Updates on Preprocedural Evaluation and Patient Selection for Prostatic Artery Embolization

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Semin Intervent Radiol 2022;39:547–554

Abstract

Prostatic artery embolization (PAE) is a safe and effective treatment for benign prostatic hyperplasia. Patient evaluation is a critical and important part of this growing practice. History taking should include symptoms score evaluations for lower urinary tract symptoms, erectile function, and prostatitis symptoms score. The objective evaluations commonly include measurement of prostate specific antigen, postvoid residual volume, and uroflowmetry as well as urodynamic studies in selective patients. Imaging evaluation may include computed tomography angiography or magnetic resonance angiography, elucidating prostate volume, prostate gland morphology, vasculature, and prostate cancer. With evolving knowledge on PAE, we aim to discuss patient evaluation and selection based on updated evidence and discuss specific scenarios.

Keywords

- prostate
- embolization
- benign prostatic hypertrophy
- prostatic artery embolization
- lower urinary tract symptoms
- imaging
- interventional radiology

Benign overgrowth of the prostate gland or benign prostatic hyperplasia (BPH) can result in lower urinary tract symptoms (LUTS) as the result of bladder outlet obstruction (BOO). The prevalence of BPH increases with age in men and is seen in more than 80% of men older than 80 years. The Health Professionals Follow-Up Study on 25,879 men has shown that the rate of moderate to severe LUTS increases linearly with age.[1] The transition from an IPSS of less than 8 to IPSS of 15 or greater, or requirement for treatment (i.e., transition to moderate-severe LUTS), occurs at a rate of about 6/1,000 man-years in 40 to 54 years old but at about 39/1,000 man-years in men 75 years or older. Similarly, a longitudinal study in men 40 to 79 years old showed that prostate volume increases with age at approximately 1.6% per year across all age groups and growth rates are higher for men with larger prostates. Patients with larger prostates had 67% higher risk of developing LUTS compared with men with prostates smaller than 40 mL.[2] These figures translate to overall increase in LUTS with age; however, the correlation between prostate size and symptoms is poor[3]; LUTS can be seen at different stages of BPH and at different sizes of prostate.

LUTS can range from mild to severe, and to complete urinary retention. The rate of urinary retention is around 0.4 to 6.6% per year.[4] Other manifestations of BPH can be gross hematuria, and more importantly, urinary tract infections (UTIs) and life-threatening urosepsis. In more advanced stages, urinary retention can be a cause of renal failure or bladder dysfunction. These symptoms can negatively affect sleep, mood, sexual function, and result in decreased performance in daily activities, reduced quality of life, and/or depression.[5]

The management of BPH ranges from medical treatments to total prostatectomy. Among these treatments, prostatic artery embolization (PAE) has proven to be both effective and safe. PAE was initially discovered to be efficacious for the

Issue Theme Men's Health; Guest Editor, Jafar Golzarian, MD, FSIR

Thieme Medical Publishers, Inc., 333 Seventh Avenue, 18th Floor, New York, NY 10001, USA

DOI https://doi.org/10.1055/s-0042-1760274.
ISSN 0739-9529.

treatment of LUTS in 2000.[6] Since that time, hundreds of studies have been published, including roughly 40 systematic reviews and meta-analyses. Previous studies on patient evaluation and selection were performed prior to this growth in knowledge.[7] This article will provide an update on evaluation of patients presenting for PAE.

Medical Treatment

Symptomatic BPH should be initially treated with a trial of medical therapy for 3 to 6 months before invasive therapies are offered. The first-line medications are alpha-1-adrenergic antagonists (tamsulosin, terazosin, doxazosin, alfuzosin, or silodosin) which work by relaxing the prostatic smooth-muscle tone. This group of medications improve IPSS scores by 30 to 40% and increase urinary flow rates by 16 to 25%.[8,9] However, side effects of these medications can be prohibitive, and include orthostatic hypotension, dizziness, ejaculatory dysfunction, and headache. 5-Alpha-reductase inhibitors (finasteride or dutasteride) are usually prescribed in combination with alpha-1 blockers. This second group of medications work by reducing the size of the gland and therefore they may take several months to reach full effect. Their effectiveness in reducing IPSS is approximately half of alpha 1 adrenergic antagonists.[7] Additionally, their side effects are more disturbing which include erectile dysfunction, decreased libido, abnormal ejaculation, and depression. The third group of medications include phosphodiesterase-5 inhibitors (tadalafil) that have an unclear mechanism of action. This group has not been demonstrated to be useful as dual therapy with alpha-1-adrenergic antagonists or 5-alpha-reductase inhibitors.

