

Prostatic urethral lift vs transurethral resection of the prostate: 2-year results of the BPH6 prospective, multicentre, randomized study

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Objectives

To compare prostatic urethral lift (PUL) with transurethral resection of the prostate (TURP) with regard to symptoms, recovery experience, sexual function, continence, safety, quality of life, sleep and overall patient perception.

Patients and Methods

A total of 80 patients with lower urinary tract symptoms attributable to benign prostatic hyperplasia (BPH) were enrolled in a prospective, randomized, controlled, non-blinded study conducted at 10 European centres. The BPH6 responder endpoint assessed symptom relief, quality of recovery, erectile function preservation, ejaculatory function preservation, continence preservation and safety. Additional evaluations of patient perspective, quality of life and sleep were prospectively collected, analysed and presented for the first time.

Results

Significant improvements in International Prostate Symptom Score (IPSS), IPSS quality of life (QoL), BPH Impact Index (BPHII), and maximum urinary flow rate (Q_{max}) were

observed in both arms throughout the 2-year follow up. Change in IPSS and Q_{max} in the TURP arm were superior to the PUL arm. Improvements in IPSS QoL and BPHII score were not statistically different between the study arms. PUL resulted in superior quality of recovery, ejaculatory function preservation and performance on the composite BPH6 index. Ejaculatory function bother scores did not change significantly in either treatment arm. TURP significantly compromised continence function at 2 weeks and 3 months. Only PUL resulted in statistically significant improvement in sleep.

Conclusion

PUL was compared to TURP in a randomised, controlled study which further characterized both modalities so that care providers and patients can better understand the net benefit when selecting a treatment option.

Keywords

BPH, LUTS, prostatic urethral lift, sexual function, UroLift, #UroBPH

Introduction

As the population ages, there is a growing need to find ways for people to live longer with satisfactory quality of life (QoL), even in the midst of increasing health problems [1]. For the ageing man in particular, QoL is challenged by two common issues: the onset of bothersome LUTS attributable to benign prostatic obstruction (BPO) [2,3] and diminishing ability to maintain normal sexual activity and function [4]. Both issues are important to men, yet often the treatment of the former has adverse effects on the latter [3,5,6].

The condition of BPO, caused by histological BPH, is common, increases in prevalence with age and causes LUTS that take a substantial toll on QoL, often leading to social isolation, depression, decreased productivity and poor sleep [3]. At the same time, many men desire to remain sexually active later in life. In a global survey of 13 618 middle-aged to older men across 29 countries, the percentage of men who rated sex as being very or extremely important was >70% in several countries [4].

Treatments for BPO offer symptomatic improvement of LUTS, but their overall impact on other factors that affect QoL must

also be considered [6,7]. For instance, when evaluating treatment options for BPH, issues of sexual function are an important measure of patient satisfaction with the outcome of treatment [7]. Treatments that improve LUTS but adversely affect a patient's sexual function may negatively affect a patient's QoL overall, with the patient viewing this as a treatment failure [6]. Iatrogenic incontinence carries a particularly negative impact on QoL [8]. Similarly, peri-operative complications and recovery time are important considerations in patient satisfaction with surgical treatment [9].

It is with this more comprehensive view of patient satisfaction and overall improved health outcome that a new endpoint for evaluating BPH treatments was developed and previously described [10]. The BPH6 is a composite of validated instruments to assess: (i) adequate relief from LUTS; (ii) high-quality recovery experience; (iii) maintenance of erectile function; (iv) maintenance of ejaculatory function; (v) maintenance of continence; and (vi) avoidance of high grade complications.

In the present study, prostatic urethral lift (PUL) treatment was compared in a prospective, randomized study with TURP using the BPH6 endpoint, its individual validated instruments and additional health outcome measures. PUL is a minimally invasive procedure that uses small implants to compress the prostatic lobes, reducing urethral lumen obstruction without resection, ablation or other thermal injury to the prostate. PUL has been shown in numerous studies to achieve significant symptom relief with low morbidity, including uniquely reproducible preservation of sexual function [11–15]. TURP has long been considered the 'gold standard' surgical treatment for maximum relief of LUTS associated with BPO and is considered standard of care; however TURP may not be the gold standard in overall patient satisfaction for those patients who value other aspects of their health. TURP is associated with a 20% rate of peri-operative morbidity and long-term complications that include urinary incontinence (1–3%), urethral stricture (7%), transurethral resection syndrome (1.4%), bleeding requiring transfusions (2.9%), erectile dysfunction (10%) and ejaculatory dysfunction (65%) [16–19]. We previously published the 1-year primary endpoint results of our study, showing that PUL is superior to TURP when using this new BPH6 endpoint [10]. We now present the 2-year results of the study, looking not only at the BPH6 concept, but also at the results of prospectively measured overall QoL indicators, including the Patient Global Impression of Improvement (PGI-I), the 12-item Short-Form Health Survey (SF-12) utility score and the Jenkins Sleep Questionnaire score. These additional measures allow a more complete characterization of patient experience after LUTS treatment of BPH. The aim was to provide a comprehensive comparison that allows a patient and physician to weigh important net health outcomes when choosing the best treatment option for the individual.

