Impact of anterior component separation technique on lowering the incidence of abdominal wall dehiscence and incisional hernia after emergent laparotomy: a feasibility study

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Introduction
Abdominal wall dehiscence is one of the critical postoperative complications following abdominal surgeries. Emergency surgery highly contributes to the incidence of a burst abdomen due to a lack of proper preoperative preparation and the presence of intraabdominal sepsis. Anterior component separation was primarily evolved in abdominal wall reconstruction in the open abdomen and huge ventral hernia repair.
Methods
This prospective study included 50 patients operated by midline laparotomy for non-traumatic abdominal emergencies. Anterior component separation technique was randomly applied in 25 patients before laparotomy closure, the other 25 patients were closed using the traditional midline closure method. Preoperative patient's demographics, operative time, and different postoperative complications were reported. Incidence of burst abdomen in both groups was reported.
Results
Preoperative patient's demographic data showed no significant difference between both groups; the mean age of the patients was 53.69±7.34. Operative time was significantly longer in the Anterior Components Separation (ACS) group ($P<0.001$). The incidence of abdominal wall dehiscence after ACS technique (4.3%) was significantly less than after traditional technique (24%). Postoperative seroma and hematoma were the common postoperative complications after ACS however the incidence was not statistically significant. Incisional hernia was detected in (13.04%) in ACS group and in (32%) in traditional group.
Conclusion
Application of ACS technique during laparotomy closure in abdominal emergencies seems to lower the incidence of abdominal wall dehiscence with no increase in different postoperative complications.

Keywords:
component separation, dehiscence, emergency, laparotomy

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Introduction

Despite the grand difference in operative and surgical wound care, still, abdominal wall dehiscence is considered one of the most critical complications following abdominal surgeries that contributes to high morbidity and mortality rates, and economic burden for the patients and health care providers [1,2].

Abdominal surgical wound dehiscence is defined as the disruption of a previously closed surgical incision site. Following midline laparotomy, the incidence of wound dehiscence ranges from 0.4% to 3.8%. It also has many synonyms like burst abdomen or wound failure [3,4].

Many local and Systemic factors are incriminated in incidence of burst abdomen. Abdominal distension, bowel edema, intra-abdominal infection, and postoperative ileus all of these factors contribute to increase the tension over the midline sutures that may increase the incidence of abdominal wall dehiscence also the technique of midline closure appears also to be crucial [5].

Anterior Components Separation (ACS) has become a well-established technique for achievement of proper fascial closure in abdominal wall reconstruction especially in large ventral abdominal wall hernia. It encompasses mobilization of the rectus abdominis muscle to the midline by means of releases of the

external oblique muscle and fascia. It was firstly described by Gibson in 1920 but it gained its wide popularity after 1990 when published by Ramirez [6,7].

Anterior component separation technique allows midline closure under physiologic tension by an additional 5 cm of lateral muscle mobilization in the upper abdomen and 10 cm in the lower abdomen [8].

Over years, some complications were observed that may result of the open anterior components separation technique like subcutaneous seroma collection, wound infections, abscess formation. These complications can be minimized using perforators sparing techniques [9].

In our prospective study we aimed to assess the feasibility of performing anterior component separation technique during closure of midline laparotomy following emergent abdominal conditions and its effect on lowering the incidence of abdominal wall dehiscence and incisional hernia also we will evaluate any undesirable results that may arise because of this technique like wound ischemia or seroma collection.

Patients and methods

Study design and setting of the study population

This is a randomized prospective trial that included patients who underwent urgent abdominal exploration by midline laparotomy for different non traumatic pathological entities. Patients included in the study were admitted through Mansoura emergency hospital under general surgery department. This prospective study was conducted in the period between September 2022 and March 2023 in Mansoura university hospitals. We gained ethical approval for this trial from the Institutional Review Board of our university (IRB code: R.23.01.2035).

Inclusion criteria were

All male and female adult patients above 40 years who underwent emergent midline laparotomy for nontraumatic different abdominal conditions.

Exclusion criteria were

Pregnant ladies, elective surgery, laparotomy for trauma, patients with intraoperative unstable vital signs and poor general conditions.

Sample size

The proper sample size for the current trial was estimated by online software (http://powerandsamplesize.com) to achieve an 80% study power and a 0.05 significance level. Consequently, we enrolled a total of 50 patients in our series; where the ACS technique was randomly applied on a sample of 25 patients compared with the traditional midline closure technique applied on the same number of patients to evaluate the technique beneficial value, safety, and feasibility before using it in a large scale.

