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ORIGINAL ARTICLE

Safety and effectiveness of Thulium VapoEnucleation of the prostate (ThuVEP) in patients on anticoagulant therapy

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Abstract
Introduction To evaluate the safety and efficacy of Thulium VapoEnucleation of the prostate (ThuVEP) for patients on oral anticoagulants (OA) with symptomatic benign prostatic obstruction (BPO).
Methods Fifty-six patients, undergoing ThuVEP at two institutions, were evaluated from May 2009 until June 2011. All patients were at high cardiopulmonary risk and presented with a median American Society of Anesthesiology score of 3 [interquartile range (IQR) 2–3]. Thirty-two patients were on aspirin, 8 were on clopidogrel or clopidogrel and aspirin, and 16 on phenprocoumon at the time of surgery. Patient demographic, perioperative, and follow-up data were analyzed.
Results Median prostate volume was 50 (IQR 34–76) cc, and resected tissue weight was 32 (IQR 20–50) g. The median operative time was 61.5 (IQR 40–100.75) min, and the catheter time 2 (IQR 2–3) days. There were no perioperative thromboembolic events. Five patients (8.9 %) required a second-look operation in the immediate postoperative course (hemorrhage $n = 4$, residual adenoma $n = 1$) and four (7.1 %) blood transfusions. Complications within the first 30 days included urinary tract infections (1.7 %), urinary retention (3.6 %), and delayed bleeding (7.1 %). These complications were managed conservatively. At 12-month follow-up, median QoL [5 (IQR 3.75–5) vs. 1 (IQR 1–2)], IPSS [21.5 (IQR 15.5–23.75) vs. 5 (IQR 3–8)], Qmax [7.7 (IQR 6.3–10) vs. 28.3 (IQR 21.25–39.2) ml/s], and postvoiding residual urine [100 (IQR 46–200) vs. 17.5 (IQR 0–36) ml] improved significantly ($p < 0.002$).
Conclusions Thulium VapoEnucleation of the prostate seems to be a safe and efficacious procedure for the treatment of symptomatic BPO in patients at high cardiopulmonary risk on OA.

Keywords Benign prostatic obstruction (BPO) · VapoEnucleation · Tm:YAG · Revolix · ThuVEP · Anticoagulants

Introduction

Transurethral resection of the prostate (TURP) is considered to be the most established surgical treatment of benign prostatic obstruction (BPO) [1]. TURP is associated with a perioperative hypercoagulability state with an overall 8 % incidence of deep venous thrombosis after TURP [2, 3]. Therefore, withdrawal of anticoagulant therapy has been considered to be a strict contraindication to TURP, although some investigators have performed TURP on anticoagulated patients with no increase in morbidity [4, 5]. On the other hand, a generally aging population leads to an increased cardiovascular risk with concomitant use of oral anticoagulants (OA) [6]. As minimally invasive alternatives to TURP [1, 7], photoselective vaporization of the prostate (PVP) and holmium laser enucleation of the prostate (HoLEP) have been applied safely and efficiently

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to patients at high cardiopulmonary risk [6, 8] and on OA [7–9]. Thulium VapoEnucleation of the prostate (ThuVEP) has been currently introduced showing promising results as a minimally invasive, size-independent treatment modality of BPO [10, 11]. We evaluated the safety and efficacy of ThuVEP in patients on OA.

Materials and methods

Fifty-six patients on OA underwent ThuVEP for symptomatic BPO between May 2009 and June 2011 at two institutions, presenting with a median American Society of Anesthesiology score of 3 [interquartile range (IQR) 2–3]. Study inclusion criteria were a maximum urinary flow rate (Qmax) < 15 ml/s and international prostate symptom score (IPSS) ≥ 7, while patients with urodynamically diagnosed neurogenic bladder, prostate cancer (PCa), previous prostatic, or urethral surgery were excluded from the study. Perioperative continuation of OA was based on cardiology consultation according to the indications for OA therapy and the degree of thromboembolic risk (Table 1). Preoperative evaluation included a digital-rectal examination (DRE), transrectal ultrasound (TRUS), uroflowmetry, postvoiding residual urine (PVR), IPSS, Quality of life (QoL), PSA, blood analysis, coagulation parameters, and urine analysis. In patients with suspect age-specific PSA values or suspect DRE, a 12-core needle biopsy of the prostate was carried out.

