Pediatric bladder augmentation – Panacea or Pandora's box?

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Abstract

Introduction: Bladder augmentation is a surgery that can increase bladder capacity and compliance. The objective of this study was to provide a longitudinal review of pediatric bladder augmentation at a tertiary Canadian center.

Methods: A retrospective review was performed on patients who underwent bladder augmentation at a tertiary pediatric hospital between 1986 and 2014. The primary objective was short- and long-term complications of augmentation. Secondary objectives were to review number of augmentation procedures performed over time and the utility of routine postoperative cystograms.

Results: A total of 56 procedures were performed on 54 patients (28 males, 26 females) of mean age 10 years (standard deviation [SD] 5) and mean followup eight years (SD 5). The most common bowel segment used was ileum (87.5%). Twenty-eight patients (50%) received catheterizable channels. Overall complication rate was 15% and the most common complications were urinary tract infections (68.5%), worsening hydronephrosis (14.8%), bladder stone formation (14%), and hematuria (13%). In total, 19 of 54 (35.2%) patients returned to the operating room. The incidence of bladder perforation was 3.6%. Complications with the catheterizable channel occurred in 13 of 28 (46.4%), of which 10 were related to stomal stenosis. Forty patients had postoperative cystograms and extravasation was seen in three (7.5%). There was no malignancy during the followup. Only four augmentations were performed from 2008–2014.

Conclusions: Bladder augmentation likely represents a safe surgical treatment option. Extravasation on postoperative cystogram was uncommon and, thus, it may not be indicated routinely. The number of augmentation procedures performed has declined in recent years.

Introduction

Patients with neurogenic bladders and high intravesicle pressures are at risk for a number of complications, including recurrent infection, urinary incontinence, and renal deterioration.[1] A number of conservative treatments have been used to help optimize bladder function in these patients, including clean intermittent catheterization, oral and intravesical anticholinergics, as well as intra-detrusor botulinum toxin injections.[2] Bladder augmentation, or augmentation cystoplasty, is a surgical procedure that is used when more conservative treatment methods have failed.[3] The surgery involves anastomosis of a harvested bowel segment to the native bladder to increase capacity and compliance.

Despite the potential benefits of bladder augmentation, there have been a number of studies that have reported high incidence of both short- and long-term morbidity associated with this procedure. Common postoperative complications include bladder stones, bladder rupture, renal deterioration, metabolic abnormalities, and malignancy.[3-10] Due to a decreased incidence of associated congenital disorders in the Western world, as well as improvements in early detection and treatment of patients with neurogenic bladders, the rates of augmentation cystoplasty performed appear to be declining in both the U.K. and the U.S.[3,4] To our knowledge, there have been no Canadian series reporting on long-term outcomes of pediatric bladder augmentation. The objective of this study is to review our experience with bladder augmentation in the Canadian pediatric population and to evaluate the incidence of postoperative complications at our institution. As part of this analysis, we will also look to evaluate the rate of augmentation procedures performed over time. A secondary objective is to evaluate the utility of routine postoperative cystograms in augmented patients. We hypothesize that for augmentation cystoplasty in our tertiary Canadian center: 1) the rate of postoperative complication is low; 2) the rate of augmentation cystoplasty has decreased over time; and 3) routine postoperative cystogram is not necessary.

Methods

Following IRB approval, a retrospective chart review was conducted for all patients who were followed post-bladder augmentation at a tertiary pediatric hospital between 1986 and 2014. Patients were followed from the time of their surgery up to 18 years of age, at which point they were

transitioned to the care of an adult urologist. Patient records were reviewed for demographic information, including date of birth, gender, age at time of procedure, and indication for augmentation. Operative details were collected, including date of procedure, tissue segment used in augmentation, and any secondary procedures performed. Length of followup, as well as the number of patients who were lost to followup prior to the age of 18 years were also collected. Details of postoperative investigations, including ultrasound and cystoscopy, were reviewed. The number of patients who underwent postoperative cystogram and the rate of extravasation were also collected.

