Case in Point

Long-Term Surgical Management of Severe Pelvic Injury and Resulting Neurogenic Bladder From an Improvised Explosive Device

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Reconstructive surgery can help veterans improve their quality of life and live free of chronic indwelling catheters following injury from an improvised explosive device.

More than 52,000 soldiers have been injured and 6,800 have been killed during the wars in Iraq and Afghanistan. Blast injuries from improvised explosive devices (IEDs) account for 70% to 79% of combat-related injuries and deaths in these wars. Advances in personal body armor, rapid and advanced surgical treatment, and the changing nature of combat in Iraq and Afghanistan have changed injury patterns and survival compared with prior military conflicts such as those in Vietnam and Korea.

The most common combat-related injuries in the recent wars are extremity, facial, brain, and gastrointestinal injuries. Pelvic and genitourinary injuries are also common, accounting for about 8% of total injuries. Pelvic and genitourinary injury can cause long-term disability from nerve injury (neurogenic bladder, neurogenic bowel, sexual dysfunction, urethral injury), as well as general loss of genital structures from blast injuries.

The usual care for bladder dysfunction from pelvic or genitourinary injury ranges from the use of chronic indwelling catheters to reconstructive surgery. However, there is no standard of care for long-term treatment of patients with pelvic or genitourinary injury who experience bladder dysfunction. Reconstructive surgery has the potential to improve quality of life (QOL) and eliminate chronic indwelling catheters, which are prone to cause infection and long-term kidney problems in patients with bladder dysfunction from traumatic injury.

This case report evaluates the efficacy of reconstructive surgery for bladder dysfunction to improve independence and QOL and decrease complications associated with chronic indwelling urinary catheters. The authors hope to raise awareness regarding this option for patients with pelvic, spinal cord, or genitourinary injury who are young and face long-term disability from their injuries.

CASE PRESENTATION

A 22-year-old man presented to the George E. Wahlen VAMC Urology Clinic in Salt Lake City, Utah with a complicated history related to combat injuries. During combat operations 3 years earlier, he was injured by an IED blast while on foot patrol. His injuries included bilateral severe extremity injury, perineal and genital blast wounds, a bladder injury, pelvic fracture, colorectal injury, and extensive soft tissue loss. He underwent multiple abdominal explorations, left leg amputation below the knee, mul-
tiple skin grafts, soft tissue debride-
ments, left-side orchiectomy, bladder
repair, and diverting colostomy. He
survived the injuries and was eventu-
ally discharged from active military
service and returned home.

Upon presentation to the VAMC,
the patient had a diverting colos-
tomy, suprapubic bladder catheter,
and bladder and bowel function con-
sistent with cauda equina syndrome
(pelvic nerve injury). Given the lack
of rectal tone, fecal incontinence was
likely with colostomy reversal. His
bladder had low volume and poor
compliance (elasticity). In addition,
the patient had no volitional control
of urination or defecation.
The patient previously performed
intermittent self-catheterization but
experienced total urinary inconti-
nence (UI) between catheterizations,
due to his bladder dynamics and a
lack of urinary sphincter tone. A su-
prapubic bladder catheter was previ-
ously placed to control UI. However,
the patient remained incontinent, and
urinary leakage, need for diapers, and
urinary tract infections (UTIs) neg-
avely impacted QOL. The patient
ambulated well and was physically
active. His priority was to reduce in-
continence and improve QOL.

Figure 1. Steps in Cutaneous Catheterizable Ileal Cecocystoplasty

A, The isolated segment of cecum, ascending colon, and terminal ileum. B, Reducing the terminal ileum to make the catheterizable channel. C, Sew-
ing the cecum and ascending colon to the bladder. D, The final appearance of the surgery with the augmented bladder and a catheterizable channel
at the umbilicus.

