ORIGINAL ARTICLE

Long-term Outcomes of Augmentation Enterocystoplasty with an Ileal Segment in Patients with Spinal Cord Injury

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Background/Purpose: Neurogenic bladder has been considered a relative contraindication for augmentation enterocystoplasty (AE), but neurogenic voiding dysfunction has become a common indication for AE. We evaluated long-term outcomes in patients with spinal cord injury (SCI) who underwent AE with an ileal segment.

Methods: We reviewed retrospectively 40 consecutive adults with SCI who underwent AE. The outcomes assessed included bladder capacity and compliance, incidence of stone formation, upper urinary tract status, urinary tract infection (UTI), need for intermittent catheterization, urinary incontinence, postoperative morbidity, persistent loose stools, and metabolic malabsorption.

Results: Four women and 36 men aged 20–56 years (mean, 36.3 ± 8.8 years), with a mean follow-up period of 7.8 ± 0.6 years were included. Twenty-nine (72.5%) patients had detrusor overactivity and the other 11 had detrusor underactivity. Simple AE was performed in 27 patients, AE with ureteral reimplantation in seven, and continent diversion by enterocystoplasty with an abdominal stoma in six. The mean bladder capacity increased from 115 ± 16.3 to 513 ± 31.4 mL after the operation. Four patients (10%) could void spontaneously and 29 (72.5%) had to perform clean intermittent catheterization to empty their bladders. Twenty-six patients (65%) had episodes of UTI. Three patients (7.5%) experienced *de novo* diarrhea that required antispasmodics. Long-term complications included urinary incontinence in four (10%) patients, reservoir calculi in 13 (32.5%) and new-onset upper tract stones in nine (22.5%).

Conclusion: AE with an ileal segment provides effective and safe therapeutic outcomes in SCI patients. However, problems with UTI, reservoir calculi and new-onset upper tract urolithiasis still need to be solved.
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Key Words: augmentation enterocystoplasty, continent diversion, ileum, spinal cord injuries

Augmentation enterocystoplasty (AE) and continent diversion using an intestinal segment are considered suitable for contracted and low compliant bladders that are refractory to conservative treatment. Bladder substitution using an ileal segment after radical resection of lower urinary tract malignancies or a contracted bladder with an incompetent outlet, such as in neurogenic bladder, has become more common. However, the complicated surgical procedure and potential complications have limited its widespread application. Reported complications include chronic diarrhea, recurrent urinary tract infection (UTI), stone formation and the need for intermittent catheterization.[1]

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Urinary incontinence and chronic contracted bladder are major problems in patients with chronic spinal cord injury (SCI). SCI patients may develop a small bladder capacity with detrusor overactivity or detrusor underactivity and low bladder compliance.[2,3] Vesicoureteral reflux (VUR) or hydroureteronephrosis with increased intravesical pressure or detrusor sphincter dyssynergia may develop in SCI patients.[4,5] Many patients with chronic SCI need to have an indwelling urethral Foley catheter or suprapubic cystostomy to resolve voiding dysfunction. Quality of life is low and catheter-related complications are troublesome. Although AE or a continent neobladder is unable to correct bladder dysfunction, SCI patients may become continent and have an improved quality of life.[6,7]

This retrospective study evaluated the long-term therapeutic results in patients with chronic SCI who underwent AE for voiding dysfunction.

Patients and Methods

Forty adult patients with chronic SCI who underwent AE from 1992 to 2006 were included in this study to evaluate long-term therapeutic outcomes and complications. All patients presented with recurrent UTI, urinary incontinence or upper urinary tract dysfunction. They were initially treated conservatively with medication and clean intermittent self-catheterization (CISC) but the results were unsatisfactory.

Preoperative evaluations included history taking, physical examination, urodynamic study, cystoscopy and upper tract imaging with ultrasound or excretory urography. The bladder capacity was determined by urodynamic study or the maximal functional volume from self-voiding or catheterization. The VUR was confirmed by excretory urography or videourodynamic study.