Patients and Methods

Study Protocol and Procedure

A prospective, randomized, controlled, non-blinded study was conducted at 10 European centres in three countries. Ethics committee approval was obtained at each site (Clinicaltrials.gov: NCT 01533038). Patients were eligible for enrolment if they were aged ≥ 50 years and a candidate for TURP, with IPSS >12 , maximum urinary flow rate ($Q_{\max}$) ≤ 15 mL/s, and prostate volume ≤ 60 cc on ultrasonography. Parallel 1:1 randomization was performed using permuted blocks of random sizes, stratified by study site, concealed through a password-protected computer system and revealed at the time of the procedure.

The PUL procedure involves transurethrally placing small permanent implants (UroLift® System) to compress tissue, enlarge the urethral lumen and reduce obstruction [20]. Investigator experience ranged from 0 to 20 PUL procedures before study commencement. Each investigator had extensive previous experience with TURP and conducted TURP procedures in accordance with their own standards and practices. Patients were followed up with visits at 2 weeks, 1 month, 3 months, 6 months, 1 year and 2 years.

Endpoints and Analyses

The BPH6 primary study endpoint is a composite of six validated instruments that assess a subject's net health outcome at 1 year: the IPSS, Sexual Health Inventory for Men (SHIM), Male Sexual Health Questionnaire for Ejaculatory Dysfunction (MSHQ-EjD), Incontinence Severity Index (ISI), Quality of Recovery visual analogue score (QoR VAS), and the Clavien–Dindo classification of adverse events. Changes from baseline in these measures were compared between the treatment arms at each follow-up visit using a *t*-test. The chi-squared test or Fisher's exact test was used to test for significant differences in the BPH6 composite and for elements of the composite. The effect of multiple testing was evaluated using the Hochberg method, which controlled the familywise error rate at 0.05 for the three families of hypotheses: tests for significant change within the TURP arm and within the PUL arm, and for significant difference between the TURP and PUL arms. All statistical analyses were performed using SAS version 9.3 or StatXact® (Cytel Corporation).

Several measures of QoL and patient satisfaction were assessed throughout follow-up, including the PGI-I questionnaire, the SF-12, and the derivative single-index SF-6D utility score [21,22]. The PGI-I is a one-item questionnaire that asks patients to rate their perceived change in condition after treatment ('very much better', 'much better', 'a little better', 'no change', 'a little worse', 'much worse' and 'very much worse'). This measure has been used

in several clinical studies worldwide and evidence of the construct validity for BPH-LUTS has been presented [22–24]. The SF-12 is a widely used tool for measuring the function health and well-being of subjects that has been demonstrated to be reliable and valid in clinical applications in several countries [21,25]. It consists of 12 questions that assess physical and emotional health. The SF-6D is a single-index measure derived from the SF-12 responses and is anchored at 1 for full health and 0 for dead. The health domains captured by the SF-6D utility values are physical functioning, mental health, role limitations attributable to physical health and mental problems, pain, vitality and social functioning. The calculation of SF-12 score and SF-6D utility values were performed using Health Outcomes Scoring Software 4.5 (QualityMetric Incorporated).

Calculation of a minimum clinically important difference (MCID) has been established as a method of giving clinical relevance to changes in standardized measures. It is the smallest difference in a health-related QoL (HRQoL) score that patients perceive as beneficial in the management of their condition. The MCID is dependent on the patient's disease category and postoperative expectations. Halme et al. [26] determined that a change of 0.0126 in SF-6D represents the MCID in this HRQoL score when studying urinary incontinence, and we have further applied this MCID to LUTS.

