



Pediatric surgical complications of major genitourinary reconstruction in the exstrophy–epispadias complex



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ABSTRACT

Purpose: Urinary continence is the goal of exstrophy–epispadias complex (EEC) reconstruction. Patients may require a continent urinary diversion (CUD) if they are a poor candidate for bladder neck reconstruction or are receiving an augmentation cystoplasty (AC) or neobladder (NB). This study was designed to identify the incidence of surgical complications among various bowel segments typically used for CUD.

Methods: A prospectively kept database of 1078 patients with EEC at a tertiary referral center from 1980 to 2012 was reviewed for major genitourinary reconstruction. Patient demographics, surgical indications, perioperative complications, and outcomes were recorded.

Results: Among reviewed EEC patients, 134 underwent CUD (81 male, 53 female). Concomitant AC was performed in 106 patients and NB in 11. Median follow up time after initial diversion was 5 years. The most common CUD bowel segments were appendix and ileum. The most common surgical complications after CUD were small bowel obstruction, post-operative ileus, and intraabdominal abscess. There was a significantly increased risk in the occurrence of pelvic or abdominal abscess when colon was used as a conduit compared to all other bowel segments (OR = 16.7, 95% CI: 1.16–239) and following NB creation compared to AC (OR = 39.4, 95% CI: 3.66–423). At postoperative follow-up, 98% of patients were continent of urine via their stoma.

Conclusion: We report the largest series to date examining CUD in the EEC population. The increased risk of abdominal and pelvic abscesses in patients who receive a colon CUD and undergo NB compared to AC indicates that while surgical complications following major genitourinary reconstruction are rare, they do occur. Practitioners must be wary of potential complications that are best managed by a multi-disciplinary team approach.

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The ultimate goal of surgical reconstruction in patients with the exstrophy–epispadias complex (EEC) is urinary continence. Urethral continence is often difficult to achieve in patients born with more severe forms of EEC (i.e. cloacal exstrophy) because of poor size and bladder template quality. However, series following classic bladder exstrophy closure have demonstrated stomal continence rates from 67% to 83% [1,2]. While continence rates are lower in patients with cloacal exstrophy, dryness is often attainable by implementation of continent urinary diversion (CUD) with or without bladder augmentation or neobladder creation [3].

A catheterizable CUD is typically required when an EEC patient has persistent upper urinary tract changes or is not a candidate for bladder neck reconstruction. During this procedure, a 2–3 cm segment of bowel is fashioned into a tube of approximately 12 French internal diameter. The proximal end is a submucosal tunnel into the bladder while the distal end is matured into a catheterizable stoma at the skin. Continence is achieved when the bladder fills and collapses the intramural tunnel preventing leakage from the stoma.

Augmentation cystoplasty (AC) can be concomitantly performed for insufficient bladder capacity (less than expected for patient's age) or a non-compliant bladder [4]. If AC cannot be achieved because the native bladder template is deemed unsalvageable for being too small (typically less than 50 cc) or severely thickened, a separate segment of bowel can be isolated to form a reservoir, called a neobladder (NB). In this patient population, the NB creation is accompanied by construction of a continent stoma [5]. There are many reported variations in the surgical techniques and types of bowel segment used for CUD, AC, and NB; however, the associated complications are not well understood or well described in long-term follow-up [6,7]. This study was designed to report a large-volume experience with major genitourinary reconstructive operative strategies in an effort to find any association between different types of bowel segment used and subsequent surgical complications.

1. Methods

After institutional review board (IRB) approval, 1046 patients who underwent a CUD between 1980 and 2012 at a single, tertiary, academic

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hospital were identified with Current Procedural Terminology surgery billing codes. These patients were cross-referenced with a 1078 patient IRB-approved exstrophy database to identify 134 patients who both had a CUD and diagnosis of complete epispadias, classic bladder exstrophy or exstrophy variant, cloacal exstrophy or cloacal exstrophy variant. Patients were excluded if the original CUD tissue was unknown, their original CUD procedure date was unknown, or if they had less than 6 months of follow-up.

Records were reviewed for patient demographics, surgical history, length of follow-up, perioperative outcomes, and bowel segments used for CUD, AC, and NB. Special attention was given to post-operative surgical complications that required surgery or hospitalization and the length of hospital stay for each complication. Fisher's exact test for categorical data, Wilcoxon test for non-parametric data, Chi-squared test for parametric data, and odds ratios were used to determine statistical significance between complications and types of bowel segments used for the genitourinary reconstruction. All statistical analysis was performed with Microsoft Excel® 2010 (Redmond, WA) and SPSS® 16 (Chicago, IL).

2. Results

The authors identified 134 EEC patients (81 male, 53 female) with at least six months of follow-up who underwent CUD. The median age for diversion was 7 years (range: 2 years–25 years) and median follow up was 5 years (range: 6 months–20 years). Among these patients, 4 were identified with complete female epispadias, 11 with complete male epispadias, 96 with classic bladder exstrophy or bladder exstrophy variant, and 23 with cloacal exstrophy or a cloacal variant.

