Laparoscopic Ventral Hernia Repair Postoperative Complications in End Stage Renal Disease Patients

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ABSTRACT

Background: The prevalence of patients with end stage renal disease (ESRD) requiring general surgical procedures is increasing. Our aim was to explore the effect of ESRD on patients undergoing elective laparoscopic ventral hernia repair.

Methods: The American College of Surgeons National Surgical Quality Improvement Program (2010–2015) database was used to identify patients who underwent elective laparoscopic ventral hernia repair. Multivariable analysis was performed adjusting for risk variables including age, gender, race, comorbidity status, body mass index ≥ 35, and presence of ESRD.

Results: A total of 8,789 patients undergoing elective laparoscopic ventral hernia repair were identified. Sixty-four patients (0.73%) had ESRD. ESRD was identified as an independent risk factor for postoperative pneumonia (odds ration [OR] 6.91, p = 0.00363), sepsis (OR 18.58, p = 0.000286), and length of stay (IRR 1.63, 95% confidence interval 1.19 – 2.27, p = 0.0036).

Conclusions: ESRD patients undergoing elective laparoscopic ventral hernia repair had an increased risk of postoperative pneumonia, sepsis, and length of stay. Clinicians should be cognizant of these risks when performing elective operations on ESRD patients.

Key Words: ACS NSQIP, Elective, ESRD, Laparoscopic ventral hernia repair.

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INTRODUCTION

End stage renal disease (ESRD) is a prevalent disease in the United States, with over 131,000 new cases reported in 2018 and a prevalence of over 785,000.[1] ESRD can be caused by many etiologies with the two most common causes in the U.S. being diabetes and long standing hypertension.[1] The number of ESRD patients continues to rise yearly by about 20,000 patients.[1] As the number of patients with ESRD rises, the number of common surgical procedures performed on ESRD patients will simultaneously increase, including laparoscopic ventral hernia repairs.

Ventral hernia repair is a frequently performed general surgery procedure. There is an estimated 400,000 – 600,000 incisional hernia repairs occurring each year in the U.S.[2] Ventral hernias can either be primary hernias or secondary to previous abdominal surgery or trauma.[3] Incisional hernias are a common complication of open abdominal surgery with rates of 10% – 32%.[4, 5] They can be repaired by open approach or laparoscopically. The laparoscopic approach for ventral hernias has proven to have fewer wound complications than the open approach, as well as a decreased length of hospital stay.[6]

Given the high incidence of ventral hernias and the increasing prevalence of ESRD, it is likely that general surgeons will encounter a growing number of these patients in their practice. Our objective was to use The American College of Surgeons National Surgery Quality Improvement Project (ACS NSQIP) database in order to determine the risks involved for ESRD patients who underwent elective laparoscopic ventral hernia repair. We found that patients with ESRD have an increased risk of postoperative pneumonia and sepsis, as well as increased postoperative length of stay (LOS) after elective laparoscopic ventral hernia repair. Identifying and understanding the associated risks can help to better guide surgeons in their judgement, decisions, and advice to ESRD patients undergoing nonemergent laparoscopic ventral hernia repair.

METHODS

The ACS NSQIP participant user files from January 1, 2010 – December 31, 2015 were utilized. Adult patients (≥ 18 years

of age) who underwent elective laparoscopic repair of an initial reducible ventral hernia (Current Procedural Terminology code 49652) were identified. These patients had a postoperative diagnosis of nonobstructed, nongangrenous ventral hernia (ICD9 5530.2, 553.20, 553.21, 553.29) who were admitted from home and underwent repair by a general surgeon under general anesthesia. Cases that had a postoperative wound class of III or IV were excluded. Cases with missing gender, body mass index (BMI), functional status, American Society of Anesthesiologists classification (ASA), and postoperative LOS data were excluded, and an unknown factor for missing race data was created. There were 8,789 total cases that met inclusion criteria.

Risk variables included age, gender, race, BMI ≥ 35 kg/m2, functional status, ASA class, and ESRD status. ESRD was defined as patients requiring treatment with peritoneal dialysis, hemodialysis, hemofiltration, hemodiafiltration, or ultrafiltration within two weeks prior to surgery. Outcome variables of interest included postoperative superficial surgical site infection (SSI), deep SSI, organ-space SSI, dehiscence, pneumonia, reintubation, failure to wean from ventilator, pulmonary embolism, cardiac arrest, myocardial infarct, bleeding, deep vein thrombosis, sepsis, septic shock, return to the operating room, and death. Univariate analysis was performed comparing ESRD patients versus non-ESRD patients (control). Student's t test or Wilcoxon Rank Sum test was used for continuous variables while χ^2 test or Fisher's exact test was used for categorical variables where appropriate. Multivariable logistic regression was performed adjusting for all risk variables. Postoperative LOS was also analyzed using negative binomial regression adjusting for all risk variables. Analysis was performed with the R statistical language version 30.50.1. A two-tailed P value of < .05 was considered statistically significant.

