Am J Clin Exp Urol 2020;8(4):133-139
www.ajceu.us /ISSN:2330-1910/AJCEU0116832

Original Article

Enterocystoplasty and appendicovesicostomy in adults: a description of demographics and 30-day outcomes of bladder augmentation

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Received June 23, 2020; Accepted August 3, 2020; Epub August 15, 2020; Published August 30, 2020

Abstract: Within the adult population, studies of the granular clinical outcomes of appendicovesicostomy (AV) and augmentation enterocystoplasty (AE) have been limited to case series. Using the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) data, this study sought to describe the population undergoing these procedures. An analysis of the ACS NSQIP database (2015 to 2018) was performed, capturing patients with procedure codes of enterocystoplasty with intestinal anastomosis or cutaneous appendicovesicostomy. Patients were stratified into three groups, if they underwent either procedure, or both procedures. Demographics, comorbidities, perioperative variables, surgeon specialty, and outcomes were described. 130 patients undergoing AV or AE were captured. Most of these patients were white (70.77%) and middle aged (46.78±17.33 years). Most patients were an American Society of Anesthesiologists class 3 or greater risk (71.54%). A higher percentage of AE patients were readmitted, returned to the operating room, and had postoperative UTI or sepsis compared to those undergoing AV or AV+AE. The most common complication overall was readmission related to the operation (14.62%). The most common postoperative diagnosis was neurogenic related in over half of cases. The study shows patients undergoing bladder augmentation and appendicovesicostomy are readmitted not infrequently. Risk of infection, sepsis, bleeding, and reoperation are also not insignificant. Further studies should be carried out to aid in decreasing complication rate and readmissions after these procedures.

Keywords: Appendicovesicostomy, bladder, bladder augmentation, enterocystoplasty, neurogenic bladder, voiding dysfunction

Introduction

Continent urinary diversion with appendicovesicostomy (AV) and augmentation enterocystoplasty (AE) are complex and rare procedures within urology for the treatment of refractory bladder dysfunction. Enterocystoplasty is performed in those with low capacity, high pressure, overactive, or poorly compliant bladders in order to provide adequate urinary storage and continence, and to prevent upper tract damage from high pressures. Additionally, if a patient's urethra cannot be used due to urethral disease or in those unable or unwilling to access the urethral meatus, an alternative outlet must be created. In 1980 Mitrofanoff described a catheterizeable channel with flap valve continence using the appendix, appendicovesicostomy, which remains a popular option today [1].

Studies focusing on long term outcomes of these procedures, including stomal stenosis, need for further surgery, metabolic sequela, stone formation, and infections have been described in both pediatric and adult literature [2-10]. Additionally, studies have assessed short-term postoperative outcomes and morbidity in the pediatric population [11, 12]. One prior study used the NSQIP database to compare adult patients who did and did not require readmission following urologic procedures, however, it did not specifically describe the procedural outcomes following continent urinary diversion [13]. A systematic review of bladder augmentation was performed by Hoen *et al.* which described studies as few and of poor quality [14]. To contribute to this growing body of knowledge, we sought to describe the population undergoing these procedures along with the perioperative complication rates using a

larger cohort of patients than available at any one institution.

Materials and methods

Data used was from the American College of Surgeons National Quality Surgical Improvement Program (ACS NSQIP), years 2015 to 2018 [15]. This database contains patient-level, aggregate data, and is Health Insurance Portability and Accountability Act compliant as it does not identify hospitals, physicians, or patients. This data is free to ACS NSQIP participating hospitals. The benefit of this particular dataset is a national dataset that collects more granular data of specific pre- and postoperative risk factors and outcomes. The Institutional Review Board of the University of Kansas Medical Center approved this study as exempt and Non-Human Subjects research.

The study included all patients 18 years of age and older undergoing appendicovesicostomy (AV) or enterocystoplasty (AE), current procedural terminology coding 50845 and 51960, respectively. The age, sex, race, comorbidities, perioperative variables, elective operation, wound class, preoperative laboratory values, admission quarter, mortality, length of operation, length of stay, discharge destination, surgeon specialty, postoperative diagnosis, and postoperative outcomes such as readmission and return to the operating room, as well as complications such as deep vein thrombosis or wound infection, were included in the analysis as available in NSQIP.

