Evaluation of the role of prophylactic onlay proline mesh in incisional hernia prevention after emergency midline laparotomy as compared with standard sheath suturing: a comparative study

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Introduction
Incisional hernia (IH) is a major and common complication of midline abdominal operations, and the risk is markedly elevated in high-risk patients and emergency procedures. Mesh enforcement has been adopted in elective laparotomies and proved beneficial by many trials; however, much less studies were conducted in emergency situations.
Objectives
To evaluate if the use of prophylactic mesh in emergency midline laparotomies is a safe and efficient intervention in reducing the risk of IH after these operations.
Patients and methods
Seventy-two patients were included in the present study and were randomized in two groups, group PM (38 patients) who had prophylactic mesh for enforcing their incision, while group SO (34 patients) had only classical suturing of the midline sheath. The surgical outcomes were divided into early and late based on the time of occurrence of complications, such as surgical-site infections, surgical wound dehiscence, seroma, and IH.
Results
Both groups had no significant differences regarding demographic data, associated comorbid diseases, causes, and types of the operations. Within the first 30 postoperative days, 24 patients developed surgical-site infection (13 in group PM and nine in group SO), surgical wound dehiscence occurred in 26 patients (14 in group PM and 12 in group SO), but despite the higher prevalence in group PM, the statistical difference was insignificant. Higher rate of seroma formation was reported in the PM group (23.6 vs. 5.8% in the SO group) with *P* value 0.0499; however, IH was markedly reduced in the patients who had prophylactic mesh in their repair (2.6% in the PM group vs. 26.4% in the SO group).
Conclusion
Mesh prophylaxis can be used as an efficient and safe option in reducing the incidence of IH in emergency midline abdominal incisions.

Keywords:
emergency midline laparotomy, incisional hernia, prophylactic mesh, surgical-site infections, surgical wound dehiscence

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Introduction

Despite the wide acceptance of minimally invasive laparoscopic approach for emergency abdominal exploration, classic open laparotomy is still extensively used by many surgeons [1]. Midline laparotomy has the advantage of being exploratory incision, rapid access to the abdominal cavity, and can be easily extended upward and downward, thus suitable for emergency cases [2,3]. The complications of the open approach include hematoma and seroma formation, surgical-site infections (SSI), nerve injury, fascial dehiscence, and incisional hernia (IH) [4].

IH is that type of hernia, which occurs through a defect in the anterior abdominal wall that was predisposed to via surgically made incision [5]. The incidence of IH in normal population is 5–25%. This incidence is doubled in high-risk patients, including emergency operations, particularly midline incisions in which the incidence of IH can reach 66% in some trials [6].

Many risk factors are accused of developing IH. These include patient's related factors, such as obesity, elderly population, malnutrition, smoking, chronic obstructive pulmonary disease (COPD), and diabetes mellitus

(DM) [7]. Inappropriate choice of the surgical procedure, long operative time, excessive dissection with increased blood loss, and according to standard techniques of surgical wound closure, are among other surgical procedure-related risk factors [8].

Repair of IH remains as difficult and potentially causing more complications that may be far more advanced than the original surgical procedure. Even with more and more advances in the suture materials, types of meshes, and the technique of IH repair, the recurrence rate is still disappointingly high up to 54% in some trials [9].

Due to the above reasons, many evolving clinical studies search for the potential role of prophylaxis in the management of IH. Standardization of the closure technique has proven effective in reducing IH in some trials but not in high-risk patients [10]. A small number of researchers have started seeking for evidence to the use of synthetic mesh in enforcing the midline-incision closures, thus preventing the occurrence of IH in elective operations [11,12]. Anticipated risk of increased SSI and other potential complications lead to the controversy of mesh utilization in IH prevention in emergency operations [13] and this explains the rationale for conducting this study.

Objectives

The present study aims to answer the question if proline mesh can be used efficiently and safely to decrease the incidence of IH in midline-emergency incisions in comparison with standardized suturing technique.

