Patient survival after open and endovascular mesenteric revascularization for chronic mesenteric ischemia

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Abstract

Objective—To evaluate long-term patient survival and causes of death after open (OR) or endovascular (ER) mesenteric revascularization for atherosclerotic chronic mesenteric ischemia using propensity score-matched comparison and clinical risk stratification.

Methods—The clinical data of 343 patients treated with mesenteric revascularization for chronic mesenteric ischemia between 1991 and 2010 were retrospectively reviewed. Clinical, anatomical, and procedure-related variables were analyzed using a multivariate model to identify independent predictors of any-cause early and late (>30 days) mortality. Cause of death was retrieved from review of the National Death Index. Patient survival was analyzed using Society for Vascular Surgery (SVS) comorbidity scores and propensity score-matched comparison based on independent predictors of any-cause mortality.

Results—There were 187 patients treated by OR and 156 patients treated by ER. Early procedure-related mortality was 2.6% (9/343), including five OR (2.7%) and four ER (2.6%) patients. Median follow-up was 96 ± 54 months (range, 1-168 months). There were 144 late deaths, most commonly from cardiac causes in 35% (51/144), followed by cancer in 15% (21/144), pulmonary complications in 13% (19/144), and mesenteric ischemia in 11% (16/144). A further 21 patients died from various identifiable causes, and 14 patients (10%) died of unknown causes. Overall, 25 patients (7.3%) died of mesenteric-related causes, including nine early and 16 late deaths (OR, 10/187; 8.0%, and ER, 6/156; 6.4%). Multivariate analysis identified age >80,

diabetes, chronic kidney disease (CKD) stage IV or V, and home oxygen therapy as independent predictors ($P < .05$) of any cause of death. Diabetes and CKD stage IV or V were independently associated with mesenteric-related death ($P < .05$). Late patient survival at 5 years in the OR and ER groups was 75% ± 4% and 60% ± 9% for low SVS risk (<9), 52% ± 8% and 43% ± 9% for intermediate SVS risk (9-16), and 67% ± 15% and 30% ± 8% for high SVS risk (>16). Using propensity matched scores, 5-year survival was nearly identical for patients treated by OR (60%) or ER (57%; $P = .7$).

Conclusions—Long-term patient survival after mesenteric revascularization was not influenced by type of arterial reconstruction. Age >80 years, diabetes, CKD stage IV or V, and home oxygen were independent predictors of any-cause mortality. Diabetes and CKD stage IV or V were independently associated with mesenteric-related death.

Mesenteric artery stenting has surpassed open surgery as the most commonly used treatment for patients with atherosclerotic chronic mesenteric ischemia (CMI), relegating open surgical bypass to patients in whom mesenteric artery stenting fails or who have lesions unsuitable to stenting. Based on the best available evidence, endovascular revascularization (ER) has reduced early mortality and morbidity compared with open revascularization (OR), but it is associated with higher rates of restenosis and reintervention.[1]

Poor prognostic indicators for long-term patient survival after mesenteric revascularization include advanced age and presence of severe cardiac, pulmonary, or renal disease.[2] The type of revascularization has not been shown to affect survival, but comparative analysis is limited by selection bias favoring OR for good-risk patients and ER for higher-risk patients. It is possible that survival may be affected by type of reconstruction, given that recurrent mesenteric ischemia and reinterventions are potentially associated with morbidity and mortality. The aim of this study was to evaluate long-term patient survival and causes of death in a large cohort of patients with CMI treated with OR or ER using standardized clinical scores and a propensity score-matched comparison.

METHODS

The study was approved by the institutional review board of the Mayo Clinic. The clinical, anatomical, and procedural data on all consecutive patients treated for atherosclerotic CMI with OR or ER between 1991 and 2010 were retrospectively reviewed. The diagnosis of CMI was made in patients with classic symptoms (abdominal pain, postprandial pain, weight loss, "food fear") for >2 weeks and angiographic evidence of high-grade stenosis or occlusion of at least one mesenteric artery. Patients with acute or acute-on-chronic mesenteric ischemia, asymptomatic lesions, vasculitis, median arcuate ligament syndrome, or other nonatherosclerotic etiologies were excluded from the study.

Demographics, clinical characteristics, radiologic data, and operative data were obtained from the medical records. Operative risk was assessed using Society for Vascular Surgery (SVS) comorbidity scores.[3] Early postprocedure period was defined as occurring within the first 30 days or within hospital stay if >30 days. Late follow-up period was defined as after 30 days or dismissal from the hospital until the last available clinical examination or correspondence. Follow-up consisted of clinical examination and duplex ultrasound every 6 months during the first year and annually thereafter. Late follow-up data were obtained from review of medical records, correspondence with patient or referral physician, phone interview, or questionnaire. The cause of death was retrieved by review of medical records or autopsy reports. The Minnesota and Olmsted County death certificate database and the National Death Index (Government account, Y11-0053) were consulted in all cases of deaths to retrieve the specific cause of death, providing an accurate account of the date and cause of death.

