



Comparison of Postoperative Outcomes of Trans-urethral Resection of the Prostate, Laser Vaporization, and Laser Enucleation: A Double Propensity Score Matched Analysis

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OBJECTIVE To compare postoperative outcomes of 3 types of endourologic surgeries (trans-urethral resection of the prostate [TURP], laser vaporization [LVP], and laser enucleation [LEP]) for benign prostatic hypertrophy (BPH) treatment using the ACS-NSQIP database.

METHODS The ACS-NSQIP database was queried for men who underwent TURP, PVP, and LEP for treatment of BPH from 2011 till 2019. Demographics, clinical, operative characteristics, and 30-day outcomes were compared. Univariate and multivariate regression models were constructed. Propensity score matching was then performed as a sensitivity analysis.

RESULTS A total of 74,273 patients underwent endourologic surgeries for BPH, 65.4% had TURP, 28.6% PVP, and 5.9% LEP. Patients undergoing TURP were more likely to be older with higher ASA class, abnormal labs, and comorbidities (diabetic, congestive heart failure, and bleeding requiring transfusion) (P -value $< .001$). After adjusting for covariates and propensity score matching, LVP demonstrated shorter hospital stays, shorter operative times, less reoperation rates, decreased DVT/PE risk, with, however, higher odds of urinary tract infection and sepsis as compared to TURP (P -value $< .028$). Furthermore, LEP was found to have shorter hospital stays, longer operative times, and decreased odds of urinary tract infections and sepsis as compared to TURP (P -value $< .006$). LVP and LEP showed better surgical outcomes and characteristics as compared to TURP. Further research is needed to account for longer duration of follow-up and patient-specific urologic outcomes, such as prostate size, urinary incontinence, erectile dysfunction, and retrograde ejaculation. UROLOGY 177: 148–155, 2023. © 2023 Elsevier Inc. All rights reserved.

Benign prostatic hypertrophy (BPH) is a common pathology in men over 50 with an estimated incidence of 11.26 million cases in 2019 increasing from 5.48 million in 1990.¹ BPH can be asymptomatic in

some men but may lead to benign prostatic obstruction (BPO) which manifests in lower urinary tract symptoms (LUTS), urinary retention, urinary tract infections (UTI), and in severe cases may result in renal failure.²

Trans-urethral resection of the prostate (TURP) has been considered the gold standard surgical treatment since its start in 1901. TURP comes with various complications such as TUR syndrome, bleeding, bladder neck stenosis, and infectious complications.³ Throughout the years, the number of TURP procedures has decreased due to alternative techniques, better office-based medicine and better understanding of indications for surgery.⁴ Nowadays, several novel approaches have been developed with the aim of reducing postoperative complications and improving patient outcomes. Notable of these approaches is the laser technology adapted in 1986 and evolved into 2 main techniques: Laser Vaporization of the Prostate (LVP) and Laser Enucleation of the Prostate (LEP). Studies comparing LVP or LEP to TURP have already established the safety and efficacy of these techniques and their advantages.^{3,5,6}

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The aim of this study is to compare the postoperative outcomes of these 3 different types of endourologic surgeries for BPH treatment using the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database.

MATERIALS AND METHODS

Study Design and Data Retrieval

The ACS-NSQIP dataset was used to collect data on patients that underwent an endourologic surgery between the years 2011 and 2019. The corresponding current procedural terminology (CPT) codes 52601 (TURP), 52648 (LVP), and 52649 (LEP) were used. The ACS-NSQIP database is a nationally validated, risk-adjusted, outcomes-based program. It encompasses 963 centers and more than 65 collaboratives both inside and outside the United States. The dataset does not include any human subject research; hence, IRB (Institutional Review Board) approval was not needed.

Patients and Covariates

Patients with laboratory-confirmed prostate cancer with a diagnosis recorded as the ICD-10 code "C61" were excluded, because such malignancy may present bias to the outcomes of interest.

