Indian J Surg (December 2015) 77(Suppl 3):S843–S849
DOI 10.1007/s12262-014-1034-5

ORIGINAL ARTICLE

Acute Mesenteric Ischaemia—*An Indian Perspective*

Raghavendra Nagaraja · Prashantha Rao · Vinay Kumaran · Amitabh Yadav · Sorabh Kapoor · Vibha Varma · Naimish Mehta · Samiran Nundy

Received: 19 September 2013 / Accepted: 8 January 2014 / Published online: 22 January 2014

Abstract In Western countries, acute mesenteric ischaemia is commonly due to arterial occlusion and occurs in patients who are usually in their seventh decade. A venous cause for intestinal gangrene has been reported in only about 10 %. We examined whether this was so in India and compared the clinical features of patients with mesenteric arterial and venous ischaemia and relate these to their ultimate prognosis. We studied retrospectively, the records of all patients admitted or referred to the department with a diagnosis of acute mesenteric ischaemia between January 1997 and October 2012, noting their demographic details and mode of presentation, the results of preoperative imaging and blood investigations, the extent of bowel ischaemia, and the length of bowel that was resected at operation and their outcome. There were 117 patients, 85 males and 32 females whose median age was 53 years. Mesenteric venous thrombosis was seen in 56 patients (48 %) and mesenteric arterial occlusion in 61 (52 %). Forty six patients died (39 %); 15 with venous occlusion (27 %) and 31 with arterial occlusion (51 %). Compared to patients with arterial occlusion, the patients with venous obstruction were younger, had a longer duration of symptoms, were less frequently hypotensive at presentation, had higher platelet counts, had a shorter length of bowel resected, had fewer colonic resections and had a lower mortality. Other predictors of mortality on multivariate analysis were a longer duration of symptoms, lower serum albumin and higher creatinine levels at presentation and a shorter length of residual bowel. In India, acute mesenteric ischaemia in tertiary care centres is due to venous thrombosis in almost half of the patients who are at least a decade younger than those in the West. Significant predictors of mortality include low serum albumin and raised creatinine levels, a shorter residual bowel length and an arterial cause for mesenteric ischaemia.

Keywords Mesenteric · Ischaemia · Gangrene · Thrombosis

R. Nagaraja · P. Rao · V. Kumaran · A. Yadav · S. Kapoor · V. Varma · N. Mehta · S. Nundy
Department of Surgical Gastroenterology and Liver Transplantation, Sir Ganga Ram Hospital, New Delhi, India

R. Nagaraja (✉)
Department of Surgical Gastroenterology and Liver Transplantation, Manipal Hospital, Old Airport Road, Kodihalli, Bengaluru, India
e-mail: rags_dr@yahoo.co.in

Introduction

Acute mesenteric ischaemia (AMI) remains a diagnosis associated with high morbidity and mortality rate [1, 2]. The majority of the publications on this rare disease have come from western countries, who have reported that the median age of patients was approximately 70 years and arterial occlusion was its predominant cause [3]. Although efforts are usually made to try and diagnose the condition before bowel infarction sets in and treat arterial occlusion with percutaneous vascular intervention or by surgery, this is rarely possible and most patients are seen after intestinal gangrene has occurred. Our impression in India was that patients with mesenteric ischaemia were different from those described in Western reports—they were younger and venous obstruction was a more common cause. Further, the majority, as in other diseases in the developing world, are referred to tertiary medical centres at advanced stages of their disease i.e. once the features of peritonitis have developed.

The main aims of the present study were to define the characteristics of Indian patients with AMI, to compare the clinical features and outcome of those who had venous and arterial obstruction and to identify prognostic factors associated with mortality.

Patients and Methods

In a retrospective study, from a prospectively maintained database between January 1997 and October 2012, we examined the clinical characteristics and outcome of all patients who were admitted to the department of Surgical Gastroenterology, Sir Ganga Ram Hospital with bowel gangrene or ischaemia due to primary mesenteric vascular disease. Those with gangrene secondary to obstruction, trauma and hernia were excluded.

