Randomized, controlled trial of laser vs. bipolar plasma vaporization treatment of benign prostatic hyperplasia

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Abstract

Introduction: Prostate vaporization technology is becoming a standard of care for treatment of moderate, symptomatic benign prostatic hyperplasia (BPH). We compared two transurethral prostate vaporization technologies with respect to cost, efficiency, efficacy, safety, and surgical team satisfaction.

Methods: Fifty-five patients meeting standardized symptom criteria for BPH were randomized to either Olympus Plasma Button™ or Biolitec EVOLVE® diode laser vaporization. Primary outcome of cost with secondary outcomes of clinical efficacy, resection time, surgical team satisfaction, and safety were analyzed. Followup was carried out at six and 12 weeks. Patient factors included baseline, as well as six- and 12-week International Prostate Symptom Score (IPSS) with quality of life (QoL) scores. We recorded surgical team satisfaction with a Likert-style survey investigating ease of set-up, reliability, efficiency, and ability to reach desired endpoint. All complications or side effects detected within three months and the resulting management were included in the cost analysis.

Results: Mean cost per patient was $3418 for the Olympus group and $4564 for Biolitec ($p<0.05$). Surgical vaporization time was significantly less for the Olympus group, 24.3 vs. 33.5 minutes ($p<0.05$). Surgical and nursing staff preferred the Olympus device ($p<0.05$). IPPS symptom improvement and complication rates were similar between groups. Patients in the Biolitec arm had more intraoperative bleeding episodes requiring conversion to monopolar transurethral resection of the prostate (TURP) (three vs. none).

Conclusions: In a head-to-head randomized trial, Olympus Plasma Button transurethral vaporization was more cost-effective, faster, and preferred by surgical staff when compared to Biolitetec Diode Laser vaporization. Both devices showed similar safety and efficacy.

Introduction

Benign prostatic hyperplasia (BPH) affects 50% of men over age 50 and progresses to bothersome lower urinary tract symptoms (LUTS) in up to one-third of men.[1-4] For eight decades, the gold standard surgery for bothersome benign prostatic obstruction (BPO) has been monopolar transurethral resection of the prostate (TURP).[5] Multiple minimally invasive techniques have emerged in the past two decades, with laser and electro-vaporization becoming a new standard.[6] Transurethral vaporization of the prostate (TUVP) provides better hemostasis and allows for the use of isotonic irrigation fluid. This permits better intraoperative visualization, treatment of those at increased risk of bleeding, and has been shown to result in shorter hospital stays, shorter postoperative catheterization, and less electrolyte derangements (TUR syndrome).[7] Despite these advantages, many Canadian institutions have been slow to adopt a prostate vaporization program. In an effort to inform our own and other Canadian institutions, we set out to compare two TUVP platforms being considered for use in our institution in a prospective, randomized fashion: the Olympus Plasma Button™ and the Biolitec EVOLVE® DUAL wavelength diode laser.

Lasers (light amplification by stimulated emission of radiation) have been in the armamentarium of urologists for decades, but only recently for the management of BPH. While long-term data for diode lasers is scarce, the available evidence suggests they provide results comparable to TURP with the advantages seen with other vaporization platforms.[7] The primary challenge with diode lasers is deep tissue penetration and coagulative necrosis.[7] This is associated with dysuria, passage of sloughed tissue, and higher reoperation rates for bladder neck stenosis.[8] The Biolitec EVOLVE is the first dual-wavelength device available for transurethral prostate surgery. It produces wavelengths of 980 nm and 1470 nm, designed to combine excellent coagulation with tissue ablation.

Bipolar TURP (B-TURP) allows for treatment in normal saline irrigation, preventing TUR syndrome. While B-TURP is associated with less bleeding, previous devices have failed to catch on as a replacement for TURP due to limited evidence of superiority.[9] Recently, an evolution of B-TURP, bipolar plasma vaporization of the prostate, has emerged.

This allows efficient tissue vaporization while maintaining all the benefits of bipolar energy. The Olympus Plasma Button has demonstrated excellent results in tissue vaporization with significantly less bleeding than TURP and boasts reduced hospital stays and catheterization time.[10]

In the current economic climate, adopting new technology is not always feasible. Surgical management of BPH is common in Canada, with 20 000 TUR procedures performed annually.[11] With an average cost of $3447 per TURP in Canada, even a modest reduction in cost would have substantial financial implications.[12] While only 7.6% of TUR procedures in 2011 employed minimally invasive techniques, this number doubled from 2007–2011.[11] If this trend continues, we could see TUVP overtake TURP in the next decade. A few groups have shown vaporization to be more cost-effective than TURP, but to date no one has performed a cost comparison of these devices in Canada.[13-15] Here, we compared cost, clinical outcomes, safety, and surgical team preference of two transurethral prostate vaporization systems using the Biolitec EVOLVE DUAL diode laser and the Olympus Plasma Button in a prospective, randomized trial.