Statistical analysis and propensity score matching system

Data were analyzed using the SVS reporting standards.[3] Patients were divided in three risk categories using the interquartile SVS sum score for age, cardiac, pulmonary, renal, and hypertension categories (score 0-30). Clinical risk stratification included low (score 0-8), intermediate (score 9-16), and high (score 17-30) risk. The primary end point was patient survival at 5 years. Patient survival was compared with the expected survival of age-matched and gender-matched controls from the general population of Olmstead County using the Olmstead Epidemiology Project database. The secondary end point was freedom from mesenteric-related death. A multivariate Cox proportional hazard model was used to identify independent predictors of any-cause early and late mortality. Patient survival after OR or ER was compared in both groups using propensity matched scores for all patients and according to SVS risk stratification. Pearson χ^2 or Fisher exact test was used for analysis of categorical variables. Differences between means were tested with two-sided t-test, Wilcoxon rank-sum test, or Mann-Whitney test. All analyses were conducted by a statistician at the Department of Statistics using SAS software version 9.2 (SAS Institute Inc, Cary, NC). Two-sided $P < .05$ was used to determine statistical significance.

RESULTS

Patient population

During the study period, 343 patients with CMI were treated, including 256 women (75%) and 87 men (25%), with mean age of 68 ± 13 years. Patients treated with OR had higher rates of cigarette smoking (79% vs 57%) but lower rates of coronary artery disease (37% vs 64%), previous myocardial infarction (19% vs 36%), chronic obstructive pulmonary disease (19% vs 30%), chronic kidney disease stage (CKD) IV or V (14% vs 25%), and congestive heart failure (7% vs 19%) compared with patients treated with ER (Table I). There were more low-risk patients (67% vs 38%; $P = .003$) in the OR group and more intermediate-risk (28% vs 36%; $P = .3$) and high-risk (5% vs 26%; $P < .001$) patients in the ER group. Only nine OR patients (5%) met high-risk criteria using SVS scores. The use of statins (44% vs 31%), acetylsalicylic acid (80% vs 51%), clopidogrel (60% vs 12%), and β-blockers (43% vs 36%) was higher among ER patients compared with OR patients ($P < .05$).

There was a shift from OR to ER after 2002 (Fig 1). An OR procedure was performed in 187 patients; 327 vessels were reconstructed (182 superior mesenteric artery, 135 celiac axis, and 10 inferior mesenteric artery) with antegrade bypasses in 156 patients (83%) and retrograde bypasses in 31 patients (17%) (Table II). In 156 patients and 173 vessels (116 superior mesenteric artery, 52 celiac axis, and five inferior mesenteric artery), ER was performed, including angioplasty and stenting in 128 patients and 138 vessels (80%) and primary angioplasty alone in 28 patients and 35 vessels (20%) (Table III).

Mesenteric-related mortality

Nine (2.6%) early procedure-related deaths occurred, including five after OR (2.7%) and four (2.6%) after ER ($P = 1.0$). Causes of death after OR were myocardial infarction in two patients, mesenteric ischemia in two, and respiratory failure in one. In the ER group, two patients died of complications of distal embolization causing bowel ischemia and multi-system organ failure, and two patients died of myocardial infarction.

The median follow-up among 334 patients who survived the initial revascularization was 96 ± 54 months (range, 1-168 months). Follow-up was significantly longer after OR (131 ± 43 months; range, 1-168 months) compared with ER (64 ± 54 months; range, 1-105 months). Reinterventions for recurrent symptoms or a high-grade restenosis were needed in 24 patients (14%) treated with OR and in 30 patients (21%) who had ER ($P = .6$). Two patients

died as a result of complications of reintervention, one in each group (OR, 1/24; 4.2%, and ER, 1/30; 3.3%; P = .87). Overall, 10 OR patients (5.8%) and six ER patients (4.1%) died of late mesenteric-related causes after 30 days or dismissal, including two patients who had complications of reintervention and 14 patients who died of acute mesenteric ischemia according to review of death certificates or autopsy reports. For the entire cohort, the combined rate of early and late mesenteric-related death was 8% for patients treated with OR (15/187) and 6.4% for patients treated with ER (10/156).

Any-cause mortality

There were 144 late deaths, 90 in the OR group and 54 in the ER group, including the 16 patients who died from late mesenteric-related causes. The cause of death was retrieved in 130 patients using medical records in 68 and review of death certificates in 62. The most common causes of late death (Table IV) in the OR and ER groups were cardiac events in 36 (21%) and 15 (10%) patients (P = .04), followed by cancer in 13 (7.5%) and eight (5.5%) patients (P = .5), respiratory complications in 12 (7%) and seven (5%) patients (P = .5), and mesenteric-related complications in 10 (5.8%) and six (4.1%) patients (P = .5). The cause of death remained unknown in 10 (6%) patients treated with OR and in four (3%) patients treated with ER (P = .2).

