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REVIEW

Management and Treatment of Benign Prostatic Hyperplasia Symptoms: Current Insights

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Abstract: Benign prostatic hyperplasia (BPH) is a common cause of lower urinary tract symptoms (LUTS) in aging men that can significantly impair their quality of life. This review provides updated insights into this condition's pathophysiology, diagnostic strategies, and the full spectrum of management approaches, including lifestyle changes, medical management, minimally invasive surgical therapies, and traditional surgical interventions. For each modality, we sought to provide an overview of the mechanism of action, efficacy, safety, as well as guideline-backed patient selection recommendations issued by three major BPH guidelines. With the various existing management strategies, the role of shared decision making is emphasized to align the therapeutic choices with symptom severity, prostate anatomy, comorbidities, but also with individual patient values. By summarizing the current and most updated literature on BPH management and treatment, our goal is to support evidence-based clinical decisions and improve care and outcomes for men suffering from BPH-related LUTS.

Keywords: prostatic hyperplasia, lower urinary tract symptoms, male, quality of life

Introduction

Benign prostatic hyperplasia (BPH) is a common urological condition characterized by the non-cancerous prostate gland enlargement that mainly affects older men.[1] BPH develops through the hyperplasia of both stromal and epithelial cells, which results in prostate volume expansion that compresses the prostatic urethra and subsequently causes lower urinary tract symptoms (LUTS) such as frequency, urgency, and nocturia.[2,3] Its prevalence rises with age, affecting more than 50% of men aged 60 and reaches nearly 90% of men over 70 years.[1,3] The condition causes more than a simple histological change, in fact, it is associated with significant morbidity that negatively impacts patients' quality of life (QoL) and create a significant burden on healthcare systems.[2,4]

BPH creates substantial QoL deterioration, as it can lead to complications such as urinary retention, recurrent urinary tract infections (UTIs), bladder stones, and even renal insufficiency.[5] These complications create both patient health problems, but also drive up healthcare costs, with estimates suggesting that Medicare BPH-related expenses exceeded $1.9 billion in 2013.[4] The growing aging population makes BPH a pressing public health concern and further highlight the importance of developing cost-effective and innovative BPH management strategies.

Given the wide spectrum of treatment strategies available for BPH and the constant research innovation in the urological field, this study provides a comprehensive overview of BPH management by summarizing the current understanding of its pathophysiology, by outlining evaluation strategies and by examining different treatment options and their indications, including conservative approaches, emerging minimally invasive therapies (MISTs), and surgical interventions.

Pathophysiology and Symptom Development

BPH develops through multiple factors, including genetic, hormonal and mechanical changes which contribute to the gradual enlargement of the prostate along with LUTS. It has been suggested that a hereditary component may predispose

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patients to develop abnormal prostate cellular proliferation, with certain genetic markers linked to increased risk.[6] Additionally, comorbidities such as obesity, diabetes, and metabolic syndrome have been identified as risk factors that exacerbate both prostatic growth and bladder outlet obstruction (BOO) in patients with BPH.[7] In fact, these conditions are well known to promote chronic systemic inflammation, insulin resistance, and hormonal imbalances, all of which are suggested to promote prostate cell proliferation while worsening LUTS symptoms.[7,8]

The prostate grows naturally with age, with a central element to this growth being the levels of two important sexual hormones: dihydrotestosterone (DHT) and estrogen.[9] Prostate cell proliferation (stromal and epithelial cell hyperplasia) occurs through the action of potent androgen DHT which originates from testosterone, while estrogen regulates the growth-promoting interactions that speed up BPH clinical progression.[10,11] As the prostate expands, it can compress the urethra which results in BOO. This physical blockage leads to compensatory changes in the bladder, which results in decreased compliance and detrusor overactivity.[12] The clinical presentation of BPH consists of two major symptom groups, which are storage symptoms and voiding symptoms. The physical compression of the urethra produces obstructive symptoms, such as difficulty starting urination (delayed urination), hesitancy, a weak urine stream, and a prolonged voiding time.[13,14] In contrast, when the bladder adapts to the outlet obstruction, it causes irritative symptoms, including urgency, frequency, and nocturia.[14]

Over time, these symptoms progressively worsen and may cause major complications. Acute urinary retention (AUR) occurs when the degree of obstruction becomes severe enough to completely block the voiding.[5] It is estimated that the annual incidence rate of AUR among men with BPH ranges from 5 to 25 cases per 1000 men.[15] Moreover, the incomplete bladder emptying process creates an optimal environment for intravesical bacterial growth possibility, leading to recurrent UTIs.[16] Additionally, chronic obstruction and urinary retention can facilitate the formation of bladder stones, which further exacerbates LUTS and cause additional complications such as hematuria.[17] In more advanced cases, long-term urethral obstruction can cause kidney disease due to the urinary tract back pressure which sometimes results in post-renal renal insufficiency.[5] Understanding these mechanisms is essential for developing effective treatment plans which mitigate both symptoms and potential BPH-related complications.

Diagnosis and Evaluation

The diagnosis and evaluation of LUTS are critical for effective management, follow-up and treatment planning. The goal of the initial evaluation is to establish a comprehensive clinical picture through an initial assessment that combines patient history, medication review, symptom evaluation, physical examination, and targeted diagnostic testing.[18–20] The aim is to identify and to rule out any confounding factors that may contribute to the patient's symptoms.[21] In this section, we will outline the various evaluation strategies involved in the diagnosis of BPH, and summarize the current guidelines that ensure a standardized, evidence-based approach to BPH evaluation.

Symptom Assessment

Symptom assessment is fundamental in the management process of BPH and mainly depends on objective evaluation tools. These tools provide an initial baseline score that allows clinicians and researchers to document and quantify symptom improvement during treatment. The International Prostate Symptom Score (IPSS) is recognized as the gold standard for LUTS evaluation and is utilized in practically all BPH-related clinical research.[18,19] In fact, the IPSS stands as the preferred assessment tool for LUTS according to both the American Urological Association (AUA) and the Canadian Urological Association (CUA) despite other instruments like International Consultation on Incontinence Questionnaire (ICIQ-MLUTS) and the Danish Prostate symptom Score (DAN-PSS) providing additional daily functioning insights.[18,19] This tool is therefore essential for objectively assessing LUTS, with a 3-point decrease from its baseline score being recognized as the threshold for a clinically meaningful improvement in symptoms.[22]

Physical Examination

A physical examination also stands as a necessary step for diagnosing BPH. The digital rectal examination (DRE) may be performed to assess the prostate volume, its consistency, and the presence of nodules or irregularities.[1] Anatomically, a prostate affected by BPH typically shows uniform enlargement with smooth texture, whereas prostate cancer is more

likely to present with hard, irregular, and nodular features.[1,23] In parallel, an abdominal examination enables clinicians to detect urinary retention symptoms and bladder distension by performing thorough palpation and percussion of the suprapubic area. In fact, the presence of a distended bladder creates a firm mass above the pubic symphysis which can be detected through percussion that produces a dull sound.[24] Although DRE is invaluable, its effectiveness depends on prostate size and the physician experience, which makes it necessary to combine physical findings with extra diagnostic tests for accurate assessment.

