# Primary anastomosis versus diverting stoma as a management of intestinal vascular gangrene: a randomized controlled study

Selmy Awad[a], Ahmed Tarabay[a], Ahmed Negm[a], Waleed Althobaiti[b], Fahad Alorabi[b], Ibrahim Dawoud[a], Mohamed S.A. Sheishaa[a]

[a]Department of General Surgery, Mansoura University Hospitals, Mansoura, Egypt, [b]Department of General Surgery, King Faisal Medical Complex, TAIF, Saudia Arabia

Correspondence to Ahmed Tarabay, MSc, Department of General Surgery, Mansoura University Hospitals, Mansoura 35516, Egypt. Tel: +20 1039 5630 545; fax: +2 050 2202834; e-mail: selmysabry2007@yahoo.com

**Received:** 30 August 2020
**Revised:** 22 September 2020
**Accepted:** 23 September 2020
**Published:** 18 May 2021

**The Egyptian Journal of Surgery** 2021, 40:73–82

**Context**
When intestinal gangrene is evident or suspected, surgical laparotomy is mandatory where the affected segment is resected with a safety margin of 5–10 cm, and the remaining part is either anastomosed or diverted on anterior abdominal wall as stoma. Stomas protect against the risks of anastomotic leakage and permit close examination of the bowel by inspection and/or endoscopy; however, it affects the quality of life.
**Aims**
To evaluate the perioperative outcomes of patients of mesenteric vascular occlusion in relation to the method of surgical intervention with either primary anastomosis or diverting ileostomy.
**Settings and design**
The study was a prospective, randomized comparative study. It involved all eligible patients fulfilling the inclusion criteria of the study. It was conducted at Mansoura Emergency Hospital in the period from November 2016 till November 2019.
**Patients and methods**
A total of 100 patients were recruited into the current study and divided into two groups after resection of gangrenous part: stoma group and anastomosis group.
**Statistical analysis**
Data were fed to the PC and analyzed using SPSS, version 26.0.
**Results**
Overall, 100 cases had a mean age of 53.0±7.6 years, with the range of 38.0–77.0 years. It included 66 (66%) males and 34 (34%) females. The leakage rate was significantly higher in the anastomotic group (18 cases), whereas it was experienced only in two (4%) cases in the other group ($P<0.001$). Consequently, postoperative mortality was higher in the same group (nine cases) ($P=0.025$).
**Conclusions**
The diverting stoma appeared to be a safer procedure to perform in mesenteric vascular occlusion with respect to morbidity and mortality rates but needs a strict nutritional, psychological, and special home care to enhance quality of life.

**Keywords:**
anastomosis, diverting stoma, intestinal vascular gangrene

Egyptian J Surgery 40:73–82

1110-1121

## Introduction

Mesenteric vascular ischemia is referred to as circulatory insufficiency that deprives one or several abdominal organs from adequate blood supply, which affects their metabolic state. Early diagnosis and treatment remains the keystone for improving the outcome of the disease [1,2]. The treatment of mesenteric vascular ischemia without evidence of intestinal gangrene is by conservative treatment with anticoagulants such as low-molecular-weight heparin in the early stages of the disease before gangrene occurrence, in addition to close clinical observation for fever, abdominal tenderness, bowel motion, and leukocyte count [3].

There is a high mortality rate depending on etiology, degree, and length of an ischemic part, associated comorbidity, and time between the onset of symptoms and final diagnosis. This rate ranges from 50 to 90% [4]. Mortality increases significantly when symptoms were presented for more than 24 h in mesenteric ischemia. Numerous literature studies have reported that mortality rate is lowest if management is achieved within 12 h of the onset of manifestations [5,6]. When intestinal gangrene is evident or suspected, surgical laparotomy is mandatory, where the affected segment is resected with a safety margin of 5–10 cm, and the remaining part is either anastomosed or diverted on the anterior abdominal wall as ileostomy [7].

Critical cases with suspicion of acutely mesenteric vascular occlusion or signs of peritonitis should be pushed to the operating theater directly for exploratory surgery regardless of the underlying etiology. Bowel is assessed at exploration for its viability, nonviable bowel is resected, equivocally viable bowel is preserved, and the causative pathology of acute mesenteric ischemia is determined. This is done with synchronous resuscitation with intravenous fluids and antibiotics [8].

Bowel anastomosis should not be performed in the presence of sepsis or septic shock or when the patient is not resuscitated adequately. Some surgeons advise primary anastomosis with a planned second look, if gangrene is limited, there is no doubt about the viability of the remaining bowel, the victim has been sufficiently resuscitated, and there is no evidence of shock. Laparoscopy can be useful in this circumstance [9]. Stomas protect against the risks of anastomotic leakage and permit close examination of the bowel by inspection and/or endoscopy [1]. A mucous fistula of very proximal jejunostomies can be used for refeeding in cases planned for delayed restoration of bowel continuity [10].

The aims of this prospective study were as follows:

(1) To compare between primary anastomosis and diverting ileostomy regarding operative time; early postoperative complications, such as intestinal leakage; complications of stoma creation such as retraction, prolapse, or gangrene; and mortality.
(2) To determine the patient's safety with each technique and the effect on the quality of life (QOL).

