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## Open repair of large abdominal wall hernias with and without components separation; an analysis from the ACS-NSQIP database



Nirav K. Desai, I. Michael Leitman\*, Christopher Mills, Valentina Lavarias, David L. Lucido, Martin S. Karpeh Jr.

Department of Surgery, Mount Sinai Beth Israel, Icahn School of Medicine at Mount Sinai, New York, NY, USA

### HIGHLIGHTS

- The repair of large abdominal wall hernias is more frequently performed using components separation.
- While this technique appears to reduce recurrence, morbidity has not been previously studied.
- When compared to a large cohort, components separation has a higher complication rate than traditional open hernia repair.

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### ABSTRACT

**Background:** Components separation technique emerged several years ago as a novel procedure to improve durability of repair for ventral abdominal hernias. Almost twenty-five years since its initial description, little comprehensive risk adjusted data exists on the morbidity of this procedure. This study is the largest analysis to date of short-term outcomes for these cases.

**Methods:** The ACS-NSQIP database identified open ventral or incisional hernia repairs with components separation from 2005 to 2012. A data set of cohorts without this technique, matched for preoperative risk factors and operative characteristics, was developed for comparison. A comprehensive risk-adjusted analysis of outcomes and morbidity was performed.

**Results:** A total of 68,439 patients underwent open ventral hernia repair during the study period (2245 with components separation performed (3.3%) and 66,194 without). In comparison with risk-adjusted controls, use of components separation increased operative duration (additional 83 min), length of stay (6.4 days vs. 3.8 days,  $p < 0.001$ ), return to the OR rate (5.9% vs. 3.6%,  $p < 0.001$ ), and 30-day morbidity (10.1% vs. 7.6%,  $p < 0.001$ ) with no increase in mortality (0.0% in each group).

**Conclusions:** Components separation technique for large incisional hernias significantly increases length of stay and postoperative morbidity. Novel strategies to improve short-term outcomes are needed with continued use of this technique.

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### 1. Introduction

Open ventral abdominal hernia repair is one of the most common procedures performed in general surgery [1]. Ramirez and colleagues introduced the components separation technique (CST) in 1990 as a new method for abdominal wall reconstruction in ventral hernia repair [2]. By separating layers of the abdominal wall, this technique allows for increased mobilization of the rectus

abdominis muscles to the midline [3]. This technique has been suggested for larger hernia defects when fascial closure may lead to excess tension, resulting in a greater risk of failure or respiratory compromise. While several studies have shown successful results and improved recurrence rates with this technique, they have not all been consistent [5–10]. There have also been increased wound healing complications seen with this technique, though this finding has also not been consistent in comparison studies [9–12]. There is minimal literature discussing the incidence of complications or additional costs that might result from use of this technique [3,5,8] when compared to more traditional repairs of large abdominal wall hernias. Further, almost all reported data is based on a single

\* Corresponding author. Mount Sinai Beth Israel, 10 Union Square East, Suite 2M, New York, NY, 10003, USA.

E-mail address: [Mleitman@chpnet.org](mailto:Mleitman@chpnet.org) (I.M. Leitman).

surgeon or institution's experience.

The American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) provides a large multi-center database allowing for risk stratification from analysis of post-operative outcomes. While components separation may reduce the incidence of recurrent hernia in patients with large fascial defects, does this result in a greater morbidity or cost? The NSQIP database presents a useful tool to look at both surgical and medical morbidity by creation of a cohort of patients undergoing prosthetic repair of abdominal wall hernias with and without components separation [12,13].

## 2. Methods

### 2.1. Population

The Human Research Committee approved this study (IRB# 023-14). The 2005–2012 ACS-NSQIP participant use data files were accessed on February 1, 2014. These files were queried to identify all patients undergoing ventral hernia repair (VHR). Current procedural terminology (CPT) codes were used to identify the following inpatient open hernia repairs: 49,560, 49,561, 49,565, and 49,566. Concurrent use of components separation technique (CST) was identified with CPT code 15,734. Patients undergoing repair of small abdominal wall hernias without prosthetic reinforcement and emergency surgery were excluded. The participant user file (PUF) was used to identify all patients undergoing abdominal wall hernia repair with and without components separation (last accessed February 24, 2014).

In 2012, over 250 academic and community hospitals participated in ACS-NSQIP throughout the country. Trained clinical reviewers collect data on patient demographics, medical history, laboratory values, operative, and post-operative data points. Patients are contacted in writing or by telephone for complete 30-day follow-up. Data is collected on randomly assigned patients and entered online in a HIPAA-compliant, secure, web-based platform. Each variable is defined in the NSQIP manual and ACS monitors data collections stringently with periodic random audits to ensure accuracy and standardization.