RESULTS

Table 1 shows the patients' characteristic data. Of the 8,789 cases that met inclusion/exclusion criteria, 64

Table 1.
Univariate Analysis of Risk Variables

Risk Variables	Control (n = 8,725)	End Stage Renal Disease (n = 64)	p-Value
Age, median (standard deviation), years	54 (13.6)	62 (14.0)	0.0147
Gender (%)			0.0080
Male	3,808 (43.6)	39 (60.9)	
Female	4,917 (56.4)	25 (39.1)	
Race (%)			0.06
White	6,756 (77.4)	41 (64.1)	
African American	1,120 (12.8)	16 (25.0)	
American Indian or Alaska Native	50 (0.6)	0 (0.0)	
Asian or Pacific Islander	90 (1.0)	0 (0.0)	
Unknown	709 (8.1)	7 (10.9)	
Body Mass Index ≥ 35 (%)	2,761 (31.6)	14 (21.9)	0.1235
Functional Status (%)			0.0605
Independent	8,684 (99.5)	62 (96.9)	
Partially Dependent	37 (0.4)	2 (3.1)	
Totally Dependent	4 (0.1)	0 (0.0)	
American Society of Anesthesiologists Class (%)			< 0.0001
Class I	677 (7.8)	0 (0.0)	
Class II	4,773 (54.7)	2 (3.1)	
Class III	3,156 (36.2)	42 (65.6)	
Class IV	119 (1.4)	20 (31.3)	

patients (0.73%) had ESRD. On univariate analysis, ESRD patients tended to be older (median (standard deviation [SD]): 62 (± 14.0) vs 54 (± 13.6) years, p = .0147), male (60.9% vs 43.6%, $P <$ .0080), and have a higher ASA class (65.6% vs 36.2% class III, p = < 0.0001). Likewise, comparison of outcomes within 30 days revealed that patients with ESRD had higher rates of dehiscence (1.6% vs 00.1%, P = .0359), postoperative pneumonia (6.3% vs 00.4%, P = .0002), bleeding requiring transfusions (3.2% vs 00.4%, P = .0238), sepsis (3.2% vs 00.3%, P = .0175), and return to the operating room (4.7% vs 1.1%, P = .0371). Results are shown in full in **Table 2**.

Logistic multivariable regression analysis, adjusting for age, gender, race, BMI ≥ 35, functional status, ASA classification, and ESRD status demonstrated that ESRD was an independent risk factor for postoperative pneumonia (OR 7.01, 95% confidence interval [CI] 1.91 – 25.68, P = .0033) and postoperative sepsis (OR 18.47, 95% CI 3.82 – 89.39, P = .0003). Dehiscence, bleeding, and return to the operating room were not found to be significant on multivariable analysis. Results are shown in full in **Table 3**. Postoperative LOS was analyzed using negative binomial

regression and again adjusting for age, gender, race, BMI ≥ 35, functional status, ASA classification, and ESRD status. Incidence rate ratio was significant for ESRD as an independent risk factor for increased postoperative LOS (incident rate ratio 1.63, 95% CI 1.19 – 2.27, P = .0036). Full results are shown in **Table 4**.

DISCUSSION

We performed an observational study which compared the outcomes of elective laparoscopic ventral hernia repairs between patients with and without ESRD. By using the ACS NSQIP database, we found an increase in postoperative complications in the ESRD patients. However, despite these increased postoperative complications and LOS, mortality was not significantly increased in the ESRD patient group. Specifically, on univariate analysis, ESRD patients undergoing laparoscopic ventral hernia repair had increased rates of postoperative pneumonia, sepsis, dehiscence, bleeding requiring transfusion, and return to the operating room when compared to patients without ESRD. Using multivariate analysis and negative binomial