Patients and methods

This was a randomized prospective study that was performed at Ain Shams University Hospitals. We took informed written consent from all participants and included their data in this study. After exclusion of eight patients due to loss of follow-up and four other patients who required reoperation within the first 30 postoperative days, 72 patients were included in the study during the period from January 2017 to April 2020.

The present study was approved by our department ethical committee and all patients participated had been thoroughly informed of the procedure details, possible complications, and importance of close follow-up for 2 years.

Inclusion criteria: all patients admitted to the emergency department who underwent emergency midline laparotomy for various causes were included in this study. Clean and clean–contaminated procedures only were included. Clean procedures were defined as an incision with no preoperative or intraoperative inflammation, no breach in sterile technique, and during which the respiratory, genitourinary, and gastrointestinal tracts were not violated. While clean–contaminated procedures were defined as an incision in which minor controlled spillage from the respiratory, genitourinary, and gastrointestinal tracts was encountered. High-risk populations were also included as old obese (BMI $\geq$30) patients, patients with COPD, DM, malnutrition, or previous midline abdominal incisions.

Exclusion criteria: contaminated and dirty (infected) procedures were excluded. Contaminated procedures were defined when major sterilization violation occurred, or gross uncontrolled alimentary-tract spillage was encountered. Dirty procedures meant those operations on perforated viscus, intraabdominal abscesses, or generalized peritonitis. Pregnant patients, pediatric-age group (<18 years), patients with metastatic tumors (short-life expectancy), and American Society of Anesthesiologists scores 4 and 5 patients were also excluded.

Patients were randomized in two groups using computer-generated block-randomization method (block size of 4 was chosen). Patients who had prophylactic mesh (group PM) were compared with those who had suturing only (group SO) to the midline fascia.

Preoperatively, all patients were subjected to full history-taking, careful general and local examination, and routine preoperative laboratory investigations (complete blood count, liver-function and renal-function tests, random blood glucose, serum albumin, PT, PTT, and INR). Imaging studies such as pelviabdominal ultrasound or computed tomography were ordered according to each case provisional diagnosis. After stabilization of critical and high-risk patients, antibiotic prophylaxis (third-generation cephalosporin) was provided on anesthesia induction.

Technical considerations: standard suture closure of the midline laparotomy sheath was done in all patients. That closure was performed using polydioxanone plus antibacterial looped suture number 1. Suturing was done employing the continuous technique with the suture bites situated 1 cm apart from each other and 1 cm from the sheath edge, keeping the suture-to-wound ratio of at least 4. Suture closure was the

only way to prevent IH in group SO. In group PM, wide-pore proline (polypropylene) onlay mesh was applied to support the sheath's suture closure. The mesh was applied after dissection of at least 5 cm of the subcutaneous tissue from the line of incision and superficial to the anterior rectus sheath. To secure the mesh in place, interrupted 2-0 proline sutures were utilized all around the mesh's edge and fixing it to the line of incision, thus removing any dead space under the mesh. After ensuring good hemostasis and wound irrigation with saline containing gentamicin (Garamycin amp.), a closed-system suction drain (Redivac drain) was inserted over the mesh. The subcutaneous tissue and the skin were closed as usual.

The subcutaneous drain was followed up as regards the amount and color of the daily fluid output and the plan was to remove the drain if the daily output was less than 50 ml.

Study outcomes: based on the time factor, the outcomes considered necessary to explore in that study were divided into early (short-term) and late (long-term) outcomes.

Early outcomes were related to wound complications occurring in the first 30 days postoperatively. Short-term outcomes were broadly divided into two main categories: SSI and surgical wound dehiscence (SWD). SSI was diagnosed when the following criteria were found: wound pain or tenderness, purulent discharge, positive wound culture with or without systemic manifestations such as temperature more than 38°C, tachycardia, or malaise. SWD was defined as reopening of surgical-incision margins with or without exposure of the underlying mesh or internal organs. SSI and SWD were further subdivided as shown in Tables 1 and 2.