Catheterizable Ileal Cecocystoplasty

The patient underwent cutaneous
catheterizable ileal cecocystoplasty
(CCIC) (Figure 1). In this surgery, a
segment of the cecum and ascending
colon with attached terminal ileum
is used to increase the size of the
bladder (augmentation cystoplasty)
and create a channel for catheteriza-
tion from the umbilicus. The cecum
and colon are detubularized, and a
large rectangular plate of large bowel
is formed, which is then sewn to the
bladder, expanding its volume. About
10 to 15 cm of the terminal ileum is
tapered to the diameter of a pencil
and brought through the base of the
umbilicus, creating a small stoma for
intermittent bladder catheterization.
The ileocecal valve is tightened and
serves as a continence mechanism to
prevent urinary leakage through the
small stoma in the umbilicus.4

A perineal urethral mesh sling was
placed at the time of the patient’s sur-
gery to bolster the deinnervated uri-
nary sphincter and prevent urethral
leakage. The goal of reconstructive
surgery for this patient was to cre-
ate a small bowel channel connect-
ing the umbilicus and bladder that
could be catheterized every 4 to
6 hours, increase bladder capacity,
and increase sphincteric resistance
to reduce urethral leakage through
the penis. Because there can be dam-
age from passing a catheter through
mesh slings and the urethra over
time, including stenosis or erosion
of the sling, an alternative catheterizable
channel was needed in this patient.
The patient recovered after the
surgery and was able to self-cath-
eterize without difficulty. However,
the urethral mesh sling did not place
enough pressure on the urethra to
prevent leakage, and he had persis-
tent incontinence from the penis.
Three months after the original sur-
gery the patient had exploration of
the perineum, which revealed that
the mesh sling was loose and exert-
ing inadequate pressure on the ure-
thra. It was likely the sling slipped
postoperatively—a known compli-
cation of urethral slings. An artificial
urinary sphincter (AUS) was placed
around the urethra during the second
surgery to address the patient’s UI.
A perineal and small-groin incision was
used to place the AUS. The AUS was
connected to a tissue expander port
rather than to a conventional pump
mechanism, to enable pressure ad-
justment within the sphincter to the
lowest possible pressure to prevent
incontinence (Figure 2). The modified AUS placement controlled his incontinence very well with minimal pressure within the system.

More than 1 year after the original surgery, the patient self-catheterizes about 4 to 5 times daily via the catheterizable channel using a single-use catheter. His bladder holds at least 500 mL. The patient does not have significant leakage from the channel or the penis. He is no longer dependent on a chronic indwelling catheter and is free from the problems associated with severe UI, including foul odor, UTIs, and social isolation.

DISCUSSION

Patients with spinal cord or pelvic nerve injury often develop spastic bladders with low capacities. This is similar to muscle spasticity that may occur with a neurologic injury, below the level of the injury, such as in the lower extremities. The powerful uncontrolled bladder spasms and small bladder capacity most often lead to incontinence. Additionally, neurologic control of the urinary sphincter is affected, leading to either uncontrolled spasms or poor tone. Patients with these injuries have no volitional control of bladder functions and are forced to catheterize intermittently, use a condom-type catheter, or have a chronic indwelling catheter (a Foley catheter or suprapubic catheter).

Intermittent catheterization is the preferred management option for neurogenic bladder. When compared with chronic indwelling catheters, intermittent catheterization is associated with lower rates of UTI and upper tract abnormalities and with the loss of renal function. Uncontrollable leakage and UI significantly impacts QOL and may cause patients to choose chronic indwelling catheters over intermittent catheterization. Several treatments are available to control incontinence associated with intermittent catheterization. Anticholinergic medications and more recently onabotulinum toxin A may help improve bladder spasticity. In 2011, the FDA approved onabotulinum toxin A for transurethral bladder injections. It has been shown to increase functional bladder capacity and decrease spasticity. Onabotulinum toxin A treatment will not enlarge a small, contracted bladder.

Onabotulinum toxin A treatment would not be ideal for the patient in this case study. His absolute bladder capacity was 200 mL, and onabotulinum toxin A treatment would not significantly improve capacity or make intermittent catheterization practical. Additionally, the patient had poor urinary sphincter function, and he would continue to leak regardless of improvements in the bladder spasticity or tone.

