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# 4th Annual Jefferson Urology Symposium: *Focus on Urinary Incontinence and the Surgical Management of BPH*

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# 4th Annual Jefferson Urology Symposium:
## *Focus on Urinary Incontinence and the Surgical Management of BPH*

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# CONTRIBUTORS

**Akhil K. Das, MD, FACS – Guest Editor**
Department of Urology
Thomas Jefferson University
Philadelphia, Pennsylvania, USA

**Brian Calio, MD**
Department of Urology
Thomas Jefferson University
Philadelphia, Pennsylvania, USA

**Courtney Capella, MD**
Department of Urology
Thomas Jefferson University
Philadelphia, Pennsylvania, USA

**Cassra B. Clark, MD**
Department of Urology
Thomas Jefferson University
Philadelphia, Pennsylvania, USA

**Maria J. D'Amico, MD**
Department of Urology
Thomas Jefferson University
Philadelphia, Pennsylvania, USA

**Andrew A. Denisenko**
Department of Urology
Thomas Jefferson University
Philadelphia, Pennsylvania, USA

**Mitchell R. Humphreys, MD**
Department of Urology
Mayo Clinic College of Medicine
Rochester, Minnesota, USA

**Edward Kloniecke, MD, MHA**
Department of Urology
Thomas Jefferson University
Philadelphia, Pennsylvania, USA

**Victor Kucherov, MD**
Department of Urology
Thomas Jefferson University
Philadelphia, Pennsylvania, USA

**Joon Yau Leong, MD**
Department of Urology
Thomas Jefferson University
Philadelphia, Pennsylvania, USA

**Alana M. Murphy, MD, FACS**
Department of Urology
Thomas Jefferson University
Philadelphia, Pennsylvania, USA

**Radhika Ragam, MD**
Department of Urology
Thomas Jefferson University
Philadelphia, Pennsylvania, USA

**Claus G Roehrborn, MD, FACS**
Department of Urology
University of Texas Southwestern Medical Center
Dallas, Texas, USA

**Patrick J. Shenot, MD, FACS**
Department of Urology
Thomas Jefferson University
Philadelphia, Pennsylvania, USA

**Asaf Shvero, MD**
Department of Urology
Thomas Jefferson University
Philadelphia, Pennsylvania, USA

**Anthony T. Tokarski, MD**
Department of Urology
Thomas Jefferson University
Philadelphia, Pennsylvania, USA

**Sandip P. Vasavada, MD, FACS**
Department of Urology
Cleveland Clinic Foundation
Cleveland, Ohio, USA

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# Contents

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# INTRODUCTION

Lower urinary tract symptoms (LUTS) including urinary incontinence are common issues for patients to seek urologic help. The 4th Annual Jefferson Urology Symposium focused on these topics in both men and women. The COVID-19 pandemic prevented an in-person conference and for the first time, the Jefferson Urology Symposium was conducted virtually. In this conference, nationally recognized experts in each of the subjects gave presentations on the etiology LUTS due to benign prostatic hyperplasia (BPH), neurogenic bladder dysfunction (NGBD) and urinary incontinence in men and women.

Newer techniques and innovative technologies have changed the strategies utilized by physicians for the procedure-oriented management of LUTS from BPH. The updated AUA guidelines for BPH state laser enucleation procedures of the prostate is the endoscopic treatment of choice for BPH, independent of prostate size. HoLEP has been extensively studied in randomized prospective trials comparing HoLEP to TURP or open prostatectomy. HoLEP has proven to be superior to TURP and open prostatectomy. This technique is utilized by many physicians throughout the world and is considered by many the "gold standard" for the surgical management of BPH. New technologies such as urethral lift procedures (Urolift) or steam therapy procedures (Rezum) have been incorporated into the AUA BPH guidelines for patients desiring office based technology with preservation of antegrade ejaculation and with minimal sexual side effects with these procedures. Lastly, the newest technology, robot assisted water jet system called Aquablation of the prostate, may prove to be an important technique to treat patients with symptomatic BPH. Aquablation has also been recently incorporated to the updated AUA guidelines BPH for patients with prostate sizes between 30 g to 80 g.

Urinary incontinence (UI) and NGBD can significantly impact quality of life for many individuals. In men, UI is often related to and manifests itself after treatment of prostate diseases. In women, UI can be seen with or without pelvic organ prolapse (POP). Lastly, NGBD can affect quality of life, cause renal deterioration or can cause an array of complications associated with urinary tract infections from the NGBD. The etiology, diagnosis and management of UI in women and men and NGBD were discussed extensively at this symposium.

Urologists often evaluate quality of life parameters such as LUTS, UI, and NGBD. The frequency of occurrence of these issues was the impetus for the topic selection for the 4th Annual Jefferson Urology Symposium: ***Focus on Urinary Incontinence and the Surgical Management of BPH***. The technologies, techniques and management have been summarized with the data presented at this meeting. We hope that you find this information helpful and useful as a quick reference guide to incorporate these new technologies and techniques into your practice.

I want to thank the symposium' faculty, the Jefferson Urology Research Scholar students, Endourology fellow, and residents who assisted in preparing this supplement. The publisher of *The Canadian Journal of Urology International* is also acknowledged for allowing us to share our symposium educational program to a wider audience.

*Akhil K. Das, MD, FACS*
*Thomas Jefferson University*
*Philadelphia, PA USA*

# *UroLift and Rezum: minimally invasive surgical therapies for the management of benign prostatic hyperplasia*

Joon Yau Leong, MD,[1] Anthony T. Tokarski, MD,[1] Claus G. Roehrborn, MD,[2] Akhil K. Das, MD[1]

[1]Department of Urology, Sidney Kimmel Medical College at Thomas Jefferson University, Philadelphia, Pennsylvania, USA
[2]Department of Urology, University of Texas Southwestern Medical Center, Dallas, Texas, USA

LEONG JY, TOKARSKI AT, ROEHRBORN CG, DAS AK. UroLift and Rezum: minimally invasive surgical therapies for the management of benign prostatic hyperplasia. *Can J Urol* 2021;28(Suppl 2):2-5.

***Introduction:*** *Minimally invasive surgical therapies for benign prostatic hyperplasia (BPH) are popular alternatives to the gold standard transurethral resection of the prostate (TURP). These procedures have fewer discernable side effects on urinary and sexual function, when compared to TURP, making it a desirable option for many patients.*

***Materials and methods:*** *We provide an updated literature review on the current landscape of minimally invasive modalities, specifically the prostatic urethral lift (UroLift) and water vapor thermal therapy (Rezum), for the surgical treatment of BPH.*

***Results:*** *Both UroLift and Rezum have demonstrated excellent efficacy and durability in relieving lower urinary tract symptoms (LUTS) in the BPH patient. When compared to TURP, these minimally invasive therapies can be performed in an outpatient setting, with decreased hospitalization, operative and catheterization times, which minimizes overall healthcare costs. Moreover, these therapies have no discernable adverse effects on sexual function (both ejaculatory and erectile) or sexual satisfaction, making it a desirable option for many patients.*

***Conclusions:*** *Both the UroLift and Rezum are office-based, minimally invasive techniques capable of providing durable, and significant relief of LUTS secondary to BPH. In select patients, they demonstrate comparable efficacy to TURP with the added advantage of preserving sexual function and minimizing patient morbidity and healthcare cost. An individualized, shared decision-making approach is essential in selecting the optimal treatment option for each patient.*

**Key Words:** UroLift, Rezum, minimally invasive, benign prostatic hyperplasia, BPH

## Introduction

Minimally invasive therapies are becoming a popular surgical alternative to the gold standard transurethral resection of the prostate (TURP) for the treatment of benign prostatic hyperplasia (BPH) in prostates up to 80 mL. While TURP is effective in treating patients with significant lower urinary tract symptoms (LUTS) secondary to BPH, it is also associated with bothersome urinary and sexual adverse effects, including urinary incontinence and retrograde ejactulation. Currently, UroLift and Rezum are among the two popular office-based procedures that are approved by the American Urological Association (AUA) guidelines for the management of symptomatic BPH in patients who have failed medical management.[1] These novel therapies have shown to provide significant, and durable relief of LUTS secondary to BPH, with the added advantage of avoiding the TURP-related adverse effects. Herein, we provide an updated literature review on the current landscape of minimally invasive modalities, specifically the prostatic urethral lift (UroLift) and the water vapor thermal therapy (Rezum), for the surgical treatment of BPH.

Address correspondence to Dr. Joon Yau Leong, Department of Urology, Thomas Jefferson University, 1025 Walnut Street, Suite 1100, Philadelphia, PA 19107 USA

## Rezum

The Rezum system (Boston Scientific, Marlborough, MA, USA) consists of a handheld delivery device and generator that utilizes convective water vapor energy ablation to reduce prostatic tissue and subsequently alleviate obstructive urinary symptoms. The vapor needle resides within the insulated lumen of the delivery device until it is deployed into the prostatic tissue. The needle is a flexible braided silicone tubing with 12 small emitter holes spaced around its tip at 120-degree intervals to allow a controlled, uniform circumferential dispersion of water vapor. The convective ablative technology is distinct from conductive heat transfer which results in non-uniform heat gradients and uneven treatment of the prostate gland.[2] This modality is indicated in men ages 50 years and above, and for prostate volumes between 30-80 grams. It is also indicated for treatment in patients with hyperplasia of the central zone and/or median lobe. Contraindications to this procedure include the presence of an artificial urinary sphincter or a penile prosthetic implant.

The objective of the Rezum procedure is to create a thermal lesion along the length of the prostatic urethra along each lateral lobe. This can be accomplished by creating contiguous, overlapping lesions between the bladder neck and proximal verumontanum, to target the bulk of the adenoma and to follow the natural slope of the urethra. The guidelines for determining the number of lesions are based on the length of the vapor treatment zone, ie the distance between the bladder neck and the verumontanum. If the distance between the bladder neck to the verumontanum is < 2 cm, 2-3 cm or > 3 cm, then 1-2, 2-3, and 3-4 estimated treatments per lobe is necessary, respectively. Excessive treatments may lead to prolonged irritative symptoms that may require prolonged catheterization. There are proprietary training modules developed by the company to allow urologists to familiarize themselves with the Rezum system.

McVary et al conducted a pivotal multicentered, randomized sham-controlled trial that randomized patients 2:1 to the thermal therapy (Rezum) versus control (rigid cystoscopy) arm.[3] The final 5-year outcomes were recently reported in 2021 and showed a continuous and substantial improvement in the IPSS (reduced 48%), Qmax (improved 44%), QoL (increased 45%) and BPHII (decreased 48%) scores. Surgical retreatment rates remained stable at 4.4% plus an additional 11.1% for medical treatment after 5 years. Moreover, procedure-related adverse events appeared to be transient and low, with the most common reported symptoms being dysuria (0.8%) and hematuria (0.5%), both of which resolved within 3 months post-procedure.[4] Importantly, there were no reported cases of sexual dysfunction or sustained de novo erectile dysfunction over the period of the study.[5,6] Catheterization post-procedure was performed in over 90% of patients for a mean of 3.4 days, of which, only 32% truly necessitated catheterizations due to unsuccessful void trial prior to discharge.[7] Additional sub-analyses among men with identifiable median lobes within this trial demonstrated that treatment of the median lobe resulted in additional clinically meaningful improvement of IPSS (by 2.2 point) and Qmax (by 4.6 mL/sec).[4]

Gupta et al also performed an analysis comparing a subset of patients from the MTOPS trial who met the pivotal Rezum study criteria.[8] They found that symptom improvement (IPSS and Qmax) was significantly greater than either doxazosin or finasteride alone, but similar to that of combination drug use. Similarly, they found that with continued daily medication therapy, patients experienced reduced desire and erectile function with doxazosin, and significantly worse sexual desire, erectile and ejaculatory function with finasteride and combination drug therapy. Rezum therapy, however, was not associated with negative impacts in sexual function throughout the 3-year study period.[9]

Overall, contemporary literature has shown that a single water vapor thermal therapy treatment can provide significant and durable improvements in LUTS scores up to 5 years, even when compared to prolonged medication use, with the additional benefit of preserving sexual function.

## UroLift

The prostatic urethral lift (PUL) UroLift (Neotract, Pleasanton, CA, USA) is a minimally invasive technique that utilizes permanent nitinol implants to retract the obstructing lateral lobes towards the prostatic capsule, to allow expansion of the prostatic urethral lumen.[10] This procedure can be performed in an ambulatory setting and the implants are deployed under cystoscopic guidance with the aid of the UroLift delivery device. The mechanism of action is primarily mechanical which allows luminal expansion via a tissue-sparing approach. Moreover, pre-clinical research on canine models have demonstrated the initiation of acute ischemia over the prostatic tissue from the implants that leads to tissue remodeling and focal atrophy. This may factor into the demonstrated durability of the effect.[11]

The largest, multinational, randomized control trial investigating the utility of UroLift to date is

the L.I.F.T. study by Roehrborn et al. This study demonstrated rapid and significant improvement of urinary symptoms that were durable up to 5 years. Specifically, when compared to baseline, patient's AUASI improved by 7.6 points (36%), QoL improved by 2.3 points (50%), BPHII improved by 3.5 points (52%) and Qmax improved by 3.5 mL/sec (44%) at 5 years. Sexual function was excellently preserved as shown by the objectively measured SHIM, MSHQ-EjD function and MSHQ-EjD bother score, with no reports of de novo, sustained ejaculatory or erectile dysfunction. The authors also report a surgical retreatment rate of 13.6% over 5 years with a return to preoperative physical activity period of 8.6 days.[12]

A prospective, randomized controlled trial, known as the BPH6 study, was also performed among a multicentered European cohort and compared the PUL with the TURP procedure. In this study, patients who underwent the UroLift procedure showed a more rapid recovery period when compared to patients who underwent a TURP. Moreover, preservation of ejaculatory function, due to the lack of effect on the apical tissue around the verumontanum and the bladder neck, and speed of recovery was superior for PUL.[13,14] Yet another multicentered review reported substantial symptomatic relief with significant improvements in IPSS, QoL, Qmax and PVR parameters within 1 month of the PUL procedure. Sexual function was unchanged and side effects were minimal and transient. They report a 12.8% retreatment rate over 2 years and 86% catheter-free rate for patients who had an indwelling catheter before the procedure.[15]

Similar to the efforts of comparing the post-procedural sexual function between the Rezum pivotal study and patients from the MTOPS trial, Roehrborn et al performed an analysis with patients who underwent PUL from the L.I.F.T. study.[16] Indirect comparison found that PUL was superior to medical management for BPH in preserving both sexual function (erectile and ejaculatory) and sexual satisfaction. Limitations to the study include the use of two different patient-reported questionnaires, namely the IIEF or MSHQ for the L.I.F.T. study and the BMSFI for the MTOPS trial.

Next, contemporary research on PUL is based on enlarged lateral lobes alone. However, a recent study in 2018 known as the MedLift study sought to examine the utility and safety of the UroLift in the setting of obstructing median lobes. With appropriately deployed implants, a portion of the median lobe can be distracted distal to the bladder neck and affixed laterally to the prostatic urethra. This opens a channel around the median lobe and reduces the "ball-valve" motion caused by the enlarged median lobe. This study was performed as a single-arm, prospective trial with a mean number of 1.3 implants deployed into the median lobe. Importantly, primary effectiveness and safety endpoints were met, with the patients among the MedLift arm demonstrating 57.7% IPSS improvement at 6 months. An effort was made to compare and combine the results from the MedLift trial to the L.I.F.T. study to demonstrate the full effect of the PUL and similar improvements of LUTS were found.[17]

The PULSAR (Prostatic Urethral Lift Subject with Acute Urinary Retention) clinical trial (NCT03194737) is currently underway to assess the utility of UroLift in patients presenting with acute urinary retention. They included patients in retention who has failed at least one void trial while on an α-blocker. Primary assessment for this study was a void trial at 3 days ± 1 day post procedure. Preliminary results suggest that the improvement of LUTS is objectively better than that of the L.I.F.T. cohort at 6 and 12 months. With regards to patient experience, 67% of patients who stopped taking their α-blockers remained medication free on follow up and 87.5% of patients reported an average of 8.5 days for a "return to normal" time period.