Patients undergoing AV, AE, or both procedures were described with descriptive statistics. Statistical comparison was not carried out due to the descriptive approach and multivariable regression modeling was not carried out due to the low sample size and inability to create a sound model and regression. Statistical analysis and data management was performed using SPSS (IBM Corp. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.) and Excel (from Microsoft version 16.32).

Results

We identified 130 patients from 2015 to 2018 ACS NSQIP with the CPT codes 50845 (AV) and 51960 (AE). Of these, 37 patients underwent AV, 68 patients underwent AE, and 25 patients had AV+AE. Most patients in this study were male, white, and middle aged (**Table 1**). Almost 75% of patients were independent and an American Society of Anesthesiologists physical status classification III or greater.

Most patients were undergoing the procedures electively (~90%) and procedures appeared more common earlier in the year (**Table 2**). Patients had clinically similar wound classifications and clinically similar preoperative laboratory values. Over 90% of operations were carried out with a urologic surgeon as the primary surgeon (**Table 3**).

Table 4 describes postoperative outcomes. Operative time was about 6 hours and length of stay about 8 days. Readmission rate ranged from 13.51% for appendicovesicostomy to 20.59% for enterocystoplasty. About 90% of patients were discharged to home or their home environment. Wound infection occurred in almost 10% of patients and urinary tract infection at nearly the same rate. Sepsis occurred in 7% of patients and bleeding requiring transfusion in nearly 12%.

Table 5 describes postoperative diagnoses. A neurogenic cause was the most common postoperative diagnosis (54.62%) while neoplasm was the second most common cause (20%). Readmission diagnoses (**Table 6**) were most often infectious or gastrointestinal related.

Discussion

In this study we examined a national surgical dataset to obtain descriptive statistics of the adult population undergoing appendicovesicostomy and augmentation enterocystoplasty, along with the 30-day clinical outcomes associated with the procedures. ACS-NSQIP is designed to measure risk-adjusted outcomes of surgical intervention with detail and completeness of follow up so that results can be compared between hospitals in order to improve the quality of surgical care. This national viewpoint gives us the ability to identify procedural outcomes at a scale that is often not possible with single-center studies given the infrequency of these operations. Additionally, NSQIP provides an opportunity to assess preoperative variables in order to better characterize those undergoing AE and AV.

Table 1. Baseline demographics and comorbidities of patients undergoing bladder augmentation

Characteristic	Total		AV		AE		AV+AE	
	130		37	28.46%	68	52.31%	25	19.23%
Age (years)	46.78	17.33	45.51	17.32	49.71	17.02	40.72	17.04
Sex								
Male	67	51.54%	17	45.95%	39	57.35%	11	44.00%
Female	63	48.46%	20	54.05%	29	42.65%	14	56.00%
Race								
White	92	70.77%	28	75.68%	47	69.12%	17	68.00%
Black	13	10.00%	0	0.00%	6	8.82%	7	28.00%
Hispanic	4	3.08%	1	2.70%	3	4.41%	0	0.00%
Not Reported	20	15.38%	8	21.62%	11	16.18%	1	4.00%
Comorbidities								
Diabetes	17	13.08%	7	18.92%	8	11.76%	2	8.00%
Current smoker	17	13.08%	3	8.11%	10	14.71%	4	16.00%
No dyspnea	126	96.92%	34	91.89%	67	98.53%	25	100.00%
COPD	4	3.08%	2	5.41%	2	2.94%	0	0.00%
Hypertension	45	34.62%	9	24.32%	30	44.12%	6	24.00%
Renal Failure	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Dialysis	2	1.54%	0	0.00%	1	1.47%	1	4.00%
Disseminated cancer	6	4.62%	3	8.11%	3	4.41%	0	0.00%
Preoperative wound infection	6	4.62%	3	8.11%	2	2.94%	1	4.00%
Weight loss	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Steroid use	6	4.62%	2	5.41%	3	4.41%	1	4.00%
Independent	95	73.08%	26	70.27%	54	79.41%	15	60.00%
ASA 3 or greater	93	71.54%	27	72.97%	50	73.53%	16	64.00%
Body mass index (kg/m^2)	28.40	6.73	28.21	6.54	28.79	7.39	27.56	5.01

[Values are mean (SD) or N (%).]

