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Original Research Article

Acute mesenteric artery occlusion in hypobaric oxygen environment

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ABSTRACT

Background: Acute mesenteric ischemia represents a challenge in Taif and related districts where hypobaric oxygen may add to other risk factors as prevalence of diabetes mellitus and obesity. The aim of this retrospective study was to record and discuss the underlying risk factors, pattern of presentation, methods of diagnosis and results of treatment of acute mesenteric ischemia in Taif Tertiary Hospitals.
Methods: In this chart review and database study, thirty-one patients met the inclusion criteria in the period from January 2009 to December 2017. The outcomes included demographics, risk factors, clinical findings, diagnostic and therapeutic methods, in addition to the mortality and follow up of the study population.
Results: The commonest presenting symptom was abdominal pain (100%), of them 45.2% had marked peritoneal signs. Diagnosis was established by CT angiography in 41.9% and after exploratory laparotomy in 58.1% of patients. Mesenteric artery thrombosis was the cause in 64.5% and embolism in 35.5%. In all patient's necrotic bowel segments were resected followed by revascularization. Reoperation was performed in 32.3% of patients. Perioperative deaths were 41.9% and the overall mortality 58.1%.
Conclusions: The findings of this study are not quite different from that performed on population living in normobaric oxygen environment except for a higher incidence of arterial thrombosis. Validation of these findings needs more standardized large prospective studies to avoid the impact of different confounding factors and the limited statistical power related to small sample sizes.

Keywords: Acute mesenteric ischemia, Hypobaric oxygen, Mesenteric artery thrombo-embolism

INTRODUCTION

The incidence of acute mesenteric ischemia (AMI) is increasing parallel to the ageing general population.[1,2] Collaterals within the mesenteric circulation are present at several levels and adequate intestinal perfusion can usually be maintained when only one artery is involved.[2] The occlusion of multiple vessels would produce impaired perfusion and possible infarction of the intestines can occur.[1,3] In literature, acute mesenteric embolism is responsible for about 50% of all cases of acute mesenteric ischemia while arterial thrombosis is responsible for about 25% of the cases only.[3,4] The source of mesenteric emboli is cardiac in the majority of cases due to atrial fibrillation or mural thrombi, however, atherosclerotic aorta may be the source.[5-7] Thrombosis of the superior mesenteric artery is often associated with pre-existing chronic atherosclerotic.[5] Early diagnosis and prompt treatment are the goals of modern therapy of AMI as delay in treatment will cause intestinal infarction with its septic sequelae worsening the prognosis and increase mortality.[1-4] In this retrospective study, the underlying risk factors, pattern of presentation, methods of diagnosis and results of treatment of acute mesenteric ischemia in Taif Tertiary Hospitals would be recorded and discussed.

METHODS

This retrospective multicentre study was conducted after approval of the ethics boards of Taif Tertiary Hospital from January 2009 to December 2017. The medical records and electronic data base of all patients who presented to the hospitals and diagnosed as acute mesenteric artery occlusion were revised and 31 patients had complete files and were included in the study.

The outcomes included evaluation of demographics, risk factors, clinical findings, diagnostic and therapeutic methods, in addition to the mortality and follow up of the study population. Patients with venous thrombosis or non-occlusive causes of acute mesenteric ischemia, patients with chronic mesenteric ischemia and patients with incomplete files were excluded from the study.

The mean follows up period was 46.6±10.2 months (range, 2-79 months). The collected data were tabulated, analyzed and SPSS program version 22.0 (SPSS Inc., Chicago, IL, USA) was used for description of quantitative variables in the form of means, standard-deviation and range. The qualitative data were expressed in number and percentage. The significance between 2 means was tested by Student's t-test. The chi-square ($\chi 2$) and Fisher exact (FE) tests were used to differentiate between two groups. $P<0.05$ was considered as statistically significant.

RESULTS

Table 1 shows the demographics of the studied specimen where, the number of males was significantly higher than females, insignificant difference between the main ages of both sexes and that Saudi patients represent the majority of the studied population.

Table 1: Demographic data and preoperative patient characteristics.

Parameters			P-value
Gender	**Males**	**Females**	<0.05 (S)
	19/31 (61.3%)	12/31 (38.7%)	
Mean age	Males	Females	>0.05 (IS)
	66.3±15.7 yrs	69.2± 17.8 yrs	
Ethnicity	Saudi	Non Saudi	<0.05 (S)
	28/3 (90.3%)	3/31 (9.7%)	

S- Significant, IS- Insignificant.

