North Clin Istanb 2025;12(2):162–172
doi: 10.14744/nci.2023.82231

Original Article General Surgery

Effective new predictors of prognosis and comparison of multidisciplinary treatment options in acute mesenteric ischemia

Ahmet Tarik Harmantepe,[1] Enis Dikicier,[1] Ugur Can Dulger,[1] Furkan Kucuk,[1] Emre Gonullu,[1] Hakan Demir,[2] Unal Erkorkmaz[3]

[1]Department of General Surgery, Sakarya University Faculty of Medicine, Sakarya, Turkiye
[2]Department of General Surgery, Sakarya University Training and Research Hospital, Sakarya, Turkiye
[3]Department of Biostatistics, Sakarya University Faculty of Medicine, Sakarya, Turkiye

ABSTRACT

OBJECTIVE: It was aimed to compare the prognostic risk factors and multidisciplinary treatments affecting mortality in acute mesenteric ischemia (AMI).

METHODS: We retrospectively analyzed 111 patients treated for acute mesenteric ischemia between January 2012 and January 2023. Patients were divided into 2 groups as alive and dead for early survey (postoperative 28 days). The characteristics of the two groups were compared and the factors affecting early mortality were investigated. Factors affecting the presence of perioperative ischemia, the length of ischemia, the length of the resected bowel, and the length of the remaining small bowel from the ligament of Treitz were investigated. The results of different treatment processes were analyzed.

RESULTS: The mean age was 71.67, years with 64 (57.6%) males and 47 (42.3%) females. Early mortality rate was 47.7%. Envas was applied to 9 (8.1%) patients. EnvasSurg to 19 (17.1%) patients. Surg to 71 (64%) and SurgEnvas to 12 (10.8%) patients during the treatment process. Preoperative D-dimer (p=0.013). lactate (p=0.006). creatine (p=0.001). LAR (p=0.031) were significantly different between the groups when compared according to the treatment process. The resected bowel length was significantly less in patients who underwent EnvasSurg compared to the other groups (p=0.002), CCI (p=0.041), D-dimer (p=0.016), lactate (p<0.001), creatine (p<0.001), LAR (p<0.001) and ischemia length (p<0.001) were found to be significantly different between the groups.

CONCLUSION: The prognosis can be predicted with serum-based blood tests and indicators at the time of diagnosis, and organ loss and prognosis can be changed with the selected treatment process.

Keywords: Acute mesenteric ischemia; AMI; bowel ischemia; endovascular; prognosis.

Cite this article as: *Harmantepe AT, Dikicier E, Dulger UC, Kucuk F, Gonullu E, Demir H, Erkorkmaz U. Effective new predictors of prognosis and comparison of multidisciplinary treatment options in acute mesenteric ischemia. North Clin Istanb 2025;12(2):162–172.*

Acute mesenteric ischemia (AMI) is an emergency condition in which the blood supply to any segment of the small intestine is interrupted, progressing to ischemia, cellular damage and intestinal necrosis [1]. This may or may not be due to vascular occlusion (NOMI). In those with vascular occlusion, it is defined as mesenteric artery embolism (50%), mesenteric artery thrombosis (15–25%) or mesenteric venous thrombosis (5–15%) [2]. The incidence increases with age and ranges from 1% in all patients presenting to the emergency department

Received: November 16, 2023 *Revised:* November 30, 2023 *Accepted:* December 21, 2023 *Online:* April 28, 2025

Correspondence: Ahmet Tarik HARMANTEPE, MD. Sakarya Universitesi Tip Fakultesi, Genel Cerrahi Anabilim Dali, Sakarya, Turkiye.
Tel: +90 534 781 03 76 e-mail: tarikharmantepe@gmail.com

Istanbul Provincial Directorate of Health - Available online at www.northclinist.com

with acute abdomen to 10% in patients over 70 years of age [3]. Mortality rate reaches 50%–70% in the absence of early intervention [4]. Despite technological advances, the management of patients with AMI remains challenging. Computed tomography angiography is key for diagnosis [5]. Surgical and endovascular interventions are the two main approaches. Surgical embolectomy was first reported in 1951, while the first successful percutaneous angioplasty was reported in 1983 [6, 7].

In the literature, age and duration of onset of symptoms were reported as poor prognosis criteria [8]. However, in recent years, demographic characteristics, comorbidities, serum-based indices have been the focus of interest in the investigation of factors affecting prognosis in different diseases [9, 10]. These parameters were found to be effective in predicting the prognosis of diseases [11, 12]. Since AMI is a rare emergency, the effect of these parameters and multidisciplinary approach options on the prognosis of AMI has not been extensively studied in the literature.

In our study, the factors predicting the prognosis at the time of diagnosis of AMI and the effect of treatment options on the prognosis in AMI were investigated extensively.

MATERIALS AND METHODS

This study was approved by the Sakarya University Faculty of Medicine Non-interventional Ethics Committee (date: 29.01.2021, number: E-71522473/050.01.04/605735). The study was conducted in accordance with the Declaration of Helsinki.

We retrospectively analyzed 111 patients treated for AMI at our center between January 2012 and January 2023. Demographic characteristics, comorbidities, serum-based laboratory results at the time of diagnosis, indicators obtained from laboratory results, treatment process, perioperative findings, postoperative pathology report and early postoperative survival were evaluated. Charlson Comorbidity Index (CCI) was calculated for each patient. Patients were divided into 2 groups as living and death for early survey (within postoperative 28 days). The features of the two groups were compared and the factors affecting early mortality were investigated. Factors affecting the presence of perioperative ischemia, the length of ischemia, the length of the resected bowel, and the distance of the resection from the ligament of Treitz were investigated.

Highlight key points

- At the time of diagnosis, the patient's prognosis can be estimated from blood tests.
- Endovascular intervention can be given priority in stable patients.
- In patients who receive endovascular intervention first, tissue loss is less even if surgical intervention is required.

