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Which Treatment Should Be Chosen for Acute Arterial Mesenteric Ischemia? Surgery or Endovascular Intervention?

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Abstract

Objective: In this study, we aimed to compare the results of both open laparotomy and endovascular intervention in patients admitted to our clinic with the diagnosis of acute mesenteric ischemia.

Methods: Twelve patients who were treated with the diagnosis of acute mesenteric ischemia in our clinic between 2014 and 2020 were included in the study. Demographic data, clinical and radiological findings, open laparotomy, and endovascular intervention data of the patients were recorded.

Results: The mean age of patients who underwent endovascular intervention was 56, and the mean age of patients who underwent open laparotomy was 72.1. White blood cell, lactate, C-reactive protein, lactate dehydrogenase, and creatinine values were slightly higher in patients treated with open laparotomy than those treated with endovascular intervention. The time from symptom onset to intervention was 13.9 hours in the endovascular intervention group and 17.1 hours in the open laparotomy group. Of the 6 patients who underwent open laparotomy, only 2 patients underwent superior mesenteric artery embolectomy and the other 4 underwent embolectomy and bowel resection. One of the 12 patients who underwent open laparotomy died due to anastomotic leakage The survival rate of the patients was recorded as 91.6%.

Conclusion: Endovascular intervention is one of the first-choice methods with its minimally invasive feature in cases where intestinal necrosis has not yet developed. Open laparotomy is necessary for making a decision for resection because intestinal vitality can be seen. Making the right decision based on the patient's clinical, laboratory, and radiological findings will reduce morbidity and mortality in the patient.

Keywords: Acute arterial mesenteric ischemia, embolectomy, endovascular embolism aspiration

Acute mesenteric ischemia (AMI) is a life-threatening emergency caused by a sudden decrease in intestinal blood flow. It constitutes 0.09-0.2% of acute abdomen admissions to emergency departments.[1] The most common cause of AMI is acute superior mesenteric artery embolism (ASMAE) with a rate of 40-50%. It can also occur as a result of arterial thrombosis, mesenteric venous thrombosis, and non-occlusive causes. Diagnosis is often delayed due to non-specific clinical symptoms and laboratory findings.[2] If untreated or diagnosed at an advanced stage, it may result in intestinal necrosis and even death, with a mortality rate of 50-70%.[3] After the diagnosis is confirmed, a surgical operation is the most common treatment from past to present. Restoration of mesenteric circulation by removing the embolus and resection of the necrotic bowel are the components of the operation. In recent years, endovascular intervention, such as catheter thrombolysis, percutaneous aspiration embolectomy, and primary superior mesenteric artery stenting, has become an emerging and alternative treatment to surgery.[4,5] In our article, we aim to examine the clinical outcomes and diagnostic procedures of patients who presented with acute arterial mesenteric ischemia in the last 7 years and to compare the interventional approach with the surgery in the treatment of ASMAE.

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Methods

In our study, we retrospectively examined 43 patients from January 1, Cerrahpaşa Medical Faculty and diagnosed with AMI. Patients who developed AMI as a complication of other operations or interventions were excluded from the study. Clinical, radiologic, and surgical/endovascular intervention data were collected retrospectively from patients' medical records. Postoperative follow-up data were obtained from outpatient clinic records.

When acute mesenteric ischemia was suspected in the patient who applied to the emergency department, computed tomography angiography (CTA) was performed. CTA revealed segmental occlusion of the main trunk or the branches of the superior mesenteric artery (SMA). If there were signs of intestinal wall infarction such as abdominal free air, pneumatosis intestinalis, and portomesenteric venous gas in the CTA or there was a sign of peritonitis on physical examination, the endovascular intervention was not performed but surgical therapy was done. Endovascular revascularization was applied when there was evidence of acute occlusion of SMA in the CTA and there was no clinical or imaging finding of advanced bowel ischemia. In our study, 12 patients who underwent procedures for acute mesenteric arterial ischemia due to ASMAE were examined in detail (embolectomy in 6 patients and endovascular intervention in 6 patients). All patients wrote an informed consent form for surgery or endovascular intervention.