Methods

This prospective, randomized, single-blinded study was conducted from July 2014 to June 2016 at a tertiary care centre in Ontario, Canada. Ethics approval was obtained from our institution. Patients with moderate to severe, symptomatic BPH who consented to participate in this trial were randomized to either the Olympus or Biolitec device. Patients were required to meet the following inclusion criteria: age over 45, International Prostate Symptom Score (IPSS) ≥12, estimated prostate volume on digital rectal exam (DRE) ≥30 cc (as this is a real-life clinical practice study, prostate size and post-void residual were not mandatory). Anticoagulation was held for all procedures. Individuals with prior invasive intervention for BPH, prostate-specific antigen (PSA) level >10 ng/ml, urinary retention, medical condition unfit for surgery, history of prostate cancer, documented prostatitis within the past three months, known bleeding disorder, unable to follow directions or sign informed consent due to organic brain or psychiatric disease, or those with history of substance abuse, which would affect compliance, were excluded from the study.

Sample size determination was undertaken using Minitab statistical software.[16] Power was calculated to detect a cost difference of $800. To detect this difference at 90% power, 25 patients were required per group (α=0.05). We planned to randomize 60 patients over a two-year period.

Patients were evaluated with an initial screening appointment to assess candidacy. Those interested in participating received verbal and written instructions and completed the informed consent agreement. They again participated in the consent process on the day of surgery. Prior to their operation, demographic information was collected and participants completed an IPSS questionnaire. Patients were randomized into two groups using GraphPad QuickCalcs, random number generator software.[17] The surgical team was notified of the patient's randomization status before the procedure.

Mentorship training on both systems was followed by operating on two patients per surgeon on each device before eligible patients were randomized to either the Olympus or Biolitec procedure and performed by one of two surgeons (JCN or SSS). The lead surgeon and scrub nurse were asked to complete a survey rating their experience following each case. A Likert-style scale was used to rate the following categories from 1–5: Ease of set-up, reliability of equipment, efficiency of resection, ability to reach desired endpoint, and overall rating, for a total out of 25. All patients discharged the day of surgery had an average of one hour of irrigation, while those admitted had overnight irrigation.

Followup appointments were scheduled at six weeks and three months postoperatively, with IPSS repeated at these visits. All ancillary visits and treatments for side effects or complications (related to the initial procedure) diagnosed within the first three months were included in the cost analysis, even when these took place beyond the three-month window. Cost projections were derived from multiple sources. Procedure and followup visit costs came from our own institution's cost for care of non-insured Canadians and correlated with Canadian Institute for Health Information (CIHI) data.[12] Equipment and disposable costs were provided from the respective companies. Medication prices were derived from the Ontario Drug Benefit (ODB) database.[18]

Intention-to-treat analysis was performed. For baseline demographics, IPSS, quality of life (QoL) scores, cost, resection time, and nursing and surgeon satisfaction data means from each group were compared with two-tailed Mann-Whitney U test for non-parametric data, with a significance value of 0.05. Cost outliers were determined as those that fell beyond two standard deviations (SD) of the mean.

Results

Enrollment was terminated at 55 patients when the two-year window was reached (30 Olympus, 25 Biolitec). Preoperative patient characteristics (age, prostate volume, IPSS, and QoL scores) were equivalent between groups (Table 1). Mean IPSS and QoL scores at six-week followup showed similar improvement between groups, with IPSS scores improving by 12 in the Olympus group and 11 in the Biolitec group (p=0.60). At three months, mean IPSS scores in the Olympus arm and Biolitec arm improved to 9.9 and 9.4, respectively (p=0.62), an improvement of 12.7 and 11.1, respectively. Mean QoL scores were similarly improved to 1.65 in both

Table 1. Patient demographics and baseline self-reported symptom scores

	Olympus	Biolitec	p
Number of patients	**30**	**25**	
Mean age at entry	71.8	69.4	0.41
Mean prostate volume	47.8	46.6	0.92
Mean prostate-specific antigen	2.3	1.4	0.32
Median lobe presence	40%	36%	0.76
IPSS at entry	22.6	20.5	0.12
Quality of life at entry	4.7	5.1	0.16

IPSS: International Prostate Symptom Score.

arms (p=0.90) from 4.7 and 5.1 for Olympus and Biolitec, respectively (Fig. 1).

