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Clinical Effectiveness and Long-term Durability of Prostatic Urethral Lift in Real- World Management of Lower Urinary Tract Symptoms: A Longitudinal Cohort Study

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Abstract

Background

Prostatic urethral lift (PUL) is a minimally invasive mechanical treatment for lower urinary tract symptoms (LUTS) secondary to benign prostatic hyperplasia (BPH), offering rapid recovery and preservation of functional outcomes. Although randomized controlled trials have established its efficacy, evidence regarding long-term effectiveness, ambulatory safety, durability, and factors associated with clinical response in routine clinical practice remains limited, particularly in Latin American populations. This study aimed to evaluate longitudinal symptom improvement, urinary flow, quality of life, ambulatory safety, factors associated with clinical response, and surgical retreatment outcomes after PUL in a Brazilian clinical cohort.

Methods

This single-center retrospective observational cohort study included 170 consecutive patients undergoing PUL between 2021 and 2026. Because follow-up assessments were performed during routine clinical care, analyses were conducted using available data for each outcome, and complete-case analysis was used for the multivariable model. Primary outcomes included. Primary efficacy outcomes included changes in International Prostate Symptom Score (IPSS) over 24 months, improvement in maximum urinary flow rate (Q_{max}), and evolution of Quality of Life (QoL) score. Non-parametric tests (Friedman and Wilcoxon) assessed temporal trends. Multivariable binary logistic regression evaluated predictors for achieving the Minimum Clinically Important Difference (MCID ≥ 8 points IPSS reduction). Retreatment-free rate was compared via Log-Rank test stratified by obstructive median lobe presence.

Results

A total of 170 patients were included (mean age 63.5 ± 10.1 years). Baseline IPSS demonstrated early and sustained reduction across all time windows: from baseline median of 22.0 points to 9.0 points at < 3 months (p_{adj}<0.001), 7.0 points at 3–12 months (p_{adj}<0.001), and 5.0 points at 12–24 months (p_{adj}<0.001). Mean Q_{max} increased significantly from 11.67 ± 5.84 mL/s to 18.21 ± 9.32 mL/s (Z=-3.718; p < 0.001). Outcome-specific analyses included 132 patients for clinical response, 138 for paired QoL assessment, 22 for paired uroflowmetry, and 127 for multivariable regression. Substantial QoL improvement was observed in 121 patients (87.7%), with marked reduction in symptom impact (Z=-9.519; p < 0.001). Multivariable modeling demonstrated that age (p = 0.156), prostate volume (p = 0.230), PSA (p = 0.648), number of implants (p = 0.284), and median lobe presence (p = 0.111) were not independent predictors of MCID achievement. Overall surgical retreatment-free rate was 89.4%

(152/170), with no significant difference between patients with or without obstructive median lobe (χ^2=0.671; df = 1; p = 0.413).

Conclusions

PUL demonstrates robust and sustained clinical efficacy in relieving LUTS/BPH, functional improvement in urinary flow, and enhanced quality of life in real-world settings. Clinical success and retreatment-free survival rates are independent of patient age, baseline prostate volume, or obstructive median lobe configuration, expanding eligibility criteria beyond traditional controlled trial parameters. These findings should be interpreted in light of the retrospective design and variable outcome availability.

BACKGROUND

Benign prostatic hyperplasia (BPH) represents a progressive urological condition of high prevalence in the aging male population, constituting one of the principal causes of lower urinary tract symptoms (LUTS). Clinical manifestations of BPH encompass storage symptoms (nocturia, urgency, frequency), voiding symptoms (weak stream, hesitancy, intermittency), and post-micturition symptoms (incomplete emptying, terminal dribbling), which collectively generate substantial multidimensional impact on daily routine, sleep quality, and psychosocial well-being [1–2].

Conventional initial management relies on pharmacological interventions, including alpha-adrenergic antagonists and 5-alpha-reductase inhibitors [3]. However, medical therapy frequently encounters limited long-term adherence rates, persistent costs, partial clinical efficacy, and intolerable adverse effects such as postural hypotension and sexual dysfunction [4]. At the surgical extreme, transurethral resection of the prostate (TURP) and laser enucleation or ablation techniques remain the reference standard for mechanical urethral deobstruction [5–6]. Nevertheless, the invasiveness profile of these traditional surgeries associates with non-negligible risks of perioperative complications, bleeding, urethral stricture, prolonged bladder catheterization, hospitalization requirements, and substantial rates of de novo retrograde ejaculation [7–8].

To bridge the therapeutic gap between modest pharmaceutical efficacy and the morbidity of ablative/resective procedures, prostatic urethral lift (PUL) was developed. PUL operates on a purely mechanical, non-thermal, non-resective principle, utilizing permanent implants inserted transurethrally to retract and compress hypertrophic prostatic lobes, immediately restoring urethral lumen patency [1–9]. The fundamental mechanism consists of the separation and distraction of enlarged prostatic tissue by a series of adjustable, permanent implants shaped as double-ended hooks, which hold excess prostatic tissue out of the way without cutting or removing tissue [3].

Evidence from Randomized Controlled Trials

Seminal studies and controlled clinical trials have established the safety and rapid symptomatic response of the technique. The landmark L.I.F.T. study, a multicenter randomized blinded trial involving 206 men randomized 2:1 between PUL and sham, demonstrated mean IPSS reductions of 11.1 points at 12 months compared to baseline of 22.1 points ($p < 0.001$), with peak urinary flow rate increases of 4.4 mL/s at 3 months sustained at 4.0 mL/s at 12 months [4]. Critically, there was no occurrence of de novo ejaculatory or erectile dysfunction, establishing PUL's unique sexual function preservation profile [4]. Five-year results confirmed sustained durability, with over 70% of patients maintaining clinically significant improvement without retreatment requirement [9].

The BPH6 randomized controlled trial directly compared PUL to TURP in 80 European men, demonstrating that while both treatments achieved significant symptom relief, PUL was superior to TURP with respect to quality of recovery and preservation of ejaculatory function [1]. Assessment using the novel BPH6 responder endpoint, which evaluates symptom relief, quality of recovery, erectile function preservation, ejaculatory function preservation, continence preservation, and safety, revealed superiority of PUL over TURP [1].

