Risk of Complications From Enterotomy or Unplanned Bowel Resection During Elective Hernia Repair

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Hypothesis: Enterotomy or unplanned bowel resection (EBR) may occur during elective incisional hernia repair (IHR) and significantly affects surgical outcomes and hospital resource use.


Setting: Sixteen tertiary care Veterans Affairs medical centers.

Patients: A total of 1124 elective incisional hernia repairs identified in the National Surgical Quality Improvement Program data set.

Intervention: Elective IHR.

Main Outcome Measures: Thirty-day postoperative complication rate, return to operating room, length of stay, and operative time.

Results: Of the 1124 elective procedures, 74.1% were primary IHR, 13.3% were recurrent prior mesh IHR, and 12.6% were recurrent prior suture. Overall, 7.3% had an EBR. The incidence of EBR was increased in patients with prior repair: 5.3% for primary repair, 5.7% for recurrent prior suture, and 20.3% for prior mesh repair (P < .001). The occurrence of EBR was associated with increased postoperative complications (31.7% vs 9.5%; P < .001), rate of reoperation within 30 days (14.6% vs 3.6%; P < .001), and development of enterocutaneous fistula (7.3% vs 0.7%; P < .001). After adjusting for procedure type, age, and American Society of Anesthesiologists class, EBR was associated with an increase in median operative time (1.7 to 3.5 hours; P < .001) and mean length of stay (4.0 to 6.0 days; P < .001).

Conclusions: Enterotomy or unplanned bowel resection is more likely to complicate recurrent IHR with prior mesh. The occurrence of EBR is associated with increased postoperative complications, return to the operating room, risk of enterocutaneous fistula, length of hospitalization, and operative time.


Operative abdominal surgery is complicated by the frequent presence of intra-abdominal adhesions. Intestinal adhesions result in future bowel obstructions, female infertility, and abdominal pain, and they also increase the risk of subsequent abdominal surgery. Postoperative adhesions have been shown to increase operative time and the conversion rate from laparoscopic to open procedures. In addition, extensive adhesiolysis increases the risk of intestinal injury.

Incisional hernia repair (IHR) is, by definition, reoperative abdominal surgery; and intestinal injury during the hernia repair may affect the type of repair performed and ultimate outcome. Incisional hernia repair is a commonly performed operation, and approximately 105,000 hernias were repaired in 2003. Hernia recurrence after repair occurs in 10% to 53% of patients. Incisional hernia repair with prosthetic mesh has been associated with a decreased recurrence rate in randomized controlled trials; however, it is less likely to be used in the presence of intestinal injury.

Little is known about the incidence of and risk factors for intestinal injury during IHR. The aim of this study is to describe the risk factors for and the consequences of enterotomy or unplanned bowel resection (EBR) on short-term IHR outcomes. We examine the effect of preoperative comorbidities obtained from National Surgical Quality Improvement Program (NSQIP) data and surgery-specific variables obtained from operative note abstraction on the risk of EBR. We specifically focus on the effect of EBR on ele-
tive IHR outcomes, especially postoperative complications and hospital resource allocation.

**METHODS**

**STUDY DESIGN**

This is a retrospective analysis of patients undergoing IHR at 16 Veterans Affairs (VA) medical centers affiliated with surgical residency programs across the United States between January 1998 and December 2002. Institutional review board approval and waiver of informed consent was obtained at all participating VA medical centers. Eligible procedures were identified by querying the Veterans’ Affairs NSQIP database by Current Procedural Terminology (CPT) codes for ventral hernia repair (49560, 49561, 49565, 49566, 49568, 49570, 49572, 49580, 49585, 49587, 49590, and 49639). Individual operative notes were obtained from each site and were abstracted by physicians to identify type of hernia repair, method of repair, intraoperative enterotomy or bowel resection, and other operative variables. Outcome variables were obtained from the NSQIP, National Patient Care Database, and the computerized patient record system.