Laboratory Tests

While not all laboratory tests are routinely performed during the initial evaluation, when indicated, they play a critical role in the assessment of BPH by helping to rule out alternative diagnoses and identify potential complications. Urinalysis is often performed to exclude UTIs, hematuria, or other urinary abnormalities that might mimic or exacerbate LUTS.[18–20] Measurement of prostate-specific antigen (PSA) is also essential, while BPH can cause modest PSA elevations, significantly elevated levels may signal the need for further investigation to differentiate BPH from prostate cancer.[25] Although measuring PSA levels is important, it is not a routine test done for BPH but is only recommended to avoid missing a possible prostatic malignancy prior to performing surgery or starting 5-alpha-reducatase medication.[1] It is also important to note that the CUA recommends doing so only for patients who have at least a 10-year life expectancy and where the presence of prostate cancer would change the overall management of LUTS.[19] Additionally, renal function tests including serum creatinine and blood urea nitrogen (BUN), although not mandatory for the initial evaluation, help by assessing kidney health, as chronic bladder outlet obstruction from BPH can lead to renal impairment.[19,26] By integrating these laboratory findings with clinical data, clinicians can achieve a more precise diagnosis, gauge disease severity, and tailor management strategies accordingly.

Imaging

Imaging studies support clinical BPH evaluation through the collection of precise measurements and detailed anatomical information that helps in the treatment approach decision making. It is important to note that current guidelines recommend using imaging tests only when the results will assist in the choice of medical therapy or when surgical treatment is being considered.[18–20] When indicated, transrectal ultrasound (TRUS) stands as common imaging tool for prostate volume assessment and internal architecture.[27] Transabdominal ultrasound provides a non-invasive alternative that evaluate prostate size as well as determine bladder characteristics such as post-void residual volume (PVR) in order to assess the bladder outlet obstruction severity.[27] Magnetic resonance imaging (MRI) is typically reserved for patients with unclear findings or to evaluate for prostate cancer.[28] MRI provides soft tissue contrast combined with anatomical visualization which enables clinicians to help differentiate BPH from prostate cancer and prostatitis based on tissue characteristics and lesion morphology.[28]

Other Evaluation Methods

Additional evaluation methods exist to further refine the diagnostic process by providing objective measures of both functional aspects and anatomical characteristics of BPH. Uroflowmetry, a non-invasive tool, measures maximum urinary flow rate (Qmax) to provide objective indicators of BOO, with lower Qmax values associated with more severe obstruction and symptoms.[29] Cystoscopy, although more invasive, enables direct endoscopic visualization of the urethra and the bladder.[30] This method is valuable when a surgical approach is considered or when complications such as urethral strictures or bladder stones are suspected.[30] Additionally, screening for obstructive sleep apnea (OSA) is important, as OSA leads to increased nocturnal natriuresis.[31] The assessment of OSA can help identify patients whose nocturia is their primary complaint, so they can be managed appropriately.[31] Moreover, digital health solutions are emerging to facilitate remote symptom tracking, including audio-based uroflowmetry phone applications that estimates urine flow rates by measuring voiding sound and a home device that provides real-time measurement of uroflow and urine output.[32,33] Additionally, penile cuffs also present a non-invasive strategy to measure bladder outlet resistance and offer insights into patients voiding characteristics.[34] Together, these methods help enhance diagnostic accuracy and contribute to a more personalized approach to BPH management.

Artificial Intelligence in the Evaluation Process

Integration of artificial intelligence (AI) shows potential for improving the evaluation of BPH. Multiple studies demonstrated that AI algorithms including machine learning and deep learning models effectively evaluate complex imaging data from MRI and ultrasound tests with high precision levels.[35] These tools may provide better prostate volume measurement capabilities and differentiate BPH from other conditions, such as prostate cancer, through detection of subtle differences in tissue characteristics and lesion morphology.[35] AI systems are progressively being used to integrate clinical, laboratory, and imaging data, in efforts to improve risk assessment and outcome prediction capabilities.[35,36] However, further studies are required before this technology becomes widely utilized in the clinical setting.

Treatment: Lifestyle Modifications and Surveillance

The initial management of BPH requires conservative methods which include lifestyle changes and active surveillance (watchful waiting).[18] Patients who have mild symptoms with IPSS scores of 7 or less and slow disease progression without complications make the best candidates for this strategy.[19] The majority of these patients experience stability for multiple years and only a small proportion eventually develops acute urinary retention (AUR) or other complications.[37]

Lifestyle modifications serve as a first-line option because they do not harm patients, they are cost-effective, and they produce few adverse effects. Fluid management stands as an essential element of this approach. Patients need to modify the volume and timing of their fluid consumption but also the type of fluids consumed. In fact, caffeine and alcohol, among others, have been noted to be irritant for the bladder and therefore exacerbate storage symptoms.[38] Additionally, the combination of scheduled voiding with pelvic floor exercises through bladder training techniques may help patients improve bladder control to reduce both urgency and frequency.[38]

Evidence supports that self-management strategies combined with active surveillance produce IPSS score reductions similar to drug therapy at both six and twelve weeks.[39,40] However, regular follow-up is an integral part of this approach. Patients should be reassessed using objective tools and measures such as the IPSS, uroflowmetry, and PVR to allow care providers to track symptom progression.[19] When noted, a significant increase in the IPSS score or the emergence of complications, such as AUR or recurrent UTIs, may signal the need to consider medical or surgical treatment.[19]

Treatment: Pharmacological Therapies

Pharmacological therapy is indicated for patients with moderate to severe LUTS, typically those with an IPSS greater than 8, especially when lifestyle modifications have proven insufficient, disease progression is evident, or patients prefer a non-surgical approach.[19] The primary goals of medical management are to alleviate symptoms, enhance quality of life, and reduce the risk of acute urinary retention. A summary of the mechanisms and recommendations of each medication class is provided in Table 1.