## Patients and methods

The research was a prospective, randomized comparative study. An informed consent was signed for every case after detailed explanation of the operation, realistic expectations, and all the possible periprocedural complications. It involved all eligible patients fulfilling the inclusion criteria of the study. It was conducted at Mansoura Emergency Hospital in the period from November 2016 till November 2019.

### Inclusion criteria

The following were the inclusion criteria:

(1) Patient with acute abdomen with clinical, laboratory, and radiological signs of mesenteric vascular gangrene.
(2) Hemodynamically stable patients.
(3) Albumin level more than 2.5 g/dl.
(4) Distance of segment resected from small intestine to duodenojejunal junction more than 2 m.
(5) Length of part resected from intestine not more than one and half meter.

### Exclusion criteria

The following were the exclusion criteria:

(1) Hemodynamically unstable patients.
(2) Patients with mesenteric vascular ischemia with no signs of gangrene.
(3) Evidence of intestinal perforation such as gas under diaphragm, intra-abdominal intestinal content, or intra-abdominal pus.
(4) Serum albumin level less than 2.5 g/dl.
(5) Distance of segment resected from small intestine to duodenojejunal junction less than 2 m.
(6) Length of part resected from intestine more than one and half meter.

A total of 100 patients fulfilling the intraoperative inclusion criteria, admitted to our ED with surgically acute abdomen, were involved into the current study and divided into two groups after resection of gangrenous part: stoma group and anastomosis group. The stoma group included the patients with uneven numbers and the anastomosis group included the patients of even numbers. The study was conducted after securing the ethical approval from the local ethical committee (Institutional Research Board) of Mansoura Faculty of Medicine.

### Preoperative evaluation

It included the following:

(1) Clinical history and thorough physical examination.
(2) Routine laboratory tests in addition to serum amylase, D-dimer LDH level, and arterial blood gases.
(3) Chest radiograph with diaphragm and abdomen radiograph with erect and supine positions.
(4) Abdominal ultrasound with comment on free fluid, duplex us on arterial and venous mesenteric tree, and CTA if possible.

### Surgical techniques

Under general anesthesia (UGA)

Patients were placed in the supine position and operated under complete aseptic technique via midline exploratory laparotomy incision. Full exploration of the whole abdomen was performed, including small

and large bowel, with addressing of the gangrenous parts of small bowel, and a sterile ruler or the equivalent length of vicryl thread was used to measure the distance of gangrenous part from D-J junction and the length of gangrenous segment. Then gangrenous part was resected with wide margin 5 cm from both ends. Then after resection, anastomosis was done by hand sewing technique or double barrel stoma was matured on the abdomen. Finally, abdominal drains were left in the abdomen followed by closure of anterior abdominal wall in layers.

#### Postoperative care and follow-up

All patients were monitored in the recovery room and transferred to the ward or to the intensive care unit if needed. LMW heparin was administered 6 h postoperatively b.i.d. according to body weight. Oral anticoagulant was given as early as possible with monitoring till optimizing the serum therapeutic level and then the patients were discharged.

Oral intake was initiated upon stoma was functioning or after good bowel motion in case of anastomosis group. Patient with stoma were discharged on high-protein and electrolyte regimen after organizing close follow-up with a dietitian. Patients were followed at OPD after discharge at 1, 2, 4, 12, and 24-week intervals, and stoma was closed after 8–10 weeks from discharge.

#### Data collection

(1) Preoperative data included the following:
   (a) Name, age, sex, and comorbidity, as well as time of onset of symptoms and risk factors.
   (b) Serum albumin, serum Na, and serum K.
(2) Intraoperative data included the following:
   (a) Arterial or venous occlusion were based on data [11] shown in Table 1.
   (b) Length of part resected, distance of gangrenous part from D-J junction, and anastomosis or stoma.
(3) Postoperative data:
   (a) Fasting days and hospital stay and postoperative mortality and morbidity.
   (b) Serum albumin in POD 1 and 5 days after starting oral feeding.
   (c) Serum $Na^+$ and $K^+$ in POD 1 and 2 days after starting oral feeding.
   (d) Anastomosis-related complications such as intestinal leakage, septicemia, and septic shock.
   (e) Ileostomy-related complications such as excoriation, stomal retraction, gangrenous stoma, stomal detachment, prolapse, and parastomal hernia.
   (f) Wound infection and midline incisional hernia.
   (g) QOL assessed by Cleveland Global Quality of Life score [12] after 1 month from anastomosis, ileostomy, and closure of ileostomy.

**Table 1 Difference between arterial and venous occlusion**

| | Arterial | Venous |
|---|---|---|
| Arterial pulsation | Absent | Usually preserved |
| Bowel wall | Thin and floppy | Thick and edematous |
| Mesentery | Thin | Thick |

The questionnaire was illustrated to patients by physician in OPD with a score from 0 to 10 in all questions, where 10 is the best in all, except in pain and vomiting questions; the total score was 120, and a median of 60 was taken for statistical assessment.

Statistical analysis and data interpretation: all of these data were collected in a special spreading data sheet and then tabulated and coded. Data were fed to the computer and analyzed using SPSS, version 26.0 (IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp.). Qualitative data were described using number and percent. Quantitative data were described using median and interquartile range for nonparametric data and mean and SD for parametric data after testing normality. Significance of the obtained results was judged if $P$ value less than 0.05.

