Abdominal wall dehiscence in emergency midline laparotomy: incidence and risk factors

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Background
Burst abdomen is a very serious postoperative complication associated with high morbidity and mortality. It has a significant effect on health care cost, for both the patients and the hospitals.
Purpose
The aim of this study was to assess the incidence and perioperative risk factors of burst abdomen in patients undergoing emergency midline laparotomy.
Patients and methods
A prospective cohort study was conducted on 250 patients who underwent midline laparotomy at Kasr Al-Ainy Hospital Emergency Department, Cairo University, from August 2017 until August 2018. Factors such as age, sex, BMI, substance abuse, previous laparotomy, malignancy, diabetes mellitus, ascites, albumin, renal functions, bilirubin, hemoglobin, intra-abdominal pathology, suture material, creation of stoma, postoperative chest infection, postoperative paralytic ileus, leakage, and wound infection were observed and analyzed.
Results
Incidence of burst abdomen was 12.4%. Wound infections (87.1 vs. 18.7%, $P<0.001$), anemia (48.4 vs. 5%, $P<0.001$), diabetes (41.9 vs. 10%, P 0.001), hypoalbuminemia (64.5 vs. 27.4%, $P<0.001$), previous laparotomy (29 vs. 2.7%, $P<0.001$), creation of stoma (48.8 vs. 18.7%, $P<0.001$), chest problems (51.6 vs. 15.1%, $P<0.001$), ascites (22.6 vs. 4.6%, $P<0.001$), leakage (38.7 vs. 0%, $P<0.001$), and peritonitis (71 vs. 45.7%, $P<0.001$) were statistically significant factors.
Conclusion
Important risk factors according to our study were wound infection, anemia, previous laparotomy, creation of stoma, hypoalbuminemia, ascites, diabetes, type of intra-abdominal pathology, with maximum incidences in peritonitis, postoperative cough, and postoperative leakage. Patient sex, age, associated morbidities such as jaundice and uremia, previous use of steroids, suture material used in closure, and postoperative paralytic ileus were not significant in our study.

Keywords:
anemia, ascites, burst abdomen, hypoalbuminemia, peritonitis, wound infection

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Introduction

Burst abdomen (abdominal wound dehiscence) is a serious, difficult, and frustrating postoperative complication experienced by many surgeons worldwide associated with high morbidity and mortality up to 36%, with significant effect on health care cost, for both the patients and the hospitals [1].

The frequency ranges from 0.4 to 3.5%. However, incidence may reach in some centers up to 10–30%, as in India [2].

Abdominal wound dehiscence can be a partial or complete disruption without or with evisceration, requiring immediate intervention. Management ranges from simple dressing to further closure of burst abdomen followed by a period of intensive care. Prolonged hospital stay, repeated dehiscence, high incidence of incisional hernia, and subsequent reoperation may be sequelae of this complication [3].

Several retrospective studies tried to identify risk factors for this complication, with conflicting results. Unfortunately, multivariate analysis has only been performed in a small number of patients [4].

Many risk factors were incriminated in causation of burst abdomen, including general patient profile like

age, sex, and nutritional status (malnutrition) and preoperative medical conditions like anemia, diabetes, hypoproteinemia, jaundice, renal failure (uremia), prolonged steroid therapy (before and after), peritonitis, malignancy, intraoperative knot breakage, type and duration of surgery, prolonged postoperative abdominal distension, cough, and wound infection [5].

No single cause is responsible for wound dehiscence, and as a rule, it is related to a combination of factors. Wound infection is the most important single factor [6].

Wound dehiscence is related to the technique of closure of the abdomen and sutures used. Numerous studies have been conducted evaluating a variety of closure techniques and suture materials [7].

The current opinion in centers in the West for closure a midline incision is toward running mass closure with nonabsorbable or slowly absorbable suture using a suture length : wound length ratio of 4 : 1. Continuous running sutures ensure that tension is distributed evenly along the length of the wound [8].

Strict postoperative care with stress on prevention of wound infection and other risk factors associated with wound dehiscence will have a positive outcome [9].

Many trials and new techniques were developed to prevent or at least reduce the risk of abdominal wound dehiscence, but burst abdomen remains a formidable morbidity [10].