Patient survival

The overall 5-year patient survival was 69% ± 4% in the OR group and 44% ± 5% in the ER group (P < .001) (Fig. 2). Patient survival was significantly less in both groups compared with the expected survival for age-matched and gender-matched control patients from the state of Minnesota. For the entire cohort, 5-year survival was 71% ± 4% for low-risk, 49% ± 6% for intermediate-risk, and 38% ± 7% for high-risk patients (P < .001) (Fig. 3). Among OR and ER groups, 5-year survival was 75% ± 4% and 60% ± 9% for low-risk patients (P = .02), 52% ± 8% and 43% ± 9% for intermediate-risk patients (P = .7), and 67% ± 15% and 30% ± 8% for high-risk patients (P = .01) (Fig 4). The rate of 5-year freedom from mesenteric-related death was 91% ± 2% after OR and 93% ± 4% after ER (P = 1.0) (Fig 5).

Propensity score-matched comparison

The multivariate regression model identified age >80 years (odds ratio, 3.3; confidence interval [CI], 1.03-1.06; P .001), CKD stage IV or V (odds ratio, 5.5; CI, 1.4-16.6; P < .01), diabetes (odds ratio, 1.7; CI, 1.2-2.6; P < .01), and home oxygen therapy (odds ratio, 3.7; CI, 1.2-9.1; P < .001) as independent predictors of any-cause mortality (Table V). CKD stage IV or V (odds ratio, 3.4; CI, 3.3-345; P = .003) and diabetes (odds ratio, 4.2; CI, 1.7-10.5; P = .005) were independently associated with mesenteric-related death (Table VI). Using these independent predictors and baseline demographics, propensity score matching analysis was obtained in 254 patients (80%) from the entire cohort, including 127 patients treated with OR and 127 patients treated with ER. There were 63 patients (20%), including 45 in the OR group and 18 in the ER group, excluded from the propensity score analysis because of inability to find a paired match. The 5-year patient survival using propensity score-matched comparison was 60% for patients treated with OR and 57% for patients treated with ER (P = .7).

DISCUSSION

Patients with CMI are often of advanced age and have a high prevalence of cardiovascular risk factors and atherosclerosis affecting other vascular beds. The choice of treatment is based on patient comorbidities, physician preference, and experience at the institution. A common criticism of prior reports addressing mesenteric revascularization is the lack of risk-stratified analysis; this introduces selection bias given that open repair is preferred in

lower-risk patients and endovascular therapy is selected in higher-risk patients.[4-11] Using propensity score-matched comparisons, this study showed that long-term patient survival was not affected by the type of reconstruction.

Despite reports of higher rates of reinterventions for symptom recurrence in patients treated with ER, this study showed similar rates of reinterventions (21% vs 14%) and of late mesenteric-related deaths (4.1% vs 5.8%) between patients treated with ER and patients treated with OR; overall, mesenteric-related death was the fourth most frequent cause of death, accounting for 10% of all late deaths after cardiac, cancer, and pulmonary causes. Late cardiac death was more common in the OR group, which is intriguing given that these patients had lower rates of cardiovascular risk factors. It is likely that improvements in medical therapy during the last decade (ie, statins, antiplatelet therapy, and β-blockers) accounted for lower rates of cardiovascular events in the ER group. Death from complications of reintervention occurred in two patients, one from each group; both patients presented with acute mesenteric ischemia because of graft or stent thrombosis. There were no deaths among patients who underwent reintervention for chronic symptoms. A further 14 patients died of acute mesenteric ischemia, a diagnosis that was obtained from review of death certificates or autopsy reports. A novel finding reported in this study is that acute mesenteric ischemia after mesenteric revascularizations accounts for 6% to 8% of all late deaths; therefore, continued patient surveillance is important to diagnose and treat graft or stent restenosis that could result in life-threatening acute mesenteric thrombosis.

Independent predictors of mesenteric-related death were advanced CKD (stage IV or V) and diabetes. In more recent studies,[12,13] a decreased preoperative estimated glomerular filtration rate was found to be the best independent predictor of early and late death after other types of arterial reconstructions, including aortic and cardiac procedures. Many causes have been ascribed, including more advanced disease affecting smaller side branches and severe calcification, which potentially render the results of operation less durable and more prone to late recurrent ischemia from a scarce collateral network and poor mesenteric reserve.