All patients who underwent AE had a small bladder capacity (< 150 mL), or low bladder compliance with or without VUR. AE was performed using a terminal ileal segment in a modified Hautmann's procedure.[8] A 40-cm ileal loop was selected (Figure A), while preserving the 30-cm terminal ileum from the ileocecal valve. The entire segment of the resected ileum was transformed into an "M" or "W" shape by suturing the seromuscular layer 2 cm from the medial edges of the flaps of the ileum, followed by detubularization by opening along the antimesenteric borders (Figure B). Ureteral reimplantation was performed concomitantly depending on the presence of VUR. The spatulated ureters were anastomosed at the end of the troughs of the detubularized ileum to form an extramural serosa-lined tunnel (Figure C).[9] The native contracted bladder was opened transversely as wide as possible to create a clam-shape bladder (Figure D). The fashioned ileal patch was then anastomosed to the bladder wall using double layer 2-0 Vicryl sutures (Figure E). Drains included a urethral Foley catheter and a Jackson-Pratt drain placed at the perivesical space. The procedure for a neobladder with continent abdominal stoma was performed for persistent urinary incontinence that resulted from severe intrinsic sphincteric deficiency, confirmed by preoperative videourodynamic study. The neobladder continent diversion was performed by creating a hemi-Koch pouch in which a 17-cm distal ileal loop was used to construct a continent abdominal stoma, in addition to the AE[10] or standard Koch pouch formation.[11]

Cystography was performed on postoperative day 14 (Figure F) and the urethral catheter was removed if there was no extravasation. Patients were allowed to try voiding after removal of the urethral catheter. Patients were instructed to perform CISC if the voiding trial was not successful. Postoperative follow-up was scheduled at 3-month intervals for the first year, then yearly, and included urodynamic study and renal and bladder ultrasonography. Postoperative cystoscopy was performed for specific indications including hematuria, refractory incontinence or recurrent UTI. UTI was defined as admission for a febrile episode, with infection confirmed by a positive urine or blood culture test. Postoperative diarrhea was defined as watery or loose stools three times or more per day, which had not occurred preoperatively.