The presence of perioperative ischemia in the patients who underwent surgery was grouped as absent (no ischemia), not settled ischemia (color change in intestinal nutrition but not settled ischemia), partial (ischemia involving part of the intestine, not total ischemia), total (ischemia involving the entire intestine from the Treitz).

In patients who underwent bowel resection, the distance of the resection to Treitz was divided into 3 groups as 0–50 cm, 50–200 cm and >200 cm. In addition, these patients were divided into two groups as those who underwent anastomosis and ostomy regarding bowel continuity.

Serum-Based Indicators and Calculations

NLR: Neutrophil count (K/uL)/Lymphocyte count (K/uL).

PLR: Platelet count (K/uL)/Lymphocyte count (K/uL).

SII: ((Neutrophil count (K/uL) x Platelet count (K/uL))/Lymphocyte count (K/uL).

MPR: Mean platelet volume (fL)/Platelet count (K/uL) .

FAR: Fibrinogen (g/L)/Albumin (g/dL).

AGR: Albumin (g/dL)/Globulin (g/dL).

CAR: C-reactive protein (mg/L)/Albumin (g/dL).

LAR: Lactat (mmol/L)/Albumin (g/dL).

DFR: D-dimer (ugFEU/L)/Fibrinogen (g/L).

LCR: Lymphocyte count (K/uL)/C-reactive protein (mg/L).

FLR: Fibrinogen (g/L)/Lymphocyte count (K/uL).

The Treatment Process

Surg: Only surgery

SurgEnvas: Surgery first, endovascular intervention 12 hours later.

EnvasSurg: Endovascular intervention first, surgery 24 hours later.

Envas: Only endovascular intervention.

The Treatment Protocol

AMI was diagnosed by computed tomography angiography in patients admitted to the emergency department with abdominal pain. When an accessible endovascular intervention specialist was available in our center, endovascular embolectomy was primarily performed in the patient who had no perforation findings on radiological imaging and was not in septic condition. No additional intervention was performed in patients whose complaints regressed and serum laboratory results tended to return to normal after the procedure. However, surgery was performed in patients whose complaints persisted after the procedure or whose serum laboratory results were abnormal.

Patients were taken directly to surgery when there was no specialist performing endovascular intervention at the time of diagnosis. In patients who underwent direct surgery, postoperative endovascular procedure was performed if ischemia was not fully settled in perioperative findings or if there were suspicious areas in the nutrition of the remaining intestinal segments after resection.

Statistical Analysis

Descriptive analyses were performed to provide information on general characteristics of the study population. Shapiro Wilk's Test was used to evaluate whether the distribution of variables was normal. Accordingly, it was seen that all variables displayed a normal distribution. Therefore, two independent sample t-test was used to compare the clinical characteristics between two groups. One-way analysis of variance (ANOVA) was used for the comparison of the clinical characteristics among groups. For multiple comparisons, Tukey HSD test or Tamhane T2 test was used. Pearson correlation coefficient was performed for correlation between variables. The continuous variables were presented as the mean±standard deviation. Categorical variables were compared by Chi-Square test. Categorical variables were presented as a count and percentage. A p-value <0.05 was considered significant. Analyses were performed using commercial software (IBM SPSS Statistics, Version 23.0, Armonk, NY: IBM Corp.)

RESULTS

The mean age of the patients was 71.67 years, 64 (57.6%) were male and 47 (42.3%) were female. The mean CCI of the patients was 4.31. Early mortality rate was 47.7%. Envas was performed in 9 (8.1%). EnvasSurg in 19 (17.1%). Surg in 71 (64%) and SurgEnvas in 12 (10.8%) patients. In patients who underwent surgery (EnvasSurg, Surg, SurgEnvas), no ischemia was observed in 10 (9.8%) patients, whereas total ischemia was observed in 21 (20.6%) patients during peroperative observation. The mean length of ischemia was 183.95 cm and the mean resected bowel length was 101.14 cm (resection was not performed in total ischemia and in cases where ischemia was not settled) (Table 1, 2).

Table 1. Basic clinical and laboratory features

	n	%
Treatment process	9	8.1
Envas	19	17.1
EnvasSurg	71	64
Surg	12	10.8
SurgEnvas		
Presence of perperative ischemia		
None	10	9.8
Ischemia unsettled	4	3.9
Partial ischemia	67	65.7
Total ischemia	21	20.6
Anastomotic distance to Treitz ligament (cm)		
0–50	20	32.3
50–200	29	46.8
>200	13	21
Anastomosis/ostomy		
Anastomosis	29	43.9
Ostomy	37	56.1
Postoperative early survey		
Alive	58	52.3
Dead	53	47.7

Surg: Only surgery; SurgEnvas: Surgery first. endovascular intervention 12 hours later; EnvasSurg: Endovascular intervention first. surgery 24 hours later; Envas: Only endovascular intervention.

Preoperative D-dimer (p=0.013), lactate (p=0.006), creatine (p=0.001), LAR (p=0.031) were significantly different between the groups when compared according to the treatment process. The resected bowel length was significantly less in patients who underwent EnvasSurg compared to the other groups (p=0.002) (Table 3).

