

# Update on Greenlight laser vaporization (PVP) 2014

Malte Rieken · Alexander Bachmann

Received: 10 October 2014 / Accepted: 31 October 2014 / Published online: 5 November 2014  
© Springer-Verlag Berlin Heidelberg 2014

## Abstract

**Purpose** To assess the (1) outcomes and (2) intraoperative, perioperative, and long-term complications of photoselective vaporization of the prostate (PVP) with Greenlight laser.

**Methods** A systematic review of outcomes and complications of PVP was conducted. The article selection process was performed according to PRISMA guidelines and included publications published between 2009 and 2014.

**Results** All generations of PVP (80, 120, 180 W) lead to a significant improvement of micturition symptoms (IPSS, QoL) and voiding parameters (Q max, PVR volume) during follow-up. Data on sexual function are heterogeneous and suggest a trend toward decline in erectile function in men with sustained preoperative erection. The rate of intraoperative complications is low. Data on peri- and postoperative complications show a large variation that mainly can be attributed to heterogeneity in documentation.

**Conclusions** PVP leads to a statistically significant and clinically relevant improvement of voiding parameters and micturition symptoms in patients with prostates <100 ml. The technique is characterized by a high degree of intra- and perioperative safety. Long-term evidence on functional outcomes and complications beyond 3 years from RCTs is currently missing for all generations of the Greenlight laser.

**Keywords** Lower urinary tract symptoms · Benign prostate enlargement · Photoselective vaporization of the prostate · Laser prostatectomy · Outcomes · Complications

## Introduction

Transurethral resection of the prostate (TURP) is the gold standard treatment of lower urinary tract symptoms (LUTS) due to benign prostate enlargement (BPE) in patients with a prostate volume <80 ml [1]. In the last two decades, several alternative surgical techniques challenged the predominance of TURP [2]. Among them, vaporization of the prostate (PVP) with the GreenLight® laser became one of the established alternatives to TURP in the treatment of men with LUTS and a prostate volume <80 ml [1]. Encouraged by early results, a relatively easy-to-learn technique and accompanied by marketing of the manufacturer, PVP nowadays is widespread used among urologists. Since the introduction of PVP with the 80 W laser in 2002, the laser system underwent several modifications in fiber design, fiber life and maximum power output of the laser generator [3]. Thus, results of early reports may not easily be extrapolated to predict outcomes of the currently used laser hardware. The objective of this comprehensive review is to provide an update of the functional outcomes as well as the complications of PVP.

## Materials and methods

A comprehensive review was carried out on a literature search through PubMed/Medline. The literature search aimed at identifying all papers reporting results of studies on PVP in English language between January 2009 and August 2014. The following key words were used in the database search: Photoselective vaporization of the prostate, Greenlight laser vaporization of the prostate, 180 W XPS laser prostate, 120 W HPS laser prostate, and 80 W

M. Rieken (✉) · A. Bachmann  
Department of Urology, University Hospital Basel,  
Spitalstrasse 21, 4031 Basel, Switzerland  
e-mail: malte.rieken@usb.ch

KTP laser prostate. The reference lists of all systematic reviews in the field were also searched to identify articles of particular relevance to the topics of the current review. Analysis of publications was categorized by the three systems of the Greenlight laser: 80 W KTP, 120 W HPS, and 180 W XPS. With respect to randomized controlled trials, inclusion and exclusion criteria as well as baseline data of patients were studied. Quality of randomized controlled trials was assessed by the Jadad score [4]. Complications were categorized by intra- and perioperative complications and postoperative complications. Postoperative complications were rated according to the Clavien–Dindo classification [5].

