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Acute Mesenteric Ischaemia Presenting With Gangrenous Bowel: A Retrospective Observational Study From a Tertiary Care Centre in Northern India

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Abstract

Introduction

Acute mesenteric ischaemia (AMI) is a surgical emergency with high case fatality. Institutional outcome data describing the clinical, radiological, operative, and histopathological characteristics of AMI presenting with gangrenous bowel from tertiary care hospitals in Northern India are lacking.

Methodology

We conducted a retrospective observational study of 18 patients who presented with AMI resulting in gangrenous bowel at our institution between April 2023 and April 2026 (36 months). Clinicopathological data, operative details, histopathological findings, and outcomes were retrospectively retrieved and analysed.

Results

The median age was 62 years (range, 38-79); 15 patients were male (83.3%). Superior mesenteric artery (SMA) thrombosis was the predominant aetiology (10 patients; 55.6%). CT angiography was performed in all patients, with findings consistent with AMI in every included patient. All patients underwent emergency exploratory laparotomy; the median length of resected bowel was 120 cm (range, 60-250 cm). Ten patients (55.6%) died during hospital admission; the leading causes were septic shock and multi-organ dysfunction syndrome (MODS). The median hospital stay among survivors was 18 days (range, 12-31 days). Histopathological examination confirmed transmural coagulative necrosis in all resected specimens.

Conclusions

AMI presenting with gangrenous bowel was associated with substantial in-hospital mortality (55.6%) in this cohort. The findings describe the clinical characteristics, operative management, and in-hospital outcomes of patients presenting with advanced disease in a resource-constrained setting.

Categories: General Surgery, Emergency Medicine, Gastroenterology
Keywords: acute mesenteric ischemia, atrial fibrillation, bowel resection, ct angiography, exploratory laparotomy, gangrenous bowel, superior mesenteric artery thrombosis

Introduction

Acute mesenteric ischaemia (AMI) is a vascular emergency caused by a sudden reduction or interruption of intestinal blood flow, resulting in bowel ischaemia that may rapidly progress to transmural necrosis and infarction if not promptly treated [1]. The condition accounts for approximately one in 1,000 acute surgical admissions, yet carries a mortality rate consistently reported between 60% and 80% in the published literature [2,3]. Delayed diagnosis remains the primary determinant of poor outcomes [1]. Gangrenous bowel, the endpoint of irreversible ischaemia, mandates emergency bowel resection and is associated with the highest mortality in this already lethal condition [1,2].

A recent systematic review and meta-analysis pooling data from over 160 studies estimated the population incidence of AMI at approximately 6 per 100,000 person-years, accounting for roughly 5 of every 10,000 acute hospital admissions, and confirmed that occlusive arterial disease (embolic and thrombotic) constitutes close to two-thirds of all cases [4]. The same analysis found that overall short-term mortality, although it has fallen from nearly 69% in series predating the year 2000 to around 55% in more recent series, remains substantial, indicating that improvements in critical care and imaging have translated into only modest gains in survival [4].

Outcome data from tertiary care centres in India and other South Asian settings remain comparatively sparse, and the available series differ considerably in etiological profile, access to CT angiography, and availability of endovascular revascularisation, which limits the direct applicability of Western treatment algorithms - largely derived from populations with a different balance of embolic, thrombotic, and non-occlusive disease - to resource-constrained settings such as ours [1,4].

To address the limited institutional evidence from Northern India, we sought to characterise the clinical profile, management, and in-hospital outcomes of patients with AMI presenting with gangrenous bowel at a tertiary care centre. Specifically, the study aimed to (i) describe the demographic, clinical, radiological, etiological, operative, and histopathological characteristics of these patients; (ii) report in-hospital mortality as the primary outcome and describe secondary outcomes, including postoperative complications, their severity according to the Clavien-Dindo classification, the need for prolonged mechanical ventilation, and length of hospital stay; and (iii) describe the histopathological findings in resected bowel specimens. Given the retrospective descriptive design and small sample size, the study was not designed to establish independent predictors of mortality.