When compared according to the presence of perioperative ischemia, preoperative neutrophils

Table 2. Distribution of the demographics and clinical characteristics

	n	Mean±SD
Age	111	71.67±13.05
Charlson Comorbidity Index (CCI)	111	4.31±2.03
Neutrophil	110	16.13±8.63
PLT	111	245.81±89.47
Lymphocyte	110	1.32±1.24
Mean platelet volume (MPV)	109	9.43±2.12
Red cell distribution width (RDW)	111	16.49±2.99
White blood cell (WBC)	111	18.64±9.04
C-reaktive protein (CRP)	91	170.96±148.24
Albumin	82	3.14±0.73
Monocyte	108	1.01±0.69
D-dimer	35	3932.31±4448.46
Fibrinogen	29	115.28±173.18
Lactate	79	5.17±3.67
Globulin	37	2.67±0.5
Creatine	110	1.52±1
International normalized ratio (INR)	107	1.8±1.8
NLR	110	18.4±16.65
PLR	110	283.49±220.39
SII	110	4457.88±3718.37
MPR	109	0.05±0.03
FAR	27	35.58±54.8
AGR	36	1.14±0.21
CAR	65	65.44±62.77
LAR	61	1.43±1.26
DFR	23	2991.9±11697.04
LCR	91	0.07±0.18
FLR	29	146.11±236.42
Ischemia length	88	183.95±135.48
Resected bowel length	77	101.14±74.96

NLR: Neutrophil count/Lymphocyte count; PLR: Platelet count/Lymphocyte count; SII: (Neutrophil count x Platelet count)/Lymphocyte count; MPR: Mean platelet volume/Platelet count; FAR: Fibrinogen/Albumin; AGR: Albumin/Globulin; CAR: C-reactive protein/Albumin; LAR: Lactat/Albumin; DFR: D-dimer/Fibrinogen; LCR: Lymphocyte count/C-reactive protein; FLR: Fibrinogen/Lymphocyte count.

(p=0.006), WBC (p=0.010), CRP (p=0.031), lactate (p=0.001), creatinine (p=0.037) and LAR (p=0.043) showed significant differences between the groups. The mean values of lactate, creatine and LAR were lowest in the non-ischemia group, increased gradually between groups and were highest in the total ischemia group (Table 4).

When compared according to the distance of the resection from Treitz, INR (p=0.035) and resected bowel length (p=0.004) were found to be significantly different between the groups (Table 5).

CCI (p=0.041), D-dimer (p=0.016), lactate (p<0.001), creatine (p<0.001), LAR (p<0.001) and ischemia length (p<0.001) were found to be significantly different between the groups when the alive and ex patients were compared (Table 6).

The effects of treatment process (p<0.001), presence of ischemia (p<0.001), extension of ischemia proximally (p=0.020), anastomosis and ostomy on survival are shown in Table 7, Table 8, Table 9 and Table 10, respectively.

When the relationship between ischemia length and clinical features was evaluated, neutrophils (p=0.035), lactate (p<0.001) and LAR (p=0.036) were found to be significantly correlated (Table 11).

DISCUSSION

The management and prevention of perioperative mortality in AMI is still difficult, despite the modern multidisciplinary treatment approach. In this research, our objective was to assess association between different clinico-pathological factors and perioperative results in patients with AMI who received surgical and/or endovascular intervention. Our analysis revealed that CCI, D-dimer, lactate, creatine and LAR were prognostic factors at the time of diagnosis. In addition, the treatment process, the presence of ischemia, the length of ischemia, and the distance of the resection to the Treitz were found to be factors affecting mortality. Neutrophils, lactate and LAR were correlated with ischemia length.

Lactate, D-dimer is a guide in the diagnosis of AMI but is not sufficient to be a biomarker on its own [13–16]. Studies have investigated lactate as a marker for early diagnosis of ischemia and reported that lactate is 100% sensitive and 42% specific in AMI [17]. Several studies have reported that D-dimer is an effective parameter in the diagnosis of AMI with a high sensitivity of 96% to 100% [18]. However, compared to lactate, D-dimer is considered a sensitive early marker, but its specificity is low [19]. Currently, there is no AMI-specific serum-based parameter to diagnose AMI with se-

TABLE 3. Comparison results of the demographics and clinical characteristics among process groups

	Envas (n=9)		EnvasSurg (n=19)		Surg (n=71)		SurgEnvas (n=12)		p
	n	Mean±SD	n	Mean±SD	n	Mean±SD	n	Mean±SD	
Age	9	68.11±16.2	19	70.53±12.3	71	71.58±13.15	12	76.67±11.2	0.467
Charlson Comorbidity Index (CCI)	9	3.22±1.86	19	4±1.6	71	4.51±2.2	12	4.42±1.51	0.295
Neutrophil	9	15.26±4.89	19	15.5±9.56	70	15.46±7.93	12	21.73±11.74	0.127
PLT	9	223.22±79.39	19	280.95±76.4	71	241.28±93.07	12	233.98±89.23	0.275
Lymphocyte	9	1.18±0.71	19	1.68±1.67	70	1.3±1.24	12	0.97±0.46	0.440
Mean platelet volume (MPV)	9	9.95±0.89	18	9.93±2.8	70	9.17±2.12	12	9.82±1.49	0.391
Red cell distribution width (RDW)	9	14.6±2.23	19	16.94±2.48	71	16.75±3.29	12	15.73±1.53	0.150
White blood cell (WBC)	9	17.4±5.74	19	18.39±9.96	71	17.97±8.27	12	23.93±12.64	0.196
C-reaktive protein (CRP)	9	111.98±104.14	18	133±149.74	53	189.13±150.97	11	193.74±156.3	0.304
Albumin	9	3.43±0.54	14	3.32±0.84	50	3.08±0.74	9	2.93±0.64	0.355
Monocyte	9	0.95±0.63	18	1.07±0.65	70	0.97±0.71	11	1.18±0.68	0.767
D-dimer	7	1331±1035.27	8	2146.63±1659.98	16	6482.13±5455.5	4	1856.75±1475.41	**0.013**[a]
Fibrinogen	6	5.03±1.55	8	122.38±172.56	11	179.03±205.33	4	91.16±172.56	0.268
Lactate	7	2.17±0.81	16	3.63±2.68	48	6.24±3.96	8	4.43±2.38	**0.006**[a.b]
Globulin	6	2.67±0.28	7	2.63±0.34	18	2.7±0.67	6	2.62±0.26	0.984
Creatine	8	0.88±0.22	19	1.02±0.49	71	1.79±1.11	12	1.17±0.59	**0.001**[a.b]
Internationel normalized ratio (INR)	8	1.38±0.31	19	1.41±0.6	69	2.01±2.18	11	1.41±0.34	0.423
NLR	9	16.11±7.81	19	17.05±12.96	70	18.3±19.04	12	22.85±11.12	0.769
PLR	9	270.2±196.01	19	323.32±284.9	70	280.01±223.34	12	250.69±59.28	0.821
SII	9	3811.76±2407.89	19	5146.83±4822.81	70	4176.9±3576.44	12	5490.68±3415.67	0.528
MPR	9	0.05±0.02	18	0.04±0.03	70	0.05±0.03	12	0.05±0.01	0.827
FAR	6	1.52±0.67	8	40.1±56.05	9	53.33±61.77	4	37.7±72.09	0.360
AGR	6	1.22±0.19	7	1.17±0.23	17	1.09±0.18	6	1.17±0.3	0.573
CAR	9	35.44±33.87	13	59.8±74.45	35	72.04±63.05	8	79.47±65.11	0.407
LAR	7	0.64±0.22	13	0.89±0.66	35	1.82±1.48	6	1.26±0.66	**0.031**[a.b]
DFR	6	280.9±329.45	6	389.88±381.18	8	8062.04±19615.05	3	97.54±128.39	0.540
LCR	9	0.06±0.09	18	0.08±0.17	53	0.07±0.21	11	0.02±0.02	0.793
FLR	6	6.93±4.45	8	184.95±243.16	11	215.83±296.1	4	85.52±161.07	0.331
Ischemia length			10	163±134.43	71	181.8±136.9	7	235.71±128.43	0.533
Resected bowel length			17	48.82±65.1	54	113.11±68.36	6	141.67±97.45	**0.002**[b.c]