Table 2.
Univariate Analysis of 30-Day Postoperative Outcomes

30-Day Postoperative Outcomes	Control (n = 8,725)	End Stage Renal Disease (n = 64)	p-Value
Postoperative Length of Stay, median (standard deviation), days	0 (2.5)	1 (8.6)	0.1608
Superficial Wound Infection (%)	49 (0.6)	0 (0.0)	1.0
Deep Wound Infection (%)	12 (0.1)	0 (0.0)	1.0
Organ Space Infection (%)	20 (0.2)	1 (1.6)	0.1424
Dehiscence (%)	4 (0.1)	1 (1.6)	0.0359
Pneumonia (%)	36 (0.4)	4 (6.3)	0.0002
Reintubation (%)	26 (0.3)	1 (1.6)	0.1793
Failure to Wean from Ventilator (%)	17 (0.2)	1 (1.6)	0.1234
Pulmonary Embolism (%)	12 (0.1)	0 (0.0)	1.0
Deep Vein Thrombosis (%)	19 (0.2)	0 (0.0)	1.0
Cerebrovascular Accident (%)	5 (0.1)	0 (0.0)	1.0
Myocardial Infarct (%)	14 (0.2)	0 (0.0)	1.0
Cardiac Arrest (%)	7 (0.1)	0 (0.0)	1.0
Bleeding Requiring Transfusions (%)	31 (0.4)	2 (3.2)	0.0238
Sepsis (%)	26 (0.3)	2 (3.2)	0.0175
Septic Shock (%)	13 (0.2)	0 (0.0)	1.0
Return to Operating Room (%)	98 (1.1)	3 (4.7)	0.0371
Death (%)	16 (0.2)	0 (0.0)	1.0

Table 3.
Multivariable Logistic Regression Analysis Showing the Effects of End Stage Renal Disease on Outcomes

Risk Variable	Odds Ratio	95% Confidence Interval	p-Value
Superficial Wound Infection	0.00	—[†]	0.8959
Deep Wound Infection	0.00	—[†]	0.9448
Organ Space Infection	6.39	0.65 – 63.35	0.1129
Dehiscence	3.82	0.22 – 66.03	0.3562
Pneumonia	7.01	1.91 – 25.68	0.0033
Reintubation	0.97	0.11 – 8.36	0.9781
Failure to Wean from Ventilator	2.78	0.29 – 2.63	0.3716
Pulmonary Embolism	0.00	—[†]	0.9378
Deep Venous Thrombosis	0.00	—[†]	0.9286
Cerebrovascular Accident	0.00	—[†]	0.9475
Myocardial Infarction	0.00	—[†]	0.9503
Cardiac Arrest	0.00	—[†]	0.9552
Bleeding Requiring Transfusions	3.67	0.72 – 18.66	0.1177
Sepsis	18.47	3.82 – 89.39	0.0003
Septic Shock	0.00	—[†]	0.9190
Return to Operating Room	1.92	0.53 – 6.95	0.3225
Death	0.00	0.65 – 2.33	0.9043

[†]Confidence interval spanning 0 - ∞.

regression, we found a higher rate of postoperative pneumonia, sepsis, and LOS in the ESRD group.

ESRD patients have previously been described as higher risk patients for postoperative complications in many surgical disciplines and can be seen in our cohort as having a higher American Society of Anesthesiologists classification. For example, ESRD patients who underwent elective endovascular repair of abdominal aortic aneurysms had increased hospital length of stay, higher hospital mortality rate, higher 30 day mortality rate, and higher one year mortality rate.[7] In elective major vascular surgical procedures, ESRD patients had higher rates of surgical site infection, unplanned intubation, and reoperation within 30 days when compared to non-ESRD patients.[8] In hip and knee replacements, stages III-V chronic kidney disease had a greater hazard ratio as a risk factor for mortality than congestive heart failure, coronary artery disease, and diabetes.[9] In common general surgeries (including colectomy, appendectomy, cholecystectomy, and ventral hernia repair), ESRD patients had an increased 30 day mortality rate, increased rates of infectious complications, and increased risk of returning to the operating room.[10–12] After a complication from a general surgical procedure, ESRD patients had a higher mortality rate than individuals with the

same postoperative complications but who did not have ESRD.[11] In our study, we found increased rates of postoperative pneumonia, sepsis, dehiscence, bleeding requiring transfusion, and return to the operating room when compared to patients without ESRD on univariate analysis. Using multivariate analysis and negative binomial regression, there was a higher rate of postoperative pneumonia, sepsis, and LOS in the ESRD group.

Alterations to the immune system of ESRD patients is complex and involves multiple aspects that lead to immune dysfunction.[13–15] Impaired immunological function helps account for infection as the second leading cause of mortality in this population, with cardiovascular disease accounting for the number one cause of mortality.[16,17] The increase in postoperative pneumonia and sepsis in ESRD patients in our study may be related to this underlying immune dysfunction described in ESRD patients resulting in immunodepression and increased risk for infectious complications. Similarly, it has previously been described that patients undergoing laparoscopic cholecystectomy had significantly higher rates of postoperative pneumonia if they had ESRD (2.3 vs 00.4%), as well as higher rates of sepsis (3.1 vs 00.4%).[18] Other studies have shown similar results of increased postoperative infectious complications in ESRD patients, including sepsis, septic shock, urinary tract