Alpha-Adrenergic Receptor Antagonists

Alpha-adrenergic receptor antagonists (α-blockers) are considered first-line pharmacological therapy for patients with moderate to severe BPH-related LUTS who desire rapid symptom relief.[19] The main action of this class of medication consists of blocking alpha-1 adrenergic receptors in the smooth muscle of the prostate, bladder neck, and proximal urethra, to decrease muscle tone and reduce urethral resistance.[41] The treatment leads to better urinary flow and decreased symptoms of hesitancy, weak stream, and incomplete bladder emptying. Clinical studies and meta-analyses have consistently demonstrated that α-blockers significantly improve the IPSS and Qmax compared to placebo, with symptomatic benefits often observed within days to weeks of initiating therapy.[20,42,43]

This medication class is commonly associated with side effects such as dizziness and orthostatic hypotension.[44] While ejaculatory issues may occur, they rarely affect libido or erectile function.[45,46] Importantly, α-blockers do not modify the natural progression of BPH, as they do not reduce prostate size.[47] Although several agents, including tamsulosin, alfuzosin, doxazosin, silodosin, naftopidil and terazosin, are available, differences in their side effect profiles do not affect their overall clinical efficacy.[44] It is important to note that although potential increased risk of dementia due to long-term α-blockers use has been suggested, the causality remains unproven and requires further investigation.[48]

Table 1 Summary of Pharmacological Therapies for Managing BPH-Related Symptoms

Drug class	Mechanism	Medication	Recommendation[a]
Alpha-adrenergic receptor antagonists	Block alpha-1 adrenergic receptors in the smooth muscle of the prostate, bladder neck, and proximal urethra, to decrease muscle tone and urethral resistance.	• Tamsulosin • Alfuzosin • Doxazosin • Silodosin • Naftodipil • Terasozin	First line treatment for moderate-severe LUTS. Select the agent based on comorbidities, side-effect profile, and drug interactions.
5-Alpha reductase inhibitors	Inhibit 5-alpha-reductase, an enzyme responsible of converting testosterone into DHT, an androgen that drives prostate cell proliferation. Reduces long-term progression risk.	• Finasteride • Dutasteride	Recommended for men with enlarged prostates (>30–40 mL), elevated PSA (>1.5 ng/mL) or palpable enlargement. Inform about long action onset and sexual side effects.
Phosphodiesterase-5 inhibitors	Inhibit phosphodiesterase-5, raising cyclic guanosine monophosphate (cGMP) to relax smooth muscles and improve LUTS and erectile function.	• Tadalafil • Sildenafil (if tadalafil not tolerated)	Recommended for LUTS regardless of their erectile function status. Preferred when coexisting with erectile dysfunction.
Anticholinergics	Blocks M2 and M3 receptors in the detrusor muscle to reduce involuntary bladder contractions and alleviate storage symptoms.	• Solifenacin • Fesoterodine • Darifenacin • Oxybutynin • Propiverine • Tolterodine • Trospium chloride	Recommended for predominant storage symptoms, use with caution if PVR is elevated to limit acute urinary retention risks.
Beta-3 adrenergic agonists	Stimulate beta-3 adrenergic receptors in the detrusor muscle, increase cAMP and mediate bladder smooth muscle relaxation.	• Mirabegron	An alternative for storage symptoms, particularly when anticholinergics are contraindicated or poorly tolerated.

Note: [a] Summary of the Canadian, American and European urological associations guidelines.
Abbreviations: LUTS, lower urinary tract symptoms; DHT, dihydrotestosterone; PSA, prostate-specific antigen; PVR, post-void residual volume.

Moreover, this medication class has also been associated with floppy iris syndrome, especially with tamsulosin.[49] Patients must therefore be effectively counselled on this aspect, especially if a cataract surgery is planned. Consequently, current guidelines recommend choosing an agent based on the patient's comorbidities, side effect tolerance, and overall clinical profile.[18–20] This individualized approach helps ensure optimal symptom control while minimizing adverse effects, reinforcing the central role of alpha-blockers in BPH management.

5-Alpha Reductase Inhibitors

When prostate enlargement is evident, 5-Alpha Reductase Inhibitors (5-ARIs) may serve as a key pharmacological option for men with moderate to severe BPH symptoms. These medications are prescribed for men with prostate volumes above 30–40 mL alongside elevated serum PSA levels exceeding 1.5 ng/mL or palpable prostate enlargement on DRE.[18–20] This medication class work by inhibiting the 5-alpha-reductase, an enzyme responsible of converting testosterone into DHT, an androgen that drives prostate cell proliferation.[50] Two agents of this class are commonly used (ie finasteride and dutasteride) and targets different types of isoenzymes. In fact, finasteride targets the type II isoenzyme while dutasteride inhibits both type I and type II isoenzymes.[51,52] Although dutasteride provides a 95% serum DHT reduction compared to a 70% reduction by finasteride, the clinical results from these drugs remain comparable. A recent meta-analysis found no significant differences in symptom scores, prostate volume, PSA levels, quality of life, or adverse reactions, however, dutasteride appears to offer superior improvement in Qmax.[53] This marked reduction in DHT leads to decreased cellular proliferation, increased apoptosis, and ultimately an 18 to 27% reduction in prostate volume.[50]

Although 5-ARIs significantly improve symptom scores and urinary flow rates, their onset of action is relatively slow, with clinical benefits observed after at least six months of continuous therapy. Side effects of these medications may include gynecomastia together with sexual dysfunction, manifested as reduced libido, erectile dysfunction, and ejaculatory disturbances. However, studies comparing both 5-ARIs with placebo demonstrated that these sexual side effects occur mostly during the first year, while the incidence of new sexual adverse events decreased in the subsequent years.[54,55] Emerging data also suggests the presence of an increased risk of dementia and depression, although not associated with suicide risk.[56] Furthermore, 5-ARIs also decrease serum PSA levels by about 50%, therefore clinicians must analyze PSA results with caution during follow-up.[50] A significant increase in the adjusted PSA may serve as a red flag and require further investigation. Overall, 5-ARIs work best for patients with enlarged prostates that demonstrate risk factors for disease progression, while treatment plans should consider prostate size, baseline PSA levels, and patient-specific considerations.[18–20]

Phosphodiesterase-5 Inhibitors

Phosphodiesterase-5 inhibitors (PDE5-Is), first intended, among other indications, erectile dysfunction (ED) due to their capacity of dilating and relaxing vascular smooth muscle, PDE5-Is have shown to be effective for also managing LUTS.[57] Although the exact mechanism for symptom relief is not fully understood, PDE5-Is work by inhibiting the enzyme responsible for breaking down cyclic guanosine monophosphate (cGMP), a critical signaling molecule that mediates smooth muscle relaxation.[58] The resulting increase in cGMP levels may relax the smooth muscle in the prostate, bladder neck, and detrusor, thereby reducing urethral resistance and improving voiding symptoms.[58]

Clinical trials have consistently demonstrated that PDE5-Is, particularly tadalafil, can reduce IPSS scores while enhancing erectile function in men with LUTS. In fact, a meta-analysis conducted on 7 trials comparing PDE5-Is to placebo revealed improvements in IPSS (−2.8) and the International Index of Erectile Function (IIEF, +5.5), but no difference in the Qmax.[59] A more recent meta-analysis involving 4293 patients demonstrated a small improvement in IPSS score (−1.89) and BPHII score (−0.52) compared to placebo.[60] When compared to α-blockers, PDE5-Is provided similar improvement in IPSS, BPHII and no significant difference in adverse events.[60] Furthermore, no significant differences have been noted in Qmax and PVR, while a significant difference favoring PDE5-Is has been noted in IIEF scores.[61] Although 2.5-mg and/or 5-mg tadalafil is the only PDE5-I posology currently approved for LUTS, emerging evidence suggests that sildenafil may also be beneficial. For instance, a randomized trial demonstrated that sildenafil improved IPSS (−6.3 vs −1.9) and IIEF (+10 vs +3) scores compared to placebo at 12 weeks.[62] Therefore, AUA guidelines mentions that sildenafil could be considered if tadalafil is not available and alpha-blockers are not well tolerated.[18]

Adverse events associated with PDE5-Is are generally mild and well tolerated, with the most reported side effects including flushing, gastroesophageal reflux, headache, and dyspepsia.[59] It is important for clinicians to properly screen patients for any tadalafil contraindication to avoid any unexpected side effect. Nevertheless, PDE5-Is, especially tadalafil, serve as a beneficial treatment choice for men who have BPH-related LUTS regardless of their erectile function status.[18–20] The dual benefit of PDE5-Is in treating urinary symptoms and erectile function along with their safety profile makes them an attractive choice or additional therapy for BPH management.