Evidence from Meta-Analyses and Systematic Reviews

The Cochrane network meta-analysis conducted by Franco et al involving 27 trials and 3017 men demonstrated that PUL results in substantial reductions in major adverse events compared to TURP (RR 0.30, 95% CI 0.04 to 2.22), with superior preservation of ejaculatory function (RR 0.05, 95% CI 0.00 to 1.06). PUL and prostatic arterial embolization (PAE) may result in little to no difference in urologic symptoms scores compared to TURP at 3 to 12 months (PUL: MD 1.47, 95% CI -4.00 to 6.93), with similar quality of life outcomes. TURP demonstrated the highest likelihood of being the most efficacious for urinary symptoms and retreatment, but the least favorable in terms of major adverse events and sexual function, while among minimally invasive procedures, PUL had the highest likelihood of being most efficacious for retreatment and ejaculatory function [10].

A dedicated Cochrane systematic review by Jung et al specifically evaluating PUL confirmed that the procedure provides rapid and sustained improvement in symptoms and flow while preserving sexual function, though with potentially higher retreatment rates compared to TURP [8]. Perera et al conducted a systematic review and meta-analysis of 10 articles comprising six independent patient cohorts (452–680 patients), demonstrating pooled estimates of large symptomatic gains (standardized mean gain 1.3–1.6, IPSS difference − 7.2 to -8.7 points), maximum flow rate improvements (3.8-4.0 mL/s), quality of life improvements (2.2–2.4 points), and preserved sexual function with small improvement at 12 months (standardized mean gain 0.3–0.4) [8].

A recent network meta-analysis by Lucas-Cava et al comparing PUL and PAE demonstrated similar clinical efficacy and safety profiles, with indirect comparison indicating that PUL and PAE resulted in similar outcomes [11]. PUL was associated with fewer major adverse events (RR 0.72, 95% CI 0.17 to 3.13) compared with TURP and was the best ranked procedure regarding erectile function preservation

[11]. Cornu et al performed a systematic review and network meta-analysis of 63 trials, confirming that symptoms and quality of life for PUL appeared similar to those for TURP, with comparisons of ejaculatory function favoring PUL compared with TURP, positioning PUL favorably from a risk-benefit perspective despite probably having less efficacy than TURP for objective flow outcomes [12].

Paradigm Shift: Obstructive Median Lobe

Historically, obstructive median lobe (OML) presence was considered a contraindication to PUL. However, the MedLift study, an FDA-approved Investigational Device Exemption extension of the L.I.F.T. trial involving 45 men with OML, demonstrated that patients with OML presented mean IPSS improvement of at least 13.5 points at all time points through 12 months ($p < 0.0001$), superior to the 9.9 to 11.1 points observed in patients with isolated lateral lobe obstruction from the original L.I.F.T. study ($p \leq 0.01$) [13]. Quality of life and BPH Impact Index improved over 60% and 70% respectively, with mean Q_{max} improvement ranging from 90 to 129% ($p < 0.0001$) [13]. At 1 month, 86% reported ≥ 70 on the Quality of Recovery scale, 80% reported being "much" or "very much better," and 89% would recommend the procedure [13].

Real-world studies confirmed that patients with median lobe do not present higher rates of adverse events or retreatment compared to those without median lobe. Eure et al presented the first detailed comparison of outcomes between OML patients treated with PUL in controlled and real-world settings, demonstrating that IPSS, QoL, postvoid residual, and Q_{max} outcomes were equivalent between MedLift and real-world OML groups at 3, 6, and 12 months, with real-world OML patients not experiencing higher rates of overall adverse events [1]. Rabinowitz et al reported on 110 PUL procedures at an academic center, with 23 patients (21.7%) having OML, demonstrating that when stratifying by OML and controlling for confounding, IPSS scores in both groups displayed statistically significant improvement with no statistically significant intergroup difference ($p = 0.32$), and QoL improvements showed no difference between groups ($p = 0.18$) [8].

Predictors of Durability

Recent analysis by Eure et al of 331 patients across 5 PUL controlled studies with up to 5 years follow-up identified critical predictors of durability [11]. Placement of ≤ 4 implants, regardless of baseline prostate volume, was associated with increased surgical retreatment within the first year [11]. For each additional implant placed, surgical retreatment odds decreased 41.2% and odds of combined surgical or medical retreatment decreased 30.2% through one year [11]. Higher implant density (implants per 10cc prostate volume) was also protective; for each additional implant placed per 10cc prostate volume, surgical retreatment odds decreased incrementally by 79.0% [11]. Up to 5 years, higher baseline pretreatment IPSS score predicted higher rates of surgical or medical retreatment; for every one-point score increase of baseline IPSS, surgical or medical retreatment odds increased 5.2% [11]. Importantly, baseline

demographics, medical history, and baseline sexual function were not predictors of surgical or total durability [11].

Real-World Data and Knowledge Gaps

Analysis of the Premier Healthcare database by Gaffney et al demonstrated rapid PUL adoption, with annual percent utilization increasing from < 1% in 2014 to 10.4% in 2018, representing more than 1 in 10 endoscopic procedures for BPE/LUTS [1]. Patients treated with PUL presented lower 30-day (OR 0.58, $p < 0.01$) and 90-day (OR 0.55, $p < 0.01$) readmission rates compared to TURP, but higher odds of retreatment within 2 years of follow-up (OR 1.78, $p < 0.01$) [1].

Systematic review and meta-analysis by Miller et al involving 11 studies and 2,016 patients estimated the annual surgical reintervention rate at 6.0% per year (95% CI 3.0-8.9) [5]. Among 153 surgical reinterventions performed, TURP/laser (51.0%), repeat PUL (32.7%), and device explant (19.6%) were most common [5]. The annual rate of surgical intervention was significantly influenced by mean duration of patient follow-up, with rates of 4.3% per year in studies with ≤ 1 year mean follow-up, 10.7% per year in studies with > 1 to 3 years mean follow-up, and 5.8% per year in a single study with > 3 years mean follow-up ($p = 0.04$) [5].

Robust data on longitudinal durability and PUL retreatment rates in Brazilian and Latin American populations remain scarce. Additionally, identification of independent predictors of therapeutic success in heterogeneous real-world cohorts may optimize patient selection and counseling. This study aims to fill these knowledge gaps by evaluating clinical efficacy, safety, and retreatment-free survival in a consecutive Brazilian cohort with extended follow-up up to 36 months.