We analysed their demographic factors, presentation, preoperative imaging and blood investigations at presentation, presence and extent of bowel gangrene, length of bowel resected and postoperative outcome. The primary outcome measure was mortality. The secondary outcome measure was postoperative morbidity.

We divided patients into those with mesenteric arterial occlusion (MAO) and mesenteric venous thrombosis (MVT). None of them had non-occlusive mesenteric ischaemia. The diagnosis was based on clinical presentation (particularly personal or family history of venous thrombosis, cardiac/peripheral vascular disease), imaging (arterial/venous thrombosis, atheroaclerotic aorta), intraoperative findings (presence of arterial pulsations/venous thrombosis) and histopathology report.

In a patient with suspicion of having AMI, we prefer to get a Triphasic CT with negative oral contrast, unless the patient is very sick with hemodynamic instability.

On confirmation of diagnosis, we would start heparin infusion with a loading dose and hourly infusion of unfractionated heparin or therapeutic dose of low molecular weight heparin along with broad spectrum antibiotics and other supportive measures. We feel that unfractionated heparin infusion is better in the perioperative period as the effect may be titrated and can easily be reversed if required for any reason.

Patients were taken up for laparotomy for one or more of the following reasons:

(1) Generalised peritonitis
(2) Localised peritonitis with systemic findings (fever, raised TLC)/organ dysfunction (renal/hemodynamic/intestinal/encephalopathy)
(3) Gangrenous bowel found on CT scan of the abdomen
(4) Strong clinical suspicion (with or without abdominal signs).

Second look laparotomy was done in patients with the following:

(1) Planned re-exploration—in patients with doubtful viability involving significant portions of small bowel at initial exploration
(2) Unplanned re-exploration—in patients with haemodynamic instability/non-improving or new-onset organ failure after primary surgery with unidentified extra-abdominal cause

– Intra-abdominal complication post surgery (anastomotic leak).

We have not tried intra-arterial infusion therapy perioperatively with vasodilator and anticoagulants/thrombolytics in patients with MAO. We feel that this aspect of the treatment should be analysed in future studies along with surgical revascularisation.

The patients were followed till discharge or death. The postoperative complications were graded according to the Clavien–Dindo classification [4]. All the complications were recorded but only the highest grades were included for analysis.

Patients with MVT, MAO with demonstrable embolic source (atrial fibrillation, atheromatous proximal aorta) and those with prior history of vascular occlusive disease (limb vessel ischaemia, ischaemic stroke) were put on long term anticoagulation with oral anticoagulants. The INR in these patients was maintained between two and three. Long term anticoagulation with oral anticoagulants was stopped only if patients developed any complication attributable to it. Patients with MAO with no demonstrable embolic source were put on long term antiplatelet drug (Aspirin) after the first month, till which time they were administered anticoagulants.

Statistical Methods

The categorical values were expressed as numbers with percentages and continuous variables as medians with range. The patients were divided into two groups—those with MVT and those with MAO. The categorical variables were compared using Fisher's exact test and continuous variables with the Mann–Whitney *U* test. Multivariate analysis was done using multiple regression.

Results

There were a total of 117 patients of whom 85 were males and 32 were females. Their median age was 53 years (range 23–91). Mesenteric venous thrombosis was the cause of AMI in 56 patients (48 %) and MAO in 61 (52 %). Forty-six patients died (39 %); 15 of those with MVT (27 %) and 31 with MAO (51 %). Their median hospital stay was 14 days (6–53).

Presentation

The most common presenting complaint was abdominal pain (n=110; 94 %), followed by constipation (n=73; 62 %) and abdominal distension (n=63; 54 %). Fifty-six patients (48 %)

had features of peritonitis (either local/generalised) and 34 (29 %) had hypotension.

