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Short-term outcomes in children undergoing restorative proctocolectomy with ileal-pouch anal anastomosis☆

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ABSTRACT

Introduction: Patients with familial adenomatous polyposis (FAP) and ulcerative colitis (UC) commonly undergo restorative proctocolectomy with ileal-pouch anal anastomosis (RP-IPAA). We sought to describe patient characteristics and postoperative outcomes in this patient population.
Methods: Using the National Surgical Quality Improvement Program-Pediatric Participant Use Files from 2012 to 2015, children who were 6–18 years old who underwent RP-IPAA for FAP or UC were identified. Postoperative morbidity, including reoperation and readmission were quantified. Associations between preoperative characteristics and postoperative outcomes were analyzed.
Results: A total of 260 children met the inclusion criteria, of which 56.2% had UC. Most cases were performed laparoscopically (58.1%), and the operative time was longer with a laparoscopic versus open approach (326 [257–408] versus 281 [216–391] minutes, p = 0.02). The overall morbidity was 11.5%, and there were high reoperation and readmission rates (12.7% and 21.5%, respectively). On bivariate analysis, preoperative steroid use was associated with reoperation (22.5% versus 10.9%, p = 0.04). On multivariable regression analysis, obesity was independently associated with reoperation (odds ratio: 3.34 [95% confidence intervals: 1.08–10.38], p = 0.04).
Conclusions: Children who undergo RP-IPAA have high rates of overall morbidity, reoperation, and readmission. Obesity was independently associated with reoperation. This data can be used by practitioners in the preoperative setting to better counsel families and establish expectations for the postoperative setting.
Type of Study: Retrospective Comparative Study.
Level of Evidence: Level III.

Patients with familial adenomatous polyposis (FAP) or ulcerative colitis (UC) are often managed with restorative proctocolectomy with ileal pouch anal anastomosis (RP-IPAA) [1–4].

FAP is an autosomal dominant disease that results in increased incidence of colorectal cancer due to mutations with various penetrance in the tumor suppressor *APC* gene [5–7]. Individuals with FAP develop colonic polyps early in childhood that inevitably progress to colorectal malignancy [8,9]. Total abdominal colectomy with or without proctectomy is indicated in these patients to prevent the development of colorectal adenocarcinoma.

UC is an inflammatory bowel disease presenting in a bimodal age distribution [10]. About 20% of patients are diagnosed during childhood and the disease is generally more severe in this patient population [11–13]. Medical management is the first line therapy; however, indications for surgical intervention include toxic megacolon, perforation, medically intractable disease, severe bleeding, and for cancer prevention [10,12].

Although there is an extensive body of literature in adults focusing on RP-IPAA for these diseases, there is a paucity of data on surgical outcomes in pediatric patients. Most reports in the literature are limited to single-institution studies or meta-analyses, limiting their generalizability [14–18]. Therefore, the aim of this study was to describe short-term outcomes in children who undergo RP-IPAA in order to better understand characteristics of patients who undergo this operation, and to find whether there are any significant differences in outcomes between children undergoing RP-IPAA for FAP or UC.

Abbreviations: RP-IPAA, Restorative proctocolectomy with ileal pouch anal anastomosis; UC, ulcerative colitis; FAP, familial adenomatous polyposis; ACS, American College of Surgeons; NSQIP-P, National Surgical Quality Improvement Program-Pediatric; PUF, Participant Use Files; CPT, Current Procedural Terminology; ASA, American Association of Anesthesiologists; BMI, body mass index; LOS, length of stay; OR, Odds ratio.

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1. Methods

1.1. Data and population

Data were extracted from the American College of Surgeons (ACS) National Surgical Quality Improvement Program-Pediatric (NSQIP-P) Participant Use Files (PUFs) from 2012 to 2015. Presently, the NSQIP-P collects 30-day postoperative outcomes in over 100 hospitals in the United States and Canada. Data in the NSQIP-P is collected by chart review by trained clinical reviewers who use standardized definitions of comorbidities and outcomes. Data collected in this database include patient characteristics, comorbidities, preoperative and intraoperative details, and 30-day postoperative morbidity and mortality [19–21].