Late outcome was the main endpoint of the present study, and it was the occurrence of IH within the defined study period, which was 2 years. IH was diagnosed by clinical examination and abdominal ultrasound for all cases. Abdominal computed tomography was done in doubtful cases or other reasons related to the original procedure.

In addition, other outcomes, such as wound seroma, hematoma, chronic pain, intraoperative time, and hospital stay, had been evaluated.

Follow-up schedule

After hospital discharge, all patients were evaluated weekly for 1 month, then monthly for 6 months, and then every 6 months, till the end of the 2-year follow-up period.

Statistical analysis

For continuous variables (mean and SD), two-sample paired Student t test was used. χ^2 tests were used for categorical variables. IBM SPSS statistics for Windows, version 21.0 (IBM Corp., Armonk, New York, USA) was employed for statistical analysis. A statistically significant difference was considered when P value is less than 0.05.

Results

Eighty-four patients were initially eligible and therefore were included in the analysis. They represented all patients admitted to the emergency room and prompted to undergo midline laparotomy incision for various reasons during the study period. The study population was randomized into two groups: patients who had prophylactic mesh (group PM) and those who had suturing only (group SO) to the sheath.

Table 1 Types of surgical-site infections [31]

Type of SSI	Definition
Superficial incisional	Involves infection of only the skin and subcutaneous tissue
Deep incisional	Involves infection of the deep soft tissues of the incision (for example, fascial and muscle layers)
Organ/space	Involves infection of any anatomical region deep to the fascial layer that is manipulated during the operation

SSI, surgical-site infection.

Table 2 A proposed grading for surgical wound dehiscence [32]

The Sandy grading system for surgical wound dehiscence	
Grades	Description
I	Minor separation of the margins, less than 2 cm depth. The subcutaneous tissue is not visible
Ia	As ?+clinical signs and symptoms of SSI
II	Medium separation of the margins with exposure of the subcutaneous tissue, more than 5 cm depth
IIa	As ?+clinical signs and symptoms of SSI
III	Major separation of the margins with exposure of the subcutaneous tissue, fascial layer±internal organs (i.e. burst abdomen)
IIIa	As ?+clinical signs and symptoms of SSI

SSI, surgical-site infection.

Table 3 Preoperative patients related demographics and risk factors

	Group PM [*n* (%)]	Group SO [*n* (%)]	*P* value
Number of patients	38	34	
Age (mean±SD)	40.26 ±13.67	43.08 ±14.03	0.7776 (NS)
Age ≥60	14 (36.8)	10 (29.4)	0.6184 (NS)
Sex M/F	29/9	22/12	0.3097 (NS)
BMI (mean±SD) (kg/m^2)	33.02±5.80	30.97±5.75	0.2651 (NS)
BMI ≥30	11 (28.9)	9 (26.4)	1 (NS)
Diabetes mellitus	8 (21)	10 (29.4)	0.4302 (NS)
Hypertension	12 (31.5)	11 (32.3)	1 (NS)
COPD	3 (7.8)	3 (8.8)	1 (NS)
Heavy smoker (≥25 cigarette per day)	5 (13.1)	2 (5.8)	0.4346 (NS)
Ischemic heart disease	2 (5.2)	1 (2.9)	1 (NS)
Previous midline incision	3 (7.8)	4 (11.7)	0.7002 (NS)
Chronic liver disease	2 (5.2)	0	0.4945 (NS)
Chronic renal disease	3 (7.8)	1 (2.9)	0.6167 (NS)
Anemia (<12 g/dl)	22 (57.8)	20 (58.8)	1 (NS)

COPD, chronic obstructive pulmonary disease; F, female; M, male; NS, nonsignificant.

However, due to loss of follow-up in eight patients (three in group PM and five in group SO) and reoperation in the first 30 days postoperatively via the same midline incision in four patients (one in group PM and three in group SO), only 72 patients were included (38 in group PM and 34 in group SO).

Preoperative demographic data characteristics and important risk factors of both groups were comparable, as shown in Table 3 with no significant statistical difference. Table 4 shows various surgical causes that required the planned midline exploratory abdominal incision in both groups with no significant statistical difference, except for a higher number of cases of traumatic splenic rupture in group PM than group SO (*P*=0.0469). In addition, Table 4 shows the distribution of the cases in both groups as regards the type of the procedure whether it was clean or clean–contaminated.