Most late deaths were not the result of complications of mesenteric ischemia but instead were associated with other pre-existing clinical factors, more frequently cardiac and pulmonary diseases. Independent predictors of any-cause mortality were age >80 years, CKD stage IV or V, home oxygen therapy, and diabetes. The causes of late death have been poorly described in prior reports addressing CMI. In this study, all available death certificates were reviewed allowing an accurate description of the cause of death. The three most common causes of late death were cardiac, cancer and pulmonary in both groups, which is consistent with other reports of patients treated for vascular disease in other territories.[14,15]

The use of clinical risk stratification is important for analysis of outcomes after mesenteric revascularization. In our report, patient survival at 5 years was significantly higher in the OR group (69% vs 44%), which reflects selection bias with a greater number of higher risk patients in the ER group. To analyze patient survival according to clinical risk, we used the SVS comorbidity grading scores, but we acknowledge that this score system has not been validated in a prospective study of patients treated for CMI. Nevertheless, there was excellent correlation between survival and clinical risk: 71% ± 4% for low risk, 49% ± 6% for intermediate risk, and 38% ± 7% for high risk in both groups. In addition, survival was similar for each risk category when we compared patients treated with OR and ER, although there were not enough high-risk patients treated with OR to allow meaningful comparison.

Given that late patient survival is not influenced by type of reconstruction, treatment selection should be based on other factors that may affect durability of the procedure, such as anatomic characteristics of the lesion. Oderich et al[16] reported that rates of restenosis are higher among patients treated for heavily calcified or long (>30 mm) lesions, particularly long occlusions. In these patients or in patients who fail endovascular therapy, open mesenteric reconstruction should be considered. Our current approach has been to offer ER to patients with anatomically suitable lesions, including patients with short ostial stenosis with mild-to-moderate calcifications.

This study is novel because it is the first to provide a comprehensive analysis of causes of death and late patient survival using propensity matched scores among patients treated for CMI. A careful review of death certificates and autopsy reports was also performed to improve accuracy when describing causes of late death. The large number of patients included in the cohort allowed us to use multivariate models to identify independent predictors of death with strong statistical power. However, there are several shortcomings that need to be discussed. Because of the retrospective design, we were unable to identify specific factors that may affect choice of therapy, specific technique, and device. Using the propensity score methodology, we were unable to identify a match for each patient; to allow a fair comparison between the open surgical and endovascular groups, a greater number of good-risk patients in the open surgical group was excluded to match the higher-risk endovascular patients. During the long study period, which spanned 2 decades, there has been significant progress in medical therapy, surgical techniques, and endovascular technology, which may have affected outcomes. Important improvements in medical therapy are difficult to analyze using a retrospective database and may have contributed to differences in cause of death between the two groups, including the higher rate of cardiac deaths in the OR group, predominantly treated in the 1990s. Finally, the follow-up period was longer among patients treated by open surgical repair, which may have affected rates of reinterventions and mesenteric-related deaths between patients treated by open and endovascular procedures.

CONCLUSIONS

Mesenteric-related mortality and any-cause mortality were not influenced by type of mesenteric revascularization. Long-term patient survival is nearly identical among patients treated by OR and ER techniques when matched for independent predictors of death using a propensity score-matched comparison.