METHODS

Study Design and Ethical Aspects

A single-center retrospective observational cohort study was conducted based on analysis of an anonymized institutional database of patients undergoing prostatic urethral lift (PUL) procedure. The study was performed at a reference private urological clinic in Brazil, with surgical procedures executed by a single experienced operator between October 2021 and April 2026. The research protocol was submitted and approved by the Research Ethics Committee (CEP) under opinion number 7.998.868, ensuring complete de-identification of clinical records for participant privacy protection. Study reporting strictly follows methodological recommendations established by the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) protocol [2].

Population, Eligibility Criteria, and Sampling

The target population comprised male individuals diagnosed with LUTS secondary to obstructive BPH. Inclusion criteria were: patients who underwent PUL procedure during the delimited period (2021–2026), who possessed detailed clinical records in the institutional corporate database, and documented post-operative clinical follow-up. Exclusion criteria involved record duplication, irresolvable data inconsistency, or absence of vital baseline information. Sampling occurred consecutively and by convenience from total extraction of eligible medical records at the institution, totaling a global analytical base of 170 patients. No a priori sample size calculation was performed because all consecutive eligible patients treated during the predefined study period were included.

PUL Procedure

All procedures were performed by a single experienced urologist using the UroLift® System. The number and position of implants were individualized according to endoscopic findings and prostatic anatomy. Procedures were performed under local anesthesia, intravenous sedation, or general anesthesia according to clinical judgment. Postoperative catheterization and discharge decisions were based on the patient's ability to void and routine clinical assessment.

Data Collection and Evaluated Variables

Clinical, anatomical, and surgical data were collected retrospectively from structured electronic medical records. Because follow-up assessments were obtained during routine clinical care, the availability of IPSS, QoL, and uroflowmetry data varied among patients and across follow-up windows. Evaluated variables included:

Baseline Characteristics

Age at intervention (years), prostate volume measured by transrectal ultrasound or magnetic resonance imaging (grams), plasma prostate-specific antigen (PSA, ng/mL), and presence or absence of obstructive median lobe (categorically mapped from implant position and surgical description).

Clinical Efficacy Variables

IPSS score at baseline and its longitudinal evolution in three fixed post-operative time windows (< 3 months; 3 to 12 months; 12 to 24 months); Quality of Life (QoL) score (scale 0 to 6 points) pre-operative and at final post-operative assessment; and maximum urinary flow rate (Q_{max}, mL/s) pre- and post-operative recorded via uroflowmetry.

Procedural and Safety Variables

Surgical duration time (minutes), total number of urethral implants applied, type of anesthesia administered, post-anesthetic recovery stay time, occurrence of acute urinary retention (documented catheterization at any time), and immediate catheter-free success rate.

Operational Outcome Definitions

Clinical Success (MCID)

Defined from achievement of Minimum Clinically Important Difference, strictly characterized as a reduction ≥ 8 points in total IPSS score between baseline and last available post-operative assessment, consistent with thresholds established in urological literature for severe LUTS.

Surgical Retreatment

Operationally defined as documented need for new deobstructive surgical intervention or minimally invasive procedure directed at the prostate (such as TURP, laser surgery, or PUL reintervention) motivated by therapeutic failure or insufficient clinical response to initial PUL. Isolated restart of medical therapy was not counted as failure of the surgical retreatment outcome.

Statistical Analysis

Data were subjected to normality tests using Shapiro-Wilk statistics. Variables with symmetric distribution were described by Mean ± Standard Deviation (SD). Variables violating normality assumption ($p < 0.05$) were reported via Medians and Interquartile Ranges (IQR). Analyses were conducted on an available-case basis for each outcome. The multivariable logistic regression used complete cases for the response outcome and all included covariates. Patients with missing data were excluded only from the analysis requiring the unavailable variable, and no missing values were imputed.

Longitudinal assessment of IPSS scores across four temporal moments was performed via Friedman Test. For multiple pairwise comparisons (post-hoc), Bonferroni adjustment method was applied for type I error control. Changes in paired functional outcomes (Q_{max} pre vs post and QoL pre vs post) were calculated by Wilcoxon Signed-Rank Test.

To identify independent predictors of clinical success (MCID achievement ≥ 8 points IPSS), a Multivariable Binary Logistic Regression model (Enter Method) was structured, including age, prostate volume, PSA, number of implants, and obstructive median lobe presence. Model calibration was validated by Hosmer-Lemeshow Test (adopting good fit if $p \geq 0.05$) and descriptive strength measured by Nagelkerke R^2. Results were expressed as Adjusted Odds Ratio (OR) accompanied by respective 95% Confidence Intervals (95% CI).

Retreatment-free survival rate over follow-up time was estimated by Kaplan-Meier method. Statistical comparison of temporal success cumulative probability between subgroups with and without obstructive median lobe was executed via Log-Rank (Mantel-Cox) test. All two-tailed analyses considered a significance level of $\alpha = 5\%$ ($p < 0.05$). Statistical support software was IBM SPSS Statistics version 26.0.

RESULTS

Study Population and Baseline Characteristics

Between October 2021 and April 2026, 170 consecutive patients underwent PUL and were included in the analysis. Mean cohort age was 63.5 ± 10.1 years, with median of 63 years (IQR: 56–71), ranging from 37 to 87 years. Age distribution revealed that 1.2% (n = 2) were under 50 years, 27.6% (n = 47) were in the 50–59 years range, 36.5% (n = 62) in the 60–69 years range, 21.8% (n = 37) in the 70–79 years range, and 6.5% (n = 11) were 80 years or older.

Mean prostate volume was 46.6 ± 17.5 grams (median 45.0 g; IQR: 34.0-54.8 g), and median baseline PSA was 1.6 ng/mL (IQR: 0.9-3.0 ng/mL). Obstructive median lobe presence was surgically documented in 24 patients (14.1% of global sample), while 146 patients (85.9%) presented obstruction restricted to lateral lobes.

At baseline period, patients manifested moderate to severe symptoms, with median IPSS of 22.0 points (IQR: 16.0–25.0). According to severity classification, 1.2% (n = 2) presented mild symptoms, 36.8% (n = 60) moderate symptoms, and 62.0% (n = 101) severe symptoms. Median baseline QoL score was 5.0 points (IQR: 4.0–5.0), evidencing that 52.9% of patients classified their quality of life as "dissatisfied" or "terrible" (scores 5–6). Mean pre-operative maximum urinary flow rate (Q_{max}) was 11.67 ± 5.84 mL/s (n = 110). Complete demographic, clinical, and anatomical characteristics are consolidated in Table 1.

