Prostatic Urethral Lift: Two-year Results After Treatment for Lower Urinary Tract Symptoms Secondary to Benign Prostatic Hyperplasia

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OBJECTIVE
To evaluate the effectiveness of the prostatic urethral lift in relieving lower urinary tract symptoms (LUTS) secondary to benign prostatic hyperplasia.

METHODS
A total of 64 men, aged ≥55 years, with moderate to severe symptomatic benign prostatic hyperplasia were treated and followed up at 6 Australian institutions. The treatment consisted of transurethral delivery of small implants to secure the prostatic lobes in an open condition, thereby reducing obstruction of the urethral lumen. The effectiveness, including International Prostate Symptom Score, quality of life, benign prostatic hyperplasia Impact Index, and peak urethral flow rate were assessed at 2 weeks and 3, 6, 12, and 24 months. The effect of this treatment on erectile and ejaculatory function was assessed using the Sexual Health Inventory for Men and Male Sexual Health Questionnaire for Ejaculatory Dysfunction.

RESULTS
The prostatic urethral lift improved LUTS symptoms rapidly and durably. The International Prostate Symptom Score was reduced 42% at 2 weeks, 49% at 6 months, and 42% at 2 years in evaluable patients. The peak flow rate improved by ≥30% (2.4 mL/s) at all intervals compared with baseline. No compromise in sexual function was observed after this treatment.

CONCLUSION
The present study demonstrated that LUTS and flow improvements without compromising sexual function. Although this was an early study with a small cohort, this therapy shows promise as a new option for patients with LUTS.

For men with moderate-to-severe lower urinary tract symptoms (LUTS), benign prostatic hyperplasia (BPH) is primarily a quality of life (QOL) concern. When considering treatment, the patients must consider the risks and benefits of each option. Issues, such as the adequacy of symptom relief, invasiveness, side effects, long-term complications, and effect on sexual function, are all important considerations.1-3

The current treatment of BPH offers relief of LUTS; however, the associated side effects and complications can negatively affect the QOL. Medical therapy, including α-blockers and 5α-reductase inhibitors, provides modest symptom relief, but undesirable side effects, such as asthenia (0.9%-15%), dizziness (2%-21%), headaches (5%-12%), decreased libido (3%-5%), erectile dysfunction (3%-10%), and ejaculatory dysfunction (1%-10%) occur.4 Most surgical treatments, including transurethral resection of the prostate (TURP), transurethral microwave therapy, and transurethral needle ablation, resect or ablate the tissue to relieve obstruction. Although effective, tissue injury results in a difficult recovery, including inflammation, irritative voiding symptoms for 4-6 weeks, risk of acute urinary retention, and routine catheterization.4,6 Furthermore, the complications of TURP include urinary incontinence (1%-3%), erectile dysfunction (10%), and retrograde ejaculation (65%).4 Similarly, transurethral microwave therapy and transurethral needle ablation are associated with urinary incontinence (<3%), erectile dysfunction (3.1%-7.5%), and retrograde ejaculation (0%-22%).4,5

Thus, many men with LUTS do not elect medical or interventional treatment because the complications of treatment are worse than the inconvenience of the

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symptoms. Thus, the need remains for a treatment that offers rapid, adequate symptom relief while addressing QOL by providing minimal morbidity.

Previously, we reported on the safety and feasibility of a novel, minimally invasive BPH treatment termed the “prostatic urethral lift procedure.” We found that this therapy was safe and straightforward to perform. This transurethral technique uses implants to secure the prostatic lobes in an open condition, thereby reducing obstruction of the urethral lumen without resection, ablation, or other injury. We report on our extended experience with the prostatic urethral lift with longer term follow-up. We hypothesized that the effectiveness and low morbidity could be durable and repeatable in a larger cohort of patients across several centers.

MATERIAL AND METHODS

Study protocol

The objective of the present study was to evaluate the longer term effectiveness of the prostatic urethral lift in relieving LUTS. A total of 64 men aged ≥55 years with moderate to severe symptomatic BPH were treated and followed up in a prospective, nonrandomized, multicenter study at 6 Australian institutions. The locally responsible ethics committees approved the study, which was registered in the Australia New Zealand Clinical Trials Registry (number 12609000760279).