The proportion of patients achieving the SF-6D MCID at each visit was compared between the PUL and TURP arms using the chi-squared test. The association between achieving the BPH6 primary composite endpoint and achieving this MCID was evaluated using a logistic generalized estimating equation (GEE) model to account for the multiple responses recorded for patients over time, with the BPH6 primary endpoint as the independent variable and SF-6D MCID as the binary dependent variable. This model was used to estimate the ratio in the odds of achieving the SF-6D MCID for patients who met the primary BPH6 endpoint as compared with those who did not.

The proportion of patients perceiving improvement after treatment was assessed using the PGI-I. Majority response was tested using a chi-squared test, with a null hypothesis of a 50% proportion. A P value ≤ 0.05 was considered to indicate statistical significance in all tests.

Continence was defined as having an ISI score of ≤ 4 ; a patient was considered to be incontinent whenever he reported an ISI score > 4 [27]. As controlled by eligibility criteria (ISI score ≤ 4), all patients were considered continent at the time of enrolment. As an assessment of how important continence preservation was to patients, a logistic GEE regression model was used to determine whether having loss of continence was associated with statistically significant increase in the odds of have decreased QoL. Decreased QoL

was defined as a drop in SF-6D score greater than or equal to the MCID value.

The Jenkins Sleep Questionnaire was administered throughout follow-up to assess sleep disturbances [28]. This questionnaire consists of four items that cover: (i) trouble falling asleep; (ii) awakening several times per night; (iii) trouble staying asleep; and (iv) waking up feeling tired and worn out. Responses are rated on a six-step Likert scale of 0 (no sleep disturbance) to 5 (sleep disturbance), with a total possible score ranging from 0 to 20. Changes from baseline in Jenkins Sleep Questionnaire score for each time point were assessed for both arms of the study. The statistical significance of change from baseline within each group was assessed using a Wilcoxon signed rank test as a result of significant departure from normality and ordinal nature of the change scores.

The relationship between improvements in sleep and improvements in HRQoL were evaluated by comparing change in the Jenkins Sleep Questionnaire score from baseline with the probability of achieving the MCID for SF-6D. The change score for the Jenkins Sleep Questionnaire was used as a linear predictor of the probability of achieving SF-6D MCID using a logistic GEE model. The results are expressed as the change in odds (odds ratio) of obtaining SF-6D MCID with each unit increase in sleep improvement. Receiver-operating characteristic analysis was also performed to identify the minimum change in sleep improvement that would best predict the achievement of SF-6D MCID. This was done by picking the sleep change score point along the receiver-operating characteristic curve that maximizes sensitivity and specificity simultaneously, each weighted equally.

Results

A total of 80 patients were enrolled in a prospective, randomized, controlled study between February 2012 and October 2013. Significant improvements in IPSS, IPSS QoL, BPH Impact Index (BPHII) and $Q_{\max}$ were observed in both arms through 2-year follow-up (Table 1). IPSS change with TURP was superior to that with PUL at 1 and 2 years, and TURP was superior with regard to $Q_{\max}$ at all time points (Table 1). HRQoL and BPHII improvements were not statistically different. Quality of recovery, as defined by at least a score of 70 on the QoR VAS (0–100 scale), was superior for PUL compared with TURP, with 82% of patients in the PUL arm achieving the recovery endpoint by 1 month compared with 53% of patients in the TURP arm ($P = 0.008$). The proportion of patients who met the BPH6 primary endpoint was found to favour PUL vs TURP (non-inferiority $P = 0.0002$, superiority $P = 0.006$).

Over the 2-year follow up, six patients in the PUL arm (13.6%) and two in the TURP arm (5.7%) underwent

Table 1 Paired outcomes after prostatic urethral lift and transurethral resection of the prostate (TURP) treatment.