Table 2. Perioperative variables of patients undergoing bladder augmentation

	Total		AV		AE		AV+AE	
	130		37	28.46%	68	52.31%	25	19.23%
Elective operation	118	90.77%	34	91.89%	62	91.18%	22	88.00%
Admission quarter								
1	42	32.31%	11	29.73%	20	29.41%	11	44.00%
2	38	29.23%	10	27.03%	20	29.41%	8	32.00%
3	25	19.23%	7	18.92%	15	22.06%	3	12.00%
4	25	19.23%	9	24.32%	13	19.12%	3	12.00%
Wound class								
Clean	7	5.38%	2	5.41%	5	7.35%	0	0.00%
Clean/Contaminated	108	83.08%	29	78.38%	57	83.82%	22	88.00%
Contaminated	11	8.46%	5	13.51%	3	4.41%	3	12.00%
Dirty/Infected	4	3.08%	1	2.70%	3	4.41%	0	0.00%
Preoperative Labs								
Sodium (mEq/L)	139.3	3.0	138.8	3.4	139.5	2.5	139.3	3.6
BUN (mmol/L)	15.7	9.0	15.6	11.5	15.6	6.4	15.7	10.8
Creatinine (mg/dL)	1.1	1.2	0.9	0.5	1.0	0.8	1.1	2.3
Albumin (g/dL)	3.9	0.5	4.0	0.5	3.9	0.6	3.9	0.5
Bilirubin (mg/dL)	0.5	0.3	0.4	0.2	0.6	0.3	0.5	0.2

AST (u/L)	21.3	11.0	21.1	7.6	20.8	8.2	21.3	19.4
ALP (u/L)	82.7	29.4	75.2	21.7	84.9	33.0	82.7	30.8
WBC (×10^9/L)	7.8	3.0	8.5	4.2	7.5	2.4	7.8	2.4
HCT (percent)	39.1	5.1	39.2	5.4	39.3	5.1	39.1	4.7
PLT (K/L)	247.9	75.2	244.5	46.1	245.5	86.8	247.9	78.0
PTT (seconds)	32.0	4.3	30.4	3.7	32.6	4.6	32.0	3.9
INR	1.0	0.1	1.0	0.1	1.0	0.1	1.0	0.1

[Values are mean (SD) or N (%).]

Table 3. Surgeon specialty of patients undergoing bladder augmentation

	Total		AV		AE		AV+AE	
	130		37	28.46%	68	52.31%	25	19.23%
Surgeon Specialty								
Urologic Surgery	118	90.77%	34	91.89%	63	92.65%	21	84.00%
General Surgery	8	6.15%	3	8.11%	4	5.88%	1	4.00%

[Values are N (%).]

Although our results showed a low 30-day mortality rate, a relatively high 30-day morbidity rate was observed. Specifically, we note a high hospital readmission rate during the immediate 30-day postoperative period, with an average rate of 16.9% between the procedures in question. Using ACS-NSQIP, Stone *et al.* identified 23,108 patients from 2011 to 2012 who underwent major inpatient urologic surgery and noted 1,329 unplanned readmissions [13]. However, within their own study, they noted that the procedures with the highest rates of readmission included upper tract reconstruction and urinary diversion with (291 of 1662 patients) and without (21 of 102 patients) cystectomy. Although our study did not exclude patients who underwent cystectomy, the readmission rate identified is consistent with the readmission rate found for other major urologic surgeries that involve bowel manipulation.

We also identified relatively high rates of urinary tract infections, with 8.4% of patients being diagnosed with a UTI in the perioperative period. Although this does suggest that a reduction in the rate of urinary tract infections should be a focus of improvement, it was significantly lower than number of post-operative urinary tract infections than McNamara *et al.* reported in a pediatric population undergoing the same procedures (49.4%) [11]. Ultimately, elevated rates of UTI in patients undergoing AV and AE should not be startling, as these procedures introduce risk factors for urinary tract infection, such as integration of bowel to the genitourinary tract and prolonged catheterization during the postoperative period. Unfortunately, we are unable to further define a UTI within the database.