Materials And Methods

Study design and setting

This was a retrospective observational study conducted in the Department of Surgery at a tertiary care academic hospital in Northern India. The study period extended from April 2023 to April 2026 (36 months). Data were collected retrospectively from inpatient records and the operation theatre register between 1 April 2023 and 1 April 2026, after the study period ended in April 2026. No data were collected prospectively. Ethical approval was obtained from the Institutional Ethics Committee. Data were extracted after ethical approval was obtained on 3 September 2026. Written informed consent was obtained from all surviving patients. For deceased patients, consent for use of anonymised data was obtained from the next of kin. The study was conducted in accordance with the ethical standards laid down in the Declaration of Helsinki (2013 revision). All patient records were de-identified prior to data extraction and analysis; no patient names, identification numbers, or other identifying information are presented anywhere in this manuscript, tables, or figures. No formal a priori sample-size calculation was performed because the study included all eligible cases identified during the specified study period.

Participants

Consecutive adult patients (age ⩾18 years) admitted during the study period with a confirmed diagnosis of AMI and who were found to have gangrenous bowel on exploratory laparotomy were eligible for inclusion. Patients with bowel gangrene attributable to closed-loop obstruction, incarcerated hernia, or colonic carcinoma (without a vascular component) were excluded. During the study period, 26 patients were identified. Eight patients were excluded: three died before surgery, three were managed non-operatively, and two had bowel gangrene attributable to other causes. Eighteen patients fulfilled the inclusion criteria and constituted the final study cohort (Figure *1*).

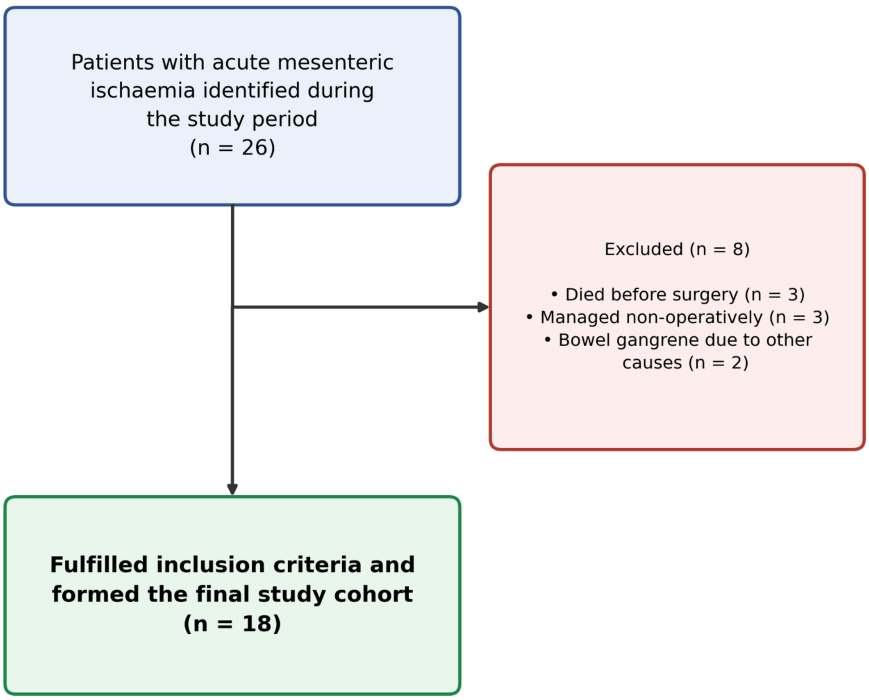


FIGURE 1: STROBE flow diagram of patient selection.

STROBE: Strengthening the Reporting of Observational Studies in Epidemiology

Diagnostic criteria

AMI was diagnosed on clinical suspicion (acute severe abdominal pain with raised lactate and/or leucocytosis), together with CT angiography showing superior mesenteric artery (SMA) filling defect or non-opacification (thrombosis/embolism), or diffuse mesenteric vasoconstriction with bowel wall hypoenhancement and patent main vessels (non-occlusive mesenteric ischaemia (NOMI)). The diagnosis was confirmed at laparotomy (gangrenous bowel) and histopathologically.