Patient demographics, laboratory values, and comorbidities were collected from the dataset. Patient demographics included age, race, body mass index (BMI), smoking, and American Society of Anesthesiology (ASA) class. Patient laboratory values included abnormal creatinine defined as serum creatinine ≥ 1.5 mg/dL, leukocytosis defined as white blood cell (WBC) count $> 11 \times 10^9$ cells/L, thrombocytopenia defined as platelet count $< 150 \times 10^3$ platelets per microliter of blood, hypoalbuminemia is albumin < 3.4 g/dL, and anemia defined as hematocrit $< 41\%$. Furthermore, operative time (mins) was collected. Patient comorbidities and pre-operative events include history of diabetes mellitus, insulin-dependent diabetes, chronic obstructive pulmonary disease (COPD), steroid use for chronic condition, bleeding disorders, hypertension (requiring medication), disseminated cancer, weight loss (defined as 10% loss of body weight in last 6 months), dyspnea, dialysis (currently, preoperatively), congestive heart failure (CHF), and prior blood transfusions. Furthermore, operative time (mins) was collected.

We also reported on 30-day postoperative outcomes which included length of hospital stay (days), bleeding requiring transfusion post-operatively, UTI, pneumonia, pulmonary embolism (PE) and deep vein thrombosis (DVT), readmissions, renal complications (renal failure and renal insufficiency), sepsis, and major adverse cardiovascular event (MACE) that includes myocardial infarction, cerebrovascular accident, or death.⁷ Postoperative outcomes were also reported and compared using the Clavien-Dindo (CD) staging system that was adapted to the NSQIP (Supplement Table 1).^{8,9} We also compared 30-day postoperative reintervention causes that included cystourethroscopy with irrigation and evacuation of multiple obstructing clots, catheter insertion, bladder drain with suprapubic catheter or cystostomy, urethral dilation or meatotomy, and resection of prostatic tissue left after a previous surgery. These outcomes were determined using their applicable CPT codes (Supplement Table 2).

Statistical Analysis

Categorical variables were compared using the chi-square test and presented as counts and percentages while continuous variables were analyzed using 1-way analysis of variance (ANOVA) and presented as mean and standard error of the mean (SEM).

Logistic regression was used for categorical outcomes, while linear regression was employed to assess continuous outcomes. Both types of regressions were run with enter, backward and forward regression to assess sensitivity. Multivariable regression models were adjusted for age, race, BMI, current smoker, ASA class, abnormal creatinine, leukocytosis, hypoalbuminemia, anemia, diabetes (Insulin and non-insulin dependent), history of severe COPD, bleeding disorder, hypertension, disseminated cancer, dyspnea, transfusion preoperatively, and history of CHF.

Propensity Score Matching

As a sensitivity analysis, we performed a 1:1 propensity score matching between the procedures. Propensity score matching can only be performed for 2 groups at a time; hence, we performed propensity score matching between TURP and LVP followed by an analysis between TURP and LEP. After propensity score matching, all pre-operative baseline demographics, lab values, comorbidities, and events were matched without differences between the groups.

For all aforementioned tests, 2-sided statistical significance was set for a P -value $< .05$. All analyses were conducted using the statistical analysis software platform (IBM SPSS) version 28.0.0.0 (190).

RESULTS

Patients' Characteristics

The database was managed and yielded a total of 74,273 patients who underwent endourologic surgeries between 2011 and 2019 of whom 48,609 (65.4%) had undergone TURP, 21,271 (28.6%) had LVP, and 4393 (5.9%) had undergone LEP.

Patients who underwent TURP were found to be older, with a higher ASA class, more likely to have abnormal labs, and more likely to have comorbidities such as diabetes, insulin-dependent diabetes, and bleeding requiring transfusion (P -value $< .001$). LVP and LEP were more likely to have higher BMI, history of COPD, bleeding disorders, and hypertension requiring medication (P -value $< .001$) (Table 1).