Despite advances in perioperative care and suture materials, incidence and mortality rates have not changed over the past decades. This is attributable to risk factors among patient population outweighing the benefits of technical achievements [11].

The goal of this study is to assess the incidence and perioperative risk factors of burst abdomen in emergency midline laparotomy.

Patients and methods

A prospective cohort study was conducted that involved 250 patients subjected to laparotomy in the surgical emergency department of Kasr Al-Ainy Hospital, Cairo University, between December 2017 and August 2018. Informed written consent was obtained from all participants after approval of Kasr Al-Ainy ethical committee. All participants were subjected to emergency midline exploration. All participants of any age and of both sexes were included. Exclusion criteria included those who arrested on the table or in the immediate postoperative period. Complete evaluation of all participants through history, with special consideration for age, sex, smoking, chronic drug use, especially steroids, history of previous laparotomies, medical history, and history of radiotherapy and chemotherapy for malignancy. General examination was done, including evaluation of weight, height, and calculation of BMI. Preoperative investigations involved hemoglobin, serum albumin, bilirubin, aspartate aminotransferase (AST), alanine aminotransferase (ALT), and serum creatinine.

General anesthesia can be appropriate for patients undergoing abdominal surgery. In common practice, rapid sequence induction with inhalation anesthetics (sevoflurane or isoflurane), opioids (fentanyl 1–2 mic/kg with induction and morphine 0.1 mg/kg), and neuromuscular blockers (succinylcholine 0.5 mg/kg or rocuronium 0.9 mg/kg) is used in general anesthesia for abdominal surgical procedures [12].

Once an adequate level of anesthesia has been reached, the initial incision into the skin may be made. A scalpel is first used to cut into the superficial layers of the skin with the diathermy. The incision is then continued through the subcutaneous fat, the abdominal muscles, and finally, the peritoneum [12].

For all the patients, closure of midline laparotomy wound was en-mass done with nonabsorbable no. 1 (polypropylene) or slowly absorbable (PDS) (double loop) sutures in continuous single-layer fashion with 1-cm interval [12].

The operative details were recorded with special consideration to the operative diagnosis, presence and types of adhesions, duration of surgery, the need for diversion and stoma formation, the use of intraperitoneal drain, and the suture material to close the rectus sheath.

During the postoperative period, visual analog scale assessment of postoperative pain at 1 and 24 h, time of ambulation, time of oral feeding, hospital stay, and postoperative hemoglobin were recorded. Any postoperative complication especially chest infection, wound infection, postoperative leakage, and postoperative paralytic ileus were reported.

Follow-up of all cases was done weekly after discharge for 4 weeks. Examination of wound included inspection for any redness, edema, or presence of discharge like pus or serosanguinous fluid. Special attention was given to maintain asepsis. Broad-spectrum intravenous antibiotics were initiated.

The antibiotic therapy for the treatment of intra-abdominal infections greatly varies according to the infection severity. It is, in fact, possible to distinguish the intra-abdominal infections in three different categories. Mild infections should be treated promptly with surgical drainage and a short-term therapy with a wide range antibiotic including those against anaerobes (ampicillin/sulbactam and cefoxitin). Mild–moderate infections, which are largely the most frequent in the clinical practice, should be also treated with a single drug, which include anaerobes in its spectrum. Finally, severe infections require a more aggressive therapeutic approach with a combination treatment covering anaerobes (clindamycin and metronidazole), gram-negative rods (ciprofloxacin and aminoglycosides) and gram-positive cocci (penicillins and cephalosporins) including methicillin-resistant *Staphylococcus aureus* (glycopeptides) and/or vancomycin resistant enterococcus (VRE) (linezolid), with anaerobic coverage started for all cases and later changed according to culture and sensitivity report.

During follow-up duration, the participants were assigned to one of two groups. Group I involved patients who developed burst abdomen whether partial (bowel not eviscerated) or complete (bowl not eviscerated) and group II involved those who did not develop it. Half of the sutures were removed after 10 days, and all the sutures removed after 14 days.

The following classifications were used to assess the risk factors: BMI, where participants were classified to normal weight, overweight, and grades I, II, and III obesity, if their BMI were 18–25, 25.1–30, 30.1–35, 30.1–40, and above 40 kg/m^2, respectively. Diabetics were classified into controlled and uncontrolled if the glycated hemoglobin was below or above 7 mg%, respectively. Renal impairment was defined as serum creatinine less than 2. Elevated liver enzymes were considered if AST and/or ALT were increased three or more folds [13]. Low serum albumin was considered below 3.5 g%.