Mean cost per patient was $3418 for the Olympus group and $4564 for Biolitec treatment (p<0.05) (Fig. 2A). With outliers excluded, these costs improved to $2946 and $3913 for Olympus and Biolitec, respectively (p<0.05). Surgical resection time was significantly less for the Olympus group, 24.3 vs. 33.5 minutes (p<0.05) (Fig. 2B). Surgical and nursing staff preferred using the Olympus device over the Biolitec device with total scores 23.4 vs. 16.7 for surgeons and 24.2 vs. 17.9 for nursing staff (out of 25), respectively (p<0.05) (Fig. 2C). Postoperative admission (and same-day discharge) rates were similar between groups, with the majority of admissions noted during the early learning curve (Table 2). Mean length of catheterization time was 2.1 days for Olympus and 2.2 days for Biolitec (p=0.15; a single outlier with 55 days of indwelling catheter was excluded from the Biolitec group).

Safety and complication rates were similar between groups (Table 3), with the exception of significant intraoperative bleeding episodes. Patients in the Biolitec arm had more intraoperative bleeding episodes requiring conversion to monopolar TURP (three events vs. none for Olympus). Overall, both devices were safe; there were no Grade IV or V adverse events in either group.

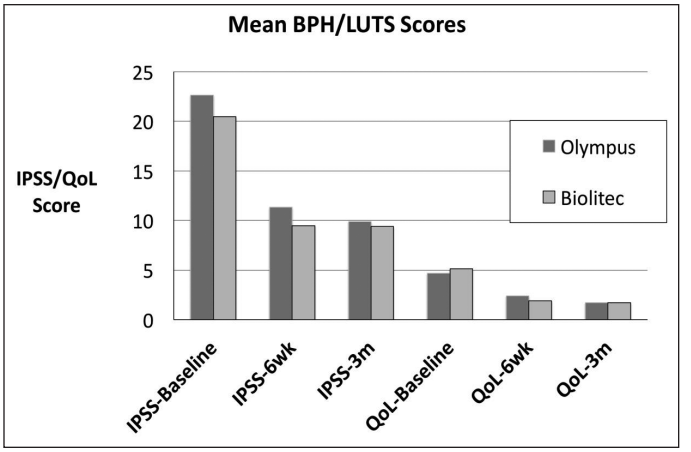

Fig. 1. International Prostate Symptom Score (IPSS) and Quality of Life (QoL) scores over time. BPH: benign prostatic hyperplasia; LUTS: lower urinary tract symptoms.

Discussion

This is the first cost analysis comparing two TUVP devices in a Canadian centre. This study was designed to be a real-life clinical practice comparison of the two devices being considered for use in our institution. Other devices initially considered were deemed ineligible because of either non-availability in Canada or refusal to agree to a head-to-head comparison. The results of our study are much stronger than those generated by an anecdotal experience of few cases undertaken on a device loaned for a trial period. Our data suggests that the Olympus Plasma Button is more cost effective, faster, and preferable to use within our centre, when compared to the Biolitec EVOLVE diode laser. Both devices were equivalent with respect to patient satisfaction, voiding outcomes, and safety.

The cost difference between groups was multifactorial. Consumables (laser fiber vs. button electrode) cost $307 more per case in the laser group. Additional physician visits, hospi-

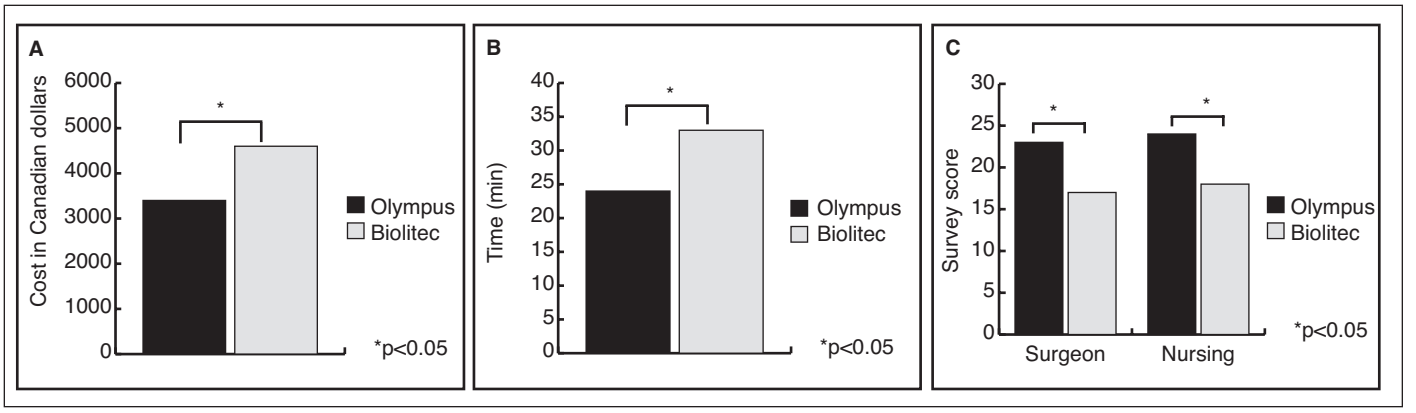

Fig. 2. (A) Mean cost per patient in Canadian dollars; ***(B)*** mean vaporization time required per patient; and ***(C)*** mean surgeon and nursing satisfaction score (out of a total of 25 points).