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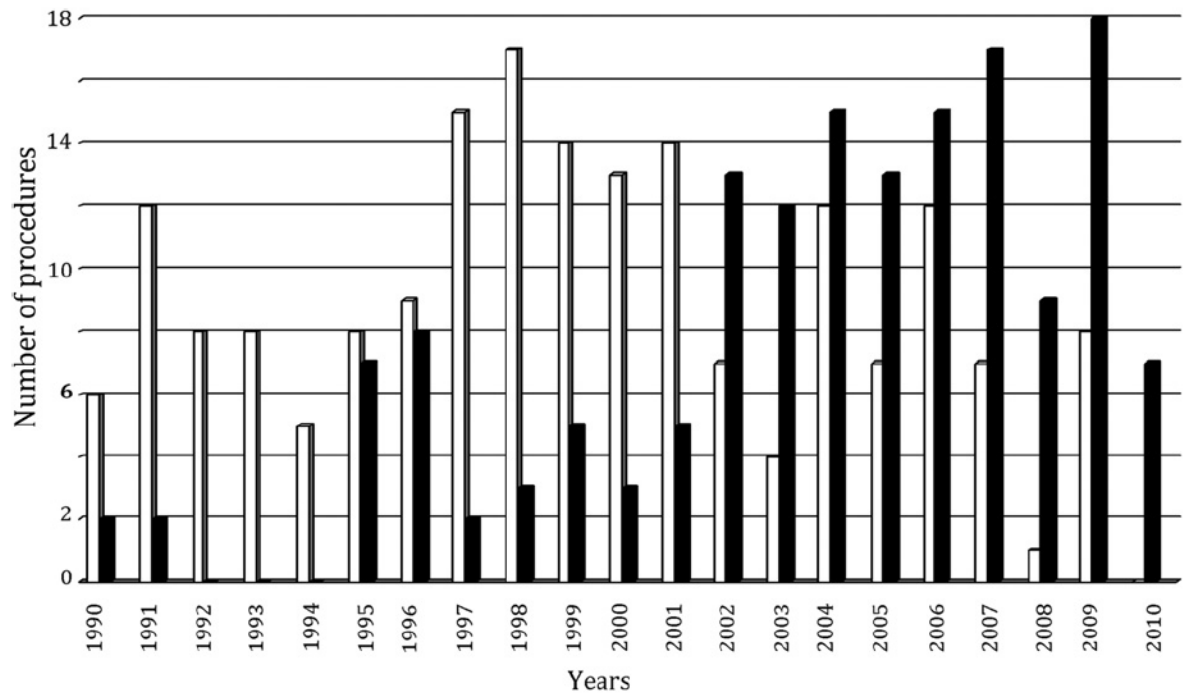
Fig 1.
Distribution of patients treated with open surgical (*open bars*) or endovascular (*solid bars*) mesenteric revascularization between 1991 and 2010.
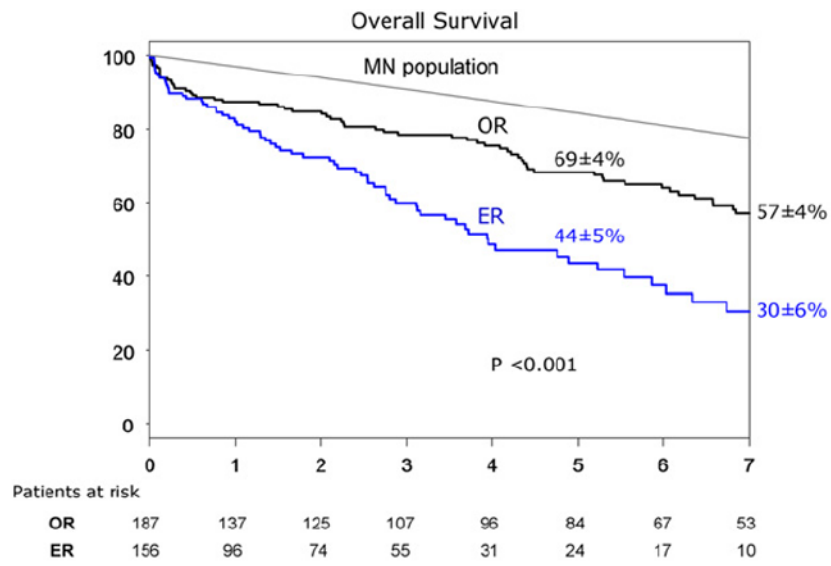
Fig 2.
Kaplan-Meier 5-year survival curve of 343 patients with chronic mesenteric ischemia treated with open (*OR*) or endovascular (*ER*) revascularizations. *MN*, Minnesota.
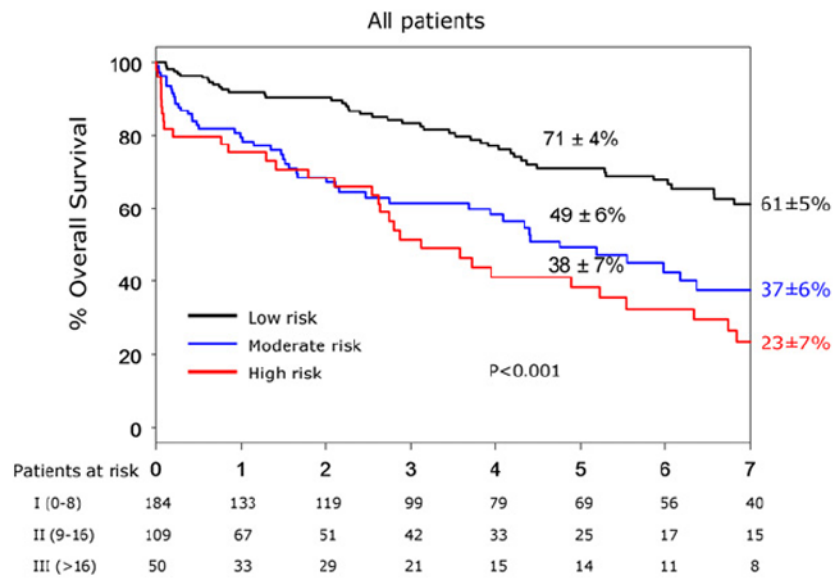
Fig 3.
Kaplan-Meier 5-year survival curve of 343 patients with chronic mesenteric ischemia treated with open (OR) or endovascular (ER) revascularizations and divided into low, moderate, and high clinical risks.