The sample size calculation was done using EpiCalc 2000 as well as Roasoft online software for sample size calculation; with confidence level set on 95% and confidence interval of ±5%, with a two-sided type 1 error=0.05 and power=0.8. The sample size needed was 217 laparotomy patient in the emergency department. We recruited 250 women to compensate for any dropout cases.

Statistical analysis

Numerical quantitative data were presented as mean, SD, and range values. Data were analyzed by applying independent Student *t* test for comparison of two groups' means.

Ordinal qualitative data were expressed as frequencies (*n*) and percentage (%) and analyzed by applying c^2 test. Nonparametric tests (Mann–Whitney) were used for qualitative variable comparison.

Correlation analysis was done using Pearson correlation tests. Multivariate analysis and binary regression were performed. The significance level was set at *P* value less than or equal to 0.05. Statistical analysis was performed with IBM SPSS Statistics (International Business Machines Corporation (IBM), New York, USA), version 23 for Windows (Fig. 1).

Results

There was no significant difference between women who had burst abdomen and others regarding age, sex, number of smokers and substance abuse, participants with controlled diabetes mellitus, hypertension, connective tissue diseases, those under chronic steroid therapy, and those under treatment for malignancy (Table 1).

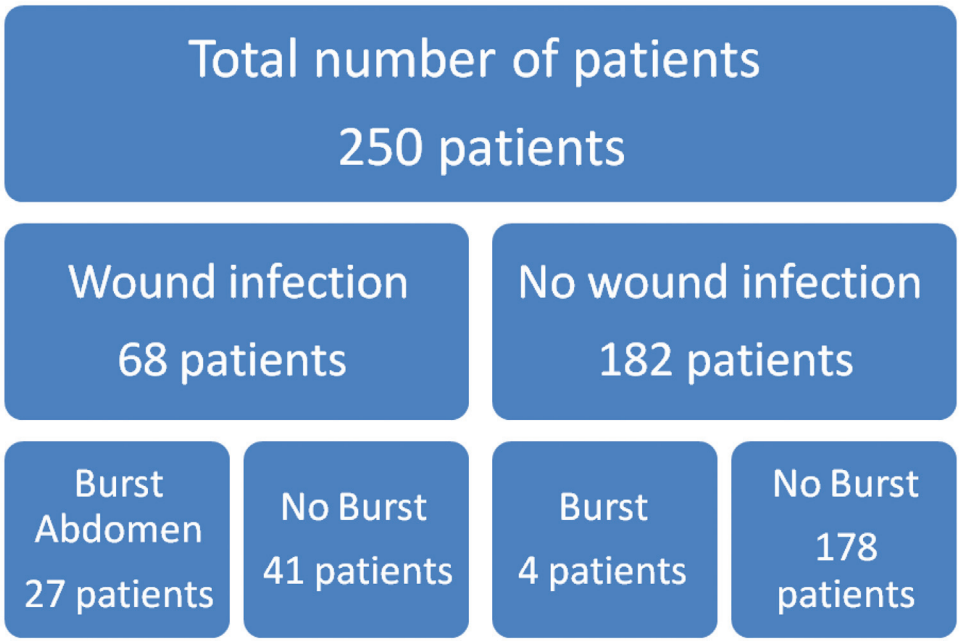
Obese and participants with high BMI, those with uncontrolled diabetes mellitus, chronic cough, and those with operative finding of ascites were more exposed to development of burst abdomen (Table 1).

The occurrence of burst abdomen was linked to lower hemoglobin level and lower serum albumin but not to serum creatinine, bilirubin, AST, or ALT (Table 1).

Regarding the operation and the postoperative period, the development of burst abdomen was related to the operative diagnosis of peritonitis and trauma but not to intestinal obstruction. It was linked to frozen field surgery but not adhesion neither filmy nor fibrous. Burst was not related to duration of surgery, postoperative visual analog scale score, time of ambulation, time of oral feeding, hospital stay, or the suture material used to close the abdomen (Table 2).