Table 2 shows the clinical findings in the studied patients where abdominal pain was the commonest symptom (100%) followed by nausea and vomiting (77.4%), bloody diarrhea (33.2%) and absolute constipation (25.8%).

It shows also that tachycardia was the commonest systemic finding followed by oliguria (25.8%), full picture of shock in (16.1%), while abdominal signs included, tenderness in all patients, distension (51.6%) and rebound tenderness, guarding or/and rigidity (45.2%).

Table 2: Clinical findings.

Finding	Number	%
Mean time from the onset of pain to admission	52.8±11.6 hours (range 26-98)	-
Abdominal pain	31	100
Nausea and Vomiting	24/31	77.4
Bloody diarrhea	10/31	32.3
Absolute constipation	8/31	25.8
Tachycardia	31	100
Oliguria (urine output <30ml/hour)	8/31	25.8
Shock	5/31	16.1
Fever	6/31	19.4
Abdominal tenderness	31	100
Rebound tenderness, guarding or/and rigidity	14/31	45.2
Distension	16/31	51.6

Table 3 shows that hyperlipidemia was the commonest risk factor (71%) followed by cardiac disorders (61.3%), diabetes mellitus (61.3), smoking (58.1%), hypertension (58.1%) and chronic obstructive air way disease (45.2%).

Table 3: Associated risk factors.

Associated Factors	Number	%
Hyperlipidemia	22/31	71
Cardiac disorders	19/31	61.3
Diabetes mellitus	19/31	61.3
Smoking	18/31	58.1
Hypertension	18/31	58.1
Chronic obstructive airway disease	14/31	45.2

Table 4 shows the laboratory findings wherein all patients the leukocytic count, D-dimer and serum lactate levels were elevated. The Table also shows increased platelet count in 90.3%, polycythemia in 54.8%, elevated blood urea nitrogen in 45.2%, and elevated creatinine in 25.8%.

Table 4: Laboratory findings.

Number of patients (%)	Mean ± SD
31 (100)	19±4.2 (X 10^3/ml)
17/31 (54.8%)	6.7±1.4 (X 10^6/µl)
28/31 (90.3)	346.4±81.3 (X 10^3/ml)
31 (100)	4.1±0.9 mg/L (range; 1.23-9.5mg/L)
31 (100)	3.9±0.9 mmol/L
14/31 (45.2)	36.7±5.6 mg/dl
8/31 (25.8)	1.6±0.3 mg/dl

Imaging included plain X-rays revealed free gas under diaphragm in 4/31 patients (12.9%), all patients

performed abdominal ultrasound and diagnosis was established by CT angiography in 13/31 patients (41.9%). In 58.1% of patients, diagnosis was confirmed after exploratory laparotomies without performing CT angiography due to presentation with marked peritoneal signs. Mesenteric artery thrombosis was detected in 20/31 patients (64.5%), and mesenteric artery embolism in 11/31 patients (35.5%). The source of embolism was cardiac in all patients, 7/11 (63.6%) patients due to atrial fibrillation secondary to mitral valve disease and 4/11 (36.4%) from mural thrombus following myocardial infarction. Anticoagulation was done once diagnosis was established.

Table 5: Findings during operation.

Findings	Number	%
Intestinal infarction	31	100
Infarcted segment >100cm	17/31	54.8
Infarcted segments <100cm	14/31	45.2
Isolated ileal lesions	12/31	38.7
Isolated jejunal lesions	10/31	32.3
Total involvement of the small bowel alone	7/31	22.6
Infarction involving the whole small bowel and extended to cecum	2/31	6.4
Isolated colonic lesion	0	0

Table 5 shows the operative findings where intestinal infarction was found in all patients and the infarcted segments where >100cm in 54.8% and <100cm in 45.2%. It shows also that isolated infarcted ileal loops were found in 38.7%, isolated jejuna loops in 32.3%, total small bowel infarction in 22.6%, and total small bowel infarction with cecum in 6.4%.

Resections with primary anastomosis and revascularization were done in 15/31 patients (48.4%), in 7/32 patients (22.6%) resection and revascularization without primary anastomosis was done and the patients were sent to the surgical ICU and planned second look operation were done after 48 hours.