The ThuVEP procedures were performed by three surgeons (AJG, TB, TRWH). ThuVEP was carried out using a 2 μm continuous wave 120 Watt Tm:YAG laser (RevoLix®, LISA Laser products, Katlenburg, Germany) as energy source. Laser energy was delivered through a 550 μm optical core bare-ended, re-usable RigiFib™ laser fibre. The procedure was performed using a 26F continuous-flow laser resectoscope in combination with a mechanical tissue morcellator. All interventions were carried out using normal saline as irrigation fluid with the patient under general anesthesia. The technique of ThuVEP has been previously reported in detail and was performed at both institutions using this standardized approach [10, 11]. At the end of surgery, a 22F foley catheter was placed in situ.

Blood loss was estimated by comparing the hemoglobin value 1 day before surgery with the corresponding value on the first postoperative day. Patients were discharged after removing the catheter and when the patients were able to void adequately. Patients were invited for a follow-up visit 12 and 24 months after surgery and re-assessed with Qmax, PVR, IPSS, QoL, and PSA.

Statistical analysis was performed using the calculating program Statistical Package for Social Sciences (SPSS, Inc., Chicago, IL., version 11.5.1) for Windows. Patient data were expressed as median (IQR). Differences between the groups were assessed using the Kruskal–Wallis test, while improvement in the assessed parameters in each group was calculated using the paired t test. A two-sided p value <0.05 was considered statistically significant. All patients gave their informed consent prior to their inclusion in the study.

Results

Table 1 lists indications for OA therapy and Table 2 perioperative data, respectively. Thirteen (32.2 %) patients

Table 1 Indications for oral anticoagulant therapy

Indication[a]	Aspirin ($n = 32$)	Clopidogrel or aspirin + clopidogrel ($n = 8$)	Phenprocoumon ($n = 16$)	Total ($n = 56$)
Ischemic heart disease (n)	13	7	7	27
Chronic atrial fibrillation (n)	2	1	8	11
Myocardial infarction (n)	7	5	2	14
Carotid arterial stenosis (n)	6		1	7
Peripheral arterial occlusive disease (n)	4	2	1	7
Apoplexy (n)	3		1	4
Cardiac pacemaker (n)	2	1	6	9
Coronary bypass (n)	5	2	2	9
(Drug eluting) coronary stent (n)	9	5	–	14
Congestive heart failure (n)	3	2	2	7
Deep venous thrombosis/ pulmonary embolism (n)	–	–	4	4
Prosthetic heart valves (n)	2	–	5	7
Aortic aneurysm (n)	1	–	–	1

[a] More than one indication in some patients

presented in urinary retention and were not able to void without a catheter. Twenty-six (46.4 %) patients had a prostate volume ≥50 cc, with 12 (21.4 %) have glands of ≥80 cc, respectively. The ThuVEP procedure was successfully completed in all patients. The catheter was routinely removed 48 h after ThuVEP regardless of preoperative prostate size.

Tables 3 and 4 list adverse events. Four (7.1 %) patients developed an episode of clot retention within the immediate postoperative period requiring manual bladder irrigation. Four patients (7.1 %) with persistent hematuria and clot retention had a cystoscopy with electrocauterization of bleeders and evacuation of a bladder tamponade and four (7.1 %) required blood transfusions. After discharge, four patients (7.1 %) had clot retention and required rehospitalization for manual/continuous bladder irrigation after a median of 9.5 (9–13.75) days. These patients were all managed conservatively. Three patients had an urge incontinence (5.4 %), and one patient had stress urinary incontinence postoperatively (1.7 %). Complete remission of incontinence was achieved in all patients within 6 months after surgery with conservative treatment.