	2 weeks		1 month		3 months		6 months		12 months		24 months	
	PUL	TURP	PUL	TURP	PUL	TURP	PUL	TURP	PUL	TURP	PUL	TURP
IPSS												
N (paired)	42	34	44	33	42	34	40	33	40	32	37	32
Baseline (SD)	21.9 (5.7)	22.6 (6.0)	22.1 (5.7)	22.8 (5.8)	22.3 (5.8)	22.6 (6.0)	22.2 (5.7)	22.6 (6.0)	21.8 (5.5)	22.8 (5.9)	21.4 (5.5)	22.8 (5.9)
Follow-up (SD)	14.6 (7.7)	15.7 (7.3)	10.5 (7.6)	12.9 (5.9)	10.5 (7.4)	10.8 (8.4)	9.2 (7.5)	8.0 (7.2)	10.9 (8.0)	7.3 (6.3)	12.2 (8.9)	7.4 (6.7)
Change (SD)	-7.3 (9.4)	-6.8 (8.8)	-11.6 (9.3)	-10.0 (7.9)	-11.7 (8.5)	-11.8 (9.5)	-13.0 (8.1)	-14.6 (8.5)	-10.9 (7.9)	-15.4 (6.8)	-9.2 (9.2)	-15.3 (7.5)
Change <i>P</i> value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Comparison <i>P</i> value	0.827		0.417		0.978		0.421		0.013*		0.004*	
IPSS HRQoL												
N (paired)	43	34	44	33	43	34	40	33	40	32	37	32
Baseline (SD)	4.7 (1.1)	4.8 (1.2)	4.6 (1.1)	4.8 (1.2)	4.7 (1.1)	4.8 (1.2)	4.7 (1.1)	4.7 (1.2)	4.7 (1.0)	4.6 (1.2)	4.6 (1.1)	4.6 (1.2)
Follow-up (SD)	3.0 (1.9)	3.7 (1.7)	2.2 (1.8)	3.0 (1.9)	2.1 (1.5)	2.4 (2.0)	1.9 (1.6)	1.8 (1.7)	1.9 (1.6)	1.5 (1.5)	2.1 (1.6)	1.3 (1.5)
Change (SD)	-1.7 (2.3)	-1.0 (1.5)	-2.5 (2.0)	-1.8 (1.9)	-2.6 (1.7)	-2.4 (2.0)	-2.8 (1.6)	-2.9 (1.9)	-2.8 (1.8)	-3.1 (1.6)	-2.5 (1.8)	-3.3 (1.6)
Change <i>P</i> value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Comparison <i>P</i> value	0.143		0.138		0.55		0.791		0.436		0.066	
BPHII												
N (paired)	43	32	43	32	42	33	40	32	40	30	36	31
Baseline (SD)	7.3 (2.5)	7.2 (3.0)	7.3 (2.5)	7.3 (3.1)	7.4 (2.4)	7.3 (3.1)	7.5 (2.4)	7.2 (3.1)	7.3 (2.4)	7.0 (3.1)	7.1 (2.4)	7.0 (3.1)
Follow-up (SD)	6.3 (3.3)	7.0 (3.1)	4.0 (3.1)	5.3 (3.0)	2.6 (2.8)	3.8 (3.4)	2.3 (2.5)	2.2 (2.5)	2.3 (2.8)	1.8 (2.6)	3.0 (2.9)	1.5 (2.7)
Change (SD)	-1.0 (4.3)	-0.2 (3.7)	-3.4 (4.3)	-2.0 (3.6)	-4.8 (3.6)	-3.4 (3.5)	-5.2 (2.9)	-5.0 (3.2)	-5.0 (3.7)	-5.2 (3.2)	-4.1 (3.7)	-5.4 (3.3)
Change <i>P</i> value	0.131	0.775	<0.001	0.003*	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Comparison <i>P</i> value	0.39		0.138		0.101		0.795		0.836		0.131	
Q _{max}												
N (paired)												
Baseline (SD)												
Follow-up (SD)												
Change (SD)												
Change <i>P</i> value												
Comparison <i>P</i> value												
PVR												
N (paired)												
Baseline (SD)												
Follow-up (SD)												
Change (SD)												
Change <i>P</i> value												
Comparison <i>P</i> value												
SHIM												
N (paired)												
Baseline (SD)												
Follow-up (SD)												
Change (SD)												
Change <i>P</i> value												
Comparison <i>P</i> value												
MSHQ-EJd function												
N (paired)												
Baseline (SD)												
Follow-up (SD)												
Change (SD)												
Change <i>P</i> value												
Comparison <i>P</i> value												
MSHQ-EJd bother												
N (paired)												
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Follow-up (SD)												
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Comparison <i>P</i> value												
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Comparison <i>P</i> value												
MSHQ-EJd bother												
N (paired)												
Baseline (SD)												
Follow-up (SD)												
Change (SD)												
Change <i>P</i> value												
Comparison <i>P</i> value												