Comorbidities

Sixty-six (56 %) of the patients had associated comorbidities including hypertension (n=33; 28 %), coronary artery disease (n=24; 21 %) and diabetes mellitus (n=20; 17 %). Six of our patients had cirrhosis at presentation, five with MVT and one with MAO. Four of these patients expired, three with MVT and one with MAO.

Imaging

A computed tomography (CT) scan of the abdomen (either a contrast enhanced scan or an angiographic examination) was done in 95 patients. The common findings were small bowel wall thickening (82 %), dilatation (75 %) and the presence of free fluid (73 %). Thrombosis of the main portal or superior mesenteric vein was seen in 39 of the 49 patients (80 %), in those with venous occlusion, and thrombosis of the mesenteric artery in 31 of the 46 patients (67 %)—CT scan was not done in 15 of the 61 patients with MAO and 7 of the 56 patients with MVT. These patients were taken up directly for surgery, without a CT scan, on clinical and abdominal X-ray findings alone. The diagnosis in these patients was based on clinical history, intraoperative findings and histopathology report.

Surgery

Surgery was performed in 113 patients and 4 were managed conservatively. The patients managed conservatively all had MVT and survived. Of the 113 patients undergoing surgery, 105 underwent some form of bowel resection. In eight patients, bowel resection was not done because of its doubtful viability (four) or because the gangrene was too extensive (three) or ischaemic region included the duodenojejunal flexure (one). Of the 105 patients undergoing bowel resection, 74 had a part of the small bowel removed, 30 had portions of both the small intestine and colon excised and 1 had only colonic resection. Forty-six underwent resection with a primary anastomosis and 59 underwent resection with exteriorization (anastomosis with either proximal diversion or a proximal stoma and a mucous fistula).

Twenty-five patients underwent exploration for massive (more than 200 cm) bowel resection for gangrene [5, 6]. No resection was done in 3, 14 underwent resection with exteriorization and 8 underwent resection with anastomosis. Fifteen of these patients died after the primary surgery (60 %). The mortality in patients with shorter (less than 200 cm) bowel resections was 34 % (27 of 80).

Second look procedures were done in 13 patients. No further resection was required in two, an anastomotic leak was found in two (the bowel was exteriorized) and further bowel resection was done in the others due to an extension of the ischaemic process.

Revascularisation was done in six patients. The procedures were thrombectomy in 1, SMA reimplantation in two, common iliac artery to SMA bypass grafting in two (saphenous vein and Gore-tex graft in one each), aorta to SMA Gore-tex graft in one. Three of them required limited bowel resection in the primary surgery and all of them recovered well. Two patients (who did not undergo bowel resection in the primary surgery) had planned reexploration, one needing massive resection of bowel and in another resection of small length of small bowel was required. The patient who required massive resection of bowel in reexploration expired subsequently.

Mesenteric Venous vs Arterial Occlusion (Table 1)

Patients with MVT were younger than those with MAO (50 vs 57 years), had a longer duration of symptoms (14 vs 2 days), hypotension was less frequent at presentation (14 % vs 43 %), had a higher platelet count (2.6 vs 2 lakhs/cumm), lower length of bowel resected (76 vs 152 cm), less frequent colonic resection (11 % vs 41 %) and a lower mortality (27 % vs 51 %).

Survivals vs Deaths (Table 2)

The surviving patients at presentation had a longer duration of symptoms (6 vs 3 days) and pain was more frequent (99 % vs 87 %). They also had higher levels of haemoglobin (12.6 vs

Table 1 MVT vs MAO—difference in characteristics

	MVT (56)	MAO (61)	p value
Age (years)	50	57	0.0019
Sex (males)	43 (77 %)	42 (69 %)	0.67
Duration of symptoms (days)	14	2	<0.0001
Hospital stay (days)	14	13	0.679
Peritoneal signs	22 (39 %)	34 (56 %)	0.09
Hypotension	8 (14 %)	26 (43 %)	0.001
Comorbidity	27 (48 %)	41 (67 %)	0.13
Haemoglobin (g/dl)	12.3	11.7	0.597
TLC (1,000/cumm)	19.4	16.7	0.082
Platelet count (l/cumm)	2.6	2.0	0.046
Albumin (g/dl)	2.5	2.6	0.919
Creatinine (mg/dl)	1.1	1.3	0.078
Bowel resection	51 (91 %)	54 (89 %)	0.29
Resected length (cm)	76	152	0.0002
Length from DJ (cm)	99	53	0.159
Length from IC (cm)	61	0	<0.0001
Colon resection	6 (11 %)	25 (41 %)	0.0003
Mortality	15 (27 %)	31 (51 %)	0.008