## Results

#### Demographic data

Regarding the demographic characteristics of the included 100 cases, the mean age was 53.0±7.6 years, with the range of 38.0–77.0 years. The study included 66 (66%) males and 34 (34%) females. These data are illustrated in the following table. When comparing the study groups regarding demographics, neither age nor sex, was found to be statistically significant between the two groups (Table 2).

#### Comorbidities' distribution among the studied cases

The most frequent medical comorbidities faced in the study cases (Table 3) were hepatic diseases (40 cases) followed by diabetes mellitus (37 cases). Hypertension was present in 35 study cases, whereas cardiac comorbidity (such as atrial fibrillation and myocardial infarction) was positive in 23 cases.

#### Risk factors of mesenteric ischemia

When it comes to risk factors of mesenteric ischemia (Table 4) that were present in the cases, previous splenectomy was the dominant one (43/100 cases),

**Table 2 Comparison of sociodemographic characteristics between cases with anastomosis and stoma operations**

| | Stoma [*n* (%)] *N*=50 | Anastomosis [*n* (%)] *N*=50 | Test of significance | *P* value |
|---|---|---|---|---|
| Age (years) (mean±SD) | 53.82±5.85 | 55.36±8.85 | *t*=1.03 | 0.31 |
| Sex | | | | |
| Male | 34±68.0 | 32±64.0 | $\chi^2$=0.18 | 0.67 |
| Female | 16±32.0 | 18±36.0 | | |

**Table 3 Distribution of comorbidities among studied cases**

| Comorbidity | *N*=100 [*n* (%)] |
|---|---|
| Cardiac (AF, MI, and valvular heart disease) | 23 (23) |
| DM | 37 (37) |
| Hepatic | 40 (40) |
| Hypertension | 35 (35) |

AF, atrial fibrillation; DM, diabetes mellitus; MI, myocardial infarction.

**Table 4 Risk factor distribution among the studied cases**

| Risk factor | *N*=100 |
|---|---|
| History of liver cirrhosis and portal hypertension | 40 |
| History of splenectomy | 43 |
| History of hypercoagulable state | 20 |
| History of intestinal angina | 3 |
| History of atrial fibrillation | 7 |
| History of myocardial infarction | 2 |

**Table 5 Comparison of arterial, venous, and time of presentation between cases with anastomosis and stoma operations**

| | Stoma [*n* (%)] *N*=50 | Anastomosis [*n* (%)] *N*=50 | Test of significance | *P* value |
|---|---|---|---|---|
| Arterial | 4 (8.0) | 6 (12.0) | $\chi^2$=0.44 | 0.51 |
| Venous | 46 (92.0) | 44 (88.0) | $\chi^2$=0.44 | 0.51 |
| Time of presentation (days) (mean±SD) | 3.24±0.98 | 3.18±1.26 | *t*=0.27 | 0.79 |

followed by liver cirrhosis and portal hypertension (40/100 cases), whereas history of previous myocardial infarction was the lowest by only two (2%) cases.

### Pathology and time of presentation between the study groups

The mean of days of presentation to the ED was about 3.21 days, ranging from 1 to 6 days. The majority of our cases experienced ischemia of venous origin in 90 (90%) cases, whereas the remaining 10 (10%) cases had a pathology of arterial origin. The mean of days of presentation of the stoma group was 3.24 days, whereas it was 3.18 days for the primary anastomosis group (Table 5).

### Types of surgical intervention

The operations that were done for the study cases (Table 6) were resection with primary anastomosis or resection with double barrel stoma, with 50 (50%) cases for each.

### The perioperative variables between the study groups

The anastomosis group experienced more prolonged operative time (96.56 vs. 61.48 min for stoma group). Moreover, it showed a significant delay in oral feeding onset when compared with the other group (3.78 vs. 1.72 days). Both of operative time and start of oral diet were statistically significant between the two groups. Neither the length of the resected part nor the intestinal length calculated from D-J flexure was significant among cases

**Table 6 Type of surgery among studied cases**

| | *N*=100 [*n* (%)] |
|---|---|
| Anastomosis | 50 (100.0) |
| Stoma | 50 (100.0) |

of the two groups. The stoma group experienced a significantly shorter hospital stay (9.2 vs. 15.7 days for anastomosis group), as shown in Table 7.

### Postoperative complications between the study groups

The leakage rate was significantly higher in the anastomotic group (18 cases), whereas it was experienced only in two (4%) cases in the other group ($P<0.001$). Consequently, postoperative mortality was higher in the same group (nine cases) ($P=0.025$). Postoperative wound infection and incisional hernia were of insignificant difference between the two groups (Table 8).

### Stoma complications

Excoriation was the most frequent stoma complication (28 cases) followed by electrolyte disturbance in 21 cases. Parastomal hernia occurred in three (6%) cases, stomal retraction and prolapse occurred in two cases each, whereas a single patient experienced stomal gangrene (Table 9).