## Results

### Functional outcomes

Only three randomized controlled trials were published during the search period comparing PVP with the 80 W KTP laser to monopolar TURP (M-TURP) [6, 7] or Holmium laser ablation of the prostate (HOLAP) [8, 9]. In addition, case series were published with a maximum follow-up of

5 years [10–12]. As shown in Table 1, PVP with the 80 W KTP laser lead to a statistically significant short-term and long-term improvement of voiding symptoms (IPSS, QoL) and micturition parameters (Q max, PVR volume) in RCTs [6–9]. Data on PSA reduction were not available from any of these RCTs. Case series of the 80 W laser with a follow-up of 60 months further support the long-term improvement in voiding parameters and micturition symptoms [10, 11]. In contrast, in one case series with a 2-year follow-up, the improvement of IPSS and maximum flow rate seems inferior to other series [12]. The impact of 80 W PVP on erectile function was analyzed in two case series including 149 and 150 patients, respectively [13, 14]. After a maximum follow-up of 12 and 24 months, the IIEF scores for patients with preoperative erectile function (defined as IIEF >19) were significantly decreased in both studies [13, 14] (Table 2).

With respect to functional results of the 120 W laser, five RCTs in comparison with M-TURP [15–18] or M-TURP and bipolar TURP (B-TURP) [19] with a maximum follow-up of 36 months are available. In all studies, a significant improvement of voiding parameters and symptoms could be noticed [15–19]. One study analyzed the change in urodynamic parameters and found a significant improvement in PdetQmax and BOOI values at 2-years follow-up

**Table 1** Functional outcomes of PVP in RCTs according to laser type

Study	Number of patients	Laser type (W)	Primary outcome	Follow-up (months)	IPSS Mean preoperative value → mean value at last follow-up	QoL	Qmax	PVR	PSA	Jadad score for RCTs
Bouchier-Hayes [6]	PVP: 59 M-TURP: 50	80	NA	12	25 → 9	5 → 2	8.8 → 18.6	129 → 22	NA	3
Elshal [8, 9]	PVP: 52 HOLAP: 57	80	Change in IPSS	70	18 → 8	4 → 2	6.4 → 15	215 → 60	NA	2
Mohanty [7]	PVP: 60 M-TURP: 57	80	Subjective and objective parameters	12	20 → 6	4 → 2	7.4 → 20.1	146 → 24	2.5 → NA	4
Al-Ansari [15]	PVP: 60 M-TURP: 60	120	Subjective and objective parameters	36	27 → 10	NA	6.9 → 17	53 → 11	2.6 → 1.5	3
Pereira-Correia [17]	PVP: 10 M-TURP: 10	120	Urodynamic evaluation, IPSS	24	22 → 7	NA	10 → 20.5	150 → 4	NA	2
Capitán [16]	PVP: 50 M-TURP: 50	120	Superiority of IPSS	24	24 → 8	5 → 1	8.0 → 23	NA	3.7 → 2.1	3
Kumar [19]	PVP: 50 M-TURP: 50 B-TURP	120	Subjective and objective parameters	12	20 → 7	4 → 2	6.7 → 19.6	143 → 31	2.4 → NA	2
Lukacs [18]	PVP: 69 M-TURP: 70	120	Non-inferiority of PVP regarding IPSS	12	22 → 6	NA	7.8 → 16.7	90 → 0	2.4 → 1.8	3
Bachmann [21]	PVP: 136 M/B-TURP: 133	180	Non-inferiority of PVP regarding IPSS and Q max at 6 months	6	21 → 7	5 → 2	9.5 → 23.3	110 → 38	2.7 → 1.4	3

NA not available

**Table 2** Functional outcomes of selected PVP case series according to laser type

Study	Number of patients	Laser type (W)	Percentage of patients with cath	Mean prostate volume	Follow-up (months)	IPSS	QoL	Qmax	PVR	PSA
Malde [11]	115	80	26 %	56	60	22 → 9	NA	8.0 → 13.9	321 → 76	4.2 → 3.4
Hai [10]	321	80	NA	55	60	24 → 5	4 → 1	8.6 → 21.1	170 → 28	3.2 → 2.2
Kim [12]	169	80	None	42	24	19 → 13	4 → 2	10.0 → 11.3	43 → 22	NA
Tasci [26]	550	120	NA	72	36	23 → 6	4 → 1	9.0 → 19.5	125 → 10	3.6 → 3.6
Bachmann [22]	201	180	25 %	68	6	20 → 9	4 → 1	8.4 → 21.0	190 → 29	5.5 → 2.0
Chung [24]	85	180	27 %	51	3	25 → 7	5 → 2	7.7 → 18.4	147 → 38	NA
Hueber [25]	622	180	NA	NA	NA	NA	NA	NA	NA	NA
Campbell [23]	50	180	14 %	68	3	20 → 7	4 → 2	9 → 26	143 → 32	3.6