BPHII, BPH impact index; HRQoL, health-related quality of life; MHSQ-EJd, male sexual health questionnaire for ejaculatory dysfunction; PUL, post-void residual urine volume; Q_{max} maximum urinary flow rate; SHIM, sexual health inventory for men. *Hochberg method for multiple testing corrected *P* value > 0.05.

secondary treatment for return of LUTS. Secondary treatments included an additional PUL, intradetrusor botox, laser treatment or TURP procedure. One patient in the PUL arm underwent removal of an implant that had been deployed too proximally, such that part of the implant was exposed to the bladder and caused intermittent haematuria. Two other patients were not included in the analysis: one patient in the TURP arm discontinued study participation after an extended hospital stay for epididymitis and one patient in the PUL arm was censored from analysis for protocol deviation.

Erectile function was preserved in both arms as assessed by SHIM (Table 1), with the vast majority of patients meeting the erectile function criterion of the BPH6 endpoint at 2 years (98% for PUL, 94% for TURP). Ejaculatory function was superior for PUL compared with TURP ($P < 0.001$), with patients in the TURP arm experiencing a significant decline ($P < 0.001$) in MSHQ-EjD function score from 1 month after the procedure and onwards. This difference was further demonstrated in the BPH6 ejaculatory function category, as 100% of patients in the PUL arm had preserved function, while 34% of patients in the TURP group reported they 'could not ejaculate' at 2 years.

The number of patients who achieved the MCID in the SF-6D utility (general health) index was compared between the groups (Table 2). Both treatments achieved a clinically important improvement in HRQoL. PUL consistently delivered a higher proportion of patients achieving HRQoL improvement, but the difference was not statistically significant. Patients who met the BPH6 primary endpoint were significantly more likely to achieve an MCID in HRQoL, with an odds ratio of 2.0 ($P = 0.02$).

The majority of patients in both treatment arms indicated perceived improvement via the PGI-I question (P value for improvement < 0.001 at all visits; Fig. 1), with the distribution skewed towards the 'very much better' and 'much better' responses. Of further interest, the number of patients in each category who achieved an MCID in HRQoL is shown in the darkest shading in Fig. 1 with crosshatching at the bottom of each column, indicating that those who perceived an improvement in LUTS condition often also reported a significant improvement in HRQoL.

Table 2 Percentage of patients in each study arm who achieved a minimal clinically important difference in SF-6D utility score.

Visit	PUL, % (n/N)	TURP	P
2 weeks	41 (17/41)	25 (8/32)	0.14
1 month	50 (21/42)	36 (12/33)	0.24
3 months	51 (21/41)	30 (10/33)	0.07
6 months	51 (20/39)	37.5 (12/32)	0.25
12 months	52 (20/39)	50 (16/32)	0.91
24 months	47 (16/34)	37.5 (12/32)	0.43

PUL, prostatic urethral lift; TURP, transurethral resection of the prostate.

The patients whose HRQoL did not significantly change are presented using the dotted mid-shading. A small proportion of patients (indicated by the lightest shading in Fig. 1) did not complete the SF-12 questionnaire and the impact on their HRQoL is unknown. The percentage of patients who would recommend their index procedure to a friend at 2 years was 81% for the PUL arm and 82% for the TURP arm.

Continence function, as assessed by average ISI score, was maintained throughout follow-up for the PUL arm and did not change significantly from baseline at any time point (Fig. 2). In the TURP arm, patients experienced a significant worsening at both 2 weeks and 3 months (Table 1 and Fig. 2). Loss of continence was significantly associated with a clinically important decrease in HRQoL ($P = 0.007$). When continence was preserved, 47% of responses to the SF-12 questionnaire indicated that a positive MCID in HRQoL could be achieved. When patients experienced a loss of continence, they were far less likely to achieve an improvement in HRQoL (9%) and were likely to experience a significant decrease in HRQoL (65%). The GEE regression model indicated that patients who became incontinent had an odds ratio of 3.25 (triple the chance) of experiencing a significant decline in HRQoL.

Although patients in both treatment arms experienced average improvements in Jenkins Sleep Questionnaire scores by the earliest follow-up visit, only PUL provided statistically significant improvement (at 6, 12 and 24 months; Table 3). Both treatment arms showed statistically significant improvement in nocturia, as measured by the IPSS question (Table 4), although nocturia had worsened in the TURP arm at the 1-month follow-up. The GEE regression model indicated that the odds ratio of achieving a significant change in HRQoL with improvement in sleep was 1.12 ($P < 0.001$). Receiver-operating characteristic curves indicated that a threshold of a 2-point improvement in Jenkins Sleep Questionnaire score maximizes the specificity and sensitivity for an MCID improvement in HRQoL.