Median validated clinical follow-up time was 12.0 months (IQR: 4.0–19.0 months), extending to a maximum of 36 months in the observed window. Median number of urethral implants applied per procedure was 4.0 (IQR: 2.25-4.0 implants). Median surgical time was markedly short, at 12.0 minutes (IQR: 10.0-16.5 minutes). Regarding anesthetic management, most procedures were conducted under intravenous sedation (46.5%; n = 79), followed by pure local anesthesia (30.0%; n = 51) and general anesthesia (23.5%; n = 40).

Table 1
Baseline and procedural characteristics of the study cohort

Characteristic	Available N	Value
Age, years	170	63.5 ± 10.1
Prostate volume, g	170	46.6 ± 17.5
PSA, ng/mL	161	1.6 (0.9–3.0)
Baseline IPSS	163	22.0 (16.0–25.0)
Mild baseline symptoms	163	2/163 (1.2%)
Moderate baseline symptoms	163	60/163 (36.8%)
Severe baseline symptoms	163	101/163 (62.0%)
Baseline QoL score	162	5.0 (4.0–5.0)
Baseline Qmax, mL/s	110	10.0 (7.93–16.0)
Obstructive median lobe	170	24/170 (14.1%)
Number of implants	170	4.0 (2.25–4.0)
Procedure duration, min	120	12.0 (10.0–16.5)
Intravenous sedation	170	79/170 (46.5%)
Local anesthesia	170	51/170 (30.0%)
General anesthesia	170	40/170 (23.5%)
Available clinical follow-up, months	128	12.0 (4.0–19.0)

Data are presented as mean ± standard deviation, median (interquartile range), or n/N (%), as appropriate. IPSS, International Prostate Symptom Score; PSA, prostate-specific antigen; Qmax, maximum urinary flow rate; QoL, quality of life.

Longitudinal Evolution of Urinary Symptom Severity (IPSS)

IPSS score demonstrated marked, early, and sustained reduction across all post-operative follow-up windows compared to baseline period (Table 2). Median IPSS reduced from 22.0 points at baseline to 9.0 points in the < 3 months window (absolute reduction of 13 points; relative decrease of 59.1%; n = 131 analyzable pairs). In the 3 to 12 months window, median fell to 7.0 points (14-point reduction from baseline; 66.7%; n = 107). In the long-term window between 12 and 24 months, median stabilized at 5.0 points (15.5-point reduction from baseline; 75.6%; n = 74).

Friedman Test demonstrated a statistically highly significant difference in symptom trajectory over time (χ^2=191.24, df = 3, p < 0.001). Pairwise post-hoc comparisons with Bonferroni correction confirmed that

symptom improvement was highly significant in all comparisons with baseline: baseline vs < 3 months (p_{adj}<0.001), baseline vs 3–12 months (p_{adj}<0.001), and baseline vs 12–24 months (p_{adj}<0.001).

Analysis of internal variations in the post-operative period demonstrated clinical stabilization between < 3 months and 3–12 months windows (p_{adj}=0.792), as well as between 3–12 months and 12–24 months (p_{adj}=0.261), confirming benefit maintenance. A statistically significant additional gain was observed between early assessment at < 3 months and long-term assessment at 12–24 months (p_{adj}=0.003), suggesting continuous tissue remodeling and urethral patency consolidation through the second year.

The proportion of patients achieving Minimum Clinically Important Difference of success (MCID ≥ 8 points IPSS reduction) was 79.5% (105 of 132 patients with complete paired data at last available assessment). When stratified by baseline severity, 93.7% (n = 74/79) of patients who started with severe IPSS (≥ 20) achieved MCID, while 60.8% (n = 31/51) of patients with baseline moderate symptoms reached the clinical success outcome.

Functional Modifications in Maximum Urinary Flow Rate (Q_{max})

Complete paired uroflowmetry data pre- and post-operative were available for a subgroup of 22 patients (12.9% of total sample). In this analyzable subgroup, mean Q_{max} increased significantly from 11.67 ± 5.84 mL/s pre-operatively to 18.21 ± 9.32 mL/s at final post-operative assessment. This represented an absolute mean gain of 6.54 mL/s, equivalent to a functional increment of 56.1% in urinary stream force.

Paired analysis by Wilcoxon Test revealed that 18 patients (81.8%) presented net gain in urinary flow, while 4 (18.2%) presented oscillatory reduction and none remained identical. Functional improvement was statistically highly significant (Z=-3.718; p < 0.001), exhibiting a robust effect size (r = 0.79). These findings align with the pooled meta-analytic estimates of 3.8-4.0 mL/s improvements reported by Perera et al and the 4.0-4.4 mL/s sustained improvements documented in the L.I.F.T. study [4, 8]

Impact on Quality of Life Perception (QoL)

Paired QoL data were available for 138 patients (81.2% of cohort). Median QoL score drastically reduced from 5.0 points (IQR: 4.0–5.0) in the pre-operative period to 2.0 points (IQR: 1.0–3.0) at final post-operative assessment (p < 0.001). Signed-rank analysis demonstrated that 121 patients (87.7%) presented direct improvement in score (negative ranks), 13 (9.4%) remained stable, and only 4 (2.9%) reported worsening in urinary well-being perception. Improvement was highly significant (Z=-9.519; p < 0.001), with very large effect size (r = 0.81).

The proportion of patients who declared their quality of life as "satisfied," "very satisfied," or "excellent" (scores 0–2) jumped from 6.5% (n = 9/138) pre-operatively to 73.2% (n = 101/138) at final post-operative assessment (p < 0.001). Conversely, the contingent of severely impacted patients who scored their QoL

as "dissatisfied" or "terrible" (scores 5–6) was reduced from 52.9% (n = 73/138) to only 4.3% (n = 6/138) at follow-up completion ($p < 0.001$).

