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Benign Prostatic Obstruction

# Plasma Vaporisation of the Prostate: Initial Clinical Results

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**Abstract**

***Background:*** Laser vaporisation of the prostate has had a considerable impact in recent years. In an attempt to achieve tissue vaporisation with bipolar high-frequency generators, plasma vaporisation was recently introduced.
***Objective:*** To provide the first clinical information on bipolar plasma vaporisation of the prostate for patients with lower urinary tract symptoms (LUTS) due to bladder outlet obstruction (BOO).
***Design, setting, and participants:*** Thirty patients were included in this prospective bicentre study.
***Intervention:*** All patients underwent bipolar plasma vaporisation with a novel electrode (Olympus Winter & Ibe GmbH, Hamburg, Germany).
***Measurements:*** International Prostate Symptom Score (IPSS), bother score, maximum flow rate ($Q_{max}$), and postvoid residual were evaluated at baseline and at the time of discharge as well as at 1, 3, and 6 mo after the intervention.
***Results and limitations:*** Mean preoperative prostate volume was $59 \pm 32$ ml (range: 30–170), and mean operating time was $61 \pm 26$ min (range: 20–140). Besides one reoperation (conventional transurethral prostatectomy) due to persistent obstruction, no major complication occurred intra- or postoperatively and no blood transfusion was required. Catheterisation time averaged $41 \pm 35$ h (range: 18–192). Transient mild to moderate dysuria was noted in four patients (13%). At 1, 3, and 6 mo, $Q_{max}$ increased from $6.6 \pm 2.7$ ml/s preoperative to $17.3 \pm 4.7$ ml/s ($p < 0.01$), $18.5 \pm 4.6$ ml/s ($p < 0.01$), and $18.1 \pm 5.0$ ml/s ($p < 0.01$), respectively. The IPSS decreased from $20.8 \pm 3.6$ to $10.4 \pm 3.5$ ($p < 0.01$), $8.2 \pm 2.9$ ($p < 0.01$), and $8.1 \pm 3.1$ ($p < 0.01$), respectively. These data represent a small nonrandomised study cohort with limited follow-up.
***Conclusions:*** Our initial experience indicates that bipolar plasma vaporisation might be a safe and effective treatment option for patients with LUTS due to BOO. To define the potential role of this novel technique, randomised trials with longer follow-up are mandatory.


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**Fig. 1 – Bipolar mushroom-like electrode (Olympus Winter & Ibe GmbH, Hamburg, Germany).**

## 1. Introduction

Transurethral resection of the prostate (TURP) has, for many decades, been the reference standard in the surgical management of lower urinary tract symptoms (LUTS) due to bladder outlet obstruction (BOO). Despite proven long-term efficacy, the associated morbidity and the necessity of hospitalisation [1–6] have initiated and maintained an ongoing search for less invasive procedures [7–9].

Laser vaporisation of the prostate, predominantly performed with the GreenLight laser at 532 nm, has rapidly gained broad acceptance [10–12]. After initially aiming for high-risk patients and/or those needing anticoagulation [13,14], the technique was increasingly applied to men who did not belong to these specific cohorts. Other sources such as diode and holmium lasers have been introduced for prostate vaporisation but have not gained any significant market share yet [6,9,15].

Even though not generated by randomised controlled trials, a growing body of evidence concerning the midterm efficacy and safety of GreenLight laser vaporisation is available [11,16,17]. Economic restraints, however, limit the diffusion of the high-priced GreenLight laser procedure in many countries and/or health care systems.

A bipolar vaporisation technique was developed recently. It derives from plasmakinetic bipolar resection of the prostate and utilises well-known electrical principles.

## 2. Patients and methods

Thirty men aged 54–87 yr (mean: 70 ± 8 yr) underwent bipolar plasma vaporisation with a mushroom-like electrode (Fig. 1) (Olympus Winter & Ibe GmbH, Hamburg, Germany) at two institutions between January and July 2008. The procedures were performed by four experienced surgeons.

The preoperative evaluation included the assessment medical history; physical examination, including digital rectal examination; transrectal ultrasonography; free uroflowmetry; postvoid residual volume estimation; routine urine analysis; and blood analysis, including coagulation parameters and determination of serum prostate-specific antigen (PSA). All patients completed the International Prostate Symptom Score (IPSS) index. Patients with suspected prostate or bladder cancer and men with neurogenic voiding dysfunction were excluded from the study. Furthermore, eligibility criteria included a maximum flow rate of $<$15 ml/s and IPSS $\geq$8. Prior to surgery, 13 of the patients (43%) were in urinary retention, necessitating a transurethral or suprapubic catheter. All patients provided informed consent. Patients were evaluated preoperatively, before discharge, and at 1, 3, and 6 mo postoperatively.

