Review Article

Prostatic Artery Embolization: A Systematic Review Article

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Abstract

Since the first case report in 2000, there has been a rapid expansion of prostatic artery embolization (PAE) as a therapy for symptomatic benign prostatic hyperplasia. The published literature and clinical experience show that this procedure is safe and effective. This article discusses the brief history, current issues in technique, and the state of the literature regarding outcomes of PAE. Current and future research topics are also discussed.

Keywords

- prostatic artery embolization
- benign prostatic hyperplasia
- International Prostate Symptom Score

Introduction

Benign prostatic hyperplasia (BPH) is a common urological condition affecting more than 50% of men by the age of 60 years and potentially affecting up to 80% by the age of 70 years.[1,2] It is associated with a diminished quality of life (QoL) due to lower urinary tract symptoms (LUTS), which, if untreated, can progress to urinary retention and renal dysfunction. Traditional conservative therapies, including lifestyle modification, medication, and surgery, are the primary treatments for managing LUTS. Prostatic artery embolization (PAE) is a technique first defined in 2000 that bleeds (secondary to biopsy or prostatectomy) or refractory hematuria of prostatic origin (RHPO).[3–7] DeMeritt et al reported the therapeutic potential of PAE for BPH, observing prostate volume (PV) reduction and International Prostate Symptom Score (IPSS) improvement at 12 months.[8] Two animal model studies demonstrated PV reduction with preserved sexual function and no significant complications with PAE.[9,10] The first report of PAE in humans for treating BPH was documented by Carnevale et al in 2010.[11] Pisco et al, from Portugal, reported favorable 3-year results for PAE, supporting its role as an effective treatment option.[12–14] Subsequent studies reported improved QoL, reduced IPSS, and minimal complications.[15,16] The first randomized controlled trial indicated that transurethral resection of the prostate (TURP) had higher complication rates with similar clinical outcomes compared with PAE.[17]

Indications

PAE is a therapeutic option for individuals with LUTS attributable to BPH. BPH is characterized by the proliferation of epithelial cells and smooth muscle fibers in the transitional zone, leading to prostate gland enlargement and abnormal smooth muscle tone. The enlarged prostate causes both obstructive and irritative symptoms categorized as LUTS, including frequency, urgency, nocturia, urge incontinence, weak stream, hesitancy, straining, intermittent stream, dribbling, overflow incontinence, and chronic urinary retention. Patients should undergo a detailed assessment before the procedure, including a complete review of medical history,

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symptoms, medications, previous treatments, and biochemical parameters.

PAE is also used to treat RHPO.[18] A comprehensive urologic examination is necessary to rule out other potential causes of hematuria, such as prostate cancer, which is initially treated with continuous bladder irrigation and can be challenging to manage. Cystoscopy-guided transurethral therapies may be needed in more advanced or therapy-resistant cases. Research shows promising outcomes; PAE resolved hematuria in at least 67% of patients with prostate cancer who had cystoscopy and bladder irrigation procedures.[19] In patients with gross hematuria due to BPH, 92% were symptom-free approximately 483 days after PAE.[20]

For patients with catheter-dependent urinary retention due to prostate cancer, PAE can serve as a palliative therapy, particularly for those not suitable for surgery. In a study involving advanced prostate cancer patients, PAE reduced the IPSS by an average of 12.2 points in five patients.[21] PAE is a viable alternative for patients with chronic indwelling catheters due to BPH, especially those who are not surgical candidates. It has demonstrated safety and efficacy, resulting in catheter removal in 81 to 87% of cases.[22–24]

In cases of iatrogenic hemorrhage following TURP or other urologic interventions, PAE has been effective, particularly when conservative measures fail.[25] It is useful when ongoing bleeding obscures the source during cystoscopy.

Finally, PAE remains an effective option for individuals who have not responded to transurethral therapies for BPH. Patients showing poor response to initial interventions displayed significant improvement 3 months after PAE, with a mean IPSS reduction of 13.7 and approximately a 32% decrease in prostate gland size.[26] In summary, for patients who have not achieved success with other urologic therapies, PAE presents a viable treatment option.