Patients who underwent a RP-IPAA and who were 6–18 years old were identified using Current Procedural Terminology (CPT) codes 45113, 44158, 44158, 44187, 44626, 45110, 45119, 45120, 45397, and 44211. We chose 6 years as the lower age cutoff in order to exclude patients who were more likely to be undergoing RP-IPAA for congenital diagnoses. Patients who underwent laparoscopic surgery were identified using the 44211 and 45397 CPT codes, or the laparoscopic variable designation in the NSQIP-P PUF.

1.2. Covariates and outcomes

Demographic data (patient age, gender, race, and ethnicity), preoperative diagnosis (FAP or UC), and comorbidities (hematologic or bleeding disorder, use of immunosuppressant medications or presence of immune disease, history of cancer, cardiac risk factors, impaired cognition, American Association of Anesthesiologists (ASA) class, obesity (defined as body mass index (BMI) greater than or equal to 30), and other preoperative characteristics (inpatient status, transfusion within 48 hours prior to surgery, recent weight loss, nutritional support at the time of surgery, preoperative albumin, etc.) were extracted from the NSQIP-P PUFs. BMI was calculated using the weight and height variables recorded in NSQIP. Operative details including case type (elective, urgent, or emergent), surgeon specialty (pediatric versus general surgeon) and operative approach (laparoscopic versus open) were also analyzed. Primary outcomes that were evaluated included operative time, composite morbidity, length of stay (LOS), readmission, reoperation, and mortality. Composite morbidity was defined as having any of the following complications: surgical site infection, wound disruption, pneumonia, unplanned intubation, deep vein thrombus, pulmonary embolism, renal failure/insufficiency, urinary tract infection, cardiac arrest, transfusion greater than 25 mL/kg in first 72 hours, ventricular tachycardia, coma, seizures, sepsis, reoperation, and central line associated bloodstream infection. Reoperation was classified as an adverse event if it appeared to be unplanned (for example, stoma closure was not classified as an adverse event). Readmission included both related and unrelated admissions. Any observations with missing variables were classified as "unknown" and omitted from the multivariable regression.

1.3. Statistical analysis

The primary independent variables of interest were diagnosis (FAP versus UC), obesity, and preoperative steroid use. Associations between these variables in addition to other patient characteristics, operative details, and postoperative morbidity were tested. Chi-squared or Fisher's Exact test were used for categorical variables and Mann–Whitney *U* test for continuous variables. Multivariable logistic regression analysis was used to identify independent risk factors that were associated with composite morbidity, readmission, and reoperation. All statistically significant variables associated (defined as $p < 0.05$) on the bivariate analysis, as well as clinically important variables, were included in the multivariable regression models, and backward stepwise regression was used.

2. Results

Using the NSQIP-PUFs from 2012 to 2015, a total of 260 patients were identified who underwent RP-IPAA. A total of 146 (56.2%) patients had UC, 93 (35.8%) patients had FAP, and the diagnosis was unknown in 21 (8.1%) patients. Demographic patient data and preoperative patient characteristics are included in Table 1. Of note, 134 (51.5%) were female, 215 (82.7%) were white, and, at the time or surgery, 83 (31.9%) patients were 6–12 years old and 177 (61.8%) were 13–18 years old. The majority of cases (151 patients or 58.1%) were performed laparoscopically.

Table 1
Demographic data and preoperative characteristics of patients included in this analysis.

	n (%)
Gender	
Male	126 (48.5)
Female	134 (51.5)
Age	
6–12 years old	83 (31.9)
13–18 years old	177 (68.1)
Race	
White	215 (82.7)
Black	24 (9.2)
Asian	5 (1.9)
Other	2 (0.8)
Unknown	14 (5.4)
Ethnicity	
Hispanic	24 (9.2)
Non-Hispanic	228 (87.7)
Unknown	8 (3.1)
Diagnosis	
Ulcerative Colitis	146 (56.2)
Familial Adenomatous Polyposis	93 (35.8)
Unknown	21 (8.1)
Hematologic or bleeding disorder	2 (0.8)
Immunosuppressant medications or immune disease	26 (10)
History of cancer	1 (0.4)
Cardiac risk factors	5 (1.9)
Impaired cognition	4 (1.5)
Preoperative steroid use	
Yes	40 (15.4)
No	220 (84.6)
History of recent weight loss	
Yes	5 (1.9)
No	172 (66.2)
Unknown	83 (31.9)
On nutritional support at the time of surgery	
Yes	8 (3.1)
No	252 (96.9)
Transfusion within 48 h prior to surgery	
Yes	2 (0.8)
No	258 (99.2)
BMI	
less than 20	104 (40.4)
20–24	63 (24.2)
25–30	56 (21.5)
greater than 30	21 (8.1)
Unknown	15 (5.8)
Albumin	
Greater than or equal to 3.5	13 (5.0)
Less than 3.5	61 (23.5)
Unknown	186 (71.5)
ASA class	
1	13 (5)
2	170 (65.4)
3	77 (29.6)
4	0
5	0
Laparoscopic approach	151 (58.1)
Type of operation	
Pouch plus proctocolectomy	200 (77)
Pouch plus proctectomy	60 (23)
Surgeon specialty	
Pediatric surgeon	234 (90)
General surgeon	26 (10)

