

Update on the current evidence for Tm:YAG vapoenucleation of the prostate 2014

C. Netsch · T. Bach · T. R. W. Herrmann · A. J. Gross

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Abstract

Introduction To evaluate the current role of thulium vapoenucleation of the prostate (ThuVEP) for the treatment of benign prostatic obstruction (BPO).

Methods A Medline search for randomized trials, case series, and comparative studies being published since the initial description of the ThuVEP procedure (2009–2014) was performed to assess the safety, the perioperative morbidity, the efficacy, and the durability of the technique.

Results A total of 14 peer-reviewed original articles, seven case series [level of evidence (LOE) 4] and seven comparative studies (LOE 3b), have been identified. ThuVEP has been shown to be a size-independent, safe, efficacious, and durable procedure for the treatment of BPO in large, prospective, and retrospective series (LOE 4/3b). The feasibility and safety of the ThuVEP procedure has also been confirmed in patients at high cardiopulmonary risk on oral anticoagulants (LOE 4). It has also been demonstrated that the erectile function is not impaired by the ThuVEP procedure (LOE 4). However, published ThuVEP series are from very few centers of excellence not exceeding a LOE of 3b. Randomized controlled trials comparing ThuVEP with standard procedures for the treatment of BPO, namely transurethral resection of the prostate, open prostatectomy,

or holmium laser enucleation of the prostate, have not been published so far.

Conclusions ThuVEP appears to be a size-independent, safe, efficacious, and durable procedure for the treatment of BPO (LOE 4/3b). Multicentric RCT are however needed to define the current role of ThuVEP in the armamentarium of minimally invasive transurethral surgery of the prostate.

Keywords Benign prostatic obstruction (BPO) · Vapoenucleation · Tm:YAG · RevoLix · ThuVEP · Anticoagulants

Introduction

Transurethral resection of the prostate (TURP) and open prostatectomy (OP) have been over decades the standard treatment of benign prostatic obstruction (BPO) due to lower urinary tract symptoms (LUTS). However, since the first description of holmium laser enucleation of the prostate (HoLEP) for the treatment of BPO in 1998, the HoLEP technique has gained increasing popularity around the world due to its major advantage of combining complete dissection of the adenoma from the surgical pseudocapsule with very low perioperative morbidity [1]. Since then, the HoLEP procedure has been shown in numerous studies to be a size-independent, safe, and efficacious procedure with excellent long-term results in terms of reoperation and complication rates [2, 3]. Based on the HoLEP technique, a vast variety of so-called me too techniques using different energy sources have been described during the past decade: i.e., transurethral enucleation of the prostate using thulium, diode, and potassium-titanyl-phosphate (KTP) lasers or bipolar energy sources [4]. However, long-term data as well as the number randomized controlled trials (RCT) for transurethral

C. Netsch (✉) · A. J. Gross
Department of Urology, Asklepios Hospital Barmbek,
Rübenkamp 220, 22291 Hamburg, Germany
e-mail: c.netsch@asklepios.com

T. Bach
Department of Urology, Asklepios Hospital Harburg, Hamburg,
Germany

T. R. W. Herrmann
Department of Urology, MHH Medical School of Hannover,
Hannover, Germany

enucleation procedures other than HoLEP are rather limited [2, 3]. One prominent representative of these “new” types of energy sources for transurethral enucleation of the prostate is the thulium:yttrium–aluminum–garnet (Tm:YAG) laser [4]. Bach et al. [5, 6] first described the thulium vapoenucleation of the prostate (ThuVEP) procedure combined with mechanical morcellation in 2009 as a safe and durable procedure. This review focuses on the literature that has been published since the initial description of the ThuVEP procedure to assess the safety, efficacy, and long-term durability of the procedure.