Table 2 Survived vs died

Variable	Survived (71)	Died (46)	*p* value
Age (years)	52	54	0.185
Sex (male)	54 (76 %)	31 (67 %)	0.29
Duration of symptoms (days)	6	3	0.010
Pain at presentation	70 (99 %)	40 (87 %)	0.0145
Peritonitis	36 (51 %)	20 (43 %)	0.44
Hypotension	14 (20 %)	20 (43 %)	0.02
Comorbidity	43 (61 %)	25 (54 %)	0.43
Haemoglobin (g/dl)	12.6	10	<0.0001
TLC (1,000/cumm)	17.2	19.2	0.463
Platelet count (l/cumm)	2.7	1.7	0.003
Creatinine (mg/dl)	1.1	1.6	0.002
Albumin (g/dl)	2.8	2.3	0.0007
Bilirubin (mg/dl)	1	1.6	0.015
Bowel resected (cm)	91	152	0.04
Bowel perforation	10 (14 %)	12 (26 %)	0.14
Massive resection	10 (14 %)	15 (33 %)	0.017
Length from DJ (cm)	91	46	0.001
Length from IC (cm)	53	15	0.13
Cause—MAO	30 (42 %)	31 (67 %)	0.008
Revascularisation	5 (7 %)	1 (2 %)	0.39
Relaparotomy	4 (6 %)	11 (24 %)	0.009
Colon resected	19 (27 %)	12 (26 %)	1.0
Primary anastomosis	30 (42 %)	16 (35 %)	0.4

10 g/dl), platelets (2.7 l/cumm vs 1.7 l/cumm) and albumin (2.8 vs 2.3 g/dl) and lower levels of creatinine (1.1 vs 1.6 mg/dl) and bilirubin (1 vs 1.6 mg/dl) at presentation. They also had shorter lengths of bowel resected (91 vs 152 cm). Massive bowel resection was significantly associated with mortality, as was relaparotomy. Patients who survived were found to have a greater length of proximal bowel from DJ flexure (91 vs 46 cm).

On multivariate analysis (Table 3), a longer duration of symptoms, lower albumin and higher creatinine levels at presentation, a shorter length of remaining bowel from the DJ flexure and MAO as cause for the AMI were significantly associated with perioperative mortality.

Cause of Mortality (Table 4)

The most common cause of death in these patients was multiorgan failure (28; 61 %). Septicaemia (with a positive blood culture) was seen in 16 of the 46 patients (35 %), in which 8 had an identifiable cause (4 anastomotic leaks, 4 respiratory infections) and in 8, no source was found. Myocardial infarction (seven), adult respiratory distress syndrome (ARDS; 3), liver failure (four) and extension of thrombus (three) accounted for the rest of cases.

Table 3 Multivariate analysis of factors significantly contributing to mortality

Variable	*t* ratio	*p* value	Significance
Duration of symptoms	2.04	0.045	Yes
Pain at presentation	0.33	0.735	No
Hypotension	0.85	0.397	No
Haemoglobin	1.86	0.067	No
Platelet count	1.08	0.280	No
Creatinine	3.12	0.002	Yes
Bilirubin	1.50	0.135	No
Albumin	3.23	0.002	Yes
Length of bowel resected	1.95	0.054	No
Residual length bowel from DJ	2.61	0.011	Yes
Cause of AMI	2.37	0.021	Yes
Relaparotomy	1.85	0.068	No