Table 4.
Negative Binomial Regression Showing the Effects of End Stage Renal Disease on Postoperative Length of Stay

Risk Variables	Incidence Rate Ratio	95% Confidence Interval	*p*-Value
Age	1.02	1.01 – 1.02	< 0.0001
Male Gender	0.73	0.69 – 0.78	< 0.0001
Race			
African American	1.28	1.16 – 1.41	< 0.0001
American Indian or Alaska Native	1.52	1.05 – 2.24	0.0345
Asian or Pacific Islander	0.89	0.64 – 1.24	0.4816
Unknown	0.97	0.86 – 1.10	0.6770
Body Mass Index > 35	1.02	0.95 – 1.10	0.5960
Functional Status			
Partially Dependent	2.38	1.62 – 3.60	< 0.0001
Totally Dependent	2.45	0.82 – 10.24	0.1478
American Society of Anesthesiologists Class			< 0.0001
Class II	1.61	1.38 – 1.88	< 0.0001
Class III	2.76	2.35 – 3.25	< 0.0001
Class IV	3.89	2.98 – 5.11	< 0.0001
End Stage Renal Disease	1.63	1.19 – 2.27	0.0036

infections, wound infections, and pneumonia after general surgery and major abdominal surgery, when compared to non-ESRD patients.[10,19,20] Mortality from sepsis has been found to be 100-fold higher in ESRD patients than in the general population.[21]

While comorbidities may increase perioperative risks including ESRD as described, there are no universally accepted guidelines on when to perform elective laparoscopic ventral hernia repair. The Society of American Gastrointestinal Endoscopic Surgeons guidelines for example, note few special considerations where laparoscopic ventral hernia repair may be contraindicated, such as loss of domain, presence of abdominal skin graft, active enterocutaneous fistula, the need to remove previously placed prosthetic mesh, or large abdominal wall defects.[22] However, pre-existing conditions and potentially associated complications are not discussed.

There is no absolute contraindication for the use of mesh in the ESRD patient population.[23] Martinez-Mier et al. reported a single wound infection (not specified whether related to mesh) among 58 hernia repairs in the setting of perioperative peritoneal dialysis. Due to their reported 12% hernia recurrence in hernioplasties performed without mesh and low incidence of infection, they recommended use of mesh in this setting.[24] Two additional studies found no evidence of mesh infection after 26 and 20 elective hernia repairs.[25, 26]

Additionally, the surgeon may encounter platelet dysfunction in ESRD patients, which can be seen in patients who are uremic. This dysfunction is caused by impaired platelet adhesiveness, as well as abnormal endothelial interaction.[27] Furthermore, many ESRD patients take antiplatelet agents, as they have been shown to reduce major cardiovascular events by 15% and decrease access failure events by 48%.[28] Platelet dysfunction can lead to increased bleeding during and after surgical procedures resulting in blood transfusions, hematomas, and reoperations. In our study, ESRD patients had an increased risk of perioperative bleeding requiring transfusions on univariate analysis. This is consistent with previous published data showing increased perioperative bleeding complications in the ESRD population.[29]

This study was performed using the ACS NSQIP database and therefore has several limitations. The ACS NSQIP database is limited to only the data points which are collected by individual hospitals and submitted to the national database. Charts are not able to be reviewed in order to obtain more information and our analyses regarding patients' return to the operating room may lack more detailed information as a result. In addition, the data that

is collected and sent by each individual hospital does not include all of their surgical patients, but rather a portion of surgical patients from each hospital that participates. These limitations; however, are true of all studies utilizing ACS NSQIP abstracted data. The host of different training mechanisms for surgical clinical reviewers, quality audits, and other safeguards employed by ACS NSQIP help to ensure the highest quality of data that can be reliably utilized for such quality improvement-driven analyses.

ACS NSQIP data also carries the advantage of representing a national pool of patients, including a total of 3,636,854 cases submitted by 2,502 hospitals between January 1, 2010 and December 31, 2015, of which 8,789 cases met inclusion criteria and were utilized in our study. Since the ACS NSQIP database is comprised of a wide distribution of patients nationally, there are patients from a wide array of cultures and ethnicities, as well as from urban areas, rural areas, teaching hospitals and community hospitals. This makes our results generalizable to the general population.

CONCLUSION

In this observational study, we found that in the setting of elective laparoscopic ventral hernia repair, patients with ESRD have an increased risk of postoperative pneumonia and sepsis, as well as increased postoperative LOS. Clinicians should consider these risks when evaluating expected outcomes and performing elective operations such as ventral hernia repair on ESRD patients.

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