Review Article

Artificial urinary sphincter for neurogenic urinary incontinence: a narrative review

Bridget L. Findlay^, Daniel S. Elliott

Department of Urology, Mayo Clinic, Rochester, MN, USA

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Correspondence to: Daniel S. Elliott, MD. Department of Urology, Mayo Clinic, 200 1st St SW, Rochester, MN 55905, USA.
Email: Elliott.daniel@mayo.edu.

Background and Objective: The artificial urinary sphincter (AUS) is most known for its use in the treatment of moderate to severe post-prostatectomy stress urinary incontinence. However, another lesser-known indication includes stress incontinence related to intrinsic sphincter deficiency (ISD) in the neurogenic bladder population. The purpose of this review is to discuss specific technical considerations related to device implantation in this population, efficacy, durability, and complications.

Methods: We performed a non-systematic literature review using the PubMed Database to identify articles specifically related to treatment of neurogenic urinary incontinence using an artificial urinary sphincter.

Key Content and Findings: More proximal placement of the cuff at the bladder neck is preferred in the neurogenic population due to higher rates of erosion and complications related to frequent clean intermittent catheterization or cystoscopic procedures when placed along the bulbar urethra. Robotic-assisted laparoscopic cuff placement has emerged as a safe and effective alternative to open surgery in select patients. Although continence rates are highly variable due the subjectivity of the term, functional continence (≤1 pad, ± nighttime incontinence) is reported to be between 75–90%. The need for secondary surgery for explanation with or without revision/replacement is higher in neurogenic patients compared to non-neurogenic patients.

Conclusions: Neurogenic urinary incontinence is a complex condition due to the interplay of urethral resistance and bladder function/compliance. While there are a variety of strategies to treat neurogenic incontinence, high quality data from direct comparisons are lacking. Although AUS comes with a high revision rate, functional outcomes for continence with bladder neck placement are promising in this population.

Keywords: Artificial urinary sphincter; neurogenic bladder; urinary incontinence

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Introduction

The artificial urinary sphincter (AUS) is most known for its use in the treatment of moderate to severe post-prostatectomy stress urinary incontinence. Since its inception in 1973 by Scott *et al.* (1), very little has changed regarding its 3-piece design of a pressure regulating reservoir, cuff, and control pump. In fact, the latest model (AMS 800; American Medical Systems, Minnesota, USA)

^ ORCID: 0000-0002-5467-5885.

Table 1 The search strategy summary

Items	Specification
Date of search	September 30, 2022
Databases and other sources searched	PubMed
Search terms used	"artificial urinary sphincter"; "neurogenic"; "adult"; "pediatric"; "female"
Timeframe	1975–2022
Inclusion and exclusion criteria	Inclusion criteria: relevance to topic
	Exclusion criteria: editorials/author replies
Selection process	Independent review by a single author for article relevance
Any additional considerations, if applicable	Additional articles related to artificial urinary sphincter were included to provide historical context

was last updated in the mid to late 1980s with a surface treated cuff and narrow back design (2). Although the AUS is the gold standard for treatment of moderate to severe stress urinary incontinence following prostate treatment (3,4), another lesser-known indication includes stress incontinence related to intrinsic sphincter deficiency (ISD) in the neurogenic bladder population.

Neurogenic urinary incontinence is a complex entity to manage due to the multifactorial etiologies (i.e., congenital, acquired, functional) and interplay of urethral resistance and bladder function/compliance. Examples of etiologies of ISD in the neurogenic population include lower motor neuron disorders, myelomeningocele (particularly affecting the lower lumbar spine or sacrum), and erosion secondary to prolonged urethral catheterization (5). Management options for sphincter deficiency in the neurogenic population include bladder neck reconstruction, fascial slings, bulking agents, and AUS (5). Ultimately, the benefit of AUS over the other options is the ability to void spontaneously. A majority case series regarding treatment of neurogenic incontinence with AUS are in pediatric populations with few studies conducted strictly within adult populations. The purpose of this review is to discuss specific technical considerations related to device implantation in this population, efficacy, durability, and complications. We present this article in accordance with the Narrative Review reporting checklist (available at https://tau.amegroups.com/article/view/10.21037/tau-22-794/rc).

Methods

We performed a non-systematic literature review using the PubMed Database. Search strategy is illustrated in *Table 1*. We used a combination of search terms ("artificial urinary sphincter AND neurogenic"; "artificial urinary sphincter AND neurogenic AND adult"; "artificial urinary sphincter AND neurogenic AND pediatric"; "artificial urinary sphincter AND neurogenic AND female) to identify studies related to treatment of neurogenic urinary incontinence using AUS between 1975 and 2022. Additional articles of interest were included to provide context to the topic.