a: There was statistically significant difference between Envas and Surg groups; b: There was statistically significant difference between EnvasSurg and Surg groups; c: There was statistically significant difference between EnvasSurg and SurgEnvas groups. NLR: Neutrophil count/Lymphocyte count; PLR: Platelet count/Lymphocyte count; SII: (Neutrophil count x Platelet count)/Lymphocyte count; MPR: Mean platelet volume/Platelet count; FAR: Fibrinogen/Albumin; AGR: Albumin/Globulin; CAR: C-reactive protein/Albumin; LAR: Lactat/Albumin; DFR: D-dimer/Fibrinogen; LCR: Lymphocyte count/C-reactive protein; FLR: Fibrinogen/Lymphocyte count; Surg: Only surgery; SurgEnvas: Surgery first, endovascular intervention 12 hours later; EnvasSurg: Endovascular intervention first, surgery 24 hours later; Envas: Only endovascular intervention.

TABLE 4. Comparison results of the demographics and clinical characteristics among presence of perioperative ischemia groups

	None (n=10)		Ischemia Unsettled (n=4)		Partial Ischemia (n=67)		Total Ischemia (n=21)		p
	n	Mean±SD	n	Mean±SD	n	Mean±SD	n	Mean±SD	
Age	10	69±13.26	4	74.5±3.87	67	71.24±13.38	21	75.29±11.6	0.513
Charlson Comorbidity Index (CCI)	10	3.9±2.13	4	5±0.82	67	4.45±2.07	21	4.38±2.06	0.806
Neutrophil	10	16.13±7.71	4	29.41±14.89	66	14.7±7.45	21	18.49±10.36	**0.006**[a.d]
PLT	10	297.6±45.39	4	302.5±109.33	67	236.55±88.82	21	249.6±101.17	0.135
Lymphocyte	10	2.05±1.57	4	1.22±0.73	66	1.31±1.38	21	1.06±0.68	0.244
Mean platelet volume (MPV)	9	8.63±1.65	4	10.98±1.12	66	9.49±2.44	21	9.05±1.53	0.285
Red cell distribution width (RDW)	10	17.59±2.93	4	15.58±0.82	67	16.59±3.26	21	16.65±2.39	0.684
White blood cell (WBC)	10	19.45±8.29	4	32.09±16.37	67	17.26±7.68	21	20.62±11.06	**0.010**[d]
C-reaktive protein (CRP)	9	46.02±40.41	4	138.6±211.34	54	203.29±156.79	15	173.55±122.07	**0.031**[b.c]
Albumin	7	3.57±0.61	3	2.87±0.45	48	3±0.76	15	3.26±0.76	0.217
Monocyte	10	1.09±0.61	4	1.43±0.95	64	0.96±0.59	21	1.04±0.97	0.584
D-dimer	4	1776.25±1437.47	2	1268.5±1430.48	15	4536.2±3240.35	7	7232.71±7629.69	0.209
Fibrinogen	2	113.16±153.92	3	119.91±199.27	14	193.6±201.59	4	4.13±3.91	0.348
Lactate	7	3.17±1.68	3	3.47±1.85	46	4.91±3.35	16	8.41±4.04	**0.001**[c.f]
Globulin	4	2.68±0.42	1	3	19	2.7±0.64	7	2.53±0.29	0.838
Creatine	10	0.9±0.21	4	0.96±0.24	67	1.61±1.06	21	1.92±1.03	**0.037**[b.c.d.e]
INR	10	1.4±0.77	3	1.21±0.17	66	1.77±1.82	20	2.34±2.42	0.496
NLR	10	12.66±9.92	4	25.87±12.12	66	16.94±10.62	21	25.31±31.08	0.126
PLR	10	209.55±112.21	4	271.47±72.86	66	295.5±259.38	21	288.94±144.53	0.733
SII	10	3729.06±2954.44	4	7879.72±4348.37	66	4173.88±3443.37	21	5322.64±4887.6	0.172
MPR	9	0.03±0.01	4	0.04±0.01	66	0.05±0.03	21	0.04±0.03	0.229
FAR	2	30.54±41.66	3	49.68±83.27	12	61.27±62.02	4	1.56±1.7	0.378
AGR	4	1.2±0.06	1	1.1	18	1.09±0.23	7	1.16±0.25	0.770
CAR	6	16.49±17.46	3	61.68±82.46	38	79.76±68.46	9	68.88±54.78	0.176
LAR	6	0.56±0.29	3	1.3±0.9	35	1.48±1.26	10	2.4±1.54	**0.043**[b.c]
DFR	2	66.93±89.65	2	24.12±24.89	9	338.44±323.27	4	15975.06±27032.26	0.262
LCR	9	0.07±0.06	4	0.03±0.02	54	0.08±0.22	15	0.03±0.05	0.789
FLR	2	166.83±231.27	3	112.06±186.26	14	250.36±289.55	4	5.22±3.36	0.384
Ischemia length					67	116.24±68.48	21	400±0	<**0.001**
Resected bowel length	10	0			67	116.24±68.48			<**0.001**