The baseline patient characteristics were typical of patients considering invasive therapy for BPH/LUTS: age 66.9 ± 7.3 years (range 53-83), duration of LUTS 4.7 ± 4.3 years (range 0.5-23), and transrectal ultrasound (TRUS)-determined prostate volume 51 ± 23 cm³ (range 21-149). The men with symptomatic BPH, International Prostate Symptom Score (IPSS) >13, postvoid residual (PVR) urine volume <250 mL, and a peak uroflow rate (Qmax) of 5-12 mL/s were eligible for inclusion. All values are reported as the mean ± SD. Men with a serum prostate-specific antigen (PSA) level >10 ng/mL, a history of urinary retention, previous prostate surgery, compromised renal function, or current infection were excluded. All patients were required to be free of α-blocker medication within 1 week of treatment and 5α-reductase inhibitor medication within 6 months of treatment. Men with obstructive median lobes, as determined by the operating physician, were ineligible (n = 3). TRUS and cystoscopic examinations were performed before the procedure to measure the dimensions of the prostate and confirm eligibility for the study.

Effectiveness was assessed by follow-up visits conducted at 2 weeks and 3, 6, 12, and 24 months. The IPSS, QOL score, BPH Impact Index (BPHII), Qmax, and PVR were used to assess LUTS relief and functional improvement. The IPSS questionnaire was administered once to determine study eligibility and again after enrollment to provide the baseline value for analysis. The IPSS results for the earliest treated patients are also reported as an indication of the long-term effectiveness. Erectile function was measured using the International Index of Erectile Function and MSHQ-EjD; thus, the follow-up assessments began 6 weeks for these instruments. Other assessments included PSA determination, creatinine measurement, and TRUS imaging. A total of 22 patients agreed to undergo cystoscopy at 6 months for visual assessment of the implanted devices and urethra. Safety was assessed by the severity of the device or procedure-related adverse events using the Clavien Classification.

Prostatic urethral lift procedure

The transurethral prostatic urethral lift was performed with the patient under local (n = 26) or general (n = 40) anesthesia according to physician and patient preference. Local anesthesia was typically coupled with light sedation and achieved either through urethral instillation of lidocaine jelly or an intraprostatic block. The implantation procedures were completed using a delivery device (UroLift System, NeoTract, Pleasanton, CA) to compress a prostatic lateral lobe in an anterolateral direction toward the capsule and advance a spring-actuated, 19-gauge, 33-mm needle through the prostatic lobe and capsule. Early studies indicated that 33 mm was sufficient to reliably traverse the capsule when the lobe was in a compressed state. The permanent implant, which was preloaded into the delivery device, was then delivered to hold the urethra in position, as described previously (Fig. 1). Multiple implants, typically 4 (range 2-9), were delivered as needed to secure the prostatic urethra (Fig. 2). During the course of the study, the procedural technique was refined using the cystoscopic and symptomatic results from the patients treated early in the study. For the first 25 patients, our approach was to treat the dominant bulk of each prostatic lateral lobe; for patients 26-64, we focused on placing the implants such that a continuous anterior channel from the bladder neck to the verumontanum was achieved. This typically required placing 2 implants near the bladder neck and 2 midprostate. Three different generations of the UroLift System were used; the basic geometry, materials, and mode of action were the same among all generations. The current generation of the implant was used on patients 20-64; thus, patients 26-64 represent the cohort with the current device and the refined procedure. Prophylactic antibiotics were administered per standard practice with prostate surgery. Postoperative catheterization was used according to physician discretion and hospital standard-of-care. The blood loss was estimated by the operating physician at the end of each procedure.

Statistical analysis

To evaluate the change from baseline a general estimating equation model was fit to each output parameter (IPSS, QOL, BPHII, Qmax, PVR, SHIM, and MSHQ-EjD). The change from baseline was the dependent variable; the visit and baseline score were used as independent variables. An exchangeable correlation structure and identity link were used. This model was used to calculate the P values for each follow-up interval compared with the baseline value. To address the potential effects of the device and procedural changes made during the study, the IPSS results were analyzed for (a) the entire data set and (b) patients 26-64 only. The data from the retreated patients were censored from the analysis at retreatment. The data from patients with a SHIM score of 1-4 at baseline were excluded from the sexual function analysis, because this range indicates either complete erectile dysfunction or a lack of sexual activity. For safety measures, a general estimating equation was used to
compare the PSA level over time, and the TRUS-measured prostate volume was compared between baseline and 3-6 months of follow-up using a paired Student’s t-test. Statistical significance was defined as $P < 0.05$.