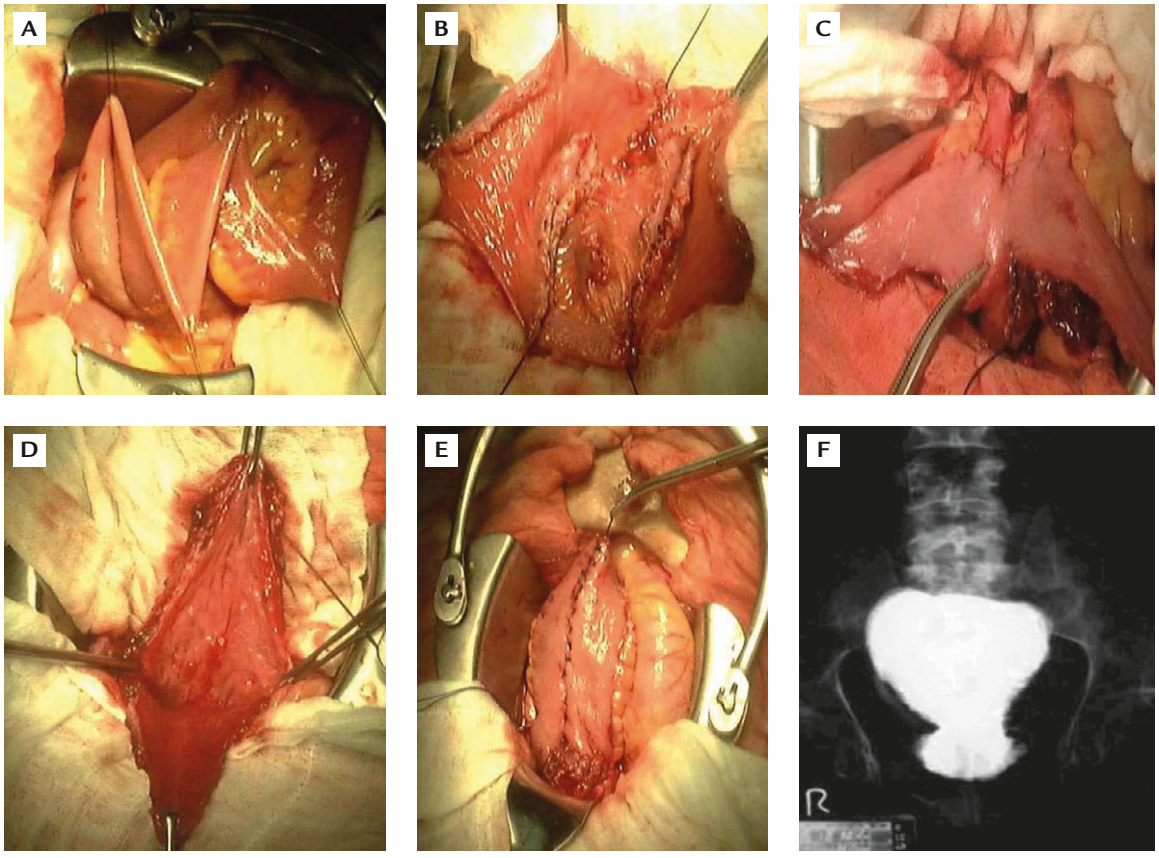

Figure. The procedure for augmentation enterocystoplasty and bilateral ureteral reimplantation. (A) A 40-cm ileal loop was selected. (B) The entire segment of the resected ileum was transformed into an "M" shape by suturing the seromuscular layer 2 cm from the medial edges of the flaps of the ileum, followed by detubularization by opening along the antimesenteric borders. (C) The spatulated ureters were anastomosed at the end of the troughs of the detubularized ileum, to form an extramural serosa-lined tunnel. (D) The contracted bladder was opened transversely as wide as possible to create a clam-shape bladder. (E) The fashioned ileal patch was then anastomosed to the bladder wall using double layer 2-0 Vicryl sutures. (F) A cystography was performed on postoperative day 14.

Other complications were recorded from the records if they had a direct relationship with intestinal surgery for urinary tract dysfunction.

Statistical analysis was performed by Student's *t* test between groups and a paired *t* test for longitudinal comparison using SPSS version 10 software (SPSS Inc., Chicago, IL, USA).

Results

Four women and 36 men with chronic SCI were included in this study. They were aged between 20 and 56 years (mean, 36.3 ± 8.8 years) at the time of surgery. The follow-up periods ranged from 1 to 14 years (mean, 7.8 ± 0.6 years). The level of the SCI was the suprasacral cord in 33 patients and sacral cord in seven. Preoperative urodynamic study revealed detrusor overactivity in 29 (72.5%) patients and detrusor underactivity in 11 patients. Thirty eight (95%) patients had preoperative urinary incontinence and all of them had to wear an external device, or a diaper, or used long-term catheterization with a diaper in cases of wetting.

Simple AE was performed in 27 patients: AE with ureteral reimplantation in seven and neobladder continent diversion in six (hemi-Koch pouch in four and Koch pouch in two). No ureteral strictures, stoma strictures or small bowel obstruction occurred after the operation. No major surgical complications or mortality was noted in this series, except in one patient who had a wound infection.

The bladder capacity after AE or neobladder continent diversion increased significantly from

115 ± 16.3 to 513 ± 31.4 mL ($p < 0.0001$). The bladder compliance after surgery increased significantly from 6.08 ± 0.98 to 33.5 ± 5.4 mL/cmH_2O ($p < 0.0001$). The serum creatinine level improved or remained normal in all but one patient. There was no significant difference between the serum creatinine levels preoperatively (1.00 ± 0.12 mg/dL) and postoperatively (1.24 ± 0.31 mg/dL) ($p = 0.20$). One of the four patients who presented with azotemia preoperatively had a preoperative serum creatinine level of 3.8 mg/dL, and later received hemodialysis. The other three had improved results.