Outcomes of Interest

TURP patients showed longer length of stay (1.9 ± 0.02 days) and higher cases of bleeding requiring transfusion (1.7%), PE/DVT (0.4%), MACE (0.9%), and renal complications (0.4%) as compared to LVP and LEP (P -value $< .049$). LEP showed longer operative times (102.21 ± 0.92 mins) as compared to TURP and LVP (P -value $< .001$). Finally, LVP showed higher cases of UTI (5.7%) and sepsis (1.1%) as compared to TURP and LEP (P -value $< .001$). LVP and LEP also showed decreased rates of CD complications I-V as compared to TURP (P -value $< .001$) (Table 2). Regarding reintervention causes, LVP showed lower odds of cystourethroscopy with irrigation and evacuation of multiple obstructing clots and resection of prostatic tissue left after a previous surgery as compared to TURP (Table 2).

Table 1. Patient demographics, pre-operative labs, medical comorbidities, and pre-operative events stratified by type of endourologic surgery between the years 2011 and 2019

		Procedure Type			P-Value
		TURP (N = 48,609) N (%)	Laser Vaporization (N = 21,271) N (%)	Laser Enucleation (N = 4393) N (%)	
N = 74,273					
Demographics					
Age	< 50	648 (1.3)	196 (0.9)	49 (1.1)	< .001*
	50-59	4496 (9.2)	1947 (9.2)	483 (11)	
	60-69	15,162 (31.2)	6517 (30.6)	1659 (37.8)	
	70-79	18,036 (37.1)	7970 (37.5)	1604 (36.5)	
	> 80	10,267 (21.1)	4641 (21.8)	598 (13.6)	
Race	Black	2980 (8.5)	1041 (6.3)	240 (5.9)	< .001*
	White	30,264 (86.2)	14,763 (89.7)	3600 (88.7)	
	Others	1859 (5.3)	656 (4)	218 (5.4)	
BMI	< 25	13,123 (27)	5564 (26.2)	983 (22.4)	< .001*
	25-29.9	20,316 (41.8)	8932 (42)	1891 (43)	
	30-34.9	10,356 (21.3)	4609 (21.7)	998 (22.7)	
	35-39.9	3425 (7)	1496 (7)	378 (8.6)	
	> 40	1389 (2.9)	670 (3.1)	143 (3.3)	
Smoker		5299 (10.9)	2017 (9.5)	389 (8.9)	< .001*
ASA Class > 2		26,415 (54.3)	11,518 (54.1)	2050 (46.7)	< .001*
Pre-operative Labs					
Abnormal Creatinine (> 1.5 mg/dL)		5498 (11.3)	2171 (10.2)	381 (8.7)	< .001*
Leukocytosis		3202 (6.6)	1075 (5.1)	206 (4.7)	< .001*
Thrombocytopenia		4292 (8.8)	1944 (9.1)	371 (8.4)	.232
Hypoalbuminemia		3263 (6.7)	1191 (5.6)	183 (4.2)	< .001*
Anemia (HCT < 41%)		19,671 (40.5)	7770 (36.5)	1403 (31.9)	< .001*
Medical Comorbidities and Pre-operative Events					
Diabetes		10,627 (21.9)	4527 (21.3)	833 (19)	< .001*
Insulin-Dependent Diabetes		3179 (6.5)	1291 (6.1)	246 (5.6)	.007*
History of severe COPD		3023 (6.2)	1366 (6.4)	174 (4)	< .001*
Steroid use for chronic condition		1255 (2.6)	576 (2.7)	106 (2.4)	.444
Bleeding disorders		1470 (3)	962 (4.5)	129 (2.9)	< .001*
Hypertension requiring medication		29,234 (60.1)	13,041 (61.3)	2509 (57.1)	< .001*
Disseminated cancer		660 (1.4)	149 (0.7)	26 (0.6)	< .001*
Weight loss		300 (0.6)	118 (0.6)	19 (0.4)	.232
Dyspnea		3047 (6.3)	1429 (6.7)	193 (4.4)	< .001*
Dialysis		246 (0.5)	112 (0.5)	16 (0.4)	.38
Congestive Heart Failure		507 (1)	215 (1)	21 (0.5)	< .001*
Bleeding Requiring Transfusion		358 (0.7)	75 (0.4)	6 (0.1)	< .001*

BMI indicates body mass index (kg/m²); ASA indicates American Society of Anesthesiologists; Abnormal Creatinine is serum creatinine ≥ 1.5 mg/dL; Leukocytosis is WBC > 11 cells/L; Thrombocytopenia is platelet count < 150×10^3 platelets per microliter of blood; Hypoalbuminemia is albumin < 3.4 g/dL; Anemia indicates hematocrit < 41%; COPD indicates chronic obstructive pulmonary disease; Blood Transfusion is receiving packed red blood cells 72 h before surgery; Weight loss is defined as > 10% loss body weight in last 6 months.