Discussion

The BPH6 study provides a prospective head-to-head comparison of PUL vs TURP for outcomes that are important to patients and influence their HRQoL. It has long been established that TURP offers maximum improvement in IPSS and Q_{max} , but the BPH6 study results indicate that an exclusive focus on these two goals may not result in the greatest improvement in HRQoL for patients who value other important health outcomes. Often when evaluating LUTS treatment options, HRQoL improvement is assessed only by the IPSS question 8, which asks specifically and exclusively about the patient's LUTS. If, on the one hand, a man is likely to be satisfied with the 43% mean IPSS improvement that

Fig. 1 Distribution of responses to the Patient Global Impression of Improvement (PGI-I) question and proportion of patients who achieved minimal clinically important difference (Δ) in quality of life (QoL) after prostatic urethral lift (PUL) or transurethral resection of the prostate (TURP) procedure. (Note: N/A indicates that the patient did not complete the SF-12 questionnaire and consequently Δ QoL was not assessed).

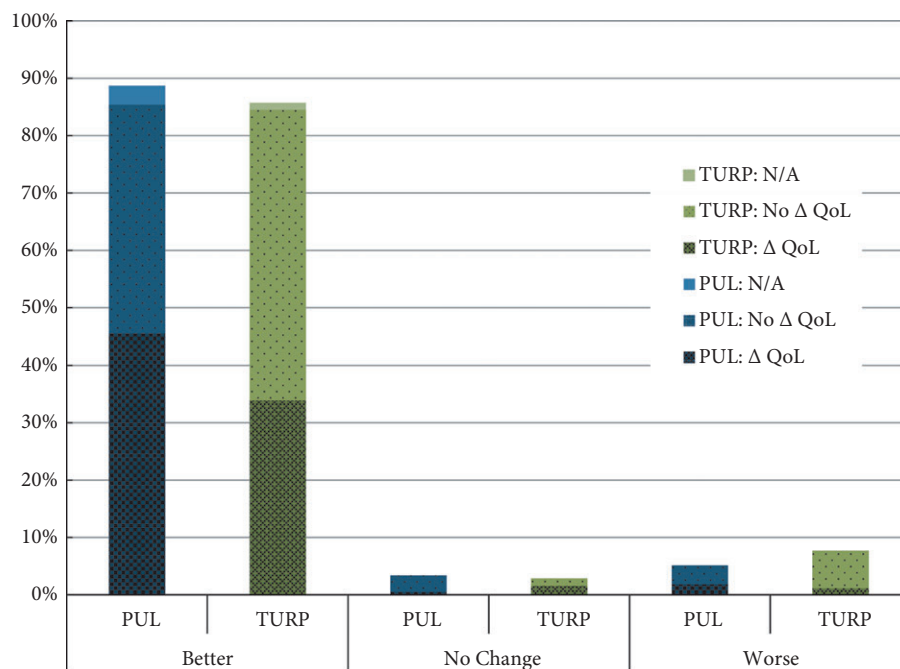
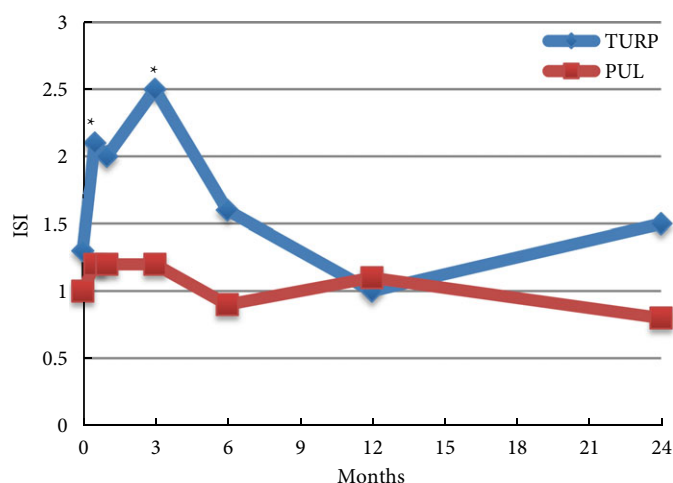


Fig. 2 Incontinence severity index (ISI) score change from baseline over time (*statistically significant).