A retrospective review by Eure et al aimed to evaluate the safety and efficacy of PUL in the real world setting and determine if outcomes would hold up to those from controlled clinical studies. Overall, these men were found to be older and less symptomatic, and the authors found that PUL did in fact perform well in the real-world setting with regards to symptom relief, patient experience and overall morbidity. Only 72 patients (5.1%) of patients underwent surgical retreatment, 39 (2.8%) of which underwent a repeat PUL procedure. When stratifying based on prostate volume, there were no significant difference in symptomatic improvement, adverse event rates and catheter-free rates of prostates measuring > 80 cc when compared to smaller prostates.[18]

With regards to safety of this procedure, an analysis of device malfunctions and complications related to BPH surgery using the MAUDE database revealed a total of 16 incidents with the UroLift device. Of these, 10 were due to failure to deploy implant, while the other 6 were due to needle detachment. When compared to the other treatment modalities including TURP, HoLEP, GreenLight, the 16 UroLift cases accounted for only 0.6% of all malfunctions reported in this database.[19]

Lastly, a small study published in 2020 aimed to evaluate the early postoperative patient experience between Urolift and Rezum over 2 months post-procedure. Although the preliminary data suggest better improved overall experiences for patients

undergoing PUL over Rezum with regards to sexual function, catheterization rates, recovery rates and symptomatic relief, one should take into account the mechanism of action for both these procedures. For the UroLift, the process of widening the urethral lumen is mechanical and more instantaneous, while with the Rezum procedure, there is likely to be tissue edema postoperatively requiring prolonged catheterization followed by long term prostatic volume reduction. As such, this study presents an important perspective to consider when assessing the risk/benefit profile for each patient and the importance of managing patient expectations during the process of informed consent.[20]

## Conclusion

Both the UroLift and Rezum are effective procedures for select patients desiring treatment of LUTS associated with BPH. It is currently included in the AUA guidelines for surgical management in patients who have prostate volumes up to 80 mL.[1] Aside from demonstrating comparable efficacy to current standard therapies for treating BPH, these procedures can be performed on an outpatient basis without the use of general anesthesia, and also has no discernible effects on sexual function, making this a desirable option for many patients. Ultimately, when selecting the optimum treatment option for patients, physicians should utilize an individualized, shared-decision making approach to achieve an informed preference between the surgeon and each patient. □

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# *HoLEP: the new gold standard for surgical treatment of benign prostatic hyperplasia*

Asaf Shvero, MD,[1,2] Brian Calio, MD,[1] Mitchell R. Humphreys, MD,[3] Akhil K. Das, MD[1]

[1]Department of Urology, Thomas Jefferson University Hospital, Philadelphia, Pennsylvania, USA
[2]Department of Urology, Sheba Medical Center, Ramat-Gan, Israel. Affiliated with Tel Aviv University, Tel Aviv, Israel
[3]Department of Urology, Mayo Clinic College of Medicine, Rochester, Minnesota, USA

SHVERO A, CALIO B, HUMPHREYS MR, DAS AK. HoLEP: the new gold standard for surgical treatment of benign prostatic hyperplasia. *Can J Urol* 2021;28(Suppl 2):6-10.

***Introduction:*** *Transurethral resection of the prostate (TURP) was considered the "gold standard" surgical treatment for medication-refractory benign prostatic hyperplasia (BPH) for decades. With the desire to reduce hospital stay, complications, and cost, less invasive procedures gained usage in the 1990's. With the advent of a soft tissue morcellator, holmium laser enucleation of the prostate (HoLEP) was introduced as an efficacious alternative to TURP and due to its advantageous side effect profile compared to TURP, has grown in popularity ever since. HoLEP has become a size-independent guideline endorsed procedure of choice for the surgical treatment of BPH.*

***Materials and methods:*** *We provide a review on the evolution of HoLEP as a gold standard compared to the historical reference procedures for BPH, and provide a review of emerging laser technologies.*

***Results:*** *A growing body of literature has shown HoLEP to be a safe and efficient procedure for the treatment of BPH for all prostate sizes. Long term studies have proven the durability of HoLEP, as a first line surgical therapy for BPH.*

***Conclusions:*** *HoLEP is a proven modality for the surgical treatment of BPH. It can be performed on patients with high risk for postoperative bleeding, or after previous prostate reducing procedures. HoLEP is the only procedure that is AUA guideline-endorsed for all prostate sizes for the surgical treatment of BPH. Given these considerations, HoLEP has become the new gold-standard for the surgical treatment of BPH.*

**Key Words:** benign prostatic hyperplasia, HoLEP, TURP

## Introduction

Benign prostatic hyperplasia (BPH) is the most common benign lesion affecting men in the United States, affecting 3 in 4 men by the 7th decade of life.[1] BPH becomes clinically significant when it results in lower urinary tract symptoms (LUTS), and affects between 50%-75% of men older than 50 years, and 80% of men older than 70 years.[2] While watchful waiting and medical treatment may be suitable for managing mild symptoms, surgical treatment remains the cornerstone of treatment in the disease for moderate and severe symptoms.[3] Historically, the gold standard surgical treatment for BPH consisted of open prostatectomy (OP), until the introduction of the transurethral resection of the prostate (TURP). TURP was shown to be an effective alternative to OP for prostates between 30 mL and 80 mL.[4] One clinical concern regarding TURP is the well-known risk of TUR-syndrome syndrome, which can lead to fatal morbidity and has a prevalence of 1.1% of all TURPs.[5] TURP also has a significant postoperative bleeding risk, especially for anticoagulated patients, and has limited utility for large prostates > 80 mL.[6] With the continuous aging of the general population and the increased prevalence

Address correspondence to Dr. Asaf Shvero, Department of Urology, Thomas Jefferson University, 1025 Walnut Street, Suite 1100, Philadelphia, PA 19107 USA

of BPH and LUTS with age, less invasive treatments have become increasingly desirable.[7] In the 1990's with advancements in laser technology, Holmium:YAG was introduced in the application of BPH treatment, first for ablation and soon after for complete enucleation. With the development of morcellation devices, the procedure matured to what we call today holmium laser enucleation of the prostate (HoLEP).[8]

## What is a gold standard?

A gold standard is the criteria by which scientific evidence (such as a procedure) is evaluated. This standard, necessarily, changes over time, as new treatments are developed and more evidence becomes available. In defining the gold standard surgical treatment for BPH, many factors should be considered. First, prostate sizes and shapes vary significantly and may or may not have a prominent median lobe or intravesical component, thus a treatment considered the gold standard should be efficacious in treating a wide range of prostate sizes and shapes. Morbidity risk should also be considered. Surgical intervention for BPH is often done on an elective, quality of life basis; as such, treatments should demonstrate acceptably low rates of adverse quality of life impacts from treatment. Additionally, and perhaps most importantly, functional outcome should be demonstrated via both objectively measured data and subjectively from patient reported symptomatic relief and improvement in quality of life. It should be taken into account the risk for/need for additional interventions or therapy in the planning of any surgical treatment for BPH. Lastly, cost must be considered, and the resultant economic burden on the healthcare system and on the patient himself.

## Comparison of historical standards

### *Open prostatectomy (OP)*

This procedure, although the most invasive, has a high rate of symptomatic improvement and a low rate of treatment failure; however, it also carries considerable risk of surgical complications and cost.[9-11] The advantages of OP are its durability, efficiency (volume of the resected adenoma and resultant decrease in serum PSA), and the ability to detect incidental prostate cancer. Some of the disadvantages of OP are the relatively high risk of transfusion (reported at 7.5%), prolonged postoperative catheterization, hospitalization, and continence recovery. Further, it involves a lower abdominal incision and the subsequent recovery time.[11] Lin et al[12] conducted a systematic review and metanalysis of nine randomized control trials including 758 patients comparing TURP with OP. Functional outcomes including maximum urinary flow rate, postvoid residual volume, PSA and IPSS scores were similar between the two groups. Operative time favored OP, while blood loss, catheter period, irrigation length and hospital stay favored transurethral enucleation. As for robotic "simple" prostatectomy – the considerations are similar, but the robotic procedure had less blood loss along with a high cost of disposables, similar to reported data for other robotic associated procedures.[13]

### *TURP*

Historically, it took almost a century for the surgical paradigm to shift from OP to TURP. The eventual change was not dictated by better clinical outcomes, but rather based on convenience to the surgeon and the patient, therapeutic burden and economic considerations.[14] TURP has been shown to be an efficient and safe procedure, but has its limitations for patients at increased bleeding risk and in those with large prostates. Because of these limitations, other minimally invasive procedures were introduced in the early 1990's with the purpose to transition the procedure from the operating room to the office, which would reduce cost, free up hospital beds, and allow for the management of high risk surgical patients not candidates for more invasive procedures. A large systematic review and meta-analysis covering 26 randomized controlled trials and 3,283 patients provided analysis of the efficacy and safety of TURP with transurethral enucleation of the prostate.[15] TURP had a shorter operative time, and functional outcome were similar at 6 months follow up; however, at 12 months postoperatively, IPSS and Qmax were significantly higher in the enucleation group, indicating a more complete treatment. Safety profiles and hospital stay also favored transurethral enucleation. These data support the claim that HoLEP should be considered the "gold standard" for smaller prostates.

## HoLEP technique

At our institution, HoLEP is performed using a continuous flow 26Fr resectoscope with a laser-bridge and a 550-micron end-fire laser fiber, with laser settings of 50Hz/2J for resection and 30Hz/2J for hemostasis and apical dissection (both settings are set to wide/long pulse). The high-power holmium laser generator (120W, Lumenis, Yokne'am, Israel) uses two pedals and enables alternation between the two laser settings.

Enucleation is performed using the 2-lobe, 3-lobe, or en-bloc techniques, depending on the specific anatomy of the patient. After the urethral mucosa is incised, the plane between the adenoma and the surgical capsule is identified and developed using blunt dissection. The laser is used to assist tissue release and hemostasis. All efforts are made to preserve the bladder neck and avoid using high energy in proximity to the external sphincter. After enucleation, tissue morcellation is performed using a soft-tissue morcellator introduced through an offset nephroscope, followed by insertion of a 24Fr 3-way catheter with postoperative continuous bladder irrigation. The catheter is usually removed the morning after surgery and the patient is discharged after a successful voiding trial on postoperative day 1.

## What does HoLEP bring to the table?

HoLEP is considered the endoscopic equivalent to OP as it follows the plane between the adenoma and the surgical capsule similar to the surgeon's finger during OP, which can explain the excellent volume of tissue removal using this modality.[16] In a study comparing results of HoLEP for prostates smaller than 75 mL, between 75 mL and 125 mL, and larger than 125 mL – there was no difference in the need for blood transfusion or incontinence rates between the groups, providing strong evidence of the size-independent efficacious application of HoLEP.[17] In a large retrospective study of 1,065 patients who underwent HoLEP, de-novo incontinence rates were very low at 1.4%, periop complications rate was 2.3%, and an improvement by almost 23 mL/sec in Qmax after 12 months was observed.[18]

In addition to the functional outcomes and safety profile of the procedure, it is important to look at the patient's perspective on the procedure. Abdul-Muhsin et al[19] conducted a prospective study using a third-party administered survey among patients who underwent surgical treatment for BPH – HoLEP, TURP, photoselective vaporization of the prostate (PVP), transurethral incision of the prostate (TUIP), OP, and HoLAP, aiming to assess subjective quality of life impact among patients post-procedure. Mean IPSS score was lowest for HoLEP, and responses involving quality of life impact and lack of regret significantly favored HoLEP versus all other treatment modalities. HoLEP was also shown to be durable. Elmansy et al[20] conducted a retrospective study looking at the durability of HoLEP among 949 patients with a mean follow up time of 62 months, with 89 patients that had been followed up on for 10 years or more. Total re-operation rate was 0.7%. At 10 years of follow up, IPSS was 3.6, Qmax was 27 mL/sec, and PSA reduction was stable at 84%, which implicates the large amount of tissue that is removed, and demonstrates the complete treatment of the bladder outlet obstruction that this modality offers. HoLEP was also shown to be effective for very large prostates. In a retrospective study of 88 patients with prostates over 200 mL, only 10 patients (11.4%) required a conversion to an OP or required a cystotomy for tissue extraction. Enucleation time was 78 minutes and morcellation time was 49.7 minutes. Only 3 patients (3.9%) needed continence surgery 1 year out of the HoLEP.[21]

Recently, papers have been published about the feasibility of removal of the catheter the same day of HoLEP. Agarwal et al conducted a retrospective analysis of 30 patients undergoing HoLEP with same-day catheter removal. Mean prostate size was 81 mL. In order to facilitate same-day catheter removal, a laryngeal mask was used for ventilation (instead of endotracheal tube), no neuromuscular paralysis was used, opiate use was reduced, and early ambulation before catheter removal was encouraged. Same-day voiding trial was done after a mean of 4.9 hours, and was successful in 90% of patients.[22] Another study by Comat et al looked at not only same-day catheter removal, but also same-day discharge.[23] Among 90 patients, same-day discharge was successful in approximately 80% of patients, with the remaining 20% requiring continuous bladder irrigation at least overnight. In an attempt to stratify which of the patients were eligible for same-day discharge, Abdul-Muhsin et al conducted a prospective trial of 47 patients with prostates smaller than 200 mL.[24] Per-protocol, continuous bladder irrigation was performed for 2 hours post-surgery, then stopped for 2 hours. Urine color was documented and graded according to a hematuria grading scale. For discharge, hematuria grade 4 or less had to be present. Using this method, 59.5% of patients were able to be discharged the same-day of surgery. Twenty-four same-day discharged patients were compared to 19 patients that could not be discharged the same day. Four hr. urine color (hematuria grade) was found to be associated with same-day discharge.

### *Guidelines*

AUA guidelines on management of BPH was published in 2018, and was amended in 2019, and 2020.[6] HoLEP was recommended as a size-independent option for surgical management of BPH. For larger prostates, open, lap, or robotic assisted prostatectomy is recommended, depending on the expertise of the

surgeon. For high-bleeding patients, HoLEP, PVP or ThuLEP should be considered. In a sub-stratification of recommendations according to prostate size, the only surgical procedure that is represented across the spectrum of sizes, is HoLEP. This makes HoLEP the standard across multiple prostate sizes and other variables that we can compare other treatments to. In the EAU guidelines on BPH management released on 2021, OP is considered effective but invasive with less favorable safety profile compared to HoLEP. Compared to TURP, HoLEP demonstrated longer operative times, but a favorable perioperative safety profile compared to TURP. According to the EAU guidelines, if laser enucleation is not available, OP should be offered.[3] Similar to the AUA guidelines, we see HoLEP across the spectrum of the disease.

## Emerging techniques

### *The science behind MOSES and MOSES 2.0*

MOSES laser technology (Lumenis, Yokne'am, Israel) was launched in 2017 to reduce stone retropulsion and increase the efficiency in treatment of stones. This technology uses pulse modulation to maximize the photothermal effect that breaks down the stone, while minimizing the photomechanical effect that pushes the stone away. The first part of the pulse modulation (initiation sequence) creates an air bubble. The second pulse modulation (target sequence) passes through that bubble and pushes the energy towards the target and not back to the fiber. In this way, less energy is lost and energy transmission is optimized per working distance from stone, and well as soft tissue.[25,26] MOSES 2.0 was optimized for soft tissue and specifically for BPH, by maximizing the photomechanical effect without increasing the photothermal charring effect. In a study comparing HoLEP using non-MOSES laser with MOSES 2.0, enucleation time was reduced by 43% in the MOSES 2.0 group, hemostasis time was decreased by 50%, and fiber degradation was decreased by 79%.[27] All of these advantages of MOSES 2.0 laser may help facilitate HoLEP for larger prostates by allowing for shorter operative times, allow expanded usage of HoLEP in anti-coagulated patients due to better hemostasis, and subsequently facilitate same-day discharge.

### *Thulium fiber laser*

Tm-Fiber laser is a laser with custom wavelengths of 1800 to 2050nm, a frequency that can range to 2000Hz, delivered via relatively small-diameter laser fibers and unique characteristics which make it ideal for soft tissue applications as well as lithotripsy. Compared to Ho:YAG laser, the depth of penetration in tissue is much lower (0.077 mm) but the energy absorption is much higher, which enables the laser to operate at lower energy and achieve the same results.[28-30] The reduction of penetrance length adds precision to tissue cutting without adding carbonization, and makes this laser an ideal candidate for soft tissue applications such as laser enucleation of the prostate. In a prospective trial comparing this modality with TURP, enucleation with thulium laser was shown to have good functional outcomes with a comparatively larger decrease in PSA, suggestive of a more complete removal of the adenoma.[31] Further studies about soft tissue applications and specifically laser enucleation of the prostate are currently being conducted.