Four of the 30 (13%) men received ongoing medication of thrombocyte aggregation inhibitors for cardiovascular indications. Anaesthesia was spinal in 11 patients (37%) and general in 19 (63%). PSA and prostate volume data of the follow-up were insufficient and thus are not mentioned. This lack represents a limitation in describing the ablative properties of the technique.

Plasma vaporisation requires a bipolar high-frequency generator such as the UES-40 SurgMaster (Olympus Winter & Ibe GmbH, Hamburg, Germany). For sufficient plasma activation, the power output is set at 290 W and 120 W for vaporisation and coagulation modes, respectively.

A 26-Fr continuous flow resectoscope with a separate irrigation channel is utilised. Isotonic 0.9% sodium chloride solution at room temperature is used as irrigant. A continuous-flow setup is important to ensure excellent visibility and sufficient elimination of vaporisation bubbles.

Plasma vaporisation of the prostate is performed under direct visualisation using the electrode in a near-contact technique (*hoovering* technique). The procedure is performed like a TURP, starting at the bladder neck, continuing to the lateral lobes and to the anterior lobe, and, finally, to the apical portion of the prostate. After finishing at the level of the capsular fibres, a transurethral resection (TUR)–like cavity is obtained.

For statistical analysis, the Wilcoxon test was used; $p < 0.05$ was considered statistically significant. SPSS (SPSS Inc, Chicago, IL, USA) was used for statistical analysis.

## 3. Results

The mean baseline prostate volume, evaluated by transrectal ultrasound, was 59 ± 32 ml (range: 30–170), resulting in a mean operating time of 61 ± 26 min (range: 20–140). One single-use electrode was employed per patient, including three patients with a prostate volume $>$100 ml. In all cases, the procedure was able to be performed without technical failures. Only one electrode was utilised in every case.

Except one reoperation mentioned below, none of the patients treated experienced any significant perioperative complication associated with the plasma vaporisation. None of the patients required blood transfusions. The mean preoperative haemoglobin (Hb) value was 13.8 ± 1.9 gm/dl (range: 9.8–15.4); the mean postoperative Hb value at the end of the procedure was 12.7 ± 2.1 gm/dl (range: 8.9–15.3). No patient displayed any evidence of intraoperative fluid

**Table 1 – Subjective and objective outcome of plasma vaporisation of the prostate**

| | | Baseline | Discharge | 1 mo | 3 mo | 6 mo |
|---|---|---|---|---|---|---|
| $Q_{max}$, ml/s | | | | | | |
| | Mean ± SD | 6.6 ± 2.7[§] | 14.0 ± 5.4<br>+112%<br>($p < 0.01$)[£] | 17.3 ± 4.7<br>+162%<br>($p < 0.01$) | 18.5 ± 4.6<br>+180%<br>($p < 0.01$) | 18.1 ± 5.0<br>+174%<br>($p < 0.01$) |
| | Range | 3–12 | 6–24 | 5–24 | 6–24 | 9–28 |
| PVR, ml | | | | | | |
| | Mean ± SD | 165 ± 169[§] | 80 ± 49<br>−52%<br>($p < 0.01$) | 58 ± 36<br>−65%<br>($p < 0.01$) | 39 ± 32<br>−76%<br>($p < 0.01$) | 38 ± 30<br>−77%<br>($p < 0.01$) |
| | Range | 30–700 | 20–200 | 10–140 | 0–120 | 0–105 |
| IPSS | | | | | | |
| | Mean ± SD | 20.8 ± 3.6 | [†] | 10.4 ± 3.5<br>−50%<br>($p < 0.01$) | 8.2 ± 2.9<br>−61%<br>($p < 0.01$) | 8.1 ± 3.1<br>−61%<br>($p < 0.01$) |
| | Range | 15–30 | – | 5–22 | 3–16 | 2–14 |

$Q_{max}$ = maximum flow rate; PVR = postvoid residual; IPSS = International Prostate Symptom Score.
[§] $n = 17$, excluding 13 patients with transurethral or suprapubic catheter preoperatively.
[£] Wilcoxon test compared to baseline value.
[†] IPSS not evaluated at discharge.

absorption leading to serum electrolyte abnormalities. The mean preoperative serum sodium (Na+) value was 141.3 ± 2.5 mmol/l (range: 135–146); the mean immediate postoperative Na+ value at the end of the procedure was 140.6 ± 2.4 mmol/l (range: 133–145). Likewise, in those 12 patients for whom the breath ethanol technique [18] evaluating fluid absorption was available, none showed any increase in ethanol concentration compared to baseline.