Two patients died of colorectal cancer and apoplexy during follow-up, respectively. Thirteen patients did not respond since they lived abroad or were unwilling to be followed. Six patients with incidental PCa were excluded from analysis. Follow-up was available for 35 (62.5 %) after 12 and 13 (23.2 %) patients after 24 months. IPSS, QoL, Qmax, and PVR improved significantly at 12-month follow-up ($p < 0.002$) (Table 5). PSA decreased from 3.44 (IQR 1.82–9.34) to 0.95 (IQR 0.56–1.62) µg/l at 12-month follow-up, corresponding to a median PSA reduction of 81.04 % (IQR 64.9–88.4).

Discussion

A generally aging population leads to an increased cardiovascular risk with concomitant use of OA [6], and thus, more patients requiring surgical treatment for BPO are on OA therapy [12]. Some investigators have performed TURP on coumarin derivatives [4], full heparinization [5], low molecular weight heparin (LMWH) substitution [13], or antiplatelet agents [14], but failed to provide acceptable safety with blood transfusion rates up to 33 % (Table 6). However, even withdrawal of OA for secondary prevention remains a controversial issue: Raj et al. [15] found no increased risk of perioperative complications, while cessation of OA resulted in an increased rate of cardiovascular and cerebrovascular complications after TURP in an other series [14]. Various, more minimally invasive, methods have been developed for the treatment of BPO:

Table 2 Baseline characteristics and perioperative data

Characteristics	Aspirin ($n = 32$)	Clopidogrel or aspirin + clopidogrel ($n = 8$)	Phenprocoumon ($n = 16$)	Total ($n = 56$)	p value[a]
Age (years)	75.5 (69.5–79)	69 (65–73)	75.5 (71–78.5)	75 (69–79)	0.175
ASA score	3 (2–3)	3 (2–3)	3 (2–3)	3 (2–3)	0.909
Prostate volume (ml)	55 (35–80)	34.5 (27.75–69.5)	50 (37.5–75.25)	50 (34–76)	0.385
PSA (ng/ml)	3.53 (1.58–7.33)	1.28 (0.75–3.48)	4.04 (2.35–6.06)	3.42 (1.55–5.97)	0.195
INR/Quick (%)	–/–	–/–	1.91 (1.43–2.62)/40 (28–70.75)	–/–	
Operation time (min)	55.5 (35.25–91.5)	60 (36–88.75)	77.5 (55–122.5)	61.5 (40–100.75)	0.188
Resected tissue (g)	32 (26.5–44.75)	16 (10–62)	42.5 (18.5–59.75)	32 (20–50)	0.330
Preoperative hemoglobin (g/dl)	13.75 (13–15.3)	14.73 (13.55–15.75)	13.4 (11.95–15)	13.85 (12.78–15.3)	0.212
Hemoglobin decrease (g/dl)	1.15 (0.68–1.83)	1.95 (0.4–2.75)	1 (0.43–2.23)	1.15 (0.58–2.08)	0.615
Catheterization time (days)	2 (2–3)	2 (2–3)	2 (2–3)	2 (2–3)	1.000
Postoperative hospital stay (days)	4 (3–5)	5 (2–6)	4 (3–5)	4 (3–5)	0.459

Data indicated as median (interquartile range)