### Serum albumin between the study groups

Despite serum albumin levels being significant from each other at admission or at the $POD_1$, the

**Table 7 Comparison of the perioperative variables between both groups**

| | Stoma *N*=50 | Anastomosis *N*=50 | Test of significance | *P* value |
|---|---|---|---|---|
| Operative time (min) | | | | |
| Mean±SD | 61.48±8.06 | 96.56±10.71 | *t*=18.50 | <0.001* |
| Length of part resected (cm) | | | | |
| Mean±SD | 71.44±9.13 | 72.06±16.54 | *t*=0.23 | 0.82 |
| Length from DJ (cm) | | | | |
| Mean±SD | 242.52±9.04 | 244.68±14.33 | *t*=0.90 | 0.37 |
| Postoperative fasting (days) | | | | |
| Mean±SD | 1.72±0.97 | 3.78±0.82 | *t*=11.49 | <0.001* |
| Hospital stay (days) | | | | |
| Mean±SD | 9.20±2.29 | 15.7±5.14 | *t*=8.18 | <0.001* |

**P*-value < 0.05.

**Table 8 Comparison of complications between anastomosis and stoma operations**

| Complications | Stoma [*n* (%)] *N*=50 | Anastomosis [*n* (%)] *N*=50 | Test of significance ($\chi^2$) | *P* value |
|---|---|---|---|---|
| Leakage | 2 (4.0) | 18 (36.0) | 16.0 | <0.001* |
| Wound infection | 12 (24.0) | 20 (40.0) | 2.94 | 0.08 |
| Postoperative | | | | |
| Morbidity | 12 (24.0) | 10 (20.4) | 0.19 | 0.67 |
| Mortality | 2 (4.0) | 9 (18.0) | 5.01 | 0.025* |
| Incisional hernia | 6 (12.0) | 10 (20.0) | 1.19 | 0.28 |

**P*-value < 0.05.

**Table 9 Stoma complications in the stoma group patients**

| Stoma complications | *N*=50 [*n* (%)] |
|---|---|
| Excoriation | 28 (56) |
| Parastomal hernia | 3 (6) |
| Stomal retraction | 2 (4) |
| Stomal gangrene | 1 (2) |
| Electrolyte disturbance | 21 (42) |
| Stomal prolapse | 2 (4) |

anastomosis group showed a significantly higher albumin levels after 5 days from starting oral feeding (2.96 vs. 2.7 g/dl – $P<0.001$). Both groups experienced a significant drop in serum albumin levels after the operation, but only the anastomosis group experienced a significant rise upon starting oral intake (Table 10).

### Serum Na and K between the study groups

Although serum Na levels (Table 11) did not show significant difference before the operation, the stoma group experienced significantly lower Na levels in the second postoperative day ($P<0.001$). The stoma group had a significantly lower potassium levels (Table 12) at admission and during the postoperative period ($P<0.05$).

### Comparing albumin and electrolytes before and after ileostomy closure

The stoma group experienced higher levels of albumin, Na, and K during the preoperative and postoperative periods ($P>0.05$), as shown in Table 13.

**Table 10 Comparison of serum albumin between stoma and anastomosis operations**

| Serum albumin | Stoma (*N*=50) | Anastomosis (*N*=50) | Significance test | *P* value |
|---|---|---|---|---|
| At admission | 2.95 ±0.22 | 3.00±0.23 | *t*=1.17 | 0.24 |
| 1st day postoperative | 2.73 ±0.21 | 2.75±0.22 | *t*=0.47 | 0.64 |
| 5 days after oral intake | 2.70 ±0.21 | 2.96±0.31 | *t*=4.34 | <0.001* |
| Test of significance days of follow up | | *P*1<0.001**P*2<0.001* | | |

*P*1: difference between at admission and first day postoperative. *P*2: difference between first day postoperative and second day oforal intake. **P*-value < 0.05.

### Quality of life between the study groups

The anastomotic group showed a significantly better QOL when compared with the stoma group (Table 14).

### Quality of life before and after ileostomy closure

As shown in Table 15, the stoma cases experienced a significant improvement of the QOL after closure ($P<0.001$).

## Discussion

There is a high mortality rate of acute mesenteric ischemia depending on etiology, degree, and length of an ischemic part, associated comorbidity, and time

**Table 11 Comparison of serum Na between stoma and anastomosis operations**

| Serum Na | Stoma (*N*=50) | Anastomosis (*N*=50) | Test of significance | *P* value |
|---|---|---|---|---|
| At admission | 129.68±2.19 | 125.80±16.53 | *t*=0.96 | 0.34 |
| 1st day | 127.76±1.57 | 125.80±16.53 | *t*=0.84 | 0.41 |
| 2nd day | 127.82±1.55 | 131.06±3.17 | *t*=6.49 | <0.001* |
| Test of sig days of follow up | *P*1<0.001* | *P*1=0.06 | | |
| | *P*2=0.58 | *P*2=0.028* | | |

**P*-value < 0.05.

**Table 12 Comparison of serum K between stoma and anastomosis operations**

| Serum K | Stoma *N*=50 | Anastomosis *N*=50 | Test of significance | *P* value |
|---|---|---|---|---|
| At admission | 3.17±0.15 | 3.30±0.36 | *t*=2.4 | 0.018* |
| 1st day | 2.97±0.13 | 3.05±0.20 | *t*=2.2 | 0.03* |
| 2nd day | 2.99±0.16 | 3.33±0.28 | *t*=7.43 | <0.001* |
| Test of sig days of follow up | *P*1<0.001* | *P*1<0.001* | | |
| | P2=0.29 | *P*2<0.001* | | |

*P*1: difference between at admission and first day postoperative.P2: difference between first day postoperative and second day oforal intake. **P*-value < 0.05.