Fig 4.
A, Kaplan-Meier 5-year survival curve of 187 patients with chronic mesenteric ischemia treated with open revascularizations (ORs) and divided into low, moderate, and high clinical risks. **B**, Kaplan-Meier 5-year survival curve of 156 patients with chronic mesenteric ischemia treated with endovascular revascularizations (ERs) and divided into low, moderate, and high clinical risks.

Freedom from mesenteric related death

Fig 5.
Kaplan-Meier curve depicting 5-year survival free from mesenteric-related deaths in patients with chronic mesenteric ischemia treated with open (*OR*) vs endovascular (*ER*) revascularizations.

Table I

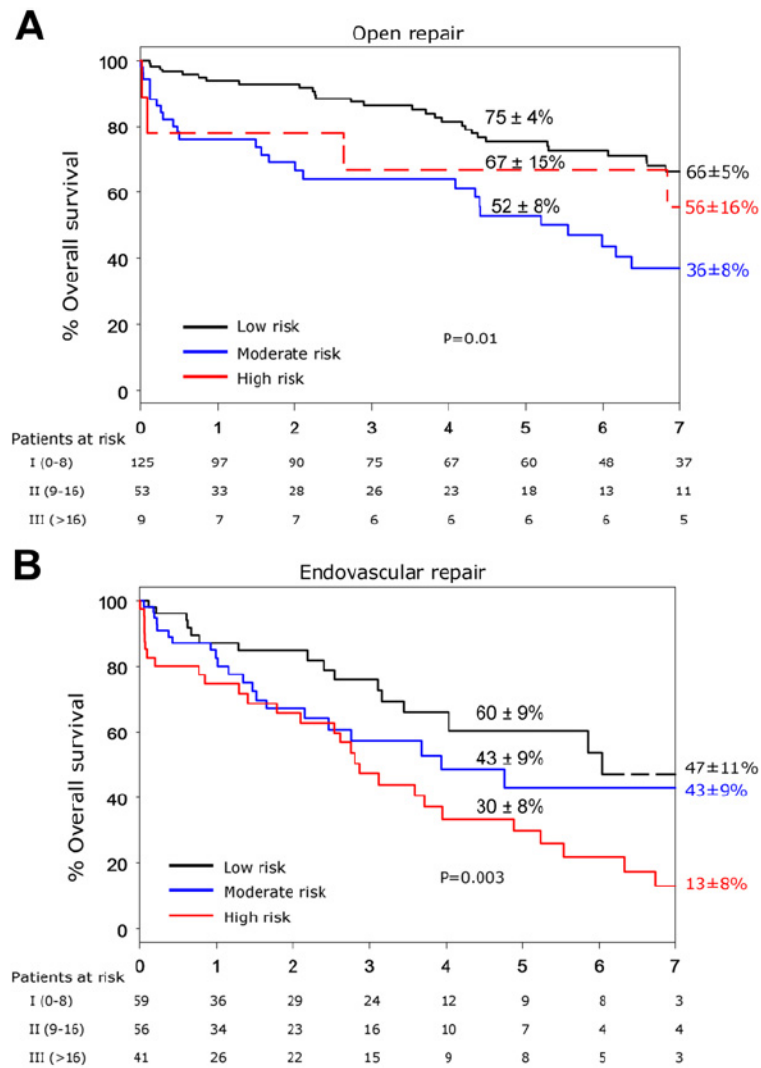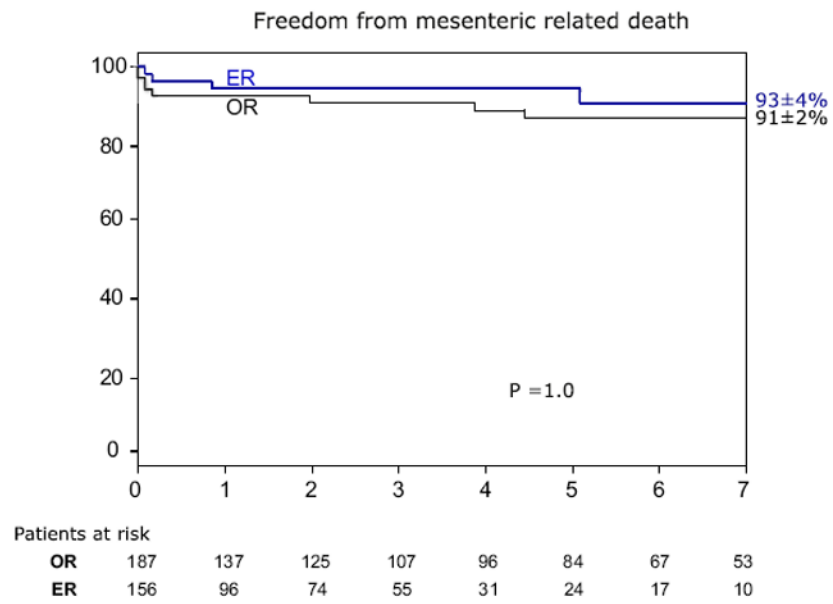Demographics, clinical characteristics, and cardiovascular risk factors of 343 patients with chronic mesenteric ischemia treated with ORs or ERs