ASA American Society of Anesthesiology, *INR* international normalized ratio

[a] Subgroup comparison

Table 3 Intraoperative and postoperative complications

Complications	Aspirin ($n = 32$)	Clopidogrel or aspirin + clopidogrel ($n = 8$)	Phenprocoumon ($n = 16$)	Total (%) ($n = 56$)
Intraoperative complications				
Superficial bladder injury due to morcellation[a]	1	–	–	1 (1.7)
Postoperative complications				
Blood transfusions	2	1	1	4 (7.1)
Transient urge incontinence	1	–	2	3 (5.4)
Transient stress incontinence	–	–	1, Grade II	1 (1.7)
Clot retention without surgical revision	–	3	3	6 (10.7)
Acute urinary retention requiring re-catheterization	–	–	2	2 (3.6)
Residual prostate adenoma[d]	1	–	–	1 (1.7)
Hemorrhage requiring coagulation[d]	3	–	1	4 (7.1)
Overall immediate re-operation rate	4	–	1	5 (8.9)
Readmission[b]				
Clot retention (without surgical revision)	–	1	3	4 (7.1)
Acute urinary retention requiring re-catheterization	–	2	–	2 (3.6)
Urinary tract infection	–	1	–	1 (1.7)
Complications at 12-month follow-up				
Surgical re-intervention	–	–	–	0 (0)
Death unrelated to ThuVEP procedure	1	–	1	2 (3.6)[c]
Cumulative incidence of UTI during follow-up	4	2	1	7 (12.5)
Complications at 24-month follow-up				
Surgical re-intervention	–	–	–	0 (0)

ThuVEP Thulium VapoEnucleation of the prostate, *UTI* urinary tract infection

[a] Treated effectively with prolonged catheterization, [b] within the first 30 days postsurgery, [c] died of colorectal cancer/apoplexy, [d] performed as electrocautery transurethral resection/coagulation of the prostate

HoLEP has been considered to be a size-independent method [7], while elevated re-treatment rates of PVP might advocate this technique to smaller-sized glands [7, 16, 17]. PVP and HoLEP have been applied to patients at high cardiopulmonary risk [6, 8, 9, 18, 19] on OA [6, 8, 9, 19–24] effectively (Table 6). ThuVEP is known as a minimally invasive, size-independent treatment modality, using a comparable approach as HoLEP [10, 11]. The safety and efficacy of ThuVEP in patients on OA has been shown, but follow-up data have not been given so far [25] (Table 6).

We provide the first 12- and 24-month follow-up data of ThuVEP in patients with symptomatic BPO on OA showing significant relief of obstructive symptoms, in accordance with HoLEP [7, 8], TURP [1, 7], PVP [6, 7, 9, 16, 17, 19, 20, 22–24], and previous ThuVEP series [10, 11]. The median PSA reduction of 81.04 % 12 months after ThuVEP confirms complete removal of the prostatic adenoma, comparable with HoLEP (82.7 %) [8, 26]. In contrast, PSA decrease was 44 % at 24-month follow-up after PVP [9], which is lower than in HoLEP [8, 26] and this ThuVEP series. However, the need of a complete dissection of the adenoma in patients at high cardiopulmonary risk on OA is debatable.

This ThuVEP series showed a low incidence of perioperative complications in consideration of the high cardiopulmonary risk of the patients on OA. The transfusion (7.1 %) and re-intervention rates (7.1 %) in this series were lower than in TURP [4, 5, 13, 14], and even lower than in HoLEP (Table 6). Elzayat et al. [8] and Tyson and Lerner [21] reported a transfusion rate of 9.6 % and zero with an immediate re-intervention rate of 3.6 and 7.9 % after HoLEP, respectively. However, international normalized ratio (INR) was subtherapeutic in patients on coumadin in the series by Tyson et al. when compared with Elzayat et al. [8] and our series. Currently, Martin et al. [27] reported a transfusion rate of 6.7 % after HoLEP. Of these patients, six were on OA before surgery

Table 4 Analysis of complications according to the modified Clavien classification system [30]

Complication	Treatment	Aspirin ($n = 32$)	Clopidogrel or aspirin + clopidogrel ($n = 8$)	Phenprocoumon ($n = 16$)	Total (%) ($n = 56$)
Clavien grade 1 complications ($n = 15$ of 56; 26.8 %)					
Urinary retention after catheter removal	Bedside recatheterization	–	2	2	4 (7.1)
Clot retention without surgical revision	Bladder irrigation (prolonged) and tamponade evacuation through catheter	–	4	6	10 (17.9)
Superficial bladder injury due to morcellation	No special therapy	1	–	–	1 (1.7)
Clavien grade 2 complications ($n = 11$ of 56; 19.6 %)					
Postoperative hematuria	Blood transfusions	2	1	1	4 (7.1)
Urinary tract infection	Antibiotics	4	2	1	7 (12.5)
Clavien grade 3b complications ($n = 5$ of 56; 8.9 %)					
Residual prostate tissue	Secondary apical resection	1	–	–	1 (1.7)
Hemorrhage/ clot retention	Cystoscopy with clot evacuation, coagulation of prostate fossa	3	–	1	4 (7.1)