Special considerations

Although bulbar urethral placement is standard in management of nonneurogenic sphincter incompetence, the most common location for cuff placement in the neurogenic population is around the bladder neck. There are several factors favoring more proximal placement. First, a large size cuff can be used, thereby facilitating passage of a cystoscope for management of stone disease or catheters for CIC (5). Additionally, due to wheelchair dependence of many neurogenic patients, particularly those with spinal cord injuries or myelomeningoceles, there is increased perineal pressure and risk for pressure sores. While erosion rates are relatively low overall in comparison to other perioperative complications, this risk of perineal ulceration can increase the risk of erosion in peri-bulbar cuffs (6).

Use of clean intermittent catheterization (CIC) is common in the neurogenic population. In the largest series of ISD treatment using AUS, 57% (29/51) of patients performed CIC preoperatively, whereas 86% (44/51) used CIC postoperatively (7). Timing of resuming CIC postoperatively was not consistently reported in the literature. Route of CIC (i.e., via catheterizable channel versus urethra) was also inconsistently reported,

however López Pereira *et al.* described catheterizable channel creation in conjunction with AUS placement in patients who had difficulty with urethral catheterization preoperatively (8). This is an important consideration as consistent CIC may have an impact on device survival and erosion (9,10), however this has not been widely supported in the AUS literature (11,12).

Surgical approaches

Open

Open placement of a bladder neck AUS in the neurogenic population is the most commonly described approach. A posterior approach to bladder neck dissection has been previously described in the literature (7,13). With this approach, the dissection plane is created between the rectum and the bladder extending caudad towards the bladder neck, separating the ureters and bladder neck anteriorly from the rectum posteriorly. The endopelvic fascia is incised bilaterally to develop a plane circumferentially around the bladder neck. Opening of the bladder is avoided, unless performing a concurrent augmentation, and the cuff is positioned around the bladder neck above the prostate (13). The one challenge to this approach is creating a safe dissection plane in a patient with a prior augmentation. Alternatively, Shankar *et al.* (14) described a superior transperitoneal approach that involved first developing the retropubic plane down to the endopelvic fascia bilaterally prior to entering the peritoneum and proceeding with the retrovesical dissection. One benefit described for this approach includes avoiding dissection around the dorsal venous complex (DVC), thereby reducing the risk of severe hemorrhage. However, authors did acknowledge the challenge of this dissection following augmentation cystoplasty.

Robotic

A robotic-assisted laparoscopic approach has emerged as a safe alternative to open bladder neck AUS placement (15,16). Ports are arranged similar to a robotic assisted radical prostatectomy. Like the open approach, dissection is first carried out posteriorly to reflect the rectum off of the posterior bladder neck and prostate. The retropubic space is then developed and the lateral borders of the prostate are fully exposed in order better define the bladder neck (15). Placement of the reservoir is retropubic, and the pump is placed in the scrotum through an assistant port. Of note, the anterior and posterior peritoneum are closed in order to completely extra-peritonealize the cuff, tubing, and reservoir.

Yates *et al.* (16) was the first to describe a robotic-assisted approach for bladder neck AUS placement. In this small case series of 6 male patients with short-term follow-up (median 13 months), an important exclusion criterion for a robotic-assisted approach was a BMI >30. Overall, mean operative time was 195 min with an average cuff size of 7.5–8.0 cm. Only 2 minor (Clavien-Dindo Grade I) complications were identified, and there were no reports of early erosion or device revision. Continence rates were 100%.

In a larger series with longer follow-up (median 58 months), Chartier-Kastler *et al.* (15) reported complete continence (0 pads) in 90% (17/19). There was 1 mechanical failure at 21 months, and no reported erosions or explants for infection. Complication rates were low (16%), consisting of only Grade I–II complications. Patients with complex abdominopelvic surgical history were excluded from a robotic-assisted approach.

While a robotic assisted approach has promising results in terms of continence and overall safety, we are lacking robust studies directly comparing it to open surgery.

Modifications

Two modifications to device placement in have been described in an effort to improve device longevity. One approach involves placing the cuff only, without the reservoir or pump, at the time of augmentation cystoplasty (17,18). After a median follow-up of 115 months, Mor *et al.* (17) reported a revision rate of 18% (2/11) consisting of placement of a pump and reservoir, and an erosion rate of 9% (1/11). Overall continence with CIC was 73% (8/11).

Our group published a series of 18 patients undergoing AUS placement at the time of augmentation cystoplasty, 13 of whom underwent cuff-only placement versus 5 with complete components (i.e., cuff, reservoir, pump) (18). Continence was defined as >4 hrs dry intervals between catheterization or voids. In the cuff-only group, 77% (10/13) were initially continent, however 9 ultimately required conversion to include pump and reservoir with a final continence of 92% (12/13) following this revision surgery. Nearly half of those who were continent could void spontaneously, whereas the rest remained catheter dependent. Only 1 patient from the complete component group experienced an erosion.