Specific attention was directed towards the short- and long-term complications of augmentation. Postoperative complications related to the augmentation procedure included urinary tract infection (UTI), renal deterioration, worsening hydronephrosis, bladder perforation, gastric reservoir perforation, bladder stone formation, metabolic abnormalities, wound infection, and hematuria. UTI was defined as any positive urine culture in addition to at least one of the following associated symptoms: dysuria, abdominal pain, hematuria, and/or fever. Renal deterioration was defined as the development of chronic kidney disease following augmentation in the context of documented normal preoperative renal function. Metabolic abnormalities included patients who developed persistent electrolyte disturbances necessitating ongoing medical management. Wound/channel infections were identified based on the presence of localized inflammatory symptoms, including erythema, edema, and/or purulent discharge. Hematuria included any instance of gross hematuria, which was not secondary to traumatic catheterization. The incidence, as well as the indication for reoperation was collected for both augmentation and catheterizable channel-related complications. All eligible patients underwent routine screening for malignancy, with annual cystoscopy starting at 10 years following their augmentation.

Results

A total of 56 augmentation procedures were performed on 54 patients, of which there were 28 males and 26 females. Five different urologists performed augmentation procedures during this time period. The mean age at the time of augmentation was 9.6 (standard deviation [SD] 5) years. The mean followup was 7.6 (SD 5) years. Catheterizable channels were created in 28 (50%) patients. In total, three patients were lost to followup prior to the age of 18 years (5.6%). Twenty-two (40.7%) patients underwent an additional procedure at the time of augmentation. This included unilateral ureteric reimplantation in 10, bilateral ureteric reimplantation in eight, bladder neck closure in four, bladder neck reconstruction in two, open appendectomy in two, cystolithotomy in one, and rectus fascial sling in one. Gastric reservoirs were performed in two patients in 1995 and 1996, respectively. A summary of patient demographics, as well as a breakdown of the indication for augmentation and type of augmentation performed can be seen in Table 1.

Thirty-seven (68.5%) patients experienced at least one symptomatic UTI. Among the patients with normal baseline renal functioning, worsening of renal function occurred in one patient with ileocystoplasty and two patients with gastric reservoirs. Metabolic abnormalities were noted in one patient with a gastric reservoir and two patients with ileocystoplasty. The patient with the gastric reservoir developed hypochloremic hypokalemic metabolic alkalosis, whereas one patient with the ileocystoplasty developed hyperchloremic metabolic acidosis and the other developed vitamin B12 deficiency. Complications with the catheterizable channel were noted in 13 of 28 (46.4%) patients, which included stomal stenosis in 10 patients, bleeding in two, and infection in one (Table 2).

In total, 19 of 54 (35.2%) patients returned to the operating room due to postoperative complications. The mean time to reoperation was 31.4 months (SD 28.8). Of the patients who required a second operation, 10 (52.6%) were due to complications with the catheterizable channel. Repeat bladder augmentation was required in one ureterocystoplasty and one ileocystoplasty. Bladder perforation occurred in one ileocolocystoplasty and one ileocystoplasty. Bladder calculi extraction was performed using an open approach in two patients and an endoscopic approach in two patients (Table 3).

Table 4 shows the timing of postoperative complications in patients who underwent augmentation cystoplasty. Bladder perforation occurred within eight days postoperatively in both patients. Other complications, including stoma

Table 1. Patient gender, indication for augmentation, and type of augmentation procedure performed

	Number (%)
Number of patients	54
Males	28 (51.9)
Females	26 (48.1)
Indication for augmentation:	
Spina bifida	32 (59.3)
Bladder/cloacal exstrophy	9 (16.7)
Posterior urethral valves	4 (7.4)
Non-neurogenic neurogenic bladder	3 (5.6)
Sacral agenesis	3 (5.6)
Traumatic spinal cord injury	2 (3.7)
Bilateral ectopic ureters	1 (1.9)
Number of procedures	56
Ileocystoplasty	49 (87.5)
Ileo-colocystoplasty	2 (3.6)
Colocystoplasty	1 (1.8)
Gastrocystoplasty	1 (1.8)
Ureterocystoplasty	1 (1.8)
Gastric reservoir	2 (3.6)

Table 2. Incidence of postoperative complications following bladder augmentation

Complications (total of patients 54)	Incidence n (%)
Decreased renal function	3 (5.6%)
Bladder perforation	2 (3.6%)
Gastric reservoir perforation	1 (1.9%)
Bladder stone formation	8 (14.8%)
Metabolic abnormality	3 (5.6%)
Wound infection	3 (5.6%)
Hematuria	7 (13.0%)
Worsening hydronephrosis	8 (14.8%)

stenosis, electrolyte abnormalities, bladder stone formation, and worsening hydronephrosis, were seen in more long-term followup.