In open surgery, SMA is found by palpating at the root of the mesentery or by following the middle colic artery. Sharp dissection is performed to expose the artery from the surrounding tissue. Transverse arteriotomy is preferred. At the same time, heparin (5000 IU) was infused through the peripheral intravenous catheter. Embolectomy was performed using No. 2 or 3 Fogarty balloon catheter.

In endovascular intervention, mechanical aspiration of the embolus from the SMA was performed via femoral access. The SMA embolus was passed through a guidewire, and then, the blood clot was sucked by vacuum aspiration using a 6 French catheter (Figure 1). Recombinant tissue plasminogen activator was used in patients undergoing thrombolysis.

Results

Demographic features and laboratory findings in ASMAE patients undergoing open surgery and endovascular intervention are listed in Tables 1 and 2. The mean age of the patients who underwent endovascular intervention and open surgery was 56 and 72.1, respectively. All patients presented to the hospital with abdominal pain. This symptom was followed by nausea (33%), vomiting (25%), and diarrhea (16%). The most common comorbidities in patients were atrial fibrillation (AF), coronary heart disease (CAD), and hypertension (HT). While the white blood cell (WBC) value was above the maximum in all patients who underwent open surgery, this rate was 50% for patients who underwent endovascular intervention. Besides, the mean value of some laboratory values in patients who underwent open surgery was slightly higher than those who underwent endovascular intervention (lactate: 3.98-1.6; CRP: 86.5-76.6; LDH: 482-177; creatinine: 1.13-0.87).

Locations and treatments and outcomes of ASMAE patients undergoing open surgery and endovascular intervention are listed in Tables 3 and 4. The median duration of symptoms from onset to angiography was 13.9 hours (range, 9-20) while the time for surgery was 17.1 hours. The in-hospital survival rate was 91.6% (11 of 12 patients; only 1 patient died because of sepsis related to anastomotic leak). Most of the emboli lodged 1.8 to 5 cm distal to the origin of the SMA except 1 that was 0.5 cm away and required massive bowel resection but died due to anastomotic leak.

Except for one patient, a second look was required in patients who underwent open surgery (83%). Diagnostic laparoscopy was required in only one of the patients who underwent endovascular intervention in whom bowel resection was not performed.

Discussion

Since SMA is separated from the abdominal aorta at an acute angle and has a great diameter, embolism to this artery occurs easily.[2] AF, valvular heart disease, coronary artery disease, bacterial endocarditis, and hypercoagulability are risk factors for the embolus in SMA. In these patients, the embolus originates from the left atrium. Also, atherosclerotic aorta can be a source of the embolus.[1] Rarely, SMA embolism secondary to cardiac sarcoma can be seen, as presented by Robinson et al.[4]

The most important thing in diagnosis is to suspect ASMAE for the patient who presented to the emergency department.

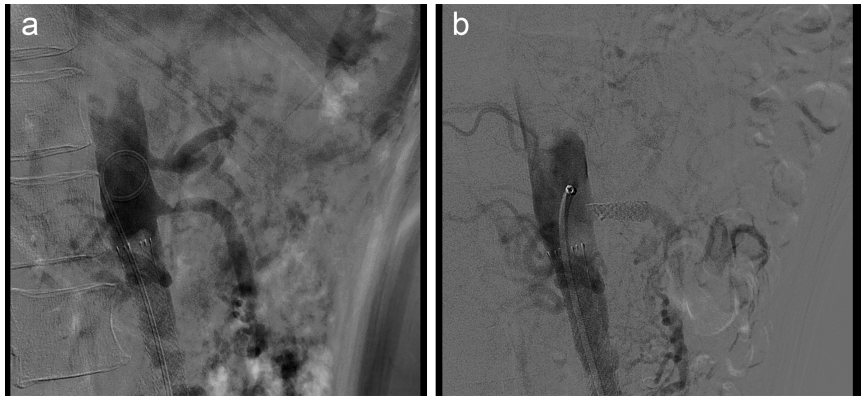

Figure 1. a, b. (a) Stent deployed in the superior mesenteric artery (SMA) in a 65-year-old man presented with acute abdominal pain. (b) Successful stenting of SMA was performed with the 0.018-inch wire.