BMI – Body mass index, ASA – American Society of Anesthesiologists.

Patients with FAP were more likely undergo proctocolectomy at the time of IPAA (91 patients or 97.8%), with most of these procedures being done utilizing the laparoscopic approach (64 patients or 68.8%). Fifty-five (37.7%) patients with UC underwent proctectomy alone with IPAA only, compared to only 2.2% of patients with FAP (Fig. 1).

Overall postoperative outcomes are described in Table 2. The overall morbidity was 11% and there were high rates of reoperation (12.7%) and readmission (21.5%). The median LOS was 6 days (5–9 days), and the median operative time was 313 min (235–402 min). On bivariate analysis, there was a trend towards obese patients having higher rates of morbidity (23.8% versus 11.2%, $p = 0.07$), although this did not reach statistical significance. This included higher SSI rates (19.1% versus 8%, $p = 0.09$), and higher rates of reoperation (24% vs. 12%, $p = 0.08$). Being underweight (defined as a BMI < 20) was not associated with increased rate of adverse outcomes (Fig. 2). Patients who received preoperative steroids had higher rates of reoperation (22.5% versus 10.9%, $p = 0.04$) and a longer LOS (7.5 days [6–10 days] versus 6 days [5–8 days], $p = 0.006$). Patients who underwent laparoscopic surgery had a longer operative time, compared to those who underwent open surgery (326 min [257–408] versus 281 min [216–391], $p = 0.02$). There were no statistically significant differences in rates of morbidity, reoperation or readmission for patients with UC vs. FAP, or for patients undergoing proctocolectomy with IPAA versus proctectomy only with IPAA.

The most common reasons for reoperation included explorations performed in 10 (34.5%) patients, and ostomy revisions in 8 (27.6%) patients (Fig. 3a). Patients were commonly explored for lysis of adhesions and bowel resections. Reasons for readmission were most commonly due to bowel obstruction in 13 (26.5%) patients or due to other gastrointestinal (GI)-related complaints, such as abdominal pain, in 13 (26.5%) patients (Fig. 3b).

Multivariable logistic regression was performed to identify variables that were independently associated with composite morbidity, readmission, and reoperation. There were no variables that were independently associated with composite morbidity or readmission. However, after adjusting for covariates and operative approach, preoperative obesity was independently associated with reoperation (odds ratio (OR) 3.34 [1.08–10.38], $p = 0.04$) (Table 3).

3. Discussion

This study summarizes characteristics and outcomes of children who underwent RP-IPAA from 2012 to 2015 using the NSQIP-P PUF, which collect data from participating centers in the United States and Canada. RP-IPAA is a commonly performed operation for both adults and children with FAP or UC. The results of our study suggest that RP-IPAA is feasible and safely performed in pediatric patients with an overall postoperative morbidity of 11%, which is lower than other reports in the literature [17,22]. There were no significant factors associated with morbidity, although obesity and higher ASA approached significance. Patients who underwent laparoscopic surgery did not experience higher rates of morbidity. The only statistically significant difference between open and laparoscopic surgery was a longer operative time, and this is consistent with recent single-center reports [17,18,23].