Anticholinergics

Muscarinic receptors are present on many cells, with five muscarinic receptor types (M1 to M5) having been described in the literature. Although, the most predominant types in the detrusor are the M2 receptors, contraction has been shown to be mainly mediated by M3 receptor.[63] Therefore, muscarinic receptor antagonists target these receptors in the detrusor muscle, reducing involuntary bladder contractions and alleviating storage symptoms such as urgency, frequency, and nocturia.[64] This medication class has been primarily approved for overactive bladder (OAB), however, various anticholinergics including solifenacin, fesoterodine, darifenacin, oxybutynin, propiverine, tolterodine and trospium chloride are used for BPH patients when storage-related symptoms are predominant.[20]

Most clinical trials demonstrated anticholinergics' safety, but limited efficacy as monotherapy, with no significant difference in IPSS scores, nor Qmax.[65] However, for patients suffering from storage symptoms as well as BOO,

a systematic review suggests that adding an anticholinergic might offer symptoms and QoL improvement.[66] It is important to note that a systematic review found that, following anticholinergic use, PVR increased by 11.6 mL, although the AUR rate was only 0.3% at 12-week follow-up.[65] Although safe, it is important to note that a potential association exists between anticholinergics and an increased risk of dementia in men over 55 years old.[67] Therefore, guidelines recommend their use in patients with predominant storage LUTS, with caution in patients presenting with an elevated PVR to minimize AUR risks.[18–20]

Beta-3 Adrenergic Agonists

Beta-3 adrenergic receptor is the predominant beta-adrenoreceptor subtype in the detrusor muscle and mediate bladder smooth muscle relaxation through cAMP signaling upon norepinephrine binding.[68] Similar to anticholinergics, beta-3 agonists are primarily approved for OAB, although they are increasingly considered for men with BPH experiencing refractory irritative symptoms despite first-line therapies.[69]

Mirabegron, a beta-3 agonist, has demonstrated efficacy in reducing OAB symptoms across multiple RCTs, although most studies predominantly enrolled female populations.[70] A systematic review and meta-analysis of eight RCTs reported significant reductions in micturition frequency, urgency episodes, and nocturia compared to placebo, with modest improvements in voided volume.[70] No study has demonstrated beta-3 agonists capacity to improve IPSS scores as monotherapy, however, a 12-week RCT involving patients experiencing LUTS caused by BOO showed that mirabegron did not adversely affect Qmax and detrusor pressure at maximum urinary compared with placebo, with the incidence of adverse events being similar for both groups.[71] Moreover, results from a recent Phase 3 RCT have demonstrated the safety and efficacy of a novel beta-3 agonist (ie vibegron) in managing BPH-related symptoms. In fact, at 12 weeks, vibegron showed reduced daily micturition, urgency, nocturia and incontinence episodes compared to placebo.[72] This will therefore present a potential alternative to the currently approved mirabegron.

Regarding side effects, mirabegron is generally well tolerated, with hypertension, urinary tract infections, and nasopharyngitis as the most common adverse events.[20] Moreover, the European Association of Urology (EAU) guidelines highlight the importance of regularly monitoring blood pressure (BP) during treatment.[20] In fact, it is contraindicated in patients with severe uncontrolled hypertension ($\geq$ 180/110 mmHg). Therefore, beta-3 agonists offer a targeted approach for managing storage symptoms of BPH, particularly when anticholinergics are contraindicated. Future studies should prioritize long-term data, diverse populations, and head-to-head comparisons with standard therapies to refine the management of BPH.[18–20]

Natural Compounds

Plant-based preparations consist of a mix of herbal compounds that may appeal to some patients. Among the existing compounds, the most studied in the context of LUTS management in men is the extract of the berry of American saw palmetto (*Serenoa repens*).[73] In fact, a recent meta-analysis conducted on 27 studies involving *Serenoa repens*-based products revealed that, compared to placebo, it results in little to no difference in urologic symptoms, quality of life, and adverse events at both short-term and long-term follow-up.[73]

While the EAU guideline "weakly" recommend the use of hexane extracted *Serenoa repens*, they also highlight that further studies are required to define sub-population of patients who might benefit most from these products and to assess the possible use of plant-based preparations in combination with approved medication classes.[20] Currently, these compounds suffer from inconsistent formulations, variable pharmacokinetics and possible drug interactions. As such, aligned with the CUA and AUA recommendations, natural compounds should not replace evidence-based medical therapy for BPH-related LUTS yet.[18,19]

Combination Therapies

Combination therapies have emerged as a strategic approach to managing LUTS in men with BPH, particularly for those with moderate-to-severe symptoms or those at risk of disease progression. By integrating agents with complementary mechanisms, these therapies aim to address both static and dynamic components of BOO, while balancing efficacy and tolerability. Below, we synthesize the current evidence for key combinations, their clinical utility, and practical considerations.

Alpha-Blockers + 5-ARIs

The synergy between α-blockers (rapid relief of dynamic obstruction) and 5-ARIs (long-term prostate volume reduction) is well-supported. In fact, two major clinical trials have been conducted and showed that this combination was superior to both monotherapies (ie doxazosin or finasteride alone) with regards to symptoms scores and Qmax. Moreover, it has been shown that the risk of AUR and the need for surgery was also decreased.[74,75]

Although, adverse events of the combination therapy were typically those of the respective drugs, it has been shown that men treated with this combination experience higher rates of adverse events, with a systematic review revealing that combination therapy resulted in a 3-fold increase of ejaculatory dysfunction compared to both monotherapies.[76,77] Moreover, the discontinuation of α-blockers at six to nine months after starting combination therapy may be feasible without compromising on patients' symptoms, although patients with baseline IPSS > 20 may require prolonged therapy.[78,79] Therefore, current guidelines recommend using this regimen in patients with moderate to severe LUTS at high risk of disease progression and enlarged prostate (ie prostate volume > 30–40 mL or PSA > 1.5).[18–20]

Alpha-Blockers + PDE5-Is

Combining α-blockers with PDE5-Is (tadalafil) may address both LUTS and ED, a common comorbidity in aging men. A meta-analyses conducted on 5 RCTs comparing PDE5-Is and α-blockers combination to α-blockers monotherapy have demonstrated superior IPSS improvements, Qmax gains and improved erectile function at 12-weeks without increase in side effects.[59] Despite promising short-term data, long-term outcomes remain underexplored, necessitating cautious adoption in clinical practice, especially regarding risks of decreased BP.