* Significant $P < .05$.

Regression Analysis

LVP and LEP showed shorter length of stay as compared to TURP (P -value < .001). Furthermore, LVP showed shorter operative times (-3.46 mins), higher odds of UTI (OR = 1.13), lower odds of bleeding transfusion (OR = 0.28), and lower odds of PE/DVT (OR = 0.54) as compared to TURP (P -value < .001). In addition, LEP showed longer operative times (39.64 mins), lower odds of UTI (OR = 0.61), and lower odds of sepsis (OR = 0.45) as compared to TURP (P -value < .001). LVP also showed decrease odds of CD III complications (OR = 0.72) whereas LEP showed decrease odds of CD I, II, & III complications (OR = 0.71 and 0.57, respectively) as compared to TURP (P -value < .004) (Table 3).

Propensity Score Matching

After propensity score matching, TURP and LVP matched analysis yielded 15,357 matched individuals for each group. LVP still showed shorter operative times (-0.92 mins), shorter length of stay (-3.27 days), lower odds of bleeding transfusion (OR = 0.21), PE/DVT (OR = 0.52), MACE (OR = 0.76), and readmissions (OR = 0.64), and higher odds of UTI (OR = 1.15) as compared to TURP (P -value < .041). Furthermore, LVP showed decreased odds of CD III and V complications (OR = 0.36 and 0.52, respectively) as compared to TURP (P -value < .002) (Table 3).

Next propensity score matching was performed for TURP and LEP and the matched analysis yielded 3971 matched

Table 2. Description of the main outcomes of different endourologic surgeries from 2011 to 2019