**STUDY DATABASES**

The NSQIP prospectively collects data from all 123 VA facilities that perform surgery and includes preoperative, intraoperative, and postoperative outcome variables. The NSQIP accrues the CPT code and date of procedure for all noncardiac procedures performed in the VA system. Additional risk variables are collected on a subset of patients based on a sampling algorithm that minimizes bias from high-volume centers and roughly includes 70% of all major operations performed. Thirty-day morbidity and mortality data, operative time, and length of stay were obtained from the NSQIP database.

The VA National Patient Care Database is composed of the Patient Treatment File (PTF) and the Outpatient Care Files (OPC). The PTF is a national VA database that includes all admissions to VA hospitals along with up to 10 International Classification of Diseases, Ninth Revision (ICD-9) diagnostic and procedure codes. The OPC is a national VA database that contains information on all ambulatory contacts with VA staff. The PTF and OPC were queried for the presence of enterocutaneous fistula (ECF) by CPT codes (44120, 44121, 44125, 44130, 44620, 44640, and 44650) and ICD-9 codes (537.4, 565.1, 569.60, 569.62, 569.69, and 569.81). The computerized patient record system is a comprehensive electronic medical record available through Web access. Medical record abstraction for patients with potential postoperative ECF identified from the PTF and the OPC was performed to confirm whether an ECF was present.

**STUDY POPULATION**

We identified all patients at the 16 VA hospitals with CPT codes noted. Patients were excluded if their repair was urgent or emergent, if the repair was not an IHR (ie, umbilical hernia repair or ventral hernia repair), if there was a same-site concomitant procedure (ie, cholecystectomy or planned colectomy), if their operative note was not available for abstraction, or if the case had 1 or more missing NSQIP preoperative risk variables.

**STUDY VARIABLES**

The main variable of interest, enterotomy or unplanned bowel resection (EBR), was defined by the presence of EBR in the dic-
graduate year were not associated with EBR occurrence (Table 2). In multivariate logistic regression analysis of predictors of EBR, previous repair with mesh (odds ratio [OR], 5.0; 95% confidence interval [CI], 3.0-8.3) and long-term steroid use (OR, 6.2; 95% CI, 2.6-14.8) were independently associated with EBR, whereas congestive heart failure was not.

No postoperative 30-day mortality occurred in the study group. Patients undergoing procedures in which EBR occurred were more likely to develop 1 or more postoperative complications at 30 days (26/82 [31.7%] vs 99/1042 [9.5%]; OR, 4.5; 95% CI, 2.3-9.1; P < .001). Postoperative complications among patients with EBR included wound infection or dehiscence (n = 15), urinary tract infection (n = 3), failure to wean from ventilator (n = 3), renal insufficiency (n = 2), systemic sepsis (n = 2), and deep vein thrombosis (n = 1). The occurrence of EBR was associated with an increased rate of return to the operating room (12/82 [14.6%] vs 38/1042 [3.6%]; OR, 4.5; 95% CI, 2.3-9.1; P < .001). The development of ECF after EBR was also more frequent than in procedures without EBR (6/82 [7.3%] vs 7/1042 [0.7%]; OR, 11.7; 95% CI, 3.8-35.6; P < .001). The median time for ECF to develop was 27.5 months (range, 0.3-83.4 months) postoperatively and was similar between patients with and without EBR.

Univariate analysis of patients experiencing an EBR found that they had longer operative times and lengths of stay. The median (interquartile range) operative time was 3.48 (2.48-4.62) and 1.33 (1.08-2.50) hours in the EBR and no EBR groups, respectively (P < .001). The occurrence of EBR was associated with increased operative time (1.6 hours; P < .001) in multivariate linear regression modeling, adjusting for age, recurrent repair, repair technique, and American Society of Anesthesiologists (ASA) class. Similar results for
After Elective Incisional Hernia Repair

We found that EBR occurred in 7.3% of elective IHRs in a large cohort of patients from 16 VA medical centers. The incidence of EBR was highest in recurrent hernia repair after prior mesh placement. The occurrence of an EBR was associated with increased complication and subsequent operation rates at 30 days. Furthermore, EBR was associated with a significantly increased risk of ECF formation in the follow-up period.