The Workup

All patients scheduled for the PAE procedure should undergo evaluation by both a urologist and an interventional radiologist. Conditions that mimic LUTS symptoms in BPH, such as neurogenic bladder, overactive bladder, urethral stricture, or detrusor dysfunction, need to be ruled out before planning the procedure.[27,28]

The preprocedure workup for PAE includes a comprehensive review of the patient's medical history, physical examination, blood tests, the IPSS, imaging studies, urodynamic studies, and possibly a prostate biopsy.[29] Preexisting conditions or risk factors that might affect the procedure or its outcomes are identified. Urinary tract infections can cause complications during embolization, increasing the risk of postprocedural issues, and may warrant urinalysis and culture if suspected. Bladder stones and strictures can affect the success of PAE, requiring further imaging with a pelvic sonogram or cystoscopy for confirmation.

A complete blood count is performed to identify any potential bleeding disorders. Additional tests, such as measuring prostate-specific antigen (PSA) levels, aid in diagnosing and monitoring prostate conditions before and after the treatment.[30] Reviewing medications is essential, as patients might be on alpha-adrenergic blockers and anticoagulants, which may require temporary discontinuation under medical guidance during the procedure and recovery period.

Urodynamic studies provide crucial information about bladder and urethral function, differentiating between obstructive and nonobstructive symptoms and assessing bladder capacity and compliance. In atypical cases, a prostate biopsy may be suggested to rule out prostate cancer.

IPSS is a standardized tool used to assess the severity of symptoms in BPH management. The survey consists of seven questions, each scored from 0 to 5, classifying symptoms into mild (0–7), moderate (8–19), and severe (20 and above). It includes a QoL assessment, allowing patients to rate their satisfaction on a scale from 0 (satisfied) to 6 (miserable).[31,32] A symptom score exceeding 13 generally indicates the need for treatment interventions, though consensus on this threshold is not universal.[33–35]

IPSS evaluation separates into storage symptoms, such as frequent and urgent urination, and voiding symptoms, such as incomplete emptying and weak urine stream. Prostate conditions mainly elevate voiding symptom scores, whereas increased storage symptoms may suggest other LUTS causes, necessitating more detailed urologic assessments such as urodynamic testing. Differentiation between these symptom types can predict PAE effectiveness, with beneficial outcomes noted in patients with prominent voiding symptoms.[36,37]

The International Index of Erectile Function (IIEF) evaluates erectile dysfunction. Sexual side effects are common with BPH treatment, impacting treatment decisions. Reports suggest PAE does not worsen erectile function; some patients observe improvement. For example, a study indicated a mean improvement of 1.2 ± 5.74 points in IIEF scores among 630 participants, with 64% maintaining or improving their scores.[38] By contrast, TURP patients have about a 70% rate of retrograde ejaculation.[39] Although new TURP techniques may reduce this incidence, a study found rates of 24.1% for PAE and 47.5% for TURP.[40] Despite limitations (baseline data absence and medication influence), a retrospective PAE study reported no retrograde ejaculation occurrences.[41] Meta-analyses indicate a 0 to 2.3% probability of retrograde ejaculation post-PAE; however, 16% may experience temporary sexual side effects such as hematospermia.[42,43]

Most patients undergo transrectal ultrasound and contrast-enhanced computed tomography (CT) or magnetic resonance (MR) for cross-sectional imaging before consultation. This imaging assesses anatomy, the arterial supply, and PV, noting arterial tortuosity, calcifications, and iliac artery stenosis.[44]

Research on PV significance in PAE outcomes is mixed. Some studies associate improved clinical outcomes with larger prostate sizes. For example, patients with prostates larger than 80 g showed better improvements in IPSS, residual urine postvoiding, and PV compared with those with smaller prostates.[45,46] However, other studies find minimal correlation between prostate size and clinical outcomes. Patients with prostates smaller than 40 g should be counseled on treatment options.[47–49]

Prostate lobe morphology, especially intravesical prostatic protrusion (IPP) or median lobe hypertrophy, may impact PAE outcomes. IPP can potentially worsen post-PAE obstructive symptoms due to gland softening. A prospective study linked IPP to negative post-PAE outcomes, such as acute urinary retention.[50] However, the degree and morphology of IPP are more critical than mere presence, as a thickness-to-height ratio below 1.3 was linked to complications and lower clinical outcomes.[51] Finally, discussing the procedure, risks, and alternatives in detail before obtaining consent is crucial, allowing patients to understand the risks and benefits and provide informed consent.[52]