NA not available

[17]. The rate of improvement was found to be comparable between 120 W PVP and TURP [17]. Over the course of 2 years, the improvement of IPSS storage symptoms and voiding symptoms was comparable in another RCT comparing 120 W PVP and TURP [16]. Sexual outcomes were analyzed in two RCTs [18, 19]. Kumar et al. [19] report no significant differences in IIEF-5 scores between patients who underwent M-TURP, B-TURP, and 120 W PVP. However, it has to be acknowledged that the mean IIEF-5 scores in these groups ranged around 16, with only a small proportion of patients with sufficient preoperative erectile function [19]. Lukacs et al. [18] analyzed the postoperative course of erectile function and sexual satisfaction in depth. The authors found an improved or unchanged sexual satisfaction after surgery compared with baseline in around 86 % of the patients after PVP compared to 77 % following TURP. When improved and unchanged patients were grouped and compared with worsened patients in both arms of the study, evolution of ejaculation and erection appeared to be superior in the 120 W PVP arm of the study [18]. One larger case series including 550 consecutive patients who underwent PVP with the 120 W laser found a significant improvement of voiding parameters and symptoms over the postoperative course of 3 years [20]. However, as in the majority of case series, at 36 months less than 10 % of the patients were available for follow-up, which has to be acknowledged as major limitation.

With the 180 W laser, one RCT in comparison with M- and B-TURP with a follow-up of currently 6 months [21] and four case series is available [22–25]. The GOLIATH study included 281 men who were randomized to treatment with the 180 W laser or TURP [21]. It is the first study powered to demonstrate the non-inferiority of 180 W PVP over TURP with regard to IPSS and Qmax at 6 months. At 6 months, voiding symptoms and parameters significantly improved compared to the preoperative values with a non-inferiority of PVP over TURP [21]. Sexual

function was not evaluated at 6 months. One larger international case series including 201 patients [22] as well as two smaller series with 50 and 85 men [23, 24] report a significant improvement of all relevant parameters at 3- and 6-month follow-up, respectively. Sexual function was only analyzed in one study and showed a reduction in median IIEF score from 21.5 at baseline to 19- at 3-month follow-up [23]. As the maximum follow-up of data on the 180 W laser currently only is 6 months, further results from the GOLIATH study and larger case series have to be awaited.

### Complications

The definition and documentation of complications varies strongly between different studies. In recent years, the Clavien–Dindo classification of postoperative complications found widespread use and facilitates the comparison between techniques and different studies.

#### *Intra- and perioperative complications*

Intraoperative complications are rarely reported in RCTs. This may be attributed to the lack of a standardized reporting scheme of intraoperative complications in endourology. Only few RCTs report intraoperative complications including intraoperative bleeding and capsule perforation [8, 15, 16, 19]. No TUR syndrome or capsule perforation was reported in any of the randomized trials with all PVP techniques, and the rate of intraoperative bleeding was reported at 6 % [8, 15, 16, 19] (Table 3). Details on perioperative and early postoperative complications are listed in Table 4. A huge variation in the incidence of complications can be noted. This may mainly be attributed to differences of documentation between studies. For examples, the severity of hematuria can range from transient staining of the urine to clot retention with the need for surgical revision under anesthesia. Assigning different Clavien–Dindo grades to

