Benign prostatic hyperplasia: an update on minimally invasive therapy including Aquablation

Akhil K. Das, MD,[1] Timothy M. Han, BA,[1] Alex Uhr, MD,[1]
Claus G. Roehrborn, MD[2]

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

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Introduction: *Lower urinary tract symptoms (LUTS) secondary to benign prostatic hyperplasia (BPH) is a common condition affecting older men. New interventional treatments have emerged and evolved over the years, each with their own distinct efficacy and safety profiles. While some have fallen out of favor, new options continue to be explored.*

Materials and methods: *We provide a review and update on minimally invasive treatment modalities for BPH, including prostatic artery embolization (PAE), Aquablation, convective water vapor thermal therapy (Rezum), and prostatic urethral lift (Urolift).*

Results: *While current urologic guidelines recommend against PAE outside of the context of clinical trials, Aquablation, Rezum, and Urolift have demonstrated excellent efficacy and durability in relieving LUTS in the BPH patient. When compared to the gold standard, transurethral resection of the prostate (TURP), these novel therapies yield equivalent or superior objective outcomes, with the additional benefit of significantly reduced sexual side effects. Additionally, Rezum and Urolift may be performed as outpatient procedures under local anesthesia, allowing for decreased hospitalizations, operative times, catheterization duration, and financial burden on the health care system.*

Conclusions: *Aquablation, Rezum and Urolift are minimally invasive surgical treatment options capable of providing rapid, significant, and durable relief of LUTS secondary to BPH. Each technique demonstrates comparable efficacy to TURP with the added advantages of preserving sexual function, decreasing patient morbidity, and limiting healthcare costs.*

Key Words: prostatic arterial embolization (PAE), Urolift, Rezum, Aquablation, benign prostatic hyperplasia (BPH), lower urinary tract symptoms (LUTS), minimally invasive therapy

Introduction

Patients with benign prostatic hyperplasia (BPH) frequently experience significant lower urinary tract symptoms (LUTS), a common myriad of urinary symptoms including urinary frequency, urgency, nocturia, incomplete bladder emptying, or weakened stream that often results in presentation to an urologist's office. While multiple medical therapies exist as first line treatment options, men who continue to have obstructive voiding symptoms, urinary tract infections, kidney injury, persistent prostatic bleeding or bladder stones may require surgical evaluation. Transurethral resection of prostate (TURP) is generally considered the standard of care for surgical management of BPH, but has been associated with both sexual and urinary comorbidities. In an effort to maximize symptom relief and patient satisfaction while minimizing negative side effects such as incontinence and sexual dysfunction (i.e. erectile dysfunction, retrograde ejaculation), multiple novel therapies have been reported. Despite the development and evolution of various treatment

Address correspondence to Dr. Akhil K. Das, Thomas Jefferson University, Department of Urology, 1025 Walnut Street, College Building, Suite 1110, Philadelphia, PA 19107 USA

modalities, only a handful have gained popularity and stood the test of time.[1] We aim to provide a review and update on the current landscape of minimally invasive therapy for BPH, with specific focus on prostatic artery embolization, Aquablation, water vapor thermal therapy (Rezum), and prostatic urethral lift (Urolift).

Prostatic artery embolization (PAE)

PAE is a minimally invasive interventional radiological technique that can be performed under local anesthesia usually with intravenous (IV) conscious sedation. Vascular access through the femoral or radial arteries and small embolization particles are injected directly into the prostatic arteries bilaterally in order to devascularize adenomatous tissue. There is a slight advantage since it does not require any transurethral manipulation. However, the procedure requires experienced radiologists to perform as it is technically challenging with a large variation in prostatic arterial anatomy seen across patients.