Table 5 Baseline and follow-up data

	Qmax (ml/s)	PVR (ml)	IPSS	QoL
Preoperative	7.7 (6.3–10)[a]	100 (45–200)[a]	21.5 (15.5–23.75)	5 (3.75–5)
At discharge[b]	21.25 (17.3–24.33)	30 (10–40)	NA	NA
p value	<0.001	<0.003		
12 months[b]	28.3 (21.25–39.2)	17.5 (0–36)	5 (3–8)	1 (1–2)
p value	<0.001	<0.002	<0.001	<0.001
24 months[b]	30.5 (21.25–40.63)	11 (0–27.5)	5 (3.5–9)	1 (1–2.5)
p value	<0.001	<0.001	<0.001	<0.001

Data indicated as median (interquartile range)

IPSS international prostate symptom score, *QoL* quality of life, *Qmax* maximum urinary flow rate, *PVR* postvoiding residual urine, *NA* not analyzed

[a] Except those in urinary retention. [b] Compared with preoperative baseline

and two patients were on OA during surgery. Mean prostate volume was 147 ml and resected tissue 101 g in those patients who required transfusions [27]. Therefore, differences in preoperative prostate volume might contribute to different blood transfusion rates in HoLEP [8, 21, 27] and in ThuVEP (Table 6). Hemoglobin decrease in this ThuVEP series (1.15 g/dl) and in HoLEP (1.3 g/dl) [8] was higher than in PVP (0.2–0.9 g/dl) [6, 19, 24] (Table 6). PVP provides an almost bloodless procedure in patients on OA without the need of blood transfusions except in one series (2 %) [22], when compared with HoLEP [8, 21], ThuVEP [25], and TURP [4, 5, 13, 14]. However, INR was only therapeutic in two series during PVP in patients on coumarin derivatives [6, 9] (Table 6). Four patients (7.1 %) required rehospitalization for manual/continuous bladder irrigation in this series as in

Table 6 Incidence of complications after ThuVEP, HoLEP, PVP, and TURP in anticoagulated patients