**Table 3** Intraoperative complications of PVP in RCTs

Study	Number of patients	Laser type (W)	Bleeding <i>n</i> (%)	Capsule perforation <i>n</i> (%)	TUR syndrome <i>n</i> (%)
Bouchier-Hayes [6]	PVP: 59 M-TURP: 50	80	NA	NA	NA
Elshal [8, 9]	PVP: 52 HOLAP: 57	80	3 (5.7)	NA	NA
Mohanty [7]	PVP: 60 M-TURP: 57	80	NA	NA	NA
Al-Ansari [15]	PVP: 60 M-TURP: 60	120	0	0	0
Pereira-Correia [17]	PVP: 10 M-TURP: 10	120	NA	NA	NA
Capitán [16]	PVP: 50 M-TURP: 50	120	0	NA	0
Kumar [19]	PVP: 50 M-TURP: 50 B-TURP	120	NA	NA	0
Lukacs [18]	PVP: 69 M-TURP: 70	120	NA	NA	NA
Bachmann [21]	PVP: 136 M/B-TURP: 133	180	NA	NA	NA

the same kind of complication may be able to properly address these differences. However, different Clavien–Dindo grades were only assigned to the same condition in detail in one study [21].

The rate of postoperative hematuria ranges from none to 11.8 % with the highest rates reported from the 180 W laser. However, only 3 % of the patients had to undergo invasive treatment for hematuria. Increased storage symptoms associated with pain are observed frequently after BPO surgery. One study reported irritative symptoms in almost all patients treated with 120 W PVP [15]. In contrast, a thorough evaluation of postoperative dysuria after 120 W PVP [18] found 10.3 % of the patients to experience postoperative dysuria. In addition, no significant difference in comparison with TURP could be noticed [18, 21]. Urinary tract infections were reported relatively frequently after 180 W PVP [21]. However, no uniform definition of infection was applied in the study, and it is unclear whether positive urine culture results were awaited in all patients prior to initiation of antimicrobial therapy. Transient urinary incontinence was reported in up to 50 % of the patients. However, the assessment of incontinence varied between studies, and different methods were used to evaluate the severity of incontinence. Thus, further research and high-quality data are needed to properly assess the incidence postoperative incontinence.

#### Postoperative complications

Table 5 summarizes the rate of postoperative complications (>6 months). Similar to intra- and perioperative

complications, the incidence of reoperations shows distinct differences between the studies. As the rate of loss to follow-up is low in RCTs, priority was given to data from such studies. No clear difference between the complication rate after 80 and 120 W PVP can be noticed. Importantly, the duration of postoperative follow-up differs strongly between the analyzed studies. The two studies with the longest follow-up [8, 15] also observed the highest rates of urethral strictures, bladder neck contractures, and adenoma regrowth, respectively. By the end of the literature research, no RCT data from 180 W PVP beyond 6 months were published.

#### Discussion

Photoselective vaporization of the prostate has become an established treatment alternative to TURP for men with benign prostate enlargement. In recent years, several randomized trials in comparison with TURP or other laser techniques could show comparable functional outcomes. Based on the evidence provided by several studies, all generations of PVP (80 W, 120 W, 180 W) lead to a significant improvement of voiding parameters and symptoms during follow-up. The rate of intra- and perioperative complications seems low. The reoperation rate appears comparable to TURP, with limitations in trials with longer follow-up.

Regardless of the evidence that could be accumulated in recent years, this review also highlights limitations, unmet needs, and areas for further improvement. First, long-term evidence of safety and efficacy from RCTs beyond 3-year follow-up is still missing for PVP and currently seems