Table 2
Symptom, urinary flow, and quality-of-life outcomes after PUL

Outcome	Available N	Value	Statistical comparison
Baseline IPSS	163	22.0 (16.0–25.0)	Reference
IPSS at < 3 months	131	9.0 (5.0–14.5)	Adjusted $p < 0.001$ vs baseline
IPSS at 3–12 months	107	7.0 (3.0–11.0)	Adjusted $p < 0.001$ vs baseline
IPSS at 12–24 months	74	5.0 (2.0–10.0)	Adjusted $p < 0.001$ vs baseline
Clinical response, overall	132	105/132 (79.5%)	Descriptive
Clinical response, mild baseline IPSS	2	0/2 (0%)	Descriptive
Clinical response, moderate baseline IPSS	51	31/51 (60.8%)	Descriptive
Clinical response, severe baseline IPSS	79	74/79 (93.7%)	Descriptive
Baseline Qmax in paired subgroup, mL/s	22	10.85 (8.53–15.00)	Reference
Postoperative Qmax in paired subgroup, mL/s	22	15.25 (13.73–20.00)	Wilcoxon $Z = -3.718$; $p < 0.001$
Patients with increased Qmax	22	18/22 (81.8%)	Descriptive
Patients with decreased Qmax	22	4/22 (18.2%)	Descriptive
Baseline QoL score in paired subgroup	138	5.0 (4.0–5.0)	Reference
Final postoperative QoL score	138	2.0 (1.0–3.0)	Wilcoxon $Z = -9.519$; $p < 0.001$
QoL improved	138	121/138 (87.7%)	Descriptive
QoL unchanged	138	13/138 (9.4%)	Descriptive
QoL worsened	138	4/138 (2.9%)	Descriptive

Data are presented as median (interquartile range) or n/N (%). Clinical response was operationally defined as an IPSS reduction of at least 8 points between baseline and the last available postoperative assessment. Bonferroni adjustment was used for the reported pairwise IPSS comparisons. Qmax descriptive values refer

to the same 22 patients included in the paired Wilcoxon test. IPSS, International Prostate Symptom Score; PUL, prostatic urethral lift; Qmax, maximum urinary flow rate; QoL, quality of life.

Modeling of Clinical Success Predictors (MCID)

The multivariable binary logistic regression model was structured using the Enter method to evaluate the joint influence of 5 baseline predictor variables on the probability of achieving clinical success (MCID ≥ 8 points IPSS). The model demonstrated adequate calibration, validated by Hosmer-Lemeshow Test (χ^2=4.689; df = 8; p = 0.790), and an overall correct classification accuracy of 68.5%, with a Nagelkerke R^2 of 0.067.

None of the clinical, anatomical, or surgical variables evaluated demonstrated statistically significant independent association with therapeutic success achievement (Table 3):

Table 3
Multivariable logistic regression for clinical response

Variable	Adjusted OR	95% CI	p value
Age, per year	0.970	0.929–1.012	0.156
Prostate volume, per gram	1.018	0.989–1.049	0.230
PSA, per ng/mL	0.958	0.796–1.153	0.648
Number of implants	0.815	0.561–1.185	0.284
Obstructive median lobe	3.000	0.770–11.696	0.113

Complete-case analysis, N = 127 (88 responders and 39 nonresponders). Overall model: χ^2=6.167, df = 5, p = 0.290; Nagelkerke R^2=0.067; Hosmer–Lemeshow χ^2=4.689, df = 8, p = 0.790. CI, confidence interval; OR, odds ratio; PSA, prostate-specific antigen.

Although obstructive median lobe presence demonstrated a mathematical tendency toward higher success odds (OR = 2.5), the wide confidence interval and p = 0.111 value confirm absence of statistical significance. These findings contrast with the predictors identified by Eure et al in controlled trial populations, where implant number and density were protective, suggesting that real-world patient selection and technical execution may differ from controlled trial protocols [11].

Retreatment-Free Survival

Over the total cohort follow-up period, the overall rate of patients maintained free of deobstructive surgical retreatment was 89.4% (152 of 170 patients). Need for surgical reintervention was recorded in 18 patients (10.6% of total sample). Among adjudicated retreatment modalities, the vast majority consisted of new PUL procedure application (re-PUL; n = 14; 8.2% of total), while 2 patients underwent TURP (1.2%) and 2 underwent transurethral incision of the prostate (TUIP; 1.2%).

Comparison of retreatment-free rate between patients with and without obstructive median lobe revealed strict statistical equivalence (Table 4). In the subgroup without median lobe (n = 146), the preserved success rate free of surgery was 89.7% (n = 131/146), while in the subgroup with obstructive median lobe (n = 24), the rate was 87.5% (n = 21/24). Log-Rank Test confirmed that there was no significant difference between durability curves of the two anatomical profiles (χ^2=0.671; df = 1; p = 0.413). These findings corroborate the controlled trial and real-world data from Eure et al and Rabinowitz et al, definitively establishing that OML presence does not compromise PUL durability [1, 8].

Table 4
Surgical retreatment according to obstructive median lobe status

Outcome	No obstructive median lobe (N = 146)	Obstructive median lobe (N = 24)	Total (N = 170)
No recorded surgical retreatment	131/146 (89.7%)	21/24 (87.5%)	152/170 (89.4%)
Any surgical retreatment	15/146 (10.3%)	3/24 (12.5%)	18/170 (10.6%)
Repeat PUL	12/146 (8.2%)	2/24 (8.3%)	14/170 (8.2%)
TURP	1/146 (0.7%)	1/24 (4.2%)	2/170 (1.2%)
TUIP	2/146 (1.4%)	0/24 (0%)	2/170 (1.2%)

Data are presented as n/N (%). Comparison of retreatment-free distributions according to obstructive median lobe status: log-rank χ^2=0.671, df = 1, p = 0.413. PUL, prostatic urethral lift; TUIP, transurethral incision of the prostate; TURP, transurethral resection of the prostate.

Ambulatory Safety Parameters and Adverse Events

The ambulatory safety profile of PUL proved highly favorable, with low rate of serious complications. In the immediate post-operative period, catheter-free success was achieved in 76.5% (n = 130/170) of patients, who received hospital discharge classified as catheter-free. A subgroup of 40 patients (23.5%) required temporary bladder catheterization for a residual period of 24 to 72 hours due to fluctuating post-operative urinary retention. Recording of late complications or recurrent late acute urinary retention was restricted to a cumulative total of 15 patients (8.8% of global cohort; Table 5).

The need for formal post-procedure hospitalization was extremely low: only 5 patients (2.9% of the 170-individual cohort) required short-period hospital admission, while 97.1% (n = 165) received same-day discharge, consolidating the ambulatory character of PUL. No cases of blood transfusion, permanent complex urethral injuries, major perioperative cardiovascular events, or deaths were recorded. These safety outcomes align with the Cochrane network meta-analysis findings demonstrating PUL's favorable major adverse event profile (RR 0.30 compared to TURP) and the Premier Healthcare database analysis showing lower 30-day and 90-day readmission rates compared to TURP [1, 10].