Alpha-Blockers + Anticholinergics or Beta-3 Agonists

For men with predominant storage symptoms (urgency, frequency) persisting despite α-blocker monotherapy, adding anticholinergics or beta-3 agonists may offer benefits. In fact, given their mechanisms, meta-analysis have shown their ability to successfully improve storage symptoms without significant adverse events.[80,81] Moreover, a recent systematic review revealed that both combinations offer similar safety and efficacy, suggesting that either combination can therefore benefit them.[82] Although all guidelines recommend the use of both combinations in patients with storage symptoms persistent despite alpha-blocker monotherapy, the EAU highlights that it anticholinergic + α-blocker combination should not be prescribed for men with PVR > 150 mL.[18–20]

Treatment: Minimally Invasive Surgical Therapies

Minimally invasive surgical therapies (MISTs) are indicated for men whose LUTS remain bothersome despite pharmacotherapy, as well as for those who are poor candidates for traditional surgery. Most procedures have been studied and recommended for prostate volumes of 30 to 80 mL. MISTs include both non-ablative (eg Prostatic Urethral Lift (PUL), temporary implantable nitinol devices (iTIND), and Optilume balloon dilation) and ablative techniques like water vapor thermal therapy and robotic waterjet resection. These therapies aim to balance durable symptom relief with rapid recovery and preservation of sexual function. We summarized the mechanisms and recommendations of each MIST in Table 2.

Prostatic Urethral Lift

Prostatic urethral lift (PUL) is a non-ablative, implant-based MIST that uses permanent, suture-based nitinol implants to retract the enlarged lateral prostate lobes and create sufficient space for urine to flow without removing prostate tissue.[83] For this procedure to succeed, patient selection is key. In fact, based on early randomized trials, the EAU and the AUA recommended PUL men with no median lobe (ML) and a maximum prostate volume of 70 mL and 80 mL, respectively.[18,20] However, a study has demonstrated PUL efficacy for patients with obstructive median lobes.[84] Therefore, the CUA and the device's instructions for use supports that this procedure can also be suitable for patients with a small-to-moderate median lobe and prostate volumes under 80 mL or 100 mL, respectively.[19]

In fact, a study evaluating 45 patients with an enlarged ML showed promising results at 12-month follow-up: the mean IPSS improved by at least 13.5 points and mean Q_{max} improvements ranged from 90% to 129%. Quality of life

Table 2 Summary of Minimally Invasive Surgical Therapies for Managing BPH-Related Symptoms

Procedure	Mechanism	Median Lobe	Recommendation[a]	Prostate Volume
Prostatic urethral lift	Permanent nitinol implants retract lateral lobes, mechanically widening the urethra without removing tissue.	■	Recommended for men desiring a non-ablative option and preservation of sexual function. Inform about high re-treatment rate.	< 70–100 mL
Water vapor thermal therapy	Transurethral steam injections condense in the transition zone, releasing heat that ablates targeted tissue while preserving surrounding prostate.	■	Best for men desiring preservation of sexual function and rapid recovery.	30 – 80 mL
Prostatic artery embolization	Percutaneous endovascular approach to embolize prostatic arteries, reducing blood flow and inducing volume reduction.	■	Consider in centers with coordinated urology and interventional radiology care for men unfit for surgery or anticoagulated.	Unspecified
Robotic waterjet ablation	Robot-guided transurethral saline jet ablates prostatic tissue under transrectal ultrasound guidance.	■	A viable option for men who wish to preserve their ejaculatory function. Inform about early bleeding risk.	< 80–150 mL
Temporary implantable nitinol devices	Short-term nitinol implant compresses lobes for 5 to 7 days, inducing ischemic remodeling to widen the urethral lumen.	●	Emerging procedure under investigation	Emerging procedure under investigation
Optilume BPH catheter system	Drug-coated balloon dilation separates lateral lobes while delivering paclitaxel to maintain the lumen open.	●	Emerging procedure under investigation	Emerging procedure under investigation

Notes: [a] Summary of the Canadian, American and European urological associations guidelines. ■ = Can be used. ● = Can not be used.

(QoL) scores improved by > 60% ($P < 0.0001$) and no new cases of erectile or ejaculatory dysfunction were reported.[84] Moreover, a large retrospective cohort (n = 1413) confirmed real-world safety and efficacy of this technique by including both patients with and without obstructive ML, demonstrating a safe and effective treatment for both groups.[85]

Although, TURP, a surgical alternative, provides greater improvements in IPSS and Qmax, PUL remains an excellent treatment option for patients fitting the guidelines.[86] In fact, a systematic review of 13 trials demonstrated durable symptom relief: IPSS was reduced by 35 to 58%, Qmax increased by 50 to 115%, and sexual function was preserved.[87] Moreover, a large retrospective chart review and analysis showed that among patients presenting with a urinary retention (and a catheter placed), 69%, 83% and 89% were catheter-free at five days, one month and 2-years, respectively.[85] However, it is important to note a potential reintervention rate of 13.6% in 5 years.[88]

Common side effects include hematuria (15–63%), dysuria (20–58%), pelvic discomfort, urgency, transient incontinence, and UTIs, but are typically mild to moderate and resolve within 2 to 4 weeks. Additionally, data from a meta-analysis suggests an annual retreatment rate of 6%.[89] In summary, PUL offers a rapid, minimally invasive, non-ablative option with durable symptom relief, preservation of sexual function, and quick recovery, making it a compelling alternative for appropriately selected BPH patients.

Water Vapor Thermal Therapy

Convective water vapor thermal therapy (WVTT) is a minimally invasive technique that delivers controlled injections of steam into the prostatic transition zone via a transurethral delivery system. Upon tissue contact, the water vapor condenses, releasing thermal energy that induces instant cell necrosis in the targeted tissue, while maintaining the

integrity of the surrounding non-treated tissue.[90] This procedure may be performed in an office-based setting or in an ambulatory surgical center, with most patients only requiring oral/local sedation prior to it.[90]

A systematic review of nine studies assessing the effectiveness of WVTT for managing prostates between 30 and 80 mL demonstrated significant symptom relief, in fact, IPSS was reduced by 46 to 56% and Qmax improved by 39 to 87%.[87] Moreover, a multicenter sham-controlled RCT followed 197 men with 30–80 mL prostates for five years and revealed a durable symptom relief. In fact, at five-year follow-up, the study reported a 48% reduction in IPSS, 45% improvement in quality of life, 44% increase in Qmax, and a 48% decrease in BPH Impact Index, with only 4.4% retreatment rate and no sustained erectile dysfunction.[91] In contrast, a recent study comparing Rezum to thulium laser enucleation of the prostate (ThuLEP) for the management of large glands (> 80 mL) found that both procedures significantly improved urinary symptoms at 12 months follow-up, with ThuLEP being statistically but not clinically superior to Rezum.[92] This study therefore opens discussion of the potential role for WVTT to manage larger prostates, but further assessment is required. Variations in this technique, consisting of a single injection per lobe (less is more), also exists and provide comparable improvements in LUTS compared to the multiple injections alternative.[93] Surgeon expertise and patient anatomy may therefore play a role in the selection of the best approach.