In a large multicenter trial on more than 3,000 patients, on long-term combination therapy with doxazosin and finasteride, the overall clinical progression of BPH (defined as symptoms worsening, acute retention, UTI, or renal insufficiency) was significantly less than single-agent treatment.[8] However, combination therapy was associated with higher incidence of abnormal ejaculation, peripheral edema, and dyspnea, and therefore at mean follow-up of 4.5 years, 27% discontinued doxazosin and 24% discontinued finasteride by the end of the study raising medical treatment as a challenge. Finally, medical therapy alone is rarely adequate in men with severe LUTS.[7]

History and Physical Examination

As frequently has been expressed in literature, the evaluation of patients for PAE should always be a coordinated effort between a urologist and an interventional radiologist. The common causes of LUTS that should be ruled out prior to consideration of PAE are listed in ►**Table 1**.

The evaluation of patients with LUTS should include a complete medication and procedural history. Medication history's aim is to rule out if sympathomimetics, antidepressants, antipsychotics, antiarrhythmics, anticholinergics, or antiparkinsonian drugs could explain the patient's symptoms. Procedural history elucidates any prior history of surgical or nonsurgical treatments for LUTS.

Table 1 List of commonly encountered etiologies for lower urinary tract symptoms which need to be evaluated prior to consideration of prostatic artery embolization

Etiology
Urethral stricture
Bladder neck contracture
Prostate cancer
Passing stone
Meatal stenosis
Overactive bladder
Urinary tract infection
Radiation cystitis or prostatitis
Noninfectious chronic prostatitis
Bladder stones
Bladder cancer
Bladder diverticulum
Neurogenic bladder/detrusor sphincter dyssynergia

The components of LUTS are categorized into voiding or storage symptoms based on the mechanism and nature of symptoms. The voiding symptoms include weak stream, intermittency, hesitancy, dysuria, straining, incomplete emptying, and terminal dribbling which are obstructive in nature. These can be distinguished from storage symptoms such as urgency, frequency, and nocturia, which can also be related to an overactive bladder and are considered irritative in nature. Most men experience a combination of voiding and storage symptoms. These are evaluated in a self-reported questionnaire to quantify the patient's symptoms and assess their impact on quality of life, called International Prostate Symptom Score (IPSS) questionnaire. IPSS has been extensively validated and is a widely adopted evaluation tool for patients with LUTS. It has seven questions assessing the severity of the LUTS and is composed of three questions regarding irritative symptoms (urinary frequency, nocturia, and urgency) and four questions about obstructive symptoms (poor bladder emptying, intermittency, straining, and weak urinary stream).

Erectile function should also be assessed at baseline and follow-up using International Index of Erectile Function (IIEF) which is composed of 15 questions. A short version of this questionnaire which includes only five questions is called IIEF-5 or sexual health inventory of men (SHIM) and has been validated in multiple studies.[10]

Symptoms associated with chronic prostatitis should be evaluated in select patients with a history of chronic prostatitis. Chronic prostatitis symptoms can be evaluated using a standardized questionnaire called the Chronic Prostatitis Symptoms Index (CPSI) which assesses urinary and pain symptoms and their impact on quality of life.