In the UK Register of Prostate Embolization (UK-ROPE) study, Ray et al investigated the efficacy and safety of PAE for LUTS secondary to BPH in an indirect comparative study between PAE and TURP.[2] The prospective multicenter matched cohort study recruited 305 total patients (216 PAE, 89 TURP) across 17 UK urological/interventional radiology centers. While the results showed that PAE may provide clinically and statistically significant improvement in symptoms and quality of life (QoL), TURP demonstrated superior improvements in median International Prostate Symptom Score (IPSS) (-15.0 versus -10.0 [PAE]) and QoL (-4.0 versus -3.0 [PAE]) scores with lower overall reoperation rates (5.6% versus 19.9% [PAE]) at 12 months post-procedure. To further assess the role of PAE in BPH treatment, Zumstein et al performed a systematic review and meta-analysis with results suggesting that PAE is not as effective as established surgical therapies (TURP, open prostatectomy). However, PAE may result in fewer adverse events and side effects including patient-reported erectile function (International Index of Erectile Function 5 [IIEF5]).[3]

Although prostatic embolization may be limited or inferior compared to gold standard surgical therapies for BPH, PAE has still been shown to provide symptomatic benefit in patients with significant LUTS. Pisco et al performed a randomized, single blind, sham-controlled superiority clinical trial showing this treatment effect.[4] Patients in the PAE arm demonstrated significantly greater improvement in IPSS ($p < 0.0001$) and QoL scores ($p < 0.0001$) at 6 months post-procedure compared to the sham arm. Nevertheless, despite Food and Drug Administration (FDA) approval in 2017, PAE is considered by current AUA guidelines to be purely experimental with recommendations against its use outside of clinical and experimental trials.[5] Therefore, large-scale randomized controlled trials with longer follow up periods are necessary before PAE is considered as an alternative therapy for BPH-LUTS management to TURP.

Aquablation

Aquablation is performed using the AQUABEAM Robotic System (PROCEPT BioRobotics Inc., Redwood City, CA, USA) and was approved by the FDA in 2017. The technique involves an ultrasound-guided, robot-assisted waterjet that can precisely ablate prostatic tissue. Faber et al first described the procedure in 2015[6] with multiple updated techniques published by others.[7,8] Current AUA guidelines recommend Aquablation in symptomatic BPH patients with prostate sizes 30-80 grams.[5] Surgery requires a robotic handpiece, console, and conformal planning unit (CPU) and is performed under general or spinal anesthesia. The patient is positioned in dorsal lithotomy and the bi-planar transrectal ultrasound (TRUS) probe is positioned. TRUS is utilized before treatment to map out specific prostatic tissue to be ablated. This is performed using the mapping software, allowing for changes in depth up to 25 millimeters (mm) and angle of resection up to 225 degrees. Using the software, the desired area of ablation is outlined on a screen, with special care to avoid ablation in the area of the verumontanum. TRUS is then also used to monitor tissue resection in real-time during treatment as a targeted high velocity saline stream from the transurethrally placed robotic handpiece ablates tissue in a "windshield wiper" motion, with the computer system automatically adjusting the flow rate in each direction to alter the depth of penetration. Importantly, this procedure does not generate thermal energy, with safety mechanisms built in place to ensure that only the outlined tissue is ablated with the external sphincter protected. After completion of ablation, further hemostasis maybe needed by electrocautery via a standard cystoscope/resectoscope or light traction with a Foley catheter balloon. Post-procedure, a three-way catheter is required for continuous bladder irrigation.

Aquablation is a newer technology, lacking robust data and published literature. To our knowledge, the WATER trial represents the first randomized controlled trial studying Aquablation. This was a double-blind,

multicenter, prospective noninferiority trial comparing the safety and efficacy of Aquablation to TURP in 181 men ranging 45-80 years old with prostate sizes 30-80 grams (TRUS), moderate to severe baseline LUTS (IPSS ≥ 12), and Qmax < 15 mL/sec.[9] End points included efficacy (reduction in IPSS at 6 months) and safety (development of Clavien-Dindo persistent grade 1, or 2 or higher operative complications). Results demonstrated that Aquablation was noninferior to TURP in efficacy (mean difference in the change IPSS score at 6 months was 1.8 points greater for men undergoing Aquablation [noninferiority $p < 0.0001$]) and superior to TURP in safety (26% of men in the Aquablation group versus 42% of men undergoing TURP experienced a primary safety end point [$p = 0.0149$]). Of note, there were significantly lower rates of anejaculation in sexually active men treated with Aquablation (10% versus 36% TURP, $p = 0.0003$). This is likely due to the unique ability to carefully define the target area of prostate ablation, thereby avoiding damage near the verumontanum. Additionally, Aquablation demonstrated faster resection times (4 versus 27 minutes [TURP], $p < 0.0001$) despite similar mean total operative times (33 versus 36 minutes [TURP], $p = 0.2752$). Subgroup analysis of the WATER trial looking at men with 50-80 g prostates demonstrated significantly superior IPSS score improvement and superior safety profile with significantly lower rates of postoperative anejaculation in men undergoing Aquablation.[10] Furthermore, recently published 3-year outcome data of the WATER trial, summarized in Table 1, demonstrated similar improvements in patient symptom scores, quality of life, and uroflow parameters in the Aquablation and TURP groups, but with significantly marked reduction in postoperative anejaculation after Aquablation ($p = 0.0039$).[11]