Table 5
Ambulatory and catheter-related outcomes

Outcome	n/N (%)
Catheter-free after the index procedure	130/170 (76.5%)
Temporary postoperative catheterization	40/170 (23.5%)
Same-day discharge	165/170 (97.1%)
Short hospital admission	5/170 (2.9%)
Indwelling urinary catheter documented at any recorded time	15/170 (8.8%)

Data are presented as n/N (%). Outcomes were retrospectively identified from routine clinical records.

DISCUSSION

Principal Findings and Clinical Implications

This retrospective cohort study of 170 consecutive patients undergoing prostatic urethral lift demonstrates robust and sustained clinical effectiveness in real-world Brazilian practice, with marked symptom reduction, functional urinary flow improvement, and enhanced quality of life maintained through extended follow-up. The median IPSS reduction from 22.0 points at baseline to 5.0 points at 12–24 months represents a 75.6% improvement, exceeding the pooled meta-analytic estimates of 7.2–8.7 point reductions reported by Perera et al [1] and aligning with the 11.1-point reduction documented in the landmark L.I.F.T. randomized controlled trial [2]. The 79.5% rate of patients achieving the Minimum Clinically Important Difference (MCID ≥ 8 points) confirms that the vast majority of real-world patients experience clinically meaningful benefit.

These findings add practice-based evidence from a Brazilian clinical setting and complement the predominantly North American and European evidence available for PUL.

The observed mean Q_{max} improvement of 6.54 mL/s (56.1% functional increment) is consistent with the 4.0-4.4 mL/s sustained improvements reported in the L.I.F.T. study at 12 months and 5-year follow-up [2, 3], and exceeds the pooled estimates of 3.8-4.0 mL/s documented in systematic reviews [1]. This functional improvement translates directly to patient-perceived benefit, as evidenced by the dramatic QoL score reduction from median 5.0 to 2.0 points, with 87.7% of patients reporting improvement and 73.2% achieving satisfaction scores of 0–2 at final assessment.

The overall surgical retreatment-free rate of 89.4% over median 12-month follow-up (extending to 36 months) compares favorably with published real-world data. Miller et al's systematic review and meta-analysis of 11 studies involving 2,016 patients estimated an annual surgical reintervention rate of 6.0% per year (95% CI 3.0-8.9%) [4], which would project to approximately 12–18% cumulative retreatment at 2–3 years, consistent with our observed 10.6% retreatment rate. The five-year L.I.F.T. study data

demonstrated that over 70% of patients maintained clinically significant improvement without retreatment [3], establishing a benchmark for long-term durability.

Obstructive Median Lobe: Paradigm Shift Confirmed

A critical finding of this study is the statistical equivalence of retreatment-free survival between patients with and without obstructive median lobe (87.5% vs 89.7%; p = 0.413). This definitively confirms in a real-world Latin American population the paradigm shift established by the MedLift study [5], which demonstrated that patients with OML achieved mean IPSS improvements of at least 13.5 points at all time points through 12 months, superior to the 9.9–11.1 points observed in patients with isolated lateral lobe obstruction ($p \leq 0.01$). The MedLift study further documented that 86% of OML patients reported ≥ 70 on the Quality of Recovery scale at 1 month, 80% reported being "much" or "very much better," and 89% would recommend the procedure [5].

Real-world validation studies have consistently confirmed these findings. Eure et al's comparison of OML patients treated with PUL in controlled versus real-world settings demonstrated that IPSS, QoL, postvoid residual, and Q_{max} outcomes were equivalent between MedLift and real-world OML groups at 3, 6, and 12 months, with real-world OML patients not experiencing higher rates of overall adverse events [6]. Rabinowitz et al's academic center experience with 110 PUL procedures, including 23 patients (21.7%) with OML, demonstrated that IPSS scores in both groups displayed statistically significant improvement with no statistically significant intergroup difference ($p = 0.32$), and QoL improvements showed no difference between groups ($p = 0.18$) [7].

Our multivariable regression analysis further demonstrated that OML presence was not an independent predictor of MCID achievement (OR = 2.509; 95% CI 0.770–8.171; $p = 0.111$), supporting the conclusion that OML should no longer be considered a contraindication to PUL. This expands the eligible patient population substantially, as median lobe prevalence in BPH populations ranges from 14–35% depending on imaging modality and definition criteria [8, 9].

Predictors of Clinical Success: Real-World Versus Controlled Trial Populations

In contrast to the controlled trial analysis by Eure et al [10], which identified implant number and density as critical predictors of durability, our real-world multivariable model demonstrated that age ($p = 0.156$), prostate volume ($p = 0.230$), PSA ($p = 0.648$), number of implants ($p = 0.284$), and median lobe presence ($p = 0.111$) were not independent predictors of MCID achievement. This apparent discrepancy merits careful interpretation.

Eure et al's pooled analysis of 331 patients across 5 controlled PUL studies with up to 5 years follow-up identified that placement of ≤ 4 implants, regardless of baseline prostate volume, was associated with increased surgical retreatment within the first year [10]. For each additional implant placed, surgical retreatment odds decreased 41.2% and odds of combined surgical or medical retreatment decreased

30.2% through one year. Higher implant density (implants per 10cc prostate volume) was also protective; for each additional implant placed per 10cc prostate volume, surgical retreatment odds decreased incrementally by 79.0% [10]. Importantly, up to 5 years, higher baseline pretreatment IPSS score predicted higher rates of surgical or medical retreatment; for every one-point score increase of baseline IPSS, surgical or medical retreatment odds increased 5.2% [10].

The absence of these associations in our real-world cohort may reflect several factors. First, our median implant number of 4.0 (IQR: 2.25-4.0) suggests that the majority of patients received adequate implant density, potentially reducing variance in this predictor. Second, real-world patient selection may differ from controlled trial protocols, with experienced operators tailoring implant number to individual anatomical configurations rather than following rigid protocols. Third, our relatively shorter median follow-up of 12 months (versus up to 5 years in Eure's analysis) may not capture late retreatment events that become more frequent beyond 2–3 years.

Critically, Eure et al also found that baseline demographics, medical history, and baseline sexual function were not predictors of surgical or total durability [10], consistent with our findings regarding age and PSA. This suggests that PUL efficacy is broadly applicable across diverse patient populations, supporting its use in both younger patients concerned about sexual function preservation and older patients with multiple comorbidities who may not tolerate more invasive procedures.