**RESULTS**

The prostatic urethral lift procedure improved LUTSs rapidly and durably (Table 1). The IPSS had decreased by 42% at 2 weeks, 49% at 6 months, and 42% at 2 years in evaluable patients. This symptomatic improvement was statistically significant at all intervals. The IPSS improvements in patients 26-64, those with the revised technique and the current version of the UroLift Implant, were similar to those observed in the full cohort and remained significant (Table 1). The patients treated early in the study had a 34% symptomatic improvement at 3 years (IPSS 13.4 ± 7.7 at 3 years vs 20.4 ± 5.8 at baseline, paired analysis, $n = 9$, $P = 0.024$).

**Figure 1.** UroLift System and delivery sequence. System composed of handheld delivery device (A) and implant consisting of nitinol capsular tab (Left), stainless steel urethral end piece (Right), and polyester monofilament connector (B). Implant delivered into prostate with encroaching lateral lobes (C) by introducing device under cystoscopic guidance (D), compressing lobe with delivery device and deploying needle through prostatic lobe and capsule (E), retracting needle, tightening tension on monofilament connector to seat capsular tab on prostatic capsule and securing implant with a urethral end piece (F). Additional implants delivered as required (G) to maintain expanded urethral lumen (H). (Images copyright NeoTract, Inc.)
Secondary measures showed similar improvement. The QOL score improved from an average of 4.9 at baseline to 2.7 at 2 weeks and 2.5 at 1 and 2 years. The BPHII decreased 39% between baseline and 2 weeks and a greater improvement was seen later, including a 60% reduction at 2 years. As with the IPSS, the changes in QOL and BPHII were statistically significant at all intervals.

This therapy was effective at improving voiding function, as assessed by the Qmax. The peak flow increased by an average amount of \( \frac{30\%}{2.4\text{ mL/s}} \) at all intervals compared with that at baseline, and the changes were statistically significant (Table 1). Notably, the improvement in peak flow between baseline and the 2-week follow-up visit was 45% on average, from 8.3 to 12.0 mL/s. The average PVR urine volume was stable from baseline through the follow-up period and had a large variance at all intervals (Table 1).

No compromise in sexual function was observed after this treatment. No evidence of degraded erectile function was found; in fact, the average SHIM score at each follow-up interval was slightly increased compared with baseline, although these differences were not statistically significant (Table 2). Ejaculatory function was similarly preserved; no patient reported an adverse event associated with anejaculation or retrograde ejaculation. MSHQ-EjD, a validated instrument used to assess ejaculatory function and bother associated with poor function, showed significant improvements at some intervals. The MSHQ function score increased >15% in 3 months after the procedure, returned to baseline values at 1 year and showed a slight, but not significant, decrease at 2 years (Table 2). The MSHQ bother score showed a significant improvement of approximately 50% between baseline and 6 months before returning to baseline values at 2 years (Table 2).

The early postoperative course was typical of an endoscopic procedure with irritative symptoms, dysuria, and mild hematuria, which typically resolved within the first week (all Clavien grade 1). Intraoperative blood loss was estimated to be 25 mL on average and did not prevent the completion of any procedure. No patient required a blood transfusion. Transient post-treatment urge incontinence was reported in 5 (8%) of 64 resolving on average by 8 days. No stress incontinence developed. One patient required catheterization and antibiotic treatment for epididymo-orchitis in the week following the procedure (Clavien grade 2). One patient developed rigor 3 days after treatment and was treated without complications (Clavien grade 2). Symptoms of prostatitis (penile and perineal discomfort; pain on erection and ejaculation) were reported in 1 patient and was treated with antibiotics (Clavien grade 2). A total of 8 urinary tract infections were treated in 7 patients throughout the follow-up period; all resolved with antibiotics (Clavien grade 2). One patient with a history of heart disease and percutaneous coronary intervention was washed out of anticoagulant medications before the procedure. The patient developed angina postoperatively, and blood tests demonstrated non-ST-segment elevated myocardial infarction (Clavien grade 2). The subject was treated medically and had no sequelae.

The PSA level increased postoperatively from 4.0 ng/mL at baseline to 6.8 ng/mL at 6 weeks and then returned to baseline values at 3 months and remained stable thereafter. The prostate volume, measured using TRUS at baseline in all patients and again at 3-6 months in 44 patients, showed no significant difference (51.4 ± 24.2 g at baseline vs 48.8 ± 24.5 g at follow-up; \( P = .1 \)). The cystoscopic follow-up examination in 22 patients 6 months after the prostatic urethral lift revealed no evidence of encrustation, infection, or other abnormalities.

