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.

**Design:** Retrospective review of patients undergoing IHR between January 1998 and December 2002.

**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.


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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, 49563, 49565, 49566, 49568, 49570, 49572, 49580, 49585, 49587, 49590, and 49659). 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.13,16 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).17 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, 44120, 44120, 44120, and 44120) and ICD-9 codes (537.4, 565.1, 569.60, 569.62, 569.69, and 569.81). A dichotomous variable was constructed for technique of repair to classify repairs as either suture or mesh. Type of repair was analyzed on 3 levels: primary repair, recurrent repair prior suture, and recurrent repair prior mesh prosthesis.

The effect of EBR on IHR outcomes was assessed. Dichotomous outcomes of interest were the presence of IHR or more postoperative complications, return to the operating room, and development of postoperative ECF. The occurrence of ECF was identified by querying administrative data and was verified by cross-referencing with the medical record. Continuous outcomes of interest were operative time and postoperative length of hospitalization.

STATISTICAL ANALYSIS

Univariate analysis of demographics and operative variables was performed to describe the study population. χ² Tests were performed to examine differences in proportions among cases based on the presence of EBR. Multivariate logistic regression models were used to examine possible predictors of EBR, effect of EBR on postoperative complications, and return to the operating room. Those variables with P ≤ .10 in testing of univariate association with EBR were used as main effects in logistic regression analysis. Manual backward elimination was used to achieve a best-fit logistic regression model. All statistical tests were performed using SAS statistical software, version 9.1 (SAS Institute Inc., Cary, North Carolina).

RESULTS

The NSQIP query identified 4444 ventral hernia repairs performed at the 16 VA hospitals between January 1998 and December 2002. Analysis was limited to patients undergoing elective primary and recurrent IHR. Cases excluded from analysis included the following: (1) those with urgent or emergent case status (n=470), (2) cases of umbilical hernia repair (n=1591), (3) cases of primary epigastri ventral hernia repair (n=217), (4) cases of IHR with a same-site concomitant procedure (n=747), and (5) cases with missing NSQIP preoperative risk factor data (n=295). The final study population included 1124 procedures.

Of the 1124 procedures available for analysis, 1033 (95.1%) were performed on men. Overall, EBR occurred in 82 (7.3%) IHRs. The composition of the study population by type of repair is as follows: primary repair, 74.1%; recurrent, prior suture repair, 12.6%; and recurrent, prior mesh repair, 13.3%. No differences in patient age, sex, or the presence of diabetes mellitus were found between those with and those without EBR (Table 1). Patients with EBR had a higher frequency of preoperative congestive heart failure and steroid use.

A significantly increased incidence of EBR was found during repair of recurrent hernia with prior mesh repair (Figure). The number of fascial defects and resident post-

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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, 4.4; 95% CI, 2.7-7.4; 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
multivariate linear regression modeling of postoperative length of stay found an increase of 3.2 days \((P < .001)\) after an EBR, adjusting for age, recurrent repair, postoperative complication, repair technique, and ASA class.

Best-fit logistic regression models of postoperative complications and return to the operating room after IHR demonstrated that the occurrence of EBR was the strongest predictor of postoperative complications and was associated with a greater than 4-fold increase in return to the operating room (Table 3).

### 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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</thead>
<tbody>
<tr>
<td>1: Development of ≥ 1 postoperative complications</td>
<td></td>
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<tr>
<td>Enterotomy or bowel resection</td>
<td>3.8 (2.2-6.6)</td>
</tr>
<tr>
<td>Steroid use</td>
<td>2.8 (1.2-6.3)</td>
</tr>
<tr>
<td>ASA class ≥ 3</td>
<td>1.6 (1.0-2.4)</td>
</tr>
<tr>
<td>2: Patient return to the operating room Enterotomy or bowel resection</td>
<td>4.9 (2.4-9.9)</td>
</tr>
<tr>
<td>ASA class ≥ 3</td>
<td>2.3 (1.1-4.8)</td>
</tr>
</tbody>
</table>

Abbreviations: See Table 1.

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%. Prior studies have reported that most bowel injuries occurred during procedures complicated by the presence of multiple adhesions or prior abdominal surgery. A study reported a 1.2% incidence of intestinal injury during laparoscopic IHR attributed to 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. 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. 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 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 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.

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.

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. Statistical

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