Expanding on the results of the WATER trial, Desai et al conducted the WATER II trial to assess safety and efficacy of Aquablation in larger prostates (80-150 mL).[12] The WATER II trial defined the same efficacy and safety primary end points as the original WATER I trial, however lacked a direct comparative control arm (TURP). The initial data included 101 enrolled men and demonstrated adequate adenoma resection with a single pass in 34 patients, and with additional passes in 67 patients (mean 1.8 treatment passes). The primary safety endpoint of Clavien-Dindo grade ≥ 2 event rate at 1 month was 29.7% with bleeding complications recorded in 10 patients (9.9%), including 6 (5.9%) peri-operative transfusions. Nonetheless, the published 6-month follow up data showed that the

TABLE 1. **Three-year outcome data from the Aquablation WATER trial**

	Clinical outcomes - Mean (SD)		
Measure	**Aquablation**	**TURP**	**p value**
IPSS reduction	14.4 (6.8)	13.9 (8.6)	0.6848
IPSS reduction (Larger prostates ≥ 50 cc)	3.5 points larger reduction with Aquablation		0.0125
IPSS QoL improvement	3.2 (1.8)	3.2 (1.7)	0.7845
Changes in MSHQ-EjD	2.8 points lower with TURP		0.0008
MSHQ bother score	0.6 points higher in TURP		0.0411
IIEF-15	no statistically significant changes		not significant
Qmax improvement	11.6 (14) cc/sec	8.2 (8) cc/sec	0.0848
PVR reduction	52 (163) cc	53 (224) cc	0.9801
PSA reduction	0.9 ng/dL	1.1 ng/dL	0.5983
Anejaculation rate	11%	29%	0.0039
Urethral stricture rate	0.9%	6.2%	0.0567
Meatal/submeatal stenosis rate	2.5%	0.0%	0.5539
Retreatment rate	4.3%	1.5%	0.4219

IPSS = International Prostate Symptom Score; QoL = quality of life; MSHQ-EjD = Male Sexual Health Questionnaire-Ejaculatory Dysfunction; IIEF-15 = International Index of Erectile Function-15; Qmax = maximum urinary flow rate; PVR = post-void residual urine; PSA = prostate-specific antigen

WATER II trial met the study design goals for both safety (45.5% at 3 months, $p < 0.001$) and efficacy (mean IPSS improvement of 16.5 points at 3 months, $p < 0.001$) with significant improvements at 6 months in Qmax (10.1 mL/s increase, $p < 0.001$) and post-void residual urine (PVR) (84 mL decrease, $p < 0.0001$).[13] At 12-months follow up, effective and durable results were demonstrated with mean IPSS improvement of 17.0 points ($p < 0.0001$), mean IPSS QoL improvement of 3.3 points ($p < 0.0001$), Qmax improvement of 12.5 mL/s, and decrease in PVR of 171 mL in those with PVR > 100 at baseline.[14] Additionally, anterograde ejaculation was maintained in 81% of sexually active men. Notably, prostate-specific antigen (PSA) levels were still elevated at 12 months with mean of 4.4 ng/mL, improved from baseline mean of 7.1 ng/mL. When these 12-month results were compared to those of the WATER I trial, similar benefits were observed in both 30-80 mL and 80-150 mL prostate sizes.[15] This suggests that Aquablation may be an effective therapy independent of prostate size. However, there may be an increase in complication risk with patients with larger prostates.