Materials and methods

A Medline search with these keywords was performed: benign prostatic hyperplasia, bladder outlet obstruction, laser, RevoLix, enucleation, prostate enucleation transurethral, ThuVEP, 2 μm continuous wave laser, and ThuLEP. We reviewed the literature regarding the ThuVEP procedure that has been published since its initial description in 2009. Papers dealing with techniques other than the ThuVEP technique, i.e., Tm:YAG vaporization of the prostate (ThuVAP), Tm:YAG vaporessection (ThuVARP), and Tm:YAG laser enucleation of the prostate (ThuLEP), were excluded from further analysis. Therefore, a total of 14 peer-reviewed original articles, seven case series [level of evidence (LOE) 4] and seven comparative studies (LOE 3b), have been identified.

Technical aspects

Three types of thulium lasers have been introduced for the treatment of BPO: a 2.013 nm Tm:YAG laser (2 μm RevoLix[®], LISA Laser products, Katlenburg, Deutschland), a 1.940 nm Tm:fiber laser (1.9 μm Vela[®] XL, Starnedtec, Starnberg, Deutschland), and a 2,010 nm Tm:YAG laser (2 μm Cyber[™], QuantaSystem, Solbiate Olona, Italia), respectively. The target chromophore is water, with radiation emission in a continuous wave mode. The wavelength is close to the absorption peak of water and, together with a shallow penetration depth of 0.2 mm, this results in a high-energy density leading to rapid vaporization of water and tissue [7, 8]. The side-fire technique is available, but published applications of the thulium:YAG laser are mainly resection and enucleation procedures using front-firing fibers [9]. Due to the high proportion of vaporization during these procedures, the terms vaporessection and vapoenucleation have been introduced into clinical practice [10].

Surgical technique of the ThuVEP procedure

In principle, all transurethral enucleation techniques for the treatment of BPO are based on the surgical descriptions by

Hiraoka et al. and Gilling et al. [1, 11]. Briefly, either the beak of the resectoscope is used to bluntly dissect the prostate off the pseudocapsule, and then the source of energy is used to coagulate the bleeding vessels or the source of energy is continuously applied to the layer of enucleation using a 2-lobe or 3-lobe technique [1, 11]. The blunt enucleation technique using the Tm:YAG laser has been introduced as thulium laser enucleation of the prostate (ThuLEP) [10], while the continuous use of the Tm:YAG laser for dissecting off the prostate from the surgical pseudocapsule was named ThuVEP due to the concomitant excellent vaporization capacities of the Tm:YAG laser during enucleation [10]. The ThuVEP technique was described in the initial publication as follows [5]: “The distal resection border close to the prostatic apex was identified and marked with the Tm:YAG laser. After making a Turner-Warwick-like incision at the 5 and 7 o’clock positions down to the surgical capsule, the median lobe was enucleated in a retrograde manner. The lateral lobes were enucleated by dissecting the prostatic adenoma from the peripheral zone at the layer of the surgical capsule. Enucleated tissue was morcellated in the bladder. Residual apical tissue was vaporized as needed using the vaporizing properties of the Tm:YAG laser device” [5].

The excellent physical properties of the Tm:YAG laser have allowed the use of the ThuVEP technique for larger prostates (>80 ml) [12–14], for patients on oral anticoagulant (OA) therapy [15, 16], for patients at high cardiovascular and pulmonary risk [15, 16], or for patients with acute urinary retention [17], respectively.

Intra- and perioperative morbidity

It has been recently shown that ThuVEP is a safe and effective procedure for the treatment of BPO with low perioperative morbidity, short catheterization times, and hospital stay [13, 14]. Treatment of larger volume prostates (≥ 80 ml) was not associated with higher blood transfusion rates, prolonged catheterization times, or hospitalization stay compared with medium-sized (40–80 ml) and small-sized prostates (<40 ml) [13, 14] (Table 1). Enucleation efficiency (g/min) as well morcellation efficiency increased significantly with increasing prostate size (Table 1) [13, 14]. Table 1 lists the perioperative data from all ThuVEP series that have been published yet [5, 6, 12–23].