The occurrence of burst abdomen was linked to diversion and stoma formation, development of

Figure 1



The flow chart of the study.

postoperative complications, namely, chest infection, leakage, and wound infection, but not ileus and the use of drain (Tables 2 and 3).

Discussion

In our study, we reported an incidence of burst abdomen of 12.4% in emergency midline laparotomy. Choudhury *et al.* [14] reported 4.99% incidence in emergency laparotomies (44/779 patients). In the study by Waqar *et al.* [2], wound dehiscence rate was observed to be 12% in emergency (5/62 patients). In the study by Talukdar *et al.* [13], 12.6% of patients developed wound dehiscence (27/213 patients). In the study by Parmar *et al.* [15], the incidence was 5.6% (60/1070 patients).

There are several factors that affect outcome in different centers. These include patient factors and hospital factors. Patient factors are demographics, factors related to presentation, and etiology. Hospital factors depend on its infra-structure, attending personnel, and volume of workload.

The relatively higher incidence in our study could be because our cases were emergency patients. In elective cases, there is time to correct or control the risk factors such as anemia, diabetes, malnutrition, and hypoproteinemia. Moreover, there is no abdominal sepsis or increased intra-abdominal pressure in the elective cases. In our setup, the emergency laparotomies are usually performed for acute abdomen cases that have deteriorated owing to the course of acute illness, and by the time they are referred to tertiary care hospitals (Kasr Al-Ainy), most of them are already having complications like septicemia and fluid and electrolytes derangements.

Age in our study was not a significant factor in burst abdomen development. This is in accordance with the study by Choudhury *et al.* [14]. Most of the studies that claim age as a risk factor have included many geriatric patients, which is not the case in our study.

Sex was not a significant risk factor (64.5% were males in group I compared with 54.3% in group II). Kenig and colleagues found similar findings in their study, whereas Kotwal *et al.* [16] demonstrated a higher incidence in the male sex. However, male to female ration in their study was 4 to 1, leading to uncertain results regarding sex.

Obesity in our study was identified as a major risk factor for wound dehiscence. This was also reported by Kapoor *et al.* [17] and Ramneesh *et al.* [18].

It is well known that the oxidative stress associated with obesity leads to adiponectin deficiency which results in impairment of wound perfusion and epithelialization. The low wound perfusion and lower oxygenation result in tissue injury and higher wound complications [19].

Substance abuse and smoking were not a risk factor in our study. Moreover, Mäkelä *et al.* [20] reported alcoholism

Table 1 Characteristics of the study population

	Burst (*N*=31)	No burst (*N*=219)	Total	*P* value
Age (years)				
<40	15 (48.4)	130 (59.4)	145	0.248
>40	16 (51.6)	89 (40.6)	105	
Sex				
Male	20 (64.5)	119 (54.3)	139 (55.6)	0.287
Female	11 (35.5)	100 (45.7)	111 (44.4)	
BMI (kg/m^2)				
Normal	6 (19.4)	97 (44.3)	103	<0.001
Overweight	6 (19.4)	66 (30.1)	72	
Obese I	8 (25.8)	36 (16.4)	44	
Obese II	6 (19.4)	11 (5)	17	
Obese III	5 (16.1)	9 (4.1)	14	
Smokers	13 (41.9)	80 (36.5)	93 (37.2)	0.561
Substance abuser	4 (12.9)	34 (15.5)	38 (15.2)	0.704
Previous laparotomy	9 (29)	6 (2.7)	15 (6)	<0.001
Medical disorders				
DM				
Uncontrolled HbA1C >7	8 (19.4)	11 (4.6)	19 (7.6)	<0.001
Controlled HbA1C <7	5 (16.1)	11 (4.6)	16	0.242
Total	13 (41.9)	22 (10)	35	0.001
Chronic cough	13 (41.9)	36 (16.4)	49 (19.6)	0.001
Hypertension	5 (16.1)	36 (16.4)	41	0.758
Connective tissue diseases	2 (6.5)	2		0.115
Others (liver cirrhosis and bronchial asthma)	2 (6.5)	3 (1.4)		0.137
Chronic steroid use	2 (6.5)	10 (4.6)	12 (4.8)	0.646
Under malignancy ttt (radiotherapy and chemotherapy)	3 (9.7)	17 (7.8)	20 (8)	0.714
Operative findings of ascites	7 (22.6)	10 (4.6)	17 (6.8)	0.000
Preoperative investigations				
Hemoglobin (g/dl)				
<9	15 (48.4)	11 (5)	26	<0.001
9.1–11	11 (35.5)	88 (40.2)	99	
>11	5 (16.1)	120 (54.8)	125	
Serum albumin (g/dl)				
<3.5	20 (64.5)	60 (27.4)	80	0.000
3.5–5	11 (35.5)	154 (70.3)	165	
>5.1	0	5 (2.3)	5	
Creatinine				
<2	29 (93.5)	205 (93.6)	234	0.990
>2	2 (6.5)	14 (6.4)	16	
Bilirubin				
Normal less than 1 mg%	29 (93.5)	205 (93.6)	234	0.826
Abnormal more than 1 mg%	2 (6.5)	14 (6.4)	16	
AST				
Normal <40	29 (93.5)	209 (95.5)	238	0.826
Abnormal >40	2 (6.5)	10 (4.6)	12	
ALT				
Normal <40	29 (93.5)	207 (94.5)	236	0.826
Abnormal >40	2 (6.5)	12 (5.5)	14	