Postoperatively, 36 patients failed to void spontaneously and CISC was performed in 31, while a long-term indwelling urethral catheter was used in five. Bladder stone formation was found in 13 patients (32.5%) at 44.0 ± 8.5 months, and new-onset upper urinary tract stones were noted in nine (22.5%) at 54.4 ± 8.4 months. Twenty-six patients (65%) experienced at least one UTI and needed to be admitted for treatment. The rate of overall reservoir calculi was 46.2% (12/26) and 7.14% (1/14) in patients with and without symptomatic UTI, respectively; and was 36.1% (13/36) and 0% (0/4) in patients with catheterization and self voiding, respectively ($p < 0.05$).

Two patients with CISC (5.6%) experienced recurrent epididymitis and underwent a vasectomy to prevent recurrent infection. Four patients (10%) had persistent urinary incontinence caused by intrinsic sphincteric deficiency, which improved after adjusting the voiding or CISC intervals. Three patients (7.5%) experienced new onset, persistent loose stools or diarrhea that required treatment with antispasmodics. No patient had vitamin B12 deficiency, pernicious anemia or clinically relevant malabsorption.

Discussion

Neurogenic bladder has been considered a relative contraindication for AE for more than 20 years. Nowadays, neurogenic voiding dysfunction has become one of the common indications for AE as a result of the widespread acceptance of CISC as a means of bladder emptying.[12] In previous reports, AE and continent diversion were proven safe and effective for a contracted bladder, such as in neurogenic bladder, iatrogenic urethral obstruction and incontinence, chronic cystitis caused by tuberculosis, radiation, chemical cystitis and schistosomiasis.[13–15]

The goal of AE is to create a large capacity reservoir with good compliance that can be emptied by CISC or spontaneous voiding. When clean intermittent catheterization is impossible or impractical, continuous catheterization from the urethra and creation of a continent stoma are alternatives. AE is preferred to neobladder continent diversion because of the simpler procedure and natural anatomy. Neobladder continent diversion was performed in this study only for patients with a severely incompetent bladder outlet. Theoretically, both procedures offer similar properties of a urinary reservoir.

AE and neobladder continent diversion provide a large, compliant urinary reservoir that can protect the upper urinary tract from high pressure damage.[16] Our previous study has shown that AE can increase effectively bladder capacity and decrease intravesical pressure about 6 months after surgery.[17] Here, all 20 patients with preoperative hydronephrosis and VUR had resolution or marked improvement after surgery, and in seven of these, VUR subsided spontaneously without ureteral reimplantation. These results indicate that AE is an efficient treatment for patients with upper urinary tract dysfunction. Previous studies have shown that > 95% of VUR in patients with neurogenic bladder is cured or improved after AE without ureteral reimplantation, even in patients with high-grade VUR.[18,19] In patients with chronic SCI and a contracted and poorly compliant bladder, AE without ureteral reimplantation might be adequate for those with low-grade VUR.

Lower urinary tract stones are common after AE and occur with increasing frequency with longer follow-up. Bladder augmentation itself does not affect the incidence of stone formation.[20] The factors that promote stone formation during

bladder reconstruction are complex and incompletely elucidated. It is accepted that the use of permanent sutures within the reconstructed bladder should be avoided because a suture acts as a nidus for stone formation. Hensle et al reported that, overall, patients with an abdominal stoma had a greater risk of reservoir calculi (66%) than those using the native urethra (15%).[21] Patients with long-term catheterization had a significantly greater risk of stone formation than those on intermittent catheterization, independent of age, sex and injury level.[22] In addition, urine accumulation in the bladder with mucus and bacteriuria might contribute to stone formation.[23] Here, the rate of symptomatic UTI and the need for intermittent catheterization were significantly associated with the rate of reservoir stone formation, further proving these facts. To reduce the risk of reservoir calculi, periodic bladder washout,[24] eradication of the urea-splitting uropathogens that predispose to stone formation, spontaneous voiding or CISC instead of long-term catheterization may be solutions.