Like other surgical BPH treatments, Aquablation carries the risk of blood loss and need for transfusion. In an effort to optimize benefits and minimize blood loss and transfusion rates, refined techniques have been published. Elterman et al compared athermal methods of hemostasis in preventing blood transfusions to the use of cautery across various prostate volumes following Aquablation.[16] Out of 801 patients analyzed in the study, 31 transfusions (3.9%) were reported with prostate size and method of traction contributing most to transfusion risk. In prostates ranging from 20-280 mL, an increased risk of transfusion of 0.8%-7.8% was observed when robust traction using a catheter-tensioning device (CTD) without cautery was used, whereas risk of transfusion was 1.4%-2.5% in men who underwent selective bladder neck cauterization with standard traction (catheter taped to the leg, gauze knot synched to the meatus, or no traction). This suggests an important role for transurethral cautery in hemostasis and reduction in transfusion risk.

Water vapor thermal therapy (Rezum)

The Rezum system (Boston Scientific, Marlborough, MA, USA) is a minimally invasive transurethral water vapor therapy used to treat LUTS secondary to BPH. Current AUA guidelines suggest it may be offered to patients with prostate volume less than 80 grams, especially as an effective option for preservation of erectile and ejaculatory function.[5] Another major advantage of Rezum is its ability to be performed safely as an outpatient procedure under local anesthesia.[17] The procedure is suitable for treating men over the age of 50 with evidence of efficacy in treating enlarged median lobes. However, it is contraindicated in patients with concurrent artificial urinary sphincter or implantable penile prothesis.

The Rezum system, approved by the FDA in 2015, creates water vapor (steam) thermal energy through the application of radiofrequency (RF) current against an inductive coil heater in the device's handle. This steam (103°C) can then be injected into the prostatic transitional zone. Upon contact with prostatic tissue, the steam phase shifts or condenses from vapor to liquid, releasing and convectively delivering large amounts of thermal energy (540 calories/gram). This results in disruption of prostatic cell membranes leading to immediate cell death and necrosis. Mynderse et al demonstrated that the ablative tissue was reduced in volume by 91.5% at 3 months and 95.1% at 6 months after treatment as shown on magnetic resonance imaging (MRI).[18] There was a mean reduction in whole prostate volume of about 28.9% and transition zone volume reduction of 38% on MRI at 6 months compared to baseline 1-week images. The ablative lesions were confined within the targeted treatment zone without compromising the integrity of surrounding structures. This is consistent with the thermodynamic principles of convective heating and allows for minimization of postoperative complication rates by reducing risk of injury to the bladder, rectum, or striated urinary sphincter.[19]

To our knowledge, McVary et al performed the only double-blind trial investigating Rezum in a multicenter, prospective, randomized controlled study with reported 5-year outcome data. Their data demonstrated subjective and objective improvements in LUTS observed as early as 2 weeks post-procedure with durable results through 5 years.[20-24] Previously published improvements of IPSS, IPSS-QoL, BPH Impact Index, and Qmax were sustained to 5 years with improvements of 48%, 46%, 49% and 49%, respectively ($p < 0.0001$).[24] In addition, their published 4-year data reported clinically meaningful improvements of Qmax and IPSS scores for patients who underwent treatment of enlarged median lobes when compared to those who had untreated median lobes.[23] Moreover, urinary incontinence scores (International Continence Society Male Incontinence Scale questionnaire-Short Form [ICS male IS-SF]) significantly decreased by 15% with no reported cases of sexual dysfunction at 4 years (IIEF and MSHQ-EjD scores stable and maintained).[25] Paired analysis of outcomes was also performed as part of

a crossover study to negate potential placebo effect, which revealed significantly greater improvements of IPSS, QoL, and Qmax after crossover treatments compared to that of the control period.[21] In a separate pilot study investigating safety and efficacy of Rezum, Dixon et al also demonstrated positive and evident responses as early as 1-month post-procedure with durable results at 2 years.[26,27]

In terms of safety, Rezum resulted in very few adverse events, all of which were transient and only mild-to-moderate severity. Most procedure-related adverse events occurred in the first 3 months and resolved spontaneously within 3 weeks. The most common events included dysuria (16.9%), hematuria (11.8%), hematospermia (7.4%), urinary frequency and urgency (5.9%), acute urinary retention (3.7%), and suspected urinary tract infection (3.7%).[20] Serious procedure-related adverse events were rare and included one case of bladder neck contracture and bladder calculi reported 6 months post-procedure and a second case of urosepsis after follow up cystoscopy. At 4 years follow up, there were no late occurring related adverse events, or de novo erectile dysfunction reported.[23] Mean catheterization time was reported as 3.4+/-3.2 days in a total of 90.4% (122/135) of patients in the initial study.[20] However, of these, only 32% (39/122) truly required catheterization due to unsuccessful voiding trials before discharge, whereas the remaining 68% (83/122) were at the surgeon's discretion of when to remove the catheter. As such, these results may not reflect true catherization rates in real-world practice.