The operative time also increases with prostate size in ThuVEP (Table 1). However, there has been no transurethral resection syndrome (TURS) being reported in the literature after ThuVEP due to the use of physiologic saline as irrigant solution (Table 2) [5, 6, 12–23]. Intraoperative complications such as extraperitoneal fluid collection (range 0–1.6 %), superficial bladder injury during morcellation (range 0–2.8 %), malfunction of the Tm:YAG laser

Table 1 Perioperative data after Thu VEP combined with mechanical morcellation

References	[17]	[5]	[12]	[19]	[20]	[18]	[15]	[21] [†]	[13]**	[23]	[22]	[14]**	[16]
Year of publication	2009	2009	2011	2012	2012	2012	2012	2013	2013	2014	2014	2014	2014
Level of evidence	3b	4	4	3b	3b	4	4	3b	3b	4	4	3b	3b
Laser power (Watt)	70	70	70	70–120***	120–200 ^{††}	120	120	120	70–200	70	120	70–200	120
No. of patients (n)	208	88	90	44–40	28–28	207	39	32–32–32	1,080	124	72	687	56
Preop prostate wt (gm)	45.6–43.1*	61.3	108.6	79.9–88.5	68.6–65.4	57.8	50.3	45.1–51.6–52.6	30–54–100	58.5	52.5	27.9–54.4–109.8	50
Resected wt (g)	NA	31.7	70.5	38.3–25.5	53.2–40.7	40.3	NA	29.9–31.3–38.2	14–32–65	25	30	15.8–33.6–70.1	32
Operative time (min)	72–68	72	100.3	90.7–81.9	78.7–69.2	64.9	92	94.6–65.4–51.2	40–55–75	74	60	51.1–67–93.9	61.5
Morcellation time (min)	NA	NA	28.2	NA	20.5–16.5	16.4	NA	17.1–12.9–15.2	10–11–20	NA	NA	10.6–14.1–24.5	NA
Enucleation efficiency (min)	NA	NA	1.5	1.2–2.2	1.3–1.1	1.2	NA	0.5–0.7–1.4	0.6–1–1.5	NA	NA	0.7–1.1–1.6	NA
Morcellation efficiency (min)	NA	NA	3.5	NA	3–2.8	2.8	NA	2.1–3.1–2.8	1.7–2.8–3.6	NA	NA	NA	NA
Hb decrease (g/dl)	0.6–1.0*	NA	1.6	0.75–1.8	1.5–1.2	1.5	9%	1.4–1.1–1.6	1–1–1.5	0.9	1.2	1.1–1.3–1.6	1.15
Catheter time (days)	2.3–1.9*	2.1	2.2	2.3–2.4	2.1–2.2	2.2	4.8	2.1–2.2–2.2	2–2–2	2	2	2–2–2	2
Hospitalization (days)	NA	NA	NA	NA	NA	NA	5	NA	4–4–4	NA	NA	NA	4

Data n (%) or mean

NA not analyzed. *Thu VEP* thulium vapoenucleation of the prostate

* Subgroup 1: urinary retention, subgroup 2: no urinary retention

** Subgroups of prostates <40, 40–80, and ≥80 ml

*** 70 versus 120 Watt ThuVEP

[†] Learning curve analysis: unexperienced surgeon versus experienced TURP surgeon versus experienced ThuVEP surgeon

^{††} 120 versus 200 Watt ThuVEP

Table 2 Incidence of intra- and perioperative complications after ThuVEP combined with mechanical morcellation