Additionally, it was discovered that almost 7% of patients undergoing AE or AV were diagnosed with sepsis, 9.2% with a superficial surgical site infection, and 11.5% required blood transfusion in the 30-day period following surgery. Kovell *et al.* similarly described elevated rates in patients who underwent continent urinary diversion incorporating bowel, with 11.5% of patients being diagnosed with sepsis, 6.4% superficial surgical site infection, and 37.1% requiring a transfusion [16]. These findings do not seem to be isolated as Redshaw *et al.* also described a nearly 26% rate of Grade II complications, including: surgical site infection, UTI, and need for transfusion, in patients who underwent a continent cutaneous ileal cecocystoplasty [7].

Although surgeries such as AE and AV may significantly improve a patient's quality of life, our findings highlight the significantly increased risk of perioperative morbidity following complex urologic procedures that incorporate bowel into the genitourinary tract. Additionally, patients who undergo operations such as these often have multiple comorbidities, as demonstrated by over 71% of our population falling into the ASA 3 or greater group. As many of the patients that undergo these procedures will require readmission, further treatment and or reoperation, data such as this can be useful not only for preoperative counseling, but also in identifying variables that can be targeted for

Table 4. Perioperative outcomes of patients undergoing bladder augmentation

	Total		AV		AE		AV+AE	
	130		37	28.46%	68	52.31%	25	19.23%
Hospital days to operation	0.45	2.07	0.38	1.71	0.54	2.55	0.45	0.68
Hospital length of stay (days)	8.16	5.74	6.78	4.77	9.04	6.80	8.16	2.94
Operative time (minutes)	325.6	159.3	297.1	163.2	317.5	152.9	325.6	159.4
30-Day mortality	2	0.40%	1	0.51%	1	0.32%	0	0.00%
Discharge to home	114	87.69%	32	86.49%	57	83.82%	25	100.00%
Complication								
Readmission	22	16.92%	5	13.51%	14	20.59%	3	12.00%
Related to operation	19	14.62%	4	10.81%	13	19.12%	2	8.00%
Return to Operating Room	4	3.08%	0	0.00%	3	4.41%	1	4.00%
Related to operation	2	1.54%	0	0.00%	1	1.47%	1	4.00%
Unplanned intubation	2	1.54%	1	2.70%	1	1.47%	0	0.00%
On ventilator >48 hours	2	1.54%	1	2.70%	1	1.47%	0	0.00%
Wound infection (superficial)	12	9.23%	5	13.51%	5	7.35%	2	8.00%
Wound infection (deep)	2	1.54%	1	2.70%	1	1.47%	0	0.00%
Organ space SSI	5	3.85%	1	2.70%	3	4.41%	1	4.00%
Wound dehiscence	1	0.77%	0	0.00%	1	1.47%	0	0.00%
Pneumonia	5	3.85%	0	0.00%	3	4.41%	2	8.00%
Urinary tract infection	11	8.46%	2	5.41%	8	11.76%	1	4.00%
DVT	6	4.62%	0	0.00%	4	5.88%	2	8.00%
Pulmonary embolism	5	3.85%	1	2.70%	2	2.94%	2	8.00%
Cardiac arrest requiring CPR	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Myocardial infarction	1	0.77%	0	0.00%	1	1.47%	0	0.00%
Sepsis	9	6.92%	2	5.41%	7	10.29%	0	0.00%
Shock	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Bleeding transfusion	15	11.54%	5	13.51%	8	11.76%	2	8.00%
Renal failure or insufficiency	3	2.31%	0	0.00%	3	4.41%	0	0.00%
[Values are mean (SD) or N (%).]								

Table 5. Postoperative diagnoses of patients undergoing bladder augmentation

	Total		AV		AE		AV+AE	
	130		37	28.46%	68	52.31%	25	19.23%
Neurogenic	71	54.62%	19	51.35%	37	54.41%	15	60.00%
Incontinence of bladder or bowel	6	4.62%	2	5.41%	3	4.41%	1	4.00%
Neoplasm	26	20.00%	6	16.22%	18	26.47%	2	8.00%
Obstructive	6	4.62%	2	5.41%	2	2.94%	2	8.00%
Exstrophy	1	0.77%	0	0.00%	1	1.47%	0	0.00%
Other urologic diagnosis	16	12.31%	6	16.22%	6	8.82%	4	16.00%
Non-urologic diagnosis	4	3.08%	2	5.41%	1	1.47%	1	4.00%
[Values are N (%).]								