## Conclusions

HoLEP is a proven modality for the surgical treatment of BPH, with a growing body of evidence in the literature citing its safety, and efficiency in all prostate sizes. HoLEP can be performed on patients with higher bleeding risk, or after previous prostate reducing procedures. According to the recent AUA guidelines, HoLEP is the only procedure that should be offered to patients with all prostate sizes for surgical treatment of BPH. HoLEP is as effective as other procedures like TURP and OP, with fewer complications, shorter catheterization times, and shorter hospital stays. Penetrance of the procedure has been limited due to high initial cost, and a relatively steep learning curve, especially for larger prostates. Recent advancements in laser technology have further increased the efficiency of the procedure. Given all of these considerations, HoLEP has become the procedure of choice, and the gold-standard for the surgical treatment of BPH. □

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# *HoLEP techniques – lessons learned*

Asaf Shvero, MD,[1,2] Edward Kloniecke, MD,[1] Courtney Capella, MD,[1] Akhil K. Das, MD[1]

[1]Department of Urology, Thomas Jefferson University Hospital, Philadelphia, Pennsylvania, USA

[2]Department of Urology, Sheba Medical Center, Ramat-Gan, Israel. Affiliated with Tel Aviv University, Tel Aviv, Israel

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***Introduction:*** *Holmium laser enucleation of the prostate (HoLEP) with mechanical tissue morcellation is one of the most effective surgical modalities for the treatment of symptomatic BPH. HoLEP has many advantages over the historical gold standards open prostatectomy (OP) and transurethral resection of the prostate (TURP). HoLEP is an AUA guideline endorsed surgical treatment for lower urinary tract symptoms (LUTS) due to benign prostatic hyperplasia (BPH), independent of prostate size.*

***Materials and methods:*** *We provide a detailed presentation of our experience in performing HoLEP in a teaching university hospital, with an emphasis on the surgical technique and its evolution.*

***Results:*** *HoLEP is an efficient and durable procedure, although it is very equipment sensitive and has a relatively long learning curve. HoLEP can be performed by several surgical approaches that can be used according to the specific anatomy of the patient. Advances in laser technology, endoscopic morcellators, and surgical technique has improved the HoLEP procedure in efficiency, hemostasis, and safety.*

***Conclusions:*** *The HoLEP procedure, first introduced in 1998, has undergone significant changes including advancements in laser technology, endoscopic morcellation devices, and modifications to the surgical technique. These advancements have made HoLEP a more effective, more efficient, easier to perform, and easier to learn technique for the surgical management of BPH. The modified 2-lobe and the en-bloc techniques are a natural progression from the classic 3-lobe technique.*

**Key Words:** HoLEP, surgical management of BPH

## Introduction

Lower urinary tract symptoms (LUTS) that originate from benign prostatic hyperplasia (BPH) represent a group of chronic urinary conditions, and occur in 15%-60% of men 40 years or older, and 80% of men 70 years or older in the United States. The prevalence of BPH is increasing due to the aging of the population.[1-3] Histological BPH is a proliferation of the glandular elements, smooth muscle, and connective tissue of the transitional zone of the prostate. BPH may progress to benign prostatic enlargement that can either grow outwards from the prostatic urethra or compress the prostatic urethra and eventually lead to bladder outlet obstruction; this, combined with prostatic inflammation, is considered the main cause of LUTS.[4-6] LUTS from BPH is variable, and early symptoms in the course of this disease can often be controlled with medical therapy alone. Patients who continue to suffer from persistent LUTS or develop complications from BPH will eventually require a surgical intervention.

Holmium laser enucleation of the prostate (HoLEP) with mechanical tissue morcellation is one of the most effective surgical modalities for the treatment of symptomatic BPH. HoLEP, according to the

Address correspondence to Dr. Asaf Shvero, Department of Urology, Thomas Jefferson University, 1025 Walnut Street, Suite 1100, Philadelphia, PA 19107 USA

American Urological Association (AUA) guidelines, is a size-independent procedure for prostatic size reduction. This technique can be employed for the treatment of large prostates over 80 grams. Traditional endoscopic procedures like transurethral resection of the prostate (TURP) are limited to glands under 80 grams due to the absorption of hypotonic fluid used for irrigation during the procedure which can lead to TUR syndrome.[7,8] Patients with large prostates, greater than 80 grams, often require a simple prostatectomy involving a skin incision and longer catheter times due to the cystotomy.

HoLEP has several advantages over TURP, such as the absence of potentially fatal TUR syndrome (which was reported to occur in 1.4% of TURP cases), ability to operate on antithrombotic medication with fewer complications, more efficient tissue removal, improved functional outcomes, etc.[9-11] HoLEP has been previously described as the endoscopic equivalent to open prostatectomy (OP) in which the endoscope during the HoLEP procedure functions as the "surgeon's finger" during blunt enucleation during OP.[12,13] Compared to OP, HoLEP avoids a lower abdominal incision and has shorter recovery time, hospital stay, and catheterization time, as well as a lower complication rate.[14] In total, HoLEP does not seem to add any cost to a traditional TURP, and has significantly reduced cost compared to OP.[15,16] But, HoLEP also has some disadvantages including a higher initial cost of surgical equipment (laser generator, laser fiber, and endoscopic soft-tissue morcellator), longer duration of the procedure (especially at the beginning of the learning curve), and most importantly, a longer learning curve of 20-50 cases.[17,18] The relatively long learning curve and the resultant lack of teaching opportunities present an obstacle and ultimately prevent HoLEP from being adopted by many urologists. Here, we present our experience in performing HoLEP in a teaching university hospital, with an emphasis on the surgical technique.

## Surgical technique

Holmium laser prostatectomy can refer to any of the following procedures – holmium laser ablation of the prostate (HoLAP),[19] holmium laser resection of the prostate (HoLRP),[20] holmium laser incision of the prostate (HoIP), and HoLEP. HoLEP is the most equipment intensive out of these procedures, and it is imperative that the surgeon is familiar with the specialized equipment while having access to all the proper tools to finish the procedure. There are other variations of holmium enucleation procedures that utilize the same equipment. These procedures include median-lobe-only enucleation, hybrid procedures such as HoLEP combined with open cystotomy for lobe extraction, distal HoLEP combined with open/robotic prostatectomy, HoLEP combined with robotic diverticulectomy, or lateral lobe prostatic urethral lift combined with median-lobe only HoLEP. The choices of holmium enucleation techniques enable the surgeon to tailor the right procedure for the individual patient. For example, in the case of an extremely large prostate, a combined HoLEP/OP can be considered, or in the situation with a patient who desires to preserve antegrade ejaculation – a HoIP or a median lobe HoLEP may be considered if the anatomy is favorable.

There are several variations of HoLEP that have been described in the literature and include classic 3-lobe, modified 2-lobe, and en-bloc enucleation techniques. The choice for the specific technique is dependent on several factors. The first and most important is the comfort level and experience of the surgeon with a specific technique. This can be an important factor in large teaching university centers; frequently residents perform portions of the procedure. In our experience, it has proven easier for a less-experienced surgeon to start with enucleation of the median lobe and go on to the 3-lobe technique. Second, there is always a concern about residual adenoma tissue that has not been completely resected. This factor is dependent on the recognition of the surgical plane between the adenoma and the prostate, which may be challenging at times, especially for larger glands. And third, the technique used in the distal dissection may impact the possibility of transient stress incontinence (SUI) after surgery. To reduce transient SUI, the beak of the endsoscope is always proximal to the sphincter and the external sphincter is minimally manipulated during the enucleation.[21] Several HoLEP techniques have been introduced to address these issues. The enucleation techniques differ from one another in the incisions that are made in the urethral mucosa and down to the surgical capsule, as well as in the direction of dissection. Here, we will describe the classic 3-lobe technique, the modified 2-lobe technique, en-block technique, and bladder neck preserving techniques.

### *3-lobe technique*

The classic technique described previously by Gilling et al is referred to as the "3-lobe technique".[22] Briefly, in this technique, two mucosal incisions are made and carried down to the fibers of the prostatic capsule at 5 and 7 o'clock, and then these are carried distally to the level of the verumontanum on each side. The distal incisions are connected proximal to the verumontanum

and enucleation of the median lobe is performed from distal to proximal fashion and the lobe is released it into the bladder. Next, the12 o'clock bladder neck incision is made from the bladder neck to the level of the verumontanum. This incision is then connected distally to the posterior incisions on both sides. Enucleation of the lateral lobes are done one at a time. The 3-lobe technique is possibly the easiest to learn and is helpful since the lateral lobes can either be enucleated or during the process of learning the technique, the lateral lobes can be addressed with a TUR loop. Another factor of the 3-lobe technique that is helpful for surgeon's learning this technique is the irrigation flow improves as the incisions are widened and endoscopic visibility is improved. In addition, the surgeon will get comfortable using the endoscope beak to lift the adenoma off the capsule, an essential part of advancing the surgeon's skills for true anatomic enucleation. Lastly, the surgeon becomes familiar with the rotating movement of the endoscope and allows the surgeon to follow the contour of the prostatic lobes and identify the point of enucleation, and avoid pushing against the external sphincter. After enucleation, meticulous hemostasis is achieved by activating the laser from a distance on the tissue (usually with "coagulation" setting 2J at 30Hz). Finally, tissue morcellation, to be described in depth later, is performed using a soft-tissue morcellator introduced through an offset nephroscope. A 24 French 3-way Foley catheter is inserted and continuous bladder irrigation is initiated.

From a teaching standpoint, the three-lobe technique provides easy division of the case. Trainees can begin learning the nuances of the procedure with enucleation of the median lobe, which is considered less challenging than the lateral lobes.

### *Modified 2-lobe technique*

In this technique, only one posterior incision is needed at either the 5 or the 7 o'clock position, depending on the configuration of the specific prostate, as well as surgeon's preference. In cases where only one sulcus can be identified this approach can prevent undermining of the trigone. The incision is carried proximal to distal fashion and taken to the level of the verumontanum. Next, the incision divides the adenoma into a lateral lobe on one side, and the median lobe en-bloc with the other lateral lobe. The 12 o'clock incision is the same as in the 3-lobe technique and the posterior and anterior incisions are connected on both sides distally. Enucleation is then completed, followed by tissue morcellation. The advantage of this technique includes only one posterior bladder neck incision, which saves time. In a prospective study comparing HoLEP with the 3-lobe, 2-lobe, and en-bloc techniques, enucleation time was significantly longer for the 3-lobe technique by almost 20%, compared with the other two techniques, with no difference in functional outcome.[23] The 2-lobe technique represents a natural progression from the 3-lobe technique. Nonetheless, it adds complexity as it makes identification of the surgical plane more difficult, and so should be performed by an experienced HoLEP surgeon.

### *En-bloc technique*

This technique involves complete detachment of all 3 prostatic lobes in a distal-to-proximal approach.[21,24] There are several en-bloc techniques described in the literature. The techniques differ in the incisions of the urethral mucosa, but all follow the same principle. The procedure starts with the identification of the distal landmarks - external sphincter, distal border of the lateral lobes and the median lobe, and the verumontanum. Two circular incisions are made from both sides of the verumontanum and laterally around the lateral lobes, to meet at 12 o'clock. The two incisions are connected posteriorly just proximal to the verumontanum, to complete a circumferential incision. These incisions are deepened down to the surgical capsule between the adenoma and the prostate and carried proximally in a circumferential fashion towards the bladder neck while using the beak of the scope and the irrigation for blunt dissection together with the laser fiber for hemostasis and delicate dissection. The adenoma is then released to the bladder and tissue morcellation is performed.[25] In a retrospective study that reviewed 1,115 patients who underwent en-bloc or 2-lobe HoLEP, there was no difference in enucleation time or 6-month functional outcome, but morcellation was more efficient in the 2-lobe approach for prostates > 150 cc by about 30%.[26] Others found en-bloc enucleation to be more time-efficient than other techniques by as much as 30%.[27] The surgeon's preference is the main factor in determining the technique to be used.

### *Bladder neck preservation techniques*

One of the most common side effects of HoLEP is retrograde ejaculation occurring in 70%-80% of cases.[28] In young and sexually active patients undergoing treatment of BPH, this side effect may have a negative impact on quality of life and can adversely affect sexual function.[29] In an effort to maintain antegrade ejaculation after surgery, bladder neck preservation techniques have been described.[30] The bladder neck can be preserved in all HoLEP techniques, by sparing the bladder neck when incising the 5 and 7 o'clock

incisions and enucleating in the distal-to-proximal approach without performing any incisions in the bladder neck. This requires identification of the fibers of the bladder neck when enucleating the adenoma before going into the bladder at the final stage of enucleation. In a retrospective report, among 213 patients who underwent en-bloc bladder neck sparing HoLEP, 88.3% had antegrade ejaculation after surgery.[30] There are no reports of the results of these techniques with long term follow up, and rates of re-treatment and bladder neck contractures are not known.

## Surgical equipment

Most commonly, a 26 French continuous flow endoscope with a 30° lens used with a laser bridge. A 550-micron end-fire laser fiber is inserted through a 7 French laser catheter that has a locking adapter that stabilizes the fiber. The irrigation fluid used is normal saline. We currently use a high-power 120W laser generator with a dual-foot pedal. The laser settings are usually 2J and 50Hz in wide-pulse for enucleation and 2J and 30Hz, wide-pulse mode for hemostasis and apical dissection. The dual-pedals allow easy switching between these two laser settings as needed. Morcellation is done with a 26.5 French offset nephroscope and a 5Fr oscillating soft-tissue morcellator unit with a single-use blade. The nephroscope fits inside the outer sheath of the 26 French continuous flow endoscope with an adapter. The adapter allows us to omit the need for re-introduction of the nephroscope through the urethra. In addition, to maximize visibility and prevent injury to the bladder mucosa by the endoscopic soft-tissue morcellator, both ports of the continuous flow endoscope are used for inflow. The blades of the morcellator have a reciprocating hollow blade with suction and are positioned under the adenoma inside the bladder. The initial morcellator setting is 450 rotations-per-minute (RPM) and is changed if needed.

## Energy

HoLEP employs a 2140nm wavelength Ho:YAG laser that is absorbed by water and water-containing soft tissue and has a soft tissue penetration depth of only 0.4 mm, and an incision depth of 2 mm.[31] At a distance of less than 3 mm from the tissue, the laser will achieve hemostasis, and in direct contact with the tissue, it will achieve cutting and/or vaporization of the prostatic tissue. The minimal depth of absorption of holmium laser energy in tissue and the absorption of energy in normal saline allows the surgeon to be more precise in cutting the tissue. The ultimate outcome of the holmium laser on tissue is the "what you see is what you get" effect.[32,33] Pulse width does not affect energy output but delivers the same energy for a longer time. The newer 120 Watt laser has the option for using a wider pulse (longer pulse) which has been shown to lessen fiber degradation during lithotripsy,[34] and have a better coagulation effect, but does not affect the soft-tissue incision depth.[31,35] Recently, a modulated pulsed holmium laser energy used initially at lower settings technology for lithotripsy has been optimized for HoLEP at higher energy settings. This newer and more powerful laser has been shown to reduce enucleation and hemostasis times.[36,37]

### *Morcellation*

The purpose of morcellation is to remove of the enucleated prostatic tissue safely out of the bladder. Electromechanical morcellation of enucleated prostatic tissue was first described in 1998.[38] Newer generations of these devices have made much progress in an effort to enhance efficiency (measured in grams removed per minute) and safety. During morcellation, especially for small-volume bladders, or when bleeding hampers visualization – there is a risk of damaging the bladder wall, mostly the posterior wall or the dome of the bladder.[39] The morcellator is introduced through an offset nephroscope. Once enucleation is completed, just prior to endoscopic soft-tissue removal, it is important to not let the bladder drain completely. The rapid decompression of the bladder may cause bleeding from the bladder lining or prostate capsule which affects visualization. The commonly available morcellators differ in the way their cutting blade moves - the Pirhana (Richard Wolf, Knuittlingen, Germany) has a toothed oscillating blade, DrillCut (Karl Storz, Tuttlingen, Germany) has a toothed rotating blade, and the VersaCut (Lumenis, Santa Clara, CA, USA) has a non-toothed guillotine blade. The morcellator devices have one or two pedals and enable the surgeon to perform suction-only or suction-and-morcellation (either by a different pedal or by pushing the single pedal lightly for suction and forcefully for suction and morcellation). Head-to-head studies have failed to find a significant difference in the efficiency and rate of complications of the different devices.[40,41] A recent review of 26 studies and 5,652 patients assessed the efficiency and safety of the three available morcellators: efficiency was 5.3, 5.29, and 3.95 g/min for the DrillCut, Pirhana, and VersaCut devices respectively. Bladder wall injury was more common with the VersaCut device (5.23%) compared to the Pirhana (1.24%) and DrillCut (1.98%), but VersaCut had the lowest malfunction rates (0.74%) compared to Pirhana (2.07%) and DrillCut (7.86%).[39]

Morcellation can be challenging at times. In situations where it is difficult to collect the tissue pieces via the morcellator (i.e. the "beach-ball" effect, the tissue bounces off the morcellator caused by an indurated nodular adenoma), the RPM of the morcellator is reduced and the adenoma is carried to the prostatic fossa. In this reduced space of the prostatic capsule and decreased morcellator blade speed, the ability to remove difficult adenoma pieces is optimized. Extraction devices such as a basket-grasping device introduced through the nephroscope (a device normally used for nephrolithotomy), or a retrieval loop used with a 26Fr resectoscope bridge can drag large indurated pieces out of the urethra.