**Table 13 Comparison of serum albumin and Na and K levels before and after closure**

| | Stoma | | | |
|---|---|---|---|---|
| | Before closure (*N*=50) | After closure (*N*=48) | Test of significance (paired *t* test) | *P* value |
| Serum | | | | |
| At admission | 2.95±0.22 | 3.32±0.15 | 16.6 | <0.001* |
| Albumin | | | | |
| 1st day | 2.73±0.21 | 3.29±0.20 | 20.80 | <0.001* |
| 5 days after oral intake | 2.73±0.21 | 3.66±0.13 | 33.32 | <0.001* |
| At admission | 129.68±2.19 | 131.67±2.35 | 2.11 | <0.001* |
| Serum Na | | | | |
| 1st day | 127.76±1.57 | 131.0±1.90 | 11.64 | <0.001* |
| 2nd day | 127.82±1.55 | 135.33±2.4 | 25.31 | <0.001* |
| At admission | 3.17±0.15 | 3.24±0.12 | 3.13 | 0.003* |
| Serum K | | | | |
| 1st day | 2.97±0.13 | 3.17±0.14 | 7.87 | <0.001* |
| 2nd day | 2.99±0.16 | 3.72±0.21 | 20.77 | <0.001* |

**P*-value < 0.05.

**Table 14 Comparison of global quality of life between stoma and anastomosis operations**

| | Stoma *N*=48 | Anastomosis *N*=41 | Test of significance | *P* value |
|---|---|---|---|---|
| Global QOL | | | | |
| Mean±SD | 60.54±4.1 | 99.24±20.01 | *t*=11.06 | <0.001* |
| ≤60 | 25 (52.1) | 6 (14.6) | $\chi^2$=13.66 | 0.002* |
| >60 | 23 (47.9) | 35 (85.4) | | |

Median (60) was taken as an arbitrary cutoff point. **P*-value < 0.05.

**Table 15 Comparison of global quality of life between stoma cases before and after closure**

| | Before closure *N*=48 | After closure *N*=48 | Test of significance | *P* value |
|---|---|---|---|---|
| Global QOL | | | | |
| Mean±SD | 60.54±4.1 | 89.52±3.37 | *t*=49.97 | <0.001* |
| ≤60 | 25 (52.1) | 0 (0.0) | $\chi^2$=33.8 | <0.001* |
| >60 | 23 (47.9) | 48 (100.0) | | |

Median (60) was taken as an arbitrary cutoff point. **P*-value < 0.05.

between the onset of symptoms and final diagnosis; this rate ranges from 50 to 90% [4]. When intestinal gangrene is evident or suspected, surgical laparotomy is mandatory, where the affected segment is resected with a safety margin of 5–10 cm, and the remaining part is either anastomosed or diverted on the anterior abdominal wall as ileostomy [7].

Ischemia of the small bowel with subsequent morphological changes of the intestinal wall always mandates the complete resection of the necrotic tissue. The primary anastomosis should be considered whenever possible. In the case of stoma creation, stoma viability alone may be misleading, because some remote areas can be affected by the same pathological process [13].

Urgent operations are at a rising risk of postoperative complications in general, which include surgical site infections, intra-abdominal collections, anastomotic failure, wound dehiscence, and mortality. The disease process itself, location of the anastomosis to be performed, and condition of the patient play (tobacco and alcohol and ASA; scores of 3 or more) a role in the development of a leak. A combination of risk factors may increase the significance. Urgent operations and the condition of peritonitis have been defined before as risk factors for anastomotic failures [13–15].

The effectiveness of proximal diverting stoma is highly debatable. Most research studies have focused on whether proximal diversion can prevent anastomotic failure. Some have observed that proximal diversion does not avoid but only reduces the clinical effect of failures [16]. In a systematic review by Montedori *et al.* [17], proximal diverting stoma was suggested to be important in protecting against both anastomotic failure and the need for emergency reoperations.

The stomas of small bowel are occasionally needed following urgent small bowel resection in some settings like bowel ischemic, inflammatory, or traumatic conditions. The clinical setting of these cases mandates a prompt and safe surgery preserving as much of the bowel length as possible. A small bowel stoma, however, has a significant morbidity, mostly because of fluid, electrolyte, and nutrient imbalance. Furthermore, the restoration of intestinal continuity usually needs meticulous dissection of the afferent and efferent parts and the formation of a new anastomosis [13].

In this current study, 100 cases with mesenteric vascular gangrene were included aiming to compare between primary anastomosis and diverting ileostomy in their management after resection of the gangrenous bowel portion for all cases. The cases were divided into two groups: 50 cases who underwent primary anastomosis, whereas the remaining 50 underwent temporary diverting ileostomy.

The mean age of the patients was 53 years, and the predominant sex was male (66 cases – 66%). Another study was conducted to determine the characteristics of cases with acute mesenteric ischemia. There were 117 cases, comprising 85 males and 32 females. Their median age was 53 years [18]. There was insignificant difference in the present study in relation to the previous ones regarding the age and sex as a risk factor.