In assessing Rezum's durability, it is important to consider retreatment rates. The 5-year surgical retreatment rates were reported to be 4.4%.[24] This demonstrates Rezum's advantage over other conductive thermal ablative devices such as the transurethral needle ablation (TUNA) and transurethral microwave therapy (TUMT), with reported 5-year retreatment rates of 14%-51% and 9%-21%, respectively.[28-33] Additionally, Rezum demonstrates similar, or favorable, durability compared to TURP (retreatment rates 3%-14.5% after 5 years).[34] Evidence for Rezum validates the procedure as a safe, effective, and durable BPH treatment option that can be performed under local anesthesia in an office-based setting with minimal sexual dysfunction.

Prostatic urethral lift (PUL, Urolift)

PUL using the Urolift system (NeoTract/Teleflex Inc., Pleasanton, CA, USA) is a minimally invasive technique that mechanically retracts the obstructing prostatic lobes to create a wider prostatic urethral lumen from bladder neck to the verumontanum. Urolift, approved by the FDA in 2013, is a tissue-sparing procedure using permanent nitinol and stainless steel implants to anchor luminal tissue to prostatic capsule. Implants are placed under direct cystoscopic vision in an ambulatory setting and are sized in situ to the prostatic lobe after deployment with the Urolift delivery device. While the mechanism of action is primarily mechanical, pre-clinical research on canine and cadaveric models suggests that tissue compression causes acute ischemia and focal atrophy with subsequent tissue remodeling.[35] When performing the PUL, it is recommended to start working from the bladder neck towards the verumontanum distally. Special care should be taken to avoid injury and disruption to the neurovascular bundle by deploying the Urolift implants in the anterior chamber. After implants are deployed, the procedure is considered complete when there is a continuous open channel observed on cystoscopy. Current AUA guidelines recommend its use for men with prostates less than 80 grams with a non-obstructing median lobe.[5] Men undergoing PUL report minimal sexual side affects, an additional attractive advantage over procedures designed to remove tissue. Preservation of sexual function is known to have a significant impact on quality of life, making this procedure a well-suited option for men with this priority.[36]

Another advantage of PUL is that it can be performed in an office setting under local anesthesia, including the use of topical anesthetics (lidocaine), oral sedation (benzodiazepines), and/or analgesics (acetaminophen, opioids).[37] Chilled topical lidocaine gel should be applied into the urethra for sufficient anesthetic coverage, with adequate time allowed for preoperative anesthetics to take effect.[38] If additional anesthetic is necessary, a prostatic block using 1% lidocaine injection can be performed, similar to that of a transrectal ultrasound guided prostate biopsy.

With PUL gaining popularity and use among clinicians, there is increasing scientific evidence demonstrating its safety, efficacy, and durability in treating BPH. Chin et al performed the first safety and feasibility study for PUL and demonstrated significant improvements in IPSS, QoL, BPHII and Qmax as early as 2 weeks with durable effects at 2 years follow up.[35,39] Adverse events were rare, transient, and consistent with those expected for any minimally invasive transurethral treatments. The most common device-related events were hematuria (12 patients), dysuria (11), and irritative symptoms (9), which typically resolved within 1 month. Preservation of sexual function following PUL has also been demonstrated

with improvements in MSHQ-EjD bother parameters, IIEF-5, and MSHQ-EjD function scores up to 2 years.[39]

To date, the largest, multinational, prospective randomized controlled trial investigating PUL is the L.I.F.T. study comparing PUL to a sham control with reported outcomes of up to 5 years.[40,41] At 5 years, improvements were durable in IPSS (36%), QoL (50%), BPHII (52%), and Qmax (44%), with no difference seen between Intent to Treat and Per Protocol populations. Furthermore, sexual function was stable over 5 years with no de novo, sustained erectile, or ejaculatory dysfunction.