References	[17]	[6]	[12]	[19]	[20]	[18]	[15]	[21]	[13]	[23]	[22]	[14]	[16]
Year of publication	2009	2010	2011	2012	2012	2012	2012	2013	2013	2014	2014	2014	2014
Laser power (Watt)	70	70	70	70–120	120–200	120	120	120	70–200	70	90	70–200	120
No. of patients (n)	208	88	90	84	56	207	39	96	1,080	124	72	687	56
Patients on anticoagulants during ThuVEP (n)	-	-	-	-	-	-	39	-	53	-	-	-	56
Intraoperative complications													
Extraperitoneal fluid collection (%)	-	-	-	-	-	-	-	-	1.5	1.6	1.4	-	-
Superficial bladder injury during morcellation (%)	-	-	-	-	1.8	0.5	-	-	1.4	1.6	2.8	1.8	1.7
Tm:YAG malfunction (%)	-	-	-	-	-	-	-	-	0.2	-	-	0.3	-
Capsular perforation (%)	-	-	-	-	-	-	-	-	2.1	3.2	1.4	2.3	-
Ureteric orifice injury (%)	-	-	1.1	-	-	0.5	-	1	0.7	0.8	1.4	1.2	-
Bladder neck false passage (%)	-	-	-	-	-	-	-	-	0.9	-	1.4	1.2	-
Perioperative complications													
Recatheterization (%)	3.8	1.1	2.2	3.6	5.4	1	18	2.1	9	11.9	5.6	8	7.1
Prolonged bladder irrigation and tamponade evacuation (%)	-	3.4	2.2	-	-	1.9	18	2.1	3.5	3.2	2.8	4.1	17.9
UTI (%)	7.7	6.8*	7.1*	9.5*	12.5*	14*	2.6	12.5*	8.4	7.3*	8.3*	4.7	12.5*
Phlebotrombosis (%)	-	-	-	-	-	-	-	-	0.3	-	-	0.2	-
Transfusions (%)	1	2.2	2.2	1.2	1.8	1.9	2.6	1	1.7	1.6	1.4	2.0	7.1
Myocardial infarction (%)	-	-	-	-	-	-	-	-	0.09	-	-	-	-
Ureteral stenting (%)	-	-	-	-	-	-	-	-	0.6	0.8	1.4	0.7	-
Secondary morcellation (%)	-	-	-	2.4	-	0.5	-	-	1.7	1.6	2.8	1.7	-
Secondary apical resection (%)	-	2.2	-	2.4	3.6	3.9	-	3.1	2.7	3.2	2.8	2.9	1.7
Coagulation of prostate fossa (%)	-	-	1.1	2.4	1.8	1.9	-	3.1	2	2.4	2.8	0.9	7.1
Reoperation rate(%)	2.8	2.2	1.1	7.2	5.4	6.3	-	6.2	6.4	7.3	8.3	6.3	8.9

Data n (%)

UTI urinary tract infection, ThuVEP thulium vapoenucleation of the prostate

* Cumulative rate of UTI at 1-year follow-up

(range 0–0.3 %), capsular perforation (range 0–3.2 %), ureteric orifice injury (range 0–1.4 %), and bladder neck false passage (range 0–1.4 %) have been reported, but the incidence of these complications was low (Table 2). In addition, most of these complications could be managed conservatively with prolonged catheterization [13]. Table 2 lists all intraoperative complications that have been reported in detail [6, 12–23].

Although high-risk patients on OA therapy have been treated, the rate of postoperative phlebothrombosis (range 0–0.3 %) and myocardial infarction (range 0–0.09 %) was very low. In addition, the perioperative blood transfusion rate was low and did not depend on prostate size (range 1–2.2 %) [13, 14] (Table 2). However, in patients on OA or with bleeding disorders, the blood transfusion rates were 7.1 and 2.6 %, respectively [15, 16].

Indications for immediate perioperative reoperation (range 0–8.9 %) were secondary morcellation (range 0–2.8 %), ureteral stenting (range 0–1.4 %), secondary apical resection (range 0–3.9 %), and coagulation of the prostate fossa (range 0–3.1 %), respectively (Table 2). To note, the perioperative reoperation rates did not depend on prostate size [13, 14]. On the other hand, the highest perioperative reoperation rate (8.9 %) was found in patients on OA during the ThuVEP procedure [16].