Table 2. Postoperative admissions following vaporization of prostate

	Olympus		Biolitec		
	n	%	n	%	p
Early (1–15)	8/12	67	2/3	67	1
Late (16–55)	5/18	20	6/22	27	0.97
Overall	12/30	40	8/25	32	0.54

talizations, and procedures provided the majority of the costs for both groups. A few individuals consumed the bulk of these costs; however, when outliers were excluded, the difference between groups still remained nearly $1000. There is conflicting data regarding whether vaporization procedures are less expensive than TURP, but TUVP probably costs less.[13-15,19] When compared to the national average TURP cost reported by CIHI ($3447), the cost of Olympus TUVP was comparable ($3418).[12] With outliers removed, this device averaged $2946 per patient, a savings of $500 per treatment over the current cost of TURP. This represents a potential savings of $10 million per annum over 20 000 procedures. Care must be taken when interpreting these results, however, as CIHI data likely measures some different cost factors. Our costs include a significant number of admissions, as per early trial protocol. After our initial learning curve of 15 patients, we routinely sent patients home with only 20–27% of patients requiring admission. Performing TUVP routinely as day surgery would increase the cost savings of TUVP.

With respect to resection time, we speculate that learning curve plays a role in the difference between groups. The Olympus device resembled the resectoscope already in use at our institution; however, when resection time was broken down by tertile (data not shown), there was no significant improvement in time between tertiles in the laser group. This may be partly related to the TURP conversions that added considerable surgical time. Other studies[20] have commented that the learning curve for this device is short; however, surgeons at our institution felt that the laser procedure was less intuitive. It is also likely with our small sample size shared by two surgeons that some improvement was still to be expected, as Gross et al demonstrated a learning curve of over 200 cases with another laser device.[21] Surgical time is an important consideration in Canada, as surgeons have limited access to operating room time and may be able to better manage wait lists by completing more TUVPs in a given day.

Patient outcomes (IPSS score), patient satisfaction (QoL score), and safety were not significantly different between groups. Both groups showed over 10-point reduction in average IPSS scores after treatment, and QoL scores decreased by an average of over three following treatment. This correlates with the symptomatic improvement seen in other TUVP studies.[10,22] Safety profiles were also comparable. While three individuals in the laser group required conversion to TURP for hemostasis, none these individuals required blood transfusions and no adverse events occurred postoperatively related to bleeding. Other minimally invasive laser technologies have documented conversions, with 21.6% of Green Light Laser procedures requiring conversion to TURP in one study.[23] We should also note that the majority of patients in both arms were discharged home the day of surgery. This is an important consideration over TURP, as overnight beds are an increasingly scarce resource in Canadian hospitals.

TUVP is a safe, effective, and potentially cost-saving approach to management of BPO in a Canadian centre. We should continue to strive to find cost-effective technologies to improve Canadian healthcare. These findings support the adoption of minimally invasive devices by Canadian institutions and may help inform other Canadian institutions deciding on device selection.

Conclusion

The Olympus Plasma Button was more cost-effective and surgically efficient for management of moderate, symptom-

Table 3. Complications associated with postoperative costs by Clavien-Dindo classification

Adverse event	Olympus				Biolitec			
Clavien-Dindo	I	II	IIIa	IIIb	I	II	IIIa	IIIb
Convert to TURP	0	0	0	0	3 (12%)	0	0	0
Bladder injury	0	0	0	0	0	0	1 (4%)	0
Clinically significant storage LUTS	0	(17%)	0	0	0	6 (24%)	0	0
ER/GP visits	0	11 (37%)	0	0	0	13 (52%)	0	0
Clot retention	0	4 (13%)	0	0	0	3 (12%)	0	0
Readmission	0	3 (10%)	0	0	0	3 (12%)	0	0
Additional urology visits	0	8 (27%)	0	0	0	7 (28%)	0	0
Postoperative cystoscopy	0	0	6 (20%)	0	0	0	5 (20%)	0
Urethral stricture	0	0	2 (7%)	0	0	0	2 (8%)	0
Re-TURP	0	0		1 (13%)	0	0	0	1 (4%)

ER: emergency room; GP: general physician; LUTS: lower urinary tract symptoms; TURP: transurethral resection of the prostate.

atic BPH compared to the Biolitec Evolve diode laser, however, both devices proved to be effective and safe.

Competing interests: Dr. Steele has been an advisor for Allergan and Astellas; a speaker for Abbott and Astellas; has received grants from Astellas and Pfizer; and has participated in clinical trials supported by Astellas and Pfizer. The remaining authors report no competing personal or financial interests.

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