	Procedure Type				Univariate Analysis Odds Ratio (95% CI)(TURP as Reference)					
	TURP (N = 48,609)		LVP (N = 21,271)		LVP (N = 4393)		LVP vs TURP		LVP vs TURP	
	Mean ± SDN (%)	Mean ± SDN (%)	Mean ± SDN (%)	Mean ± SDN (%)	P-Value	P-Value	P-Value	P-Value	P-Value	P-Value
Length of Stay (Days)	1.9 ± 0.02	0.81 ± 0.03	1.21 ± 0.04	1.21 ± 0.04	<.001*	<.001*	-1.09 [-1.16, -1.02]	<.001*	-0.69 [-0.83, -0.55]	<.001*
Operative Time (Minutes)	56.01 ± 0.17	55.15 ± 0.24	102.21 ± 0.92	102.21 ± 0.92	<.001*	<.001*	-0.86 [-1.48, -0.24]	.007*	46.2 [45.01, 47.39]	<.001*
Bleeding Transfusion	814 (1.7)	101 (0.5)	54 (1.2)	54 (1.2)	<.001*	<.001*	0.28 [0.23, 0.35]	<.001*	0.73 [0.55, 0.96]	.027*
UTI	2487 (5.1)	1216 (5.7)	139 (3.2)	139 (3.2)	<.001*	<.001*	1.12 [1.05, 1.21]	<.001*	0.61 [0.51, 0.72]	<.001*
Pneumonia	173 (0.4%)	87 (0.4)	7 (0.2)	7 (0.2)	.041*	.041*	1.15 [0.89, 1.49]	.289	0.45 [0.21, 0.95]	.037*
PE/DVT	194 (0.4)	41 (0.2)	13 (0.3)	13 (0.3)	<.001*	<.001*	0.48 [0.34, 0.68]	<.001*	0.74 [0.42, 1.30]	.296
MACE†	414 (0.9)	168 (0.8)	16 (0.4)	16 (0.4)	.002*	.002*	0.93 [0.77, 1.11]	.408	0.43 [0.26, 0.70]	<.001*
Renal Complication‡	171 (0.4)	60 (0.3)	7 (0.2)	7 (0.2)	.049*	.049*	0.80 [0.60, 1.08]	.140	0.45 [0.21, 0.96]	.04*
Sepsis	449 (0.9)	240 (1.1)	15 (0.3)	15 (0.3)	<.001*	<.001*	1.22 [1.05, 1.43]	.012*	0.37 [0.22, 0.62]	<.001*
Readmission	150 (0.3)	61 (0.3)	5 (0.1)	5 (0.1)	.071	.071	0.93 [0.69, 1.25]	.629	0.37 [0.15, 0.9]	.028*
Clavien-Dindo Classification	3506 (7.2)	1430 (6.7)	207 (4.7)	207 (4.7)	<.001*	<.001*	0.93 [0.87, 0.99]	.02*	0.64 [0.55, 0.73]	<.001*
I & II	1032 (2.1)	313 (1.5)	75 (1.7)	75 (1.7)	<.001*	<.001*	0.69 [0.61, 0.78]	<.001*	0.80 [0.63, 1.10]	.065
III	756 (1.6)	366 (1.7)	31 (0.7)	31 (0.7)	<.001*	<.001*	1.11 [0.98, 1.26]	.11	0.45 [0.31, 0.65]	<.001*
IV	244 (0.5)	80 (0.4)	7 (0.2)	7 (0.2)	<.001*	<.001*	0.748 [0.581, 0.964]	.025*	0.32 [0.15, 0.67]	.003*
V										
Reintervention Causes										
Cystourethroscopy with irrigation and evacuation of multiple obstructing clots	245 (0.5)	60 (0.3)	24 (0.5)	24 (0.5)	<.001*	<.001*	0.56 [0.42, 0.74]	<.001*	1.08 [0.71, 1.65]	.706
Catheter insertion	14 (0.03)	2 (0.01)	1 (0.02)	1 (0.02)	.256	.256	0.33 [0.74, 1.44]	.139	0.79 [0.10, 6.01]	.820
Bladder drain with suprapubic catheter or cystostomy	15 (0.03)	8 (0.04)	2 (0.05)	2 (0.05)	.820	.820	1.22 [0.52, 2.88]	.651	1.48 [0.34, 6.45]	.605
Urethral dilation or meatotomy	4 (0.01)	2 (0.01)	0(0)	0(0)	.99	.99	1.14 [0.21, 6.24]	.878	-	-
Resection of prostatic tissue left after a previous surgery	55 (0.1)	10 (0.05)	1 (0.023)	1 (0.023)	.008*	.008*	0.42 [0.21, 0.82]	.011*	0.2 [0.03, 1.45]	.112

* Significant P < .05

† MACE indicates major cardiovascular events that include myocardial infarction, cerebrovascular accident, or death.

‡ Renal Complication is a combination of renal insufficiency and renal failure.

Table 3. Multivariable analysis and propensity score matching of characteristics and risk factors of patients who have undergone endourologic surgeries from 2011 to 2019 on outcomes