The reported risk factors for embolic events are atrial fibrillation, rheumatic valvular heart disease, prosthetic valves, and infective endocarditis. Moreover, those for thrombotic events that are more common are generalized atherosclerosis, hyperlipidemia, diabetes mellitus, and hypertension [19]. Other reported risk factors include old age, COPD, history of splenectomy, blood clotting problems, and illegal drug use like cocaine and methamphetamine [20].

This current study was in agreement with the previous study regarding the risk factors of mesenteric ischemia that were present in the cases; previous splenectomy was the dominant one (44%), followed by DVT (20%), whereas history of previous ischemic attacks was positive in 14 (14%) cases.

An Indian study also reported some comorbidity in the included cases of acute mesenteric ischemia. A total of 66 (56%) patients had associated comorbidities including hypertension (28%), coronary artery disease (21%), and diabetes mellitus (17%) [18].

The previously mentioned comorbidities were also detected in the cases of this study like cardiac diseases (43%), diabetes mellitus (40%), hepatic disease (40%), and hypertension (35%). When comparing both groups, there was no significant difference regarding the prevalence of these risk factors between the study groups.

The reported pathologies of acute ischemia were as follows: acute arterial emboli in 25–30% of cases, nonocclusive mesenteric ischemia in 20–30%, mesenteric venous thrombosis in 6–9%, and arterial thrombosis in the remaining cases of acute ischemia [21].

A small contradiction with the previous study was present in the current study, as the pathology of mesenteric ischemia cases was distributed between

two categories: venous pathology in 90 (90%) cases, and arterial pathology in the remaining 10 (10%) cases. This difference could be explained by increased incidence of hepatic patient with portal vein thrombosis and previous history of splenectomy in our region. In addition, many cases with arterial pathology were excluded from our study, as they did not meet our inclusion criteria.

The diversion group experienced significant shorter operative times more than the anastomosis group ($P<0.001$). Moreover, diversion group showed early oral intake ($P<0.001$) and shorter hospital stay ($P<0.001$). Many studies have reported that diversion allows early oral feeding and shorter hospital stay compared with primary anastomosis, especially in distal GI anastomosis [18].

The findings of this study were in line with the previous study regarding the operative time and the start of oral intake. The anastomosis group experienced more prolonged operative time (96.56 vs. 61.48 min for stoma group). Moreover, it showed a significant delay in oral feeding onset when compared with the other group (3.78 vs. 1.72 days). Both of operative time and start of oral diet were statistically significant between the two groups. The stoma group experienced a significantly shorter hospital stay (9.2 vs. 15.7 days for anastomosis group).

Peristomal cutaneous excoriation is the most commonly occurring complication for ostomates. Although skin irritation can occur at any time during the course of the stoma, dermatologic conditions are most commonly seen in the early postoperative period as the ostomate learns proper stoma care techniques. Up to 70% of new ostomates may have peristomal dermatitis, which is often undetected by the case. The incidence of parastomal hernias is widely estimated between 30 and 50%; however, detecting the true numerator is limited by heterogeneous definitions, observation periods, and means of diagnosis [22–24].

Long-term mild ischemia may result in late-term stoma stenosis and retraction, which may reach up to 22% in diversion cases. Nonischemic stomal retraction can be seen in patients with inadequately mobilized stoma conduits and the obese. Akin to ischemic colitis, necrosis, and atrophy of the bowel conduit may cause variable degrees of stomal stricture and/or retraction that may necessitate surgical revision depending upon symptom severity [24].

In this study, 28 (56%) cases in the ileostomy group experienced skin excoriation, three (6%) cases experienced parastomal hernia, two (4%) cases each experienced stomal retraction and prolapse, and only one (2%) case had stomal gangrene. Postoperative wound infection and incisional hernia were of insignificant difference between the two groups.

In a follow-up research, the surgeons were able to do a primary resection and anastomosis with a respectable 5.7% leak rate without the use of proximal diversion in cases with peritonitis. The authors excluded those with fecal peritonitis, in addition to unstable or immunocompromised cases. Peritonitis was not considered as an independently associated risk factor for anastomotic failures [25]. Proximal diversion also diminishes the clinical effect of failures by reducing the failure rate and the need for reoperation. Unfortunately, there is also added morbidity with proximal diversion. Complications ranging from dehydration and electrolyte abnormalities to mechanical complications can be as high as 30%, resulting in an 18% readmission rate. In addition, there is a 15–20% complication rate with ostomy closure [17].

In the current study, the results were supporting the previous studies, as the primary anastomosis group experienced leakage and mortality more significantly than the ileostomy group (36 vs. 4%, $P<0.001$ for leakage – 18.5 vs. 4%, $P=0.025$ for mortality). Postoperative morbidity did not differ between our study groups, being experienced in 20 and 24% cases for each group, respectively ($P=0.67$). The leakage rate was significantly higher in the anastomotic group (18 cases), whereas it was experienced only in two (4%) cases in the other group ($P<0.001$). Consequently, postoperative mortality was higher in the same group (nine cases) ($P=0.025$).