Morbidity (Table 5)

Postoperative morbidity was frequent in these patients with 46 patients (of 67 surviving patients; 69 %) experiencing at least one complication. Most of the patients with a stoma experienced a high output (20 of 41; 49 %) with dyselectrolytemia (hyponatremia and hypokalemia) with or without prerenal azotemia, needing intravenous fluids and antimotility drugs. Subacute intestinal obstruction (adhesive/ileus) was the next most common complication seen (n=11; 16 %) and all improved with conservative management. Many patients (n=9; 13 %) required prolonged ICU care with ventilatory support, due to toxic or septic or metabolic encephalopathy. Six more patients required ICU care because of cardiac complications. Four patients required relaparotomy in this group of surviving patients. Chest complications (n=6; 9 %) included bronchospasm, pneumonitis and pneumothorax; cardiac complications (n=6; 9 %) included mainly tachyarrhythmias, also

Table 4 Cause of mortality

Cause of mortality[a]	No. of patients
Multiorgan failure	28
Septicemia	
Anastomotic leak	4
Chest infection	4
Unidentifiable source	8
Myocardial infarction	7
ARDS	3
Liver failure	4
Extension of thrombus	3

[a] Some patients had more than one cause

Table 5 Complications graded as per Clavien–Dindo classification and type of complication

	No. of patients (67)
Complication grade (Clavien)	
0	21
1	7
2	22
3	4
4	13
Type of complication*	
High stoma output (with dyselectrolytemia, needing antimotility drugs)	20
Ileus/SAIO	11
Prolonged ICU care with ventilator/inotropic support (>48 h)	9
Chest complications	6
Cardiac complications	6
Fever	7
Surgical site infection	7
Bleeding complications (due to anticoagulation)	6
Relaparotomy	4
Others (ascites, disorientation)	5

*Some patients had more than one complication

malignant hypertension and pulmonary embolism. Surgical site infections complicated the course in seven patients, three of whom had intraabdominal collections.

Discussion

AMI is a catastrophic illness and has a poor outcome even when the disease is diagnosed and treated promptly [7]. Despite the considerable advances in the diagnosis and treatment of such patients and a better understanding of the pathophysiology of the disease, the mortality and morbidity still remain high [8]. The reasons for this are manifold. These include the facts that its aetiology and presentation are variable, and, thus, recognition of the condition is delayed, extensive resection of the gangrenous bowel is sometimes incompatible with life and translocation of bacteria with the resultant endotoxaemia or septicaemia contribute to the morbidity. Furthermore, the rarity of AMI (1–2 per 1,000 hospital admissions) [9] makes it difficult to undertake randomised or case–control trials. Hence, most of our understanding of the disease process comes from an analysis of observational studies. The total number of admissions in our department during the study period was 9,573 and AMI accounted for only 1.2 % (117 patients) of the total number, indicating the rarity of the disease even when only surgical patients were considered getting admitted to a surgical department.

The study was conducted in a tertiary care hospital in New Delhi, capital city of India with a population of about 1.67 crore as per 2011 census. The city has about 16 such tertiary care hospitals (6 government hospitals) catering to the needs of patients not only from Delhi/national capital region but from most of the northern India. Hence, it is difficult to estimate the population in the drainage area of one particular hospital.

Most articles on AMI are from the western literature. In a systematic review [3] of reports published over four decades on AMI which included 3,692 patients, Schoots et al. found that MAO accounted for 71 % of cases, only 12 % were due to MVT and the remaining 17 % were due to NOMI. In contrast, we found that MVT accounted for 56 of 117 patients (48 %), while the arterial thrombosis and embolism were the cause in 61 patients (52 %). None of our patients had NOMI and only four patients were treated successfully with conservative management. This was probably because ours is mainly a referral practice. A patient with abdominal pain or other features of AMI, which are usually non-specific, at least initially, is usually admitted under the services of Gastroenterology or General medicine. They are initially managed conservatively and then referred for surgery to our department if their condition worsens. Hence, our data may not represent all patients admitted to hospital with bowel ischaemia but only those who were referred to us for operation.