Preprocedure, Intraprocedure, and Postprocedure Care

Preprocedure Preparation

Before the procedure, patients receive a prophylactic dose of antibiotics, typically 400 mg of ciprofloxacin or 2 g of ceftriaxone intravenously.[28,48,53] Intravenous fluids (0.9% normal saline) are administered at a rate of 100 mL/h to ensure adequate hydration. Patients are also given nonsteroidal anti-inflammatory drugs (NSAIDs) to manage postembolization pain or discomfort.[28] The procedure is conducted under conscious sedation in the interventional radiology suite. A Foley catheter may be placed postsedation, filled with a diluted contrast solution at a 1:10 ratio, to aid in locating the prostate gland during fluoroscopy.[54] While not mandatory, the Foley catheter can be beneficial for precise gland localization and extended procedures.

Intraprocedure Care

During the procedure, the patient's vital signs, including heart rate, respiratory rate, and blood pressure, are closely monitored. Transradial and transulnar approaches are preferred for their comfort and reduced hospital stays, although they require careful equipment selection due to smaller vessel diameters.[55,56] Before a transradial approach, collateral circulation is assessed using the Barbeau or modified Allen's test. The traditional approach uses the femoral artery.[57] The arterial access site is prepared, and local anesthesia is administered.

For PAE, after femoral access, the contralateral internal iliac artery is catheterized with a 5F angled catheter. A longer vascular sheath may be used for challenging cannulation due to arterial tortuosity. Digital subtraction angiography (DSA) images, taken at specific angles, visualize the arterial anatomy and prostate blood supply. Reviewing previous imaging is important for minimizing radiation exposure and optimizing DSA acquisition. Cone-beam CT can assist if the prostate artery's origin is unclear.[27,58] An alternative is using cone beam CT with a 5F pigtail catheter in the abdominal aorta to visualize pelvic vasculature before catheter insertion, minimizing necessary angiographic runs.[59]

Understanding anatomical variations is crucial to avoid nontargeted embolization. The proximity of the prostate artery to the bladder, rectum, and ejaculatory system vessels requires careful navigation to prevent ischemia of nonprostatic tissues due to various anastomoses.[60–62] Identifying and coiling collateral vessels before embolizing the prostatic artery can mitigate complications. After identifying the artery, a 0.020" microcatheter with a 0.014" wire is advanced for precise embolization. DSA imaging is conducted to confirm prostate contrast uptake and rule out nontarget embolization.[63] Navigating vessel tortuosity is accomplished using hydrophilic guidewires, microcatheters, and advanced imaging techniques, enhancing procedural safety and success.

Embolic material is injected into the prostate arteries, with the choice of the agent being critical for optimal outcomes. The selection depends on factors such as artery size, desired occlusion level, and patient condition. Spherical polyvinyl alcohol and tris-acryl gelatin microspheres are commonly used. Spherical particles provide predictable embolization, while nonspherical microspheres improve vessel occlusion. Studies show no significant therapeutic outcome differences between particle sizes, but smaller particles are preferred for superselective embolization.[62–65] Embolic coils are used for targeting large collateral vessels. The embolization end point is determined by observing stasis in the prostatic arteries and the contrast reflux.

The "PErFecTED technique," developed by Carnevale et al, enhances PAE outcomes by initially embolizing from the artery's proximal location, then advancing the microcatheter distally for further embolization, leading to improved clinical results.[54] To manage vasospasm, diluted nitroglycerin is prepared for intra-arterial use due to the small and tortuous nature of prostatic arteries.[58] Coil embolization is used as necessary, in up to 26% of cases, to prevent distal particle embolization.[66] Following contralateral embolization, the ipsilateral internal iliac artery is cannulated using a Waltman loop or reverse curve catheter. Ipsilateral PAE is conducted following the same protocol.[59,67]

Postoperative Care

Immediate postoperative care involves monitoring the patient's vital signs, managing pain, and ensuring proper hemostasis at the access site. Close observation is required to detect any potential complications, such as bleeding or infection. Depending on the specific case and the protocol of the medical center, the patient may be observed for a few hours or overnight. If a Foley catheter is inserted, it is removed postprocedure. Patients must demonstrate the ability to urinate voluntarily before discharge, as urinary retention occurs in approximately 5 to 8% of patients, likely due to prostate inflammation.[27,68,69] Prescriptions for NSAIDs and antibiotics continue as needed postprocedure.[28] Follow-up clinic visits are scheduled to evaluate the patient's symptoms, urinary function, and QoL. Ultrasound or MR imaging (MRI) studies can be conducted during follow-up to assess prostate size and the degree of necrosis, thereby evaluating the procedure's outcome.

