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ORIGINAL ARTICLE

The endoscopic component separation technique for hernia repair results in reduced morbidity compared to the open component separation technique

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Abstract
Purpose The component separation technique for hernia repair results in significant wound morbidity due to the need for large undermining skin flaps. The endoscopic component separation technique allows for advancement of the abdominal wall while preserving the blood supply originating from the epigastric vessels. This study compares the outcomes following hernia repair utilizing these techniques.
Methods A retrospective review of patients undergoing component separation or endoscopic component separation hernia repair from 2008 to 2010. Patients underwent open component separation or endoscopic component separation with closure of the linea alba and reinforcement with mesh.
Results Thirty-five patients that underwent a component separation [14 open component separation (CST) and 21 that underwent endoscopic component separation (ECST)] were identified. There was no difference in hospital length of stay (CST 5.0 ± 3.0 days vs ECST 6.3 ± 3.6 days, $P = 0.28$) or operating room times (CST; 268 ± 62 min vs ECST; 229 ± 57 min, $P = 0.07$). Wound complications occurred in 57% of CST and 19% of ECST, $P = 0.03$. One recurrent hernia was identified in the ECST group with a mean follow up of 8 months (range 1–21 months). No recurrences were seen in the CST group.
Conclusions ECST is associated with comparable hospital length of stay and operative times and reduced wound complications compared to CST.

Keywords Component separation technique · Abdominal wall · Hernia repair

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Introduction

Abdominal wall hernia repair and abdominal wall reconstruction are challenging surgical entities with numerous described techniques. Wound complications related to open component separation technique (CST) in complex abdominal wall reconstruction cause profound wound morbidity in up to 50% of cases [1–5]. Minimally invasive approaches to component separation hernia repair have been described in an attempt to reduce wound morbidity. Described techniques for minimally invasive component separation differ in surgical approach, yet accomplish the same goal of dividing the external oblique aponeurosis lateral to the linea semilunaris without devascularization of the anterior abdominal wall [2, 5–7]. The endoscopic component separation technique (ECST) allows for similar advancement of the rectus abdominis muscles to CST while avoiding the creation of large skin flaps, thus preserving the perforating vessels of the epigastric arteries. The aim of this study is to compare the early outcomes of ECST and CST with regard to wound complications.

Methods

After obtaining Institutional Review Board approval, all patients who had undergone either CST or ECST for abdominal wall hernia repair between 2008 and 2010 at the University of Kentucky Chandler Medical Center were reviewed. Medical records and charts were reviewed for demographics including gender, age, co-morbidities, body mass index (BMI), operative time, hospital length of stay, wound classification, prior hernia repair, American Society of Anesthesiology (ASA) classification, operative details, and outcome measures. Wound complications were defined as either major or minor based on the need for additional interventions. Major wound complications included abscess, dehiscence, necrosis, wound infection and seroma requiring drainage. Minor wound complications included cellulitis and self-limited seromas not requiring drainage. Fisher's exact test was used to compare binary risk factors and outcomes between groups, and Student's *t* test was used for comparing continuous variables. Statistical analysis was performed using SPSS version 18 statistical software.

Open CST is performed utilizing the technique described by Ramirez et al. [8]. A midline laparotomy is performed. Subcutaneous skin flaps are raised bilaterally to a distance approximately 3 cm lateral to the linea semilunaris. The external oblique aponeurosis is divided from the inguinal ligament to a distance 5 cm above the costal margin. The posterior rectus sheath is incised 1–2 cm lateral to the midline and the posterior rectus sheath is dissected from the rectus muscle. The posterior rectus sheath is closed primarily when feasible, and the linea alba is approximated with permanent sutures. Reinforcing mesh is placed either in the retro-rectus space or as an anterior, based only on surgeon preference. Two drains are placed into the midline wound and exit the abdominal wall at remote skin incisions.