Preoperative work up

Included proper history taking from the patient himself or relatives if presented with altered mental status. Personal history included name, age, sex, occupation, marital status, and smoking history. Details about the complaints including onset, course and duration before admission and any associated symptoms like fever were inquired. Past medical history including any associated comorbidities (diabetes mellitus (DM), chronic liver disease, Chronic obstructive pulmonary disease (COPD), and immunosuppressive diseases) and previous abdominal surgeries were reported. Detailed general and local examination was done with assessment of BMI, signs of sepsis, and abdominal signs of peritonitis.

Routine blood works: complete blood count (CBC), Arterial blood gases (ABG), Serum creatinine, liver function test and serum albumin was done. Radiological investigations included Pelvis-abdominal Ultrasound, abdominal radiography erect, chest radiography and computed tomography (CT) abdomen and pelvis if needed. All patients received preoperative empirical antibiotic (third generation cephalosporins), patients with low hemoglobin and albumin levels were optimized.

Patients eligible for our trial were allocated into two groups via computer-based randomization; group A (n=25) included patients who had the ACS technique, and group B (n=25) included the remaining patients who had the traditional midline closure.

Operative details

All the patients were operated on by qualified surgical teams and standard surgical techniques. Surgery was done via midline laparotomy incision, proper abdominal exploration was done, dealing with the pathological findings correspondingly.

Traditional midline closure

Abdominal closure was done using nonabsorbable sutures (proline 1–0) in a continuous manner following (4 Suture length: 1 wound length) concept in addition to interrupted (Vicryl 0) sutures.

Subcutaneous suction drain was inserted routinely for all patients.

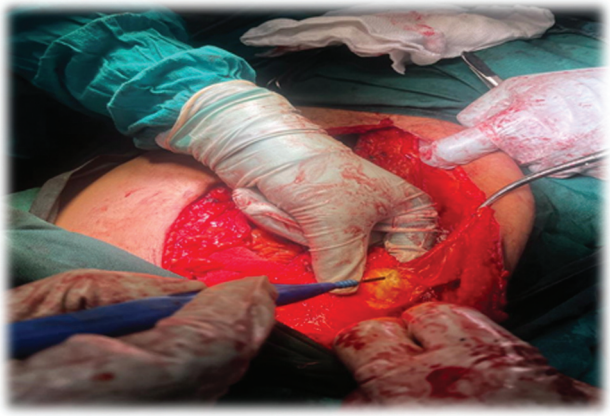
Anterior component separation technique

(1) Identification of both recti and linea semilunaris on both sides of the abdominal wall musculature (Fig. 1).
(2) Creation of incision in the abdominal wall muscles just lateral to linea semilunaris extending from costal margin till inguinal ligament (Fig. 2).
(3) Dissection of the external oblique muscles from underlying internal oblique and transversus abdominis muscles (Fig. 3).
(4) Creation of large flap under the external oblique muscles trying to preserve the vessels (perforators) to maintain adequate blood supply to abdominal wall flapping (Fig. 4).
(5) Extension of this flap from the costal margin to the inguinal ligament.
(6) The same steps were performed on the other side (Fig. 5).
(7) After releasing the abdominal muscles, the midline was closed using non absorbable Suture (Proline 1–0) in a continuous manner in addition of using interrupted sutures with Vicryl 1–0 (Fig. 6).

Figure 1

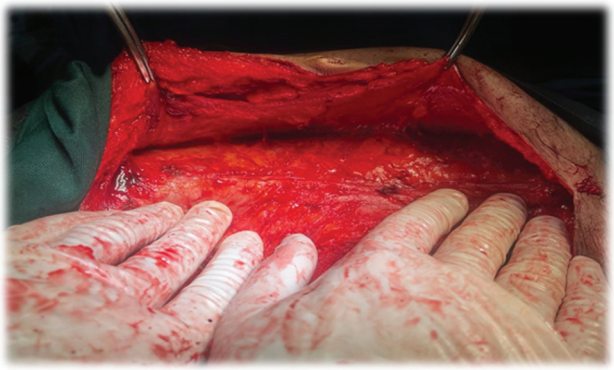
Identification of linea semilunaris.

Figure 2



Incision of linea semilunaris.