Symptomatic and objective outcomes at discharge and at 1, 3, and 6 mo of follow-up are summarised in Table 1. Clinical improvement was significant compared to baseline for all parameters evaluated. There were no essential differences in functional outcome or complications among the four surgeons.

Postoperatively, four patients (13%) had to be recatheterised temporarily within 24 h following initial removal of the Foley catheter. Including recatheterisation, the mean overall catheterisation time was 41 ± 35 h (range: 18–192). Half of the patients ($n = 15$) had their Foley catheters removed the morning following surgery on a regular basis, leading to an overall median catheterisation time of 30 h. One patient experienced a catheterisation time of 8 d due to prolonged postoperative haemorrhage. Sixteen patients (53%) required catheter irrigation postoperatively. The duration and power of the irrigation was at the discretion of the nursing staff. Most patients were irrigated at very low levels. In our limited follow-up of 6 mo, one patient (3%) had to be reoperated by conventional TURP (resection weight 12 gm) due to persistent obstructive voiding. This individual with a prostate volume of 100 ml was within the first five men treated in one of the sites.

Postoperatively, transient mild to moderate dysuria for <14 d was seen in four patients (13%), resolving with anti-inflammatory medication. Self-limiting urinary stress incontinence was observed in one patient (3%). Urinary infection with significant bacteriuria occurred in three men (10%). None of these patients developed fever.

No other relevant surgery-related complications occurred throughout the limited follow-up.

## 4. Discussion

Numerous alternative techniques have been challenging TURP for decades in an effort to lower morbidity. Among these minimally invasive procedures, laser-based techniques; specifically, GreenLight laser vaporisation and holmium laser enucleation of the prostate (HoLEP), have played a dominant role in the last years [6,7,9]. Specific obstacles, however, limit an even broader use of these laser procedures. For the GreenLight laser vaporisation, performed with the 80-W potassium-titanyl-phosphate (KTP) laser, or, more recently, with the 120-W lithium triborate (LBO) laser, cost issues are of utmost relevance in most countries and health care systems. For the HoLEP procedure, the rather steep learning curve, denoting the complexity of the procedure, restricts the technique to rather few centres, albeit showing excellent results in the literature [9,19].

In an attempt to take advantage of the practicability and acceptance of a vaporisation technique, bipolar plasma vaporisation of the prostate was introduced. This procedure utilises electrical principles well known to urologists from transurethral high-frequency surgery. The so-called *plasma technique* has previously been introduced for TUR in saline (TURis) [20]. It is important to point out the distinct discrepancy between monopolar electrovaporisation of the prostate, which was introduced >1 decade ago [21], and the current technique utilising bipolar high-frequency current. Monopolar electrovaporisation of the prostate, which was performed using a rollerball electrode, has been abandoned due to the disproportionate extent of coagulation (up to 10 mm) in the tissue treated, leading to mostly irritative side-effects and stress incontinence [22,23]. In a pilot study, bipolar plasma vaporisation, evidently performed without a neutral electrode, nonetheless consistently displayed coagulation zones <2 mm microscopically in vivo (unpublished data). Clinically, following bipolar plasma vaporisation of the prostate, temporary mild to moderate

dysuria for <14 d was seen in 13% of the patients. In three of these four men, the use of anti-inflammatory medication was required. In no patient did dysuria persist or relapse. Importantly, self-limiting urinary stress incontinence was observed in one patient (3%) only. These data, though preliminary, can be considered acceptable and seem to be in line with short-term findings for those techniques based on laser vaporisation [9,19]. Moreover, regarding side-effects concerning storage function, these findings are in accordance with results generated by vaporisation resection of the prostate [24]. By combining vaporisation and resection, the portion of vaporisation is estimated to make up to 30% of the total tissue ablation. Still, the majority of ablation is obviously achieved through resection of tissue. In contrast, bipolar plasma vaporisation, described herein, represents a pure vaporisation technique, clearly comparable to laser vaporisation.