Epididymo-orchitis is another complication that is discussed infrequently in patients with SCI. Kaver et al demonstrated that the main distribution of epididymo-orchitis in male patients aged > 50 years was in those with bladder outlet obstruction.[25] Both of our patients with postoperative recurrent epididymitis had detrusor sphincter dyssynergia in the preoperative and postoperative urodynamic study. Vasectomy might be considered when recurrent infection occurs if fertility is not a concern.

Ureteral and stomal strictures are other complications that lead to hydronephrosis, and they require revision. Here, no ureteral or stomal stricture was noted and all patients with preexisting hydronephrosis showed improvement after surgery. Limited dissection and skeletonization of the ureter, wide ureteral spatulation, and tension-free ureteroneocystostomy can reduce the risk of local ischemia that leads to stricture.

Vitamin B12 and most bile acids are absorbed in the ileum. These absorptive functions cannot be assumed by another part of the gut.[26–28] The terminal ileum and ileocecal valve are particularly important for resorptive function, regulation of bowel emptying, and compensation of small bowel loss.[29] Vitamin B12 deficiency, clinically relevant electrolyte abnormalities, and malabsorption are potential complications after long segment ileal resection. Subclinical increased reabsorption of electrolytes might occur, which causes upper tract stone formation in patients with an intestinal urinary reservoir. Resection of < 100 cm of the ileum and preservation of the terminal ileum and ileocecal valve can prevent these complications.[30,31] We showed that resection of a 40-cm section of the ileum proximal to the ileocecal valve did not cause these complications.

Metabolic changes after enterocystoplasty may aggravate renal function, especially in patients with preexisting renal insufficiency. Only one of four patients with preoperative azotemia had deteriorating renal function. It is difficult to discern the etiology of this undesired outcome. Skinner et al recommended that orthotopic urinary diversion should not be offered to patients with significant abnormality in renal function, with a serum creatinine level > 2 mg/dL or creatinine clearance rate < 50 mL/min, to avoid rapid deterioration of renal function after surgery.[32] Long-term indwelling catheterization can be an alternative management strategy.

AE with an ileal segment provides effective and safe therapeutic outcomes in SCI patients with a contracted bladder, refractory urinary incontinence or upper urinary tract deterioration. However, problems with UTI, reservoir calculi and new onset of upper urinary tract stones still need to be resolved.

References

1. Hasan ST, Marshall C, Robson WA, et al. Clinical outcome and quality of life following enterocystoplasty for idiopathic detrusor instability and neurogenic bladder dysfunction. *Br J Urol* 1995;76:551–7.
2. Yoshimura N. Bladder afferent pathway and spinal cord injury: possible mechanisms inducing hyperreflexia of the urinary bladder. *Prog Neurobiol* 1999;57:583–606.