**Table 4** Perioperative and early postoperative ( $\leq 6$  months) complications of PVP in RCTs

Study	Number of patients	Laser type (W)	Hematuria, bleeding <i>n</i> (%) Clavien–Dindo grade	Irritative symptoms, pain, discomfort <i>n</i> (%) Clavien–Dindo grade	Urinary tract infection <i>n</i> (%) Clavien–Dindo grade	Retention <i>n</i> (%) Clavien–Dindo grade	Urinary incontinence <i>n</i> (%) Clavien–Dindo grade
Bouchier-Hayes [6]	PVP: 59 M-TURP: 50	80	4 (6.7)	5 (8.5)	5 (8.5)	1 (1.7)	NA
Elshal [8, 9]	PVP: 52 HOLAP: 57	80	1 (1.9), °2	2 (3.8), °1 2 (3.8), °2	3 (5.7), °2	6 (11.5), °2	5 (9.6), °2
Mohanty [7]	PVP: 60 M-TURP: 57	80	0	15 (25)	5 (8.3)	4 (6.7)	NA
Al-Ansari [15]	PVP: 60 M-TURP: 60	120	0	56 (93.3)	NA	0	NA
Pereira-Correia [17]	PVP: 10 M-TURP: 10	120	NA	NA	NA	NA	5 (50)
Capitán [16]	PVP: 50 M-TURP: 50	120	6 (12), °1	NA	4 (8), °2	4 (8), °1	NA
Kumar [19]	PVP: 50 M-TURP: 50 B-TURP	120	0	5 (8.6), °2	4 (6.9), °2	5 (8.6), °3a	NA
Lukacs [18]	PVP: 69 M-TURP: 70	120	7 (10.3)	7 (10.3)	2 (2.9)	NA	NA
Bachmann [21]	PVP: 136 M/B-TURP: 133	180	9 (6.6), °1 3 (2.2), °2 2 (1.5), °3a 2 (1.5), °3b	22 (16.2), °1 4 (2.9), °2	5 (3.7), °1 20 (14.7), °2	8 (5.9), °1 7 (5.1), °3a 2 (1.5), °3b	12 (8.8), °1 3 (2.2), °2

**Table 5** Postoperative complications (>6 months) of PVP in RCTs

Study	Number of patients	Laser type (W)	Urethral stricture <i>n</i> (%) Clavien–Dindo grade	Bladder neck contracture <i>n</i> (%) Clavien–Dindo grade	Adenoma regrowth <i>n</i> (%) Clavien–Dindo grade	Urinary incontinence <i>n</i> (%) Clavien–Dindo grade
Bouchier-Hayes [6]	PVP: 59 M-TURP: 50	80	0	0	6 (10.2), °3	0
Elshal [8, 9]	PVP: 52 HOLAP: 57	80	4 (7.7), °3	5 (9.6), °3	4 (7.7), °3	2 (3.8), °2
Mohanty [7]	PVP: 60 M-TURP: 57	80	1 (1.7), °3	1 (1.7), °3	0	NA
Al-Ansari [15]	PVP: 60 M-TURP: 60	120	0	4 (7.4), °3	6 (11), °3	0
Pereira-Correia [17]	PVP: 10 M-TURP: 10	120	NA	NA	NA	NA
Capitán [16]	PVP: 50 M-TURP: 50	120	2 (4), °2 1 (2), °3	0	0	1 (2), °2
Kumar [19]	PVP: 50 M-TURP: 50 B-TURP	120	1 (1.7)	1 (1.7)	NA	NA
Lukacs [18]	PVP: 69 M-TURP: 70	120	NA	NA	NA	NA

unlikely that these data will be provided in the near future. In that context, cohort studies seem largely insufficient to provide high-quality data as lost to follow-up is high. Second, in the period of literature research, no novel high-quality data on the safety and efficacy of PVP in comparison with open prostatectomy in patients with larger (>100 ml) prostates were published. Thus, high-level evidence on PVP in patients with large prostates is missing. Third, it has to be noticed that while the assessment of effectiveness of PVP seems standardized by questionnaires and measurable data, documentation of complications needs further improvement. Although the Clavien–Dindo Classification of complications may not seem perfectly suitable for the grading of complications in endourology, investigators should be encouraged to adhere to this classification. The comparative evaluation of surgical techniques is largely depending on the quality of data on complications. Thus, it is crucial that complications are not only documented but also graded according to the measures that had to be taken for resolution. Strict adherence will improve the quality of future clinical trials and ultimately the quality of treatment we are providing for our patients.

## Conclusions

Based on the evidence provided by several randomized studies, all generations of PVP (80 W, 120 W, 180 W) lead to a significant improvement of voiding parameters and symptoms. The rate of intra- and perioperative complications appears low.

The reoperation rate seems comparable to TURP, with limitations in trials with longer follow-up. More evidence is needed to support the use of PVP in patients with large prostates.

**Conflict of interest** M. Rieken: No conflict of interest. A. Bachmann: Principal investigator of the GOLIATH study, which was sponsored by American Medical Systems (AMS), is advisor for AMS, and receives honoraria for presentations.