The major advantage of vaporisation compared to resection of prostatic tissue is to be seen in its superior haemostasis. By and large, this can be applied to all vaporisation techniques irrespective of their initiation, be it laser or high-frequency current. The indistinct differences in haemostasis achieved through vaporisation between KTP, diode, or holmium lasers, on the one hand, and monopolar or bipolar current, on the other hand, discovered mostly ex vivo or in vitro, seem to be clinically irrelevant and of rather academic relevance [13,23,25–28]. The lack of histology, however, must be seen as a drawback for all pure vaporisation techniques.

Due to the excellent haemostasis of vaporisation procedures, some authors claim that these techniques are especially, if not solely, indicated for patients at high risk and/or for those receiving oral anticoagulation [9,19]. It is widely accepted that, as a rule, vaporisation procedures will achieve less tissue ablation compared with resection or enucleation techniques (ie, HoLEP). On the one hand, it is not known whether the amount of tissue ablation has a significant impact on voiding and may only be relevant in the long term. On the other hand, improved haemostasis apparently yields short catheterisation and hospitalisation times and might decrease overall morbidity. This is certainly of benefit, and not only for the cohort of high-risk patients.

A potential advantage of plasma vaporisation of the prostate is the option to combine bipolar vaporisation and bipolar resection. This could be achieved by simply replacing the mushroom electrode with a bipolar loop electrode without the need for a change of generator, endoscope, or irrigant. In this initial experience, we certainly sought to explore the merits and limitations of genuine plasma vaporisation of the prostate and thus did not perform a combination of the two techniques. A hybrid technique of tissue ablation by plasma vaporisation and bipolar resection (ie, at the apical region) might be a promising modification for some cases.

Finally, it must be stressed again that these initial data represent a nonrandomised, small-sized cohort and that longer follow-up is to be awaited before definite conclusions can be drawn.

## 5. Conclusions

Our initial experience indicates that bipolar plasma vaporisation of the prostate could be a safe and effective treatment alternative for patients with LUTS due to BOO. To define the potential role of this promising procedure, prospective randomised trials against conventional TURP as well as established laser vaporisation techniques with longer follow-up are compulsory.

***Author contributions***: Oliver Reich had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

*Study concept and design*: Reich, Bachmann, Stief
*Acquisition of data*: Reich, Riecken, Schlenker, Seitz, Bachmann
*Analysis and interpretation of data*: Tilki, Schlenker
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*Critical revision of the manuscript for important intellectual content*: Stief
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## Editorial Comment on: Plasma Vaporisation of the Prostate: Initial Clinical Results

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Reich et al [1] present their preliminary results of a prospective two-center study introducing a new instrumental therapy for treating bladder outlet obstruction due to benign prostatic hyperplasia: bipolar plasma vaporization of the prostate. The innovation looks interesting, as it simply utilizes "well-known electrical principles" mimicking the effects and advantages (ie, superior hemostasis) of laser vaporization but probably at substantially lower costs. The initial results are promising, and, at least for endoscopically skilled surgeons, this new bipolar vaporization technique seems easy to adapt in prostates $\geq$100 g.

Except for one reoperation, no major complications occurred. The mean operation time of 1 h for a mean estimated prostate volume of 59 ml was acceptable, particularly considering that all of the surgeons were at the point of crossing their personal learning curves. The functional results reflected by International Prostate Symptom Score, maximum flow rate, and residual urine improved instantly after a relatively short mean catheter time of 41 h [1]. The rate of minor complications, such as recatheterization (13%) and dysuria (13%), seemed to be fairly high but in approximately the same range as for GreenLight laser vaporization [2].

A major limitation of the study is its design: a nonrandomized, noncomparative trial of a small cohort ($n$ = 30) with short follow-up (6 mo). Thus, no definite clinical conclusions can be drawn. The real value of the study consists of its pioneering character. It is known that outcomes are the more durable the more tissue is ablated [3]. For this reason, information about postoperative prostate-specific antigen or transrectal ultrasound data as surrogates for the amount of tissue ablation would have been valuable. Furthermore, pre- and postoperative pressure flow studies could have contributed significantly to the clinical implication of the preliminary data presented. In fact, this principle was, definitively, one of the great strengths of initial and subsequent (randomized)

studies contributing to the acceptance of holmium laser enucleation of the prostate as a minimally invasive alternative to transurethral resection of the prostate and open prostatectomy [4,5].

The authors, however, have to be congratulated. Despite being key opinion leaders of GreenLight laser vaporization, they strive to overcome one of the major drawbacks of that technique: high economic costs.

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