The median age of patients reported in the west [3] is approximately 70 years for all causes of AMI, while that of our patients was 53 years—slightly lower in patients with MVT (50 years) than those with MAO (57 years).

Several previous studies have also indicated prognostic differences between different causes of AMI. In the systematic review by Schoots et al. [3], patients with MVT had a better prognosis with a mortality rate of 45 % compared to MAO (70 % for embolism and 83 % for thrombosis) and NOMI (78 %). We also found that patients with MVT had a lower mortality than those with MAO (27 % vs 51 % resp.; p=0.008).

As might be expected, most of these patients have comorbidities, the most commonly reported being hypertension [10, 11], which is present in more than 70 %. Other common associated conditions include coronary artery disease, chronic renal failure, diabetes, peripheral vascular disease, cerebrovascular disease and chronic obstructive pulmonary disease. We also found hypertension to be the most common comorbidity (28 %), followed by coronary artery disease (21 %) and diabetes mellitus (16 %). Compared to the western studies, however, our patients had fewer coexisting illnesses, probably because MVT was more common and they were a decade younger than their western counterparts.

The diagnosis of AMI has greatly improved with advances in imaging. Early reports of the role of CT scan in mesenteric ischaemia revealed a low sensitivity rate of 64 % [12]. However, the development of MDCT has greatly improved the

sensitivity so that it is now greater than 90 % [13, 14]. A CT scan of the abdomen is now the imaging study of choice for mesenteric ischaemia, because it is rapid, non-invasive, and widely available in most hospitals and provides specific information on the location of the occluded vessel and the presence of bowel ischaemia [15] by showing bowel wall thickening, mucosal enhancement, intramural air, dilatation, portal venous gas and pneumatosis [16–18]. Kirkpatrick and colleagues [13] suggested that CT angiography findings of portal venous gas, pneumatosis, or a combination of bowel wall thickening with venous thrombosis, solid organ infarction, or focal lack of enhancement of bowel wall to be criteria for the diagnosis of mesenteric ischaemia; with sensitivity and specificity rates of 96 % and 94 %, respectively. The presence of pneumatosis on CT does not necessarily indicate that transmural infarction has occurred—this is more likely in patients who have both pneumatosis and portomesenteric venous gas [19]. Using Kirkpatrick's criteria, we found CT scans diagnosed bowel ischaemia preoperatively in 79 of the 95 (83 %) patients in whom the investigation was performed.

We were surprised to encounter so many patients with venous occlusion and tried to identify these patients separately from those with arterial obstruction. Kumar S et al. [20] described differences in risk factors between the two main causes of AMI as including thrombophilia and cancer in MVT; atherosclerosis in MAO, and in MVT an insidious onset of pain corroborated by CT scan changes, a rarity of involvement of inferior mesenteric veins (and colon) and the presence of arterial pulses at operation. We found patients with MVT to be significantly younger than those with MAO (50 vs 57 years), they had a longer duration of symptoms (14 vs 2 days), less frequent hypotension at presentation (14 % vs 43 %), higher platelet counts (2.6 vs 2 lakhs/cumm), a shorter length of bowel resected (76 vs 152 cm), colonic involvement was less frequent (11 % vs 41 %) and they had a lower mortality (27 % vs 51 %).

The probable reasons we could identify for more frequent occurrence of MVT in the present study were many. The patients with MAO were probably much sicker with rapid progression of illness, early presentation with peritonitis and either succumbed to disease or got operated before reaching our hospital. The patients with MVT had prolonged duration of illness, less frequent peritonitis and diagnostic confusion as to the cause of symptoms before consultation with us. The Indian patients with AMI we believe are probably more thrombophilic than their western counterparts because of lower age at presentation, less comorbidity and greater proportion of MVT in the present study.