Citations	[4]	[5]	[13]	[14]	[6]	[20]	[9]	[19]	[22]	[24]	[23]	[18]	[8]	[21]	[25]	–
Intervention	TURP	TURP	TURP	TURP	PVP	PVP	PVP	PVP	PVP	PVP	PVP	HoLEP	HoLEP	HoLEP	ThuVEP	ThuVEP
Study design	R	R	R	R	P	R	P	P	R	R	R	NA	R	R	R	R
Single-, two-, multi-center study	S	S	S	M	T	S	T	S	S	S	S	S	S	S	S	T
No. of surgeons (*n*)	NA	NA	NA	NA	4	NA	NA	3	1	NA	NA	NA	1	1	NA	3
No. of patients	12	11	20	7	66	24	116	128	162	60	43	40	83	38	39	56
No. full anticoagulation	12	11	–	7	26	16	116	62	162[h]	30	43	?	14	38	36	56
Aspirin	–	–	–	6	10	14	71	15[c]	101	NA	–	NA	–	25	19	32
Clopidogrel	–	–	–	1	–	2	9	?	19	NA	–	NA	–	–	6	8
Coumadin/warfarin (mean INR)	12 (2.3)	–	–	–	16 (2.5)	–	36 (2)	47 (–)	31 (–)	NA (1)	43 (–)	NA	14 (2)	13 (1.5)	5 (–)	16 (1.9)
Full heparinization	–	11[a]	–	–	–	–	–	–	–	–	–	NA	–	–	–	–
Stopped temporarily	–	–	–	–	–	8	–	–	–	30	–	NA	33	–	–	–
LMWH substitution (mean INR)	–	–	20 (-)	–	–	–	–	–	–	–	–	NA	34 (1.25)	–	6 (-)	–
Prostate volume (ml)	NA	23.2	NA	NA	49	82	62	62.5	91	34.1	75.3	NA	82.4	57.7	50.3	50[e]
Resected weight (g)	22	NA	26	17	–	–	–	–	–	–	–	NA	54.7	NA	NA	32[e]
Hb decrease (g/dl)	NA	1.6	1.2	NA	0.9	1.7[d]	NA	0.2	1.94	0.5	NA	0.2	1.3	NA	1.2	1.15[e]
Catheterization time (days)	NA	NA	3.2	NA	1.8	1[b]	1.8	1	NA	1	14[f]	NA	2.2	2.1	4.8	2[e]
Clot retention/bleeding	NA	NA	2 (10)	6 (8.6)	0 (0)	0 (0)	0 (0)	0 (0)	8 (4.9)	0 (0)	3 (7)	NA	5 (6)	0 (0)	2 (5.1)	6 (10.7)
Bleeding requiring reoperation	NA	NA	0 (0)	NA	0 (0)	0 (0)	0 (0)	0 (0)	1 (0.6)	0 (0)	0 (0)	1 (2.5)	3 (3.6)	3 (7.9)	0 (0)	4 (7.1)
No. transfusion	4 (33)	1 (9.1)	4 (20)	2 (28.6)	0 (0)	0 (0)	0 (0)	0 (0)	3 (2)	0 (0)	0 (0)	2 (5)	8 (9.6)	0 (0)	1 (2.6)	4 (7.1)
Full anticoagulation	4 (33)	1 (9.1)	–	2 (28.6)	–	–	–	–	3 (2)	–	–	NA	2 (14.3)	–	1 (2.6)	4 (7.1)
Full heparinization	–	1 (9.1)	–	–	–	–	–	–	–	–	–	NA	–	–	–	–
Stopped temporarily	–	–	–	–	–	–	–	–	–	–	–	NA	1 (3)	–	–	–
LMWH substitution	–	–	4 (20)	–	–	–	–	–	–	–	–	NA	5 (14.7)	–	–	–
No. readmission for bleeding	NA	3 (27.3)	0 (0)	3 (42.9)	0 (0)	0 (0)	0 (0)	0 (0)	6 (3.7)	0 (0)	1 (2.3)	NA	3 (3.6)	0 (0)	5 (12.8)	4 (7.1)
Follow-up (months)	NA	NA	3	NA	12	12	12	12	12	3	3	–	12	3	NA	12
No. of patients at 12-month follow-up	NA	NA	NA	NA	51 (77)	11 (46)	51 (44)	119 (93)	86 (53)	NA	27 (63)	–	83 (100)	0 (0)	NA	35 (63)
Reoperation for residual tissue	NA	NA	NA	NA	0 (0)	0 (0)	2 (1.7)[g]	0 (0)	3 (2)	0 (0)	0 (0)	–	0 (0)	0 (0)	NA	0 (0)
Bladder neck contracture	NA	NA	NA	NA	1 (1.5)	0 (0)	2 (1.7)[g]	0 (0)	0 (0)	0 (0)	0 (0)	–	1 (1.2)	0 (0)	NA	0 (0)
Urethral stricture	NA	NA	NA	NA	0 (0)	0 (0)	6 (5.2)[g]	5 (3.9)	0 (0)	0 (0)	0 (0)	–	1 (1.2)	0 (0)	NA	0 (0)

Table 6 continued

Citations	[4]	[5]	[13]	[14]	[6]	[20]	[9]	[19]	[22]	[24]	[23]	[18]	[8]	[21]	[25]	–
PSA decrease at follow-up (%)	NA	NA	NA	NA	NA	NA	44 [g]	NA	NA	NA	NA	–	82.7	NA	NA	81.04[e]
ASA score	NA	NA	NA	2[e]	≥3	2.4	2.6	≥3	3[e]	NA	3	–	NA	NA	2.9	3[e]