In another randomized prospective controlled trial known as the BPH6 study, PUL was compared to the gold standard TURP with 2 year published outcomes data.[42] This study demonstrated that while significant improvements in IPSS, IPSS QoL, BPHII, and QMax were observed in both groups through 2 years, PUL was superior to TURP in quality of recovery, ejaculatory function preservation, and performance on the composite BPH6 index. However, TURP demonstrated superior change in IPSS and Qmax. There were no statistically significant differences between the study arms in IPSS QoL, and BPHII score and no significant change in ejaculatory function bother scores in either arm. Interestingly, PUL resulted in a statistically significant improvement in sleep.

Intending to simulate PUL in a day-to-day clinical setting without the rigid exclusion criteria of clinical studies, Sievert et al investigated PUL outcomes in patients with confirmed moderate-to-severe BPH-related LUTS, who were unresponsive to oral therapy, and were surgical candidates for TURP.[43] Patients were included regardless of prostate size, PVR, or history of retention, with the only exclusion criteria being presence of an obstructive median lobe. Out of 212 men, 86 chose PUL with a mean of 3.8 (2-7) implants placed in patients 38-85 years old with prostate sizes ranging 17-111 mL. Even with these looser exclusion criteria, within 1 month of surgery, 86% (74/86) of patients reported substantial symptom relief with significant improvements in Qmax, PVR, IPSS, and QoL ($p < 0.001$) that was maintained at 2 year follow up. Notably, sexual function was unchanged or improved and no Clavien-Dindo Grade ≥ 2 adverse events were reported postoperatively. However, 12.8% (11/86) of patients were retreated over the 2 year follow up period, compared to 2 year retreatment rates reported in the L.I.F.T. study (7.5%).[44] Nonetheless, the study demonstrated that PUL is an effective and promising surgical technique, with potential benefits in men with larger prostates than currently recommended in guidelines.

To better explore PUL efficacy, Eure et al retrospectively analyzed 1413 consecutive patients who received PUL with reported comparisons to the L.I.F.T. study in baseline demographics and symptom outcomes.[45] Patients in the real-world retrospective (RWR) study were modestly older ($p < 0.001$) and less symptomatic (IPSS [$p < 0.0001$], QoL [$p < 0.0001$], Qmax [$p < 0.0001$], PVR [< 0.001]) compared to those in the L.I.F.T. study. Thirty-eight patients with prostates ≥ 80 cc experienced similar absolute symptom scores throughout 6 months of follow up compared to those with smaller prostates less than 80 cc (IPSS baseline: 19.4 versus 17.6, $p = 0.1$; 1 month: 10.6 versus 9.0, $p = 0.3$; 6 months: 10.0 versus 9.6, $p = 0.8$). These results suggest that patients with prostates larger than 80 grams may still benefit from PUL. In fact, the FDA recently granted NeoTract/Teleflex Inc. an expanded indication for the use of Urolift to treat prostates up to 100 grams. However, further investigation should be performed before widespread use in larger prostates, with current AUA guidelines for surgical management of BPH still recommends an upper limit of 80 grams.[5]

In addition to prostate size, patient anatomy must be considered for men who desire PUL. Current guidelines recommend against using Urolift in men with large median lobes. This guideline has recently been challenged in the literature. Urolift is currently indicated for treating lateral lobe hyperplasia, with implants deployed at the 2 and 10 o'clock positions when viewing the transverse plane of the urethra. However, for treating median lobes, the implants are intended to affix the obstructing portion laterally to the prostatic urethra and should be deployed anterior to the 4 or 8 o'clock positions to avoid damage to the neurovascular bundles. This method opens the bladder neck and reduces the "ball-valve" effect caused by enlarged median lobes. MedLift examined the safety and efficacy of PUL in treating obstructing median lobes. Twelve-month results were recently published, demonstrating significant improvements in mean IPSS from baseline (-13.5; $p < 0.0001$), QoL (> 60%; $p < 0.0001$), BPHII (> 70%; $p < 0.0001$), and Qmax (range 90%-129% improvement; $p < 0.0001$).[46] From a safety standpoint, there was a 0% observed rate of post-procedure device-related serious complications, meeting the safety primary endpoint. Furthermore, there were no reported cases of de novo ejaculatory or erectile dysfunction. When results were compared to and combined with the original L.I.F.T. study, similar effectiveness and improvement of LUTS was found for treatment of lateral and median lobes. Further studies may help to continue expanding the indication and utility of PUL for treating median lobes in BPH.