Physical exam of the patient should include the routine airway assessment for the candidacy of moderate sedation during the procedure. Pulse exam is necessary to assess the

Table 2 Broad classification of patients who can be candidates for PAE

Age	Gland size and morphology	Other considerations
- Elderly group who are not surgical candidates - Younger men who wish to preserve sexual function and to avoid effects of surgery	- >50 mL No upper limit - Enlarged median lobe	- Hematuria due to BPH or prostate malignancy - Coexisting BPH with localized prostate cancer - Prior to prostatectomy to reduce the risk of bleeding (?) - Patients with chronic prostatitis

Abbreviations: BPH, benign prostatic hyperplasia; PAE, prostatic artery embolization.

vascular access site(s). Radial access has become more and more routine for PAE given the availability of longer microcatheters. The modified Barbeau test should be performed and documented to assess a patent palmar arch as has been previously described.[11] Genital examination is performed to assess any preexisting skin discolorations or other lesions that could potentially be confused for nontarget embolization complications. Finally, during the patient evaluation if patient has urinary catheter or any signs of UTI, it is important that those be documented, and any suspicion of UTI is ruled out.

Digital rectal exam provides a rough evaluation of the prostate, whereas imaging and laboratory evaluations for prostate cancer are more thorough and are widely adopted as part of the practice for preprocedural evaluation. Therefore, digital rectal exam is not frequently performed in the offices during the physical examination prior to PAE (►**Table 2**).

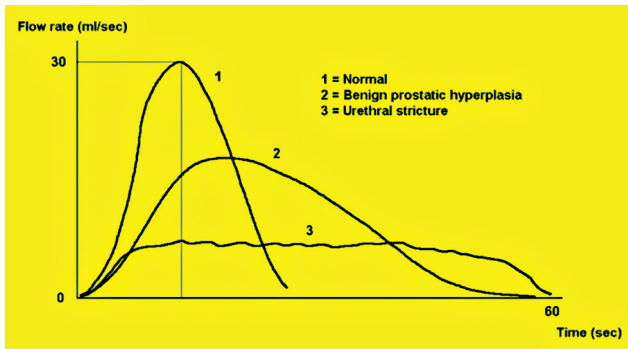

Fig. 1 Three common patterns of voiding during uroflowmetry. 1, normal pattern; 2, demonstrative of BPH with dampened maximum flow rate and then a prolonged duration of bladder contraction to empty the bladder. 3, indicative of urethral stricture, with a "box-shape" pattern, where there is a continuously restricted flow of urine and peak can be achieved due to stricture in the urethra.

Objective Measurements

Uroflowmetry is a noninvasive assessment of free flow of urine (measured in mL/s) and is performed in the patient's preferred voiding position. This is followed by the measurement of postvoid residual (PVR) volume using transabdominal ultrasound or urinary catheter. Although PVR has not been shown to correlate with degree of LUTS, it is helpful in the assessment of the patient's baseline bladder function, and for follow-up after PAE. A PVR volume of less than 50 mL is normal. PVR of less than 100 mL is usually acceptable in patients 65 and older, but it is abnormal in patients younger than 65 years. The PVR greater than 300 mL is indicative of chronic retention. The third important parameter measured in uroflowmetry is volume of urine voided (mL). The accuracy of the test is improved with sufficient volume of voided urine (125–150 mL). BOO is diagnosed when maximum urine flow (Qmax) is less than 15 mL/second. A box-shape flow curve pattern typically indicates urethral stricture which renders PAE ineffective, as the primary etiology of LUTS is not BPH (►**Fig. 1**).

If uroflowmetry does not show obstruction definitively, or if there are mixed or equivocal findings, then urodynamic evaluation can be considered. Urodynamic study provides measurements on storage and voiding pressures, and pelvic floor electromyographic activity and therefore is a more direct measurement of physiological parameters in lower urinary tract. Patient is placed supine, and a multilumen catheter is inserted into the bladder. This catheter is usually 6 to 7 Fr and has multiple lumens for concurrent pressure monitoring and fluid infusion simultaneously. Another catheter is inserted into either rectum or vagina for estimation of intra-abdominal pressure. The two phases of standard urodynamic testing include cystometry during the filling phase and a pressure-flow study during the voiding phase. Cystometry is the dynamic measurement of detrusor pressure during the continuous filling of the bladder and determines bladder compliance and capacity. A pressure-flow study is the measurement of the pressure generated by the detrusor muscle and the resulting flow and begins following the micturition. Poor urine flow results from either impaired detrusor contractility or outflow obstruction which urodynamic study can distinguish based on synchronous measurement of detrusor pressure. While urodynamic study provides invaluable information, it is not routinely performed in patients with BPH due to its invasive nature.