## Conclusions

HoLEP is an AUA guideline endorsed surgical treatment for LUTS due to BPH, independent of prostate size. HoLEP has a growing body of literature supporting its efficacy, long term durability, and favorable risk profile, with several advantages over other procedures, such as TURP and OP. Still, disadvantages such as a long learning curve and the resulting lack of learning opportunities have prevented its widespread acceptance. HoLEP, first introduced in 1998, has had many advancements in techniques due to improved laser technology, endoscopic mechanical morcellation devices, and modifications to the surgical technique. These advancements have made HoLEP more effective, more efficient, easier to perform, and easier to learn. The modified 2-lobe and the en-bloc techniques are a natural progression from the classic 3-lobe technique. HoLEP is becoming the new gold standard for surgical treatment of BPH. □

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# *Aquablation of the prostate: a review and update*

Anthony T. Tokarski, MD,[1] Joon Yau Leong, MD,[1] Claus G. Roehrborn, MD,[2] Asaf Shvero, MD,[1,3] Akhil K. Das, MD[1]

[1]Department of Urology, Sidney Kimmel Medical College at Thomas Jefferson University, Philadelphia, Pennsylvania, USA
[2]Department of Urology, University of Texas Southwestern Medical Center, Dallas, Texas, USA
[3]Department of Urology, Sheba Medical Center, Israel. Affiliated with Tel Aviv University, Tel Aviv, Israel

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***Introduction:*** *Historically, transurethral resection of the prostate (TURP) was considered the endoscopic "gold standard" surgical treatment of benign prostatic hyperplasia (BPH). Over the years, several other endoscopic procedures emerged, including the size-independent holmium laser enucleation of the prostate (HoLEP). In an effort to reduce the cost and morbidity associated with traditional endoscopic techniques, novel minimally invasive techniques have been developed, one of which is Aquablation. This review is an update of a previously published review article looking at the most recently published available data on Aquablation.*

***Materials and methods:*** *This review article covers the technical aspects of Aquablation and provides an update on the recently published literature regarding Aquablation compared to TURP and HoLEP.*

***Results:*** *At up to 3 years of follow up, Aquablation performs favorably when compared to TURP in terms of alleviation of lower urinary tract symptoms (LUTS) and preservation of sexual function compared to TURP. Safety profile was similar between Aquablation and TURP.*

***Conclusions:*** *Aquablation is a safe and effective method of treating LUTS associated with BPH. At up to 3 years of follow up, it has shown a durable with efficacy similar to TURP.*

**Key Words:** Aquablation, minimally invasive therapy, lower urinary tract symptoms, benign prostatic hyperplasia

## Introduction

Benign prostatic hyperplasia (BPH) is a common condition affecting approximately 25% of men at the age of 50, with almost 80% of men older than 70 affected.[1] BPH is caused by the unregulated proliferation of the transitional zone of the prostate, which leads to compression of the prostatic urethra. Physical compression of the urethra causes bladder outlet obstruction (BOO), and leads to the symptoms of BPH, known as lower urinary tract symptoms (LUTS).[2] The gold standard for endoscopic surgical treatment of this condition has historically been the transurethral resection of the prostate (TURP), which was first developed in the early 1920s.[3] The TURP technique, although effective, has well established morbidities, such as TUR-syndrome, infection, bleeding risk, sexual side effects, and others.[4]

Innovations in BPH managed have been targeted towards decreasing surgical morbidity and decreasing overall operative time while maintaining successful alleviation of the LUTS associated with BPH. One such technique is the ultrasound guided, robot assisted waterjet that can precisely target and ablate prostatic tissue, known as Aquablation. This technique is performed using the Aquabeam system (PROCEPT Biorobotics, Redwood Shores, CA, USA). This surgical intervention was developed with the aim to

Address correspondence to Dr. Anthony T. Tokarski, Department of Urology, Thomas Jefferson University, 1025 Walnut Street, Suite 1100, Philadelphia, PA 19107 USA

reduce operative time, relative to other widely used endoscopic techniques such as TURP and holmium laser enucleation of the prostate (HoLEP). This technique also shows promise in preserving sexual function, both erectile and ejaculatory, similar to the effects seen with prostatic urethral lift (Urolift, Neotract/Teleflex, Pleasanton, CA, USA) and convective water vapor therapy (Rezum, Boston Scientific, Marlborough, MA, USA) procedures.

This article updates a previous review,[5] examines the use of Aquablation and provides an update on the newer longer term data that recently became available.

## Technique

The technique for this procedure was first described by Farber et al in 2015 using the Aquabeam system has been further described by several others.[6-8] The AquaBeam Aquablation system has three main components: the conformal planning unit (CPU); robotic 24 Fr handpiece; and a console. The procedure can be performed under general anesthesia or spinal anesthesia. From here the patient is placed in the dorsal lithotomy position, and the biplanar transrectal ultrasound (TRUS) is mounted into position. Next, the handpiece is used to gain access to the bladder to allow visualization with a cystoscope. The handpiece is positioned with the tip just inside the bladder before the scope is retracted to visualize the bladder neck, and placed proximal to the external sphincter. Once proper positioning is confirmed, the handpiece can be stabilized using an articulating attachment mounted to the bed. Once secured, the TRUS probe can be inserted until the center of the prostate is visualized. At this point, the surgeon can use the ultrasound probe to compress the prostate and improve visualization for the Aquabeam handpiece.

Once the hand piece and TRUS probe are positioned, the software must be adjusted to confirm appropriate planning for the tissue ablation, which is performed using the mapping software. The software allows for changes in depth up to 25 millimeters, and the angle of resection up to 225 degrees. Complete ablation of the transition zone is performed by outlining the prostate with the Aquabeam software. A high velocity jet of physiologic saline is then initiated under the control of a foot pedal. The computer system automatically adjusts the flow rate in each direction to alter the depth of penetration and remove the tissue as outlined in the mapping stage. There are safety mechanisms in place to ensure only the outlined tissue is ablated, and the external sphincter remains protected. Once resection is complete, hemostasis can be completed either through electrocautery or balloon catheter tamponade, with expert opinion favoring balloon tamponade.[9] The balloon remains in place for 2 hours to ensure hemostasis. Post procedure, a 3-way catheter is inserted and bladder irrigation is commenced and patients can be discharged the following day after the catheter has been removed.

## Outcomes and safety of Aquablation

While this procedure is relatively new, several authors have been able to publish medium term follow up data for their cohorts. Some of the earliest outcomes were reported by Gilling et al, who published their findings in a prospective, multicenter trial at three Australian centers which included 21 men.[10] All patients were between the ages of 50 and 80 years and had prostate volumes ranging from 30 to 102 mL. The results from this study showed an average procedural duration of 38 minutes and a mean resection time of 5 minutes, with an average hemoglobin drop of 0.8 gr/dL after the operation. Subjective and objective findings were also reported, with data from 1, 3, 6, and 12 months. Average international prostate symptom scores (IPSS) were significantly decreased down to an average of 6.8 from pretreatment values. Maximum flow rate (Qmax) increased to 18.3 mL/second at 12 months follow up. Post void residual (PVR) volume decreased down to an average of 31 mL, and quality of life subjective scores improved significantly as well. The authors obtained urodynamics studies after the operation for comparison to baseline and found that detrusor pressure at maximum flow was decreased by 40% on average. Prostate volume reduced by 39% on average as well. Finally, no adverse events were reported, there were no reports of incontinence, and sexual function was preserved in all patients.

The WATER trial was able to directly compare Aquablation to TURP in a prospective manner across 17 different centers.[11] This double blind, randomized controlled trial include 181 patients. The goal of the trial was to assess Aquablation and TURP in a non-inferiority trial using composite endpoints for safety and efficacy. There was no significant difference seen in overall mean operative time, but resection time was significantly less with Aquablation. The group looked at 3 months postoperative safety data as well as 6 months postoperative IPSS scores. The primary safety endpoint was defined as a persistent Clavien-Dindo grade one event, or a Clavien-Dindo grade two or higher event. At 3 months, safety data showed Aquablation to be non-inferior to TURP. Additional analysis showed Aquablation to be superior to TURP

with regards to safety with 26% of the cohort meeting the safety endpoint, while 42% of patients undergoing TURP met these criteria. Importantly, all of the persistent Clavien-Dindo grade one events were due to retrograde ejaculation which was seen in 6.9% of Aquablation patients and 24.6% of TURP patients. To further assess ejaculatory function, MSHQ-EjD self-reported data was collected, showing that 90 days after the procedure, the Aquablation patients had a slight improvement overall in ejaculatory scores while the TURP group had a significant decrease in scores.

A similar analysis was done to assess incontinence using the incontinence severity index, which is also self-reported. Results of this analysis showed significant improvement in the Aquablation group. The change in IPSS scores overtime was used to determine the efficacy endpoint. The Aquablation cohort had an average IPSS score of 6.0 at 6 months, compared to an average of 6.7 for the TURP group, demonstrating non-inferiority. Lastly, Qmax and PVR volumes were assessed at 30-day postoperative intervals up to 180 days. This analysis showed similar results for PVR in both groups with slightly improved Qmax at 180 days for the Aquablation group relative to those patients who had undergone TURP.

After the WATER trial, the WATER II trial was conducted to assess the safety and feasibility of Aquablation in larger prostates, those measuring between 80-150 mL.[12] This was also a prospective multicenter study. In total 101 men were included in the final cohort. Despite larger prostate sizes, average operating time was 37 minutes with an average resection time of 8 minutes. A total of 66.3% of patients included required additional passes with the machine to complete the resection, but all were completed in a single setting. Again, composite endpoints were used for both safety and efficacy. At 3 months, safety was assessed using the same safety endpoints as described in the original WATER trial. For efficacy, the change in IPSS scores at 3 months from baseline was used. Both the safety and efficacy endpoints were then compared to an objective performance criterion (OPC) which allowed for assessment of non-inferiority. Operative reports showed that 82% of these procedures were done under spinal anesthesia. Safety endpoints at 3 months were met in 44.5% of patients well below the OPC of 65%. These results reached statistical significance, and the procedure was non-inferior when compared to the OPC. When assessing efficacy, Aquablation greatly exceeded the OPC set for the change in IPSS score, demonstrating non-inferiority. Additionally, prostate volume reduction was measured, showing a 44% reduction in size at 3 months post procedure. Hemostasis was achieved for the majority of patients using a Foley catheter placed in the bladder under traction overnight using a device from PROCEPT BioRobotics. Three patients did require a catheter balloon being inflated in the prostatic fossa. The average length of catheter duration was 94 hours with an average of 18 hours under traction when this method of achieving hemostasis was used. There was an average hemoglobin drop of 2.9 g/dL when comparing baseline values to discharge lab values. Of the 101 patients, there are a total of 10 transfusions required between the completion of the operation and 1 month, with one patient requiring a return to the operating room.

While there is no trial that directly compares newer minimally invasive surgical techniques for the management of BPH (Rezum, Urolift, and Aquablation), Tanneru et al performed a meta-analysis of the available data to compare the three techniques.[13] This study included outcome reports among patients with prostates up to 80 mL. Follow up data was available up to 24 months across all three interventions. At 1 month, Aquablation showed higher improvement in IPSS scores compared to Rezum and Urolift. Aquablation and Rezum continued to showed improvement up to 6 months, whereas Urolift showed improvement up to 3 months with a steady decline thereafter. In terms of quality of life (QoL) scores, Aquablation and Urolift showed a greater improvement than Rezum. Aquablation continues to be superior to both at 6 months, a trend which persisted up to 24 months. Aquablation showed further improvement in Qmax at time intervals assessed, with an average improvement of 6.3 mL/s higher improvement compared to Rezum and Urolift. Improvement in PVR favored Aquablation out to 24 months. In terms of sexual function, Male Sexual Health Questionnaire – Ejaculatory Domain (MSHQ-EjD) scores showed a greater improvement in Urolift compared to Aquablation and Rezum at 6 and 12 months, though patients who underwent Aquablation, showed continued improvement beyond this point, which was not seen after the other two interventions. Aquablation patients were more likely to experience postoperative urinary retention. At 2 years follow up, the retreatment rates for Aquablation, Rezum, and Urolift were 4.3%, 4%, and 7.5% respectfully.

One concern over Aquablation would be the relative lack of control of postoperative bleeding, as the water jet does not have the same coagulative properties as monopolar and bipolar electrocautery and the various laser modalities used (holmium, thulium, and photovaporization) in the surgical treatment of

BPH. Some authors have advocated for selective electrocauterization in conjunction to Aquablation to minimize postoperative bleeding. Gloger et al performed a retrospective review of patients who underwent Aquablation followed by selective cauterization of the bladder neck and resection bed and compared them to those patients undergoing HoLEP.[14] They found that despite the added step of electrocauterization, operative times were still shorter in the Aquablation group compared to the HoLEP cohort. Return to the OR for bleeding within 6 weeks was similar between the two groups at 13.6% and 9.8% for Aquablation and HoLEP respectively. The average drop in Hgb was also similar between the two groups (1.3 mg/dL for Aquablation and 1.22 mg/dL for HoLEP), with no patients undergoing Aquablation requiring blood transfusion and one patient in the HoLEP group requiring transfusion.

## Durability and adverse events

The same cohort used in the original WATER trial was followed out to 12 months post procedure with a purpose of investigating the safety and efficacy of this procedure compared to TURP.[15] The notable findings of this study were that TURP and Aquablation had similar improvements in Qmax, similar decrease in serum PSA levels, and similar low re-treatment rates at 12 months. The Aquablation cohort had 2.6% of patients who underwent reoperation compared to 1.5% in the TURP group which was not statistically significant. The study also analyzed results in patients who had larger than 50 mL prostates before treatment.[16] This subgroup analysis favored Aquablation for both the safety and efficacy endpoints. There was no difference in average procedure time (33 minutes for Aquablation versus 36 minutes for TURP), but Aquablation did have a significant difference in resection time (4 minutes versus 27 minutes). Additional analysis of this larger prostate size subgroup showed that on average, there was a greater drop in postoperative hemoglobin in the Aquablation group compared to those patients undergoing TURP, which was statistically significant. The Aquablation group had one patient that required blood transfusion with, no patients requiring transfusion in the TURP group.

The patients in the WATER II trial were followed up to 6 months.[17] When analyzing adverse events at 6 months, 22% of the patients had experienced a Clavien-Dindo grade II event, 14% a grade III event, and 5% a grade IV event. Qmax increased from 8.7 cc/s at baseline to 18.8 cc/s at 6 months. PVR decreased from 131 mL to 47 mL at 6 months. QoL scores decreased from 4.6 at baseline to 1.4 by 6 months. PSA showed a 44% reduction on average while TRUS volume showed a 42% reduction compared to baseline. With regard to the patients' postoperative sexual function, MSHQ-EjD scores at 6 months continued to show slight improvement compared to baseline though not as pronounced as at 3 months. IIEF-5 scores improved by an average of 0.1 at 3 months and an average of 0.7 at 6 months.

Nguyen et al compared the results of the original WATER trial with those of WATER II once 12 month data was available.[18] Specifically they stratified patients into prostate sizes between 30 g and 80 g and those patients with prostates between 80 g and 150 g. These authors noted that there was no relationship between IPSS scores and prostate volume across both studies. They did however note that there was an inverse relationship between prostate size and Qmax at baseline and patients had higher PVRs with increased prostate size. There was no difference between the two groups when comparing postoperative IPSS scores or Qmax at 1, 3, 6, or 12 months. There was a significantly higher decrease in PVR when comparing the two groups, however this could be attributed to the larger prostates seen in the WATER II trial. Transient Clavien-Dindo I events were similar between both groups. Persistent Clavien-Dindo I events were more common in the WATER II trial (16% versus 8%) and were mostly related to anejaculation. Clavien-Dindo grade II or higher events were more common in WATER II. Operative times were 4 minutes longer in the cohort of patients with larger prostates. Based on this comparison the authors were able to conclude that with short term follow up Aquablation provides a safe and efficacious treatment for both small to moderate gland as well as large gland BPH.

Recently, 3-year follow up data has become available for the patients in the original WATER trial. Three years of follow up was achieved in 87% of Aquablation patients and 85% of TURP patients from the original study. The mean percent reduction in IPSS scores was 64% and 61% in the Aquablation and TURP groups respectively. In patients with prostates larger than 50 mL, there was an average of 3.5 points greater reduction in IPSS for those who underwent Aquablation. Changes in ejaculatory function, measured by MSHQ-EjD, also favored Aquablation as seen in the original study. At 3 years, the improvement from baseline in Qmax, PVR, and reduction in PSA persisted and were statistically similar between both groups. The 3-year retreatment rates were 4.3% and 1.5% in the Aquablation and TURP groups respectively, with no interventions happening beyond 20 months. The results of this continued follow up study demonstrate the durability of Aquablation compared to TURP at medium term follow up.

To specifically study the effect of novel BPH surgical techniques on sexual function, Bhojani et al assesses three FDA clinical trials (WATER for Aquablation, LIFT for Urolift, and REZUME II for Rezum) and compared IIEF and MSHQ-EjD scores at 3 years.[19] With regards to MSHQ-EjD scores, Aquablation and Urolift showed a positive change at 3 years, with Rezum showing a negative change in that time frame. None of the interventions studied showed a change in IIEF scores from baseline at 3 years. This group demonstrated similar results to other authors, showing a positive association between Aquablation and preserved sexual function, specifically with regards to ejaculatory function.

## Future research

While Aquablation has been directly compared to TURP, little research has compared the safety as efficacy of Aquablation to HoLEP. Currently, a prospective, randomized, controlled trial is being undertaken at a Swiss tertiary care center to assess non inferiority of Aquablation compared to HoLEP.[20] This study will be an important comparison, as HoLEP is consider a size independent method for the surgical treatment of BPH per current AUA guidelines.