	All patients, N = 343, %	OR		ER		P
		n = 187	%	n = 156	%	
Demographics						
Age (mean ± SD)	68 ± 13	65 ± 12		72 ± 12		.01
Female gender	256 (75)	143	77	113	72	.7
Clinical presentation						
Abdominal pain	324 (94)	177	95	147	94	.9
Weight loss	285 (83)	159	85	126	80	.7
Food fear	179 (52)	97	52	82	52	1.0
Nausea/vomiting	91 (26)	50	27	41	26	.9
Cardiovascular risk factors						
Hypertension	271 (79)	137	73	134	85	.3
Smoking	237 (69)	148	79	89	57	.05
Hyperlipidemia	195 (57)	92	49	103	66	.1
Coronary artery disease	170 (49)	70	37	100	64	.004
Peripheral arterial disease	140 (41)	73	39	67	43	.7
Prior vascular surgery	91 (26)	46	25	45	29	.9
Prior myocardial infarction	93 (27)	37	19	56	36	.01
COPD	82 (24)	35	19	47	30	.05
Chronic renal insufficiency	66 (19)	27	14	39	25	.04
Diabetes	66 (19)	30	16	36	23	.2
Arrhythmia	65 (19)	30	16	35	22	.2
Valve disease	51 (15)	22	12	29	18	.1
Congestive heart failure	43 (12)	13	7	30	19	.002
Society for Vascular Surgery (mean ± SD)[a]						
Age	1.6 ± 0.9	1.2 ± 0.8		1.9 ± 0.9		<.001
Hypertension	1.2 ± 0.9	1.0 ± 0.8		1.5 ± 0.9		<.001
Cardiac (×4)	3.6 ± 4.0	2.7 ± 3.5		4.5 ± 4.5		<.001
Pulmonary (×2)	0.8 ± 1.7	0.7 ± 1.4		1.0 ± 1.9		.06

	All patients, N = 343, %	OR		ER		P
		n = 187	%	n = 156	%	
Renal (×2)	0.5 ± 1.1	0.4 ± 0.9		0.6 ± 1.3		<.001
Sum	9.0 ± 7.0	6.5 ± 5.4		9.7 ± 6.0		<.001
Clinical risk categories						
Low risk	185	125	67	59	38	.003
Moderate risk	109	53	28	56	36	.3
High risk	50	9	5	41	26	<.001
Medical therapy						
1991-1999[b]						
Acetylsalicylic acid	66 (19)	43	42	23	72	0.1
Clopidogrel	8 (2)	4	4	4	12	0.2
β-blockers	27 (8)	23	23	4	12	0.3
Statins	23 (7)	21	21	2	6	0.2
2000-2010[c]						
Acetylsalicylic acid	155 (45)	53	62	102	82	0.2
Clopidogrel	119 (35)	18	21	101	81	<0.001
β-blockers	114 (33)	44	52	70	56	0.8
Statins	105 (31)	38	45	67	54	0.5

COPD, Chronic obstructive pulmonary disease; *ER*, endovascular revascularization; *OR*, open revascularization; *SD*, standard deviation.

Clinical risk was estimated by using the Society for Vascular Surgery comorbidity score based on the presence of one or more comorbidities (ie, cardiac, pulmonary, and renal). This grading score has not been validated in a prospective study of patients with chronic mesenteric ischemia.

[a] Based on the Society for Vascular Surgery comorbidity score risk statistic[3]

[b] n = 102 OR patients; n = 32 ER patients.

[c] n = 85 OR patients; n = 124 ER patients.

Table II

Operative characteristics of 187 patients with chronic mesenteric ischemia treated with OR

Operative characteristics	No. of patients/vessels (187/327)	%
Extension of disease		
Single-vessel disease	11	6
Two-vessel disease	103	55
Three-vessel disease	73	39
Target vessel[a]		
Celiac artery	135	41
SMA	182	56
IMA	10	3
Single-vessel revascularization	52	28
Two-vessel revascularization	133	71
Three-vessel revascularization	3	1
Mean number of vessels	1.75 ± 0.5	
Technical data		
Bypass	177	94
Bifurcated graft	136	72
Single graft	41	22
Endarterectomy/patch angioplasty	9	5
Endarterectomy/transposition	1	1
Configuration		
Antegrade	156	83
Retrograde	31	17

IMA, Inferior mesenteric artery; *OR*, open revascularization; *SMA*, superior mesenteric artery.