Neurogenic includes neurogenic bladder or bowel, spina bifida, spinal cord injury, and other neurogenic diagnoses.

quality improvement protocols to improve overall outcomes.

Our study's limitations lie in its retrospective nature, the limitations inherent to the database, and the inherent differences between specialties' approaches. The ACS NSQIP database acknowledges several limitations inherent to their database. Generic variables are collected, patients are only followed for 30 days, data is only from participating hospitals, and some variables are not present for each case.

Table 6. Readmission diagnoses of patients undergoing bladder augmentation

	Total		AV		AE		AV+AE	
	130		37	28.46%	68	52.31%	25	19.23%
Readmission	22	16.92%	5	13.51%	14	20.59%	3	12.00%
Related to operation	19	14.62%	4	10.81%	13	19.12%	2	8.00%
Infection	11	8.46%	3	8.11%	6	8.82%	2	8.00%
Superficial Incisional SSI	2	1.54%	1	2.70%	0	0.00%	1	4.00%
Organ/Space SSI	1	0.77%	1	2.70%	0	0.00%	0	0.00%
Sepsis	3	2.31%	0	0.00%	3	4.41%	0	0.00%
Pneumonia	1	0.77%	0	0.00%	0	0.00%	1	4.00%
Urinary Tract Infection	2	1.54%	1	2.70%	1	1.47%	0	0.00%
Infection following a procedure	1	0.77%	0	0.00%	1	1.47%	0	0.00%
Infection due to cystostomy catheter	1	0.77%	0	0.00%	1	1.47%	0	0.00%
Gastrointestinal	4	3.08%	2	5.41%	2	2.94%	0	0.00%
Enterostomy bleeding	1	0.77%	1	2.70%	0	0.00%	0	0.00%
Vomiting	1	0.77%	0	0.00%	1	1.47%	0	0.00%
Ileus	1	0.77%	1	2.70%	0	0.00%	0	0.00%
Fistula of intestine	1	0.77%	0	0.00%	1	1.47%	0	0.00%
Renal insufficiency/injury	2	1.54%	0	0.00%	2	2.94%	0	0.00%
Pulmonary Embolism	2	1.54%	0	0.00%	1	1.47%	1	4.00%
Wound Disruption	1	0.77%	0	0.00%	1	1.47%	0	0.00%

[Values are N (%).]

Further detail about case complexity, such as prior operations or exact procedures or augmentation performed (clam, supratrigonal bladder resection, laparoscopic, open, etc.) is not available. Without a longer period of time tracking the patients, it is not possible to describe long term outcomes or disease recurrence and disease-free survival with this database. Data is only from participating hospitals and surgical or surgeon volume is not a variable, thus we are unable to control for this. Also, hospital volume is not available. Having these variables in such a database would allow for analysis and control of specialty volume and hospital volume. ACS NSQIP has worked to eliminate sampling error, but complete removal of bias is not possible without random assignment of cases by some computer generation algorithm or similar mechanism. Although our study has several limitations, the database allows for analysis of trends on a more granular level than the National Inpatient Sample and avoid some of the biases that may be inherent in other databases as described by LaPar and colleagues [17].

Augmentation enterocystoplasty and appendicovesicostomy are complex urologic procedures associated with high incidence of 30-day morbidity. Patients undergoing these procedures are readmitted in almost 20% of the population and the risk of infection, sepsis, bleeding, and reoperation are not insignificant. Our findings align with previous studies of these populations and procedures and provides further data describing outcomes and demographics. Prospective studies should be carried out to aid in decreasing both the rate of complications and readmissions following these procedures.

Acknowledgements

American College of Surgeons National Surgical Quality Improvement Program and the hospitals participating in the ACS NSQIP are the source of the data used herein; they have not verified and are not responsible for the statistical validity of the data analysis or the conclusions derived by the authors. This study was designated “Non-Human Subjects Research” by the Human Subjects Committee at the University of Kansas School of Medicine.

Disclosure of conflict of interest

None.

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