Postoperative functional results—late morbidity

At ≥ 12 -month follow-up, IPSS (≤ 6.8 vs. ≥ 18.4), QoL (≤ 1.8 vs. ≥ 3.8), Qmax (≥ 20 vs. ≤ 10.2 ml/s), and PVR (≤ 33.5 vs. ≥ 89.5 ml) improved significantly compared to preoperative assessment [6, 12, 18–21] and continued to do so at 24-month follow-up (Table 3). At 4-years postoperatively, Qmax (20 vs. 7.6 ml/s), PVR (25 vs. 107.5 ml), IPSS (4 vs. 21), and QoL (1 vs. 5) differed significantly from baseline ($p < 0.001$) [23] (Table 3). The reintervention rates for urethral strictures and bladder neck contractures were ranging from 0 to 3.6 and 0 to 3.6 % at 12-month follow-up, respectively. Table 3 shows the reoperation rates after ThuVEP in series with a follow-up ≥ 12 months. As expected, the overall reintervention rates (0–2.4 %) in series with a follow-up ≥ 24 months were low [16, 23], presumably due to peeling off the complete adenoma from the surgical pseudocapsule during ThuVEP.

Postoperative storage symptoms were often reported after transurethral laser treatments of the prostate [2, 3], ranging from 4.3 to 27 % in current ThuVEP series (Table 4). In addition, transient urge and stress incontinence after ThuVEP were reported to occur in up to 7.1 and 17.9 % of the patients [6, 12, 16, 18–21, 23] (Table 4). However, these adverse events usually resolved spontaneously or with conservative treatments (i.e., anti-inflammatory drugs, antibiotic therapy, and pelvic floor exercise).

At 12-month follow-up, the incidence of storage symptoms (range 0–4.8 %), urge incontinence (range 0–1.8 %), and stress incontinence (range 0–3.6 %) had significantly decreased [6, 12, 16, 18–21, 23] (Table 4).

Efficacy

PSA and prostate volume decreased significantly from baseline at 12-month follow-up confirming an effective anatomic desobstruction [6, 12, 18–21, 23] (Table 5). The minimum PSA-decrease was 81.0 % (range 81–88 %), and the minimum prostate volume decrease 71.8 % (range 71.8–86 %) at 12-month follow-up, respectively. To note, the series with the lowest prostate volume decrease (71.8 %) was the initial series by Bach et al. [5, 6] which included the learning curve of the ThuVEP procedure.

Learning curve

The shallow learning curve of the HoLEP technique has restricted its use to a limited number of centers worldwide [24]. Reasonable efficiency of HoLEP was found after at least 20–30 procedures [25–27] reaching up to 50 cases in other series [28]. Netsch et al. [21] compared the learning curves of a resident without experience in transurethral prostate surgery (surgeon A) and an experienced endourologist (surgeon B) with those ThuVEP procedures performed by an experienced surgeon in ThuVEP (surgeon C), who served as the mentor for the ThuVEP beginners. As expected, enucleation efficiency (g/min) differed significantly between surgeon A (0.48 ± 0.3), B (0.7 ± 0.36), and C (1.4 ± 0.67 ; $p \leq 0.001$). However, ThuVEP was performed by the ThuVEP beginners with reasonable enucleation and morcellation efficiency after 8–16 procedures (Table 1) [21]. At 12-month follow-up, the functional parameters (IPSS, QoL, Qmax, PVR), PSA, and prostate volume had improved significantly in each surgeon (Table 3). In addition, there were no differences in the incidence of complications among the surgeons during follow-up (Tables 2, 3). Immediate improvement of the functional parameters, reasonable efficiency of enucleation, and morcellation combined with low perioperative morbidity during the initial learning course was found when ThuVEP beginners were closely mentored. These short learning curves were explained by the use of the mentor-based approach and the specific physical properties of the Tm:YAG laser [21]. The energy of the Tm:YAG laser is delivered in a continuous wave mode, which can provide maximum hemostasis and coagulation, to perform a smooth incision or tissue vaporization. This specification allows an uncomplicated correction of the layer of enucleation during ThuVEP or switching from vapoenucleation to vaporesection or pure vaporization, which may facilitate to become adapt with

Table 3 IPSS, QoL, Qmax, PVR, and surgical complications at ≥ 12 -month follow-up after ThuVEP combined with mechanical morcellation