## Conclusions

Aquablation is one of the novel surgical techniques that has been developed for the treatment of BPH. Current studies report on medium-term follow up for patients undergoing this procedure. Aquablation provides comparable operative times to TURP and shorter operative times to HoLEP while having a similar efficacy and safety profile. Newer data has shown that alleviation of LUTS and preservation of sexual function persisted up to 3 years after the procedure. As the technique continues to become more refined and experience further gained, Aquablation will be more widely available and provide a safe and efficacious alternative to TURP and other surgical treatments for the management of LUTS associated with BPH. □

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# *Surgical management of vaginal prolapse: current surgical concepts*

Alana M. Murphy, MD,[1] Cassra B. Clark, MD,[1] Andrew A. Denisenko,[1] Maria J. D'Amico, MD,[1] Sandip P. Vasavada, MD[2]

[1]Department of Urology, Sidney Kimmel Medical College at Thomas Jefferson University, Philadelphia, Pennsylvania, USA
[2]Department of Urology, Cleveland Clinic Foundation, Cleveland, Ohio, USA

MURPHY AM, CLARK CB, DENISENKO AA, D'AMICO MJ, VASAVADA SP. Surgical management of vaginal prolapse: current surgical concepts. *Can J Urol* 2021;28(Suppl 2):22-26.

***Introduction:*** *Pelvic organ prolapse (POP) is a condition defined by a loss of structural integrity within the vagina and often results in symptoms which greatly interfere with quality of life in women. POP is expected to increase in prevalence over the coming years, and the number of patients undergoing surgery for POP is expected to increase by up to 13%. Two categories of surgery for POP include obliterative and reconstructive surgery. Patient health status, goals, and desired outcomes must be carefully considered when selecting a surgical approach, as obliterative surgeries result in an inability to have sexual intercourse postoperatively.*

***Materials and methods:*** *This review article covers the role of traditional native tissue repairs, surgical options and techniques for vaginal and abdominal reconstruction for POP and the associated complications, and considerations for prevention and management of post-cystectomy vaginal prolapse.*

***Results:*** *Studies comparing native and augmented anterior repairs demonstrate better anatomic outcomes in patients with mesh at the cost of more surgical complications, while different procedures for posterior repair result in similar improvements in symptoms and quality of life. In the management of apical prolapse, vaginal obliterative repair, namely colpocleisis, results in very low risk of recurrence at the cost of the impossibility of having sexual intercourse postoperatively. Reconstructive procedures preserve vaginal length along with the ability to have intercourse, but show higher failure rates over time. They can be divided into vaginal approaches which include sacrospinous ligament fixation (SSLF) and uterosacral vaginal vault suspension (USVS), and the abdominal approach which primarily includes abdominal sacrocolpopexy (ASC). There is evidence that ASC confers a distinct advantage over vaginal approaches with respect to symptom recurrence, sexual function, and quality of life. Patients who have had radical cystectomy for bladder cancer are at an increased risk of POP, and may benefit from preventative measures and prophylactic repair during surgery. Importantly, the success rates of POP surgery vary depending on whether anatomic or clinical definitions of success are used, with success rates improving when metrics such as the presence of symptoms are incorporated.*

***Conclusions:*** *The surgical management of POP should greatly take into account the postoperative goals of every patient, as different approaches result in different sexual and quality of life outcomes. It is important to consider clinical metrics in the evaluation of success for POP surgery as opposed to using exclusively anatomic criteria. Preoperative counseling is critical in managing expectations and increasing patient satisfaction postoperatively.*

**Key Words:** pelvic organ proplapse, apical prolapse, colpocleisis, vaginal reconstruction, abdominal sacrocolpopexy

## Introduction

Pelvic organ prolapse (POP) is defined as the descent of any or all of the following: anterior vaginal wall, posterior vaginal wall, and vaginal apex. Symptoms of POP can include a vaginal bulge, pelvic pressure, urinary and fecal symptoms, and sexual dysfunction.[1] Risk factors associated with POP include parity (particularly an instrumented vaginal delivery), aging, obesity, connective tissue disorder, and history of pelvic surgery.[2] In the Oxford Family Planning Association study, the cumulative risk of POP rises from 1% 3 years following hysterectomy to 5% at 15 years after hysterectomy.[3] Furthermore, the study showed that the risk of prolapse is 5.5 times higher in women whose reason for hysterectomy was due to prolapse. It is estimated that up to 13% of women in

Address correspondence to Dr. Alana M. Murphy, Department of Urology, Thomas Jefferson University, 1025 Walnut Street, Suite 1100, Philadelphia, PA 19107 USA

the United States will undergo surgery for POP and that the number of women who will suffer from POP will increase twofold by the year 2050.[4]

The two categories of surgical approach to POP are obliterative and reconstructive. The approach must be tailored to the patient as obliterative procedures, despite their high success rate and low perioperative morbidity, will eliminate the possibility of vaginal intercourse. In this paper, we will discuss the role of traditional native tissue repairs, surgical options for vaginal and abdominal reconstruction for apical prolapse, the latest considerations in abdominal sacrocolpopexy (ASC) and its complications, and considerations for prevention and management of post-cystectomy vaginal prolapse.

## Anterior and posterior vaginal prolapse

Anterior colporrhaphy for anterior vaginal wall prolapse (also known as a cystocele) is performed by plicating the pubocervical fibromuscularis towards the midline.[5] It has been performed with both plication along or augmented repair with a biologic graft. In 2019, the FDA halted the use of surgical mesh for transvaginal repair of anterior prolapse.[6]

Many studies have been performed comparing native and augmented anterior repairs. In a prospective randomized trial of 160 women with anterior prolapse who underwent anterior colporrhaphy by Sand et al, they demonstrated recurrence at 1 year in 43% of patients who underwent anterior colporrhaphy without mesh compared to only 25% recurrence in patients with mesh ($p = 0.02$).[7] Another study by Weber et al compared anterior colporrhaphy, mesh augmented anterior colporrhaphy and ultra-lateral anterior colporrhaphy techniques, and found similar anatomic cure rates (between 30%-46%) and symptom resolution.[8] Their definition of cure was stage 0 or 1 (optimal and satisfactory respectively) as defined by the International Continence Society (ICS) POP Quantification (POP-Q) System.[9] In a 2016 Cochrane review by Maher et al, they found that augmented biological graft or absorbable mesh repair provided marginal benefit over a traditional colporrhaphy repair.[10] While anterior colporrhaphy with mesh demonstrated better anatomic success, it came at the cost of more surgical complications.[11] Some of the challenges with traditional suture-based repair identified by the Cochrane review include lack of surgical technique standardization, lack of robust clinical studies, and the question of how success/failure is defined.

Nearly three quarters of women with POP suffer from posterior prolapse.[12] Three methods of repairing posterior prolapse are posterior colporrhaphy, site-specific rectocele repair, or site-specific rectocele repair augmented with a porcine small intestinal submucosa graft. Paraiso et al conducted a randomized trial comparing these three methods, all of which resulted in significant improvements in symptoms, quality of life, and sexual functions. There was no improvement in anatomic outcomes when using the porcine-derived graft.[12]

## Defining success and failure

Failure after a POP repair surgery can be defined by need for reoperation, recurrence of symptoms, or anatomic recurrence (e.g. beyond hymen, stage 2+, stage 3+ etc.). In the Pelvic Organ Support Study (POSST), 1,004 women between age 18 to 83 were examined and over 50% of them had stage 2 or 3 POP.[13] If we extrapolate this data, then over half the population fall into that category. Perhaps a strict anatomic definition of failure is too stringent.

The presence of a vaginal bulge is a valuable screening tool for POP.[14] The absence of a vaginal bulge postoperatively has a significant relationship with a patient's assessment of treatment success and Healthcare Related Quality of Life (HRQoL) while anatomic success does not directly correlate with QoL.[15] In a randomized control trial of 322 woman undergoing POP repair by Barber et al, the success rate was approximately 94% when success was defined as absence of prolapse beyond the hymen. Furthermore, subjective cure was associated with improvement in both the patient's assessment of success and overall improvement ($p < 0.001$ and $p < 0.001$ respectively).

Therefore, using anatomic criteria alone as the definition for success may be too strict and many times not clinically relevant. The NIH Pelvic Floor Disorders Network has put forth a recommendation regarding clinically relevant criteria for defining success after POP surgery: no prolapse beyond the hymen, no vaginal bulge symptom, and no retreatment of POP.[15]

## Apical prolapse

Apical POP repairs can be divided vaginal and abdominal approaches. The advantage to the vaginal approach is that the peritoneal cavity does not need to be entered for patients with an extensive surgical history. When compared to obliterative repairs, reconstructive repairs correct prolapse while preserving vaginal length to allow for sexual function. Patients need to be aware of the benefits and drawbacks of each option to come to an informed decision on the approach that best meets their needs. Whatever approach is ultimately

chosen, the cornerstone of any good vaginal prolapse repair is solid support of the apex.[16]

### *Vaginal obliterative repair*

Colpocleisis is the standard for vaginal obliterative repair. A total colpocleisis removes all of the vaginal epithelium, while a Le Fort colpocleisis leaves a portion of the epithelium to allow for a drainage tract for women who still have a uterus. It is a highly effective procedure with very low risk of POP recurrence on the order of < 5%.[17] It also has the advantage of shorter operating time, less blood loss and decreased perioperative morbidity. Since it eliminates the possibility of vaginal intercourse, colpocleisis is reserved for women who no longer desire vaginal intercourse. Preoperative counseling before a colpocleisis must be thorough and ensure that woman understand the obliterative nature of the procedure.

### *Vaginal reconstruction*

Two of the best-studied vaginal reconstructive repairs are sacrospinous ligament fixation (SSLF) and uterosacral vaginal vault suspension (USVS). They can be performed concomitantly with a hysterectomy or with a uterine sparing technique. SSLF is an extraperitoneal procedure that supports the vaginal apex by suspending to the sacrospinous ligament with either absorbable or permanent sutures. In a systematic review, anatomic cure rates range from 69%-100%.[18] Common complications reported following SSLF include dyspareunia, recurrence in the anterior compartment, and gluteal pain. The USVS procedure can be performed both vaginally and laparoscopically. Unlike SSLF, this procedure is intraperitoneal. The vaginal apex is sutured to the uterosacral ligament bilaterally. In one cohort study, USVVS was shown to reduce recurrence rate to 13.7%.[19]

### *Abdominal reconstruction*

Abdominal sacrocolpopexy (ASC) is the mainstay of the abdominal approach to POP repair and has been well studied since its first introduction by Lane et al in 1962. ASC can be done by an open, laparoscopic, or robotic assisted method.[20] ASC is considered the gold standard for women desiring a restorative repair of an apical POP.[21] The procedure entails the placement of synthetic mesh on the anterior and posterior aspects of the vagina. The mesh is then suspended to the anterior longitudinal ligament as it passes over the sacral promontory.[22] There is growing evidence that sufficient support for the vaginal apex is imperative in sustaining the structural integrity of the anterior and posterior compartments, and without adequate apical support, vaginal repairs run an increased risk of failure.[23,24]

When compared to vaginal reconstructive surgery, ASC has unique advantages. A comprehensive review by Nygaard et al found that 78%-100% of patients had no apical prolapse postoperatively, and 58%-100% had no prolapse at all.[25] A systematic review conducted by Maher et al found that ASC is associated with a significantly lower risk of awareness of prolapse, recurrent prolapse on examination, and repeat surgery for prolapse.[24] The use of synthetic mesh was associated with superior anatomic outcomes when compared to cadaveric fascia.

ASC may also confer some advantage over the vaginal approach with respect to postoperative sexual function. ASC has been shown to conserve more vaginal length in comparison to vaginal approaches.[26,27] A study by Siddiqui et al, which evaluated postoperative sexual function following ASC, reported a "relatively high" sexual function score of 40 based on the Pelvic Organ Prolapse/Urinary Incontinence Sexual Function Questionnaire short form.[28] Several studies have shown that postoperative dyspareunia was significantly less with ASC compared to a vaginal POP repair.[24,26] Based on these findings, sexually active patients or patients with shorter vaginal length may benefit from ASC over a vaginal POP repair.

With respect to different minimally invasive approaches to abdominal reconstruction, two randomized trials demonstrated that both laparoscopic and robotic techniques result in a similar duration of operation. However, laparoscopy resulted in less postoperative pain compared to robotic assisted surgery.[36,37] The laparoscopic approach has also been shown to have reduced blood loss when compared to the open approach.[24] The robotic approach with ASC is also associated with a faster learning curve, with Geller et al reporting that after 20 cases, the overall time needed to perform the cases decreases dramatically.[38]

Although intraoperative complications are rare, ASC comes with risks which must be carefully weighed when considering the procedure. Nygaard et al discusses the median rates of such complications as: cystotomy (3.1%), enterotomy or proctotomy (1.6%), and ureteral injury (1.0%). Median rates for postoperative events included urinary tract infection (10.9%), wound problems (4.6%), and hemorrhage or transfusion (4.4%).[25] Mesh erosion was 3.4%, and varied depending on the materials used as follows: Teflon (5.5%), Marlex (5%), Mersiline (3%), Gortex (3%), polypropylene (0.5%). Moreover, mesh erosion was a factor which increased over time, suggesting a need for long term follow up of such patients. Vaginal suture erosion also presented as a rare complication which was managed by excision in the office.

Selection of suture type and placement has also been shown to contribute to complications of ASC and presents a valuable lesson in the application of surgical technique. Recent observations suggest that postoperative discitis has increased as a more ASC procedures are performed using a minimally invasive technique.[39] Durdag et al described L5-S1 discitis 3 months following ASC, with likely contribution from penetration of the L5-S1 disk with sutures. The authors of this study recommended careful placement of suture only to the depth of the anterior longitudinal ligament using monofilament sutures.[40]

Similar to other POP repairs, ASC has been found to have degradation of success rates over time. Up to 95% of women enrolled in the CARE trial were eligible for the extended CARE (ECARE) trial, of which 84% and 59% completed 5 and 7 year follow up, respectively. By year 7, the probabilities of failure (including POP, stress urinary incontinence (SUI), urinary incontinence (UI) between urethropexy and no urethropexy groups were 0.27 and 0.22 for anatomic POP, and 0.29 and 0.24 for symptomatic POP. By this time, probability of mesh erosion is up to 10.5%. Interestingly, the same study found that 95% of patients did not seek retreatment for POP. This could reflect that patients found the treatment adequate, or that other health and social concerns took precedence over seeking retreatment.[28]

## Prevention and management of post-cystectomy prolapse

Radical cystectomy is the standard of care for recurrent high grade or muscle invasive bladder cancer, and includes removal of the bladder, uterus, ovaries, and anterior vagina. This results in the loss of three levels of vaginal support: the cardinal-uterosacral ligaments hysterectomy), paravaginal attachments (anterior vaginectomy and cystectomy, periurethral fascia and ligamentous support to the pubic symphysis (anterior vaginectomy and urethrectomy).[41] There is a surprising deficiency of information for functional and sexual outcomes for women with muscle invasive bladder cancer who undergo radical cystectomy and urinary diversion. This is important, especially considering the attention to these outcomes in men undergoing urologic procedures.[42] It is critical that in initiating treatment for women with bladder cancer, postoperative sexual function and goals for quality of life must be a part of the conversation. Routine screening for POP can play an important role in the prevention and treatment of this condition and can be done simply through performing a history and genitourinary exam. The single validated question, "Do you ever feel a bulge or that something is falling out of your vagina?" has an 81% positive predictive value for clinically significant POP.[13]

In light of the substantial decreases in quality of life, which can occur following cystectomy, it is important to consider preventative measures when performing this procedure. This may include techniques such as vaginal and uterine sparing when feasible, the inclusion of omental or peritoneal flaps between a neobladder and vagina, or prophylactic apical repair.[43,44] Prophylactic repair would make use of measures discussed through this article, such as ASC or transvaginal sacrospinous ligament fixation. Additional measures such as round ligament preservation and abdominal uterosacral plication also represent potential preventative measures. As with prevention, the discussion of post-cystectomy repair of POP and other complications requires the consideration of numerous factors such as oncologic status, desired sexual outcome, vaginal length, and tissue quality. Conservative interventions such as pessaries are probably suboptimal, as the patient population often has poorer tissue quality, damaged musculature, and shorter vaginal length.[45]

## Conclusions

When patients undergo a POP repair, all prolapsed compartments should be addressed simultaneously. The success rate of POP repairs varies considerably depending upon the definition of success used. When strict anatomic criteria are used, the success rates of POP repairs, especially anterior repairs, is lower compared to when a composite definition is utilized. When more clinically relevant criteria, such as the presence of symptoms, are incorporated into the definition of success, then success rates improve. As our understanding of POP has grown over time, it has become clear that proper apical support is required for successful repair. Surgical approach for a POP repair must be tailored to the patient's needs and functional status. Finally, thorough preoperative counseling is paramount in managing expectations and increasing patient satisfaction in the postoperative setting. □

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# *Evaluation and management of female urinary incontinence*

Andrew A. Denisenko, Cassra B. Clark, MD, Maria D'Amico MD, Alana M. Murphy, MD

Department of Urology, Sidney Kimmel Medical College at Thomas Jefferson University, Philadelphia, Pennsylvania, USA

DENISENKO AA, CLARK CB, D'AMICO M, MURPHY AM. Evaluation and management of female urinary incontinence. *Can J Urol* 2021;28 (Suppl 2):27-32.