Data are presented as *n* (%). ALT, alanine aminotransferase; AST, aspartate aminotransferase; DM, diabetes mellitus; HbA1C, glycated hemoglobin.

as a risk factor for burst abdomen. This was not evident in our study as most of our patients are not alcoholic as a result of religious beliefs in our community.

Previous steroid therapy was not a significant factor related to burst abdomen in our study. Choudhury *et al.* [14], Afzal and Bashir [21], Van Ramshorst *et al.* [22], and Kenig *et al.* [23] also reported steroid therapy was not a risk factor in their studies, However, other authors considered chronic use of steroids a risk factor for abdominal wound dehiscence [24]. The difference in their finding is easily explained as most

Table 2 Operative and postoperative characteristics

	Burst (*N*=31)	No burst (*N*=219)	Total	*P* value
Operative diagnosis				
Peritonitis	22 (71)	100 (45.7)	122 (48.8)	<0.001
Intestinal obstruction	7 (22.6)	74 (33.8)	81 (32.4)	0.074
Trauma	2 (6.5)	45 (20.5)	47 (18.8)	0.006
Adhesions				
Filmy	2 (6.5)	5 (2.3)	7	0.121
Fibrous	4 (12.9)	11 (5.0)	15	0.089
Frozen	12 (38.7)	11 (5.0)	23	<0.001
Duration of surgery	162.2±77.1	169.7±82.3	164.5±79.9	0.528
Diversion and stoma formation	15 (48.8)	41 (18.7)	56 (22.4)	0.000
Postoperative complications				
Chest infection	16 (51.6)	33 (15.1)	49 (19.6)	0.000
Ileus	2 (6.5)	13 (5.9)	15 (6)	0.910
Leakage	12 (38.7)	0	12 (4.8)	0.000
Others (wound infection)	27 (87.1)	41 (18.7)		0.000
Postoperative pain VAS				
1 h	8.7±1.8	8.2±1.9	8.4±1.9	0.745
6 h	7.6±2.1	6.9±2.0	7.1±2.1	0.341
12 h	6.3±2.2	6.0±2.1	6.1±2.1	0.719
Time of ambulation	8.2±2.3	8.9±2.9	8.6±2.6	0.652
Time of oral feeding	9.9±4.6	10.1±4.5	10.0±4.5	0.773
Postoperative Hb	8.1±3.2	9.9±3.5	9.6±3.4	0.032
Hospital stay	7.8±3.1	6.8±3.7	7.0±3.5	0.643
Drain	30 (96.8)	141 (64.4)	171 (68.4)	0.001
Suture material				
Nonabsorbable	14 (45.2)	117 (52.4)	131 (52.4)	0.390
Delayed absorbable	17 (54.8)	102 (46.6)	119 (47.6)	

Data are presented as *n* (%) and mean±SD. Hb, hemoglobin; VAS, visual analog scale.