Other perioperative data, such as the type of the incision, the intraoperative time, postoperative ICU, and hospital stay, are summarized in Table 5. The PM group had a slightly statistically significant longer operative time (142.86±44.34 min) than the SO group (120.05±39.54 min) with *P* value 0.0421.

Within the first 30 postoperative days, 22 patients developed SSI distributed as 13 patients in group

Table 4 Causes for midline abdominal incision and types of the procedures

	Group PM [*n* (%)]	Group SO [*n* (%)]	*P* value
Total no.	38	34	
Traumatic causes	22 (57.8)	24 (70.5)	0.3287 (NS)
Isolated splenic rupture	1 (2.6)	6 (17.6)	0.0469 (S)
Isolated gastric injury	2 (5.2)	1 (2.9)	1 (NS)
Isolated intestinal injury	5 (13.1)	3 (8.8)	0.7140 (NS)
Small intestinal	3 (7.8)	2 (5.8)	1 (NS)
Large intestinal	1 (2.6)	1 (2.9)	1 (NS)
Rectosigmoid	1 (2.6)	0	1 (NS)
Isolated diaphragmatic injury	1 (2.6)	0	1 (NS)
Isolated mesenteric injury	1 (2.6)	0	1 (NS)
Multiple injuries (≥two of the above)	12 (31.5)	14 (41.1)	0.4653 (NS)
Obstructive causes	13 (34.2)	9 (26.4)	0.6096 (NS)
Adhesive IO	4 (10.5)	3 (8.8)	1 (NS)
Malignant mass	6 (15.7)	4 (11.7)	0.7395 (NS)
Obstructed diaphragmatic hernia	2 (5.2)	1 (2.9)	1 (NS)
Gall stone ileus	0	1 (2.9)	0.4722 (NS)
Obstructed paraduodenal hernia	1 (2.6)	0	1 (NS)
Other causes	3 (7.8)	1 (2.9)	0.6167 (NS)
MVO	2 (5.2)	1 (2.9)	1 (NS)
GI hemorrhage (due to intestinal GIST)	1 (2.6)	0	1 (NS)
Clean procedure	11 (28.9)	13 (38.2)	0.4589 (NS)
Clean–contaminated procedure	27 (71.1)	21 (61.8)	0.4589 (NS)

GI, gastrointestinal; GIST, gastrointestinal stromal tumor; IO, intestinal obstruction; MVO, mesenteric vascular occlusion; NS, nonsignificant; S, significant.

PM and nine patients in group SO, but despite the higher prevalence in group PM, the statistical difference was insignificant (*P*=0.6096). Table 6 shows the distribution of patients with SSI in both groups according to the type of the SSI and its relation to the type of the operation and risk factors other than mesh placement, that is, DM, hypertension, old age, etc.

Trial of conservative management was applied in all patients complicated with SSI. Systemic antibiotics according to the results of wound culture and antibiotic sensitivity in association with wound management was successful in 20 patients who had superficial and deep incisional SSI. Wound management involved wound drainage by reopening the incision for pus drainage, wound irrigation with

Table 5 Perioperative data including types of incisions, intraoperative time, ICU and hospital stay

	Group PM [*n* (%)]	Group SO [*n* (%)]	*P* value
Incision type	38	34	
Supraumbilical	8 (21)	9 (26.4)	0.7817 (NS)
Infraumbilical	3 (7.8)	1 (2.9)	0.6167 (NS)
Combined	27 (71.1)	24 (70.5)	1 (NS)
Operative time (mean±SD)	142.86±44.34 min	120.05±39.54 min	0.0421 (S)
ICU stay (mean±SD)	3.63±2.41 days	3.38±1.87 days	0.621 (NS)
Hospital stay (mean ±SD)	7.5±2.86 days	7.73±2.72 days	0.7266 (NS)

NS, nonsignificant; S, significant.

saline, and daily dressing, thus allowing the wound to heal by secondary intension.