Figure 3

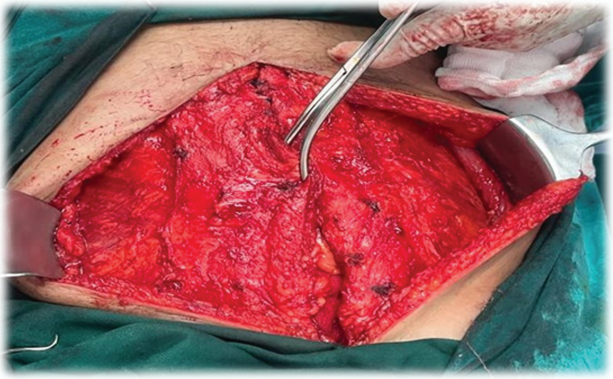


External oblique dissection.

Figure 4

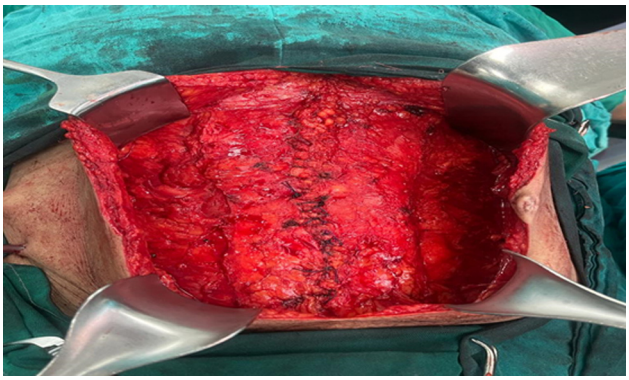
Flapping under external oblique muscle.

Figure 5



Same steps on both sides.

Figure 6



Closure of midline.

(8) Subcutaneous suction drain was applied to all patients.
(9) Skin closure in interrupted manner (proline 2–0).

Operative time (abdominal closure time) was estimated as the time elapsed since completion of the main operative steps for dealing with the pathological findings starting from midline closure till skin closure.

Postoperative care

Majority of the patients were transferred to the surgical ward apart from those required ICU admission. All patients received postoperative appropriate fluid therapy, due medications. Antibiotics were modified after the results of culture and sensitivity (C and S) swab. Postoperative laboratory workup when required: ABG, CBC, C-reactive protein (CRP), serum electrolytes and serum albumin levels. Optimization of electrolytes, albumin and hemoglobin level was done. Daily wound dressing was done by the surgical resident.

Data collection

Operative data

The abdominal closure time was recorded as the time from starting closure of the abdomen till skin closure; any undesirable events during the procedure were recorded.

Postoperative data

Any postoperative wound complications during the period of inpatient admission like (wound erythema, subcutaneous seroma collection, hematoma, wound ischemia or gangrene, and wound infection) were reported. Any wound infection or collection was drained, and wound swab C and S was taken.

Incidence of abdominal wall dehiscence was reported in both groups. Abdominal wound dehiscence was defined as partial or complete disruption of the stitches closing the Linea alba with or without protrusion of intra-abdominal viscera.

Follow-up

After discharge all patients were followed up in the surgical outpatient clinic at regular visits till removal of skin stitches, and they had appointment after 6 months for assessment of incidence of incisional hernia.

Data analysis

All the patient's demographic data were gathered. The incidence of wound dehiscence was reported, all the perioperative variables for each patient were collected in the excel datasheet then analyzed.

Data analysis was carried out by SPSS software, version 18 (SPSS Inc., PASW statistics for windows version 18. Chicago: SPSS Inc.). Qualitative data were illustrated using number and percent other quantitative data were showed using mean±Standard deviation for regularly distributed data after testing normality using Shapiro Wilk test. Significance of the achieved results was obtained at ($\leq$0.05) level. χ^2, Fisher exact tests were used to compare qualitative data between the groups as appropriate. Student t test was used to compare two independent groups for regularly distributed data.

Results

Out of 74 patients operated by midline laparotomy for abdominal emergencies, 50 patients who met the inclusion criteria were included in our study, we applied ACS technique during closure of midline on (25) patients while the rest (25 patients) were closed in a traditional way. Later, two patients from the ACS group were ruled, one of them was expired in the first week because of pulmonary embolism and the other lost follow-up in surgical outpatient clinic.

Analysis of the patient's demographic data showed that mean age of the cases in ACS Group was 53.69±7.34

Table 1 Demographic data of patients

	ACS group n=23 (%)	Traditional group n=25 (%)	Test of significance
Age/years Mean±SD	53.69±7.34	53.44±7.90	t=0.116 P=0.908
Sex			
Male	16 (69.6%)	18 (72%)	χ^2=0.034
Female	7 (30.4%)	7 (28%)	P=0.853

and 53.44±7.90 in traditional group. Male sex represented the majority of cases in both groups 34 (70.83%), while females were 14 (29.17%) (Table 1).