PUL offers at 2 years and highly values avoiding sexual dysfunction or episodic incontinence, PUL is perhaps the better choice. If, on the other hand, sexual function and high-quality, rapid recovery are not important concerns, TURP may be the better choice to maximize impact on LUTS.

The BPH6 composite endpoint is as yet not validated, although it is composed of individually validated instruments. Achieving the BPH6 endpoint, regardless of treatment option,

strongly predicts improved HRQoL. This finding supports the need for a future BPH6 validation study assessing all BPO-related LUTS therapies. In the meantime, the present study provides in-depth separate analyses of BPH6 elements, comparing two disparate therapies, PUL and TURP, with regard to several important health outcome measures. Unfortunately, a larger-scale randomization between these two treatments is problematic because they are clearly different in nature and both generally available; it is unlikely that many patients would agree to random selection to undergo these disparate treatments. This fact underlines the need to offer both options and to tailor treatment to individual patient needs.

Durability of effect is another important characteristic of treatment options. The present study demonstrates the durability of PUL for up to 2 years, with 11% of patients requiring an additional procedure for LUTS compared with 6% of patients in the TURP arm. Recently, Roehrborn [12] reported PUL durability in a larger randomized study, with 13.6% of patients undergoing additional LUTS procedures in 4 years of follow-up. This durability appears to be of a greater magnitude than that reported for minimally invasive procedures that rely on heat ablation (20–40% by 3 years) [11,12]. Additional context with regard to durability is provided by Strobe et al. [29], showing that in a study of >6 000 men after TURP or laser vaporization, 22% remain on LUTS medication at 3 years.

Table 3 Jenkins sleep questionnaire score change from baseline over time.

Visit	PUL				TURP				Comparison P value
	N	Mean	SD	P	N	Mean	SD	P	
2 weeks	41	−1.0	5.1	0.33	34	−0.7	5.0	0.85	0.64
1 month	43	−1.1	5.2	0.18	33	−0.5	4.9	0.71	0.38
3 months	42	−1.6	5.3	0.08	34	−1.1	5.0	0.35	0.61
6 months	39	−1.9	5.5	0.03	33	−1.2	4.3	0.14	0.47
12 months	37	−2.0	5.9	0.04	32	−1.4	4.5	0.10	0.46
24 months	34	−1.5	6.2	0.05	32	−1.2	4.1	0.10	0.27

PUL, prostatic urethral lift; TURP, transurethral resection of the prostate.

Table 4 Nocturia score change from baseline over time.

Visit	PUL				TURP				Comparison P value
	N	Mean	SD	P	N	Mean	SD	P	
2 weeks	42	−0.4	1.6	0.15	34	0.1	1.6	0.67	0.20
1 month	44	−0.8	1.5	<0.001	33	−0.7	1.2	0.002	0.70
3 months	43	−0.9	1.5	<0.001	34	−1.1	1.3	<0.001	0.69
6 months	40	−1.1	1.6	<0.001	33	−1.3	1.6	<0.001	0.56
12 months	40	−0.8	1.5	0.002	32	−1.5	1.0	<0.001	0.04
24 months	37	−0.6	1.6	0.02	32	−1.2	1.3	<0.001	0.10

PUL, prostatic urethral lift; TURP, transurethral resection of the prostate.

The importance of preserving continence when treating LUTS was demonstrated in this study by the strong tendency for loss of continence to cause a drop in HRQoL. Patients in the PUL arm were found to have stable average ISI scores, whereas patients in the TURP arm experienced a significant decrease in continence at 2 weeks and 3 months. The probability of experiencing weeks to months of incontinence, although not permanent, would appear to represent another important issue to discuss in patient consultation and to consider when making a treatment choice.

Poor sleep and its deleterious effects on QoL represent a common chief complaint in male LUTS. The ability to achieve high-quality sleep (as assessed using the Jenkins Sleep Questionnaire) improves after LUTS treatment, as demonstrated in both arms of this study. Improvement in sleep is correlated with MCID in HRQoL ($P < 0.001$). Notably, an individual who experiences at least a 2-point change in Jenkins Sleep Questionnaire score maximizes the chance of improving his HRQoL. Results from this study indicate that an exclusive focus on nocturia may not fully address sleep disorder. Clearly, reducing nocturia is a primary objective for any LUTS treatment, but iatrogenic negative effects on sleep should also be considered. While both TURP and PUL significantly reduced nocturia for 2 years, only PUL showed significant improvement in overall Jenkins sleep quality. The origins of this difference are unknown, but represent an interesting area for further study in larger cohorts.