Data given as no. (%) or mean unless otherwise indicated

ASA American Society of Anesthesiologists, *LMWH* low molecular weight heparin, *Hb* hemoglobin, *INR* international normalized ratio, *S* single center, *M* multi-center, *T* two-center, *P* prospective, *R* retrospective

[a] Activated partial thromboplastin time = 1.7; [b] $n = 92$ % of the patients; [c] thrombocyte aggregation inhibitors (aspirin/clopidogrel) not specified; [d] decrease in hematocrit; [e] median; [f] hours; [g] at 24 months; [h] including 11 patients with ≥ 2 anticoagulant agents

HoLEP [8], which is higher than in PVP [6, 9, 19, 20, 22–24]. These differences in bleeding complications may be attributed to the specific properties of the laser types and the surgical approaches (vaporization or enucleation): the pulsed Ho:YAG and the continuous wave Tm:YAG laser have wavelengths of 2,100 and 2,013 nm with a penetration depth (i.e., the coagulation zone) of 0.4 and 0.2 mm, while the KTP laser has a wavelength of 532 nm with a penetration depth of 0.8 mm [28].

The rate of other complications in this ThuVEP series was low. Acute urinary retention requiring recatheterization was necessary in 4 (7.1 %) patients, which is in line with HoLEP [7, 8, 21], TURP [7], and PVP [6, 9, 19, 20, 22–24]. The immediate re-intervention rate of 8.9 % mainly consisted of those 4 patients with bleeding complications in our series, while 1 patient (1.7 %) had a residual adenoma at the apex of the prostate fossa, which is comparable with HoLEP [7], TURP [7], and PVP [6, 7, 9, 19, 20, 22–24]. A superficial bladder injury during morcellation occurred in one patient (1.7 %) in this ThuVEP series, comparable with HoLEP (0.5–18.2 %) [29]. The rate of urinary infections (UTI) at 12-month follow-up was 12.5 % in this ThuVEP series and slightly higher when compared with HoLEP (3.6–10.5 %) [8, 21] and PVP (0–9.3 %) [6, 9, 19, 20, 22–24]. Reasons for the high incidence of UTI in our study may be explained by the high number of patients in urinary retention before surgery. Also, antibiotic prophylaxis was not given routinely during hospital stay in patients with negative urine testing, and the rate of secondary interventions within the first 30 days (8.9 %) was considerable. However, in one HoLEP and one PVP series, the UTI rates were 10.5 % [21] and 9.3 % [24] at 3-month follow-up, respectively.

None of our patients required a surgical re-intervention for prostatic tissue, bladder neck contractures (BNC), or urethral strictures during follow-up. To note, there are only few studies that have assessed a 1-year follow-up in patients at high cardiopulmonary risk on OA after PVP and HoLEP (Table 6). The re-intervention rates for prostatic tissue were ranging from 0 to 2 % [6, 9, 19, 20, 22] for PVP, while 0–1.7 % (0–5.2 %) of the patients after PVP [6, 9, 19, 20, 22] and 1.2 % (1.2 %) [8] after HoLEP developed BNC (urethral strictures).

The limitations of our results lie within the non-randomized retrospective study design, the possible bias when reporting own complications, and the bias seen in any tertiary care referral center population. Prospective multicenter studies may be more appropriate to assess the surgical outcome and complication rates of HoLEP, PVP, and ThuVEP in patients on OA. However, it would be difficult to receive an institutional approval for a prospective randomized trial where patients under OA were randomized to TURP or laser prostatectomy.

Conclusions

Thulium VapoEnucleation of the prostate seems to be a safe and efficacious treatment modality in patients with symptomatic BPO at high cardiopulmonary risk on OA. Larger prospective series are required to confirm these promising results. ThuVEP decreases the risk of hemorrhage in patients on OA when compared with TURP.

Conflict of interest The authors have nothing to disclose.

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