As shown in (Table 2) diabetes and hypertension represented the main associated comorbidities with no significant difference between both groups. Also, there was no significant difference in the mean serum albumin level in both groups (3.21±0.46 vs. 3.31±0.33).

Different intraoperative pathological findings were found in our series; intestinal obstruction was the commonest in both ACS and traditional group (34.80% and 40.00%), respectively. Also, operative time was found significantly longer in ACS than traditional group ($P<0.001$) as shown in (Table 3).

Concerning postoperative complications, although the results revealed non-significant difference in the incidence of postoperative ileus ($P=0.77$) and wound infection ($P=0.14$) between both groups, there was significant decrease in the incidence of abdominal wall dehiscence in patients who underwent ACS technique (4%) compared with those underwent traditional closure (24%) also other postoperative complications had reported with no significant difference in both groups as shown in (Table 4).

As regard the length of hospital stay, results revealed no significant difference in the mean duration of hospital stay in both groups. Also, on long term follow-up of the patients in both groups there was less incidence of incisional hernia in ACS group (13.04%) compared with those in traditional group (32.0%) however it was not statistically significant (Table 5).

Discussion

Abdominal wall dehiscence is one of the frequent serious postoperative complications following midline laparotomy particularly in emergent septic abdominal conditions, it carries high risk of

Table 2 Medical co-morbidities in both groups

Preoperative data	ACS group *n*=23 (%)	Traditional group *n*=25 (%)	Test of significance
Diabetes	10 (43.5%)	10 (40%)	χ^2=0.06 *P*=0.807
Hypertension	10 (43.5%)	13 (52%)	χ^2=0.349 *P*=0.555
Others			
Hepatic	3 (13%)	2 (8%)	χ^{2MC}=0.463
COPD	2 (8.7%)	3 (12%)	*P*=0.927
Cardiac	4 (17.4%)	5 (20%)	
No	14 (60.9%)	15 (60%)	
Serum Albumin Means±SD	3.21±0.46	3.13±0.33	*t*=0.742 *P*=0.462
HB level (gm /dl)	10.5 (8-13.2)	10.2 (7.5-12.6)	*t*= 0.31 *P*=0.635

Table 3 Operative parameters

Operative parameters	ACS group *n*=23 (%)	Traditional group *n*=25 (%)	test of significance
Operative time/mins Means±SD	48.0±3.26	26.20±3.89	*t*=20.93 *P*<0.001*
Pathology			
Intestinal obstruction	9 (39.13%)	12 (44%)	χ^2=2.133
Perforated gall bladder	2 (8.69%)	1(4.0%)	*P*=0.831
MVO ®	5 (21.7%)	3 (12%)	
Intestinal Fistula	1 (4.3%)	2 (8%)	
Perforated DU	3 (13.04%)	5 (20%)	
Acute Diverticulitis	3 (13.04%)	2 (8%)	

®Mesenteric Vascular Occlusion.

Table 4 Postoperative complications

	ACS group *n*=23 (%)	Traditional group *n*=25 (%)	Test of significance
Postoperative ileus	12 (52.2%)	12 (48%)	χ^2=0.083 *P*=0.773
Superficial wound infection	8 (34.8%)	14 (56%)	χ^2=2.17 *P*=0.141
Abdominal wall dehiscence	1 (4.3%)	6 (24.0%)	χ^2=4.83 *P*=0.02*
Skin dehiscence	7 (30.4%)	9 (36%)	χ^2=0.167 *P*=0.683
Subcutaneous hematoma	3 (13.04%)	0	FET=3.48 *P*=0.102
Seroma Collection	3 (13.04%)	0	FET=3.48 *P*=0.102
Deep wound infection	0	0	
Wound ischemia	0	0	

Table 5 Hospital stay and incisional hernia

	ACS group *n*=23 (%)	Traditional group *n*=25 (%)	Test of significance
Hospital stays/ days Mean±SD	8.0±2.26	8.56±3.71	*t*=0.625 *P*=0.535
Incisional hernia	3 (13.04%)	8 (32.0%)	χ^2=2.68 *P*=0.101

morbidities and mortalities that represent a burden to the patients and health care providers [10].

Many factors contribute to the incidence of burst abdomen (3.5%–5.5%) but emergency laparotomy for intraabdominal sepsis and intestinal obstruction were found significant enough to raise the incidence up to (12%–30%) in some centers [11].