Data collection

Data were retrieved retrospectively from inpatient case records and the operation theatre register. The information extracted included demographic characteristics, comorbidities, duration of symptoms before admission, clinical findings at presentation, haematological and biochemical parameters, including serum lactate, CT angiography findings, operative findings, the length and segment of bowel resected, the type of reconstruction performed, postoperative complications, histopathological findings, length of hospital stay, and in-hospital mortality. Information regarding perioperative management, including anticoagulation and the reasons for choosing primary anastomosis or stoma formation, was reviewed from the available clinical and operative records. Resected specimens were examined by a single pathologist, who was not blinded, using full-thickness sections.

Operative management

All included patients underwent emergency exploratory laparotomy after initial resuscitation and clinical assessment. Operative findings, including the location and extent of gangrenous bowel, the length of bowel resected, and the type of reconstruction performed, were retrieved from the operative records.

The decision between primary anastomosis and stoma formation was based on the operating surgeon's intraoperative assessment, including haemodynamic stability and the degree of contamination.

Statistical analysis

Data are presented as descriptive statistics. Continuous variables are expressed as median and range; categorical variables are presented as absolute numbers and percentages. Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 26.0 (Released 2018; IBM Corp., Armonk, NY, USA). No

inferential or multivariable analysis was performed; all findings are descriptive. Because of the sample size, no multivariable analysis was attempted, and all comparisons are hypothesis-generating. Data completeness was assessed for all variables included in the analysis. Available observations were used for descriptive analysis, with the relevant denominators reported wherever data were incomplete. Certain details of perioperative management, particularly the exact dose and duration of anticoagulation, were inconsistently documented in the retrospective records. No imputation was performed for missing observations.

Results

Patient demographics and comorbidities

Eighteen patients (15 male, 83.3% and 3 female, 16.7%) with a median age of 62 years (range, 38-79) were included. Hypertension was present in 10 patients (55.6%), atrial fibrillation (AF) in five (27.8%), and diabetes mellitus in three (16.7%). Four patients (22.2%) were current smokers. Demographic and comorbidity profiles of the study patients are summarised in Table *1*.

Characteristic	Value
Median age, years (range)	62 (38-79)
Male sex, n (%)	15 (83.3)
Hypertension, n (%)	10 (55.6)
Atrial fibrillation, n (%)	5 (27.8)
Diabetes mellitus, n (%)	3 (16.7)
Smoking (current), n (%)	4 (22.2)

TABLE 1: Demographic and comorbidity profile of study patients (n = 18).

Presentation and investigations

The median duration of symptoms before hospital admission was 36 hours (range, 12-72 hours). All patients presented with acute-onset severe abdominal pain (100%); 14 (77.8%) had associated vomiting. Abdominal tenderness was present in all cases (100%); peritonism (guarding and/or rigidity) was documented in 12 patients (66.7%) at the time of the laparotomy decision. Leucocytosis (white cell count >12 × 10^9/L) was present in 16 patients (88.9%). Serum lactate was elevated (>2 mmol/L) in all patients at the time of measurement (100%); 10 patients (55.6%) had severe lactic acidosis (lactate >4 mmol/L). CT angiography was performed in all patients (100%). Clinical presentation and investigations are summarised in Table *2*.

Variable	Value
Median symptom duration before admission (hours, range)	36 (12-72)
Severe abdominal pain, n (%)	18 (100)
Vomiting, n (%)	14 (77.8)
Peritonism (guarding/rigidity), n (%)	12 (66.7)
Leucocytosis (WCC >12 × 10^9/L), n (%)	16 (88.9)
Elevated serum lactate (>2 mmol/L), n (%)	18 (100)
Severe lactic acidosis (lactate >4 mmol/L), n (%)	10 (55.6)
CT angiography performed, n (%)	18 (100)

TABLE 2: Clinical presentation and investigations.