The experience on surgical/endovascular revascularisation in the present study is limited with only 6 of the 61 patients with arterial AMI undergoing revascularisation. This we attribute to late presentation or referral of patients for expert care. We believe that revascularisation is required in patients with doubtful viability of significant portion of small bowel with absent arterial pulsations. In patients with gangrene, involving significant portion of small bowel or limited gangrene with well demarcation and palpable pulsations in viable portions of bowel, bowel resection may suffice. We have not found any survival benefit in patients who underwent revascularisation, even on subgroup analysis in patients with MAO.

The systematic review by Schoots et al. [3] did not reveal any short-term survival benefit for patients with arterial AMI undergoing revascularisation with or without bowel resection. The revascularisation, however, did decrease mortality in patients with MVT by nearly half, but the numbers were small. The reason for poor outcome even after revascularisation may be due, in part, to the reperfusion syndrome, along with preoperative morbid state of these patients with organ dysfunction.

Although systematic review, which is now a decade older, has not revealed any survival benefit of revascularisation, newer studies have shown promising results in these patients with endovascular or surgical revascularisation [21, 22].

The reported risk factors for mortality in these patients are—renal insufficiency, old age (>70 years), metabolic acidosis, longer symptom duration, preoperative coma, open wound, preoperative sepsis, low albumin, higher ASA class, recent cardiac surgery and non-resective surgery. These studies either do not include MVT or their proportion is too small [10, 23], and one study has not done subgroup analysis based on aetiology which is the most important prognostic factor [3] as shown by the systematic review and many other studies. The present study analyses data after dividing patients with AMI into aetiological subgroups. We have included patients with arterial thrombosis and embolism together for analysis. This is because of the difficulty in differentiating the two conditions in all circumstances except in cases where overt cardiac cause is obvious.

In the present study on multivariate analysis, MAO as a cause of AMI, long duration of symptoms, lower serum albumin, higher serum creatinine, and shorter length of residual bowel from DJ flexure were significantly associated with mortality. The probable explanation for these is that the sicker patients have poor outcomes. Patients with MAO may be sicker than those with MVT, having greater extent of bowel gangrene (as has been shown before in MVT vs MAO). Patients with greater extent of bowel gangrene are more likely to have greater loss of albumin from microcirculation and third spacing of fluids, manifesting with lower albumin and higher serum creatinine value.

Two recent studies [10, 11] have studied the postoperative complications after surgery for AMI. Respiratory failure and infection (including respiratory, surgical site infections and septicemia) were most common; other complications were myocardial infarction, renal failure and extension of thrombus and gangrene. We graded our complications according to the

Clavien–Dindo classification and found that 46 (69 %) of the 67 surviving patients had at least one complication. Most of them had grade 2 (22; 33 %) and 13 patients (19 %) had grade 4 complications. Bleeding due to anticoagulant therapy was seen in six patients.

One study [10] reported multiorgan failure to be the most common cause (75 %) of death in these patients, the others being rethrombosis, myocardial infarction and obstructive pulmonary disease. Similarly, we found multiorgan failure to be the cause of mortality in 28 of our patients (61 %) with septicaemia in 16 patients, only 8 of which were from an identifiable source.

Conclusions

In India, AMI in a tertiary care centre is due to MVT in about half of the patients who present at least a decade earlier than those in western countries. Our patients with MVT were also younger than those with MAO, had a longer duration of symptoms and hypotension was less frequent at presentation. They also had higher platelet counts, shorter bowel resections, with colonic involvement to be uncommon and a lower mortality. Significant predictors of mortality in patients with AMI include low serum albumin and raised creatinine levels, a shorter residual bowel length and an arterial cause for mesenteric ischaemia. An awareness of MVT to be a frequent cause of AMI in India may help in the prognostication of outcome in these patients and direct studies to elucidate its cause.

Source of Support None.

Conflict of Interest None.