Seventeen patients with appropriate bladder size underwent only CUD, while all others received CUD with AC or NB creation. Indications for reconstruction included failed primary exstrophy closure, failed bladder neck reconstruction resulting in cutaneous fistula formation or persistent urinary incontinence, insufficient bladder capacity (less than expected for the patient's age), and neurogenic bladder. Bowel segments used to create the CUD included ileum, colon, and appendix either alone or combined with other bowel segments. Fifty-six percent of the patients' medical records documented the stoma location, with the overwhelming known majority of patients having their stoma at the umbilicus. Table 1 provides further details regarding the major genitourinary reconstructions. Median hospital length of stay was 7 days. After CUD placement or stomal revision, 98% of the patients were continent via stomal catheterization at most recent follow-up. Two patients have persistent leakage from their stomas and one patient did not follow-up after stomal revision.

Tissues used for AC (Table 2) include: sigmoid colon, ileum, a combination of ileum and sigmoid colon, ureter, and stomach. The tissue type used in four patients is unknown. The one patient who underwent known gastrocystoplasty had the longest length of stay (45 days) while the mean lengths of stay for ileal and sigmoid cystoplasty were equal (9 days). Eleven neobladders were constructed either with colon or a combination of ileum and colon. Eight of these eleven patients had a Mitrofanoff CUD with their neobladder while three patients had a Monti CUD.

Table 3 shows the CUD post-operative surgical complications. The most prevalent complication was small bowel obstruction, occurring in 5% of all CUD patients at a median of 21.5 days (range: 14–40) post-operatively. The occurrence rate of this complication was 5% for both appendiceal and ileal patients. All six of the patients who had a small bowel obstruction underwent an emergent exploratory laparotomy and spent a median of an additional 9.5 days (range: 8–23) after re-operation. Five CUD patients with prolonged post-operative ileus had a longer median length of hospital stay of 21 days (range: 11–26 days) compared to 9 days (range: 5–49 days) in all other patients ($P = 0.03$). All five of these patients had a Mitrofanoff CUD. There was a significant 16-fold increased risk of abdominal and pelvic abscess in colon

Table 1
CUD procedure details.

CUD Associated Procedure	
None	17
Augmentation	106
Neobladder	11
CUD Indication	
Failed Primary Exstrophy Closure	36 (27%)
Failed BNR	31 (23%)
Insufficient Bladder Capacity	20 (15%)
Neurogenic Bladder	3 (2%)
Unknown	44 (33%)
CUD Bowel Segment	
Appendix	103 (77%)
Tapered Ileum	22 (16%)
Colon	3 (2%)
Appendix & Other Segment	6 (5%)
Median Length of Stay (days) (Range)	
CUD alone (n = 17)	7 (5–22)
CUD at different time of augmentation (n = 9)	7 (6–19)
CUD at same time as augmentation (n = 97)	9 (6–44)
CUD at same time as neobladder (n = 11)	10 (7–49)

CUD compared to all other CUD tissue types (OR = 16.7, 95% CI: 1.16–238.53).

The subset of 117 CUD patients who also had AC or NB presented with six events of small bowel obstruction, four events of post-operative ileus, one event of inguinal hernia, and three events of abscess. However, there was no correlation between the rates of these complications and the tissue used for reconstructed bladder/reservoir.

There were no events of small bowel obstruction, hernia, or post-operative ileus in the patients who received an NB (Table 4). However, 4 patients developed pelvic or abdominal abscesses. When comparing this group to AC patients, there was a significant increase in the rate of abscess formation in those with NB (OR = 39.4, 95% CI: 3.66–423.17).

3. Discussion

While traditional EEC management relied on acceptance of simple survival, recent advancements have shifted the goal to improved quality of life measures such as cosmesis and urethral or voided continence [8,9]. The latter is usually achieved with bladder neck reconstruction if there is sufficient sphincteric tone and bladder capacity [6]. Unfortunately, reconstruction is precluded in patients with hydroureter, a small bladder capacity, or unfavorable urodynamic parameters (i.e. poor compliance, elevated detrusor pressure, or poor voiding pressures) [10,11]. Instead, most of these patients will undergo CUD with or without AC or NB creation.

Table 2
Augmentation cystoplasty and neobladder bowel types.

Augmentation Cystoplasty Bowel Type (n = 106)		Length of Stay (days)
Ileum	48 (45%)	9 (7–32)
Sigmoid	45 (42%)	9 (7–24)
Sigmoid & Ileum	6 (6%)	9 (8–12)
Ureter	1 (1%)	11
Ileum & Ureter	1 (1%)	10
Stomach	1 (1%)	45
Unknown	4 (4%)	N/A
Neobladder Bowel Type (n = 11)		Length of Stay (days)
Colon	6 (55%)	9 (7–24)
Colon + Ileum	5 (45%)	11 (9–49)

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