3. Burns AS, Rivas DA, Ditunno JF. The management of neurogenic bladder and sexual dysfunction after spinal cord injury. *Spine* 2001;26(Suppl 24):S129–36.
4. McGuire EJ, Brady S. Detrusor-sphincter dyssynergia. *J Urol* 1979;121:774–7.
5. McGuire EJ, Woodside JR, Borden TA, et al. Prognostic value of urodynamic testing in myelodysplastic patients. *J Urol* 1981;126:205–9.
6. Chartier-Kastler EJ, Mongiat-Artus P, Bitker MO, et al. Long-term results of augmentation cystoplasty in spinal cord injury patients. *Spinal Cord* 2000;38:490–4.
7. Quek ML, Ginsberg DA. Long-term urodynamics followup of bladder augmentation for neurogenic bladder. *J Urol* 2003;169:195–8.
8. Hautmann RE, Egghart G, Frohneberg D, et al. The ileal neobladder. *J Urol* 1988;139:39–42.
9. Abol-Enein H, Ghoneim MA. A novel uretero-ileal reimplantation technique: the serous lined extramural tunnel. A preliminary report. *J Urol* 1994;151:1193–7.
10. Skinner DG, Lieskovsky G, Skinner E, et al. Continent urinary diversion. *J Urol* 1989;141:1323–7.
11. Skinner DG, Boyd SD, Lieskovsky G, et al. Lower urinary tract reconstruction following cystectomy: experience and results in 126 patients using Koch ileal reservoir with bilateral ureteroileal urethrostomy. *J Urol* 1991;146:756–60.
12. Mitchell ME, Kulb TB, Backes DJ. Intestinocystoplasty in combination with clean intermittent catheterization in the management of vesical dysfunction. *J Urol* 1986;136: 288–91.
13. Medel R, Ruarte AC, Herrera M, et al. Urinary continence outcome after augmentation ileocystoplasty as a single surgical procedure in patients with myelodysplasia. *J Urol* 2002;168:1849–52.
14. Zachoval R, Pitha J, Medova E, et al. Augmentation cystoplasty in patients with multiple sclerosis. *Urol Int* 2003; 70:21–6.
15. Blaivas GJ, Weiss JP, Desai P, et al. Long-term followup of augmentation enterocystoplasty and continent diversion in patients with benign disease. *J Urol* 2005;173:1631–4.
16. McGuire EJ, Noll F, Maynard F. A pressure management system for the neurogenic bladder after spinal cord injury. *Neurourol Urodynam* 1991;10:223–30.
17. Kuo HC. Clinical outcome and quality of life after enterocystoplasty for contracted bladders. *Urol Int* 1997;58: 160–5.
18. Simforoosh N, Tabibi A, Basiri A, et al. Is ureteral reimplantation necessary during augmentation cystoplasty in patients with neurogenic bladder and vesicoureteral reflux? *J Urol* 2002;168:1439–41.
19. pez Pereira P, Martinez Urrutia MJ, Lobato Romera R, et al. Should we treat vesicoureteral reflux in patients who simultaneously undergo bladder augmentation for neuropathic bladder? *J Urol* 2001;165:2259–61.
20. Barroso U Jr, Jednak R, Fleming P, et al. Bladder calculi in children who perform clean intermittent catheterization. *BJU Int* 2000;85:879–84.
21. Hensle TW, Bingham J, Kam J, et al. Preventing reservoir calculi after augmentation cystoplasty and continent urinary diversion: the influence of an irrigation protocol. *BJU Int* 2004;93:585–7.
22. Ord J, Lunn D, Reynard J. Bladder management and risk of bladder stone formation in spinal cord injured patients. *J Urol* 2003;170:1734–7.
23. Nurse DE, Mcinerney PD, Thomas PJ, et al. Stones in enterocystoplasties. *BJU Int* 1996;77:684–6.
24. Brough RJ, O'Flynn KJ, Fishwick J, et al. Bladder washout and stone formation in paediatric enterocystoplasty. *Eur Urol* 1998;33:500–2.
25. Kaver I, Matzkin H, Braf ZF. Epididymo-orchitis: a retrospective study of 121 patients. *J Fam Pract* 1990;30:548–52.
26. Mellstrom D, Johansson C, Johnell O, et al. Osteoporosis, metabolic aberrations, and increased risk for vertebral fractures after partial gastrectomy. *Calcif Tissue Int* 1993;53: 370–7.
27. Weiner IM, Lack L. Absorption of bile salts from the small intestine *in vivo*. *Am J Physiol* 1962;202:155–7.
28. Borgstrom B, Lundh G, Hofmann A. The site of absorption of conjugated bile salts in man. *Gastroenterology* 1968; 54(Suppl):S781–3.
29. Bochenek W, Rodgers JB, Balint JA. Effects of changes in dietary lipids on intestinal fluid loss in the short bowel syndrome. *Ann Intern Med* 1970;72:205–13.
30. Alpers D, Wessler S, Avioli LV. Ileal resection and bile salt metabolism. *JAMA* 1971;215:101–4.
31. Hofmann AF. Bile acid malabsorption caused by ileal resection. *Arch Intern Med* 1972;130:597–605.
32. Skinner DG, Studer UE, Okada K, et al. Which patients are suitable for continent diversion or bladder substitution following cystectomy or other definite local treatment? *Int J Urol* 1995;2(Suppl 2):105–12.