Interestingly, there were no differences in postoperative outcomes dependent on preoperative diagnosis (FAP versus UC) nor age at the time of surgery. In this cohort, however, 55 patients with UC underwent proctectomy alone at the time of IPAA. This suggests that 37.7% of the patient population with UC included in this analysis had undergone urgent colectomy, with reconstruction performed at a later date. Since the indication for colectomy in most patients with UC is failure of medical therapy usually including steroids as well as biologic immunomodulators, the lack of difference in outcomes between patients with FAP and UC may be due to the fact that children with UC are optimized after urgent colectomy prior to undergoing IPAA. This explanation is supported by the fact that children undergoing proctocolectomy and IPAA concurrently had similar outcomes to those undergoing proctectomy only with IPAA. We also found that albumin < 3.5 at the time of surgery and recent weight loss were not associated with increased postoperative

Table 2
Overall postoperative outcomes for patients who underwent RP-IPAA for either FAP or UC.

Outcome	n (%)
Overall morbidity	30 (11.5)
Superficial SSI	22 (8.5)
Organ space SSI	9 (3.5)
Urinary tract infection	3 (1.2)
Pneumonia	1 (0.4)
DVT	3 (1.2)
Transfusion >25 mL/kg in 72 h postoperatively	0 (0)
Sepsis	7 (2.7)
Reintubation	2 (0.8)
Related reoperation	37 (14.2)
Readmission	56 (21.5)
Still in hospital at 30 days	1 (0.4)
30-day mortality	0 (0)
Overall median LOS (IQR)	6 days (5–9)
Median operative time (IQR)	313 min (235–402)

SSI – Surgical site infection, LOS – length of stay, IQR – interquartile range.

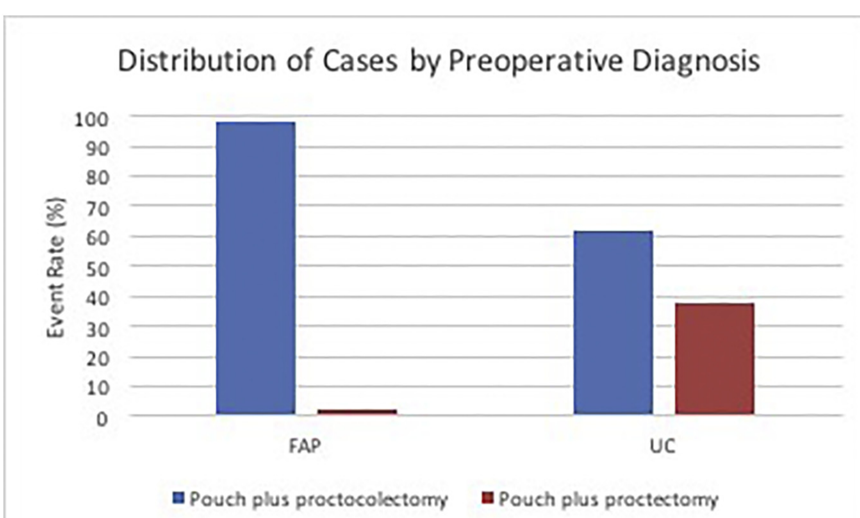

Fig. 1. Distribution of case type performed based on the patient's diagnosis.

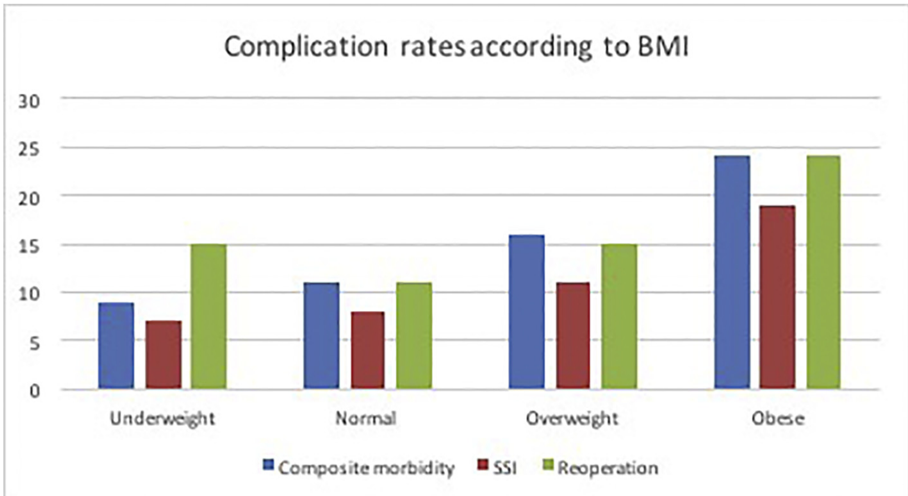

Fig. 2. Complication rates (composite morbidity, SSI, and reoperations) based on patient's preoperative BMI.