Variable (TURP as Ref.)	Multivariate Regression			Propensity Matched			
	LVP [†]	P-Value	LEP [†]	LVP	P-Value	LEP	P-Value
Length of Stay (days)	-0.86 [-0.92, -0.81]	< .001*	-0.17 [-0.27, -0.08]	-0.92 [-0.98, -0.85]	.001*	-0.46 [-0.6, -0.33]	< .001*
Operative Time (mins)	-3.46 [-4.18, -2.73]	< .001*	39.64 [38.37, 40.91]	-3.27 [-4.01, -2.50]	< .001*	39.1 [36.8, 41.4]	< .001*
Bleeding Transfusion	0.28 [0.22, 0.37]	< .001*	1.18 [0.87, 1.6]	0.21 [0.15, 0.29]	< .001*	0.55 [0.38, 0.80]	.002*
UTI	1.13 [1.04, 1.22]	.004*	0.61 [0.51, 0.73]	1.15 [1.04, 1.28]	.005*	0.58 [0.46, 0.73]	< .001*
Pneumonia	1.12 [0.81, 1.55]	.489	0.74 [0.34, 1.59]	1.08 [0.70, 1.67]	.279	0.64 [0.25, 1.64]	.349
PE/DVT	0.54 [0.38, 0.78]	< .001*	0.82 [0.46, 1.44]	0.52 [0.35, 0.79]	.002*	0.40 [0.21, 0.77]	.006*
MACE [‡]	1.04 [0.84, 1.30]	.712	0.74 [0.45, 1.24]	0.76 [0.58, 0.99]	.041*	0.38 [0.21, 0.70]	.002*
Renal Complication [§]	0.92 [0.66, 1.28]	.626	0.54 [0.24, 1.22]	0.71 [0.47, 1.08]	.113	0.249 [0.053, 1.175]	.079
Sepsis	1.20 [0.997, 1.45]	.054	0.45 [0.26, 0.76]	1.10 [0.87, 1.40]	.433	0.399 [0.16, 1.03]	.057
Readmission	1.18 [0.84, 1.67]	.342	0.56 [0.23, 1.37]	0.64 [0.44, 0.92]	.017*	0.09 [0.04, 0.23]	< .001*
Clavien-Dindo	0.96 [0.89, 1.03]	.279	0.71 [0.61, 0.83]	0.95 [0.86, 1.04]	.237	0.58 [0.48, 0.70]	< .001*
Classification	0.72 [0.62, 0.83]	< .001*	0.79 [0.61, 1.02]	0.36 [0.31, 0.42]	< .001*	0.10 [0.08, 0.14]	< .001*
I & II	1.14 [0.98, 1.32]	.097	0.57 [0.39, 0.84]	1.01 [0.84, 1.21]	.925	0.36 [0.23, 0.55]	< .001*
III	0.84 [0.62, 1.14]	.255	0.59 [0.27, 1.27]	0.52 [0.35, 0.79]	.590	0.37 [0.15, 0.96]	.04*
IV							
V							
Reintervention Causes							
Cystourethroscopy with irrigation and evacuation of multiple obstructing clots	0.52 [0.38, 0.71]	< .001*	0.99 [0.63, 1.56]	0.31 [0.22, 0.43]	< .001*	0.15 [0.1, 0.24]	< .001*
Catheter insertion	0.69 [0.14, 3.37]	.652	1.55 [0.19, 12.85]	0.29 [0.06, 1.38]	.118	0.2 [0.02, 1.71]	.142
Bladder drain with suprapubic catheter or cystostomy	1.47 [0.53, 4.10]	.462	2.74 [0.59, 12.73]	0.83 [0.25, 2.73]	.764	0.5 [0.09, 2.73]	.423
Urethral dilation or meatotomy	0.79 [0.08, 7.92]	.843	-	0.33 [0.04, 3.20]	.341	-	-
Resection of prostatic tissue left after a previous surgery	0.46 [0.19, 1.10]	.082	0.31 [0.04, 2.31]	0.23 [0.1, 0.56]	< .001*	0.05 [0.007, 0.37]	.003*

* Significant $P < .05$.

[†] Multivariate logistic or linear regression model adjusted for age, race, BMI, current smoker, ASA class, abnormal creatinine, leukocytosis, hypoalbuminemia, anemia, diabetes (Insulin and non-insulin dependent), history of severe COPD, bleeding disorder, hypertension, disseminated cancer, dyspnea, transfusion preoperatively, and history of congestive heart failure.

[‡] MACE indicates major cardiovascular events that include myocardial infarction, cerebrovascular accident, or death.

[§] Renal Complication is a combination of renal insufficiency and renal failure.

individuals for each group. LEP showed longer operative times (39.1 mins), shorter length of stay (-0.46 days), and lower odds of UTI (OR = 0.58), bleeding transfusion (OR = 0.55), PE/DVT (OR = 0.40), MACE (OR = 0.38), and readmissions (OR = 0.09) (P -value < .006). In addition, LEP showed decreased odds of all CD complications as compared to TURP (P -value < .04) (Table 3).