Although ACS technique was described in 1950 by Albaneses [12] for closure of complex open abdomen, it does not gain its popularity until described by *Ramirez et al.* 1990 [13] in complex ventral hernia repair then it has been described for early abdominal wall closure in trauma [14].

In our study we aimed to apply ACS technique in abdominal wall closure after emergency laparotomy to assess its role in reduction of the incidence of burst abdomen and incisional hernia compared with the traditional closure. There was no significant difference between both groups as regards mean age, sex, and associated comorbidities.

Most of the patients had low serum albumin level upon presentation because of septic condition without any significant difference between both groups.

Intestinal obstruction represented the majority of the cases in both groups, (39.13%) in ACS group and (44%) in traditional group followed by different pathological conditions causing intraabdominal sepsis.

Estimated mean operative time for abdominal wall closure was significantly longer in ACS group compared with traditional group and this makes sense because of spending more time in creation of external oblique muscle flaps on both sides.

In current study the incidence of burst abdomen was significantly lower in patients underwent ACS technique (4.3%) when compared with those in traditional group (24%).

Emergency surgery is usually incriminated in such high incidence of abdominal wound dehiscence when compared with planned elective laparotomy and this can be explained by poor general condition of the patients, lack of preoperative optimization and presence of intraabdominal infection.

Also, the increased intraabdominal tension because of the intestinal obstruction or postoperative ileus plays a significant role in incidence of burst abdomen that is why upon releasing this tension by ACS technique significant decrease in the incidence of burst abdomen occurred.

Modi *et al.* [15] and Waqar *et al.* [16] reported the incidence of burst abdomen in (22.15%) and (12%) of the patients after emergency laparotomy, respectively, also Hegazy and Soliman [10] in a study involving 250 patients underwent emergency laparotomy, 31 (12.5%) patients developed burst abdomen.

In a study conducted by Talukdar *et al.* [17] discussing factors affecting incidence of wound dehiscence after emergency laparotomy, they found that 18.75% of patients who were presented with peritonitis developed burst abdomen after laparotomy.

Concerning postoperative wound complications, superficial wound infection took the upper hand in both groups, (34.8%) in ACS and (56%) in traditional group with non-significant difference. This high incidence can be explained by the preoperative intraabdominal sepsis in most of the cases.

Alkaaki *et al.* [18] considered emergency surgery as an independent risk factor for wound infection as they found that (58%) of cases who had wound infection after abdominal surgery were in emergency.

Superficial skin dehiscence was reported in (30.4%) of patients in ACS group and in (36%) of patients in traditional group, this was because of high incidence of wound infection in both groups.

In our study (13.04%) of the cases underwent ACS technique had postoperative seroma and hematoma collection none of them required surgical intervention and improved with conservative treatment.

Elhage *et al.* [6] and Opera *et al.* [19], reported postoperative seroma collection after ACS technique in (14.5%) and (9.75%), respectively. A higher incidence of postoperative seroma collection (30%) was reported by Kesicioglu *et al.* [20] but this can be because they applied the technique for huge ventral hernia repair with mesh.

None of our cases in ACS group developed neither deep wound infection nor significant wound ischemia.

Rodriguez *et al*. [21], and Gala *et al*. [22] reported skin necrosis after ACS in (4.4%) and (4%) of their patients, respectively. On the other hand, a higher incidence of skin necrosis (10%) was reported by Kesicioglu *et al*. [20].

A relatively low incidence of incisional hernia (13.04%) was noticed among patients underwent ACS technique compared with those in traditional group (32%) however this difference is not statistically significant.

Usually, the incidence of incisional hernia following laparotomy is contributed by many preoperative, operative, and postoperative factors that is why alteration of closure technique alone may not sufficient enough to affect incidence of incisional hernia significantly.

Conclusion

In conclusion the higher incidence of burst abdomen after emergency laparotomy represents a burden to the patients and health care providers. Although anterior component separation is a well-known technique for complex ventral hernia and abdominal wall reconstruction, its application in emergency laparotomy closure is not popular. Incidence of burst abdomen after emergency laparotomy significantly decreased after use of ACS technique.

Limitations of the study

No other studies discussed application of this technique in abdominal emergencies in addition to the small sample size of feasibility study.

Recommendations

Use of ACS technique after emergency laparotomy in wide scale on larger sample of population.

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Ethical Consideration: Our study was approved by our institute research board belonging to our medical school. (IRB code: R.23.01.2035).

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Conflicts of interest

There are no conflicts of interest.

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