**Ethical standard** All human studies have been approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

## References

1. Oelke M, Bachmann A, Descaseaud A, Emberton M, Gravas S, Michel MC, N'Dow J, Nordling J, de la Rosette JJ (2013) EAU guidelines on the treatment and follow-up of non-neurogenic male lower urinary tract symptoms including Benign prostatic obstruction. *Eur Urol* 64(1):118–140
2. Cornu JN, Ahyai S, Bachmann A, de la Rosette J, Gilling P, Gratzke C, McVary K, Novara G, Woo H, Madersbacher S (2014) A systematic review and meta-analysis of functional outcomes and complications following transurethral procedures for lower urinary tract symptoms resulting from Benign prostatic obstruction: an update. *Eur Urol*. doi:10.1016/j.eururo.2014.06.017
3. Rieken M, Bachmann A (2014) Laser treatment of benign prostate enlargement—which laser for which prostate? *Nat Rev Urol* 11(3):142–152
4. Jadad AR, Moore RA, Carroll D, Jenkinson C, Reynolds DJ, Gavaghan DJ, McQuay HJ (1996) Assessing the quality of reports of randomized clinical trials: is blinding necessary? *Control Clin Trials* 17(1):1–12

5. Dindo D, Demartines N, Clavien PA (2004) Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg* 240(2):205–213
6. Bouchier-Hayes DM, Van Appledorn S, Bugeja P, Crowe H, Challacombe B, Costello AJ (2010) A randomized trial of photo-selective vaporization of the prostate using the 80 W potassium-titanyl-phosphate laser vs transurethral prostatectomy, with a 1-year follow-up. *BJU Int* 105(7):964–969
7. Mohanty NK, Vasudeva P, Kumar A, Prakash S, Jain M, Arora RP (2012) Photoselective vaporization of prostate vs. transurethral resection of prostate: a prospective, randomized study with one year follow-up. *IJU* 28(3):307–312
8. Elshal AM, Elmansy HM, Elhilali MM (2013) Two laser ablation techniques for a prostate less than 60 ml: lessons learned 70 months after a randomized controlled trial. *Urology* 82(2):416–422
9. Elzayat EA, Al-Mandil MS, Khalaf I, Elhilali MM (2009) Holmium laser ablation of the prostate versus photoselective vaporization of prostate 60 cc or less: short-term results of a prospective randomized trial. *J Urol* 182(1):133–138
10. Hai MA (2009) Photoselective vaporization of prostate: five-year outcomes of entire clinic patient population. *Urology* 73(4):807–810
11. Malde S, Rajagopalan A, Patel N, Simoes A, Choi W, Shrotri N (2012) Potassium-titanyl-phosphate laser photoselective vaporization for benign prostatic hyperplasia: 5-year follow-up from a district general hospital. *J Endourol* 26(7):878–883
12. Kim HS, Cho MC, Ku JH, Kim SW, Paick JS (2010) The efficacy and safety of photoselective vaporization of the prostate with a potassium-titanyl-phosphate laser for symptomatic benign prostatic hyperplasia according to prostate size: 2-year surgical outcomes. *Korean J Urol* 51(5):330–336
13. Kumar A, Vasudeva P, Kumar N, Nanda B, Mohanty NK (2012) Evaluation of the effect of photoselective vaporization of the prostate on sexual function in a prospective study: a single center experience of 150 patients. *J Endourol* [Epub ahead of print]
14. Bruyere F, Puichaud A, Pereira H, Faivre d'Arcier B, Rouanet A, Floc'h AP, Bodin T, Brichart N (2010) Influence of photoselective vaporization of the prostate on sexual function: results of a prospective analysis of 149 patients with long-term follow-up. *Eur Urol* 58(2):207–211
15. Al-Ansari A, Younes N, Sampige VP, Al-Rumaihi K, Ghafouri A, Gul T, Shokeir AA (2010) GreenLight HPS 120 W laser vaporization versus transurethral resection of the prostate for treatment of benign prostatic hyperplasia: a randomized clinical trial with midterm follow-up. *Eur Urol* 58(3):349–355