Two patients in the PM group had deep incisional SSI with exposure of the mesh. The first patient had responded to the conservative treatment with complete healing within 35 days. The other patient, who originally had exploratory laparotomy for obstructing the ascending colonic mass and underwent extended right hemicolectomy, had a trial of SWD. This trial failed, and the patient underwent mesh removal on the 21st day postoperatively. This patient was the only patient in group PM, who developed IH after 3 months of follow-up.

One patient in the PM group had nonmesh-related space SSI in the form of a moderate-sized intraabdominal abscess (10×6 cm) at the site of the splenectomy for traumatic rupture spleen. Ultrasound-guided drainage was done, and complete resolution was achieved.

According to The Sandy Grading System, SWD occurred in 26 patients, mostly grade ?a. Majority of the patients (22 patients) were associated with SSI either spontaneously or due to bed side reopening the wound for drainage. Only one patient in the SO group had abdominal evisceration (burst abdomen). This patient was morbidly obese (BMI 37.2) associated with COPD and was admitted for adhesiolysis after failure of conservative management. The patient developed abdominal evisceration on the ninth postoperative day. Urgent surgical resuturing of the sheath after bilateral relaxing incisions to allow tension-free repair was performed with onlay mesh for reinforcement. After management of SSI, patients with SWD continued the conservative treatment till complete healing of their incisions.

Table 6 Incidence and types of surgical-site infection and its relation to the type of operation and presence of risk factors

	Group PM [*n* (%)]	Group SO [*n* (%)]	*P* value
Total SSI	13 (34.2)	9 (26.4)	0.6096 (NS)
Superficial incisional	10 (26.3)	8 (23.5)	1 (NS)
Deep incisional	2 (5.2)	1 (2.9)	1 (NS)
Organ/space	1 (2.6)	0	1 (NS)
Clean op. with no RF	1 (2.6)	0	1 (NS)
Clean op. with one or more RF	3 (7.8)	3 (8.8)	1 (NS)
Clean–contaminated op. with no RF	3 (7.8)	2 (5.8)	1 (NS)
Clean–contaminated op. with one or more RF	6 (15.7)	4 (11.7)	0.7395 (NS)

NS, nonsignificant; op, operation; RF, risk factor; SSI, surgical-site infection.

Table 7 Incidence of surgical wound dehiscence in both groups according to the Sandy grading system

	Group PM [*n* (%)]	Group SO [*n* (%)]	*P* value
Total SWD	14 (36.8)	12 (35.2)	1 (NS)
Grade I	0	0	
Grade Ia	1 (2.6)	2 (5.8)	0.5992 (NS)
Grade II	2 (5.2)	2 (5.8)	1 (NS)
Grade IIa	9 (23.6)	6 (17.6)	0.5740
Grade III	0	1 (2.9)	0.4722 (NS)
Grade IIIa	2 (5.2)	1 (2.9)	1 (NS)

NS, nonsignificant; SWD, surgical wound dehiscence.

Table 7 summarizes the rate of SWD and its frequency in both groups.

Wound seroma represented a statistically significant higher incidence in the PM group (nine cases) than the SO group (two cases) with *P* value of 0.0499. All patients were managed conservatively: simple bed-side drainage in eight cases or ultrasound-guided drainage in three cases with no reported incidence of recurrence. Otherwise, the present study did not report any case of wound hematoma or chronic wound pain.