WCC: white cell count; CT: computed tomography

Aetiology

SMA thrombosis was the most common aetiology, identified in 10 patients (55.6%). SMA embolism was the cause in five patients (27.8%), and NOMI accounted for three patients (16.7%). All 10 patients with SMA thrombosis had atherosclerotic risk factors (hypertension, smoking, or diabetes). The patients with SMA embolism had known AF and were not anticoagulated at the time of presentation. Representative CT findings are shown in Figure 2.

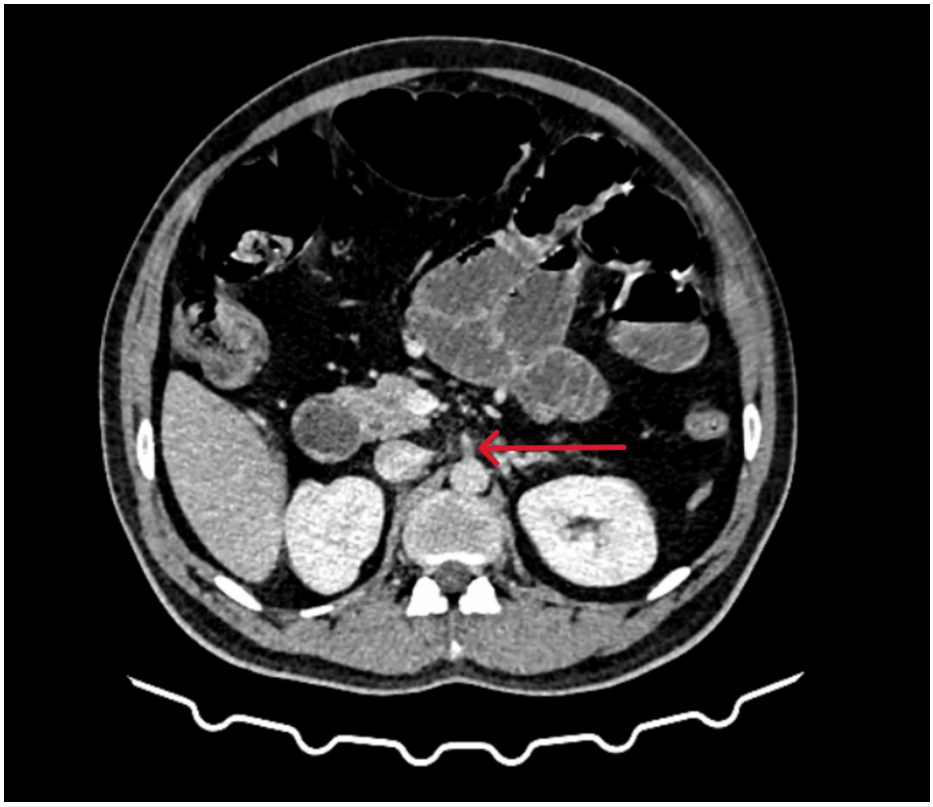


FIGURE 2: Axial contrast-enhanced CT angiographic image demonstrating a partial intraluminal filling defect in the superior mesenteric artery (red arrow), consistent with partial thrombosis.

Source: Image from the authors' institutional radiology archive.

CT: computed tomography

Operative findings and management

All patients underwent emergency exploratory laparotomy after resuscitation and relevant investigation (100%). On-table findings included gangrenous small bowel in all cases (100%); two patients (11.1%) also had gangrenous caecum and ascending colon requiring right hemicolectomy. The median length of resected bowel was 120 cm (range, 60-250 cm). A primary anastomosis was fashioned in eight patients (44.4%); the remaining 10 (55.6%) had a defunctioning stoma, reflecting haemodynamic instability or gross faecal contamination precluding safe primary anastomosis. Aetiology, operative findings, and intraoperative management are summarised in Table 3. Representative operative specimens are shown in Figure 3.