Table 3 The correlation between development of burst abdomen and its risk factors

Burst	Laparotomy	DM	Ascites	Cough	Hemoglobin	Albumin	Chest infection	Wound infection	Leakage	Diagnosis	Stoma
P value	0.000	0.049	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.006	0.000
r	+0.365	+0.125	+0.236	+0.212	+0.468	–0.263	+0.303	+0.506	+0.597	+0.173	–0.235

DM, diabetes mellitus. Significant at *P* value less than or equal to 0.05.

of their patients had an underlying malignancy, which lowers the immunity and not merely the effect of steroids.

Previous laparotomy history was found to be a significant risk factor for burst abdomen (29% of cases had previous laparotomies in group I compared with 2.7% in group II). This may be explained by collagen fiber alignment is usually of inferior functional quality compared with the normal collagen, and re-incision in a scar tissue will give a lower quality of healing in these cases.

Diabetes – especially when uncontrolled – was a significant factor in development of burst abdomen. Mahey *et al.* [25] found that diabetes mellitus was the most common comorbid condition found in 42% of patients who had wound dehiscence. Jaiswal and Shekhar [26] reported that 29% of cases were diabetic. Choudhury *et al.* [14] reported 17.86% of cases were diabetics. Kotwal *et al.* [16] and Afzal and Bashir [21] reported diabetes as a risk factor of burst abdomen. However, Kenig *et al.* [23], Ramneesh *et al.* [18], and Van Ramshorst *et al.* [22] found that diabetes was insignificant.

Diabetes impairs wound healing through many mechanisms. Low wound oxygenation is a result of poor perfusion and ischemia, which lead to prolonged inflammation with release of oxygen radicals with resultant tissue injury. High matrix metalloproteases result in tissue destruction [19].

Ascites was a significant risk factor for burst abdomen. Its effect may be explained by increase in intra-

abdominal pressure and effect of other associated factors like wound infection and anemia. Van Ramshorst *et al*. [22] reported ascites in 23% of burst cases. However, Kenig *et al*. [23] and Talukdar *et al*. [14] reported ascites was not found to have a significant effect in predicting wound dehiscence. Moreover, their trials were retrospective depending on patient files.

Chronic cough was a significant factor in our study. Probably its effect results from increase intra-abdominal pressure and associated anemia of chronic element.

Postoperative chest infection was also a significant risk factor. Probably its effect is related to the increase in intra-abdominal pressure and associated wound infection.

Previous studies supported our findings. Jaiswal and Shekhar [26] found 52.4% of cases had chest disease. Kotwal *et al*. [16] reported chronic obstructive pulmonary disease as a risk factor of burst abdomen. Van Ramshorst *et al*. [22] reported cough as a risk factor with 17% of cases versus 4% of controls. Kenig *et al*. [23] also reported cough as a risk factor. Parmar *et al*. [15] reported 45% of cases had cough.

Anemia was found to be a significant risk factor for burst abdomen. Previous studies supported that finding. Kotwal *et al*. [16] and Van Ramshorst *et al*. [22] also reported anemia as a risk factor of burst abdomen. Jaiswal and Shekhar [26] reported that 73% of the cases were anemic. Mahey *et al*. [25] reported that 24% of patients had hemoglobin less than 10. Choudhury *et al*. [14] reported 66.07% of cases were anemic. Muneiah *et al*. [27] reported 72.2% had hemoglobin level less than 10 g%. Parmar *et al*. [15] reported 56.6% of cases were anemic. However, Kenig *et al*. [23] reported no significant differences between the study and control groups regarding anemia. Kenig *et al*. [23] defined anemia as hemoglobin below 12 g% and did not categorize it as we did, where hemoglobin provides the oxygen to the regenerating granulation tissue and lower hemoglobin levels affect the wound healing.

Hypoalbuminemia was found to be a risk factor for burst abdomen. Hypoalbuminemia probably was due to sepsis, so it is mostly associated with anemia and wound infection. Previous studies supported that finding. Choudhury *et al*. [14] reported 76.79% of cases had hypoalbuminemia. Parmar *et al*. [15] reported 46.6% had hypoalbuminemia. Jaiswal and Shekhar [26] reported 58% of cases with burst abdomen had hypoproteinemia with serum total proteins less than 6 g%.