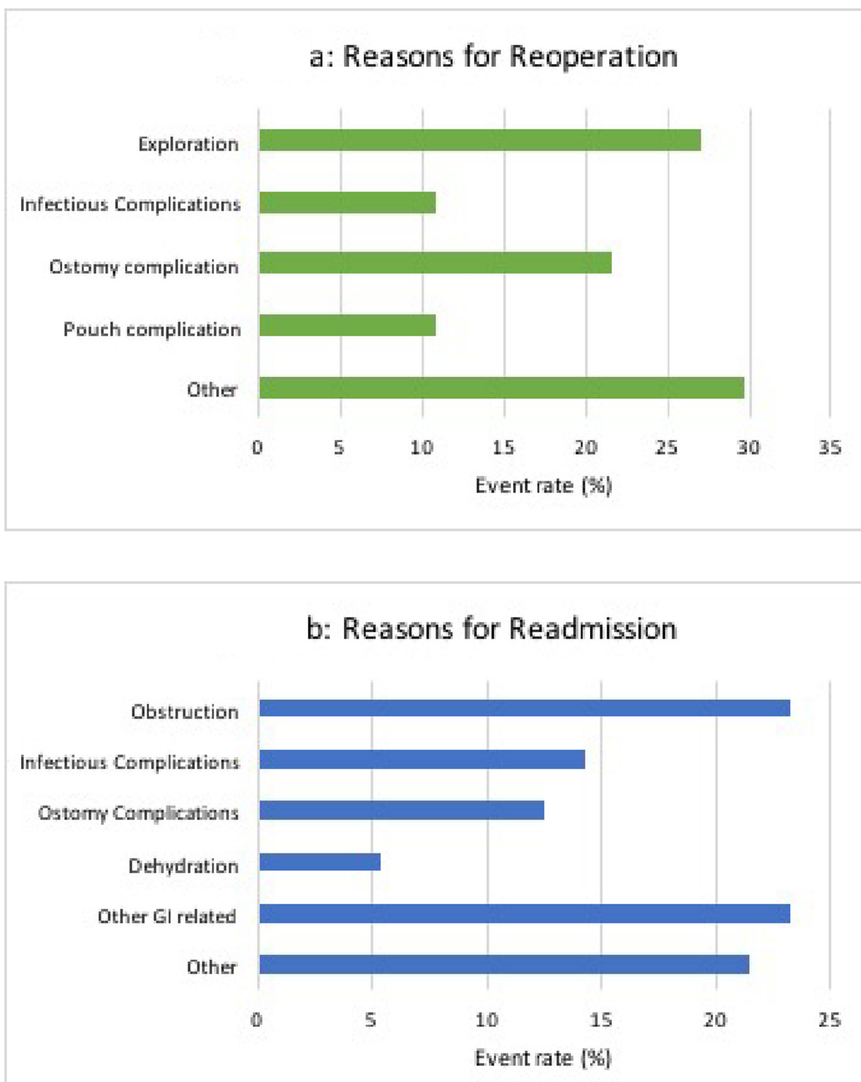

Fig. 3. Reasons for reoperation (3a) and readmission (3b).

Table 3
Multivariable regression analysis evaluating factors that were independently associated with reoperation.

Odds ratio estimates for reoperation				
Variable	Point estimate	95% Wald confidence limits		p value
Gender (male is reference)				
Female	0.56	0.27	1.17	0.12
Age (13–18 is reference)				
6–12	1.35	0.60	3.04	0.46
Preoperative diagnosis (FAP is reference)				
Ulcerative colitis	1.53	0.68	3.45	0.30
Preoperative BMI (<30 is reference)				
Greater than or equal to 30	3.34	1.08	10.38	0.04
Surgical approach (open is reference)				
Laparoscopic surgery	1.13	0.53	2.40	0.75
Surgeon subspecialty (pediatric surgeon is reference)				
General surgeon	0.70	0.19	2.61	0.59

FAP – Familial adenomatous polyposis, BMI – Body mass index.

morbidity. Of note, most patents did not have an albumin level recorded in the NSQIP-P. Therefore, it is possible that a relationship exists between preoperative albumin and postoperative outcomes that we were not able to detect.