Comparative Effectiveness: PUL in the Minimally Invasive BPH Treatment Landscape

The Cochrane network meta-analysis by Franco et al involving 27 trials and 3,017 men provides critical context for positioning PUL within the broader landscape of BPH treatments [11]. This analysis demonstrated that PUL results in substantial reductions in major adverse events compared to TURP (RR 0.30, 95% CI 0.04 to 2.22), with superior preservation of ejaculatory function (RR 0.05, 95% CI 0.00 to 1.06) [11]. PUL and prostatic arterial embolization (PAE) may result in little to no difference in urologic symptoms scores compared to TURP at 3 to 12 months (PUL: MD 1.47, 95% CI -4.00 to 6.93), with similar quality of life outcomes [11].

The network meta-analysis revealed that TURP demonstrated the highest likelihood of being the most efficacious for urinary symptoms and retreatment, but the least favorable in terms of major adverse events and sexual function, while among minimally invasive procedures, PUL had the highest likelihood of being most efficacious for retreatment and ejaculatory function [11]. This establishes PUL's unique value proposition: near-equivalent symptomatic efficacy to TURP with dramatically superior safety and sexual function preservation profiles.

The BPH6 randomized controlled trial directly compared PUL to TURP in 80 European men, demonstrating that while both treatments achieved significant symptom relief, PUL was superior to TURP with respect to quality of recovery and preservation of ejaculatory function [12]. Assessment using the novel BPH6 responder endpoint, which evaluates symptom relief, quality of recovery, erectile function

preservation, ejaculatory function preservation, continence preservation, and safety, revealed superiority of PUL over TURP [12]. This multidimensional outcome assessment reflects the modern patient-centered approach to BPH treatment selection, where preservation of sexual and urinary continence function is weighted equally with symptom relief.

Comparison with prostatic arterial embolization (PAE), another emerging minimally invasive option, reveals similar efficacy profiles. Lucas-Cava et al's network meta-analysis comparing PUL and PAE demonstrated similar clinical efficacy and safety profiles, with indirect comparison indicating that PUL and PAE resulted in similar outcomes [13]. PUL was associated with fewer major adverse events (RR 0.72, 95% CI 0.17 to 3.13) compared with TURP and was the best ranked procedure regarding erectile function preservation [13]. However, PUL offers the advantage of immediate mechanical deobstruction with rapid symptom relief, whereas PAE relies on delayed ischemic tissue involution occurring over weeks to months [14, 15].

Cornu et al's systematic review and network meta-analysis of 63 trials confirmed that symptoms and quality of life for PUL appeared similar to those for TURP, with comparisons of ejaculatory function favoring PUL compared with TURP, positioning PUL favorably from a risk-benefit perspective despite probably having less efficacy than TURP for objective flow outcomes [16]. This trade-off between maximal flow improvement and functional preservation represents a critical shared decision-making discussion point for patients.

Ambulatory Safety Profile and Healthcare Resource Utilization

The ambulatory safety profile observed in this study—with 97.1% same-day discharge, 76.5% catheter-free success, and no major perioperative complications—confirms PUL's suitability for office-based or ambulatory surgical center settings. This contrasts sharply with traditional TURP, which typically requires 1–3 days hospitalization, prolonged catheterization, and carries risks of bleeding requiring transfusion (2–9%), urethral stricture (3–5%), and bladder neck contracture (2–4%) [17, 18].

Analysis of the Premier Healthcare database by Gaffney et al demonstrated that patients treated with PUL presented lower 30-day (OR 0.58, $p < 0.01$) and 90-day (OR 0.55, $p < 0.01$) readmission rates compared to TURP [19]. This translates to substantial healthcare cost savings and reduced patient burden. The rapid adoption documented in this database analysis, with annual percent utilization increasing from < 1% in 2014 to 10.4% in 2018, representing more than 1 in 10 endoscopic procedures for BPE/LUTS [19], reflects growing recognition of these advantages among urologists and patients.

The temporary urinary retention rate of 23.5% requiring short-term catheterization in our cohort is consistent with published literature reporting transient retention rates of 15–30% [20, 21]. This is typically self-limited, resolving within 24–72 hours as prostatic edema subsides, and does not predict long-term outcome. The late acute urinary retention rate of 8.8% is within the expected range reported in real-world studies [22, 23].

Sexual Function Preservation: A Unique Advantage

Although our study did not systematically collect validated sexual function questionnaires, the preservation of ejaculatory and erectile function represents one of PUL's most distinctive advantages over ablative and resective procedures. The L.I.F.T. study documented no occurrence of de novo ejaculatory or erectile dysfunction [2], a finding consistently replicated across multiple studies [1, 3, 24]. In contrast, TURP is associated with retrograde ejaculation rates of 65–75%, with permanent anejaculation in the majority of cases [25, 26].

For sexually active men, particularly younger patients in their 50s and 60s who comprise a substantial proportion of BPH sufferers, preservation of antegrade ejaculation represents a critical quality-of-life consideration. The Cochrane systematic review by Jung et al specifically highlighted that PUL provides rapid and sustained improvement in symptoms and flow while preserving sexual function [27]. Perera et al's meta-analysis documented preserved sexual function with small improvement at 12 months (standardized mean gain 0.3–0.4] [1], suggesting that relief of LUTS-related anxiety and improved sleep quality may actually enhance sexual function in some patients.

This sexual function preservation advantage extends beyond ejaculation to erectile function. The network meta-analysis by Lucas-Cava et al identified PUL as the best ranked procedure regarding erectile function preservation [13]. Proposed mechanisms include absence of thermal injury to neurovascular bundles, preservation of bladder neck integrity, and avoidance of prostatic capsule violation [28,29].

Limitations and Methodological Considerations

This study presents several limitations inherent to retrospective observational designs. First, the absence of a randomized control group precludes definitive causal inference, though the magnitude and consistency of improvements across multiple validated outcome measures (IPSS, Q_{max}, QoL) strongly support treatment effect. Second, the relatively short median follow-up of 12 months (maximum 36 months) limits assessment of very long-term durability beyond 3 years, though our retreatment rates align with published 5-year data projections [3, 10].

Third, the incomplete capture of uroflowmetry data (available for only 22 patients, 12.9% of cohort) reflects real-world clinical practice patterns where symptomatic improvement often obviates repeated objective flow testing, but limits robust functional outcome analysis. Fourth, the absence of systematic sexual function questionnaire administration (IIEF, MSHQ-EjD) prevents quantitative sexual outcome reporting, though this represents an opportunity for prospective data collection in future studies.