Regarding reintervention causes, both LVP and LEP showed lower odds of cystourethroscopy with irrigation and evacuation of multiple obstructing clots and resection of prostatic tissue left after a previous surgery as compared to TURP (Table 3).

DISCUSSION

This study is unique in comparing 3 different surgical methods for BPH treatment in a large real-life cohort with more than 900 centers reflecting the current practice in the US and other international centers who are part of the NSQIP database.

Patients with bleeding disorders or hypertension underwent LVP more frequently which demonstrated a lower incidence of bleeding requiring transfusion as compared to TURP. In addition, LEP also demonstrated lower incidence of bleeding requiring transfusion as compared to TURP. In fact, LEP using either Holmium or Thulium laser has been extensively investigated and has proven better short-term outcomes with respect to blood drop and blood transfusion as compared to TURP.^{5,10-12} An added advantage to LVP is the ability to operate on patients on anticoagulants or with bleeding disorders. Several studies aimed to assess the safety and efficacy of greenlight LVP in patients taking oral anticoagulants (OA) and at risk of bleeding. These studies showed that LVP performed similarly when used on patients on or off anticoagulants.^{13,14} Patients who underwent Greenlight LVP had similar postoperative outcomes, with no significant differences in postoperative hematuria, bleeding complications or clot retention between patients on or off OA.¹³ In our study, patients in the LVP and LEP groups demonstrated lower odds of DVT/PE which is probably related to continuation of OA during the period of surgery in this higher risk population. Both the American Urologic Association (AUA) and European Urologic Association (EAU) recommend laser techniques for treating patients with BPO who are at higher risk of bleeding or receiving antiplatelets or oral anticoagulation with, however, a weak level of strength.^{15,16} This demonstrates the importance of further evidence in this subset of patients in particular who pose a challenge in our daily practice, especially with the global population aging.

Despite this fact, we found in our study population that patients with comorbidities (CHF, diabetes, disseminated cancer, history of severe COPD, and smoking) were more likely to undergo TURP. It could be hypothesized that physicians and patients are more comfortable with established techniques and resistant towards more novel ones when patients exhibit a multitude of comorbidities. In this

context, Lee et al. reviewed attitudes of physicians and trends in BPH treatment; they found that urologists preferred to use techniques that are minimally invasive and have adequate clinical outcomes.¹⁷ Furthermore, the type of surgery chosen was found to be dependent on the hospital setting and availability of training and equipment.¹⁷ Indeed, whereas TURP is acquired during residency training, LVP and LEP are not an integral part of the training in many centers. Furthermore, the learning curve of LVP has been reported to be around 100 cases,¹⁸ while LEP requires a steeper learning curve and continuous improvement in outcomes was observed with a plateau after 270 cases.¹⁹

In our analysis, patients undergoing LVP showed higher rates of UTI, whereas patients undergoing LEP showed a lower trend of UTI when compared to TURP. LEP was previously found to have a decreased risk of infections including fever, UTI, sepsis, septic shock, or pneumonia as compared to TURP.³ Nevertheless, LVP has been shown to have similar risks of infections when compared to TURP.^{6,20-22} Indeed, very few articles have addressed LVP as having a higher infectious rate as compared to TURP.²³ No clear conclusion could be reached regarding UTI rates when comparing LVP to TURP. Risk factors for infection include pre-operative infections, procedure duration, catheter discontinuation, and length of stay, some of which are not included within our dataset and so could not be explored.²⁴ However, LVP is known to reduce catheter time and hospital stay and our study showed that the duration of surgery is the shortest compared to TURP and LEP. One hypothesis could be that the residual necrotic tissue in the transitional zone following LVP could be a nidus for bacterial infection. Based on this finding, we recommend prophylactic antibiotic treatment in the peri-operative setting.

