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## Urologic complications of major genitourinary reconstruction in the exstrophy–epispadias complex

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### KEYWORDS

Exstrophy–epispadias complex;  
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**Abstract** *Objective:* To present the authors' experiences with urologic complications associated with various techniques used to create a continent stoma (CS), augmentation cystoplasty (AC), and neobladder in the exstrophy–epispadias complex (EEC) population.

*Methods:* Retrospective review of medical records of patients who underwent CS with or without bladder augmentation were identified from an institutional review board-approved database of 1208 EEC patients. Surgical indications, tissue type, length of hospital stay, age, preoperative bladder capacity, prior genitourinary surgeries, postoperative urological complications, and continence status were reviewed.

*Results:* Among the EEC patients reviewed, 133 underwent CS (80 male, 53 female). Mean follow-up time after initial continent stoma was 5.31 years (range: 6 months to 20 years). Appendix and tapered ileum were the primary bowel segments used for the continent channel and stoma in the EEC population. The most common stomal complications in this population were stenosis, incontinence, and prolapse. Seventy-nine percent of EEC CS patients underwent AC primarily done with sigmoid colon or ileum. Eleven patients (8%) underwent neobladder creation with either colon or a combination of colon and ileum. Bladder calculi, vesicocutaneous fistula, and pyelonephritis were the most common non-stomal complications. Stomal ischemia was significantly increased in Monti ileovesicostomy compared to Mitrofanoff appendicovesicostomy in classic bladder exstrophy patients ( $p = 0.036$ ). Furthermore, pyelonephritis was more than twice as likely in colonic neobladder than all other reservoir tissue types in the same cohort (OR = 2.53, 95% CI: 1.762–3.301,  $p < 0.001$ ).

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*Conclusions:* To the best of the authors' knowledge, this is the largest study examining catheterizable stomas in the exstrophy population. While Mitrofanoff appendicovesicostomy is preferred to Monti ileovesicostomy because it is technically less challenging, it may also confer a lower rate of stomal ischemia. Furthermore, even though ileum or colon can be used in AC with equally low complication rates, practitioners must be wary of potential urologic complications that should be primarily managed by an experienced reconstructive surgeon.

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## Introduction

Urinary continence is the ultimate goal of urologic reconstruction in patients with the exstrophy–epispadias complex (EEC). The ability to maintain continence via the urethra is often difficult in patients born with more severe forms of EEC (i.e., cloacal exstrophy) because of poor bladder template quality and size. Series following early classic bladder exstrophy closure with subsequent bladder neck reconstruction demonstrated continence rates from 67% to 83% [1,2]. Voided continence rates are lower in patients with cloacal exstrophy, but dryness can be attained with a catheterizable, continent stoma (CS) with or without bladder augmentation [3].

The CS, usually constructed of appendix or tapered bowel, is a channel from the bladder to the skin ending in a stoma. Clean intermittent catheterization (CIC) is done through the stoma for the patient to empty his or her bladder, instead of using the native urethra. At times, if the patient's bladder is non-compliant or of insufficient capacity, there will be a need for augmentation cystoplasty (AC). Typically augmented by ileum or sigmoid bowel, AC patients who do not catheterize via their native urethra instead use stomal CIC through a CS extending to their augmented bladder. If the native bladder template is deemed unsalvageable because of it being too small (less than 50 mL) and/or severely thickened, a cystectomy with creation of a neobladder utilizing ileum and/or colon is performed [4]. The neobladder is not anastomosed to the native urethra so these patients also require CS for emptying of their bladder via stomal CIC.

At the authors' institution, CS is typically required when an EEC patient has persistent upper urinary tract changes, is not a candidate for bladder neck reconstruction (BNR), has failed BNR, or if the patient undergoes AC or neobladder creation [5]. There are many reported variations in the surgical techniques and types of bowel used for both CS and AC; however, the associated urologic complications are not well understood or well described in long-term follow-up [6,7]. The authors aim to report their experience with CS and AC operative strategies in an effort to find any associations between different types of bowel segment used and subsequent urologic complications.

## Methods

After receiving approval from the institutional review board (IRB), 1046 patients who underwent CS, AC, or neobladder construction between 1980 and 2012 were identified with Current Procedural Terminology surgery billing codes.

These were cross-referenced with a 1208 patient IRB-approved exstrophy database to identify those that have a diagnosis of complete epispadias, classic bladder exstrophy, cloacal exstrophy, or cloacal variant. Patients were excluded if their CS tissue was unknown, their original CS procedure date was unknown, or if they had less than 6 months of follow-up. One bladder exstrophy variant fit the inclusion criteria, but was excluded since the small sample size skewed statistics. Included patients were then categorized into four different groups based on their exstrophy diagnosis since a diagnosis such as cloacal exstrophy or cloacal exstrophy variant may limit which tissue is available for reconstruction and presents with many different and severe anatomical anomalies compared to complete epispadias and classic bladder exstrophy.

Records were reviewed for exstrophy closure and bladder neck surgical histories (reconstruction vs. transection), age at the time of these procedures, length of follow-up, indications for CS, length of postoperative hospital stay, bowel segments used for CS, augmentation, and neobladder, and preoperative bladder capacities. Special attention was given to postoperative urologic complications that required surgery or hospitalization, and the length of hospital stay for each was recorded. While reviewing exstrophy closure history, a failed closure was one in which there was wound dehiscence, bladder prolapse, or bladder outlet obstruction following the primary exstrophy closure. Patients undergoing AC underwent a cystoscopy and gravity cystogram under anesthesia to measure bladder capacity at the beginning of their operation. Continence was defined as being able to intermittently catheterize the continuously dry stoma.

All statistical analysis was performed with Microsoft Excel® 2010 (Redmond, WA, USA) and SPSS® 16 (Chicago, IL, USA). Categorical variables were compared using the chi-square test. Mann–Whitney *U* test, Student *t* test and Fisher exact test were performed when applicable. Data are expressed as mean  $\pm$  SD if there are more than 20 events or as median (range) if there are less than 20 events;  $p < 0.05$  is considered statistically significant. Odds ratios were used to determine statistical significance between complications and different procedures or bowel segments used. Multivariate analysis was not performed due to the small number of patients and complications.

## Results

### Baseline characteristics

Cross referencing the exstrophy database yielded 133 exstrophy patients (80 male, 53 female) with at least 6 months

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