Generally, the incidence of electrolyte abnormalities ranges from 0.8 to 16.7%. Ostomates can be expected to begin function between 1 and 3 days postoperatively. Bowel edema is often still present and impairment of fluid absorption across the mucosal surface can lead to high volume output. Postoperative adaptation of the bowel takes several days to weeks. Cases are at particular risk during the third to eighth postoperative day, at which point they commonly have already been discharged to home [26].

Most of the cases with a stoma had a high output (49%) with 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 (16%), and all improved with conservative management. Many cases (13%) required prolonged ICU care with ventilatory support, owing to septic or metabolic derangement. Surgical site infections complicated the course in seven patients, three of whom had intra-abdominal collections [17].

In this study, although serum Na levels did not show significant difference before the operation, the stoma group experienced significantly lower Na levels in the second postoperative day ($P<0.001$). The stoma group had a significantly lower potassium level at admission and during the postoperative period ($P<0.05$). Regarding electrolyte imbalance in this study cases, the ileostomy group experienced significant hyponatremia more than the primary anastomosis group, especially on the second postoperative day ($P<0.001$). When it comes to potassium levels, diversion cases experienced significant hypokalemia on the first and second postoperative days when compared with the other group ($P<0.05$). Moreover, the ileostomy group showed significant improvement of these electrolyte abnormalities after ileostomy takedown ($P<0.05$).Regarding the QOL, the stoma group had lower QOL scores when compared with the other group ($P<0.001$). Many researchers suggest that stoma construction has a significant detrimental effect on QOL. Literature studies examining the psychosocial effect of a stoma reveal that up to one third of cases experience depression, social problems, and/or sexual problems. Surprisingly, QOL studies have included both the patient population receiving a stoma as well as the group maintaining continuity, and results have been mixed [27–29].

In the present study, the same conclusions were observed. The anastomotic group showed a significantly better QOL when compared with the stoma group. The stoma cases experienced a significant improvement of the QOL after closure ($P<0.001$).

Owing to its associated morbidity, proximal diversion should not be routinely done. The decision for diverting stoma must be carefully weighed against the negative effect of leak and the morbidity of an ostomy. This decision-making process can be gained by focusing on three main questions: (a) 'What is the risk of failure based upon the locus of the anastomosis?' (b) 'Can the case tolerate a failure?' and (c) 'What are the case's wishes?.' Older cases and those with multiple medical comorbidities should be considered for proximal diversion. These patients typically have very little physiologic reserve to tolerate a failure [30].

We consider that the small sample size was one of the limitations of this study. However, the randomization usually saved the results from the risk of bias, but our recommendation is to involve the cases in your decision making. Some cases will reject any types of stoma. Others may be more concerned with the complications from an intestinal failure than with having an ostomy. A fully informed candidate will be able to better voice their own issues and be much more satisfied with the eventual outcome. Knowing what the case wants can simplify intraoperative decision making. In the future, more focus can be directed toward new trends like same admission ileostomy closure as a new surgical procedure which can achieve better QOL along with low rates of morbidity and mortality.

## Conclusion

Mesenteric vascular occlusion carries a challenge for physician and surgeons for early diagnosis and proper management of these patients, especially in the postoperative period. The critical decision for surgeon after resection of infarcted bowel either to do stoma or anastomosis should consider the long-term effect on patient life quality and psychological status.

The diverting stoma group showed significant difference in postoperative morbidity and mortality. On the contrary, patients faced marked decrease in their QOL which increased a lot after ileostomy closure. Moreover, ileostomy group needed strict follow-up and nutritional support to prevent postoperative electrolyte disturbance.

The ileostomy appeared to be a safer procedure to perform in mesenteric vascular occlusion regarding morbidity and mortality rates but needs a strict nutritional, psychological, and special home care to enhance QOL. On the contrary, anastomosis group carried higher risk for mortality and morbidity especially after leak but experienced better QOL.

#### Acknowledgements

Authors' contributions: S.A. (2, 3) and A.T. (1–3), the principal authors, have made substantial contributions to the conception, design of the work, acquisition of data, and analysis. A.N. (2, 3), W.A. (2, 3), and F.A. (2, 3) created a new software used in the work and have drafted the work. I.D. (1–3) and M.S.A.S. (2, 3) have substantively revised the work. All authors were

involved in (1) the conception and design of the study, acquisition of data, analysis, and interpretation of data; (2) drafting the article or revising it critically for important intellectual content; and (3) final approval of the version to be submitted.

**Financial support and sponsorship**
Nil.

**Conflicts of interest**
There are no conflicts of interest.

## References

1 Klar E, Rahmanian PB, Bücker A, Hauenstein K, Jauch KW, Luther B. Acute mesenteric ischemia: a vascular emergency. Dtsch Arztebl Int 2012; 109:249–256.

2 Kärkkäinen JM, Acosta S. Acute mesenteric ischemia (part I)–Incidence, etiologies, and how to improve early diagnosis. Best Pract Res Clin Gastroenterol 2017; 31:15–25.

3 Arthurs ZM, Titus J, Bannazadeh M, Eagleton MJ, Srivastava S, Sarac TP, Clair DG. A comparison of endovascular revascularization with traditional therapy for the treatment of acute mesenteric ischemia. J Vasc Surg 2011; 53:698–704.

4 Ryer EJ, Kalra M, Oderich GS, Duncan AA, Gloviczki P, Cha S, Bower TC. Revascularization for acute mesenteric ischemia. J Vasc Surg 2012; 55:1682–1689.

