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Acute mesenteric ischemia in the surgical intensive care unit: Analysis of clinical characteristics and risk factors for mortality

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ABSTRACT

Objectives: This study aimed to present the clinical characteristics of patients followed due to acute mesenteric ischemia (AMI) in the surgical intensive care unit and evaluate mortality-related prognostic factors.

Patients and methods: This retrospective study reviewed clinical records of 28 patients (19 males, 9 females; mean age: 67.5±17 years; range, 29 to 86 years) who were followed due to AMI in the intensive care unit between May 2016 and April 2023. We analyzed the clinical characteristics, risk factors, and prognostic factors of the patients. The Acute Physiology and Chronic Health Evaluation II (APACHE II) score was calculated in each patient to assess its prognostic value in AMI patients.

Results: Of the 28 patients, 19 had acute arterial occlusive mesenteric ischemia (AOMI), four patients had acute mesenteric venous thrombosis (MVT), and five patients had nonocclusive mesenteric ischemia (NOMI). Overall mortality was 60.7% (n=17). The mortality rate was 57.8% (n=11) in the AOMI group, 50.0% (n=2) in the MVT group, and 80.0% (n=4) in the NOMI group. Compared to survivors, the APACHE II score, shock incidence, arterial lactate concentration, specifically more prominent 24 h after diagnosis ($p<0.001$), acute renal failure, serum creatinine level, vasoactive agent consumption, and maximum vasopressor dose were significantly higher among nonsurvivors ($p<0.05$).

Conclusion: The clinical outcomes remain poor in AMI, and even in-hospital mortality is rather high. The death following AMI was mostly related to multiorgan failure, renal failure, elevated lactate level, and colon involvement. It appears that monitoring arterial lactate is helpful in identifying patients with poor prognosis. Early diagnosis, timely treatment, correction of shock, and renal protection are important to improve clinical prognosis.

Keywords: Acute mesenteric ischemia, arterial occlusive mesenteric ischemia, mesenteric venous thrombosis, nonocclusive mesenteric ischemia, prognostic factors.

Acute mesenteric ischemia (AMI) is a rare entity with high morbidity and mortality rate (30 to 100%), which frequently results in intestinal infarction due to acute impairment of intestinal perfusion.[1-5] It may develop as a result of arterial occlusivse mesenteric ischemia (AOMI), mesenteric venous thrombosis (MVT), and nonocclusive mesenteric ischemia (NOMI).[5]

Arterial occlusive mesenteric ischemia occurs following acute thrombosis or embolism of the superior mesenteric artery (SMA), accounting for approximately two-third of AMI cases.[5,6] Cardiac emboli due to causes such as heart valve diseases, bacterial endocarditis, myocardial infarction, and atrial fibrillation can readily pass SMA due to aortic outlet angle and large caliper and occlude the mesenteric artery, resulting in AOMI. Less commonly, atherosclerotic plaque or mural thrombus in an aortic aneurysm or aortic dissection can also lead to AOMI.[5-8]

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Mesenteric vein thrombosis is a rare cause of acute abdomen, accounting for 5 to 15% of all AMI cases.[6,7,9] Mesenteric vein thrombosis is classified as primary MVT, where underlying predisposing factors are lacking, and secondary MVT, where an etiological factor is detected. The secondary causes include previous history of abdominal surgery, malignancy, myeloproliferative diseases, medication, such as oral contraceptives, protein S and C deficiencies, antithrombin III deficiency, and prothrombin and factor V Leiden mutation, which may lead to hypercoagulability.[6,7,9] Cases of mesenteric artery and vein thrombosis due to COVID-19 (coronavirus disease 2019) were reported during the pandemic.[10]

Nonocclusive mesenteric ischemia accounts for 15 to 20% of all AMI cases.[11] Vasoconstriction due to factors such as severe cardiac failure, sepsis, or low cardiac output reduces splanchnic blood flow. The decreased blood flow often involves the ileocolic artery, resulting in proximal colonic ischemia and necrosis. It may occur after open heart surgery. Hypovolemia and vasoconstrictive use may exacerbate NOMI.[4,6,11]