Variable	Value
SMA thrombosis, n (%)	10 (55.6)
SMA embolism, n (%)	5 (27.8)
Non-occlusive mesenteric ischaemia, n (%)	3 (16.7)
Median resected bowel length, cm (range)	120 (60-250)
Resection involving caecum/ascending colon, n (%)	2 (11.1)
Primary anastomosis, n (%)	8 (44.4)
Defunctioning stoma, n (%)	10 (55.6)

TABLE 3: Aetiology, operative findings, and intraoperative management.

SMA: superior mesenteric artery



FIGURE 3: Resected gangrenous small bowel specimen.

Source: Intraoperative photograph taken by the authors during laparotomy.

Postoperative course and outcomes

Postoperative complications were assessed in all 18 patients during the index hospital admission, from the time of surgery until discharge or in-hospital death. Surgical site infection (Clavien-Dindo Grade II) was the most common complication (eight patients; 44.4%) [5]. Six patients (33.3%) required prolonged mechanical ventilation (Clavien-Dindo Grade IVa) [5]. Of the 10 in-hospital deaths, five occurred within the first seven postoperative days (5/18 patients in the overall cohort, 27.8%; equivalent to 50% of the in-hospital deaths). Among the eight survivors (44.4%), the median hospital stay was 18 days (range, 12-31 days). Anastomotic leakage occurred in two of the eight patients (25%) who underwent primary anastomosis (Clavien-Dindo Grade IIIb). Three patients (16.7%) underwent reoperation/relook laparotomy (Clavien-Dindo Grade IIIb). Histopathological examination confirmed transmural coagulative necrosis in all resected specimens.

Postoperative complications and outcomes are summarised in Table 4. Representative histopathology is shown in Figure 4.

Variable	n/N (%)	Clavien-Dindo grade
In-hospital mortality	10/18 (55.6)	V
Cause of death: septic shock*	4/10 (40)	V
Cause of death: MODS*	4/10 (40)	V
Cause of death: respiratory failure*	2/10 (20)	V
Deaths within 7 postoperative days	5/10 (50)	V
Surgical site infection	8/18 (44.4)	II
Prolonged mechanical ventilation	6/18 (33.3)	IVa
Anastomotic leak	2/8 (25)#	IIIb
Reoperation/relook laparotomy	3/18 (16.7)	IIIb
Median hospital stay, survivors only (days, range)	18 (12-31)	-

TABLE 4: Postoperative complications and outcomes.

*Each death is assigned a single primary cause. Percentages are calculated using the stated denominator. # Primary anastomosis.