UroCuff® is a new noninvasive evaluation tool, which provides similar findings to urodynamics in a noninvasive fashion. A small cuff is wrapped around the penis and patient will be asked to urinate into the UroCuff® flow meter. As patient urinates, the cuff will begin to inflate until it disrupts urine flow and then it will deflate allowing urination. Bladder function based on urine flow rate versus cuff interruption pressure (estimating bladder pressure) will be measured. At completion, usually a PVR is also measured by ultrasound.

Objective measures of maximum urine flow rate and PVR are two widely accepted parameters, and are frequently measured by practices at baseline and at follow-up.

Update on Cross-Sectional Imaging Angiographic Evaluation

Review of any cross-sectional imaging that patient may have had within a year is helpful in the evaluation as well as planning for PAE. The pelvic vasculature, prostate gland volume and morphology, configuration of the gland by characterizing adenomatous prostate tissue, and the prostate cancer evaluation are the main aspects of evaluation.

Preprocedural pelvic CT angiograms (CTAs) can assess the degree of iliofemoral atherosclerosis and tortuosity of the vessels and the prostatic arterial anatomy for planning purposes. Sublingual nitroglycerin can be administered immediately prior to the scan to vasodilate the prostate arteries, optimizing their visualization.[12] The practices vary in this regard, and some practices prefer a preprocedural CTA, whereas others prefer an intraprocedural cone-beam CT (CBCT). Advantages of preprocedural evaluation include proper planning by informing the providers on vasculature and prostate volume and configuration. On the other hand, CBCT can provide collateral flow to sites of nontarget embolization while also provide information on prostate gland and vasculature and some data indicate that there is no added value for preprocedural CTA.[7,13,14] A CT urogram is the standard of care for gross hematuria which includes an unenhanced scan, a nephrographoc phase and an excretory phase to assess for upper tract pathology including stones, renal masses, and urothelial thickening that may signal transitional cell carcinoma.

Some practices incorporate MR angiography (MRA) and report a significant benefit. In a retrospective study on 259 BPH patients, 137 patients underwent MRA prior to PAE. The origin of prostatic artery was identified in all cases. More importantly, there were significant differences regarding volume reduction (-20 mL with MRA vs. -17 mL without MRA), radiation dose (5,518.54 μGym^2 with MRA vs. 23,963.50 μGym^2 without MRA), and fluoroscopy times ($\sim$19 minutes with MRA vs. $\sim$27 minutes without MRA). There were even more IPSS reductions in the MRA group (-11 points with MRA vs. -7 points without MRA, $p < 0.001$) after PAE.[15] A similar study with randomized controlled clinical trial design, on 100 men who were randomly assigned to MRA and non-MRA groups, showed that MRA led to shorter PAE detection times and lower radiation dose. MRI evaluations can also be informative in the determination of the gland configuration.[16] A case–control study compared 12 patients who had adenomatous-dominant BPH with a matched group of patients without this feature. Adenomatous-dominant BPH was defined as two or more adenomas measuring 1 cm or greater, within the periurethral transition zone on MRI. This study demonstrated that patients with adenomatous-dominant BPH had more volume reduction (34 vs. 22%, $p = 0.04$) and had better improvement in IPSS.[17]

Cystoscopic Evaluation

Cystoscopic evaluation has critical roles in patients presenting with both hematuria and LUTS. The management of gross hematuria usually starts with conservative measures and bladder irrigation. Cystoscopy is needed for the evaluation of gross hematuria which can demonstrate the sources of bleeding such as bladder tumors, bladder calculi, prostate cancer, or BPH. If the source of the patient's hematuria is found to be BPH without any other culprit etiologies, fulguration of the bleeding tissue can be performed when prior conservative measures such as 5-alpha-reductase inhibitors has not worked. In patients with intractable or recurrent hematuria, PAE is extremely effective in resolving the bleeding.[18,19]

In patients presenting with LUTS, the cystoscopy can also elucidate etiologies such as urethral strictures, bladder neck contractures, bladder stones, or indirect findings related to bladder dyssynergia. In cases that etiologies other than BPH are ruled out, cystoscopy is very helpful in revealing the size as well as the morphology of prostate gland (median lobe hypertrophy, lateral lobe impingement, or trilobar hyperplasia) which can in turn guide the type of treatment and preprocedural planning.