***Introduction:*** *Urinary incontinence (UI) is a common condition in all demographics of women and consists of stress UI (SUI), Urgency UI (UUI), and mixed UI (MUI). Treatment includes lifestyle modifications, medical treatment, and surgery depending on the type of UI and severity of symptoms. This review is an update on the evaluation and management of UI in women.*

***Materials and methods:*** *This review article covers the evaluation and management options for UI in women and includes the most recent guidelines from the American Urological Association (AUA) as well as recently published literature on the management of UI.*

***Results:*** *Any evaluation of UI should include a thorough targeted history and physical, and counseling for treatment should consider patient goals and desired outcomes. For both SUI and UUI, behavioral therapy and lifestyle modifications are effective first line treatments. Patients with UUI can benefit from medical therapy which includes anticholinergics and ß3-agonist medications, as well as neuromodulation in treatment refractory patients. SUI patients may further benefit from mechanical inserts which prevent leaks, urethral bulking agents, and surgical treatments such as the mid urethral sling and autologous fascial pubovaginal sling.*

***Conclusions:*** *Treatment of UI in women requires a graded approach that considers patient goals and symptom severity, beginning with lifestyle and behavioral modifications before progressing to more aggressive interventions.*

**Key Words:** urinary incontinence, stress urinary incontinence, urgency urinary incontinence, mid urethral sling, autologous fascial pubovaginal sling

## Introduction

Urinary Incontinence (UI) is common across all demographics of women and is characterized by the involuntary loss of urine. UI can be divided into three subtypes: stress urinary incontinence (SUI), urgency urinary Incontinence (UUI), and mixed urinary incontinence (MUI). Risk factors for UI include age, race/ethnicity, body mass index (BMI), parity, smoking, diabetes, and hysterectomy.[1] Data from a national survey of women in the United States shows that 49.6% of women report having some form of UI.[2] When broken down by subtype, 49.8% of that group have SUI, 34.4% have MUI, and 15.9% have UUI. Longitudinal studies have reported the incidence of SUI to range from 4%-11% per year, and recent estimates for the United States estimate that the number of women with UI will increase from 18 million in 2010 to 28.4 million in 2050.[3-5]

Idiopathic overactive bladder (OAB) is considered a symptom complex as opposed to a single, discrete disease.[6] The prevalence of OAB in women in the United States has been estimated to be as high as 43%.[7] It is defined by urinary urgency, where UUI may occur but is not necessarily present, with no signs of urinary tract infection (UTI) or other obvious underlying pathology (i.e. neurogenic bladder). Urgency can also be accompanied by urinary frequency and nocturia. Urinary frequency is defined as urination that occurs more often than the normal interval. Nocturia is the interruption of sleep in order to void one or more times. UUI results when there is involuntary loss of urine associated with urgency.

SUI is the most common manifestation of UI, being found in about 50% of women with symptoms of

Address correspondence to Andrew A. Denisenko, Department of Urology, Thomas Jefferson University, 1025 Walnut Street, Suite 1100, Philadelphia, PA 19107 USA

UI.[5] SUI is defined by the involuntary loss of urine in response to physical exertion or sudden increase in intraabdominal pressure that is generated during such activities as sneezing or coughing.

UI places a considerable medical, psychosocial and economic burden on patients.[8,9] Because of this, an understanding of screening, evaluation, and treatment of UI is essential in any clinical practice to adequately address the growing demographic of UI patients. This article will review the evaluation and management of female urinary incontinence including the initial evaluation and considerations for treatment.

## Initial evaluation of the UI patient

The pathophysiology of UI can broadly be divided into issues of urine storage and emptying.[10] Therefore, it is critical to elicit the exact nature of UI symptoms the patient is experiencing to properly manage them. The initial evaluation of any suspected UI should always begin with a thorough history and physical exam.[11] A focused history should include the type of incontinence, duration, severity, bother, previous evaluation/testing, and prior treatments. Having the patient log a voiding diary is an important tool to assess for drinking habits, voiding volumes, frequency of void, daytime and nighttime urinary output, and episodes of incontinence. Diaries should be 3 days in length.[12] The physical portion should include BMI, a pelvic exam, and an objective demonstration of SUI with a full bladder. Helpful exams to elicit SUI are the cough test or Valsalva maneuver. The genitourinary exam should also assess for peri-urethral cysts, urethral hypermobility, and prolapse. Post void residual (PVR) assessment and urinalysis (UA) to evaluate for UTI or microhematuria should also be included in an initial evaluation. Routine urine culture is not necessary unless there are symptoms to suggest UTI or a positive dipstick. In most cases, a thorough history and physical exam are sufficient to diagnose the subtype of incontinence.[13,14]

Additional evaluation may be considered in the diagnosis of UI in situations where the initial assessment does not provide a diagnosis, or those with abnormal urinalysis, elevated PVR, failure of prior anti-incontinence surgery, or high-grade pelvic organ prolapse (POP). Cystoscopy and/or urodynamic testing (UDS) should not be performed in an otherwise standard patient. It may be appropriate to perform cystoscopy in patients with concern for lower urinary tract abnormalities. Patients with a history of anti-incontinence surgeries, mismatch between subjective and objective measures, significant voiding dysfunction, elevated PVR, MUI with a substantial urgency component, or neurogenic lower urinary tract dysfunction may undergo UDS.[14] Other forms of UI which should be mentioned for completeness' sake but will not be reviewed in depth in this article include overflow incontinence, continuous incontinence, and insensible incontinence.

## UUI treatment

Once a proper history and physical have been performed and OAB/UUI has been identified, patients should be educated about the normal physiology of voiding. Treatment goals for OAB/UUI should be discussed with the patient and aimed at improving patient quality of life. It is important that treatment outcomes should be addressed up front as this has been shown to improve adherence.[15]

According to the AUA/SUFU guidelines on treatment for non-neurogenic OAB, first-line treatment is behavioral therapy.[16,17] Behavioral therapies pose no risk to patients and should be offered to all as they have been shown to improve UI outcomes compared to no treatment.[18] Possible interventions include bladder training, fluid intake modification, pelvic floor muscle training (PFMT), and biofeedback. Patients should be advised to reduce intake of bladder irritants such as caffeine, alcohol, acidic/citrus liquids, and artificial sweeteners. Bladder training is intended to help patients increase the interval between voiding as well as increase bladder capacity. Patients can perform timed voiding and utilize techniques like Kegels to suppress urgency.

Second-line treatments involve pharmacologic therapy of the bladder.[16,17] There are two drug classes: anticholinergic and ß3-agonist medications. Anticholinergics (also known as antimuscarinics) block the muscarinic receptors in the bladder which facilitate the voiding phase of urination by contracting the detrusor smooth muscle. ß3-agonists target the storage phase by enhancing relaxation of detrusor smooth muscle. Currently there are eight approved medications on the market in the United States, Table 1.[19,20]

A systematic review of anticholinergics has found them to be comparably efficacious and safe, but with varying side-effect profiles.[21] Common side-effects include dry mouth, dry/itchy eyes, constipation, blurred vision, dyspepsia, and impaired cognitive function. Extended-release formulations can offer a more favorable side-effect profile as there is less risk of dry mouth compared to their immediate-release counterpart.[22] Anticholinergic medications are contraindicated in patients who have previously

TABLE 1. **List of medications for overactive bladder**

| Trade name | Generic name | Class |
|---|---|---|
| Vesicare | Solifenacin | Anticholinergic |
| Toviaz | Fesoterodine | Anticholinergic |
| Sanctura | Trospium | Anticholinergic |
| Detrol | Tolterodine | Anticholinergic |
| Enablex | Darifenacin | Anticholinergic |
| Ditropan | Oxybutynin | Anticholinergic |
| Myrbetriq | Mirabegron | ß3-agonist |
| Gemtesa | Vibegron | ß3-agonist |

exhibited high sensitivity to this medication class, narrow angle glaucoma, gastroparesis, and cognitive impairment. Of note, recent studies have also shown an association between anticholinergic medications and increased brain atrophy, dysfunction, and clinical decline.[23] Anticholinergic medication adherence is a known issue with up to 89% of patients reporting either unmet treatment expectations and/or tolerability as the reason for discontinuation.[15,24]

ß3-agonists have shown similar efficacy to anticholinergics but offer a different side-effect profile.[25] Mirabegron side-effects include headaches, nasopharyngitis, and elevated systolic blood pressure. It is contraindicated in patients with uncontrolled hypertension. Mirabegron is metabolized by cytochrome P450 CYP3A4, as well as CYP2D6, so there is a risk of drug-drug interactions.[26] Approved by the FDA in 2020 following the results of the EMPOWUR trial, Vibegron is the second and newest medication in the ß3-agonist class.[27] Unlike mirabegron, it is metabolized independently from CYP3A4, 2D6, and 2C9 and less likely to cause drug-drug interactions. It is also not associated with an increase in systolic blood pressure. An important factor that will also impact the choice of pharmacologic agent is drug cost and insurance coverage.

Third line treatments for OAB include various forms of neuromodulation such as peripheral tibial nerve stimulation (PTNS), sacral neuromodulation (SNS), and chemodenervation via onabotulinumtoxinA.[16,17] PTNS and SNS are both forms of neuromodulation that have been described in the literature since the 1980s.[28,29] PTNS involves stimulation of the tibial nerve which is a mixed motor and sensory nerve innervated by L4-S3 roots. Electrical stimulation of the posterior tibial nerve causes retrograde neuromodulation of the bladder and pelvis floor which shares common innervation from the sacral nerve plexus. Stimulation is delivered via a battery powered stimulator connected 34 gauge needle electrode inserted above the medial malleolus.[30] Treatment involves 30 minute weekly sessions for 12 weeks. Maintenance therapy is once a month. Absolute contraindications to PTNS include pregnancy and presence of a pacemaker or defibrillator. Relative contraindications include peripheral neuropathy, peripheral edema, and neurogenic bladder. Complications of treatment are minimal but consideration must be given to the time commitment required by the patient.

Sacral neuromodulation (SNS) for OAB has been FDA approved since 1997 and there are currently three devices on the market, Table 2.[31,32] It involves direct stimulation of the S3 nerve root of the sacral nerve plexus that modulate the reflexes influencing the bladder, urinary sphincter, and pelvic floor.[33] It is a two staged procedure that requires an initial temporary lead placement to check for at least 50% improvement in patient symptoms. After this has been confirmed, the second stage of the procedure involves surgically implanting a permanent pulse generator. During the procedure, proper S3 lead placement is confirmed by observing bellows of the perineum and plantar flexion of the big toe. Complications from the procedure include device infection which would require explantation and loss of efficacy due to lead migration. Contraindications, like for PTNS, include pregnancy and presence of a pacemaker or defibrillator. It should be noted that anti-coagulation

TABLE 2. **Sacral neuromodulation devices**

| Device | Size | MRI compatibility | Battery life |
|---|---|---|---|
| InterStim | 14 $cm^3$ | Head 1.5T | 4-5 years |
| InterStim Micro | 2.8 $cm^3$ | Full Body 1.5T + 3T | 15 years (rechargeable) |
| Axonics r-SNM | 5.5 $cm^3$ | Head 1.5T + 3T<br>Full body 1.5T | 15 years (rechargeable) |

must be held in the peri-operative setting. Patients should also be advised that the device will require battery replacement for the generator over time.

OnabotulinumtoxinA (BTX-A) was first FDA approved for neurogenic OAB in 2011.[34] Following successful Phase 2 and 3 clinical trials, BTX-A was FDA approved in 2013 for idiopathic OAB at a recommended dose of 100 units.[35-37] Its mechanism of action is inhibiting acetylcholine release from pre-synaptic cholinergic junctions which results in chemodenervation and reduced muscle contractility and possibly reduced afferent input.[38] Treatment can be performed in the office with local anesthesia or in the operating room with sedation with either a flexible or rigid cystoscope.[39] A UA should be performed prior to procedure to rule out UTI. Patients should also have a baseline PVR and be followed up with a PVR after procedure to check on incomplete bladder emptying. The treatment effects usually last for 6 months before requiring retreatment. Complications of the procedure include UTI, hematuria, urinary retention, and systemic weakness. In the case of urinary retention, patients should be advised about the possibility of requiring clean intermittent catheterization (CIC) if they are unable to void following the procedure.

If the patient has failed the first three lines of therapy, the guidelines allow for augmentation cystoplasty and urinary diversion as a last resort.[16,17] The goal of treatment is to disrupt coordinated detrusor contractions, increase bladder capacity, and create a low-pressure urinary storage system. Patients undergoing the procedure must also be willing to do CIC. However, with the advent of neuromodulation and BTX-A treatments, augmentation cystoplasty has become less frequently utilized.[40] Complications include revision, metabolic acidosis (from use of ileum), stone formation, and UTI.

## SUI treatment

When starting treatment for SUI, non-surgical options should be considered before more aggressive interventions where it is appropriate. In general, SUI can be managed in a graded approach that includes measures such as lifestyle modifications and vaginal inserts before progressing to urethral bulking agents and then surgical measures such as the synthetic mid urethral sling (MUS) or the autologous fascial pubovaginal sling.

## Lifestyle modifications

As with UUI, lifestyle modifications are often an effective first line treatment in the management of SUI. These include behavioral therapy and pelvic floor muscle therapy (PFMT), and weight loss. PFMT is considered a mainstay of treatment for SUI, in some cases showing up to 70% improvement in symptoms across all age groups.[41] A meta-analysis conducted by Dumoulin et al demonstrated that PFMT can improve symptoms of SUI, reducing the frequency of leakage and the amount of urine voided. Moreover, it is a cost-effective treatment with a low risk for adverse effects, making PFMT an attractive first line therapy for the motivated SUI patient.[42]

## Vaginal devices

Another non-surgical treatment for SUI entails introducing devices into the vaginal canal which exert a mechanical force on the urethra, in turn increasing urethral outlet resistance. This includes continence pessaries, vaginal inserts, and urethral plugs. The few studies which describe these interventions suggest they are an effective means of maintaining urinary continence, though their effectiveness can be reduced by previous UI surgery or anatomic variations among patients such as wide urethra or decreased bladder capacity.[43,44]

## Bulking agents

Bulking agents are a form of injection treatment which combat SUI through improved coaptation of the proximal urethra, thus increasing outlet resistance. These are an effective treatment, though long term data for their effectiveness is scant.[14] The most common site of injection for bulking agents is the submucosa of the proximal urethra through either the periurethral or transurethral approach. The two classes of bulking agents are particulate agents (solid microparticles in a liquid or gel carrier), and non-particulate agents (homogenous gel). The composition of the microparticulate material in such agents includes polyacrylamide, calcium hydroxylapatite, polydimethylsiloxane, and carbon coated zirconium beads.[45] Bulking agents may represent an appropriate treatment in patients who have restricted surgical options, however, they are associated with a high rate of treatment failure and may therefore require multiple administrations to maintain symptom relief.[46,47]

## Mid-urethral sling (MUS)

MUS is a surgical procedure for SUI with either a retropubic or transobturator approach. The retropubic approach features the insertion of two needles which are passed through the retropubic space from the vagina

to the abdomen or from the abdomen to the vagina (top down and bottom up) and has a success rate between 51%-81%.[14] There is no difference in outcomes between the approaches. The transobturator approach avoids entering Retzius' space and was introduced in response to the complication profile associated with the retropubic approach. In this approach, the sling is inserted into a horizontal plane underneath the middle of the urethra between the two obturator foramina.[48] The transobturator approach has a success rate between 43%-95% in follow up studies of up to 5 years.[14]

In long term analysis of these two approaches, patients treated with the transobturator approach experience less urinary urgency, negative quality of life impact, and sexual dysfunction compared to the retropubic approach. However, the transobturator approach resulted in a lower 5-year success rate compared to the retropubic approach.[49]

While complication rates for MUS placement are low, they must be considered as with any surgery. Some of the more common complications included bladder perforation with a retropubic MUS, reoperation for persistent SUI, urinary retention requiring sling incision, pelvic hematoma, infection, vaginal mesh erosion, and postoperative groin pain. The retropubic approach and the transobturator approach have differing adverse event profiles, with the retropubic approach having a higher rate of bladder perforation and problems with voiding, while the transobturator approach having lower long-term efficacy and increased groin pain.[48]

## Autologous fascial pubovaginal sling

An autologous pubovaginal sling procedure utilizes autologous fascia lata or rectus fascial tissue to recreated the periurethral support.[14] This procedure has been shown to be an effective and durable long term treatment option, with a success rate between 85%-92%.[50-52] Because of this, AFPS may be an attractive option in patients who had a previous mesh complication or placement failure, prefer to avoid mesh, or are high-risk for poor wound healing.[14] The SISTEr trial compared AFPS to a Burch colposuspension and found that an autologous pubovaginal sling was a more effective treatment overall and had a lower retreatment rate.[53] A systematic review by Fusco et al reported that patients undergoing an autologous pubovaginal sling had similar short term cure rates when compared to patients who had MUS, though pubovaginal sling patients were more likely to have postoperative storage lower urinary tract symptoms. Complication profiles were otherwise similar between pubovaginal slings and MUS.[54]

## Conclusions

UI is a prevalent condition that affects nearly half the female population in the United States. While not a life-threatening condition, it can significantly reduce patient quality of life. Determining the type of UI and level of bother to the patient are critical. The work up must always include a thorough history and physical, UA, and PVR. Appropriate adjunct tests can be utilized if the diagnosis is still not certain. Advanced therapies should only be used when needed. Education and advocacy remain cornerstones of treatment since it can they establish treatment expectations, improve adherence, and increase patient satisfaction. □

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# *Management of neurogenic detrusor overactivity*

Cassra B. Clark, MD, Radhika Ragam, MD, Akhil K. Das, MD, Patrick J. Shenot, MD
Department of Urology, Thomas Jefferson University, Philadelphia, Pennsylvania, USA

CLARK CB, RAGAM R, DAS AK, SHENOT PJ. Management of neurogenic detrusor overactivity. *Can J Urol* 2021;28(Suppl 2):33-37.