MODS: multi-organ dysfunction syndrome

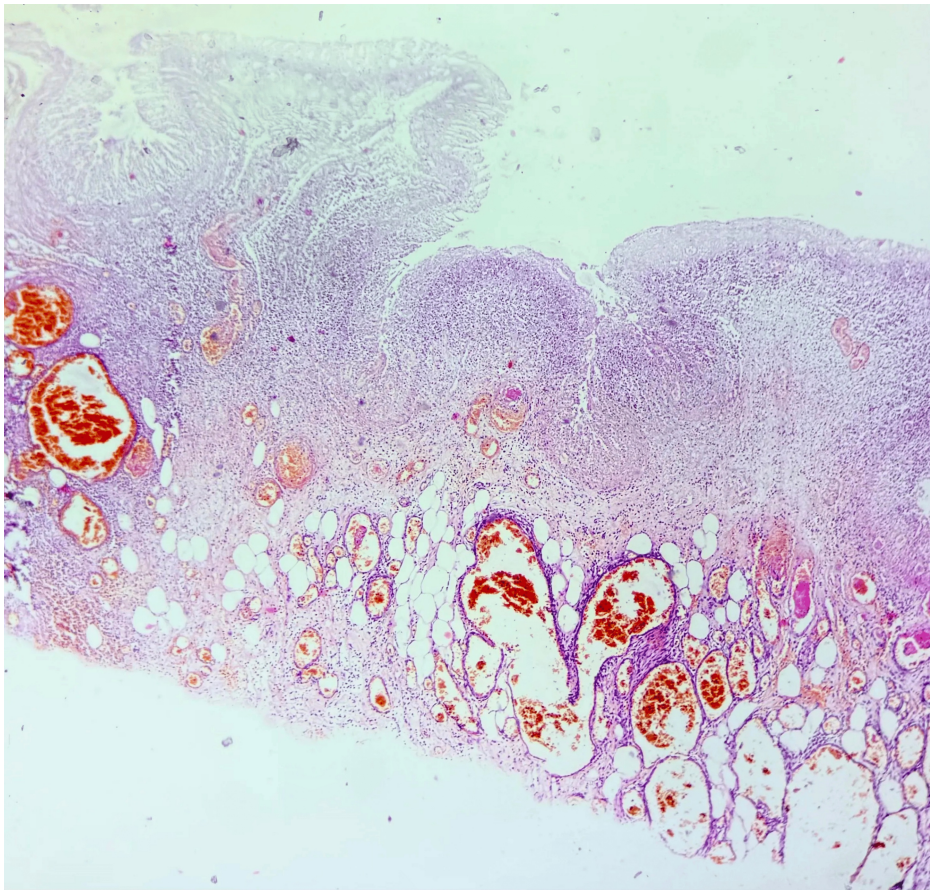


FIGURE 4: Representative H&E-stained histopathological section (100× magnification) showing sloughing and necrosis of the mucosal epithelium with marked congestion in the submucosa.

Transmural coagulative necrosis was documented in the histopathological examination of the resected bowel specimens.

Source: Slide prepared and photographed by the Department of Pathology at the authors' institution.

Discussion

The in-hospital mortality of 55.6% observed in this series is consistent with published data from comparable resource-constrained settings in South Asia and other low- and middle-income countries, where outcomes are substantially worse than the 25%-35% mortality reported from endovascular-capable tertiary centres in high-income countries [1,6]. Nagaraja et al. reported an overall mortality of 39%, rising to 51% in the subgroup with arterial occlusion - a figure directly comparable to the present series, which comprised exclusively arterial and non-occlusive ischaemia [7]. In the only prospective Indian study identified, Kundan et al. reported a 62.5% mortality in patients undergoing exploratory laparotomy for AMI at a Northern Indian government institution, attributing the excess mortality to late presentation and limited preoperative CT availability [8].

SMA thrombosis was the predominant aetiology in this series (55.6%), a finding that contrasts with Western literature, where SMA embolism has historically been reported as the leading mechanism in approximately 50% of cases [1,9]. However, this aetiological shift is consistent with published Indian and East Asian experience. Nagaraja et al. found a high proportion of venous occlusion (48%) in their Indian cohort, while a retrospective Chinese cohort study of AMI due to SMA thromboembolism similarly emphasised thrombotic arterial occlusion as a major pathway to transmural bowel necrosis, consistent with an atherosclerotic vascular substrate underlying arterial AMI in Asian populations [7,10]. The present cohort reflects this pattern: all 10 patients with SMA thrombosis (55.6%) had documented atherosclerotic risk factors (hypertension, diabetes, or smoking), with a median age of 62 years - consistent with a predominantly atherosclerotic population. The five patients with SMA embolism (27.8%) all had known AF and were not receiving anticoagulation at the time of presentation - a modifiable risk that underscores the importance of adherence to anticoagulation therapy in AF patients at a population level [1,11].

CT angiography was performed in all 18 patients and demonstrated findings consistent with AMI in the included cohort. However, this 100% proportion represents the positivity observed in a highly selected group of patients with surgically confirmed gangrenous bowel and should not be interpreted as an estimate of diagnostic accuracy, sensitivity, or specificity. As the study did not include a representative cohort of patients with suspected AMI who had negative imaging findings or alternative diagnoses, the diagnostic performance of CT angiography could not be independently evaluated [1,12].