Ref. (no.)	Year	Power (Watt)	No. of patients (n)	Follow-up (months)	Preop prostate volume (ml)	Preop IPSS	IPSS [†]	Preop QoL	QoL [†]	Preop Qmax (ml/s)	Qmax [†] (ml/s)	Preop PVR (ml/s)	PVR [†] (ml)	Urethral stricture (%)	BNC (%)	Re-OP rate (%)
[6]	2010	70	88	16.5**	61.3	18.4	6.8	4.6	1.5	3.5	23.3	121.4	33.5	1.1	–	1.1
[12]	2011	90	90	12	108.6	23.5	4.7	4.3	1.0	3.8	26.2	178.9	16.5	1.1	–	1.1
[18]	2012	120	207	12	57.8	21.9	5.1	4.4	1.2	9.4	23.5	159.2	26.7	1.5	1.9	3.4
[20]	2012	200	28	12	65.4	23	4.3	4.5	1.1	10.2	27.1	89.5	20.9	–	3.6	3.6
	2012	120	28	12	68.6	21.2	4.9	4.5	1.5	7.9	23.3	138.5	21.8	3.6	–	3.6
[19]	2012	120	40	12	88.5	17.6	4.7	3.8	1.5	8.4	22.9	254.7	18.4	–	2.3	2.3
	70	44	44	12	79.9	17.8	4.9	4.7	1.3	8.2	23.8	110	25.8	–	2.5	2.5
[21]	2013	120	32	12	45.1	22.4	4.5	4.5	1.3	9.1	26.2	106.3	32.9	3.1	–	3.1
	120	32	32	12	51.6	21.2	6.8	4.2	1.8	9	23.5	116.5	24.8	3.1	–	3.1
	120	32	32	12	52.6	22.4	5.1	4.7	1.1	9.9	22.2	136.7	23.5	–	3.1	3.1
[16]	2014	120	56	12	50*	21.5*	5*	5*	1*	7.7*	28.3*	100*	17.5*	–	–	–
			24	24			5*		1*		30.5*		11*			
[23]	2014	70	124	12	58.5*	21*	3*	5*	5*	7.6*	21*	107.5*	15*			
			24	24			3*		1*		21.1*		10*			
			36	36			4*		1*		21.1*		14.5*			
			48	48			4*		1*		20*		25*	0.8	1.6	2.4

Data n (%) or mean

NA not analyzed mean, ThuVEP thulium vapoenucleation of the prostate, IPSS international prostate symptom score, QoL quality of life, Qmax maximum urinary flow rate, PVR post-voiding residual urine, BNC bladder neck contracture

** Mean; * median; † at follow-up

Table 4 Perioperative storage symptoms and continence rates after ThuVEP combined with mechanical morcellation and those reported after 12-month follow-up

Reference	[6]	[12]	[19]	[20]	[18]	[21]	[23]	[16]
Year of publication	2010	2011	2012	2012	2012	2013	2014	2014
Laser power (Watt)	70	70	70–120	120–200	120	120	70	120
No. of patients (<i>n</i>)	88	90	84	56	207	96	124	56
Transient urge incontinence (%)	NA	–	–	7.1	3.4	3.1	0.8	5.4
Transient urgency/dysuria (%)	27	5.6	20.2	12.5	4.3	5.2	5.6	NA
Transient stress incontinence (%)	NA	11.1	3.6	17.9	6.3	11.5	3.2	1.7
Urge incontinence at 12-month follow-up (%)	NA	–	–	1.8	–	–	–	–
Urgency/dysuria at 12-month follow-up (%)	NA	–	4.8	1.8	–	1	–	NA
Stress incontinence at 12-month follow-up (%)	NA	3.6	–	1.8	1.5	2.1	–	–

Data as *n* (%)

ThuVEP Thulium Vapoenucleation of the prostate

Table 5 PSA and prostate volume changes 12 months after ThuVEP combined with mechanical morcellation