Long-term follow-up of all patients for 24 months had revealed a highly statistically significant difference (*P*=0.0048) between both groups as regards the incidence of IH in favor of the PM group. Ten (13.8%) patients were complicated with IH during the 2-year follow-up period of the present study. Only one (2.6%) patient of the PM group had IH, while the other nine (26.4%) patients were of the SO group. Most of the IH (eight patients) occurred in the first 6 months after surgery, while two patients developed IH 8 and 12 months after surgery. All patients with IH were diagnosed both clinically and radiologically. Repair of IH was performed in nine patients. One patient refused to undergo the IH-repair

Table 8 Incidence and timing of incisional hernia and its relation to surgical-site infection, surgical wound dehiscence and other risk factors

	Group PM [*n* (%)]	Group SO [*n* (%)]	*P* value
Total IH	1 (2.6)	9 (26.4)	0.0048 (S)
Less than 6 months postop.	1 (2.6)	7 (20.5)	0.0227 (S)
6–12 months postop.	0	2 (5.8)	0.2195 (NS)
12–24 months postop.	0	0	
No SSI, SWD or other RF	0	1 (11.1)	1 (NS)
With SSI, SWD, one or more RF	1 (100)	8 (88.8)	1 (NS)

IH, incisional hernia; NS, nonsignificant; postop, postoperative; RF, risk factor; S, significant; SSI, surgical-site infection; SWD, surgical wound dehiscence.

operation due to high risk of surgical intervention. IH repair was performed with resuturing of the previous midline incision and enforcing the repair with onlay proline mesh. Three patients required anterior or posterior component separation of the rectus sheath to facilitate the closure. Postoperative follow-up was unremarkable and no reported cases of IH recurrence.

Table 8 shows the incidence and timing of IH and its relation to the occurrence of SSI and SWD and its association with patient's risk factors (DM, hypertension, ischemic heart diseases, morbid obesity, and COPD).

A summary of the early and late postoperative outcomes is shown in Table 9.

Table 9 Postoperative outcomes of the present study

Number of patients	Group PM [*n* (%)]	Group SO [*n* (%)]	*P* value
Early outcomes			
SSI	13 (34.2)	9 (26.4)	0.6096 (NS)
SWD	14 (36.8)	12 (35.2)	1 (NS)
Seroma	9 (23.6)	2 (5.8)	0.0499 (S)
Late outcomes			
IH	1 (2.6)	9 (26.4)	0.0048 (S)

IH, incisional hernia; NS, nonsignificant; S, significant; SSI, surgical-site infection; SWD, surgical wound dehiscence.

Discussion

Any incision to the abdominal wall, either surgical or even traumatic, is a predisposing factor to the occurrence of IH. IH is a type of ventral hernia that occurs at the site of a previous abdominal incision where the abdominal-wall layers did not heal properly [14]. Despite all the efforts to minimize the rate of IH, the frequency of IH is still as high as 25% in normal population and up to 66% in high-risk groups [6]. High-risk population includes diabetic patients, renal impairment, malnourishment, impaired immunity, smoking, and morbid obesity [15].

Emergency midline surgeries have the highest incidence of IH, especially if the patient is of the high-risk group. Many trials for proper management of IH and even for preventing the development of IH via improving and standardizing the techniques of closure were proposed for lowering IH rate with minimal success, especially in high-risk population [9,10]. Recent research has proved the efficiency and safety of using mesh-augmented closure for preventing IH in elective operations as the Kohler *et al*. [16] randomized trial and Borab *et al*. [21] meta-analysis. That led the concept to use synthetic mesh for enforcing midline incisions in high-risk groups, especially in emergency situations.

In the present study, 84 patients have met the inclusion criteria, but due to loss of follow-up and reoperations for causes not related to the mesh use, 72 patients were included in the analysis. High-risk group of patients as diabetic patients, anemia, COPD, smokers, and morbid obese patients were included in the study representing more than 50% of the study participants collectively. In contrast to other studies, such as Kurmann *et al*. [17] and Argudo *et al*. [18], who considered the use of the mesh in contaminated and dirty surgeries as a safe option, the present study included only clean and clean–contaminated procedures as the mesh use in infected operations is still controversial [19].

Several studies had compared mesh positioning onlay, inlay, or preperitoneal as the PRIMA study [20] and Borab *et al*. [21] and no difference was found as regards the IH rate. In the present study, the onlay mesh position was preferred because it is technically easier and requires reduced intraoperative time than the sublay or the preperitoneal position. Proline (nonabsorbable) mesh was chosen over other types of meshes due to lower cost and proven efficiency [22,23].