Size of the prostate gland is very important as some procedures are not recommended per guidelines for gland size larger than 80 mL or an enlarged median lobe. While markedly enlarged glands or hypertrophic median lobes may affect the surgical procedures, these factors are not raising issues for PAE and more and more ensuing data confirm the efficacy and safety of PAE in situations such as large glands or with intravesical prostatic protrusion.

Prostate Cancer Evaluation

The prostate-specific antigen (PSA) level can be used to screen for prostate cancer, although one should be aware that PSA also increases with increasing glandular volume and that some men with prostate cancer will have a normal PSA. That is why PA density (PSA/gland volume) is preferred and PSA density of greater than 0.15 is associated with higher likelihood of prostate cancer.[20]

The lifetime risk of being diagnosed with prostate cancer is 15% but risk of dying of prostate cancer is less than 4%.[21,22] Early stages are usually asymptomatic, but advanced stages may have symptoms similar to BPH. Radical prostatectomy for prostate cancer can be considerably more challenging and has a higher complication rate after transurethral resection of the prostate (TURP). However, it is not entirely clear whether PAE changes the prostate cancer surgery. Nonetheless, it is generally accepted to evaluate for prostate cancer prior to PAE using PSA values, digital rectal exam, or prostate MRI.

It is noteworthy that palliative PAE to treat LUTS in prostate cancer has been reported in small series. In 14 patients (10 bilateral, 4 unilateral), PAE was performed and 9 had urinary retention (for mean of 20.4 months) and 5 had severe LUTS (mean IPSS of 23.6). The mean prostate volume was 66.7 cm^3. All men with LUTS in this study had significant improvement in IPSS without major adverse events.[23]

Additionally, in the patients with localized prostate cancer and LUTS due to concomitant BPH, PAE can also be considered. A series of 21 men with localized prostate cancer (Gleason score of 7) and elevated PSA mean of 8.64 and prostate MRI

findings consistent with prostate imaging-reporting and data system (PIRAD 4—clinical significant cancer is likely) were evaluated. These patients also had LUTS (IPSS of 20) due to BPH and underwent PAE and had improved IPSS with median improvement of 12 and 14 points at 6 and 12 weeks after PAE, respectively. Similarly, quality of life improved by a median of 2 and 3 ($p < 0.0001$) at 6 and 12 weeks and the prostate volume decreased by a median of 24 and 36% at 6 and 12 weeks. In this series, there was no disease progression and no PSA increase after radiation, concluding that PAE was effective and safe in the setting of concomitant BPH and a localized, nonobstructive prostate cancer.[24]

PAE for the control of hematuria in the setting of prostate cancer is also historically performed with a high success.[25] In a series of 20 patients who initially failed conservative measures (continuous bladder irrigation, silver nitrate, or cystoscopy to confirm site of bleeding with attempted resection/fulguration), PAE was successfully performed in all (100%) patients and all treated patients had immediate cessation of gross hematuria within 48 hours.[26]

Further studies are needed to evaluate the surgery after PAE, but available small series have shown that surgical procedures were safe and uneventful after PAE.[27] In summary, PAE has proven to be effective and safe in the control of hematuria and LUTS in localized prostate cancer or in palliative setting and this emphasizes the role of multidisciplinary decision-making in these patients.