We found no significant effect of renal impairment on the development of abdominal wound dehiscence. Similar findings were reported by Kenig *et al*. [23], Talukdar *et al*. [14], and Ramneesh *et al*. [18]. However, Jaiswal and Shekhar [26] reported that 33% of cases were uremic. Mahey *et al*. [25] reported 20% of patients had elevated renal parameters. Choudhury *et al*. [14] reported 19.64% of cases had impaired renal functions. Van Ramshorst *et al*. [22] identified renal failure as a risk factor (31% of cases in comparison with 23% of controls). The lower incidence of renal impairment in our study (6.5 and 6.4%) may not reach statistical significance. Moreover, the studies with different results considered renal failure, not merely renal impairment.

Jaundice and impaired liver functions were found to be of no significance. The same finding was documented by Kenig *et al*. [23], Afzal and Bashir [21], and Ramneesh *et al*. [18], whereas some studies listed jaundice as a risk factor for dehiscence [16,22]. Moreover, the lower incidence of renal impairment in our study (6.5 and 6.4%) may not reach statistical significance.

Peritonitis was a significant risk factor for burst abdomen. It probably exerts its effect through sepsis-induced anemia and wound infection. Previous studies supported that finding. Jaiswal and Shekhar [26] reported that 56% of cases were peritonitis. Ramneesh *et al*. [18] reported 70% of cases had perforation of hollow viscus. Muneiah *et al*. [27] reported 72.2% were peritonitis. Parmar *et al*. [15] also reported most patients had gastrointestinal perforation (53.3%). Talukdar *et al*. [14] found peritonitis was found to have a significant effect in predicting wound dehiscence.

Regarding suture material, we found no statistical difference between prolene group and PDS group (both have high tensile strength and either slowly or nonabsorbable). It was not a matter of chemical nature of the suture material at all. Bloemen *et al*. [28] also reported no statistical difference between both groups regarding incidence of wound dehiscence and incisional hernia. Henriksen *et al*. [29] reported that no suture material proved superior in abdominal closure.

Ostomy was a significant factor of burst abdomen in our study, and also was a significant factor for wound

infection. This means it may exert its effect via wound infection also. Waqar *et al*. [2] also reported ostomy as a risk in their study. Moreover, Riou *et al*. [30] reported creation of ostomy as a risk factor for burst abdomen. Stoma cause traction on wound edges, which in turn impair wound healing. Moreover, stoma increases wound infection, which in turn impairs wound healing and finally lead to burst abdomen.

Wound infection was a significant risk factor for burst abdomen. We found that 87.7% developed postoperative wound infections in group I compared with 18.7% in group II. Its importance has been confirmed by every study on this topic: 91% according to Muneiah *et al*. [27], 73% according to Parmar *et al*. [15], 52% of cases versus 11% of control according to Van Ramshorst *et al*. [22], 61% of cases versus 14% of controls according to Kenig *et al*. [23], and 90% according to Ramneesh *et al*. [18]. Talukdar *et al*. [14] reported wound infection as a risk factor for burst abdomen. Afzal and Bashir [21] reported wound sepsis is the single most important risk factor for wound dehiscence. Bacterial growth leads to consumption of oxygen and release of toxins, which impair wound healing. Infection also leads to slough out of the stitches and separates the rectus sheath.

Postoperative leakage was a significant risk factor (38.7% of burst abdomen cases had leakage). It was noted that leakage was a significant risk factor for wound infection. This means it probably exerts its effect through sepsis and wound infection. Parmar *et al*. [15] reported 10% of cases had bowel leakage.

Postoperative paralytic ileus was not a significant factor in our study (6.5% of cases in group I developed paralytic ileus compared with 5.9 in group II). Van Ramshorst *et al*. [22] reported postoperative paralytic ileus was not a significant factor in burst abdomen.

To the best of our knowledge, this study is the first prospective study done in the Middle East evaluating the risk factors and incidence of midline emergency laparotomy of unprepared patients without exclusion criteria allowing evaluation of all risk factors. Our study is not without limitations. The main limitation is the relatively small sample and inability to evaluate the management of burst cases, as some of them were managed in other hospitals.

Our research is a good start to minimize the occurrence of burst abdomen and correction of the risk factors, and taking more precautions when dealing with risky cases can save these patients from the high mortality associated with that, as well as serious conditions, especially in developing countries with limited resources.

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Conflicts of interest
There are no conflicts of interest.

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