There was an increase in the rate of augmentation procedures performed between 2002 and 2008. The maximum number of augmentations performed in a single year was six in 2003. Between 2008 and 2014 only four augmentations were performed (Fig. 1).

Forty patients received a postoperative cystogram (74%). The mean time to postoperative cystogram was 21.4 days. Extravasation on postoperative cystogram was reported in three (7.5%) patients, however, these were minor and all resolved with longer suprapubic drainage. There were no malignancies identified on surveillance cystoscopy for those 18 patients with a followup period greater than or equal to 10 years. Mean duration of annual cystoscopy surveillance was 4.7 years for these patients. There were no deaths attributable to augmentation.

Discussion

The overall postoperative complication rate of augmentation cystoplasty was 15%. This incidence of complication post-augmentation is not unexpected, as other studies have also documented a high rate of morbidity in these patients. Most complications encountered, however, were minor in severity and required only minimal intervention. The incidence of more serious complications of bladder augmentation, including bladder perforation, malignancy, and renal deterioration, were low in comparison. Of note, the incidence of complications secondary to the catheterizable channel was relatively high in comparison, with an overall rate of 46.4%.

While symptomatic UTIs were common in the postoperative period (68.5%), they were not considered a direct surgical complication. It is well-known that there is a high incidence of bacteriuria in these patients, particularly in those patients employing clean intermittent catheterization.[4,11-15] Furthermore, there is a lack of consensus in terms of how to properly define and treat UTIs among this population.[15] Given the high incidence of UTIs and the difficulty of diagnosis within this population, physicians should be vigilant for symptoms of infection.

Metabolic abnormalities were noted in 5.6% of patients. Of these, two patients received ileocystoplasty, of which one developed hyperchloremic metabolic acidosis while the other developed vitamin B12 deficiency. This is consistent with existing literature, which suggests that up to 50% of patients with ileocytstoplasty will develop metabolic acidosis, while the incidence of vitamin B12 deficiency was 3–20%.[10,16,17] Furthermore, one patient with a gastric reservoir developed hypochloremic hypokalemic metabolic alkalosis. This is a known risk factor for the use of stomach tissue in augmentation due to gastric secretion of hydrochloric acid and has been found to occur in up to 7% of patients post-gastrocystoplasty.[18,19] The recognized risk of electrolyte disturbance necessitates the need for routine laboratory monitoring of these patients. At our institution, patients underwent annual screening for electrolyte and other metabolic disturbances postoperatively.

Bladder stone formation was a common postoperative complication (14.8%). Our rate of bladder stones is consistent with other studies, which have described an incidence of 11–52%.[7,10,20-23] The high rate of bladder stones among augmented patients suggests that regular screening may be indicated. At our institution, patients underwent annual screening with ultrasound to assess for development of possible complications, including stones. Bladder stones result from calcification of accumulated bowel mucous, as well as chronic bacterial colonization of the urinary tract. Therefore, the use of preventative strategies, including frequent bladder

Table 3. The incidence of re-operation secondary to channel and augmentation complications

	Number (%)
Channel complications	
Total	10/28 (35.7)
Debridement of infection	1/28 (3.6)
Stenotic channel revision	2/28 (7.1)
Dilation/revision of stenotic stoma	7/28 (25.0)
Augmentation complications	
Total	9/54 (16.7)
Repeat augmentation	2/54 (3.7)
Bladder calculi extraction	4/54 (7.4)
Bladder perforation	2/54 (3.7)
Repair of gastric reservoir leak	1/54 (1.9)

Table 4. Timing of postoperative complications for augmentation cystoplasty

Complication	Mean time to complication (range)
Stomal stenosis	21 months (6–64)
Bladder calculi	58 months (36–72)
Metabolic abnormalities	22 months (8–37)
Worsening hydronephrosis	34 months (5–83)
Bladder perforation	5 days (3–8)