The second interesting modification was described by Bersch *et al.* (19), where a tissue expander port system was

placed under the abdominal wall in lieu of a scrotal pump. In this study of 51 patients with neurogenic incontinence related to spinal pathology, a pump was not thought to be beneficial or practical for continence. The cuff and reservoir were filled via the tissue expander port until continence was achieved and confirmed fluoroscopically using video urodynamics at 6-week follow-up. This system provided a static pressure within the cuff that rarely exceeded 80 cmH_2O. Reoperation rates for device failure were relatively low (35%) compared to other reports in the literature, and cuff-specific revision rate was 20% (10/51). Median time to surgery for revision of the balloon, cuff, or tissue expander were 2, 5.2, and 3.8 years, respectively.

Outcomes

Urinary continence

There is no universal definition of continence and is therefore a challenging outcome to compare across studies. Due to the lack of objectivity in this definition, reported success in terms of continence is highly variable (22–100%) (20). Preoperatively, patients either void spontaneously or perform CIC per urethra or via a continent catheterizable channel. In a study with a median follow-up of 17.2 years, 90% of patients had adequate continence (absence of continuous wetting/leaking or dry without diapers), with 9 patients able to spontaneously void and 62 patients requiring CIC (21). Interestingly, when an AUS was placed before puberty or in conjunction with augmentation cystoplasty, the ability to maintain the ability to spontaneously void was significantly reduced (22). In a multi-center study with a mean follow-up of 83 months, 74% of patients with an AUS still in place had perfect or moderate continence, defined as nocturnal incontinence, mild stress incontinence, or need to wear one protection pad during the daytime (7).

Durability

One well known disadvantage of the AUS is the need for revision. In the largest series examining device outcomes following primary AUS placement, 31% of patients underwent a secondary surgery for explantation with or without reimplantation or revision, with a 10-year device survival of 57% (23). When comparing AUS longevity in neurogenic and non-neurogenic patients, 85% of neurogenic patients underwent secondary surgery at 6-year follow-up compared to 59% of non-neurogenic patients (10). In this study, there were no significant differences in mechanical failure between the two groups. Chartier Kastler *et al.* (7) reported a median device survival of 8 years, and nearly 50% of patients underwent secondary surgery within the first 5 years. In a small single institution experience, the estimated annual revision rate was 0.2 revisions per patient (24). Mechanical failure is the most common etiology for revision, occurring in 20–50% of patients (6,7,21).

Revision surgery is a challenging endeavor particularly in the setting of replacement following explantation. There is paucity of literature describing differences in approach (open versus laparoscopic) for revision surgery, as well as complications specifically associated with revision/replacement surgery. In the female stress urinary incontinence literature, Tricard *et al.* described their experience with AUS reimplantation following explantation (25). Approach was based on surgeon preference, and differences in outcomes were not directly compared. Of the 13 reimplanted devices, 6 were explanted at a median time of 6.5 months, mostly due to urethral or bladder perforation.

Augmentation cystoplasty

Due to the complexity of neurogenic incontinence and interplay with bladder compliance, AUS placement in these patients often occurs concurrently with augmentation cystoplasty (32%) (20). Despite violation of the urinary and intestinal tracts during placement, there are no reports of increased rates of device infection in patients undergoing these combined procedures. Following bowel anastomosis and completion of enterocystoplasty, our group would copiously irrigate the abdomen and pelvis with bacitracin saline irrigation prior to AUS placement (18).

It is important to note that bladder function can continue to change in these neurogenic patients, even after AUS placement. The most common urodynamic findings on long-term follow-up were detrusor overactivity (40%) and decreased compliance (19%) (6). Augmentation can occur after AUS placement in 15–76% of patients due to changes in bladder function, particularly due to decreased compliance (6,7,20-22).

Female patients

Few studies have described AUS placement for neurologic incontinence in female patients. Gasmi *et al.* (26) reported on long-term functional outcomes of AUS in 23 female patients with spinal dysraphism and stress urinary incontinence (SUI) over a mean follow-up of 14 years.

Complete continence was achieved in 74% of patients. Median time to first operation was 10 years, with nearly 60% of patients needing a revision at 10 years. Phé *et al.* (27) reported similar outcomes on continence rates (71%) and 10-year revision-free survival (51%). On systematic review, erosion rates were slightly higher in women compared to men (41% *vs.* 26%) (20).

Conclusions

While there are a variety of strategies to treat neurogenic incontinence, high quality data from direct comparisons are lacking. The AUS is the gold standard for treatment of moderate to severe stress urinary incontinence following prostate treatment, however its use in neurogenic incontinence is less known, and much of the literature is based on pediatric populations. We hope this review highlights important considerations for the AUS placement in this specific population, as well as long term outcomes.

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Footnote

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