16. Capitan C, Blazquez C, Martin MD, Hernandez V, de la Pena E, Llorente C (2011) GreenLight HPS 120 W laser vaporization versus transurethral resection of the prostate for the treatment of lower urinary tract symptoms due to benign prostatic hyperplasia: a randomized clinical trial with 2-year follow-up. *Eur Urol* 60(4):734–739
17. Pereira-Correia JA, de Moraes Sousa KD, Santos JB, de Moraes Perpetuo D, Lopes-da-Silva LF, Krambeck RL, Muller VJ, Vaz FP (2012) GreenLight HPS 120 W laser vaporization vs transurethral resection of the prostate (<60 mL): a 2-year randomized double-blind prospective urodynamic investigation. *BJU Int* 110(8):1184–1189
18. Lukacs B, Loeffler J, Bruyere F, Blanchet P, Gelet A, Coloby P, De la Taille A, Lemaire P, Baron JC, Cornu JN, Aout M, Rousseau H, Vicaut E, Group RS (2012) Photoselective vaporization of the prostate with GreenLight 120 W laser compared with monopolar transurethral resection of the prostate: a multicenter randomized controlled trial. *Eur Urol* 61(6):1165–1173
19. Kumar A, Vasudeva P, Kumar N, Nanda B, Jha SK, Mohanty NK (2013) A prospective randomized comparative study of monopolar transurethral resection of prostate (TURP), bipolar TURP and photoselective vaporization of prostate in patients presenting with benign prostatic obstruction—a single center experience. *J Endourol* 27(10):1245–1253
20. Gu X, Vricella GJ, Spaliviero M, Wong C (2012) Does size really matter? The impact of prostate volume on the efficacy and safety of GreenLight HPS laser photoselective vaporization of the prostate. *J Endourol* 26(5):525–530
21. Bachmann A, Tubaro A, Barber N, d'Ancona F, Muir G, Witzsch U, Grimm MO, Benjam J, Stolzenburg JU, Riddick A, Pahernik S, Roelink H, Ameye F, Saussine C, Bruyere F, Loidl W, Lerner T, Gogoi NK, Hindley R, Muschter R, Thorpe A, Shrotri N, Graham S, Hamann M, Miller K, Schostak M, Capitan C, Knispel H, Thomas JA (2014) 180 W XPS GreenLight laser vaporisation versus transurethral resection of the prostate for the treatment of benign prostatic obstruction: 6-month safety and efficacy results of a European multicentre randomised trial—the GOLIATH study. *Eur Urol* 65(5):931–942
22. Bachmann A, Muir GH, Collins EJ, Choi BB, Tabatabaei S, Reich OM, Gomez-Sancha F, Woo HH (2012) 180 W XPS GreenLight laser therapy for benign prostate hyperplasia: early safety, efficacy, and perioperative outcome after 201 procedures. *Eur Urol* 61(3):600–607
23. Campbell NA, Chung AS, Yoon PD, Thangasamy I, Woo HH (2013) Early experience photoselective vaporisation of the prostate using the 180 W lithium triborate and comparison with the 120 W lithium triborate laser. *Prostate Int* 1(1):42–45
24. Chung AS, Chabert C, Yap HW, Lam J, Awad N, Nuwayhid F, Redwig F, Rashid P, Woo HH (2012) Photoselective vaporization of the prostate using the 180 W lithium triborate laser. *ANZ J Surg* 82(5):334–337
25. Hueber PA, Liberman D, Ben-Zvi T, Woo H, Hai MA, Te AE, Chughtai B, Lee R, Rutman M, Gonzalez RR, Barber N, Al-Hathal N, Al-Qaoud T, Trinh QD, Zorn KC (2013) 180 W vs 120 W lithium triborate photoselective vaporization of the prostate for benign prostatic hyperplasia: a global, multicenter comparative analysis of perioperative treatment parameters. *Urology* 82(5):1108–1113
26. Tasci AI, Ilbey YO, Luleci H, Cicekler O, Sahin S, Cevik C, Tugcu V (2011) 120 W GreenLight laser photoselective vaporization of prostate for benign prostatic hyperplasia: midterm outcomes. *Urology* 78(1):134–140