a: There was statistically significant difference between none and ischemia Unsettled groups; b: There was statistically significant difference between none and partial ischemia groups; c: There was statistically significant difference between None and Total Ischemia groups; d: There was statistically significant difference between ischemia unsettled and partial ischemia groups; e: There was statistically significant difference between ischemia unsettled and total ischemia groups; f: There was statistically significant difference between partial ischemia and total ischemia groups. NLR: Neutrophil count/Lymphocyte count; PLR: Platelet count/Lymphocyte count; SII: (Neutrophil count x Platelet count)/Lymphocyte count; MPR: Mean platelet volume/Platelet count; FAR: Fibrinogen/Albumin; AGR: Albumin/Globulin; CAR: C-reactive protein/Albumin; LAR: Lactat/Albumin; DFR: D-dimer/Fibrinogen; LCR: Lymphocyte count/C-reactive protein; FLR: Fibrinogen/Lymphocyte count.

Table 5. Comparison results of demographic and clinical characteristics between groups in terms of distance from the ligament of Treitz

	0–50 cm (n=20)		50–200 cm (n=29)		>200 cm (n=13)		p
	n	Mean±SD	n	Mean±SD	n	Mean±SD	
Age	20	70.65±14	29	72.14±13.43	13	70±15.44	0.881
CCI	20	4.35±1.9	29	4.45±1.82	13	3.85±2.3	0.646
Neutrophil	20	12.85±6.57	28	15.19±7.71	13	16.32±8.3	0.383
PLT	20	235.24±72.91	29	223.87±100.47	13	239.76±85.21	0.838
Lymphocyte	20	1.82±2.22	28	1.01±0.64	13	1.27±0.87	0.148
MPV	20	10.02±2.83	28	9.5±2.18	13	9.11±2.56	0.570
RDW	20	16.56±3.09	29	16.51±2.41	13	17.05±5.29	0.886
WBC	20	15.91±6.29	29	17.2±8.13	13	19.53±8.66	0.423
CRP	19	225.84±162.67	22	223.49±168.62	10	149.15±121.65	0.409
Albumin	14	2.99±0.88	20	2.95±0.74	10	2.96±0.73	0.989
Monocyte	18	0.96±0.55	28	0.95±0.59	13	1.05±0.69	0.875
D-dimer	6	4396.17±4222.82	5	4930±2082.27	4	4254±3618.58	0.952
Fibrinogen	6	183.36±200.46	5	130.51±169.16	2	253.23±344.75	0.777
Lactate	15	5.48±3.14	20	4.22±3.41	9	4.33±2.98	0.496
Globulin	6	2.67±0.88	10	2.51±0.43	3	3.4±0.1	0.101
Creatine	20	1.82±1.35	29	1.46±1.02	13	1.59±0.68	0.524
INR	20	2.71±3.11	28	1.43±0.37	13	1.34±0.25	**0.035**[a]
NLR	20	15.18±10.89	28	18.8±11.66	13	16.66±8.88	0.519
PLR	20	287.73±288.59	28	302.04±283.2	13	278.43±205.01	0.963
SII	20	3682.88±3215.41	28	4474.56±3905.66	13	4080.07±2957.93	0.743
MPR	20	0.05±0.03	28	0.05±0.03	13	0.04±0.02	0.580
FAR	5	48.68±63.93	4	58.04±65.44	2	67.14±90.01	0.945
AGR	6	1.05±0.18	9	1.16±0.27	3	0.97±0.11	0.433
CAR	14	94.65±63.96	14	86.2±77.23	8	57.02±62.38	0.468
LAR	12	1.68±1.23	15	1.24±1.25	7	1.49±1.46	0.674
DFR	4	275.39±200	3	624.17±367.64	2	35.93±43.16	0.103
LCR	19	0.11±0.28	22	0.07±0.23	10	0.05±0.11	0.713
FLR	6	293.81±314.13	5	83.89±90.47	2	413.93±548.26	0.340
Ischemia length	20	144.6±66.38	29	118.79±61.03	13	69.69±49.36	**0.004**[b,c]
Resected bowel length	20	144.6±66.38	29	118.79±61.03	13	69.69±49.36	**0.004**[b,c]

a: There was statistically significant difference between 0–50 and 50–200 groups; b: There was statistically significant difference between 0–50 and >200 groups; c: There was statistically significant difference between 5–200 and >200 groups. NLR: Neutrophil count/Lymphocyte count; PLR: Platelet count/Lymphocyte count; SII: (Neutrophil count x Platelet count)/Lymphocyte count; MPR: Mean platelet volume/Platelet count; FAR: Fibrinogen/Albumin; AGR: Albumin/Globulin; CAR: C-reactive protein/Albumin; LAR: Lactat/Albumin; DFR: D-dimer/Fibrinogen; LCR: Lymphocyte count/C-reactive protein; FLR: Fibrinogen/Lymphocyte count.

rum-based laboratory results. Because these parameters can be elevated in other inflammatory conditions. Computed tomography angiography, the key diagnostic tool for suspected AMI, has a sensitivity of 93% and specificity of 100% [5]. However, we can use serum-based lab results to predict the patient's prognosis. High lactate, D-dimer, creatinine levels and increased CCI may be related with poor prognosis in our study as well as in other studies [20–25]. We reported for the first time that LAR is an important prognostic factor in AMI and is significantly correlated with ischemia length. In the literature, MPR, AGR, CAR, DFR, LCR, FLR have