Ref. no.	Year	Laser power (Watt)	No. of patients (<i>n</i>)	Follow-up (months)	Preoperative PSA (ng/dl)	Postoperative PSA (ng/dl)	PSA decrease (%)	Preoperative prostate volume (ml)	Postoperative prostate volume (ml)	Prostate volume decrease (%)
[6]	2010	70	88	16.5*	7.4 ± 7.7	NA	NA	61.3 ± 24	17.3 ± 9.7	71.8
[12]	2011	90	90	12	11.2 ± 10.9	0.8 ± 0.7	88	108.6 ± 26.5	14.4 ± 8.1	86
[18]	2012	120	207	12	5 ± 5.2	0.6 ± 0.5	87	57.8 ± 31.5	10.7 ± 4.4	80
[20]	2012	200	28	12	8.7 ± 11.2	0.5 ± 0.3	85	65.4 ± 39.2	9.8 ± 10.4	84
			28	12	3.8 ± 3.3	0.5 ± 0.3	83	68.6 ± 38.8	10.5 ± 5.3	83
[19]	2012	120	40	12	8 ± 7.3	NA	NA	88.5 ± 25.1	14.7 ± 12.8	82.2
		70	44	12	10.7 ± 11.1	NA	NA	79.9 ± 27.5	20.4 ± 13.7	81.7
[21]	2013	120	32	12	4.9 ± 6.9	0.4 ± 0.4	NA	45.1 ± 21.2	8.6 ± 3.6	81.0
			32	12	5.0 ± 7.1	0.3 ± 0.2	NA	51.6 ± 28.8	10.3 ± 3.8	80.1
			32	12	4.3 ± 3.5	0.4 ± 0.3	NA	52.6 ± 28.6	10.0 ± 3.9	80.2
[16]	2014	120	56	12	3.4 (1.6–6)**	0.9 (0.6–1.6)**	81.04**	50 (34–76)**	NA	NA
[23]	2014	70	124	12	4.7 (2.6–8.9)**	0.9 (0.4–1.5)**	83.6**	58.5 (45–70.8)**	NA	NA

NA, not analyzed

* Mean; **median (interquartile range)

the ThuVEP technique during the initial learning course of the procedure [6, 21, 29].

Sexual dysfunction

The impact of ThuVEP on erectile function (EF) has been demonstrated in one series [22]. Tiburtius et al. evaluated the EF of 72 patients who underwent ThuVEP for the treatment of BPO secondary to LUTS using the EF domain of the International Index of Erectile Function (IIEF-EF). They found a slight but no statistically significant increase of the IIEF-EF domain score at 12-month follow-up (19.5 vs. 20) compared to the preoperative assessment. According to preoperative IIEF-EF score, the 72 patients were

classified into subgroup A (IIEF-EF ≥ 19, *n* = 38) and subgroup B (IIEF-EF < 19, *n* = 34). Again, a slight nonsignificant increase of the IIEF-EF domain score at 12-month follow-up could be found in subgroup A (25 vs. 26) and B (6 vs. 8). However, data on retrograde ejaculation or IIEF orgasmic function were not presented in this series.

Conclusions

ThuVEP has been shown to be a size-independent, safe, and efficacious procedure for the treatment of BPO secondary to LUTS with low perioperative morbidity and excellent long-outcome regarding micturition improvement and

complication rates. However, the ThuVEP series that have been published so far are from few centers of excellence with a maximum LOE of 3b. To the best of our knowledge, no PRT has been published for the ThuVEP procedure so far. Multicentric PRT are however required to investigate ThuVEP in comparison with HoLEP, TURP, and OP to define the current role of ThuVEP in the armamentarium of minimally invasive transurethral surgery of the prostate. To note, the perioperative morbidity of ThuVEP is expected to be lower than in OP. The ThuVEP procedure should therefore be rather compared with HoLEP in large volume prostates.

Conflict of interest The authors declare that they have no conflict of interest.

Ethical standard All included human and animal 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. All persons gave their informed consent prior to their inclusion in the presented studies. Details that might disclose the identity of the subjects under study are omitted. The corresponding author takes on the above responsibilities.

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