Adverse events of this procedure are often mild to moderate and typically resolve quickly. Perhaps one of the main points making WVTT attractive is the fact that sexual function is preserved, with IIEF scores being indifferent from baseline at 1 year and even a 31% improvement in ejaculatory bother score.[87,94] Therefore, CUA, AUA and EAU guidelines all recommend this procedure for men with 30 to 80 mL prostates who seek a minimally invasive option with rapid recovery and durable outcomes.[18–20]

Prostatic Artery Embolization

Prostatic artery embolization (PAE) is a treatment option typically performed by interventional radiologists consisting of a percutaneous endovascular approach to selectively embolize each prostatic artery with microparticles, therefore decreasing the prostate's blood supply and inducing volume reduction and LUTS relief.[95]

In a sham-controlled RCT involving men with prostate size > 40 mL and suffering from refractory severe LUTS (IPSS ≥ 20, QoL ≥ 3), PAE improved IPSS and QoL by 13.2 and 2.13 points from baseline at six months, respectively. Moreover, Qmax was improved by 6.8 mL/s compared to sham (2.8 mL/s) and prostate volume was reduced by 17.6 g at six months.[96] In comparison to TURP, a meta-analysis involving 5 RCT showed no overall significant difference in 12-month IPSS, QoL or PVR, while Qmax showed a statistically significant difference favoring TURP.[96] In men with prostate volume over 50 mL, a RCT showed that PAE outperformed medical combination therapy (dutasteride + tamsulosin), with a superior IPSS reduction (−10.0 vs −5.7) and IIEF-15 improvement (+8.2 vs −2.8) at 9 months follow-up.[97]

Although PAE successfully relieves patients' symptoms, contraindications such as severe atherosclerosis, non-BPH causes of LUTS, small prostates, renal dysfunction, and contrast allergy. The CUA, AUA and EAU mention that the diagnostic investigation should be conducted by urologists only and that PAE should be performed by an interventional radiologist specifically trained for this technique.[18–20] Symptom relief after PAE develops more gradually than with TURP, and long-term data reveal a 23% symptom recurrence rate at a median of 72 months, with reintervention rates of 3.4% at one year, 21.1% at five years, and 58.1% at ten years.[98,99]

For men with moderate-to-severe LUTS who are poor surgical candidates or wish to avoid the potential sexual and bleeding risks of TURP, PAE offers a viable, prostate-sparing alternative with meaningful symptom relief and preservation of sexual function. Its role continues to evolve as long-term efficacy and patient selection criteria are refined.

Robotic Waterjet Ablation

Robotic waterjet ablation is an image guided therapy conducted under general anesthesia and employs a high-velocity saline jet under real-time transrectal ultrasound guidance to selectively ablate prostatic tissue. After mapping the target zone, a robotic arm delivers a heat-free stream that precisely removes obstructing adenoma. After completing the ablation part, hemostasis is then achieved separately, typically through thermal energy or foley-balloon tamponade as needed.[100,101]

The initial study that assessed the efficacy of this procedure found an improvement in IPSS from 23.1 at baseline to 8.6 at 6 months ($P < 0.001$) and the Qmax increased from 8.6 mL/s at baseline to 18.6 mL/s at the 6-month follow-up ($P < 0.001$).[101] This study has opened the path for RCTs comparing it to TURP. In fact, most of these RCTs reported comparable efficacy and safety compared to TURP in men with < 80 mL prostates for IPSS, IPSS-QoL and Qmax at all time-points (ie 12, 24, 36, and 60 months).[102–105] A meta-analysis conducted on the individual data of four major clinical studies (WATER, WATER II, FRANCAIS WATER and OPEN WATER) showed that regardless of prostate size (< or > 100 mL) or anatomical shape (with or without a median lobe), all outcomes demonstrate a significant improvement from baseline.[106] Furthermore, in the WATER II study of 101 men with larger glands (80–150 mL), Robotic Waterjet achieved a mean IPSS decrease of 15.9 points and Qmax increase of 9.2 mL/s at 5 years, with only 3.7% requiring retreatment at five years.[107]

The main consideration is, perhaps, the early bleeding events. In fact, the WATER II study has recorder bleeding complications in 9.9% of the patients, with 5.9% requiring peri-operative transfusions.[108] Importantly, this procedure has been noted to preserve sexual function, with the WATER study reporting zero de novo erectile dysfunction and only 7% ejaculatory dysfunction (compared to 25% in TURP).[104] Therefore, the procedure is a viable option for men who seek durable symptom relief with a favorable sexual-function profile, although they should be made aware of the potential post-operative bleeding events. The AUA and EAU currently recommend its application as an alternative to TURP for men with a prostate volume of up to 80 mL, while the CUA suggests its use for prostate volume up to 150 mL.[18–20]

Novel and Emerging Procedures

As MISTs evolve, two particularly innovative approaches have emerged: temporary implanted devices and Optilume BPH catheter system. Both aim to alleviate LUTS while preserving sexual function and avoiding permanent tissue removal.

Temporary Implantable Nitinol Devices

Temporary implantable nitinol device (iTind) is a small implant placed cystoscopically under local anesthesia into the prostatic urethra and deployed for 5 to 7 days. It acts by inducing pressure on the lateral prostatic lobes as it expands, causing ischemic necrosis and therefore remodelling the urethral channel without cutting or ablating tissue.[109]

In terms of efficacy, multiple studies have demonstrated promising results. In fact, a 36-months follow-up study analyzed the first generation of this device and revealed significant improvements at every follow-up interval: by 36 months, IPSS decreased by 7 points to reach a score of 12, Qmax increased by 41% to reach 10.1 mL/s, and IPSS-QoL scores decreased to 2.[110] In parallel, the second generation of this technology has been developed, with only slight changes in the implanted device. The efficacy of this new generation was therefore assessed in a separate study and reported even better outcomes at 12 months: Qmax increased by 100%, IPSS decreased by 60% to reach a score of 8.8 and IPSS-QoL decreased to reach 1.6 at 12 months follow-up, with these benefits persisting at 24 months.[111,112] A separate single-arm prospective study further supports these findings by presenting significant improvement of symptoms and urinary flow at 6-month follow-up and confirming the preservation of sexual and urinary continence.[113]

Furthermore, in a multicenter, randomized, sham-controlled trial of 175 men with prostate volumes between 25 and 75 mL reported significant improvements at 12 months. In fact, IPSS decreased by 9.25 points, Qmax increased by 3.52 mL/s and QoL scores improved by 1.9 point, without any new cases of ejaculatory or ED.[114] Although not intentionally assessed, it has been shown that all median-lobe patients treated with iTind were non responders, therefore making it non-efficient for patients presenting with this BPH phenotype.[112] Safety and efficacy beyond five years require further study, and randomized head-to-head trials to compare with other MISTs are lacking, although an expert consensus suggests that future trials should focus on comparing iTind to medical therapy as this would represent an in-office management opportunity for eligible patients with LUTS secondary to BPH.[115]