Table 6. Comparison results of the demographics and clinical characteristics between alive and dead groups

	Alive (n=58)		Dead (n=53)		p
	n	Mean±SD	n	Mean±SD	
Age	58	69.55±13.7	53	73.98±12.01	0.074
CCI	58	3.93±2.1	53	4.72±1.88	**0.041**
Neutrophil	58	16.01±8.73	52	16.28±8.59	0.870
PLT	58	246.52±81.99	53	245.04±97.8	0.931
Lymphocyte	58	1.38±1.08	52	1.25±1.41	0.612
MPV	56	9.33±1.82	53	9.54±2.42	0.607
RDW	58	16.15±3.3	53	16.88±2.59	0.199
WBC	58	18.67±9.23	53	18.6±8.91	0.971
CRP	48	150.26±148.89	43	194.06±145.77	0.161
Albumin	44	3.16±0.65	38	3.12±0.83	0.804
Monocyte	57	1.01±0.58	51	1±0.8	0.986
D-dimer	19	2143.42±1898.17	16	6056.63±5627.07	**0.016**
Fibrinogen	18	104±172.38	11	133.74±181.27	0.662
Lactate	40	3.44±2.47	39	6.95±3.86	<**0.001**
Globulin	19	2.76±0.4	18	2.57±0.58	0.264
Creatine	57	1.16±0.6	53	1.91±1.19	<**0.001**
INR	56	1.5±1.46	51	2.12±2.07	0.082
NLR	58	15.98±10.09	52	21.1±21.55	0.108
PLR	58	262.6±203.58	52	306.79±237.57	0.296
SII	58	4047.83±3121.9	52	4915.24±4272.34	0.224
MPR	56	0.04±0.02	53	0.05±0.03	0.360
FAR	18	31.6±51.34	9	43.54±63.65	0.603
AGR	19	1.14±0.2	17	1.13±0.23	0.918
CAR	37	60.01±65.45	28	72.62±59.44	0.427
LAR	34	0.89±0.84	27	2.11±1.39	<**0.001**
DFR	14	250.6±301.83	9	7256.15±18506.8	0.166
LCR	48	0.07±0.19	43	0.06±0.16	0.646
FLR	18	117.36±219.18	11	193.17±266.29	0.412
Ischemia length	37	108.78±68.36	51	238.49±146.14	<**0.001**
Resected bowel length	46	87.5±75.11	31	121.39±71.15	0.051

NLR: Neutrophil count/Lymphocyte count; PLR: Platelet count/Lymphocyte count; SII: (Neutrophil count x Platelet count)/Lymphocyte count; MPR: Mean platelet volume/Platelet count; FAR: Fibrinogen/Albumin; AGR: Albumin/Globulin; CAR: C-reactive protein/Albumin; LAR: Lactat/Albumin; DFR: D-dimer/Fibrinogen; LCR: Lymphocyte count/C-reactive protein; FLR: Fibrinogen/Lymphocyte count.

been reported to be indicators of prognosis in different diseases [26–31]. But our study showed that these indices are not important in AMI.

The surgical approach is based on restoring perfusion and removal of the bowel, whereas endovascular intervention only contributes to reperfusion [32]. In principle, endovascular therapy can be applied as initial treatment to a group of patients without signs of necrosis [32]. Studies have reported a better prognosis in patients who underwent endovascular intervention [33, 34]. In our study, the prognosis was better and tissue loss was less in the Envas and EnvasSurg groups. In our study and

Table 7. The effect of the treatment process applied to the patient on survival

	Alive (n=58)	Dead (n=53)	p
Envas	9 (100)	0 (0)	<**0.001**
EnvasSurg	14 (73.7)	5 (26.3)	
Surg	29 (40.8)	42 (59.2)	
SurgEnvas	6 (50)	6 (50)	

Statistics were shown as n (%). Surg: Only surgery; SurgEnvas: Surgery first, endovascular intervention 12 hours later; EnvasSurg: Endovascular intervention first, surgery 24 hours later; Envas: Only endovascular intervention.

Table 8. Impact of the presence of ischemia on survival

	Alive (n=58)	Dead (n=53)	p
None	9 (90)	1 (10)	<**0.001**
Ischemia unsettled	3 (75)	1 (25)	
Partial ischemia	37 (55.2)	30 (44.8)	
Total ischemia	0 (0)	21 (100)	

Statistics were shown as n (%).

Table 9. Effect of ischemia extending proximally on survival

Anastomotic distance to Treitz ligament (cm)	Alive (n=58)	Dead (n=53)	p
0–50	7 (35)	13 (65)	**0.020**
50–200	15 (51.7)	14 (48.3)	
>200	11 (84.6)	2 (15.4)	
Total ischemia	0 (0)	21 (100)	

Statistics were shown as n (%).

other studies, there was no significant difference in CCI between patients who underwent surgery and those who underwent endovascular intervention [33, 34]. However, we can accept that the patients who underwent endovascular intervention were selected cases. Because direct surgery was performed in septic patients with signs of diffuse peritoneal irritation. However, although there is a bias in the results between the groups, it cannot be denied that endovascular intervention reduces morbidity and ischemic bowel length in appropriate patients.

Table 10. Effect of anastomosis-ostomy on the distance from Treitz to resection on survival

Anastomotic distance to Treitz ligament (cm)	Alive (n=58)	Dead (n=53)	p
0–50 cm			0.419
Anastomosis	3 (50)	3 (50)	
Ostomy	4 (30.8)	9 (69.2)	
50–200 cm			0.176
Anastomosis	8 (66.7)	4 (33.3)	
Ostomy	7 (41.2)	10 (58.8)	
>200 cm			0.715
Anastomosis	7 (87.5)	1 (12.5)	
Ostomy	4 (80)	1 (20)	

Statistics were shown as n (%).

The limitations of our study are the small number of cases and missing data because it was retrospective and single-center. In addition, symptom duration and vital signs of the patients at the time of diagnosis were not available in our digital data system.