Efficacy and Safety of PAE

Prospective and Retrospective Case Studies

Numerous studies have demonstrated the efficacy of PAE in improving LUTS and urinary flow rates in patients with

BPH.[37,49,70–73] Two significant prospective studies provide insight into these improvements. One study analyzed urodynamic changes post-PAE, showing enhancements in parameters such as reduced detrusor pressure, increased maximum flow rate, and improved voiding function.[55] Another single-center study with 12-month follow-ups highlighted that PAE primarily improves voiding symptoms over storage symptoms, showing a reduction for voiding symptoms of 1.9 versus 1.5 for storage symptoms ($p = 0.023$). This aligns PAE's efficacy more closely with TURP concerning flow-related symptom improvement.[74]

In one of the largest retrospective studies, Pisco et al examined medium (1–3 years) to long-term (3–6.5 years) outcomes in 630 patients, observing no sexual dysfunction or urinary incontinence in about 76.3% of cases. Both medium- and long-term follow-ups demonstrated mean improvements in the IPSS, QoL, and erectile function, with IPSS reductions of −13.7 in the short term, −14.5 in the medium term, and −16.9 in the long term. Additionally, there was a consistent decrease in PV and PSA levels over these periods, reinforcing PAE's role in alleviating LUTS in symptomatic BPH.[38]

Another extensive long-term retrospective study of 317 patients with a median follow-up of 72 months indicated a 23% symptom recurrence rate. The mean maximum IPSS improvement was 16 points (± 7), QoL improved by 4 points (± 1), and PV reduction reached 39%, with postvoid residual (PVR) volume decreasing by 70 mL ($p < 0.05$ for all). Notably, no patients experienced urinary incontinence or erectile dysfunction.[67]

The UK Register of Prostate Embolization, a multicenter registry, included 305 patients, with 216 undergoing PAE and 89 undergoing TURP.[40] Results showed a median 10-point IPSS reduction at 12 months post-PAE, slightly less than the 15-point reduction observed following TURP. Objective measures indicated a 3 mL/s increase in Qmax and a 25 mL (27.8%) decrease in PV after 12 months.[41] The Clavien–Dindo classification assessed postprocedure complications, with no major Clavien Grade 3 issues reported in either group. However, the reoperation rate was higher in the PAE group (19.9%) compared with the TURP group (5.6%).

A retrospective single-center study involving 154 patients who underwent PAE with 12-month follow-ups noted that 76 patients experienced spontaneous acute urinary retention requiring indwelling catheters. Successful catheter removal occurred in 70 (92.1%) patients within 30 days postprocedure, with catheterization freedom rates of 90.3, 83.3, and 80.6% at 3, 6, and 12 months, respectively. The median time from PAE to catheter removal was 10 days.[75]

Randomized Controlled Trials

There have been a few prospective randomized controlled trials comparing PAE with TURP. In one of the initial trials, 114 patients were randomized to either PAE or TURP, with outcomes such as IPSS, QoL, peak urinary flow, PVR urine volume, PSA level, and PV evaluated at multiple follow-ups over 5 years.[17] Both groups showed significant reductions in baseline IPSS scores, with TURP demonstrating quicker improvement at the 1-month mark (−11.0 for TURP vs. −5.1 for PAE). At longer intervals, reductions were more comparable. TURP achieved a 100% technical success rate and a 3.9% clinical failure rate, while PAE had a 94.7% technical success rate and a 9.4% clinical failure rate. Using the Clavien–Dindo classification, the PAE group exhibited more adverse events (29%), with acute urinary retention (25.9%), postembolization syndrome (11.1%), and treatment failures (9.4%) being notable.

Another trial included 30 patients undergoing TURP, original PAE (oPAE), or PErFecTED PAE.[63] Groups were similar in pretreatment parameters except for bladder contractility, peak urine flow rate (Qmax), and IIEF score. TURP improved bladder contractility and Qmax more effectively, while the PErFecTED PAE group exhibited higher IIEF scores. IPSS, QoL, PV, and Qmax improved across all groups, with TURP (−21.5 points) and PErFecTED PAE (−21 points) achieving lower IPSS scores than oPAE (−12.5 points). TURP resulted in higher Qmax and reduced PV but required spinal anesthesia and hospitalization. Two oPAE patients experienced symptom recurrence necessitating TURP. Urinary incontinence was reported in 4 out of 15 TURP patients, with additional complications such as prostatic capsule rupture, retrograde ejaculation, and readmission for hematuria.