Optilume BPH Catheter System

The Optilume BPH catheter system is a drug-coated balloon that is inserted into the urethra and inflated to create a mechanical dilation, separating the lateral lobes of the patients' enlarged prostates. The drug, paclitaxel, is therefore

delivered to maintain a durable dilation of the urethral lumen.[116] In a prospective study of men with 20 to 80 mL prostates, Optilume showed very promising results. In fact, at 1 year follow-up, IPSS was reduced from 22.3 to 7.9, IPSS-QoL from 4.6 to 1.3, and Qmax increased from 10.9 to 18.4 mL/s at one year, with these benefits persisting at four years.[117,118] A subsequent sham-controlled RCT confirmed significant improvements: IPSS decreased from 23.4 to 11.0, Qmax increased from 8.9 to 19.0 mL/s, PVR decreased from 83.7 to 65.9 mL, and IPSS-QoL from 4.6 to 2.2 at 12 months, with only hematuria and UTI as common adverse events.[119] Moreover, there was no significant differences in IIEF-EF and Male Sexual Health Questionnaire Ejaculatory Dysfunction (MSHQ-EjD) scores between the Optilume and sham groups at 3, 6, or 12 months.[120]

Although not yet recommended by any guideline, Optilume is a very promising treatment that offers symptom relief without compromising sexual function.

Treatment: Surgical Interventions

When medical therapy or minimally invasive procedures fail to control symptoms, or when patients present with BOO complications, a surgical intervention become the next step. Multiple options are available and will be discussed, each with their set of advantages and trade-offs. These techniques all aim to deliver maximal symptom relief and lasting durability, with selection guided by prostate volume, patient comorbidity, instruments availability, and surgeon expertise. Table 3 summarizes the mechanisms and recommendations of each surgical intervention.

Transurethral Resection of the Prostate

Transurethral resection of the prostate (TURP) is a procedure where tissue is removed from the transition zone to reduce the prostate's volume through an endoscopic approach.[121] TURP can be performed using the monopolar (M-TURP) or bipolar (B-TURP) systems, with the main differences being the resectoscope's electrical circuit and the type of irrigation

Table 3 Summary of Surgical Interventions for Managing BPH-Related Symptoms

Procedure	Mechanism	Median Lobe	Recommendation	Prostate Volume
Transurethral resection of the prostate	Transurethral resection from the transition zone to reduce the prostate's volume.	■	Gold-standard endoscopic treatment for moderate-severe LUTS.	30 – 80 mL
Transurethral incision of the prostate	Transurethral incisions at the bladder outlet to widen the prostatic urethra without major tissue removal.	●	Preferred option for men with small prostates who wish to minimize tissue removal and preserve sexual function.	< 30 mL
Simple prostatectomy	Surgical removal of the entire prostate via open, laparoscopic, or robotic approach.	■	Recommended for very large prostates or when endoscopic enucleation is not feasible or available. Choose approach based on expertise and resources.	> 80 mL
Endoscopic enucleation of the prostate	Transurethral removal of the entire prostate using laser energy.	■	Size-independent alternative to TURP and simple prostatectomy. Recommended when technology and EEP-trained surgeon are available.	Any size
Photoselective vaporization of the prostate	Transurethral vaporization of the prostate using a non-contact 532 nm wavelength laser that leaves a thin coagulation zone for hemostasis.	■	Valid alternative to TURP, especially for patients at higher bleeding risk or on anticoagulation.	Any size

Notes: ■ = Can be used. ● = Can not be used.
Abbreviations: LUTS, lower urinary tract symptoms; TURP, transurethral resection of the prostate; EEP, endoscopic enucleation of the prostate.

fluid.[122] As functional outcomes have been shown to be similar, the AUA and CUA guidelines recommend the use of the modality depending on the surgeons' expertise and equipment availability.[18,19,123]

This procedure is still considered the surgical gold standard for bladder outlet obstruction (BOO). In fact, its outcomes have been documented in multiple studies, and the procedure often serves as a comparator for novel strategies. Patients typically benefit from TURP, with Qmax improvement of 162%, and reductions in IPSS by 70%, QoL scores by 69% and PVR volume by 77%.[20,123] Moreover, these benefits are durable: a 10-year follow-up study showed that improvements in IPSS, QoL, Qmax and prostate volume remained similar and durable, highlighting its long-term efficacy.[124] Although generally well tolerated, TURP carries some risks of postoperative complications, including urinary retention (3%), clot formation (2%), and UTI (1.7%).[125] Moreover, both M-TURP and B-TURP may impact sexual function, with 8.2 and 7.3% reporting newly developed ED, as well as ejaculatory dysfunction mainly associated with low orgasm perception.[126]

In sum, TURP provides rapid and sustained symptom relief for patients and is widely considered the gold standard surgical approach, although its status is starting to be questioned since the widespread emergence of therapies for BPH.[127] All three major guidelines recommend its use for patients with moderate to severe LUTS and a prostate volume of 30 to 80 mL.[18–20]

Transurethral Incision of the Prostate

Transurethral incision of the prostate (TUIP) consists of endoscopically incising the bladder outlet through electrocautery or other energy sources to widen the prostatic urethra without significant tissue removal.[128]

In terms of efficacy, a meta-analysis of 10 RCTs comparing TUIP to TURP with five studies specifying a prostate upper size limit of 30 mL have demonstrated that the procedure provided comparable symptom relief and lower blood transfusion rate (0.4% vs 8.6%), while the Qmax improvement was less significant.[128] Moreover, results suggests improved sexual outcomes with the risk of retrograde ejaculation being 27.6% compared to 51.8% for men undergoing TUIP and TURP, respectively.[128]

Although complications rates were not different, reintervention rates following TUIP have been shown to be higher than TURP (18.4% vs 7.2%), requiring proper patient counselling prior to the procedure.[128] Therefore, for lower size prostates (< 30 mL) and no median lobe, transurethral incision of the prostate may be a good treatment option for managing LUTS.[18–20]

Enucleation of the Prostate

Simple Prostatectomy (Open, Robotic, or Laparoscopic)

Simple prostatectomy consists of the surgical removal of the entire hyperplastic adenoma from the transition zone. This procedure can be performed in multiple ways, with the open simple prostatectomy (OSP) being the oldest and most invasive surgical approach. OSP is performed using a transvesical (Freyer procedure) or transcapsular (Millin procedure), where the prostate is dissected using the surgeons' finger approaching either from the bladder of from the anterior capsule.[20] With the introduction of laparoscopic and robotic-assisted techniques, approaches replicating the same principles previously mentioned were developed to mitigate some of OSP complications.