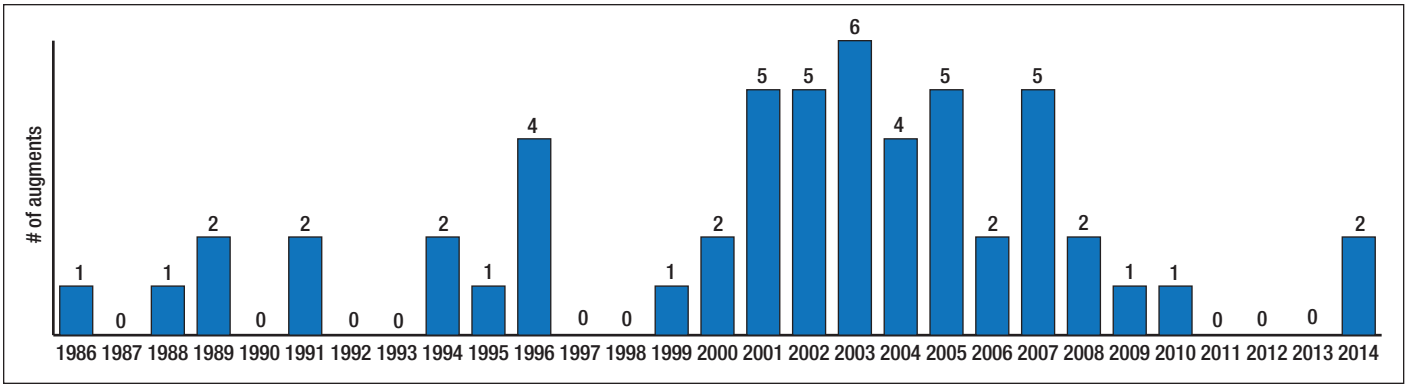

Fig. 1. Number of augmentation cystoplasties performed per year.

irrigation, should be promoted.[24] Furthermore, there was a high rate of re-operation among patients who developed bladder stones (50%). Therefore, the potential for repeat intervention secondary to stone-formation should be discussed with the patients and their family prior to augmentation.

The incidence of decrease in renal function post-augmentation was 5.6%. This is in keeping with existing literature, which suggest an incidence of 3–20.3%.[20,25] Unlike previous studies, however, patients with a diagnosis of chronic kidney disease due to a pre-existing condition, such as lower urinary tract obstruction, were not attributed as having worsening renal function as a complication of augmentation. It is of note that both patients with gastric reservoir had normal preoperative renal function and experienced a subsequent renal deterioration. The exact cause is unclear but is thought to be secondary to chronic reflux of acidic urine from the stomach.

Worsening hydronephrosis was noted in 15% of patients. Despite this relatively high incidence, a large majority were managed expectantly. Only two patients required repeat surgical intervention for worsening hydronephrosis, with one patient requiring nephrostomy tube drainage and eventual repeat augmentation, and another requiring bilateral ureteric reimplantation.

There were no cases of malignancy identified. This is reflective of literature to date, which have noted a low overall incidence of malignancy post-augmentation, ranging from 0–5.5%.[10,21,26-29] Patients underwent routine annual cystoscopy surveillance starting at 10 years postoperatively. Our screening protocol is based on the recommendations from previous studies based on the long latency period between operation and development of malignancy.[29] The mean followup period was eight years, however, and the majority of patients did not reach the point where regular screening for malignancy was indicated. Furthermore, for the 18 patients in whom regular surveillance was initiated, the mean surveillance period was short at 4.7 years. Therefore, it is possible that additional cases of malignancy could develop as the followup period for these patients is extended.

The incidence of bladder perforation was 3.6%. This is lower than other studies, which have reported rates of 5–12.8%.[20,30,31] The low rate of perforation could be attributed to the regular access to medical care and followup in our pediatric population. Furthermore, at our institution, patients received regular education and training from a multidisciplinary care team, which promoted a strict protocol of frequent bladder irrigation and catheterization to prevent bladder over-distention. Despite the relatively low incidence, bladder perforation represents a potential source of significant morbidity and mortality, which necessitates vigilant followup and patient awareness.