### 2.2. Independent variables

NSQIP variables for analysis of the two groups were selected to include demographics, baseline health characteristics, pertinent comorbidities, American Society of Anesthesiologists (ASA) class, wound class, and case complexity via CPT code. Demographics selected were age, gender, and BMI. Baseline health characteristics included current smoking within one year of operation, functional health status and level of dyspnea. Comorbidities selected were diabetes on oral medications or insulin, hypertension requiring medication, dialysis requirement, ascites within 30 days of surgery, chronic use of steroids, and medical history of chronic obstructive pulmonary disease, congestive heart failure, and myocardial infarction. These groups and their characteristics are identified in Table 1.

### 2.3. Matched cohort

Matching was done to minimize selection bias given the non-randomization for use of CST in a given abdominal wall hernia repair. Variables were identified that are most significant in producing a set of VHR patients similar to patients undergoing concurrent CST. These variables were used to develop a propensity score for each patient enabling creation of a cohort of 2245 matched pairs. The independent variables were analyzed again to

**Table 1**  
Population comparison.

Independent variable	VHR	# of cases	CST	# of cases	P value
Total# of cases		66,194		2245	
Male	42.5%	28,132	45.2%	1015	0.011*
Female	57.5%	38,062	54.8%	1230	0.011*
Age					
(20–29)	23.5%	15,556	21.4%	480	0.019*
(30–39)	24.1%	15,953	25.3%	568	0.193
(40–49)	24.3%	16,085	26.9%	604	0.005*
(50–59)	18.1%	11,981	19.7%	442	0.056
(60–69)	8.5%	5626	6.1%	137	0.000*
(70–79)	1.4%	927	0.6%	13	0.001*
BMI					
Underweight	0.8%	530	0.6%	13	0.42
Normal	17.1%	11,319	11.4%	256	0.000*
Overweight	28.5%	18,865	26.6%	597	0.047*
Obese	24.1%	15,953	26.5%	595	0.009*
Very Obese	28.6%	18,931	34.5%	775	0.000*
Diabetic	16.0%	10,591	19.9%	447	0.009*
HTN	49.8%	32,965	53.9%	1210	0.000*
Smoker	21.0%	13,901	22.6%	507	0.07
Dialysis	1.0%	662	0.8%	18	0.413
COPD	5.1%	3376	7%	157	0.000*
CHF	0.3%	199	0.1%	2	0.069
Previous MI	0.1%	66	0%	0	0.461
Steroid use	3.2%	2118	2.7%	61	0.176
Ascites	0.5%	331	0.3%	7	0.188
Level of dyspnea		66,260			
None	90.8%	60,104	89%	1998	0.006*
With exertion	8.7%	5759	10.4%	233	0.004*
At Rest	0.6%	397	0.6%	13	0.99
Functional status					
Independent	98.1%	64,936	98%	2200	0.645
Partially dependent	1.6%	1059	1.7%	38	0.599
Totally dependent	0.2%	132	0.1%	2	0.296
ASA class					
1	6.4%	4236	2.2%	49	0.000*
2	49.8%	32,965	42.7%	959	0.000*
3	41.0%	27,140	52.3%	1174	0.000*
4	2.7%	1787	2.7%	61	0.897
Wound class					
Clean	88.2%	58,383	78.7%	1767	0.000*
Clean-contaminated	8.6%	5693	12.8%	287	0.000*
Contaminated	1.5%	993	4.1%	92	0.000*
Dirty	1.7%	1125	4.4%	99	0.000*
CPT code					
Initial	77.7%	51,433	55.9%	1255	0.000*
Recurrent	22.3%	14,761	44.1%	990	0.000*
Incarcerated	23.9%	15,820	27.4%	615	0.000*

\* = statistically significant value, VHR = patients receiving ventral hernia repair, CST = patients receiving concurrent component separation technique, # = number of cases, BMI = body mass index, HTN = hypertension requiring medication, COPD = past medical history of chronic obstructive pulmonary disease, CHF = history of congestive heart failure, MI = myocardial infarction, ASA = American Society of Anesthesiologists, CPT = current procedural terminology.

ensure an adequate match and identify differences that may have persisted (Table 2). A primary outcome analysis was performed to identify differences in operative duration, hospital length of stay, surgical length of stay, 30-day morbidity and mortality (Table 3). A secondary analysis was performed to identify differences in the 21 NSQIP- defined post-operative occurrences. These include superficial and deep incisional surgical site infections, organ/space surgical site infection, wound disruption, pneumonia, unplanned intubation, pulmonary embolism, presence of mechanical ventilation greater than 48 h, progressive renal insufficiency, acute renal failure, urinary tract infection, stroke/CVA with neurological deficit, presence of coma greater than 24 h, peripheral nerve injury, cardiac arrest requiring cardiopulmonary resuscitation, myocardial infarction, administration of blood transfusion, graft/prosthesis/flap failure or loss, deep vein thrombosis or thrombophlebitis, sepsis,

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