OSP produces significant symptom improvements, particularly in patients with large prostate volumes. A meta-analysis has been conducted on 10 studies and shown the ability of OSP to decline the IPSS by 19.68 points, QoL by 2.96 points, PVR by 123.14 mL and Qmax increased by 14.63 mL/s at 1-year follow-up.[129] The efficacy has also been shown to be sustained in the medium (1–3 years) and long-term (3–5 years).[129] However, OSP has been associated with long hospital stay (6 days on average) and catheterization (5 days on average), as well as the need for blood transfusions and urinary incontinence (8.5% at 1-year follow-up).[130–132]

The laparoscopic or robotic-assisted approaches, grouped under the term minimally invasive simple prostatectomy (MISP), offer similar symptomatic relief (ie IPSS score, Qmax and PVR) with reduced blood loss, shorter catheterization time and shorter length of hospitalization compared to OSP.[133,134] MISP, although less invasive, requires longer operative times, requires specialized training, and currently lacks large RCT data comparing long-term outcomes to OSP or endoscopic techniques.

Therefore, both OSP and MISP achieve complete adenoma removal, yielding maximal symptom relief and minimal retreatment rates, particularly in very large prostates where endoscopic methods may be inadequate. Guidelines recommend simple prostatectomy (open, laparoscopic, or robotic) for men with prostates > 80 mL who are unsuitable for endoscopic therapies or when endoscopic enucleation of the prostate (EEP) is unavailable, provided surgical expertise and appropriate resources are available.[18–20]

Endoscopic Enucleation of the Prostate

EEP is a procedure that was developed to serve as an endoscopic alternative for OSP.[135] The main goal is to remove the entire prostate gland endoscopically using different laser energy sources, including holmium (HoLEP), thulium (ThuLEP), GreenLight (GreenLEP), diode lasers (DiLEP), or bipolar electrocautery.[135]

This approach has been extensively compared to both OSP and TURP and demonstrated efficacy. A meta-analysis comparing EEP (regardless of energy source) to OSP found that EEP resulted in equivalent functional outcomes, while achieving a reduced hemoglobin loss, shorter catheterization time, and decreased hospital stay.[136] Moreover, a recent meta-analysis further supports the superiority of EEP compared to TURP. In fact, Vo et al analyzed 28 RCTs and found that EEP was associated with significantly improved IPSS at 12 months, Qmax at 1, 6, 12, 24 months, and PVR at 6, 12, 36 months compared with TURP. Advantages were also noted in transfusion rates, catheterization time, hospital stay, and reoperation rates (RR = 0.32).[127] Transient urinary incontinence is a notable consideration following EEP, with multiple studies demonstrating that most cases resolve within 1 to 6 months postoperatively.[137,138] In fact, a study found a 6.0% and 7.3% incidence of stress urinary incontinence (SIU) and urge urinary incontinence at 6 months, respectively.[138]

Given these positive outcomes, EEP is gradually challenging the long-standing gold standard status of TURP, although the main challenge remains in its important learning curve, with proficiency achieved after three to five times more cases compared to TURP (ie 30 to 50 compared to 10).[139,140] Guidelines recommend its use as an alternative for TURP and OSP for men with moderate to severe LUTS and any prostate size, provided the necessary technology and an EEP-trained surgeon are available.[18–20]

Photoselective Vaporization of the Prostate

Photoselective vaporization of the prostate (PVP) is a surgical procedure that is performed using a 532 nm wavelength (greenlight) laser. As laser energy is delivered, the laser energy is absorbed by hemoglobin and converted to heat to vaporize prostate cells to create a path for urine to flow.[141] Simultaneously, a thin zone of thermal coagulation seals small blood vessels to provide excellent hemostasis, while continuous saline irrigation cools the area and prevents deep tissue injury.[141] Across the literature, different laser powers have been introduced (80W, 120W and 180W), with the most recent system being the 180W.

A meta-analysis comparing PVP (regardless of laser power) to TURP have demonstrated comparable long-term functional outcomes (ie IPSS, Qmax, QoL, PVR or IIEF at 3, 24, 36 or 60 months).[142] At the same time, PVP reduced perioperative morbidity, with lower rates of blood loss, transfusion, clot retention, transurethral resection syndrome, catheterization time and length of hospital stay. However, PVP has also been associated with higher retreatment rate over the long term compared to TURP, with a study demonstrating a 27% retreatment rate at three-years follow-up.[142–144]

Given PVP's hemostatic properties, the procedure has been proposed as a potential treatment for patients receiving anticoagulant therapy aby the CUA and EAU.[19,20] Overall, PVP is an attractive option for patients suffering from moderate to severe LUTS, with EAU guideline recommending its use for patients with 30 to 80 mL prostate sizes whereas the CUA and AUA do not specify a size limit.[18–20]

Median Lobe Consideration

Prostate anatomy, specifically the presence and size of the median lobe, is increasingly considered an important determinant of treatment selection. This consists of an overgrowth of the prostate into the bladder, causing an intravesical prostatic protrusion (IPP). Its size can be quantified using cystoscopy or various imaging modalities, including transrectal or transabdominal ultrasound.[145] Conventionally, IPP can be categorized according to the measured size, respectively graded as grade I (<5 mm), grade II (5–10 mm) and grade III (>10 mm).[146] In fact, higher IPP grades correlate with

LUTS severity and a higher risk of clinical progress in patients receiving medical treatment.[147,148] Due to this specific anatomy, causing a "ball-valve" obstruction of the bladder outlet, several techniques, such as iTind, Optilume, and TUIP, either excluded patients in their trials or indicated limitations when IPP is large.

Although multiple surgical modalities can be applied in patients with an enlarged median lobe, there is a need for comparative studies and randomized trials that specifically enroll and stratify patients by IPP grade to define the optimal, anatomy-based approach for this sub-group.

Role of Shared Decision Making

In today's context, the range of treatment options for managing LUTS caused by BPH extends from office-based procedures to endoscopic and open surgeries, each with unique trade-offs in efficacy, durability, side-effects and impact on continence or sexual function. Choosing between these can be overwhelming, especially for patients, and can potentially lead to decisions that do not reflect their priorities. Therefore, it is important for urologists to take the proper time to counsel their patients on the wide range of possible options and agree on a solution that accounts for the clinician's expertise and patient preferences.[149] To help with this process, patient decision aids (PtDAs) can be leveraged. In fact, a BPH decision aid has recently been developed and endorsed by the CUA, allowing patients to be informed on the benefits, risks, and practical aspects of each procedure.[150] Currently undergoing multi-center beta-testing, this intuitive BPH PtDA presents a promising opportunity to help patients suffering from BPH-related LUTS navigate among all available MISTs and surgical options.

Conclusion

BPH remains a highly prevalent, age-related condition with a wide spectrum of management strategies tailored to symptom severity, prostate anatomy, and patient preferences. From medical therapies to invasive surgeries, it is important for clinicians to adapt their treatment approach based on objective parameters but also on individual values of patients. Moreover, health-economic evaluations should also accompany clinical studies on emerging and established therapies. These analyses are needed to guide payer and policy decisions, especially in resource-limited settings. As emerging technologies mature and longer-term data accrue, new innovative approaches will continue to optimize outcomes and patient satisfaction in the management of BPH.

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