The rate of return to the operating room post-augmentation was high (35.2%) but not unexpected, as other studies have also reported a high incidence of surgical complications.[4,11-13,23,24] Most patients requiring repeat operation, however, were due to complications with the catheterizable channel (52.6%). Of these patients, most required only simple dilatation or revision of a stenotic stoma. A study by Husmann et al found a similar high incidence of complications associated with continent catheterizable channels, with a reported complication rate of 40% for Mitrofanoff and 71% for Monti channels.[10] The high rate of complication and reoperation for those patients with a catheterizable channel necessitates regular followup and screening. We suggest that inquiries regarding the functioning of the channel, along with thorough inspection of the stomal opening, be incorporated into every followup visit.

The timing of postoperative complications was variable depending on the type of complication. Bladder perforation was seen almost immediately in both cases, with timing ranging from 3–8 days postoperatively. Other complications, including stoma stenosis, bladder calculi, electrolyte abnormalities, and worsening hydronephrosis, were seen well over one year postoperatively on average. The wide range of timing of complications further necessitates the need for long term followup in these patients.

Within our institution, there was an increase in the number of procedures performed between 2000 and 2008, with a

total of 36 augmentations performed during this time. During this period, there was a new staff surgeon hired with special expertise in this field, which may have led to the relative higher number of augmentation surgeries. From 2009–2014, there was a relative decrease in the number of operations, with only four augmentations performed despite no change in staff surgeons during this period. Such a decrease in rate of augmentation has also been documented in other centers and may be attributed to improvements in early management of neurogenic bladder through UTI prevention and medical optimization, as well as a declining incidence of spina bifida and other congenital conditions in the Western world.[3,4]

There is lack of existing literature on the utility of routine postoperative cystogram in patients who have undergone augmentation cystoplasty. In our series, the incidence of extravasation on postoperative cystogram was low at 7.5%. Furthermore, all patients with extravasation were managed expectantly with a longer period of catheterization and no patient required active surgical intervention. We would, therefore, suggest that routine postoperative cystogram might not be indicated in regular postoperative screening. Instead, it should be reserved for select cases where a leak or perforation is suspected based on clinical suspicion.

As these patients reach the age of majority, transition to appropriate adult care is of utmost importance. At our institution, all patients 18 years of age were transitioned to an adult urologist with a specific expertise and interest in management of these complex patients. Given the complexity of these patients and need for routine ongoing followup, a thorough patient history, as well as specific followup instructions, including the need for annual cystoscopic surveillance starting at 10 years postoperatively, was provided to the accepting urologist. For the three patients that were lost to followup prior to the age of 18 years, two had moved to another city and one's parents wished to be followed closer to home. Appropriate referrals to urologists in the area of their new residence had been made prior to departure from our care.

There are some limitations to our study. First, the retrospective nature of our study represents a potential source of selection bias. In addition, we had a relatively small sample size. There was also a relatively short mean followup period of eight years; therefore, we may have under-reported certain long-term complications. Finally, our study examined the outcomes of bladder augmentation at only a single tertiary center, which may limit the applicability of our results to a broader pediatric population.

Conclusions

Overall, bladder augmentation represents a safe surgical alternative to increasing bladder capacity and compliance when other, more conservative methods have failed. Despite this, there is an evident decrease in the number of augmentation procedures performed in recent years, which may be due to better medical management options coupled with a decreased incidence of associated congenital disorders in the Western world. Catheterizable channels represent a significant source of morbidity and re-operation, thereby necessitating prudent followup and screening for associated complications. Although no malignancies were identified, this may be due to our relatively short followup period. The concern for developing malignancy warrants careful surveillance. Postoperative cystograms may not be necessary, as the rate of extravasation is low. The lower rate of bladder perforation may be due to improved access to care, along with a strict bladder catheterization and irrigation protocol in our institution. Further study would be required to confirm this.

Competing interests: Dr. Neville has received speaker honoraria from Pfizer and TerSera (OAB-focused). The remaining authors reports no competing personal or financial interests.

This paper has been peer-reviewed.

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