The ECST is performed by making a 2–3 cm incision at the level of the anterior axillary line 3 cm above the costal margin. The external oblique muscular fibers are identified and separated bluntly, exposing the underlying internal oblique muscle. A balloon dissector is placed between the internal and external oblique muscles angled toward the pelvis. The balloon dissector is replaced with a 10 mm balloon-tipped trocar, and carbon dioxide is infused into the lateral abdominal wall. One additional 5 mm port is placed along the costal margin 5 cm lateral to the initial port. A laparoscope is inserted via the 10 mm balloon-tipped trocar into the lateral abdominal cavity to provide for visualization during subsequent steps. The laparoscope is thus positioned in a newly created lateral abdominal cavity in which the ceiling is created by the external oblique muscle and the floor is the internal oblique muscle. The external oblique aponeurosis is then divided with electrocautery from the inguinal ligament to a distance 5 cm above the costal margin. The procedure is repeated on the contralateral side. The posterior rectus sheath is then dissected from the rectus muscle to create a retro-rectus space. The posterior rectus sheath is closed and mesh is placed in the retro-rectus space. The linea alba is approximated over the mesh. Drains are placed in the lateral abdominal cavities and the midline.

Table 1 Preoperative risk variable differences, open versus endoscopic component separation hernia repairs

Variable	Open ($n = 14$)	Endoscopic ($n = 21$)	*P* value[a]
Age (years)	50 ± 10	51 ± 13	0.78
BMI (kg/m^2)	35 ± 10	36 ± 7	0.63
Male (%)	50	48	1.00
Diabetic (%)	36	43	0.74
Hypertensive (%)	47	55	1.00
Pulmonary compromise (%) (COPD, asthma, emphysema)	14	19	1.00
Smoking Hx	21	48	0.16
Contaminated/infected wound class (%)	33	5	0.03
Recurrent repair (%)	71	52	0.31
ASA class III (%)	57	71	0.48

BMI Body mass index, *COPD* chronic obstructive pulmonary disease, *ASA* American Society of Anesthesiology

[a] Fisher's exact or *t* test

Results

Thirty-five patients that had undergone either CST or ECST for abdominal wall hernia repair were identified; 14 patients underwent CST and 21 patients ECST. Patients were selected routinely for CST during the first 8 months of the study period. During the latter 12 months of the study, all patients underwent ECST as the planned hernia repair. Patients were stratified based on an intent to treat. One patient in the ECST was converted to CST in an attempt to gain additional abdominal wall advancement. There were no differences in preoperative age, BMI, gender, incidence of co-morbidities, smoking status, ASA classification, or incidence of recurrent hernia repairs (Table 1). A greater number of clean wounds were seen in the ECST group.

All hernia repairs resulted in primary fascial closure and skin closure. There were no differences in hernia defect size between CST and ECST (146 ± 83 cm^2 vs 255 ± 170 cm^2). Hospital length of stay was similar between CST and ECST (5.0 ± 3.0 days vs 6.3 ± 3.6 days, $P = 0.28$). There were no differences in total operating room times (CST; 268 ± 62 min vs ECST; 229 ± 57 min, $P = 0.07$).

Table 2 Wound complications in open and endoscopic component separation technique (CST) groups

Wound complications	Total
Open CST	
Necrosis	2
Seroma requiring drainage	4
Seroma (self-limiting)	1
Wound infection	1
Endoscopic CST	
Abscess	2
Cellulitis	1
Skin deshiscence	1

Table 3 Perioperative and postoperative outcomes, open and endoscopic CST hernia repairs

Variable	Open ($n = 15$)	Endoscopic ($n = 20$)	P value
Mesh size (cm^2)	345 ± 47	326 ± 150	0.65
Defect size (cm^2)	146 ± 83 ($n = 5$)	255 ± 170 ($n = 14$)	0.19
Length of hospital stay (days)	5.0 ± 3.0	6.3 ± 3.6	0.28
Operative duration (min)	268 ± 62	229 ± 57	0.07
Any complication (%)	57	19	0.03
Wound complication (%)	57	19	0.03
Minor wound complication (%)	14	5	0.55
Major wound complication (%)	43	14	0.11
Clean wound patients only	$n = 9$	$n = 20$	
Wound complications (%)	67	20	0.03
Minor wound complication (%)	11	5	0.53
Major wound complication (%)	56	15	0.07