***Introduction:*** *Neurogenic lower urinary tract dysfunction (NLUTD) refers to altered function of the urinary bladder, bladder outlet, and external urinary sphincter related to a confirmed neurologic disorder. Neurogenic detrusor overactivity (NDO) is a subset of NLUTD that frequently results in incontinence and may be associated with elevated bladder storage and voiding pressures resulting in upper urinary tract damage.*

***Materials and methods:*** *This article provides an update on the evaluation and management of patients with NDO. Basic bladder physiology as well as classification of NLUTD, initial urologic evaluation, and management options ranging from the most conservative to surgical interventions will be covered.*

***Results:*** *NDO may be managed by conservative, pharmacologic, and surgical methods. Untreated or inadequately managed NDO may result in significant urologic morbidity and mortality, making careful evaluation and lifelong management necessary to optimize quality of life and prevent secondary complications.*

***Conclusions:*** *Patients with NDO should have life-long urologic surveillance and follow up. The extent of regular evaluation and testing should be based on the principal of risk stratification. Treatment for NDO should be considered not only for clinical symptoms such as incontinence, but also aimed at preserving renal function.*

**Key Words:** bladder augmentation, neurogenic bladder, urinary incontinence

## Introduction

Neurogenic lower urinary tract dysfunction (NLUTD) refers to altered function of the urinary bladder, bladder outlet, and external urinary sphincter related to a confirmed neurologic disorder. Common causes of NLUTD include spinal cord injury (SCI), multiple sclerosis (MS), myelomeningocele, Parkinson's disease, and cerebrovascular accident (CVA). While CVA is a most common of these conditions, multiple sclerosis and spinal cord injury/dysfunction are the most common neurologic disorders to result in clinically significant NLUTD.[1,2] The vast majority of patients with SCI have NLUTD, and about 85% of patients with MS have lower urinary tract symptoms (LUTS).[3]

Neurogenic detrusor overactivity (NDO) is a subset of NLUTD that frequently results in urinary frequency, urgency, and urge incontinence. It may be associated with elevated bladder storage and voiding pressures. Elevated bladder pressures, can lead not only loss of urinary control, but to upper urinary tract damage and renal failure.

Address correspondence to Dr. Cassra B. Clark, Department of Urology, Thomas Jefferson University, 1025 Walnut Street, Suite 1100, Philadelphia, PA 19107 USA

## Classification of neurogenic lower urinary tract dysfunction

The functional system for classification of NLUTD is simple, intuitive, and widely accepted. The function of the bladder is to store urine at appropriate pressures and volumes without incontinence, and empty completely at the appropriate place and time. This system divides lower urinary tract dysfunction into two broad categories: 1) failure to store and 2) failure to empty. Failure to store urine can result from either bladder dysfunction such as NDO or impaired bladder compliance, or outlet dysfunction such as intrinsic sphincter deficiency. Failure to empty may result from bladder dysfunction such as impaired bladder contractility. Outlet obstruction, such as detrusor external sphincter dyssynergia, may also lead to failure of bladder emptying.

Historically, sequela of poorly managed lower urinary tract dysfunction has been a significant cause of morbidity and mortality in patients with NDO, particularly those with SCI. Mortality rates from genitourinary complications in SCI patients have declined significantly, from approximately 50% in the 1950s to less than 3% today.[4] The goal of NLUTD management, in general, and NDO specifically, is to prevent upper urinary tract deterioration, minimize

urinary incontinence, prevent urinary tract infections and urolithiasis, and avoid autonomic dysreflexia.[5]

## Initial urologic evaluation

Initial evaluation includes a detailed history and physical examination, urinalysis, and bladder or catheterization diary. Patients who spontaneously void should be carefully evaluated. A post void residual should be obtained in nearly all who spontaneously void. Further evaluation can be tailored based on stratification of risk for lower and upper urinary tract complications. Initial evaluation of patients at high risk for urologic complications would generally include upper tract imaging, assessment of renal function, and urodynamic evaluation. It is important to recognize that an acute neurologic event such as SCI often is followed by a phase of spinal shock. Therefore, urodynamic evaluation should be deferred until the neurologic condition is stabilized and spinal shock has resolved.

## Conservative management

Behavioral interventions for the management of urinary incontinence secondary to NDO may be effective in selected cases. For patients who void spontaneously and have no bladder emptying deficits, timed voiding may effectively minimize or eliminate incontinence related to involuntary detrusor contractions. Adapting drinking habits to spread fluid intake throughout the course of the day, and in some cases fluid restriction, is often employed in patients with NDO to minimize incontinence and lengthen intervals between catheterization. These management options need to be carefully individualized to each patient as this population often suffers from neurogenic bowel and chronic constipation which can be exacerbated by low fluid intake. Another method to lessen detrusor overactivity and improve storage is through activation of detrusor inhibitory reflexes stimulated by activity in pelvic floor musculature.[6] Pelvic floor exercises may be offered in carefully selected patients with less severe neurologic deficits and although it may have a role in management of patients with NLUTD with multiple sclerosis or CVA, it is rarely useful in patients with SCI.

## Oral pharmacologic treatment of NDO

Systemic pharmacotherapy has long been utilized in the management of urinary incontinence secondary to NDO event though many of the commonly used agents have not been widely studied in neurogenic populations. These agents are commonly used in patients with overactive bladder (OAB) to improve symptoms of urinary urgency, frequency, and urge incontinence. The objective of pharmacologic therapy in patients with neurogenic bladder is to minimize episodes of incontinence resulting from detrusor overactivity and to lower detrusor pressures, particularly during the storage phase in order to minimize the risk of upper tract complications.

The most commonly used oral systemic agents are antimuscarinics and beta-3 agonists. These are often used adjunctively with intermittent catheterization in patients who have deficits in bladder emptying. Antimuscarinic agents, also known as anticholinergics, have been consistently shown to improve clinical and urodynamic parameters in patients with NDO. They inhibit the binding of acetylcholine at M2 and M3 muscarinic receptors on detrusor smooth muscle, allowing for relaxation of the detrusor muscle.[7] The M3 receptors appear to be the most important for detrusor contraction in the healthy state, but M2 receptors may play an important role in detrusor contractions in patients with neurogenic bladder dysfunction.[8]

Antimuscarinic treatment should be considered not only in patients with symptomatic bother from NDO, but also in those with worrisome urodynamic findings. Published studies on the use of antimuscarinics are characterized by the lack of validated and standardized reported outcomes, lack of long term follow up, and absence of sufficient evidence in particular groups of patients with NDO. Most studies primarily include patients with SCI, and to a lesser extent, patients with multiple sclerosis. A systematic review and meta-analysis of 16 randomized controlled trials published between 1966 and 2011 involving 960 patients treated with antimuscarinic medications found a significant improvement in maximum cystometric capacity, and lower detrusor pressure compared to placebo.[9] In a review including other non-randomized control trials of treatment with oxybutynin, propiverine, and trospium, maximum detrusor pressure decreased by 30%-40% and bladder capacity increased by over 30%-40%. Urodynamic improvements appear to be dosed related with further decreases in detrusor pressures at higher doses.[10] Flexible dosing, in which patients self-select different doses of antimuscarinics, may improve efficacy without diminishing tolerability.

These antimuscarinic agents are inherently non-selective and bind to smooth muscle receptors of other organs resulting in the commonly reported side effects such as dry mouth, constipation, and pupillary dilation with blurred vision. These side effects are mediated by

blocking M3 receptors in the salivary glands, intestinal smooth muscle, and ciliary and iris sphincter muscles respectively. Other anticholinergic side effects may include headache, drowsiness, and tachycardia.

There is a variety of marketed antimuscarinic agents. Although there are different molecular structures, pharmacokinetic profiles, and muscarinic receptor subtype specificities, there does not appear to be a clear superiority of any one agent in managing either clinical symptoms or improving urodynamic parameters in patients with NDO. Intolerance to one antimuscarinic agent does not necessarily portend intolerance to a different agent.

Newer antimuscarinic agents may be more selective for cholinergic detrusor receptors therefore minimizing systemic side effects. Extended release formulations of antimuscarinic medications avoid high peaks in drug levels and result in less dry mouth and constipation than the immediate release preparations.[11] Transdermal and intravesical formulations of oxybutynin offer the advantage of reducing the severity of the anticholinergic side effects of dry mouth and constipation by avoiding the first pass of oxybutynin through the liver. One pharmacologically active metabolic product resulting from first pass metabolism of oxybutynin is desethyloxybutynin, which appears to be responsible for many of the antimuscarinic side effects of immediate release oxybutynin. Oxybutynin is primarily metabolized in the liver and bowel wall by the cytochrome P450 enzyme systems, particularly CYP3A4 found mostly in the liver and gut wall. Intravesical oxybutynin has been used on an "off-label basis" to minimize the effect of first pass metabolism.[12]

Beta-3 agonists, including mirabegron and vibegron, activates detrusor beta-3 receptors to cause relaxation of detrusor muscle. Mirabegron received FDA approval in 2012 for treatment overactive bladder Although it is clearly effective in increasing bladder capacity as well as decreasing urinary frequency and urge incontinence in patients with idiopathic OAB, it has not been extensively studied as a first line treatment in patients with NDO.[13] In a prospective randomized placebo controlled study of 66 patients with NDO resulting from SCI or multiple sclerosis, the use of mirabegron significantly increased the volume at first detrusor contraction and significantly improved patient reported outcomes.[14]

Mirabegron has been shown to result in meaningful improvements in patient reported outcomes in patients with OAB when used as an add-on treatment to antimuscarinic medications, particularly solifenacin. Although the evidence for use of beta-3 agonists in patients with NDO is still limited, these medications are well-tolerated and have an excellent safety profile. They should be considered as either an alternative to antimuscarinic therapy or as an add-on treatment for patients with persistent symptoms despite treatment with antimuscarinics or botulinum toxin injections.[15]

## Intra-detrusor botulinum toxins

Intra-detrusor injection of botulinum toxin has widespread use in patients with NDO resulting from an array of neurologic conditions including multiple sclerosis, SCI, Parkinson's disease, CVA, and myelomeningocele. It has clearly been proven to be a safe and effective long term therapy in this patient population.[16] In clinical practice, it is most commonly utilized in patients who exhibit intolerance to, or have symptoms refractory to antimuscarinic therapy. It may be utilized with or without intermittent catheterization. Patients who spontaneously void must be willing to perform intermittent catheterization post-treatment due to the risk of urinary retention.

OnabotulinumtoxinA (Botox) was approved as a treatment for NDO in 2011. It is generally administered cystoscopically in twenty divided doses of 200 units. This treatment can generally be administered in an office setting with topical anesthesia using 2% lidocaine instilled in the bladder. In rare cases, patients with severe autonomic dysreflexia may require a general anesthetic. In our experience, topical and intravesical lidocaine administration, minimizing bladder distention during treatment, and the use of a flexible cystoscope minimizes the development of autonomic dysreflexia in the vast majority of patients.

Botulinum toxins prevent the release of acetylcholine on the pre-synaptic parasympathetic nerve ending resulting in detrusor relaxation.[17] These agents have been shown to significantly improve bladder capacity, increase volume at first detrusor contraction, reduce maximum detrusor pressure, and reduce episodes of urinary incontinence in comparison to placebo.

Due to the local effect of botulinum toxin, systemic side effects are exceedingly rare. The most common adverse events in this population include urinary tract infections, hematuria related to injection, and urinary retention. Urinary retention is of no concern in patients on intermittent catheterization. In patients who void spontaneously, the risk of urinary retention and need for intermittent catheterization should be discussed prior to treatment.

The durability of response is variable but typically ranges from 6 to 9 months. Retreatment is generally patient directed and requested when the beneficial effects of treatment begin to subside. In patients

with adverse urodynamic parameters, we typically recommend clinical reassessment including urodynamic evaluation 3 months after the first injection.

Other preparations of botulinum toxin, while less commonly utilized, appear to offer similar outcomes. AbobotulinumtoxinA (Dysport) is generally used at a dose of 750 IU. In one study, it was used as successful salvage therapy in over half of patients after failed treatment with onabotulinumtoxinA.[18]

## Surgical management of NDO

Surgical management of NDO with either bladder augmentation or urinary diversion is generally reserved for situations where medical methods have failed to achieve acceptable continence. Surgical intervention is also indicated in situations where ongoing adverse urodynamic findings, such as poor bladder compliance, risks progressive upper urinary tract deterioration that may progress to renal failure.

Bladder augmentation is the preferred method of surgical treatment of NDO. It provides the advantage of keeping the native urinary tract otherwise intact as access to the upper tracts via preservation of the native ureteral orifices. This is important as this population has a higher risk of upper tract urolithiasis. The functional and clinical outcomes of bladder augmentation using a bowel segment in patients with NDO are consistent and predictable.[19] Reliable improvements in bladder compliance, urinary incontinence, and quality of life are consistent.[20] Although any bowel segment may be used, ileum and colon are most commonly chosen in clinical practice.

There are a number of absolute and relative contraindications to bladder augmentation. The most important absolute contraindication is inability to perform intermittent catheterization, such as those with quadriplegia, or those unwilling to perform intermittent catheterization. Bladder augmentation should not be considered in patients with a history of bladder cancer. Metabolic alterations may result when augmented bowel segments are exposed to urine as these segments have preserved absorptive and secreting properties. Evaluation for chronic kidney disease remains important in order to minimize the risk of clinically meaningful hyperchloremic metabolic acidosis that may develop in patients undergoing bladder augmentation with ileal or colonic segments. In general, candidates for bladder augmentation should have a creatinine clearance over 40 mL/min.

Other patient specific factors include inflammatory bowel disease or prior extensive bowel resection. Functional bowel loss may affect absorption of not only nutrients, but also water from small and large bowel. A change in bowel habits in this population, particularly loose or frequent bowel movements, may dramatically impact quality of life.

While metabolic complications are uncommon in properly selected patients, there are several long term complications of bladder augmentation including the formation of bladder stones, intraperitoneal bladder rupture, and the development of adenocarcinoma or urothelial carcinoma. The risk of bladder stone formation can be minimized by implementing a bladder irrigation regimen to prevent mucus accumulation. Intraperitoneal bladder rupture is uncommon in adult patients with bladder augmentation. Great care with patient selection to assure compliance with recommended catheterization regimens and prompt attention to difficulty with catheterization minimizes this potentially life-threatening complication.

Incontinent or continent urinary diversion may be offered as a final option for patients who have failed more conservative management. In patients able to do intermittent catheterization through a catheterizable, abdominal stoma, continent diversion may be considered. This option carries many of the same long term risks as bladder augmentation including metabolic complications and urolithiasis.[21] Continent diversion should only be offered in patients with adequate renal function due to the large segment of intestine exposed to urine. Other potential complications include ureteral-intestinal anastomotic stricture, stomal stenosis, stomal incontinence, peristomal hernias, and urolithiasis.

Incontinent urinary diversion is usually considered a last resort option. In properly selected and motivated patients, urinary diversion can offer significant improvement in long term quality of life. The ileal conduit is the most commonly utilized form of incontinent urinary diversion. Although it generally allows preserved renal function in the short to medium term period, patients with longstanding incontinent urinary diversion with ileal conduits may see a gradual decline in renal function.

The incontinent ileovesicostomy also allows continuous drainage of urine using an intestinal stoma. Advantages of this reconstruction is that it avoids the need for cystectomy and maintains normal anatomy of the ureterovesical junction allowing access to the upper tracts for endoscopic management of stones.[22] Disadvantages include the potential increase of malignancy due to preservation of the bladder segment as well as the potential for urethral incontinence. The ileovesicostomy is effective in preserving renal function by allowing low-pressure storage and

drainage of urine. We have observed some patients develop urinary stasis which can result in frequent urinary tract infections. Patient selection is critical and it is important to assure a functional bladder outlet prior to considering ileal vesicostomy to minimize the risk of urethral incontinence. Complications are similar to other types of incontinent urinary diversion including stomal stenosis, peristomal hernias, and urolithiasis.[23] Patients should be counseled regarding the significant risk of needing additional treatment or surgery following ileovesicostomy.