In 6/9 patients with total bowel necrosis (66.7%) resection with no revascularization was done and in the other 3 patients the operations were abandoned. Revascularization was performed in 22/31 patients (70.1%) and included, bypass from the aorta or the right common iliac artery in 10/22 patients (45.5%), embolectomy 6/22 (27.3%), endovascular stenting in 4/22 patients (18.2%) and thrombectomy in 2/22 (9.1%). Reoperation was performed in 10/32 patients (32.3%) including the 7 patients with planned second look operation. In 8/10 of the re-operated patients (80%) further resection with bowel reconstruction was done.

Mortality 2/31(6.5%) died intraoperatively, 11/31 (35.5%) died within one month after surgery with total perioperative deaths of 13/31 (41.9%) and 5 patients died during the period of follow up (46.6±10.2 months) with total mortality of 18/31 patients (58.1%).

DISCUSSION

Previous studies found that thrombo-embolism of superior mesenteric artery was more common in females than in males, yet, Al-Saeed M et al, and Al-Mubarak M et al, recorded that males were more affected than females which were concordant with the results of this study. The mean age of the patients with thrombo-embolic mesenteric artery occlusion varies from 60-75 years in different literature records which was agreement with findings of the present study.[1,2,5-8]

Time from onset of acute symptoms to presentation in patients with arterial thrombo-embolism ranges from 2-4 days with recorded scarce cases presented few hours following the onset of pain which is similar to the findings of this study.[1,2] Numerous investigators verified that the failure to recognize AMI before intestinal necrosis was significantly correlated with the high mortality of the disease.[1-6]

In agreement with the findings of the other studies, moderate to severe abdominal pain was the most common symptom encountered in the present report followed by nausea, vomiting and bloody diarrhea and in spite of the severity of the pain, marked peritoneal signs were found only in less than half of the patients.[1-10] Acute mesenteric ischemia should be suspected in patients with acute abdominal pain which is out of proportion of the physical examination findings specially in the elderly patients with cardiovascular risk factors.[11,12] Acute mesenteric arterial embolism must be suspected in patients with atrial fibrillation who have a sudden onset of abdominal pain and in presence of evidence of atherosclerotic disease or/and a history of postprandial syndrome.[1,2,11]

In the current report heart was the only source of mesenteric emboli and atrial fibrillation was the most common cause followed by mural thrombi. Forty percent of the currently studied patients with mesenteric artery thrombosis had evident ischemic heart disease in addition to the high prevalence of other atherosclerosis risk factors, notably, smoking, obesity, hyperlipidemia, and diabetes mellitus.

Reactive polycythemia which was prevalent in the patients of the current report can be explained by the living in hypobaric environment, in addition to the prevalence of other factors that may lead to chronic hypoxemia as smoking and obesity which may cause hypoventilation syndrome and chronic obstructive pulmonary disease (COPD). Bendz B et al, emphasized in their study that thrombotic effect of reactive polycythemia would be accentuated by increased factor VII a activity, vascular spasms and dehydration which are encountered in hypobaric hypoxic environment.[13] Though the incidence of arterial thrombosis in the current report

and the studies of AL-Saeed M et al, and Al-Mubarak M et al, is higher than that reported in the literature, the impact of altitude on acute mesenteric ischemia needs more investigation.[5,6]

Yasuhara found in his study that oliguria had a significant relation to mortality rate and he emphasized on the importance of appropriate resuscitation before operation concluding that patients with normal urinary output have more chance to survive comparing to those with less urinary output volume.[14] Similar results were recorded by other investigators.[1,15]

Laboratory results are not definitive but it can affirm clinical suspicion.[1] Evennett NJ et al, and Powell A et al, found a convincing evidence that the lactate level can differentiate early ischemia from irreversible bowel injury and a level >2mmol/L was associated with irreversible intestinal ischemia. In the present study, all patients had leukocytosis and the mean of serum lactate was 3.9±0.9mmol/L which supports the findings of the previous studies as all currently studied patients had bowel infarction.[16,17]

Several studies have shown that D-dimer assay well be useful in the early assessment of AMI and it had a high negative predictive value emphasizing that no patient presenting with a intestinal ischemia had normal D-dimer.[1,15-19] Bala M et al, found that a level >0.9mg/L had a specificity, sensitivity and accuracy of 82, 60 and 79%, respectively.[1] All the patients of the current report had elevated D-dimer level which supports the results of other researchers.