TABLE 2. **Comparison between Rezum and Urolift**

	Water vapor thermal therapy Rezum	**Prostatic urethral lift Urolift**
Mechanism of action	• Heat • Necrosis of prostatic lobes using water vapor/steam injections • Long term: volume reduction	• Mechanical • Obstructing prostatic lobes held apart by small implants • Long term: tissue atrophy
Procedure type*	• Novel, minimally invasive surgical procedure for the treatment of BPH via a transurethral approach	
Indications*	• Moderate, to severe LUTS secondary to benign prostatic enlargement/ obstruction with underlying BPH • Failed medical management / Non-surgical candidates • Desires preservation of sexual function	
Anesthesia requirements*	• Local anesthesia (sufficient), transrectal prostatic block (if required)	
Treatment setting/location*	• Office, ambulatory surgical center, operating room (if required)	
Treated lobes*	• Lateral or Median	
Procedure time*	• Less than 1 hour	
Onset of action*	• < 1 month	
Prostate size*	• < 80 grams	
Post-procedural catheterization	• ~100% for an average of 3.4 days	• ~20% for an average of 1 day
Longest reported trial data	• 5 years	• 5 years
Randomized data	• **3** months against sham control	• 3 months against sham control • 24 months against TURP
Improvement of symptoms	• IPSS: mean 10.4 point decrease • Qmax: 4.3 mL/sec increase	• IPSS: 8-12 point decrease • Qmax: 2-5 mL/sec increase
Impact on sexual function	• No impact on erectile function • 3%-6% risk of developing ejaculatory dysfunction	• No impact on erectile function • No impact on ejaculatory dysfunction
Safety and adverse events*	• Transient, self-resolving within weeks • Mild to moderate symptoms, most commonly hematuria, dysuria, irritative symptoms	
Cost/reimbursements	• Covered by some of Medicare and most commercial plans	• Covered by all of Medicare and most commercial plans

*refers to both Rezum and Urolift

PUL offers a safe and effective office-based treatment option that can be performed using local anesthetic with minimal sexual side effects. Future studies continue to explore and expand the indications for PUL. The PULSAR (Prostatic Urethral Lift Subject With Acute Urinary Retention) clinical trial (NCT03194737) seeks to assess the feasibility and safety for using the PUL procedure in patients with acute urinary retention secondary to BPH. Additionally, the procedure is durable with a reported retreatment rate of 13.6% at 5 years.[41] Interestingly, this is a higher rate than the 5-year retreatment rate reported with Rezum (4.4%),[24] another office-based minimally invasive therapy for BPH. Further comparisons are listed in Table 2.

Conclusions

Minimally invasive surgical therapy is becoming a popular alternative to TURP or other more definitive prostate reducing procedures. Aquablation, Rezum, and Urolift are procedures that are currently approved by the AUA guidelines for the surgical management of BPH for patients with prostate sizes less than 80 grams. While PAE may be effective in treating LUTS by reducing prostate size, it is considered investigational by the current AUA guidelines. Aquablation, Rezum, and Urolift are surgical treatment options capable of providing rapid, significant, and durable relief of LUTS secondary to BPH. Rezum and Urolift procedures offer a distinct advantage over Aquablation since it can be performed in an office or an outpatient setting. Current AUA guidelines recommend each therapy for use in select patient populations. When performed in the appropriate patient, each therapy has been shown to have comparable or superior efficacy to TURP with the added advantage of preserving sexual function and decreasing patient morbidity and healthcare costs. It is important to counsel patients on all interventional options, considering prostate size and anatomy, sexual function, symptom severity, and patient expectations in order to provide successful individualized care. As urologists continue to investigate established and novel BPH treatments, the landscape for surgical BPH management will continue to evolve, providing unique opportunities for enhanced patient care. □

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