Unsurprisingly, LVP and LEP showed decreased morbidity and shorter length of stays in our study population. In fact, it has been well documented that both LVP and LEP present with less postoperative complications and morbidities, incurring early catheter removal and shorter hospital stay as compared to TURP.^{3,5,6,25}

Regarding reintervention causes, our analysis demonstrated that both LEP and LVP showed decreased odds of clot evacuation and resection of prostatic left after surgery in comparison to TURP. LEP and LVP have been previously shown to decrease rates of clot retention and evacuation when compared to TURP.^{22,26} In fact, a decreased incidence of bleeding witnessed in laser procedures leads to a decreased incidence of clot retention.^{26,27} In addition, TURP has been found to leave behind a significant amount of adenoma post-resection.²⁸ On the other hand, LEP has demonstrated a lower incidence of prostatic adenoma recurrence and a more complete resection as compared to TURP.^{26,28} Hypothetically, laser techniques, such as LEP, allow for a more complete removal of prostatic adenoma and a deeper en-bloc resection at the level of the capsule.²⁹ LVP, on the other hand, has not been previously

described as advantageous in terms of residual adenomatous tissue and further studies are still required to prove if an advantage exists.

Operative time was found to be similar between TURP and LVP at the univariate level whereas after our analysis LVP showed slightly shorter operative times. Conversely, various articles have described LVP as having longer operative times when compared to TURP.^{20,22} It is known that operative times highly depend on prostate size, laser energy, and surgeon's experience and results will vary when comparing different institutions with different surgeon expertise.²⁰ As for LEP, it is evident that it needed a longer operative time with respect to the other 2 techniques. This was also seen in several studies whereby LEP required longer operative time since it is used for larger prostates and includes the additional step of prostate tissue morcellation adding around 20 mins to the operative time.^{3,30}

LIMITATIONS

This study is not without limitations. Firstly, the ACS-NSQIP database does not provide patient-related urological outcomes such as international prostate symptom score (IPSS), maximum flow rate (Q_{max}), post-void residue (PVR), and prostate volume (PV) which may limit the objective assessment of different surgical methods. In addition, the ACS-NSQIP database does not report certain specific urological complications such as acute urinary retention, retrograde ejaculation, urinary incontinence, and erectile dysfunction. The presence of pre-operative catheterization is not recorded within the NSQIP dataset, and this might influence postoperative infection rates. Furthermore, NSQIP datasets capture 30-day postoperative complications hence long-term complications are not recorded within this dataset. Finally, the NSQIP data set is a collaboration of different centers; hence, criteria used to select type of operation, expertise, and surgical techniques could vary between different centers and such differences are not described nor accounted for in the dataset.

CONCLUSION

In conclusion, our study demonstrated that in a large cohort of patients LVP and LEP yielded better postoperative outcomes than TURP. LVP had shorter operative times and hospital stays, less complications, decreased odds reintervention, but a higher risk of UTI. On the other hand, LEP was found to have longer operative times, shorter hospital stays, lower risk of complications, and reintervention.

INFORMED CONSENT

The de-identified database (ACS-NSQIP) does not constitute human subject research; therefore, no consent

to participate or institutional review board (IRB) approval was required or attained.

CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

CH Ayoub: Project development, Data collection or management, Data analysis, Manuscript writing/editing. R Haber: Project development, Data collection or management, Data analysis, Manuscript writing/editing. R Amine: Data collection or management, Data analysis, Manuscript writing. D Mikati: Data collection or management, Data analysis, Manuscript writing. ZR Mahfoud: Data collection or management, Data analysis, Manuscript writing. A El Hajj: Project development, Manuscript writing/editing, Supervised the study progress.

DATA AVAILABILITY

The (ACS-NSQIP) data are subject to a data use agreement. To access the dataset, a request to the ACS-NSQIP participant use form should be placed at the following link (<https://www.facs.org/quality-programs/acs-nsqip/participant-use>). The American University of Beirut Medical Center is enrolled in ACS-NSQIP as a participating center. As such, the data were made available by the ACS-NSQIP center and the AUBMC Department of Surgery after signing the data use agreement.

DECLARATION OF COMPETING INTEREST

The authors declare no conflict of interest.

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APPENDIX A. SUPPORTING INFORMATION

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.urology.2023.05.004](https://doi.org/10.1016/j.urology.2023.05.004).

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