Emergency exploratory laparotomy with aggressive resection of non-viable bowel was the operative approach in all 18 patients (100%). The median resected bowel length of 120 cm (range 60-250 cm) reflects the extent of gangrenous change typically encountered in delayed presentations; the median symptom duration of 36 hours before hospital admission is consistent with the well-documented problem of diagnostic delay in AMI and is longer than the 12-24 hour symptom duration associated with the most favourable operative outcomes in series with endovascular first-line capability [1,13]. Primary anastomosis was possible in only 8 of 18 patients (44.4%); the remaining 10 patients (55.6%) received a defunctioning stoma, reflecting haemodynamic instability or gross peritoneal contamination at the time of surgery. This operative decision is consistent with published evidence: in a prospective study of 85 patients with AMI, Brillantino et al. reported better outcomes with a damage-control approach (resection followed by a planned second look and delayed reconstruction) than with one-stage primary anastomosis in non-critical patients [14]. Primary anastomosis was therefore reserved in our series for haemodynamically stable patients without gross faecal contamination. The stoma rate of 55.6% in this series is consistent with comparable resource-limited Indian series and represents an appropriate operative strategy for this population [7].

The two principal causes of death - septic shock (4/10 patients, 40%) and multi-organ dysfunction syndrome (MODS) (4/10 patients, 40%) - account for 8 of the 10 in-hospital deaths and are consistent with published mortality data from large series of AMI [1,4]. The remaining two deaths resulted from refractory respiratory failure in the context of prolonged mechanical ventilation, a complication documented in six patients (33.3%) in this series. Among the 10 patients who died during hospitalisation, a retrospective descriptive review demonstrated the coexistence of multiple indicators of disease severity, including older age, elevated serum lactate, extensive bowel resection, and haemodynamic instability requiring vasopressor support. However, these observations were not subjected to inferential or multivariable analysis. Given the small sample size, the observed overlap should not be interpreted as establishing statistically significant associations, independent predictors, or causal relationships with mortality. Although elevated serum lactate and other markers of disease severity have been recognised as prognostic indicators in previously published studies, their independent predictive value could not be assessed in the present cohort [15,16]. Five of the 10 deaths occurred within the first seven postoperative days (27.8% of the overall cohort; 50% of in-hospital deaths), consistent with published series identifying the early postoperative period as the highest-risk phase in AMI survivors of laparotomy [1,15].

Anticoagulation was initiated in all surviving patients and in those deceased patients in whom it was not contraindicated by operative bleeding. Anticoagulation management was reviewed retrospectively from the available clinical and medication records. The records indicated that anticoagulation was initiated in surviving patients and in patients who subsequently died when it was not contraindicated by operative bleeding. However, the agent, dose, timing of initiation, and duration of treatment could not be consistently established for all patients. Therapeutic anticoagulation is recommended by WSES guidelines for all patients with arterial or embolic AMI following bowel resection to prevent thrombus propagation and recurrence [1].

The most critical structural constraint on outcomes in the present series - and in comparable Indian public tertiary care series - is the absence of endovascular revascularisation capability. Contemporary European and North American guidelines recommend catheter-directed thrombolysis or aspiration thrombectomy as the preferred initial intervention for haemodynamically stable patients with SMA embolism without peritonitis, with surgical resection reserved for non-viable bowel [1,17]. Björnsson et al. demonstrated acceptable outcomes with catheter-directed thrombolysis for acute SMA occlusion in selected patients, with a revascularisation success rate of approximately 75% and avoidance of laparotomy in a proportion of patients [18]. In the present series, all 18 patients required emergency laparotomy, partly because the extent of bowel ischaemia at presentation precluded non-operative management and partly because endovascular infrastructure (dedicated interventional radiology suite, 24-hour vascular surgical availability) was unavailable. Development of regional endovascular capability, integration of vascular surgery into emergency AMI pathways, and establishment of a structured AMI protocol incorporating early CT angiography, multidisciplinary decision-making, and surgical damage-control principles are the most actionable institutional steps towards improving outcomes. The absence of endovascular revascularisation capability represents an important institution-specific limitation that influenced the available treatment pathways in this cohort. All included patients underwent emergency exploratory laparotomy because they presented with gangrenous bowel. In centres with established endovascular facilities, selected patients with early AMI and viable bowel may undergo catheter-directed thrombolysis or thrombectomy, potentially resulting in different patient selection and clinical outcomes. Therefore, the present findings primarily reflect a surgically managed population with advanced disease and should not be generalised to institutions with established endovascular management pathways.