We found that there were high rates of reoperation and readmission, 12.7% and 21.5% respectively. High rates of readmission and reoperations in patients undergoing RP-IPAA have been reported in both pediatric and adult series averaging 7.8% for reoperation and ranging from 12% to 32% for readmission. In these studies, the most common cause for readmission was dehydration and electrolyte disturbance while the most common reason for reoperation was small bowel obstruction [16,24,25]. As in other studies, our rates of reoperation specifically excluded elective stoma takedown in the early postoperative period. We found that surgical exploration for lysis or adhesions or bowel resections were the most common reason for in our cohort. These reoperations were likely due to small bowel obstructions, which would be consistent with prior reports [4,26,27]. Incidentally, bowel obstruction was also one of the most common reason for readmission.

We found that obesity was independently associated with reoperation on a multivariable regression model. Obesity can result in a foreshortened mesentery, and this can be a technical challenge in the operating room. Obesity is a potentially modifiable preoperative factor that could be optimized preoperatively. Similarly, preoperative steroid use was associated with reoperation on bivariate analysis but not in the multivariable analysis. Preoperative steroid use was strongly correlated with a diagnosis of UC, so the collinearity between these variables is the likely explanation for why steroid use was not significant in the multivariable model.

No preoperative factors were independently associated with readmission or composite morbidity. In order to better understand the reasons for the high readmission rates, we extracted the ICD-9 and ICD-10 diagnosis variables associated with the readmission. The NSQIP-P generally reliably captures the CPT code for reoperation. This is not always the case for the cause for readmission, and it can be difficult to ascertain whether the readmission was procedure-related. In our cohort, the most common reasons for readmission were for bowel obstruction, other GI-related complaints (i.e., abdominal pain, GI bleeding, etc.), and infectious complications. Dehydration accounted for 6.1% of readmissions in our cohort. However, extrapolating from adult studies, pediatric patients may be at a higher risk of experiencing dehydration and electrolyte disturbance due to a reduced circulating blood volume and smaller reserve when compared to adults. Careful attention to ileostomy output and liberal use of bulking and anti-diarrheal agents may be helpful in reducing postoperative readmission. Ultimately, more data is needed to better understand causes of readmission in this patient population.

Currently, outcomes data for pediatric patients who undergo RP-IPAA is generally limited to single-institution reports. Our study is unique in that it collects data from all institutions that participated in the NSQIP-P during 2012–2015. Therefore, data from this comparative analysis can be used to better understand preoperative characteristics and postoperative outcomes of patients who undergo RP-IPAA for UC or FAP on a national level.

4. Limitations

There are several limitations which need to be considered when interpreting the results of this study. First, the NSQIP-P does not collect data from all centers in the United States or Canada who perform pediatric surgery. Therefore, data from this descriptive analysis may not be generalizable to all hospitals and all patients undergoing RP-IPAA. A limitation that is inherent in any database study is constraint of the data analysis to variables which are captured. Therefore, factors that may influence surgical intervention, especially in patients with UC, such as number of hospitalizations, medical therapies, prior surgical interventions, etc., are not captured and were not analyzed in our study. The NSQIP-P does not capture long-term outcomes; therefore, we did not address long term pouch complications such as pouchitis, pouch failure, and rectal cuff adenomas. Lastly, the NSQIP-P does not capture any data regarding functional or quality of life outcomes in this patient population; therefore, this was also not addressed in our study.

5. Conclusions

We present a large cohort of 260 children who underwent RP-IPAA and associated short-term postoperative outcomes. Data from this descriptive analysis can be used by clinicians for preoperative counseling to better advise patients and their families regarding expected postoperative complication rates. Our data suggest that this procedure can be performed safely in patients with UC or FAP, but that the rates of reoperation and readmission are quite high, and should be targeted for improvement. We found that obesity was independently associated with reoperation. Data from this study may help guide preoperative patient and family counseling and set postoperative expectations. Prospective studies are needed to better understand reasons for reoperation and readmission in order to understand how to optimize outcomes for these patients.

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