC

Final approval of the article: AR, NDS, RC, QP, TB, OGB, OC, PL, MC, YC

Statistical analysis: AR

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Overall responsibility: AR

References

1. M.L. Schermerhorn, K.A. Giles, A.D. Hamdan, M.C. Wyers and F.B. Pomposelli, Mesenteric revascularization: management and outcomes in the United States, 1998-2006, *J Vasc Surg* **50**, 2009, 341–348.
2. W.B. Newton, 3rd, M.J. Sagransky, J.S. Andrews, K.J. Hansen, M.A. Corriere, P.P. Goodney, et al., Outcomes of revascularized acute mesenteric ischemia in the American College of Surgeons National Surgical Quality Improvement Program database, *Ann Surg* **77**, 2011, 832–838.
3. M.H. Eslami, D. Rybin, G. Doros, J.T. McPhee and A. Farber, Mortality of acute mesenteric ischemia remains unchanged despite significant increase in utilization of endovascular techniques, *Vascular* **24**, 2016, 44–52.
4. P. Kougias, D. Lau, H.F. El Sayed, W. Zhou, T.T. Huynh and P.H. Lin, Determinants of mortality and treatment outcome following surgical interventions for acute mesenteric ischemia, *J Vasc Surg* **46**, 2007, 467–474.
5. O. Corcos, Y. Castier, A. Sibert, S. Gaujoux, M. Ronot, F. Joly, et al., Effects of a multimodal management strategy for acute mesenteric ischemia on survival and intestinal failure, *Clin Gastroenterol Hepatol* **11**, 2013, 158–165.e2.
6. A. Roussel, Y. Castier, A. Nuzzo, Q. Oellenc, A. Sibert, Y. Panis, et al., Revascularization of acute mesenteric ischemia after creation of a dedicated multidisciplinary center, *J Vasc Surg* **62**, 2015, 1251–1256.
7. J.T. Blauw, R. Meerwaldt, M. Brusse-Keizer, J.J. Kolkman, D. Gerrits and R.H. Geelkerken, Multidisciplinary Study Group of Mesenteric Ischemia, Retrograde open mesenteric stenting for acute mesenteric ischemia, *J Vasc Surg* **60**, 2014, 726–734.
8. Z.M. Arthurs, J. Titus, M. Bannazadeh, M.J. Eagleton, S. Srivastava, T.P. Sarac, et al., A comparison of endovascular revascularization with traditional therapy for the treatment of acute mesenteric ischemia, *J Vasc Surg* **53**, 2011, 698–705.
9. R.J. Beaulieu, D. Arnaoutakis, C.J. Abularrage, D.T. Efron, E. Schneider and J.H. Black, Comparison of open and endovascular treatment of acute mesenteric ischemia, *J Vasc Surg* **59**, 2014, 159–164.
10. R. Milner, E.Y. Woo and J.P. Carpenter, Superior mesenteric artery angioplasty and stenting via a retrograde approach in a patient with bowel ischemia—a case report, *Vasc Endovascular Surg* **38**, 2004, 89–91.
11. M.C. Wyers, R.J. Powell, B.W. Nolan and J.L. Cronenwett, Retrograde mesenteric stenting during laparotomy for acute occlusive mesenteric ischemia, *J Vasc Surg* **45**, 2007, 269–275.
12. G.T. Pisimisis and G.S. Oderich, Technique of hybrid retrograde superior mesenteric artery stent placement for acute-on-chronic mesenteric ischemia, *Ann Vasc Surg* **25**, 2011, e7–e11.
13. Y. Chen, J. Zhu, Z. Ma, X. Dai, H. Fan, Z. Feng, et al., Hybrid technique to treat superior mesenteric artery occlusion in patients with acute mesenteric ischemia, *Exp Ther Med* **9**, 2015, 2359–2363.
14. T.A. Block, S. Acosta and M. Björck, Endovascular and open surgery for acute occlusion of the superior mesenteric artery, *J Vasc Surg* **52**, 2010, 959–966.
15. G.S. Oderich, L.S. Erdoes, C. Lesar, B.C. Mendes, P. Gloviczki, S. Cha, et al., Comparison of covered stents versus bare metal stents for treatment of chronic atherosclerotic mesenteric arterial disease, *J Vasc Surg* **58**, 2013, 1316–1323.
16. L.H. Moyes, D.H. McCarter, D.G. Vass and D.J. Orr, Intraoperative retrograde mesenteric angioplasty for acute occlusive mesenteric ischemia: a case series, *Eur J Vasc Endovasc Surg* **36**, 2008, 203–206.
17. G. Salsano, A. Salsano, E. Sportelli, F. Petrocelli, M. Dahmane, G. Spinella, et al., What is the best revascularization strategy for acute occlusive arterial mesenteric ischemia: systematic review and meta-analysis, *Cardiovasc Intervent Radiol* **41**, 2018, 27–36.

18. H. Mitsuoka, M. Nakai, Y. Terai, S. Gotou, Y. Miyano, K. Tsuchiya, et al., Retrograde stent placement for symptomatic spontaneous isolated dissection of the superior mesenteric artery, *Ann Vasc Surg* **35**, 2016, e17–e21.

19. B. Sonesson, R.J. Hinchliffe, N.V. Dias, T.A. Resch, M. Malina and K. Ivancev, Hybrid recanalization of superior mesenteric artery occlusion in acute mesenteric ischemia, *J Endovasc Ther* **15**, 2008, 129–132.

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Answer: Yes

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Query: The references should be sequentially cited in the text, hence references have been renumbered both in the text and in the reference list (including with tables). Please check, and correct if necessary.

Answer: Ok

Query: Please check the 1-year primary patency rate as reported variously in the text and in Table III as 91% and 92%.

Answer: Ok, 1-primary patency rate is 92%

Query: Please check the rate of intestinal continuity restoration in the text [27%] vs Table III [47%]. Should it be 20% [5/25]?

Answer: 5 patients underwent an intestinal continuity restoration among 13 patients who had a stoma after bowel and/or colon resection : 5/13 = 38%

Query: Please check "The 1-year primary patency rate of the SMA was 92%" in the text vs 91% in Table III.

Answer: Ok

Query: Please check "1-year primary patency rate was 91%."

Answer: Ok

Query: Please check: primary patency rate was 91%

Answer: ok

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