The primary strength of this study is its consecutive patient design, which minimises selection bias within

the study period. Detailed operative records and standardised data collection allowed comprehensive characterisation of the clinical course. An important strength of this study is the inclusion of consecutive patients and the presentation of institutional clinicopathological and operative data from Northern India, contributing regional evidence on a severe form of AMI that remains relatively underrepresented in the published literature.

This study has several limitations. First, the small sample size (n = 18) and retrospective single-centre design limit the generalisability of the findings and substantially restrict statistical power. The study was descriptive in nature and was not designed to establish independent predictors of mortality or determine causal relationships between clinical characteristics and outcomes.

Second, the study cohort comprised a selected population of patients who underwent exploratory laparotomy and were found to have gangrenous bowel. Patients who died before surgery, were managed non-operatively, or had reversible ischaemia without gangrene were not included in the final analysis. This selection limits the applicability of the observed mortality rate to the broader population of patients presenting with AMI, particularly those with earlier-stage disease or those managed using non-operative or endovascular approaches.

Third, the retrospective nature of data collection introduces the possibility of information bias due to incomplete or inconsistent documentation. Variables such as symptom duration, haemodynamic status, and details of perioperative management were dependent on the accuracy of the available clinical records and patient-reported histories.

Fourth, the absence of endovascular revascularisation facilities at our institution influenced the available management options. Consequently, the findings primarily reflect outcomes following emergency surgical management in a resource-constrained setting and cannot be directly compared with outcomes from centres offering catheter-directed thrombolysis, thrombectomy, or other endovascular interventions.

Fifth, the single-centre design means that institutional practices, including resuscitation strategies, antibiotic administration, operative decision-making, postoperative critical care, and ICU availability, may have influenced the observed outcomes. The retrospective data also did not permit a systematic assessment of the consistency of these interventions across all patients.

Additionally, the small sample size precluded meaningful multivariable analysis. The observed coexistence of clinical features among patients who died should therefore be interpreted as descriptive and not as evidence of independent mortality predictors. Finally, the retrospective nature of the study limited the completeness of documentation for certain treatment-related variables. In particular, the exact dose and duration of anticoagulation were not consistently recorded, precluding a systematic assessment of these treatment parameters. Additionally, long-term follow-up beyond hospital discharge was unavailable, limiting the assessment of subsequent clinical outcomes.

Conclusions

AMI presenting with gangrenous bowel was associated with substantial in-hospital mortality (55.6%) in this retrospective cohort. The study describes the clinical characteristics, aetiological profile, operative findings, histopathological features, and in-hospital outcomes of patients managed at a tertiary care centre in Northern India. The findings reflect the clinical experience of managing advanced AMI in a resource-constrained setting. However, the small sample size, retrospective design, and absence of a comparison group limit the generalisability of the findings and preclude the establishment of independent mortality predictors or the comparative effectiveness of different management strategies.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Acquisition, analysis, or interpretation of data: Md Fariduddin, Shiv Ram Singh, Shagufta Qadri, S Aun Ali Mehdi

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Concept and design: Wasif Mohammad Ali, Manzoor Ahmad

Critical review of the manuscript for important intellectual content: Wasif Mohammad Ali, Manzoor Ahmad

Supervision: Wasif Mohammad Ali, Manzoor Ahmad, Shagufta Qadri

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. Institutional Ethics Committee, Jawaharlal Nehru Medical College and Hospital, Faculty of Medicine, Aligarh Muslim University issued approval IECJNMC/2365. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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