Our finding of a 7.3% incidence of EBR is consistent with the literature, in which rates of bowel injury during laparoscopic and open ventral hernia repair range from 7.2% to 9%.\(^{19}\) Prior studies\(^{6,20}\) have reported that most bowel injuries occurred during procedures complicated by the presence of multiple adhesions or prior abdominal surgery. A study\(^{21}\) that reported a 1.2% incidence of intestinal injury during laparoscopic IHR attributed the low incidence to the advantages of pneumoperitoneum and visualization during laparoscopic adhesiolysis. We did not observe this in our study, and the low rate of EBR associated with laparoscopic IHR in previous studies could represent case selection.

We found that prior hernia repair with mesh prosthesis and long-term steroid use were independent predictors of EBR occurrence. The increased incidence of EBR seen in recurrent hernia repair with prior prosthetic mesh implantation is not surprising because the presence of foreign material is known to increase adhesion formation.\(^{2,22,27}\) Most prior mesh repairs in this study were performed with polypropylene mesh. Future studies will need to be performed to determine if the newer mesh products aimed at reducing adhesion formation result in fewer bowel injuries during subsequent operative surgery. Our finding that long-term steroid use increased the risk of EBR is novel. Other studies have found an increased risk of overall morbidity after hernia repair but did not associate it with intraoperative bowel injury.\(^{28}\) One potential explanation is that long-term steroid use may affect the tissue quality of the intestine and predispose those patients to intestinal injury. This, however, has yet to be substantiated in the literature. However, based on these findings, we recommend consideration of prophylactic bowel preparation before elective surgery on these high-risk populations.

Prior studies\(^{7,29}\) have identified EBR as a predictor of development of any postoperative complication, need for reoperation, increased operative time, and increased postoperative length of stay using univariate analyses. We found that the occurrence of EBR was the strongest predictor of the development of any postoperative complication or the need for subsequent operation in multivariate models. We were also able to show in adjusted models that the occurrence of EBR was associated with longer operative time and postoperative length of stay. The occurrence of EBR has long-term effects as evidenced by increased incidence of ECF formation. Additional studies to determine the effect of EBR on hernia recurrence are under way. It has previously been shown that mesh implantation rates are decreased in the setting of EBR, and mesh seems to be the key factor associated with decreased recurrence.\(^{9,10,14}\)

Our study has several limitations. Our study population primarily consists of older white men, limiting the generalizability of our findings. In addition, information bias may exist because of differing quality of individual operative notes and use of administrative data. This incidence of EBR is likely underestimated because we captured only those cases that were identified intraoperatively and dictated in the operative note. The development of ECF was ascertained from administrative data and likely underestimates the true incidence. Finally, our finding of increased risk of EBR in recurrent repair with prior mesh may not apply to nonadhesive mesh products available.\(^{30}\)

Our results demonstrate that patients with prior IHR with mesh and long-term steroid use are at significantly increased risk for EBR during elective IHR. The occurrence of EBR is a significant predictor of increased patient morbidity and subsequent ECF formation and is associated with increased hospital resource allocation. Additional studies on the long-term effects of EBR on IHR recurrence rates need to be performed.

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Author Contributions: Dr Hawn had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Gray, Neumayer, and Hawn. Acquisition of data: Gray, Vick, Finan, and Neumayer. Analysis and interpretation of data: Gray, Vick, Graham, Neumayer, and Hawn. Drafting of the manuscript: Gray, Vick, and Hawn. Critical revision of the manuscript for important intellectual content: Graham, Finan, Neumayer, and Hawn.

Table 3. Logistic Regression Models of Morbidity After Elective Incisional Hernia Repair

<table>
<thead>
<tr>
<th>Model</th>
<th>Odds Ratio (95% Confidence Interval)</th>
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<tbody>
<tr>
<td>1: Development of ≥1 postoperative complications</td>
<td>Enterotomy or bowel resection: 3.8 (2.2-6.6)</td>
</tr>
<tr>
<td>2: Patient return to the operating room</td>
<td>Enterotomy or bowel resection: 4.9 (2.4-9.9)</td>
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</table>

Abbreviations: See Table 1.

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