A third prospective trial involving 103 patients compared PAE and TURP, measuring primary outcomes after 12 weeks.[76] PAE achieved near-equivalent changes in IPSS compared with TURP, with reductions of −9.23 points versus −10.77 points, respectively. TURP outperformed PAE in secondary measures such as urinary flow rate, PVR, and PV reduction. The Clavien–Dindo classification showed TURP had more adverse events, highlighting a potential safety advantage for PAE.

In a recent trial involving 45 men, 23 received PAE and 22 underwent TURP.[77] At 12 months, PAE showed a Qmax increase of 6.1 mL/s, slightly lower than the 9.6 mL/s seen with TURP, and a larger IPSS reduction of 21.0 points compared with TURP's 18.2 points. QoL improved more significantly in the PAE group, which also experienced fewer adverse events than TURP.

A single-blind randomized controlled trial from 2014 to 2019, involving 80 males with severe LUTS or BPH refractory to medical treatment, compared PAE against a sham procedure.[78] Participants were randomized to either PAE or a sham group, where embolization was not performed after catheterization. At 6 and 12 months, the PAE group had significantly greater IPSS improvement (−17.1) compared with the sham group (−5.03), with a mean difference in IPSS reduction of 13.2 points. Following an open extension period, the sham group underwent PAE, showing similar substantial improvements. At 12 months, IPSS scores in patients initially undergoing PAE (9.0) were comparable to those in the sham group post-PAE (8.6), underscoring PAE's therapeutic benefit over the sham technique.

Meta-Analyses

The first meta-analysis published in 2016 reviewed studies from November 2009 to December 2015, assessing 19 studies

and including 6 in the final analysis.[68] At 12 months after PAE, the increase in Qmax was 5.39 mL/s, the reduction in IPSS was 20.39 points, and the QoL score improvement was −2.49. There was no effect on the IIEF score, and adverse events occurred in 32.93% of patients, mostly minor. Several meta-analyses have evaluated the efficacy of PAE by combining published studies.[69,79]

A 2018 systematic review of PAE trials for LUTS treatment included 13 studies with 1,254 patients.[29] Participants had moderate to severe LUTS with a mean IPSS of 23.5. Statistically significant improvements ($p < 0.05$) were noted after 12 months, including in IPSS (reduction of 16.5 points), QoL, IIEF-5, PV, PSA, Qmax, and PVR. Major complications were reported in only 0.3% of cases.

The most recent meta-analysis analyzed 11 studies and found that at 12 months, PAE and TURP had similar patient-reported outcomes, such as IPSS (2.32; −0.44 to 5.09) and QoL (0.18; −0.41 to 0.77). However, functional improvements in PAE were lower for flow rate and prostate size. PAE had fewer complications, lower costs, and shorter hospital stays.[80]

Comparison with Other Treatment Options

Medication (5-Alpha-Reductase Inhibitors) Impact on PAE versus PAE

One study compared 12-month outcomes of PAE for BPH in patients using or not using 5-alpha-reductase inhibitors (5ARIs). Among 155 patients, 40 were on 5ARIs and 115 were not. Outcomes measured included IPSS, QoL, and clinical failure, with secondary outcomes of PV reduction and Qmax improvement. Both groups showed significant improvements in all measured outcomes, with no notable differences observed between them, indicating that 5ARIs did not negatively affect PAE's effectiveness.[81]

In another study, patients were randomized to receive either PAE or combined therapy with dutasteride and tamsulosin. Ninety patients participated, and primary outcomes involved changes in IPSS at 9 months. PAE showed a greater IPSS reduction (−10 points) compared with combined therapy (−5.7 points), with a statistically significant difference (−4.4 points, $p = 0.0008$). The IIEF-15 score favored PAE, with a significant increase in patients' sexual function. The PAE group required fewer retreatment procedures than the combined therapy group, suggesting PAE provides superior relief from urinary and sexual symptoms.[82]