Many trials had been conducted on the mesh use to prevent IH in elective operations with proven decrease in IH frequency [16,21]. Few trials evaluated the role of mesh prophylaxis in the emergency setting because of the fear of increased occurrence of SSI or long-term complications such as chronic wound pain or reoperations. For that reason, the present study was performed as a trial to assess the feasibility and safety of mesh prophylaxis in the emergency-midline incisions.

As regards the primary outcome of this study, which was the rate of IH after emergency-midline laparotomies and its relation to the closure techniques with and without mesh enforcement, the present study reported a statistically significant lower IH incidence with mesh use versus only sheath suturing (2.6 vs. 26.4%) with *P* value 0.0048. The results of this study were consistent with the trend of using mesh prophylaxis in reducing IH after midline incisions, especially for high-risk patients [20,24]. For example, the PRIMA trial, a double-blind randomized controlled study conducted by Jairam *et al.* [20], concluded that IH was reduced to 13% in the mesh group versus 31% in suture-only group. Other examples for studies with longer follow-up periods, such as Glauser *et al.* [25] and Caro-Tarrago *et al.* [26] (5-year follow-up randomized controlled trials), had also established strong evidence in adopting prophylactic mesh use in preventing IH as compared with suturing alone.

As regards the safety of the use of prophylactic mesh, the present study revealed no significant difference between both groups as regards the occurrence of SSI (34.2 vs. 26.4%) and SWD (36.8 vs. 35.2%). In addition, we noticed that in the absence of risk factors other than mesh placement, only four patients of the total 13 patients have developed SSI. In the suture-only group, two patients of the total nine patients who had SSI did not have any risk factors, such as DM, COPD, or morbid obesity. In summary, mesh use did not add increased risk of SSI and the main suspect for development of SSI in those patients was the presence of patient-related risk factors and performing the surgery as an emergency procedure. Our results were in line with other studies, such as Argudo *et al.* [18], Jairam *et al.* [20], and Abo-Ryia *et al.* [27], who all demonstrated the safety of mesh prophylaxis in emergency-midline incisions, even in contaminated surgeries such as peritonitis.

Another issue with the mesh placement was the higher rate of seroma formation and its relation to SSI occurrence. Borab *et al.* [21] and Wang *et al.* [28] observed a higher incidence of seroma in the mesh group versus the suturing-only group, while Timmermans *et al.* [29] found no difference between both groups. In our study, nine cases of the PM group developed seroma versus two cases in the SO group with *P* value 0.0499. In spite of the higher rate of seroma occurrence in the PM group, it is considered of low morbidity as the management was simple with conservative and minimally invasive treatment.

Chronic wound pain was not reported in our study in contrast to other studies, such as the PRIMA study and Wang *et al.* [28], who observed a higher incidence of chronic wound pain in the mesh group. However, it was well-tolerated and seldom impedance with daily activities, thus resulting in higher patient contentment.

As regards the hospital stay and intraoperative time, the PM group had a slightly statistically significant longer operative time (142.86±44.34 min) than the SO group (120.05±39.54 min) with *P* value 0.0421, while the overall hospital stay in both groups was insignificantly comparable. That may be explained by increased time for subcutaneous dissection and mesh implantation. The same result was found by Wang *et al.* [28], but some trials did not find any significant difference [30].

This study was limited by the small number of the sample patients and further studies with higher sample size are needed to confirm our results. Also, the difference in patients' demographics and risk factors, although not statistically significant, was a limitation possibly due to low sample size. Our study was limited to clean and clean–contaminated procedures, so, future research should include contaminated and dirty operations. Financial burden and cost analysis was not done in this study.

Conclusion

The use of synthetic mesh for prophylaxis against the occurrence of IH in emergency-midline laparotomies is an effective, safe, and feasible option, especially for high-risk population in comparison with sheath suturing only with reduced incidence of IH, acceptable easily manageable higher risk of seroma formation, and insignificant risk for SSI development.

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Conflicts of interest

There are no conflicts of interest.

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