Acute mesenteric ischemia can present as the primary diagnosis, it may also develop as a complication due to other comorbid conditions in intensive care unit patients as well. The AMI incidence is unclear. Diagnosis is generally made based on clinical suspicion and findings.[2,12] Computed tomography angiography is the gold standard diagnostic procedure due to noninvasiveness, accessibility, high sensitivity (91 to 96%) and specificity (95 to 99%).[3,7] It usually manifests with acute, severe abdominal pain without marked or specific symptoms and is generally diagnosed at an advanced state.[2] In most instances, early diagnosis cannot be made due to insufficient sensitivity and specificity of clinical features and biomarkers. Despite significant advances in diagnosis and management in recent years, the disease progresses into irreversible intestinal obstruction and gangrene if early diagnosis cannot be made, resulting in extremely high mortality. Thus, early diagnosis and timely treatment are of importance for prognosis.[1-3]

In AMI, management relies on early diagnosis, resection of necrotic intestine, diminishing intestinal ischemia by restoring blood flow, second-look laparotomy, and intensive care.[2,13] The use of single or hybrid interventional therapies with increasingly available experience and proven therapeutic efficacy tends to be a better choice.[5] This study aimed to define the characteristics of patients followed due to AMI in the intensive care unit and evaluate factors affecting mortality.

PATIENTS AND METHODS

This retrospective, observational, noninterventional study investigated 28 patients (19 males, 9 females; mean age: 67.5±17 years; range, 29 to 86 years) followed with the diagnosis of AMI in the intensive care unit of the Izmir Bakırçay University, Çiğli Training and Research Hospital between May 2016 and April 2023. The diagnosis of AMI was made using at least one of the following: computed tomography angiography or surgical procedure. In all patients, clinical characteristics, relevant risk factors, and prognostic factors were analyzed. Data regarding age, sex, comorbid conditions, medication, clinical findings, laboratory results, imaging findings, surgical procedures, and postoperative outcomes were recorded in all patients. The Acute Physiology and Chronic Health Evaluation II (APACHE II) score was calculated in each patient to assess its prognostic value in AMI patients.

Statistical analysis

Statistical analyses were performed using IBM SPSS version 19.0 software (IBM Corp., Armonk, NY, USA). Groups were compared using the independent samples t-test. Univariate analyses were performed using Fisher exact test. A p-value <0.05 was considered statistically significant.

RESULTS

Of the 28 patients, 19 had AOMI, four patients had MVT, and five patients had NOMI (Table 1). Overall mortality was 60.7% (n=17). The mortality rate was 57.8% (n=11) in the AOMI group, 50.0% (n=2) in the MVT group, and 80.0% (n=4) in the NOMI group.

In patients undergoing surgery, the choice of surgical technique was up to the discretion of the surgeon who decided the surgery based on intestinal viability. Intestinal viability was defined according to color, arterial pulsation, and peristalsis of the intestinal segment. Of 19 patients in the AOMI group, withholding treatment was preferred in three cases and no surgical intervention was performed. These three patients died in the intensive care unit. Explorative laparotomy (open and close procedure)

Table 1
The demographic and clinical data of the 28 patients

	Total (n=28)					AOMI (n=19)					MVT (n=4)					NOMI (n=5)				
	n	%	Mean±SD	Median	Range	n	%	Mean±SD	Median	Range	n	%	Mean±SD	Median	Range	n	%	Mean±SD	Median	Range
Age (year)				67.5	29-86				71.1	30-86				48.7	29-74				70.3	61-81
Sex																				
Male	19	67.9				13					2					4				
Female	9	32.1				6					2					1				
Previous history																				
Hypertension	18	64.3				16					1					1				
Coronary artery disease	14	50				9					-					5				
Atrial fibrillation	9	32.1				8					-					1				
Diabetes mellitus	6	21.4				4					-					2				
Hypercoagulable state	2	7.1				-					2					-				
Peripheral artery disease	16	57.4				14					-					2				
Laboratory data																				
Serum creatinine (mg/dL)				2.1	1.1-3.1				2.0	1.2-3				1.6	1.1-2.8				2.4	1.3-3.1
WBC (×10^9)			17.2±9.3					16.0±6.0					20.1±11.3					21.0±.8.1		
Blood Gas (PH)			7.31±0.12					7.32±0.11					7.39±0.13					7.30±0.10		
D-dimer			4601.2±4093.3					4599.7±4323.8					7278.6±3236.1					3851.7±2693.5		
Bowel ischemic region																				
Jejunum	9	32.1				5					2					2				
Ileum	12	42.9				9					1					2				
Colon	7	25.0				5					1					1				
Death number	17	60.7				11					2					4				
APACHE II scores			11.3±5.3					12.0±4.7					9.5±6.1					13.8±7.4		