Conclusion

In conclusion, AMI is an emergency with high mortality. The prognosis can be predicted with the serum-based blood tests we have mentioned, and organ loss and prognosis can be changed with the selected treatment process. A multidisciplinary approach plays a role in treatment. Endovascular intervention should be prioritized in appropriate patients.

Ethics Committee Approval: The Sakarya University Faculty of Medicine Non-interventional Ethics Committee granted approval for this study (date: 29.01.2021, number: E-71522473/050.01.04/605735).

Authorship Contributions: Concept – ATH; Design – ATH, ED; Supervision – ED, HD; Materials – ATH, UCD, FK; Data collection and/or processing – ATH, UCD, FK; Analysis and/or interpretation – UE, EG; Literature review – EG, HD; Writing – ATH; Critical review – ED, EG.

Conflict of Interest: No conflict of interest was declared by the authors.

Use of AI for Writing Assistance: The authors declared that artificial intelligence-supported technologies (such as Large Language Models [LLMs], chatbots or image generators, ChatGPT) were not used in the production of the study.

Table 11. Distribution of associations between ischemia length and resected bowel length and preoperative indexes

	Ischemia Length		Resected bowel length	
	R	p	r	p
Age	0.089	0.398	-0.004	0.975
CCI	-0.089	0.398	-0.059	0.605
Neutrophil	0.220	**0.035**	0.081	0.480
PLT	0.011	0.917	-0.191	0.089
Lymphocyte	-0.064	0.547	-0.038	0.738
MPV	-0.032	0.767	0.201	0.078
RDW	-0.059	0.574	-0.162	0.151
WBC	0.196	0.059	0.077	0.498
CRP	-0.103	0.390	0.150	0.231
Albumin	0.156	0.215	-0.181	0.181
Monocyte	0.091	0.393	0.102	0.375
D-dimer	0.205	0.347	0.059	0.806
Fibrinogen	-0.304	0.206	0.160	0.540
Lactate	0.459	**<0.001**	0.347	**0.009**
Globulin	-0.262	0.197	-0.282	0.192
Creatine	0.132	0.208	0.170	0.132
INR	0.103	0.333	0.036	0.754
NLR	0.161	0.126	0.038	0.742
PLR	-0.070	0.509	-0.061	0.593
SII	0.102	0.332	0.001	0.990
MPR	-0.019	0.859	0.187	0.100
FAR	-0.389	0.136	0.148	0.613
AGR	0.257	0.214	0.196	0.381
CAR	-0.045	0.762	0.170	0.265
LAR	0.309	**0.036**	0.270	0.084
DFR	0.471	0.089	0.415	0.180
LCR	-0.035	0.773	0.139	0.271
FLR	-0.255	0.292	0.181	0.488

r: Pearson's correlation coefficient. NLR: Neutrophil count/Lymphocyte count; PLR: Platelet count/Lymphocyte count; SII: (Neutrophil count x Platelet count)/Lymphocyte count; MPR: Mean platelet volume/Platelet count; FAR: Fibrinogen/Albumin; AGR: Albumin/Globulin; CAR: C-reactive protein/Albumin; LAR: Lactat/Albumin; DFR: D-dimer/Fibrinogen; LCR: Lymphocyte count/C-reactive protein; FLR: Fibrinogen/Lymphocyte count.

Financial Disclosure: The authors declared that this study has received no financial support.

Peer-review: Externally peer-reviewed.

REFERENCES

1. Patel A. Kaleya RN. Sammartano RJ. Pathophysiology of mesenteric ischemia. Surg Clin North Am 1992;72:31-41. [CrossRef]
2. Clair DG. Beach JM. Mesenteric ischemia. N Engl J Med 2016;374:959-68. [CrossRef]
3. Kühn F. Schiergens TS. Klar E. Acute mesenteric ischemia. Visc Med 2020;36:256-62. [CrossRef]
4. Tamme K. Reintam Blaser A. Laisaar KT. Mändul M. Kals J. Forbes A. et al. Incidence and outcomes of acute mesenteric ischaemia: a systematic review and meta-analysis. BMJ Open 2022;12:e062846. [CrossRef]
5. Bala M. Kashuk J. Moore EE. Kluger Y. Biffl W. Gomes CA. et al. Acute mesenteric ischemia: guidelines of the World Society of Emergency Surgery. World J Emerg Surg 2017;12:38. [CrossRef]
6. KLASS AA. Embolectomy in acute mesenteric occlusion. Ann Surg 1951;134:913-7. [CrossRef]
7. Roberts L Jr. Wertman DA Jr. Mills SR. Moore AV Jr. Heaston DK. Transluminal angioplasty of the superior mesenteric artery: an alternative to surgical revascularization. AJR Am J Roentgenol 1983;141:1039-42. [CrossRef]
8. Kougias P. Lau D. El Sayed HF. Zhou W. Huynh TT. Lin PH. Determinants of mortality and treatment outcome following surgical interventions for acute mesenteric ischemia. J Vasc Surg 2007;46:467-74. [CrossRef]
9. Paladino NC. Inviati A. Di Paola V. Busuito G. Amodio E. Bonventre S. et al. Predictive factors of mortality in patients with acute mesenteric ischemia. A retrospective study. Ann Ital Chir 2014;85:265-70.
10. Huang Z. Fu Z. Huang W. Huang K. Prognostic value of neutrophil-to-lymphocyte ratio in sepsis: a meta-analysis. Am J Emerg Med 2020;38:641-7. [CrossRef]
11. Huang H. Liu Q. Zhu L. Zhang Y. Lu X. Wu Y. et al. Prognostic value of preoperative systemic immune-inflammation index in patients with cervical cancer. Sci Rep 2019;9:3284. [CrossRef]
12. Wu J. Zhu H. Zhang Q. Sun Y. He X. Liao J. et al. Nomogram based on the systemic immune-inflammation index for predicting the prognosis of diffuse large B-cell lymphoma. Asia Pac J Clin Oncol 2023;19:e138-48. [CrossRef]
13. Nuzzo A. Guedj K. Curac S. Hercend C. Bendavid C. Gault N. et al; SURVI (Structure d'URgences Vasculaires Intestinales) Research Group (French Intestinal Stroke Center). Accuracy of citrulline. I-FABP and D-lactate in the diagnosis of acute mesenteric ischemia. Sci Rep 2021;11:18929. [CrossRef]
14. Treskes N. Persoon AM. van Zanten ARH. Diagnostic accuracy of novel serological biomarkers to detect acute mesenteric ischemia: a systematic review and meta-analysis. Intern Emerg Med 2017;12:821-36. [CrossRef]
15. Kulacoglu H. Kocaerkek Z. Moran M. Kulah B. Atay C. Kulacoglu S. et al. Diagnostic value of blood D-dimer level in acute mesenteric ischaemia in the rat: an experimental study. Asian J Surg 2005;28:131-5. [CrossRef]
16. Destek S. Yabacı A. Abik YN. Gül VO. Değer KC. Predictive and prognostic value of L-lactate. D-dimer. leukocyte. C-reactive protein and neutrophil/lymphocyte ratio in patients with acute mesenteric ischemia. Ulus Travma Acil Cerrahi Derg 2020;26:86-94. [CrossRef]
17. Turkmen S. Mentese S. Mentese A. Sumer AU. Saglam K. Yulug E. et al. The value of signal peptide-CUB-EGF domain-containing protein 1 and oxidative stress parameters in the diagnosis of acute mesenteric ischemia. Acad Emerg Med 2013;20:257-64. [CrossRef]
18. Siragusa S. D-dimer testing: advantages and limitations in emergency medicine for managing acute venous thromboembolism. Intern Emerg Med 2006;1:59-66. [CrossRef]