5 Szabóné Révész E. Acute mesenteric ischemia: analysis of cases over a ten-years period (2001-2010). Orv Hetil 2012; 153:1424–1432.

6 Alhan E, Usta A, Çekiç A, Saglam K, Türkyılmaz S, Cinel A. A study on 107 patients with acute mesenteric ischemia over 30 years. Int J Surg 2012; 10:510–513.

7 Block TA, Acosta S, Björck M. Endovascular and open surgery for acute occlusion of the superior mesenteric artery. J Vasc Surg 2010; 52:959–966.

8 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.

9 Meng X, Liu L, Jiang H. Indications and procedures for second-look surgery in acute mesenteric ischemia. Surg Today 2010; 40:700–705.

10 Du Toit A. Nutritional management of a complicated surgical patient by means of fistuloclysis. S Afr J Clin Nutr 2014; 27:230–236.

11 Mastoraki A, Mastoraki S, Tziava E, Touloumi S, Krinos N, Danias N, Arkadopoulos N. Mesenteric ischemia: pathogenesis and challenging diagnostic and therapeutic modalities. World J Gastrointest Pathophysiol 2016; 7:125–130.

12 Kiran RP, Delaney CP, Senagore AJ, O'Brien-Ermlich B, Mascha E, Thornton J, Fazio VW. Prospective assessment of Cleveland Global Quality of Life (CGQL) as a novel marker of quality of life and disease activity in Crohn's disease. Am J Gastroenterol 2003; 98:1783–1789.

13 Crosby J, Werku D, Zewdu T, Wanjiku G, Schmidt J. Acute mesenteric ischaemia: a case of expedited diagnosis and management using point-of-care ultrasound. Afr J Emerg Med 2018; 8:164–166.

14 Choi HK, Law WL, Ho JW. Leakage after resection and intraperitoneal anastomosis for colorectal malignancy: analysis of risk factors. Dis Colon Rectum 2006; 49:1719–1725.

15 Gooszen AW, Tollenaar RA, Geelkerken RH, Smeets HJ, Bemelman WA, Van Schaardenburgh P, Gooszen HG. Prospective study of primary anastomosis following sigmoid resection for suspected acute complicated diverticular disease. Br J Surg 2001; 88:693–697.

16 Wong NY, Eu KW. A defunctioning ileostomy does not prevent clinical anastomotic leak after a low anterior resection: a prospective, comparative study. Dis Colon Rectum 2005; 48:2076–2079.

17 Montedori A, Cirocchi R, Farinella E, Sciannameo F, Abraha I. Covering ileo- or colostomy in anterior resection for rectal carcinoma. Cochrane Database Syst Rev 2010; 12:CD006878.

18 Nagaraja R, Rao P, Kumaran V, Yadav A, Kapoor S, Varma V, *et al.* Acute mesenteric ischaemia – an Indian perspective. Indian J Surg 2015; 77 (Suppl 3):843–849.

19 Dhamnaskar SS, Sawarkar PC, Mandal S, Vijaykumaran P. Predictors of mortality in acute mesenteric vascular ischemia with bowel gangrene. Int Surg J 2016; 3:1996–2002.

20 Clair DG, Beach JM. Mesenteric ischemia. N Engl J Med. 2016; 374:959–968.

21 van Dijk LJ, van Noord D, de Vries AC, Kolkman JJ, Geelkerken RH, Verhagen HJ, *et al.* Clinical management of chronic mesenteric ischemia. United European Gastroenterol J 2019; 7:179–188.

22 Salvadalena G. Incidence of complications of the stoma and peristomal skin among individuals with colostomy, ileostomy, and urostomy: a systematic review. J Wound Ostomy Continence Nurs 2008; 35:596–607.

23 Alvey B, Beck DE. Peristomal dermatology. Clin Colon Rectal Surg 2008; 21:41–44.

24 McGee MF, Cataldo PA. Intestinal stomas. The ASCRS textbook of colon and rectal surgery. United States (USA): Springer; 2016. pp. 971–1013.

25 Biondo S, Parés D, Kreisler E, Ragué JM, Fraccalvieri D, Ruiz AG, Jaurrieta E. Anastomotic dehiscence after resection and primary anastomosis in left-sided colonic emergencies. Dis Colon Rectum 2005; 48:2272–2280.

26 Kwiatt M, Kawata M. Avoidance and management of stomal complications. Clin Colon Rectal Surg 2013; 26:112–121.

27 Karadağ A, Menteş BB, Uner A, Irkörücü O, Ayaz S, Ozkan S. Impact of stomatherapy on quality of life in patients with permanent colostomies or ileostomies. Int J Colorectal Dis 2003; 18:234–238.

28 Camilleri-Brennan J, Munro A, Steele RJ. Does an ileoanal pouch offer a better quality of life than a permanent ileostomy for patients with ulcerative colitis?. J Gastrointest Surg 2003; 7:814–819.

29 Costedio MM, Merlino JI. Quality of life of the ostomate atlas of intestinal stomas. XXXX: Springer; 2012. pp. 69–73.

30 Sherman KL, Wexner SD. Considerations in stoma reversal. Clin Colon Rectal Surg 2017; 30:172–177.