AOMI: Arterial occlusive mesenteric ischemia; MVT: Mesenteric venous thrombosis; NOMI: Nonocclusive mesenteric ischemia; SD: Standard deviation; WBC: White blood cell; APACHE II: Acute Physiology and Chronic Health Evaluation II.

Table 2
Comparison of risk factors in the deceased group and the survival group

	Deceased group (n=11)				Survival group (n=11)				
	n	Mean±SD	Median	Range	n	Mean±SD	Median	Range	*p*
Age (year)			67	29-86			66.5	30-78	0.84
Serum creatinine (mg/dL)			1.6	1.1-2.8			2.1	1.3-3.1	0.014
Arterial lactate at diagnosis (mmol/L)			4.4	2.6-9.4			2.5	1.4-3.8	<0.001
Arterial lactate 24h after diagnosis (mmol/L)			7.9	3.3-15.4			1.7	1.3-2.3	<0.001
Shock	12				3				0.01
MODS	8				2				0.202
Respiratory failure	6				1				0.073
Renal failure	8				1				0.011
APACHE II score		13.5±5.1				8.3±4.3			0.013

SD: Standard deviation; MODS: Multiple organ dysfunction syndrome; APACHE II: Acute Physiology and Chronic Health Evaluation II.

was performed in three cases, all of which were nonsurvivors. Proximal colon resection was performed due to ileocolic artery involvement in 13 patients. Revascularization by embolectomy in SMA was feasible in only four patients. Mortality was 47% in the subgroup where revascularization was achieved by embolectomy.

Of the four patients in the MVT group, one patient underwent intestinal resection. Medical treatment (anticoagulant and antithrombotic therapy) was given to three patients.

Of five patients in the NOMI group, all patients had undergone open cardiac surgery. No surgical treatment was performed on any of the patients. The patients were treated for underlying causes in addition to supportive care. Majority of the patients had multiorgan dysfunction at the time of diagnosis. In the NOMI group, all patients needed inotropic support at admission to the intensive care unit.

The risk for hypertension and atrial fibrillation was higher in the AOMI group compared to the MVT and NOMI groups ($p<0.05$). Compared to survivors, APACHE II score, shock incidence, arterial lactate concentration, particularly more prominent 24 h after diagnosis ($p<0.001$), acute renal failure, serum creatinine level, vasoactive agent consumption, and maximum vasopressor dose were significantly higher among nonsurvivors ($p<0.05$) (Table 2).

DISCUSSION

There is no diagnostic method specific for the diagnosis of AMI; thus, diagnosis is challenging. The diagnosis is generally delayed, and the disease is already advanced at the time of treatment.[1-6] Given the low incidence and wide spectrum, there is limited number of studies on AMI, majority of which are retrospective.[1-15] In AMI, the mortality rate ranges from 30 to 100% in different studies.[1-6,16,17] In our study, the overall mortality rate was 60.7%.

The AOMI cases, caused by an arterial embolus or thrombus in SMA, are the cause of intestinal ischemia in 70 to 80% of cases. To a lesser extent, intestinal ischemia may occur as a result of MVT or NOMI.[5,6] In our study, there was AOMI in 67.8% of the patients, while MVT and NOMI were observed in 14.3% and 17.9%, respectively. The mortality rate was higher in the NOMI group (80%).

Nonocclusive mesenteric ischemia is mainly observed in patients with acute, severe, critical illness, such as heart failure and surgical patients.[11] Clinical presentation is often insidious and nonspecific, leading to delayed diagnosis.[11,18,19] The NOMI rate has been reported as 15% among AMIs in the literature, its incidence is unclear as diagnosis cannot be made in critically ill patients.[11,18,20] In our study, all patients with diagnosis of NOMI had history of major cardiovascular surgery.