Table 1. Demographic Features and Laboratory Findings in ASMAE Patients Undergoing Open Surgery

Age/Sex	Symptoms	Comorbidity	WBC	Crp	Lac	LDH (UI/L)	AST/ALT (UI/L)	Crea (mg/dL)
86/F	AP, N	AF, HT, CVD, CAD	16 300	151	2.8	739	106/34.1	1
63/M	AP, BD, V	HT, CAD	28 000	128	3.5	697	98/26.1	1.16
56/F	AP	AF, DM, HT, CAD	14 000	33	3.5	233	16/38	0.54
77/M	AP, N	AA, HT	18 500	89	3.4	344	76/44	0.9
84/F	AP	CAD, AF	12 800	105	4.5	460	88/124	1.8
67/F	AP, BD	HT, DM	34 000	13	6.2	419	47/38	1.4

ASMAE, acute superior mesenteric artery embolism; F, female; M, male; BMI, body mass index; AF, atrial fibrillation; HT, hypertension; CHD, coronary heart disease; AA, amyloidosis; DM, diabetes mellitus; CVD, cerebrovascular disease; AP, abdominal pain; V, vomiting; N, nausea; BD, bloody diarrhea; WBC, white blood cell.

Table 2. Demographic Features and Laboratory Findings in ASMAE Patients Undergoing Endovascular İntervention

Age/Sex	Symptom	Comorbidity	WBC	CRP	Lactate	LDH (UI/L)	AST/ALT (UI/L)	Creatinine (mg/dL)
48/F	Abdominal pain	AF	6300	19	1.2	172	18/30	1.03
66/F	AP, Vomiting	DM, AF	8100	36	0.9	104	14/11	0.78
56/F	AP	CAD	13 000	76	1.8	218	44/36	1.1
66/M	AP, Nausea	DM	11 700	69	1.9	178	10/9	1.08
52/F	AP, V	HL	6100	228	1.8	236	56/15	0.78
48/F	AP	AF	12 500	32	2	158	19/19	0.5

ASMAE, acute superior mesenteric artery embolism; F, female; M, male; AF, atrial fibrillation; HT, hypertension; CHD, coronary heart disease; DM, diabetes mellitus; HL, hyperlipidemia; WBC, white blood cell.

There must be a race against time to reduce the risks of intestinal necrosis and mortality. Ha et al[6] report that the time, until the ischemic bowel occurs, is 12 hours. However, in our study, there is a patient who recovered without bowel resection although 20 hours passed from the beginning of her symptoms to angiography. Patients present to the emergency service with persistent, non-localized, cramp-like abdominal pain. The pain may be with the symptoms of vomiting, diarrhea, fever, and rectal bleeding. In a retrospective study of 56 people, 95% of patients presenting with AMI had abdominal pain, 44% nausea, 35% vomiting, 35% diarrhea, and 16% rectal bleeding.[7] These rates were also close in our study. The pain then decreases dramatically. This is because pain receptors are affected due to insufficient perfusion in the intestinal wall.[2] Initially, the bowel sounds in patients are hyperactive. As the disease progresses, bowel sounds decrease and disappear and peritoneal irritation symptoms become more evident. Intestinal wall necrosis occurs, followed by bacterial translocation, which can lead to peritonitis, sepsis, and multiple organ failure. Incompatible physical examination despite severe symptoms, history of AF or organic heart disease, and gastric emptying disorder is known as the Bergan triad.[2]

Time to diagnosis and treatment, the location of embolus, age, and comorbidities of the patient are prognostic factors.[2,3] One of the patients included in the study died. The embolism localization in this patient was closer to the origin of SMA than in the others. The location of the emboli in our cases differs from other studies. Usually, the majority of emboli lodges 3 to 10 cm distal to the origin of the SMA, thus classically sparing the proximal jejunum and colon.[1]

Generally, patients with acute mesenteric ischemia have leukocytosis, metabolic acidosis, an elevated D-dimer, and serum lactate. Serum lactate is not specific for AMI and cannot detect early damage in the intestinal mucosa.[3] It may also be elevated in diseases such as gastric perforation, pancreatitis, or perforated appendicitis.[8] Besides, some studies have reported no L-lactate elevation despite diffuse intestinal ischemia. This is explained by the fact that the liver clears L-lactate from the portomesenteric circulation.[9] Nevertheless, the most commonly used diagnostic

Table 3. Locations and Treatments and Outcomes of ASMAE Patients Undergoing Open Surgery