In agreement with the findings of this study, plain radiography was found to have a limited role in the diagnosis of mesenteric ischemia, especially in the early setting and only becomes positive with development of bowel infarction.[1-5]

Duplex ultrasound can aid in diagnosis, yet, the multi-detector computed tomography angiography (CTA) is the gold standard as diagnostic tool.[1,2,20] In the currently studied patients CTA was performed in about half of the patients who were presented before development of marked peritoneal signs and diagnosis was established in other patients after exploratory laparotomy saving the time required for CTA.

Preoperative resuscitation is important to prevent cardiovascular collapse on induction of anesthesia and early hemodynamic monitoring should be implemented with assessment of electrolyte levels and acid-base status.[1] Extensive capillary leakage is expected in those patients, so, the fluid volume requirement may be high.[11] Vasopressors as dobutamine, low dose dopamine and milrinone could be used with caution to avoid fluid overload and abdominal compartment syndrome.[1,11,21-23]

Intestinal ischemia leads to early loss of the mucosal barrier, which facilitates bacterial translocation and the risk of septic complications, therefore, broad-spectrum antibiotics should be administered early in the course of treatment.[2,11,24] The previous recommendations was in agreement with the findings in the current report. Systemic anticoagulation should be started as soon as possible in AMI and it was found that heparin prevents propagation of the thrombus and allows collateral vessels to develop improving survival and prevent recurrence of thrombo-embolism particularly in patients with AF.[11]

Intra-arterial infusion of papaverine through the angiography catheter may be used to relieve reactive vasospasm if the patient presents early before the development of irreversible bowel damage, however, papaverine and heparin are incompatible and can't be used simultaneously.[2,11] In this retrospective study, no patient treated with papaverine infusion and heparin was administered by intravenous route immediately after establishing the diagnosis, either preoperatively by CT angiography or intraoperatively after exploration.

After correction of metabolic and hemodynamic derangements prompt laparotomy was indicated to assess bowel viability with resection of all clearly necrotic segments which will decrease morbidity and mortality.[1-6,11,23] In case of uncertainty intraoperative doppler scanning or fluorescein infusion may be helpful to assess intestinal viability.[1,11,25,26]

Concordant with the findings in this report most of the authors advocated embolectomy as a well-established definitive treatment for SMA emboli or bypass to treat thrombosis of the SMA at the origin of aorta emphasizing also on the role of thrombectomy or and stenting in partial thrombotic occlusion.[27-29]

Endovascular techniques in combination with pharmacologic therapy have been reported and these techniques have been attempted in very early cases of acute mesenteric ischemia, however, thrombolytic therapy and other infusions are contraindicated in presence of evidence of ischemic bowel or infarction.[30-32]

Damage control surgery (DCS) is advocated for critically ill patient specially those presented with advanced peritoneal signs.[33] In this abbreviated surgery, the frankly necrotic bowel is resected with revascularization and the stapled off bowel ends should be left in discontinuity without anastomosis or stoma.[1,2,33] The physiological balance should be restored by continued ICU resuscitation to enhance visceral perfusion and viability is reassessed planned second look operation.[1,2,11,33] Weber DG et al, found that physiologic stabilization by restoration of the flow of the superior mesenteric artery and resuscitation in ICU would improve borderline ischemic segments.[33] Re-exploration should be accomplished within 48 hrs and decisions regarding anastomosis, stoma or additional resection can be made

with plans for sequential abdominal closure.[1,11,33] Planned second look operation is also recommended by many authors in presence of any questionable viability of intestinal segments to limit the extent of the initial resection.[33,34] The value of damage control surgery (DCS) with planned second look operations was verified in the current study where DCS was performed in more than 20% of patients and in 86% of them further resection with bowel reconstruction was done on reoperation, however, non planned reoperation was done in 9.7% of the studied patients.

Overall mortality rates remain unacceptably high (50-69%) with slight improvement in survival over the past 50 years in spite of the improvement in diagnostic and treatment modalities.[35-37] A median survival of 52 months has been reported in patients with arterial occlusive AMI who survived their acute hospital admission.[36,37] The overall mortality in the current study are similar to that recorded in the literature.

CONCLUSION

To conclude, the findings of this study were not quite different from that performed on population living in normobaric oxygen environment except for a higher incidence of arterial thrombosis. Validation of these findings needs more standardized large prospective studies to avoid the impact of different confounding factors and the limited statistical power related to small sample sizes.

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