In some studies, it has been reported that comorbid disease is one of the risk factors for mortality.[1,19,21] In our study, atrial fibrillation and arterial hypertension rates were significantly higher in the AOMI group ($p<0.05$). There was no history of arterial hypertension in the NOMI group. The reason for the speculative protective effect of arterial hypertension remains to be unknown; however, it may be associated with better preservation of autoregulation pressure gradient in the splanchnic region.[22] In our study, the presence of comorbid disease showed no significant effect on mortality.

In AMI, the poor prognosis and mortality were associated with organ dysfunction, renal failure, high APACHE II score, and elevated lactate level, which was more prominent during the first 24 h. Persistent elevation in the serum lactate level reflects continued splanchnic hypoperfusion or multiorgan failure. Particularly in patients requiring vasoactive agents, the role of vasoactive agents in enhanced splanchnic vasoconstriction might have an influence on mortality. In AMI, a serum lactate level >2 mmol/L was associated with irreversible intestinal ischemia.[1,23] It should be kept in mind that normal arterial lactate level does not necessarily exclude AMI and that high lactate concentration may indicate delayed diagnosis.[1,23]

D-dimer is a fibrin product that is generated by enzymatic degradation during intravascular coagulation, and in case of elevated lactate levels, it can be further increased in AMI and in other diseases.[24] D-dimer level was found to be significantly higher in the MVT group. In our study, it was found that serum lactate and creatinine levels were significantly higher in nonsurvivors compared to survivors ($p<0.05$).

It has been reported that age is a negative prognostic criterion in AMI.[1,19,25] However, age was not a risk factor for mortality in AMI in our study ($p>0.05$).

Although anticoagulation with heparin is the key treatment in MVT, no benefit was observed in arterial AMI.[26] Anticoagulant therapy was initiated in all MVT patients. It was thought that COVID-19 was the underlying reason in two patients who developed MVT during the pandemic. Both of these patients died.

Only a minority of patients benefit from revascularization.[27] In our study, mesenteric artery embolectomy was performed in three AOMI patients. Intestinal resection was required in the majority of patients who underwent surgery.

Delayed diagnosis and treatment, elevated lactate level, sepsis at the time of presentation, and colonic involvement, in addition to the small intestine, are poor prognostic factors for mortality. Thus, early diagnosis and effective treatment of sepsis may reduce the mortality rate. In AMI patients with involvement of the small intestines and colon, viscera revascularization techniques (embolectomy, thrombectomy, endarterectomy, or bypass) must be attempted before wide resection.[1,2,12,21,28] In our study, colon involvement was higher in the AOMI group.

This study has some limitations. Since the data analysis period was long and the study was conducted at a new institution, the changes in healthcare providers, surgeons, and approaches might have led to significant changes in the diagnostic procedures and treatment options. Additionally, the number of diagnosed NOMI patients was limited since the diagnosis of NOMI is more challenging.

In conclusion, clinical outcomes remain poor, with high in-hospital mortality in AMI. Younger patients had a similar mortality risk to older patients. Hypertension and atrial fibrillation were more common in the AOMI group and associated with larger intestinal ischemia. The number of patients with NOMI might have been underestimated as the diagnosis is more difficult in these patients. Acute mesenteric ischemia-related deaths were mostly associated with multiorgan failure, renal failure, elevated lactate levels, and colon involvement. Monitoring the arterial lactate level appeared helpful in identifying patients with poor prognosis. Early diagnosis, timely treatment, and renal protection are of importance to improve clinical prognosis.

Ethics Committee Approval: The study protocol was approved by the Izmir Bakırçay University, Çiğli Training and Research Hospital Ethics Committee (date: 30.03.2022, no: 546). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent for Publication: A written informed consent was obtained from each patient.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Idea, design, data collection, literature review, wrting the article: İ.K.; Control, crtitical review, literature review: A.D.; Data collection, references and fundings: A.Ş.; Data collection, materials; H.A.; Wrting the article, design, crtitical review: Ş.B.

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