Patients in both treatment arms felt that their condition improved after therapy (according to PGI-I score) with the

majority in both arms indicating their postoperative condition to be ‘much better’ or ‘very much better’ for up to 2 years. Both procedures also translated into improvements in HRQoL with a high proportion of patients achieving the MCID in HRQoL after their procedure. Furthermore, the vast majority of patients were satisfied enough with their treatment to recommend the procedure to a friend. In both patient satisfaction and HRQoL improvement, PUL showed a trend of greater improvement up to 1 year, while improvements from the two treatments had levelled out by 2 years. This may be reflective of PUL superiority with regard to quality of recovery in the early postoperative period [10].

Study limitations include the modest patient numbers, which may not have provided sufficient statistical power to detect differences in some of the secondary outcome variables. For instance, the trend towards a greater percentage improvement in MCID HRQoL in the PUL arm is interesting and warrants further investigation. It was not possible to make a blind randomized comparison because episode of care and outcomes for these two treatment options are so different. The MSHQ-EjD bother score did not reflect significant changes in function score, suggesting either a lack of patient concern with ejaculatory function or a non-linear relationship between assessments. Because previous studies have shown that PUL preserves ejaculatory function, it may also be that those particularly concerned with preserving ejaculation were not willing to be randomized to TURP and thus did not elect to enroll in this study. Analysis of the SF-6D threshold for MCID is relatively new to urology and also warrants further study with respect to treatment options specifically for male LUTS.

In conclusion, both the PUL and TURP procedures offered significant improvement in symptoms, $Q_{\max}$ and HRQoL. Erectile function was preserved in both arms, whereas ejaculatory function was superior for PUL compared with TURP. TURP has been found to significantly compromise continence function at 2 weeks and 3 months, whereas average continence scores among patients in the PUL arm were stable. For both treatment methods, most patients perceive LUTS improvement after their procedure and are likely to recommend the procedure to a friend. Unlike TURP, the PUL procedure has been found to offer significant improvement in overall quality of sleep. Finally, the results of the present study indicate that the BPH6 endpoint is predictive of clinically significant improvement in HRQoL.

Acknowledgements

The authors would like to express their appreciation of the contributions of the research coordinators who facilitated the collection of data and to thank especially Drs Rodney Anderson, Kyle Anderson and Rajesh Shinghal for their participation on the independent clinical events committee. The authors would also like to thank Jacqueline Nerney Welch, MD, PhD and Theodore Lamson, PhD for their support in the preparation of this manuscript.

Conflict of Interest

Dr Gratzke reports honoraria from Astellas, Lilly, Janssen, and Amgen. Dr Barber reports support from NeoTract, Inc., Olympus, Boston Scientific and Intuitive Surgical for proctoring and lecturing. Dr Speakman reports grants from NeoTract, Inc. during the conduct of the study. Dr Berges reports grants from NeoTract, Inc. during the conduct of the study. Dr Wetterauer has nothing to disclose. Dr Greene has nothing to disclose. Dr Sievert reports grants from NeoTract, Inc. during the conduct of the study. Dr Chapple reports personal fees and non-financial support from Allergan, grants, personal fees and non-financial support from Astellas, personal fees and non-financial support from Boston, personal fees and non-financial support from Medtronic, personal fees from Pfizer, personal fees and non-financial support from Recordati, and grants from NeoTract, Inc. during the conduct of the study. Dr Sonksen reports grants from NeoTract, Inc. during the conduct of the study and support from NeoTract, Inc. for proctoring and lecturing.

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Abbreviations: BPHII, BPH impact index; BPO, benign prostatic obstruction; GEE, generalized estimating equation; HRQoL, health-related quality of life; ISI, incontinence severity index; MCID, minimum clinically important difference; MSHQ-EjD, male sexual health questionnaire for ejaculatory dysfunction; PGI-I, patient global impression of improvement; PUL, prostatic urethral lift; Q_{max} , peak urinary flow rate; QoL, quality of life; QoR VAS, quality of recovery visual analogue score; SF-12, 12-item short-form health survey; SHIM, sexual health inventory for men.