References

1. Heys SD, Brittenden J, Crofts TJ (1993) Acute mesenteric ischaemia: the continuing difficulty in early diagnosis. Postgrad Med J 69:48–51
2. Kaleya RN, Boley SJ (1992) Acute mesenteric ischemia: an aggressive diagnostic and therapeutic approach. Can J Surg 35:613–623
3. Schoots IG, Koffeman GI, Legemate DA, Levi M, van Gulik TM (2003) Systematic review of survival after acute mesenteric ischaemia according to disease aetiology. B J Surg 91(1):17–27
4. Dindo D, Demartines N, Clavien PA (2004) Classification of surgical complications a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg 244:931–937
5. Fink WJ, Olson JD (1967) The massive bowel resection syndrome: treatment with reversed intestinal segments. Arch Surg 94(5):700–706
6. Carbonnel F, Cosnes J, Chevret S, Beaugerie L, Ngô Y, Malafosse M et al (1996) The role of anatomic factors in nutritional autonomy after extensive small bowel resection. JPEN J Parenter Enteral Nutr 20: 275–280
7. Mansour MA (1999) Management of acute mesenteric ischemia. Arch Surg 134:328–330
8. Kassahun WT, Schulz T, Richter O, Hauss J (2008) Unchanged high mortality rates from acute occlusive intestinal ischemia: six year review. Langenbecks Arch Surg 393:163–171
9. Stoney RJ, Cunningham CG (1993) Acute mesenteric ischemia. Surgery 114:489–490
10. Park WM, Gloviczki P, Cherry KJ Jr et al (2002) Contemporary management of acute mesenteric ischaemia: factors associated with survival. J Vasc Surg 35(3):445–452
11. Gupta PK, Natarajan B, Gupta H et al (2011) Morbidity and mortality after bowel resection for acute mesenteric ischemia. Surgery 150(4): 779–787
12. Taourel PG, Deneuville M, Pradel JA et al (1996) Acute mesenteric ischemia: diagnosis with contrast-enhanced CT. Radiology 199(3): 632–636
13. Kirkpatrick D, Kroeker MA, Greenberg HM (2003) Biphasic CT with mesenteric CT angiography in the evaluation of acute mesenteric ischemia: initial experience. Radiology 229(1):91–98
14. Ofer A, Abadi S, Nitecki S et al (2009) Multidetector CT angiography in the evaluation of acute mesenteric ischemia. Eur Radiol 19:24
15. Bakal CW, Sprayregen S, Wolf EL (1992) Radiology in intestinal ischemia. Angiographic diagnosis and management. Surg Clin North Am 72:125
16. Horton KM, Fishman EK (2001) Multi-detector row CT of mesenteric ischemia: can it be done? Radiographics 21(6):1463–1473
17. Chou CK, Mak CW, Tzeng WS et al (2004) CT of small bowel ischemia. Abdom Imaging 29(1):18–22
18. Zandrino F, Musante F, Gallesio I et al (2006) Assessment of patients with acute mesenteric ischemia: multi-slice computed tomography signs and clinical performance in a group of patients with surgical correlation. Minerva Gastroenterol Dietol 52(3):317–325
19. Kernagis LY, Levine MS, Jacobs JE (2003) Pneumatosis intestinalis in patients with ischemia: correlation of CT findings with viability of the bowel. AJR Am J Roentgenol 180:733
20. Kumar S, Sarr MG, Kamath PS (2001) Mesenteric venous thrombosis. N Engl J Med 345:1683–1688
21. Arthurs ZM, Titus J, Bannazadeh M, Eagleton MJ, Srivastava S, Sarac TP et al (2011) A comparison of endovascular revascularization with traditional therapy for the treatment of acute mesenteric ischemia. J Vasc Surg 53(3):698–705
22. Ryer EJ, Kalra M, Oderich GS, Duncan AA, Gloviczki P, Cha S et al (2012) Revascularization for acute mesenteric ischemia. J Vasc Surg 55(6):1682–1689
23. Kougias P, Lau D, El Sayed HF et al (2007) Determinants of mortality and treatment outcome following surgical interventions for acute mesenteric ischemia. J Vasc Surg 46(3):467–474