PAE versus Holmium Laser Enucleation

A retrospective study from 2016 to 2019 compared holmium laser enucleation (HoLEP) and PAE outcomes, with 490 patients undergoing HoLEP and 57 receiving PAE. HoLEP had longer operative times and hospital stays, whereas PAE required longer urinary catheterization. HoLEP treated more PV and showed greater IPSS and QoL improvements at 12 months (−17.58 vs. −8 for IPSS and −4.09 vs. −2.27 for QoL). Both had similar rates of postoperative adverse events within the first 3 months.[83]

A recent comparative study evaluated the early postoperative and short-term efficacy of PAE and HoLEP in moderate to large BPH. The analysis of 20 qualitative and 18 quantitative studies found no significant differences at 3 months in IPSS, QoL, and PVR improvements. HoLEP was superior in Qmax improvement (mean difference of 8.47); however, no significant disparities were noted in the 1-year follow-up for IPSS and QoL improvements, suggesting PAE presents fewer major adverse effects.[84]

PAE versus UroLift System

A study on various minimally invasive therapies, including PAE, reviewed randomized controlled studies published between January 2000 and April 2020. Parameters such as IPSS, Qmax, QoL, and PVR were evaluated. No significant differences in IPSS were found at 3, 6, and 12 months among the therapies, although PAE and aquablation were more effective at 12 months. PAE particularly stood out for minimal adverse events across multiple trials. In contrast, aquablation had limited data and was associated with bleeding-related complications.[85]

PAE for Prostatic Cancer Patients

Prostatic cancer patients can experience refractory hematuria, which poses treatment challenges, especially with other comorbidities and potential local invasion into the bladder. Initial treatments often involve multiple stays in the hospital for bladder irrigations and blood transfusions, which can be risky and costly. First-line therapy for prostatic bleeding due to prostate cancer is typically external beam radiation; however, its efficacy may be limited over time. Patients may develop refractory bleeding, particularly if radiation cystitis arises from treatment. Other therapies, such as TURP, cryoablation, or high-intensity focused ultrasound, can help manage advanced prostate cancer and obstructive symptoms. PAE has shown success in treating prostatic bleeding from both BPH and prostate cancer, with success rates of 100% in BPH patients compared with 75% in prostate cancer patients.[86]

In a recent study involving four prostate cancer patients with prostatic bleeding (two with organ confined and two with metastatic cancer), PAE was applied after excluding other causes of hematuria. Follow-ups at 3, 12, and 18 months postprocedure showed resolution of hematuria in all four patients at 3 months, with technical success in each case. One patient experienced recurrence at 13 months, successfully treated with a repeat procedure. PAE offers a way to control hematuria in patients with significant prostatic bleeding and inoperable cancer, enhancing QoL but potentially necessitating repeat interventions.[87]

Emerging Clinical Trials and Their Impact

One ongoing trial is a single-center prospective study assessing PAE in symptomatic BPH patients using LC Bead LUMI as the investigational device. Particles are delivered to the

prostatic arteries via a balloon occlusion or standard microcatheter, with outcomes evaluated at 1, 6, 12, and 24 months postintervention.[88]

The STREAM trial is another emerging study: a single-center prospective cohort study aimed at identifying predictive success factors for PAE using MRI. Involving 50 BPH patients who underwent PAE, the study utilized MRI before and after the procedure at 3, 12, and 24 months. The technical success rate was 96%, with an average patient age of 67 years. Throughout the study, the mean IPSS score decreased significantly from 21 before PAE to 8 after 24 months ($p < 0.001$). Interestingly, PV reduction did not consistently correlate with symptom improvement. Patients with both median and non-median lobe enlargement showed similar symptomatic improvements, while those with stromal enlargement improved most at 24 months compared with adenomatous-dominant BPH. Different types of prostate enlargement may impact both short- and long-term PAE outcomes.[89]

Conclusion

PAE has emerged as a safe and effective alternative to traditional surgical therapies, such as TURP, offering comparable symptom relief and QoL improvements. It presents several advantages over surgery, including shorter recovery times, reduced complication risks, and the preservation of sexual function. PAE is especially beneficial for patients who are not surgical candidates due to comorbidities or who wish to avoid potential surgical side effects and long-term complications. The future of PAE appears promising, with ongoing research and technological advancements contributing to its growing acceptance as a treatment option for BPH. Continued research supports PAE's effectiveness and safety, potentially leading to broader adoption in clinical practice.

Conflict of Interest
None declared.

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