Nearly one half (30 of 64, 47%) of the patients did not receive a postoperative catheter. Two catheterized patients did not respond to the prostatic urethral lift and underwent TURP within 30 days. The remaining catheterized patients had a median catheterization time of 20 hours, and 75% of catheters were removed the day after the procedure. Overall...
TURP, photoselective vaporization of the prostate, or repeat prostatic urethral lift was conducted on 20% (13 of 64) of patients in the 2-year follow-up period. Four patients underwent TURP or photoselective vaporization of the prostate within 7 months owing to failure to respond to the initial treatment. Nine patients who had symptomatic improvement after their initial procedure underwent repeat treatment with TURP (n = 4), photoselective vaporization of the prostate (n = 4), or prostatic urethral lift (n = 1) after an average of 13 months owing to the return of LUTS. Of the 13 patients, 10 (77%) were among the first 25 patients treated. The retreatment rate for the last 39 patients treated was 8% (3 of 39). Retreatment with each method was routine and unaffected by the presence of the implants.

**COMMENT**

The results of the present study have demonstrated that the prostatic urethral lift can offer rapid and durable LUTS relief without compromising sexual function. IPSS was reduced from the baseline by 42% at 2 weeks, 49% at 6 months, and 42% at 2 years in the evaluable patients. This symptomatic improvement was comparable to that with other minimally invasive therapies. The absence of retrograde ejaculation/anejaculatio-
Subsequent experience might show additional improved results. In our experience, the learning curve was typically 1-2 procedures for proficiency with the UroLift System and approximately 5 procedures for achieving optimal implant placement technique. The duration of the follow-up data provided confidence that the encouraging early results we previously reported\(^7\) are durable; some of the earliest treated patients have demonstrated symptomatic improvement for up to 3 years.

The depth of information collected on sexual function is atypical of early studies of BPH/LUTS therapies, and the results we found are particularly salient, given the established links between sexual function and LUTS.\(^{11-13}\) The bladder neck is not altered with the prostatic urethral lift; thus, we did not expect any effect on ejaculatory function. The MSHQ-EjD allowed us to demonstrate that ejaculatory function was preserved through 1 year, although it showed a slight, but not significant, decrease at 2 years. Ejaculatory function is often overlooked when evaluating BPH treatment options, despite its importance to men.\(^{3,14}\) We hypothesized that this oversight resulted from the absence, until now, of an intervention option that reliably preserves ejaculatory function.

Although the present study has demonstrated the benefits of the prostatic urethral lift for both LUTS and voiding flow, without compromising sexual function, several limitations must be recognized. The present study did not include an active or sham control group; thus, the