Segmental Morphology and Median Lobe Hypertrophy, and Prostate Size Implications

Intravesical prostatic protrusion (IPP) is a phenomenon in which the prostate adenoma enlarges into the bladder along the plane of least resistance. Previous studies in men with IPP have demonstrated an increased rate of BOO or progression of clinical BPH in this setting. BPH as initially described by Alexander Randall in the early 20th century,[28] can have different patterns including lateral lobe, trilobular, median lobe, subtrigonal lobe, subcervical hypertrophy, or median hypertrophy, or any combination thereof.[7] The median lobe arises from the periurethral zone and is situated between the urethra and ejaculatory ducts. While lateral lobe BPH would cause compression of the prostatic urethra, median lobe IPP may trigger a "ball-valve" type of obstruction, disrupting laminar flow at the bladder neck and distorting the funneling effect of the normal prostatic–urethral angle, which leads to dyskinetic movement of the bladder during urination.[28] This would result in more severe obstruction than if there were no protrusion because the strong bladder contraction could force open a channel between the lobes, whereas it tends to aggravate the "ball-valve" effect in the presence of IPP. A clinical study found that IPP was the only significant risk factor for uroflowmetry-confirmed terminal dribbling. As a result, IPP has multiple implications in the choice of treatment. If there is a higher grade of IPP, this might cause more surgical damage at the level of the internal urethral sphincter during bladder neck dissection. Additionally newer techniques such as UroLift® are not appropriate in this setting.[29] In contrast, the embolization of median lobe can be safely performed along with the rest of the gland during PAE with successful shrinkage of this portion of the prostate.[30] Study on 43 patients who underwent MR imaging at baseline and 6-month follow-up showed that there was a mean decrease in prostate volume of 18.2% ($p = 0.0001$): 37% of patients had intravesical prostatic protrusion, and 100% of them showed a decrease in size of median lobe.[31] Additionally, recent study showed that the degree of IPP does not limit the efficacy of PAE in the control of LUTS in patients with BPH.[32,33]

Multiple emerging evidences from different series have proven that PAE is effective and safe in prostate glands larger than 80 mL as well as in smaller glands. The efficacy of PAE in large glands is very important, as surgical options for these glands become very limited and riskier.[34] Generally, prostates larger than 80 mL are considered as large glands, and many transurethral procedures will become challenging or less effective. Median lobe hypertrophy or glands greater than 80 mL are not candidates for prostatic urethral lift or water vapor energy ablation. The glands greater than 80 mL are generally not candidates for minimally invasive transurethral procedures and studies performed on water vapor surgery (Rezum, Boston Scientific, Marlborough, MA) and temporary implantable nitinol device (iTIND, Medi-Tate Ltd, Israel) and also prostatic urethral lift (PUL, Urolift, Neotract Inc., Pleasanton, CA) were all performed in populations with prostates smaller than 80 mL.[35–37] Additionally, broad-based median lobes were considered as risk factors of a poor response to Rezum, PUL, and iTIND. Aquablation (Aquabeam; PROCEPT BioRobotics, Redwood City, CA) is a novel technique using real-time ultrasound imaging combined with a high-velocity waterjet to resect prostate tissue.[29] The Aquablation was shown to have results similar to TURP with noninferiority of Aquablation in IPSS, Qmax, QoL, and PVR improvement and stable results up to 3 years. WATER II trial which was a single-arm study also showed the efficacy of Aquablation in prostate glands measuring between 80 and 150 mL,[38] indicating the usage of this technique in glands larger than 80 mL. But there was postoperative need for transfusions in approximately 8% of patients. However, the ejaculatory function was preserved in 90% patients. Given Aquablation is a resective technique there is a need for anesthesia and hospitalization. Overall, despite an inferior relief of BOO compared to resective techniques, PAE is an effective therapy for patients with LUTS/BPH, especially with larger prostate volumes as well as enlarged median lobes. PAE has shown to be safe and effective in the treatment of glands at any size and particularly larger glands have shown very promising results after PAE.[39]

Chronic Prostatitis

The National Institute of Health Type III chronic prostatitis/chronic pelvic pain syndrome represents 90% of all prostatitis cases and results from an inciting agent causing prostatic damage and results in a complex combination of symptoms including pelvic floor pain, perineal pain, and LUTS. This is a nonbacterial chronic prostatitis and the exact etiology is not clearly known. The treatment is therefore

challenging and focused on clearance of underlying inflammation, pain control, and alleviating LUTS. In this group of patients, a course of anti-inflammatory medications should be attempted first.