Overall wound complications occurred in 57% of CST and 19% of ECST, ($P = 0.03$; Table 2). An analysis of clean wounds only demonstrated wound complications in 70% of CST and 21% of ECST, $P = 0.03$. A sub-analysis of major and minor wound complications demonstrated an increase in major wound complications in the CST group (Table 3). Complications not associated with the incision occurred in one ECST patient who developed a postoperative pneumonia and acute tubular necrosis in the immediate postoperative setting. One patient in the CST group developed mesenteric ischemia secondary to a superior mesenteric artery embolus 3 months following his hernia repair, requiring additional surgical intervention and has ultimately done well.

One recurrent hernia was identified in the ECST group with a mean follow up of 8 months (range 1–21 months). The recurrence occurred in a patient with a contaminated hernia in which ECST did not result in primary fascial closure. The patient was converted to open CST which allowed for primary fascial closure. The patient did not develop wound complications postoperatively, although a recurrent hernia was detected on physical examination at the 3 month follow-up visit. The patient subsequently underwent elective synthetic mesh hernia repair without complications.

Discussion

CST for hernia repair has been utilized widely since the time of its initial description by Ramirez et al. [8]. The repair allows for advancement of the rectus abdominis muscle groups of up to 10 cm per side, allowing for closure of some of the largest and most complex hernias. As a result of the obligatory dissection, the perforating vessels to the abdominal wall originating from the epigastric arteries are transected, resulting in an area of relative ischemia to the skin and subcutaneous tissues of the anterior abdominal wall as the remaining blood supply is derived largely from subcostal arteries from the descending aorta. Accordingly, a significant incidence of wound complications can be anticipated, with reports of wound complications occurring in 24–50% of patients [4, 12]. Despite the drawbacks and complications of this procedure, it remains a viable option for surgeons and patients as it facilitates midline closure, which has been shown to augment abdominal wall function [9].

Previous authors have reported techniques for reducing abdominal wall wound morbidity associated with the CST by creating additional abdominal incisions lateral to the linea semilunaris through which the external oblique may be released [7] or alternatively through the use of balloon dissectors in the subcutaneous space anterior to the external oblique [2]. The technique utilized in this series utilizes the placement of a balloon dissector in the space between the external oblique and internal oblique muscles [6]. Utilizing this technique, abdominal wall advancement has been shown to be approximately 86% of the advancement that is typically obtained in an open component separation hernia repair [10]. The minimal reduction in abdominal wall advancement with ECST is likely related to the tethering of the abdominal wall muscles to the overlying skin and subcutaneous tissues. In a cadaver model, the process of elevating the skin from the abdominal wall has been shown to result in abdominal wall advancement of up to 3 cm [11]. In the majority of patients, the trivial loss of abdominal

wall advancement is not necessary. However, there are circumstances in which maximal advancement of the abdominal wall is required and conversion from and ECST to an open CST is performed.