## Conclusions

Patients with NDO should have life-long urologic surveillance and follow up. The extent of regular evaluation and testing should be based on the principal of risk stratification. Routine upper tract imaging and urodynamics is not indicated in NDO patients at low risk of renal and urologic complications; an example would be a patient with urge incontinence from a CVA who is adequately medically managed. In contrast, patients with worrisome storage parameters that risk upper tract damage require periodical evaluation. We recommend annual clinical assessment in patients with high risk NLUTD for assessment of symptoms, physical examination, evaluation of renal function, and upper tract imaging. The frequency of urodynamic studies in this patient population should be individualized. Treatment for NDO should be considered not only for clinical symptoms such as incontinence, but also aimed at preserving renal function. □

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# *Management of urinary incontinence following treatment of prostate disease*

Cassra B. Clark, MD, Victor Kucherov, MD, Edward Kloniecke, MD, Patrick J. Shenot MD, Akhil K. Das MD

Department of Urology, Sidney Kimmel Medical College at Thomas Jefferson University, Philadelphia, Pennsylvania, USA

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***Introduction:*** *Men who undergo treatment for prostate disease are at increased risk of urinary incontinence (UI). UI has a known negative impact on patient quality of life. Once a thorough evaluation has been performed, there are effective modalities for treatment that can be tailored to the patient.*

***Materials and methods:*** *This review article provides the most recent evidence-based work up and management for men with incontinence after prostate treatment (IPT). Etiology, prophylactic measures, work up, surgical treatments, and patient considerations will be covered. The more recent adjustable balloon device is included in this publication as well as more traditional treatments like the artificial urinary sphincter (AUS) and male urethral sling.*

***Results:*** *IPT can result from treatment of either benign or malignant prostate disease whether surgery or radiotherapy are utilized. Stress urinary incontinence (SUI), urge urinary incontinence (UUI), or mixed urinary incontinence (MUI) are all possibilities. SUI after radical prostatectomy (RP) is the most common form of IPT. Patient education and implementation of pelvic therapy as well as modern surgical techniques have greatly improved continence results. AUS remains the gold standard of SUI treatment with the broadest category of patient eligibility. Patients experiencing UUI should be treated according to the overactive bladder guidelines.*

***Conclusions:*** *For men with IPT, it is crucial to first take a thorough patient history and delineate the exact nature of UI symptoms which will determine the options for management. Patient factors and preferences must also be taken into consideration when ultimately choosing the appropriate intervention.*

**Key Words:** prostate, prostatectomy, radiotherapy, male incontinence, artificial urinary sphincter, male urethral sling

## Introduction

The treatment of prostate disease for both benign and malignant etiology has been associated with an increased risk of urinary incontinence (UI) in men.[1] UI can develop following surgery or radiation therapy (RT) for prostate cancer or after prostate reducing surgeries for benign prostatic hyperplasia (BPH). Types of incontinence include stress urinary incontinence (SUI), urge urinary incontinence (UUI), and mixed urinary incontinence. Any incontinence caused by treatment of prostate disease is referred to as incontinence after prostate treatment (IPT).[2]

The most common type of IPT is SUI after radical prostatectomy (RP). It is estimated that nearly 200,000 new cases of prostate cancer will occur in 2020.[3] Furthermore, an estimated one third or more of men diagnosed with prostate cancer undergo RP annually.[4] Compared with active surveillance, patients who undergo RP are more likely to experience UI.[5] Long term SUI rates following robotic-assisted laparoscopic

Address correspondence to Dr. Cassra B. Clark, Department of Urology, Thomas Jefferson University, 1025 Walnut Street, Suite 1100, Philadelphia, PA 19107 USA

prostatectomy (RALP) are estimated to be between 8%-16%.[6,7] It has been shown that patients with UI are at higher risk for mental health issues and experience poorer quality of life.[8] Given the prevalence of prostate disease, risk for IPT, and its associated emotional and financial burdens, it is imperative understand the evaluation and management of these patients.

## Etiology

### *Prostate cancer treatment*

SUI following RP is the most common form of IPT, although UUI can also occur. The historical incidence of SUI after RP has been estimated between 2%-87%.[9] However, progressive improvement in post-RP SUI over time has been shown. Lepor et al found the rate of men using 1 pad or fewer at 3, 6, 12, and 24 months after RP to be 71%, 87%, 92%, and 98.5% respectively.[10] Any UI following RP significantly decreases patient quality of life.[11] Four percent of men with post-RP SUI have bothersome enough symptoms to seek surgical intervention.[12] The pathophysiology of UI following RP is thought to be related to rhabdosphincter incompetence, change in urethral length, and change in detrusor compliance and overactivity.[13]

Incompetence of the rhabdosphincter (also known as the external urethral sphincter) combined with compromise of the internal urethral sphincter during RP can lead to intrinsic sphincter deficiency (ISD). ISD can be as high as 88% at 1 year post RP.[14] ISD is the sole cause of incontinence in 37%-59% of these patients.[15] Given the recovery of continence in many patients over time, it is thought that injury to the nerves and supporting tissue (rather than to the rhabdosphincter itself) is the underlying etiology. Preserved membranous urethral length above 12 mm is associated with increased continence.[16] Alternatively, UUI following RP is linked to detrusor overactivity (DO). DO is observed in up to 34% of men following RP.[14] However, this was the sole cause of UI in only a small percentage of patients. Ultimately, it is important to evaluate patients with IPT following RP for both SUI and UUI in order to determine the most appropriate treatment.

Despite advances in targeting, both the bladder and rectum can still fall within the treatment field during RT for prostate cancer. The negative sequelae from radiation damage to these organs results in chronic tissue inflammation, abnormal cell proliferation, and vascular insults.[17] Importantly for the patient and urologist who will see them, these effects can lead to DO.[18] Hoffman et al found that men who received RT for prostate cancer had a DO rate of 70% compared to 38% in those who did not.[19] This study also showed smaller bladder capacity in post-RT patients compared to those who did not receive RT (253 mL versus 307 mL, respectively). Patients who present with UI following RT should have bladder function assessed for DO and reduced capacity.

### *BPH treatment*

While not as significant as RP, prostate reducing surgeries in the setting of BPH can also cause IPT. Studies have demonstrated that patients can experience SUI following transurethral resection of prostate (TURP) or holmium laser enucleation of prostate (HoLEP). However, most cases are transient in nature with rates of IPT dropping to 1% or less at the one year interval.[20,21] Although surgery for BPH can reverse some of the pathological changes of the bladder, some patients experience irreversible changes to their bladder from longstanding BPH that persist following surgery.[22] Long-standing BPH left untreated can lead to persistent DO following surgery.[23]

## Prophylactic measures against IPT

The value of pelvic floor muscle therapy (PFMT) for IPT after RP has been demonstrated. A systematic review by Strączyńska et al demonstrated not only PFMT's effectiveness in continence outcomes but also improving patient's quality of life.[24] This can possibly be attributed to patients actively participating in their own care. The current AUA/SUFU guidelines state that PFMT can be offered prior to RP and should be offered postoperatively.[2] One of the difficulties regarding PFMT is determining the optimal regimen and educating patients on proper technique. Fernandez et al performed a meta-analysis of eight randomized trials showing three sets of 10 contractions daily led to improved continence versus no intervention.[25] A trial by Milios et al demonstrated a faster return to continence for patients who were randomized to a more intensive PFMT regimen starting 5 weeks before surgery as compared to those who had a standard treatment regimen in the same period.[26]

Improved surgical techniques and advances in technology have also improved continence results following RP. Postoperative continence has been associated with bladder neck preservation, neurovascular sparing, non-thermal ligation of the dorsal venous complex, preserving urethral length and the supporting anatomy of the rhabdosphincter, and anatomic reconstruction.[27] A randomized control trial by Asimakopoulos et al showed faster return to continence for patients undergoing Retzius-sparing RALP compared to the anterior approach.[28]

## Work up

Work-up of IPT must include a thorough history and physical examination along with appropriate diagnostic tests to elucidate the type as well as degree of UI.[2] Validated questionnaires to determine the type of UI include The International Consultation on Incontinence Questionnaire - Urinary Incontinence Short Form (ICIQ-UI SF) and the Michigan Incontinence Symptom Index (M-ISI).[29,30] Asking a patient to keep a diary is useful to understand their daily habits (such as fluid and caffeine intake) and can provide real-time recording of their triggers and symptoms. Severity of symptoms is frequently assessed by asking patients how many pads per day they use, frequency of changing their pads, and how wet the pads are when they change them. Daily pad weight, however, provides the most objective measure of degree of incontinence.[31] The Male Stress Incontinence Grading Scale (MSGIS) as well ICIQ-UI SF have been shown to correlate with heavier pads in patients with SUI.[32]

Physical exam should include maneuvers to confirm the presence of SUI such as having the patient cough or increase abdominal pressure via Valsalva maneuver. Urinalysis is a helpful adjunct to look for urinary tract infection, hematuria, or glucosuria which can cause similar symptoms to or exacerbate underlying IPT. Post void residual (PVR) can show if the patient is emptying well and rule out overflow incontinence. Cystourethroscopy should be performed prior to surgical intervention to assess the urethra and bladder for pathology such as urethral stricture or vesicourethral anastomotic stenosis as these can impact surgical intervention.[33] Ruling out bladder cancer is also important prior to surgical intervention. Bladder tumors, especially urothelial carcinoma in situ, can be associated with irritative voiding symptoms and the presence of cancer may influence the surgical options considered. For patients with a more complex presentation, invasive urodynamics is a useful tool.

If patients fail conservative therapies, surgery is indicated for those who have bothersome SUI-predominant symptoms. Surgery is contraindicated for patients with risk of renal failure due to bladder dysfunction, anatomy that does not support implantable device, or pathology that requires chronic endoscopic management. Generally, patients with SUI may be offered surgical intervention at 1 year postoperatively for bothersome SUI if they have failed non-surgical therapy. The guidelines, however, allow intervention to be as early as 6 months if the patient shows no improvement of IPT while undergoing non-surgical therapy.[2]

## Surgical treatments for IPT

### *Artificial urinary sphincter*

The artificial urinary sphincter (AUS) was first designed in 1976 and has seen several iterations over the years.[34] The AMS 800 (Boston Scientific, Marlborough, MA, USA) is a well-established and studied AUS. It is composed of a fluid-filled cuff that encircles the bulbar urethra, a pump, and a pressure regulating balloon (PRB). To be an appropriate surgical candidate, patients must have adequate cognitive function and manual dexterity to operate the device and stricture/stenotic disease must be ruled out. It is important to note that cognitive dysfunction and poor manual dexterity are predictors of AUS failure.[35]

During the procedure, the patient is placed in the dorsal lithotomy position. The dissection should expose the bulbar urethra where it is circumferentially measured to select the appropriate cuff size. If a patient's bulbar urethral circumference falls between cuff sizes, the larger cuff size should be selected to reduce risk of urethral compromise. The PRB is placed in the retropubic space and filled with enough fluid to achieve a pressure of 61-70 $cmH_2O$. The pump should be placed in a subdartos pouch within the scrotum. Special consideration must be given to patients with risk factors for or history of urethral atrophy or erosion and previous RT. Cuff size, placement, and pressure can be modified to account for these risk factors.

Patients should be counseled appropriately about AUS outcomes, durability, revision rates, and potential complications. In a study by Linder et al, 1,083 AUS placements were performed between 1983-2011 for men with SUI. With a median follow up of 4.1 years, 59% reported 0-1 pads per day and 94% reported high satisfaction.[36] A systematic review of 12 studies showed a 0-1 pads per day rate of 61%-100% with "complete dryness" varying from 4%-86%.[37] Over time, revision of AUS may become necessary. Device failure rate at 10 years has been shown to be nearly 50%.[38] Bergeson et al evaluated AUS revisions between 2007-2019 and showed PRB failure to account for one third of cases, mechanical cuff failure for 17%, and urethral atrophy for 8%.[39] In a study looking at both primary and revision AUS patients, three out of four patients were still satisfied 10 years following the procedure in both groups.[40]

### *Urethral bulking agents*

Bulking agents are cystoscopically injected submucosally at the bladder neck to help coapt tissue and improve continence. While commonly used for female SUI due to ISD, they are rarely offered in male patients due to poor evidence and low efficacy/cure rates.[41]

### *Urethral sling*

Male slings provide a minimally invasive surgical alternative to AUS for SUI. They increase resistance to urinary flow by elevating the bulbar urethra.[42] They do not require manual manipulation and can be used by patients who lack the dexterity to operate an AUS. They are considered appropriate for patients with mild to moderate SUI.[2] Sling mechanisms vary including transobturator, quadratic, and bone anchored designs.[12]

Patient positioning and dissection for the The AdVance/AdVance XP transobturator sling (Boston Scientific, Marlborough, MA, USA) is similar to AUS. The spongiosum is dissected ventrally to the perineal body. The mesh is attached to a passing device and passed from an outside to inside direction going through the thigh (about one fingerbreadth below adductor longus bilaterally) and obturator foramen (lateral to the pubic ramus) and out the perineal incision medial to the ipsilateral corporal body. The mesh is sutured to the spongiosum at the site of the central tendon. Under cystoscopic vision, tensioning should elevate the perineal body and proximal bulbar urethra about 3 cm-4 cm. A temporary Foley catheter is typically left postoperatively.

Collado et al found the AdVance and AdVance XP to have a cure rate of 77% (defined as 0 pads used) in a cohort of 94 patients with a median follow up of just over 4 years.[43] Patients in the study had mild to moderate SUI as defined by daily pad weight < 400 g. A clinical trial for the quadratic sling by Comiter et al demonstrated a 79.2% objective success rate at 12 months (considered as > 50% reduction in pad weight).[44] A review by Doudt et al on male urethral slings showed an overall success rate of nearly 80%.[45] Their review highlighted the importance of proper patient selection including mild to moderate incontinence, absence of bladder dysfunction/DO, and absence of prior RT. Potential complications from sling placement include urinary retention, perineal pain, and hematoma with explantation rarely being necessary.[46]

### *Adjustable balloon device*

The ProACT device (Uromedica, Inc., MN, USA) was FDA approved in 2015. It consists of two balloons that are implanted on the lateral aspects of the bladder neck and provide coaptation. The balloons are filled with isotonic contrast solution and can be filled with additional fluid via subcutaneous ports in a subdartos pouch in the scrotum. The device can be adjusted every 6-8 weeks following initial implant to reach optimal symptomatic improvement in SUI. In a study by Noordhooff et al, they showed a success rate (considered zero pads or 1 pad for security) among 143 patients with any degree of incontinence and no prior history of radiation of 47% at 6 months and 51% at 12 months.[47] Seventy-eight percent of patients had significant improvement (considered greater than 50% reduction of pad use) at 1 year. The 2019 AUA/SUFU guidelines state that the adjustable balloon device may be offered to patients with mild SUI after prostate treatment.[2]

## Patient factors influencing surgical treatment

In a review by Ajay et al of men who failed sling surgery, outcomes were compared between revision with AUS or a second sling operation.[48] Failure rate for the repeat sling cohort was 55% compared to only 6% for those receiving AUS. Furthermore, a study comparing men who received an AUS following failed sling placement to primary AUS patients showed a similar success rate of 96% (defined as 0-1 pads per day at 3 months) in both groups.[49]

Even though AUS and urethral slings are considered appropriate for patients who fall into the mild to moderate category of SUI, it is important to know their history, physical capabilities, and personal preferences to guide them towards the best option that would provide them a satisfying outcome. Patients with severe incontinence, previous RT, bladder dysfunction/DO, and those requiring revision should be offered AUS. Patients with cognitive dysfunction, poor manual dexterity, or not wanting to interact with a sphincter mechanism can be offered a sling. A balloon device should only be offered to patients with mild SUI.

## Post prostatectomy UUI

According to the 2019 AUA/SUFU guidelines, patients who experience UUI or mixed UI should initially be treated following the AUA overactive bladder guidelines.[2] The treatment algorithm includes patient education about normal/abnormal bladder function, modification of voiding habits, PFMT, and lifestyle modifications.[50,51] This can then be followed by pharmacologic treatment with either anticholinergics or beta-3 agonist medication. Third line therapies include tibial nerve stimulation (TNS), sacral neuromodulation, and botulinum toxin. Very rarely patients who are not adequately treated with the aforementioned therapies require urinary diversion or bladder augmentation.

## Conclusions

Prostate disease is a core men's health issue. Patients receiving RP or RT for prostate cancer or surgery for BPH have the potential of developing IPT. This

can result in mental/emotional distress and reduced quality of life. While SUI following RP is the biggest contributor to IPT, patients can also experience SUI, UUI or mixed incontinence following any modality of treatment for prostate disease.

For patients experiencing SUI, conservative therapies like PFMT are important in improving continence and patient quality of life and should be offered as standard of care. When surgical intervention is required, there are options available to patients including AUS, urethral sling, and adjustable balloon device. While AUS is considered the most established and versatile treatment, patient factors and preferences must be taken into consideration when determining the correct procedure. □

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