No.	Location of Embolus	Symptom Duration From Onset to Surgery (hours)	Surgery Technique	Second Look/Bowel Resection	Total Surgery Time (minutes)	Hospital Stay (days)	30-Day Mortality	Follow-up (months)
1	2 cm beyond the origin	19	SMA embolectomy + bowel resection	None	145	15	Alive	3
2	1.8 cm beyond the origin	34	SMA embolectomy + bowel resection	Yes/none	140	8	Alive	9
3	2.5 cm beyond the origin	8	SMA embolectomy	Yes/yes	160	11	Alive	6
4	2.5 cm beyond the origin	14	SMA embolectomy	Yes/yes	90	7	Alive	6
5	2.5 cm beyond the origin	13	SMA embolectomy	Yes/yes	150	10	Alive	9
6	0.5 cm beyond the origin	15	SMA embolectomy	Yes/yes	210	38	Dead (anastomotic leak)	1

ASMAE, acute superior mesenteric artery embolism; SMA, superior mesenteric artery.

Table 4. Treatment Techniques and Outcomes in ASMAE Patients Undergoing Endovascular Intervention

No.	Procedure Time (minutes)	Treatment	Symptom Duration from Onset to Angiography (hours)	Location	Need for Surgery	Complication	30-Day Mortality
1	64	Aspiration	9	2 cm beyond the origin	None	None	Alive
2	85	PTA	15	1.5 cm beyond the origin	None	None	Alive
3	75	Aspiration + thrombolysis	14	5 cm beyond the origin	DL	Hemorrhage	Alive
4	80	PTA	16	1.8 cm beyond the origin	None	None	Alive
5	55	Aspiration	9.5	2 cm beyond the origin	None	Allergy	Alive
6	90	PTA	20	1.6 cm beyond the origin	None	None	Alive

ASMAE, acute superior mesenteric artery embolism; PTA, percutaneous transluminal angioplasty; DL, diagnostic laparoscopy.

laboratory parameter is lactate. D-dimer is another parameter used in the diagnosis of AMI. On the one hand, it was found in a study that D-dimer could not distinguish between acute and chronic mesenteric ischemia,[8] while on the other hand, there is a publication showing that D-dimer can be used as an exclusion test (none of the 35 tested AMI patients had a normal D-dimer).[10] Also, It has been reported that leukocytosis occurs in approximately 90% of AMI patients and there is an increase in amylase in nearly 50% of the patients.[1] In some cases, evidence of increased creatine kinase, aspartate aminotransferase, and dehydrogenase may be observed.[2] As a result, although all of these parameters can help to suspect for diagnosis, they are not clearly diagnostic. There are several promising parameters. These are fatty acid-binding protein (I-FABP), α-glutathione S-transferase (GST), D-lactate, and cobalt-albumin binding assay. I-FABP and GST are found in the small intestinal mucosa, while D-lactate is a natural degradation product of gut bacteria. When ischemia begins in the small intestinal mucosa, these markers may rise early in the bloodstream.[3] Also, in the case of ischemia, the binding effect of serum albumin and cobalt is reduced, so this may be a measure of acute ischemia.[9]

When AMI is suspected, computed tomographic angiography (CTA) should be performed immediately as soon as possible. While in the past, the gold standard for the diagnosis of ASMAE, recommended by the American Gastroenterological Association (2000), was mesenteric angiography.[11] According to the American College of Radiology Eligibility Criteria, computed tomographic angiography (CTA) is the first-line diagnostic method for mesenteric ischemia.[12] The widespread use of CTA, its sensitivity of 96% and specificity of 94% for the diagnosis of ASMAE, and the fact that angiography is an invasive and time-consuming method made CTA to be used more frequently for diagnosis.[8,12] CTA is recommended even in the presence of renal failure because delaying AMI diagnosis will cause greater damage to the kidney than the contrast agent would do.[1] In CTA, embolic occlusion often appears as an oval-shaped clot surrounded by contrast in a middle and distal segment of the SMA.[13] In CTA imaging of intestinal ischemia, findings such as hypoenhancement of the intestinal wall, intestinal wall thickening, intestinal wall dilatation, and mesenteric edema are seen. Pneumatosis intestinalis, portomesenteric venous gas, and even free intraperitoneal air are also important for signs of advanced intestinal ischemia.[12]

First of all, intestinal revascularization should be done in AMI treatment.[3] If there are clinical or CT findings for intestinal necrosis, surgery should be planned urgently. However, if there is no clear evidence of intestinal necrosis, endovascular therapy is an alternative therapy.[5] There is an ongoing debate as to whether the first treatment for AMI should be open surgery or endovascular revascularization in the absence of evidence of bowel necrosis.