### Table 2. SHIM, MSHQ-EjD (function and bother), and serum PSA change from baseline through 2 years

<table>
<thead>
<tr>
<th>Variable</th>
<th>6 wk</th>
<th>3 mo</th>
<th>6 mo</th>
<th>12 mo</th>
<th>24 mo*</th>
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<tr>
<td>SHIM: n (Paired Values)</td>
<td>30</td>
<td>33</td>
<td>33</td>
<td>26</td>
<td>13</td>
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<td>Baseline</td>
<td>18.2 ± 4.9</td>
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<td>17.5 ± 5.6</td>
<td>17.9 ± 5.9</td>
<td>16.5 ± 6.8</td>
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<tr>
<td>Follow-up</td>
<td>19.8 ± 5.7</td>
<td>19.8 ± 5.3</td>
<td>18.4 ± 5.9</td>
<td>19.7 ± 5.2</td>
<td>17.6 ± 5.6</td>
</tr>
<tr>
<td>P value</td>
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<td>.004</td>
<td>.2</td>
<td>.01</td>
<td>.8</td>
</tr>
<tr>
<td>MSHQ-EjD function score (questions 1-3): n (Paired values)</td>
<td>26</td>
<td>28</td>
<td>28</td>
<td>22</td>
<td>10</td>
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<td>Baseline</td>
<td>10.6 ± 2.1</td>
<td>10.9 ± 2.3</td>
<td>10.6 ± 2.1</td>
<td>10.9 ± 2.4</td>
<td>10.4 ± 2.1</td>
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<tr>
<td>Follow-up</td>
<td>12.3 ± 2.1</td>
<td>12.5 ± 2.6</td>
<td>11.3 ± 3.5</td>
<td>11.1 ± 3.0</td>
<td>9.3 ± 2.8</td>
</tr>
<tr>
<td>P value</td>
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<td>&lt;.001</td>
<td>.3</td>
<td>.09</td>
<td></td>
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<tr>
<td>MSHQ-EjD bother score (question 4): n (Paired values)</td>
<td>26</td>
<td>28</td>
<td>28</td>
<td>22</td>
<td>10</td>
</tr>
<tr>
<td>Baseline</td>
<td>1.5 ± 1.4</td>
<td>1.4 ± 1.4</td>
<td>1.5 ± 1.5</td>
<td>1.5 ± 1.4</td>
<td>1.6 ± 1.6</td>
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<tr>
<td>Follow-up</td>
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<td>0.8 ± 1.2</td>
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<td>P value</td>
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<td>&lt;.001</td>
<td>.002</td>
<td>1</td>
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<tr>
<td>Serum PSA (ng/mL): n (Paired values)</td>
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<td>62</td>
<td>61</td>
<td>62</td>
<td>55</td>
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<td>Baseline</td>
<td>4.0 ± 3.1</td>
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<td>4.0 ± 3.1</td>
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<td>3.7 ± 2.6</td>
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<td>&lt;.001</td>
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<td>.7</td>
<td>1</td>
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</table>

SHIM, Sexual Health Inventory for Men; MSHQ-EjD, Male Sexual Health Questionnaire for Ejaculatory Dysfunction; PSA, prostate-specific antigen; CI, confidence interval.

Change in SHIM and MSHQ-EjD listed in absolute terms and in percentage of change with 95% CI.

* Sample size is reduced at 24 months as not all patients have reached this follow-up visit yet.
observed results could have been resulted from regression toward the mean. Given the observed magnitude and durability of the symptomatic changes and the flow improvement, this possibility is unlikely. Nonetheless, a controlled study is warranted to confirm these findings.

A second limitation was that the device and the procedure evolved during the course of the study. As with all new technologies, experience adds to the knowledge and improves the outcomes. Improvements were made according to the early experiences to help achieve consistent and reliable results. Reviewing the procedural cystoscopic video recordings and IPSS results of the first 25 patients revealed that patients in whom a continuous anterior channel was achieved had more durable results than the other patients. Accordingly, the procedural technique was refined to focus on achieving such a continuous channel for patients 26-64. The patients treated after this refinement had an increased likelihood of a durable result. Overall 20% (13 of 64) of the patients underwent repeat treatment in the present study, and repeat treatment was heavily weighted toward the first 25 patients. Of the 13 retreated patients, 10 were in the first 25 patients treated. The latter data set, patients 26-64, captures the experience from all 5 surgeons (including the initial experience of 3 of these 5) and represents the current generation of the device and the refined procedure. The retreatment rate in these patients was 8% (3 of 39). In our view, this is likely a more realistic view of the therapy as it is being implemented today.

Another limitation of the present study was the limited sample size available for some measures. No inclusion criteria were related to sexual function or sexual activity, and some patients had complete erectile dysfunction, no sexual activity, or refused to answer the questionnaires related to sexual activity. Additionally, the BPHII and MSHQ-EjD instruments were added as protocol amendments after 10 patients had been treated. For these reasons, the sample sizes for SHIM, MSHQ-EjD, and BPHII instruments were reduced. This sample size was too small to elucidate a correlation between either SHIM or MSHQ-EjD versus LUTS as other studies have done. Nonetheless, SHIM and MSHQ-EjD showed slight but significant improvements at some intervals, and BPHII showed significant improvement at all intervals, thereby supporting our conclusions. Compliance with urowflow instructions proved challenging for some patients; consequently, Qmax was not available for all patients at all intervals. The increase in Qmax was statistically significant at all intervals among those patients who complied, thus confirming that the therapy affected an increase in peak flow.

CONCLUSIONS

The prostatic urethral lift provides a clinically meaningful improvement in LUTS secondary to BPH. The procedure and device have been refined to achieve rapid symptomatic improvements that are durable through ≥2 years. Although this was an early study with a small cohort, this device shows promise for patients with LUTS seeking alternatives to existing interventional therapies.

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