19. Acosta S. Nilsson TK. Björck M. D-dimer testing in patients with suspected acute thromboembolic occlusion of the superior mesenteric artery. Br J Surg 2004;91:991-4. [CrossRef]
20. Leone M. Bechis C. Baumstarck K. Ouattara A. Collange O. Augustin P. et al. Outcome of acute mesenteric ischemia in the intensive care unit: a retrospective. multicenter study of 780 cases. Intensive Care Med 2015;41:667-76. [CrossRef]
21. Grotelüschen R. Bergmann W. Welte MN. Reeh M. Izbicki JR. Bachmann K. What predicts the outcome in patients with intestinal ischemia? A single center experience. J Visc Surg 2019;156:405-11. [CrossRef]
22. Kim S. Park J. Kwon JH. Oh AR. Gook J. Yang K. et al. The Charlson Comorbidity Index is associated with risk of 30-day mortality in patients with myocardial injury after non-cardiac surgery. Sci Rep 2021;11:18933. [CrossRef]
23. Witte M. Neese M. Leuchter M. Philipp M. Klar E. Schafmayer C. Acute mesenteric ischemia: preexisting comorbidity determines short-term outcome and quality of life in long-term survivors. Visc Med 2022;38:393-9. [CrossRef]
24. Miyagawa Y. Yamamoto Y. Kitazawa M. Tokumaru S. Nakamura S. Koyama M. et al. Association of serum creatinine level with prognosis of laparotomy for acute mesenteric ischemia after cardiovascular surgery. Surg Res Pract 2022;2022:1737161. [CrossRef]
25. Yang S. Fan X. Ding W. Liu B. Meng J. Wang K. et al. D-dimer as an early marker of severity in patients with acute superior mesenteric venous thrombosis. Medicine (Baltimore) 2014;93:e270. [CrossRef]
26. Liu M. Yang J. Wan L. Zhao R. Elevated pretreatment fibrinogen-to-lymphocyte percentage ratio predict tumor staging and poor survival in non-small cell lung cancer patients with chemotherapy or surgery combined with chemotherapy. Cancer Manag Res 2021;13:4921-33. [CrossRef]
27. Zhong Q. Peng J. Mean platelet volume/platelet count ratio predicts severe pneumonia of COVID-19. J Clin Lab Anal 2021;35:e23607. [CrossRef]
28. Quhal F. Pradere B. Laukhtina E. Sari Motlagh R. Mostafaei H. Mori K. et al. Prognostic value of albumin to globulin ratio in non-muscle-invasive bladder cancer. World J Urol 2021;39:3345-52. [CrossRef]
29. Lagunas-Rangel FA. Neutrophil-to-lymphocyte ratio and lymphocyte-to-C-reactive protein ratio in patients with severe coronavirus disease 2019 (COVID-19): a meta-analysis. J Med Virol 2020;92:1733-4. [CrossRef]
30. Liao CK. Yu YL. Lin YC. Hsu YJ. Chern YJ. Chiang JM. et al. Prognostic value of the C-reactive protein to albumin ratio in colorectal cancer: an updated systematic review and meta-analysis. World J Surg Oncol 2021;19:139. [CrossRef]
31. Aydin C. Yıldız BP. Hattatoğlu DG. D-dimer/Fibrinogen ratio and recurrent exacerbations might have a potential impact to predict 90-day mortality in patients with COPD exacerbation. Malawi Med J 2021;33:276-80. [CrossRef]
32. Sakamoto T. Kubota T. Funakoshi H. Lefor AK. Multidisciplinary management of acute mesenteric ischemia: surgery and endovascular intervention. World J Gastrointest Surg 2021;13:806-13. [CrossRef]
33. Block TA. Acosta S. Björck M. Endovascular and open surgery for acute occlusion of the superior mesenteric artery. J Vasc Surg 2010;52:959-66. [CrossRef]
34. Beaulieu RJ. Arnaoutakis KD. Abularrage CJ. Efron DT. Schneider E. Black JH 3rd. Comparison of open and endovascular treatment of acute mesenteric ischemia. J Vasc Surg 2014;59:159-64. [CrossRef]