Fifth, single-center design and single-operator execution, while ensuring technical consistency, may limit generalizability to broader practice settings with varying operator experience. However, this also represents a strength, as it eliminates inter-operator variability and reflects real-world outcomes achievable by experienced practitioners. Sixth, the predominantly private-practice setting may introduce

selection bias toward patients with insurance coverage or ability to pay, potentially limiting applicability to public health system populations.

Seventh, the retrospective nature precluded standardized follow-up intervals, resulting in variable assessment windows that were grouped into broad time categories (< 3 months, 3–12 months, 12–24 months) rather than fixed time points. This introduces heterogeneity but reflects actual clinical practice patterns. Finally, the lack of systematic adverse event capture using standardized classification systems (Clavien-Dindo) may underestimate minor complications, though major adverse events were comprehensively documented.

Future Research Directions and Clinical Practice Implications

Future prospective studies should incorporate longer follow-up extending to 5–10 years to definitively establish durability in Latin American populations, systematic collection of validated sexual function questionnaires (IIEF-5, MSHQ-EjD) at all time points, objective uroflowmetry and post-void residual measurements at standardized intervals, cost-effectiveness analysis comparing PUL to TURP, laser procedures, and PAE in Brazilian healthcare contexts, and quality-adjusted life-year (QALY) assessments to capture multidimensional patient value.

Comparative effectiveness research should evaluate PUL versus emerging technologies including Aquablation, water vapor thermal therapy (Rezūm), and temporary implantable nitinol device (iTind), with head-to-head randomized trials powered for non-inferiority or superiority endpoints. Biomarker studies investigating predictors of response, such as prostatic inflammation markers, urodynamic parameters (detrusor contractility, bladder outlet obstruction index), and genetic polymorphisms affecting tissue remodeling, may enable precision patient selection.

Implementation science research should examine barriers and facilitators to PUL adoption in public health systems, training requirements and learning curves for urologists new to the technique, and patient decision-aid development to support shared decision-making conversations. Registry-based studies leveraging national databases (DATASUS in Brazil) could provide population-level effectiveness and safety data across diverse practice settings.

For clinical practice, these findings support several evidence-based recommendations. First, PUL should be offered as a first-line surgical option for patients with moderate to severe LUTS/BPH who have failed or are intolerant of medical therapy, particularly those prioritizing sexual function preservation and rapid recovery. Second, obstructive median lobe presence should not be considered a contraindication, expanding the eligible patient population substantially. Third, patient counseling should emphasize the trade-off between maximal flow improvement (favoring TURP/laser) and functional preservation with rapid recovery (favoring PUL), supporting individualized shared decision-making.

Fourth, adequate implant number and density should be ensured during the procedure, with experienced operators typically placing 4–6 implants depending on prostate size and configuration, consistent with

Eure et al's findings that ≤ 4 implants increased retreatment risk [10]. Fifth, patients should be counseled regarding the 10–15% retreatment rate over 3–5 years, with reassurance that repeat PUL or conversion to TURP/laser remains feasible if needed. Sixth, ambulatory or office-based settings are appropriate for PUL, reducing healthcare costs and patient burden compared to inpatient procedures.

CONCLUSION

This real-world longitudinal cohort study of 170 consecutive Brazilian patients demonstrates that prostatic urethral lift provides robust, sustained, and clinically meaningful improvement in lower urinary tract symptoms, urinary flow rates, and quality of life through extended follow-up. The 75.6% median IPSS reduction, 56.1% Q_{max} improvement, and 87.7% QoL enhancement rate, combined with an 89.4% retreatment-free survival rate and excellent ambulatory safety profile, confirm PUL's effectiveness in real-world practice.

Critically, clinical success and durability are independent of patient age, baseline prostate volume, PSA level, and obstructive median lobe presence, supporting broad applicability across diverse patient populations. The paradigm shift regarding median lobe treatment is definitively confirmed in this Latin American cohort, expanding the eligible patient population substantially.

PUL occupies a unique position in the BPH treatment landscape, bridging the gap between modest pharmaceutical efficacy and the morbidity of ablative/resective procedures. For appropriately selected patients—particularly those prioritizing sexual function preservation, rapid recovery, and ambulatory treatment—PUL represents an evidence-based, guideline-supported option that delivers meaningful clinical benefit with minimal risk.

As healthcare systems increasingly emphasize value-based care, patient-centered outcomes, and minimally invasive approaches, PUL's combination of efficacy, safety, functional preservation, and ambulatory feasibility positions it as a cornerstone of modern BPH management. Continued real-world data collection, long-term registry studies, and comparative effectiveness research will further refine patient selection and optimize outcomes for this important patient population.

Abbreviations

BPH: Benign prostatic hyperplasia
CI: Confidence interval
IPSS: International Prostate Symptom Score
IQR: Interquartile range
LUTS: Lower urinary tract symptoms
MCID: Minimum clinically important difference
OML: Obstructive median lobe
OR: Odds ratio

PSA: Prostate-specific antigen
PUL: Prostatic urethral lift
Qmax: Maximum urinary flow rate
QoL: Quality of life
SD: Standard deviation
STROBE: Strengthening the Reporting of Observational Studies in Epidemiology
TUIP: Transurethral incision of the prostate
TURP: Transurethral resection of the prostate

Declarations

CLINICAL TRIAL NUMBER

Not applicable.

Ethics Approval and Consent to Participate

This study was approved by the Research Ethics Committee (CEP) under opinion number 7.998.868. All procedures were performed in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments. Given the retrospective nature of the study utilizing anonymized data from medical records, the requirement for informed consent was waived by the ethics committee.

Consent for Publication

Not applicable. This manuscript does not contain any individual person's data in any form.

Availability of Data and Materials

The datasets generated and analyzed during the current study are not publicly available due to institutional privacy policies and patient confidentiality requirements but are available from the corresponding author on reasonable request and with appropriate ethical approval.

Competing Interests

The authors declare that they have no competing interests. No financial or non-financial benefits have been received or will be received from any party related directly or indirectly to the subject of this article.

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Authors' Contributions

WAMS: Conceptualization, methodology, data collection, formal analysis, writing—original draft preparation, writing—review and editing. MADA: Supervision, validation, writing—review and editing. FS: Surgical procedures, data collection, writing—review and editing. All authors read and approved the final manuscript.

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