The tradeoff between advancement of the abdominal wall musculature and wound complications when comparing ECST and open CST cannot be overstated. Although we did not measure the extent of abdominal wall advancement in each procedure, the midline was primarily closed at the initial operation in all cases. The authors' practice has been to utilize either CST or ECST for patients in whom there is either infection, contamination, or a large defect at least 10 cm in width. In one patient in this study, the abdomen was not amenable to closure with the ECST approach, and the patient was converted to an open CST that allowed for closure under modest tension. The patient developed a recurrent hernia at the right lateral abdominal wall. At the time of repeat herniorrhaphy, the midline closure remained intact, but the patient had a large defect at the site of the external oblique release. This was repaired with an intraperitoneal synthetic mesh without sequelae. At the time of this patient's initial operation, he was not a candidate for synthetic mesh due to a chronic non-healing wound. Although he developed an early recurrence identified at his 3 month postoperative visit, this approach allowed for the conversion of his contaminated hernia to a clean hernia in which a bridging synthetic mesh was not contraindicated. In hindsight, this patient would have likely been better served with the placement of a bridging mesh at the time of his initial operation. This patient represented the only conversion of a patient from ECST to CST. In our study, wound complications occurred in 57% of patients undergoing an open CST. Only two of the wound complications were minor enough to not require intervention in the open CST group. Wound necrosis requiring operative debridement due to loss of a significant volume of abdominal wall skin was seen in two patients in the open group. The patients required debridement of 6 cm^2 and 30 cm^2 of abdominal wall skin, respectively. Four patients in the open group developed seromas requiring percutaneous drainage following removal of the operatively placed drains. No patients in the ECST group developed postoperative seromas or wound necrosis. This may likely be attributed to the avoidance of large subcutaneous skin flaps associated with this technique. Patients in both CST and ECST groups underwent routine drain placement at the time of the operation. The criteria utilized for drain removal was standardized between the two groups and consisted of an output of less than 30 ml per day for 2 consecutive days. The time to definitive seroma resolution ranged from 1 to 4 months following drainage. Two patients in the ECST group developed abscesses in the abdominal wall requiring percutaneous drainage. Both of these abscesses occurred in the lateral abdominal wall at the site of the ECST releases rather than in the midline. The development of these two abscesses is without obvious explanation in light of the clean operative field in which the endoscopic releases are performed. The first of the two patients had a prior history of infected mesh, which was previously removed resulting in the recurrent hernia requiring repair. Although the operative classification was clean, the presence of a prior mesh infection may have resulted in bacterial colonization of the abdominal wall, thus increasing the risk of infection [13]. The second patient that developed an infection was morbidly obese with a Grade 2 hernia based upon the classification system described by Breuing et al. [13]. In this hernia classification, patients with co-morbid conditions (class 2), potentially contaminated hernias (class 3), and contaminated hernias (class 4) have been postulated to carry progressively increasing risk for wound complications.

Upon comparison of major wound complications between the two groups, the greatest difference between ECST and CST is related to the reduction in seroma formation requiring intervention in the ECST group. CST was uniquely associated with postoperative wound necrosis, whereas ECST was associated with the development of wound abscess in the lateral abdominal wall. The necrotic wounds required both surgical debridement whereas both abdominal wall abscesses were treated by means of percutaneous drainage. Although each of these complications results in increased expense and prolongs overall recovery, the only complications that necessitated surgical intervention were in the CST group. However, there was no difference in the overall incidence of major wound complications between CST and ECST.

Minor wound complications including cellulitis or self-limiting seromas were similar between groups. When we evaluated all wound complications collectively, there was a significantly reduced incidence of wound complications in the ECST group. Prior series evaluating ECST did not demonstrate a significant reduction in wound complications with the ECST [7]. In our study, the preoperative wound classification differed between the ECST and open CST separation groups. The majority of the ECST patients were undergoing repair for massive hernias, whereas a larger number of open CST patients were undergoing repair in a contaminated or infected field such as in the presence of infected mesh, non-healing wounds, or an entero-cutaneous fistula. However, a sub-analysis of only those patients with a clean preoperative wound demonstrated a statistically significant reduction in wound complications in the ECST group. This reduction in wound complications translates into significant cost savings for patients, insurers, and hospitals, although the economic ramifications of ECST were not analyzed in this study.

Conclusions

The ECST for hernia repair offers advantages over the open CST approach. In patients with a clean preoperative wound classification, there is a reduced incidence of wound complications following ECST. The reduced incidence of seromas seen in ECST is likely attributable to the ability to perform the procedure without the creation of undermining skin flaps. No differences in hospital length of stay, operative times or recurrence rates were demonstrated. Both ECST and CST are effective methods of repairing large and complex hernias. ECST is advantageous over CST in minimizing the overall incidence of wound complications in select patient groups. Larger prospective series controlling for patient variables are needed to better define other potential advantages of ECST.

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