[a]Denominator is the total number of vessels treated (174 for endovascular and 327 for open repairs).

Table III

Operative characteristics of 156 patients with chronic mesenteric ischemia treated with ER

Operative characteristics	No. of patients/vessels (156/173)	%
Target vessel[a]		
Length, mean	15 ± 4.4	
Diameter, mean	5.8 ± 0.8	
SMA	116	67
Celiac artery	52	30
IMA	5	3
One vessel treated	125	72
Two vessels treated	24	28
Mean number of vessels	1.1 ± 0.6	
Technical data		
PTA/stent	128/138	80
PTA alone	28/35	20
Stent/balloon diameter, mm	5.8 ± 0.6	
Stent/balloon length, mm	20.8 ± 8	
Embolic protection device	14	9
Femoral approach	106	68
Brachial approach	50	33
Large profile (0.035-inch)	81	52
Small profile (0.018-inch)	75	48
Residual stenosis		
Absent	132	85
<30%	16	10
>30%	8	5

ER, Endovascular revascularization; *IMA*, inferior mesenteric artery; *PTA*, percutaneous transluminal angioplasty; *SMA*, superior mesenteric artery.

[a]Denominator is the number of vessels (n = 173).

Table IV

Early and late mortality in 343 patients with chronic mesenteric ischemia treated with OR or ER

Outcomes	OR		ER		P
	n = 187	%	n = 156	%	
Early					
Death	5	2.7	4	2.6	1.0[a]
Cause of death					
Myocardial infarction	2	1	2	1.3	1.0[a]
Mesenteric ischemia	2	1	2	1.3	1.0[a]
Respiratory failure	1	0.6	0	0	1.0[a]
Late[b]					
Mean follow-up, months	131 ± 43		64 ± 54		
Any cause of death	90	52	54	37	.09
Causes of death					
Cardiac	36	21	15	10	.04
Malignancy	13	7.5	8	5.5	.5
Pulmonary	12	7	7	5	.5
Mesenteric ischemia	9	5	5	3.5	.5
Neurologic	3	2	5	3.5	.5[a]
Sepsis	3	2	2	1.5	1.0[a]
Natural	1	0.5	3	2	.2[a]
Gastrointestinal bleeding	0	0	3	2	.1[a]
Renal	1	0.5	1	0.5	1.0[a]
Reintervention-related death	1	0.5	1	0.7	1.0[a]
Trauma	1	0.5	0	0	1.0[a]
Unknown	10	6	4	3	.2

ER, Endovascular revascularization; OR, open revascularization.

[a]
Fisher exact test used.

[b]
Late surveillance included 172 patients in the OR group and 145 patients in the ER group.

Table V

Univariate and multivariate analysis for any cause of death in 343 patients with chronic mesenteric ischemia treated with OR or ER

Any cause of death	HR	95% CI	P
Univariate analysis			
Age	1.1	1.02-1.05	<.001
Diabetes	1.7	1.1-2.5	<.001
Coronary artery disease	2.4	1.6-3.7	<.001
Congestive heart failure	2.6	1.6-4.0	<.001
Valve disease	1.8	1.1-2.8	.001
Chronic renal insufficiency	6.2	1.9-19.9	<.001
COPD	2.1	1.4-3.1	<.001
Home oxygen therapy	6.5	2.8-15	<.001
Prior myocardial infarction <30 days	2.3	1.3-4.0	<.01
Prior CABG	2.5	1.5-4.1	<.001
Celiac revascularization	0.5	0.3-0.7	<.001
Multivariate analysis			
Age >80	3.3	1.03-1.06	<.001
Chronic renal insufficiency	5.5	1.4-16.6	<.01
Home oxygen therapy	3.7	1.2-9.1	<.001
Diabetes	1.7	1.2-2.6	<.01

CABG, Coronary artery bypass grafting; *CI*, Confidence interval; *COPD*, chronic obstructive pulmonary disease; *ER*, endovascular revascularization; *HR*, hazard ratio; *OR*, open revascularization.

Table VI

Univariate and multivariate analysis for mesenteric-related death in 343 patients with chronic mesenteric ischemia treated with OR or ER

Mesenteric-related death	*HR*	*95% CI*	**P**
Univariate analysis			
Chronic renal insufficiency	8.7	1.7-45	.009
Diabetes	3.3	1.3-8.6	.01
SVS sum score >16	4.2	1.1-15.5	.03
Valve disease	3.2	0.8-13	.1
Multivariate analysis			
Chronic renal insufficiency	3.4	3.3-345	.003
Diabetes	4.2	1.7-10.5	.005

CI, Confidence interval; *ER*, endovascular revascularization; *HR*, hazard ratio; *OR*, open revascularization; *SVS*, Society for Vascular Surgery.