Augmentation enterocystoplasty is surgical enlargement of the bladder, using a piece of the bowel and is indicated in patients with low bladder volumes. With this procedure the native bladder becomes defunctionalized, and patients experience a dramatic improvement in bladder volumes and a reduction in bladder spasms and leakage. The use of the colon and terminal ileum for bladder augmentation, or CCIC, was first reported by Sarosdy in 2 patients in 1992. In 1996, King and colleagues demonstrated successful outcomes with CCIC in a cohort of 8 patients after 34 months of follow-up. Seven patients successfully used clean intermittent catheterization, and 1 patient chose an indwelling catheter because of progressive upper
extremity weakness. No patients experienced worsened renal function or pyelonephritis suggestive of upper urinary tract deterioration. A single patient had mild stomal stenosis, which was successfully revised under local anesthesia.

In another study, Sutton and colleagues reported at 27 months an improvement of 276 mL in bladder capacity, no metabolic complications, and a 95% continence rate in a cohort of 23 patients with neurogenic bladder who underwent CCIC.4 Sutton and colleagues later reported outcomes for 34 patients with a median of 31 months follow-up.11 The most common complications were recurrent UTIs (12%) and stomal stenosis (12%). Only 3 patients (9%) required surgical revisions for stomal stenosis.

Altered bowel function and metabolic abnormalities are a concern after bowel resection and reconstruction. However, a study has found no subjective change in bowel function following ileal resection of up to 60 cm for urinary diversion for bladder malignancy.12 Rates of hyperchloremic hypokalemic metabolic acidosis are low, and most changes in electrolytes are subclinical.13,14 Long-term vitamin B12 deficiency is seen with larger (> 50 cm) ileal resections but is rare with CCIC, given the small segment used for reconstruction.13 Overall, CCIC is shown to have excellent surgical outcomes in carefully selected patients with neurogenic bladder.

In addition to low bladder capacity, the case study patient also had intrinsic sphincteric deficiency (very low urinary sphincter tone), which is common with pelvic nerve injury but unusual with spinal cord injury. He initially received a suburethral mesh sling that supported and compressed the urethra and buttressed the natural urinary sphincter. However, patients can develop catheterization issues with a suburethral sling due to mechanical compression of the urethra and traversing the compressed area with a urinary catheter. Given the indication for augmentation cystoplasty in this patient, he additionally elected to undergo catheterization channel creation to avoid long-term issues of urethral catheterization through the urethra compressed by the sling.

Unfortunately, this patient had postoperative issues with his suburethral sling, and a modified AUS was inserted rather than a second sling. Normally, an AUS is attached to a pump mechanism in the scrotum. The pump allows the patient to cycle fluid from the sphincter cuff to a reservoir in the abdomen, removing compression on the urethra and allowing normal urination. Because this patient could not effectively urinate from the penis, the authors wanted to obstruct the urethra to prevent leakage without closing it permanently. The AUS was connected to a tissue expander port placed subcutaneously in the lower abdomen rather than to a pump mechanism. This modified approach used fewer mechanical parts compared with the pump mechanism, possibly reducing rates of mechanical failure. Additionally, a lower cuff pressure could be used to obstruct the urethra and prevent leakage, reducing the likelihood of urethral atrophy. Fewer mechanical parts and a lower cuff pressure could theoretically improve longevity of the AUS (Figure 3). This modified method of AUS placement has been described in patients with sphincteric deficiency and spinal cord injury.16

These 2 reconstructive surgeries freed the patient from indwelling catheter dependence and significantly improved his incontinence and QOL. Many patients with spinal cord injury or pelvic injury could benefit from similar reconstructive surgeries if conservative measures such as anticholinergic medications or onabotulinum toxin A treatments do not control incontinence.

**CONCLUSION**

Blast injuries in soldiers often cause pelvic and genitourinary injuries. These injuries can lead to chronic urinary problems and profound social and physical disability. These young veterans need innovative, individualized approaches to best manage their long-term urinary issues. Reconstructive surgery may improve QOL and decrease disability from bladder dysfunction for carefully selected patients. Clinicians caring for veterans with pelvic and genitourinary injury should strive to create a system where these options are available when they are appropriate.

**Author disclosures**
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REFERENCES