Embolectomy and primary or patch angioplasty are known surgical treatments for SMA embolus.[1] Besides, if there is intestinal necrosis, resection is applied in the surgical approach. On the other hand, endovascular intervention includes percutaneous mechanical aspiration, thrombolysis, and percutaneous transluminal angioplasty.[1]

Emergency laparoscopy is a discipline that combines the difficult cases of emergency surgery with the advantages of minimally invasive surgical techniques such as faster recovery time, shorter hospital stay, less postoperative pain, and cosmetic benefits.[14,15] Diagnostic laparoscopy can be used in cases with suspected acute mesenteric ischemia.[16] In cases where SMA revascularization or restoration is performed, planned second-look laparoscopy is required to evaluate intestinal viability.[1,16] Findings in the first surgery stand out in deciding the necessity of second-look laparoscopy.[17]

Why Should Open Surgery Be Performed as The First Treatment for ASMAE?

(1) This allows to visually analyze intestinal viability*:*

(a) It may be misleading to decide according to physical examination in elderly patients or patients taking pain medication to say that there is no bowel ischemia or necrosis.[18]

(b) The rate of radiology showing necrosis or ischemic bowel is not very high. Bani Hani et al.[19] reported that only 34% of patients with bowel ischemia or necrosis had pneumatosis or portal venous gas and also that 42% of these patients had signs of peritoneal irritation on physical examination.

(2) Variability of treatment depending on the doctor is minimal.[18]

(3) There is no significant difference in mortality between the endovascular approach and open surgery. Acosta et al[20] reported that the 30-day mortality rate was similar after open vs. endovascular intervention for embolic occlusions (37% vs. 33%).[20]

(4) There are complications such as vascular dissection and distal embolism in the endovascular approach.[18]

(5) There is no significant difference between the endovascular approach and open surgery in revascularization of SMA.

Block et al[10] reported revascularization as 86% (96 of 111) after open surgery and revascularization as 79% (33 of 42) after endovascular intervention in their patients between 1999 and 2006.

(6) The rate of intestinal resection is high. It is already seen at a high rate of 31-93.4% in patients with AMI.[18]

Why Should Endovascular Intervention Be Performed as the First Treatment for ASMAE?

(1) Lower mortality rates have been noted in some studies compared to surgery. Heiss et al[21] reported that the 30-day mortality rate of SMA aspiration was 33%. Also, Kawasaki et al[22] reported a 30-day mortality rate of 14% (1 out of 7 patients). In a 5-year study conducted at Kuopio University Hospital in Finland, they first applied endovascular intervention in 88% of ASMAE cases. The mortality rate was reported as 32%.[18]

(2) It is a minimally invasive method. ASMAE patients are generally elderly individuals with multiple comorbidities, such as malnutrition. Open surgery is not a good option for them.[2]

(3) There are studies about the high rate of SMA revascularization with endovascular intervention. Raupach et al[22] reported a success rate of revascularization in the SMA body with a rate of 91.9% in 37 patients by percutaneous transluminal angioplasty (PTA).

(4) EVT involves a completion angiogram to ensure revascularization. Although this procedure can be applied after surgery, it is not used routinely. However, this is a routine procedure for endovascular intervention.[18]

(5) Avoiding prolonged general anesthesia gives patients better control of damage.[18]

AMI is an emergency disease with high mortality if not performed early. Because AMI is both a rare and an emergency, it is difficult to evaluate this issue in a randomized, controlled trial. Open surgery is the traditional method, and treatment options have increased in recent years with the inclusion of endovascular intervention. As a result of all studies including ours, it is still not clear that endovascular intervention is the best treatment, despite its success in selected patients, but it is obvious that it cannot go ahead in terms of directly seeing the necrotic intestine in the early period in open surgery.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of İstanbul University-Cerrahpaşa (Date: January 15, 2021 No: E-83045809-604.01.02-27379).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

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