The key in the evaluation of these patients is to pinpoint the different symptoms categories by filling the CPSI score, and clearly documenting the severity of LUTS versus pain-related symptoms from chronic prostatitis. The size of the prostate gland in these patients is not as critical in decision-making and the goal of treatment is to prune the distal vasculature. Little is known regarding management of this entity but in a small series of patients who had findings of chronic prostatitis in the setting of prior radiation for prostate cancer, there was improvement in CPSI score of 9 points and quality of life was improved in 89% (8 out of 9) at 12 weeks.[40]

Adverse Events

For patients who fail medical management, or have side effects from medical management, PAE is one of the proven procedural options for treatment of LUTS. Multiple clinical trials have compared PAE with gold standard of TURP. Those studies have all shown similar positive impact on improvement of IPSS and quality of life, with less hospitalization, catheterization, recovery time, and complications.[41–43]

Other minimally invasive options include photoselective vaporization, water vapor (Rezum), prostatic urethral lift (UroLift), transurethral microwave thermotherapy, Aquablation, and transurethral incision. A recent systematic review compared the minimally invasive methods for treatment of BPH[44] and showed no difference in major or minor adverse events between Rezum, Urolift®, Aquablation, and PAE. Surgical options for larger glands include open or laparoscopic prostatectomies which are extremely invasive options with complications. Transurethral holmium and thulium laser enucleation of prostate (HoLEP and ThuLEP) are transurethral techniques that can be used for large glands. These techniques have a steep learning curve and require general anesthesia.

There are no reports of urethral or sexual/ejaculatory dysfunctions associated with PAE. These include retrograde ejaculation, which can be seen in up to 66% of patients after TURP. Only in one large study, retrograde ejaculation was reported after PAE but it was thought to be due to concomitant use of alpha blockers.[45] The risk of urethral stricture and incontinence is also present after transurethral procedures but are not seen after PAE. Erectile dysfunction can be seen in transurethral procedures, but interestingly some studies have shown slight improvement in erectile function[46] and no reports have shown any negative impact on erectile function after PAE. Bleeding requiring transfusion is reported in 2.5% of patients in large TURP series, but this is not reported after PAE. In a meta-analysis of 662 patients,[47] there were only two Society of Interventional Radiology class C adverse events (requiring therapy and minor hospitalization <48 hours) and most commonly encountered adverse events were minor and were seen in 3 to 7% of patients and included transient urinary retention, dysuria, transient hematuria, hematospermia, and transient rectorrhagia. Another meta-analysis comparing PAE with TURP from six studies and on 598 patients reported overall 50% total adverse events among PAE patients versus 98.6% in patients who underwent TURP ($p < 0.00001$). Within these, the severe adverse events were no different (2.8 vs. 5.8%, in PAE vs. TURP, $p = 0.069$) (►**Table 2**).[48]

Conclusion

BPH is a common health condition and a variety of treatments are available for it. Few characteristics of PAE are heavily studied such as performing PAE under sedation and medically unfit patients for anesthesia. Additionally few studies have shown promising results in prostate glands greater than 80 mL. Radial access allows treatment of patients who are on anticoagulation/antiplatelet agents. PAE also preserves sexual and ejaculatory functions which will be particularly important in men younger than 65 years. PAE for control of hematuria or LUTS in patients with prostate cancer has shown promising results. IPP can be considered a contraindication for multiple transurethral methods, but PAE has proven efficacious for this condition. New horizons such as consideration of PAE for patients with chronic pain symptoms related to chronic prostatitis require further evidence but has shown promising preliminary response in select group of patients. Additionally small series have shown improvement of LUTS in patients with concomitant BPH and localized prostate cancer without adversely affecting course of prostate cancer treatment. Future research should focus on long-term results after PAE in these selective groups of patients to delineate better the patient selection for this procedure as well as more long-term durability of results after PAE.

Conflict of Interest
None declared.

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