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INVITED REVIEW

Recent evidence for anatomic endoscopic enucleation of the prostate (AEEP) in patients with benign prostatic obstruction on antiplatelet or anticoagulant therapy

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Abstract

Introduction Due to demographic changes in today's society, the number of patients with lower urinary tract symptoms (LUTS) due to benign prostatic hyperplasia (BPH) is increasing. Similarly, the proportion of patients with cardiovascular risk factors undergoing antiplatelet (AP) or anticoagulation (AC) therapy is growing as well.

Methods This review discusses the current literature on various techniques used for anatomic endoscopic enucleation of the prostate (AEEP) in patients on AC/AP therapy.

Results The large number of energy sources used for AEEP makes it difficult to compare them. Overall, fewer bleeding-associated complications arise in patients under AP compared to AC or bridging therapy with low molecular weight heparin. However, perioperatively both AP and AC therapy lead to a higher risk of bleeding complications compared to patients not taking anticoagulants.

Conclusions The literature shows that AEEP is possible and efficacious in patients under AC/AP therapy, with only slight differences compared to patients not taking AC/AP drugs, on a short and long-term basis. Nevertheless, the sparse data, the retrospective nature of many studies and the inclusion of prostate sizes between 50 and 110 ml only, make it difficult to come to strong conclusions.

Keywords Benign prostatic obstruction · BPO · Enucleation · Oral anticoagulation · Transurethral enucleation

Introduction

Holmium laser enucleation of the prostate (HoLEP) was initially described in 1998 [1]. HoLEP has proven to be a minimally invasive, size-independent method for the treatment of benign prostatic obstruction (BPO) with excellent long-term results [2, 3]. Based on HoLEP, alternative techniques for anatomic endoscopic enucleation of the prostate (AEEP) using different energy sources have been described [4]. The surgical management of BPO by AEEP is hindered by an increasing use of chronic oral anticoagulant (AC) and/or antiplatelet (AP) therapy for primary and secondary prevention of cardiovascular diseases [5–7]. Perioperative management of AC/AP therapy is a matter of debate: only sparse data exist for AEEP in patients on AC/AP therapy [8]. This review focuses on the literature regarding all AEEP techniques, to assess the safety, efficacy and durability of these procedures in patients on AC/AP therapy, and to further elucidate their potential advantages and limitations.

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Materials and methods

Data collection was based on a PubMed search of papers published in the English language from 1998 until September 2020 assessing the impact of intraoperative AC/AP therapy on patients undergoing AEEP for BPO. All retrospective and prospective cohort studies, and randomized controlled trials (RCT) were assessed for possible inclusion (Table 1). Two authors (CN, BB) independently screened all articles.

HoLEP

The first HoLEP series with patients on AC/AP therapy was published in 2002 [9]. Nineteen patients were on oral AC therapy: none of the patients required blood transfusions, and 2 (10.5%) patients developed clot retention, which was managed conservatively. However, neither baseline nor follow-up characteristics of these 19 patients on AC therapy were presented or compared to those of the patients not taking AC therapy. Since then, several HoLEP studies on patients taking AC/AP drugs have been published [10–23] (Table 2). Most of the studies presented perioperative data [11, 12, 17–20, 22, 24] not exceeding 6-month follow-up [13, 14, 22], except four series with a longer follow-up [9, 10, 15, 20]. While AP therapy was continued [11–17, 19–24], AC therapy was bridged with low molecular weight heparin (LMWH) (Table 2). Only three studies evaluated HoLEP in patients under continuous AC therapy [9, 10, 12]. Highest transfusion rates were found in patients with LMWH bridging or under continuous AC therapy (up to 15%), while transfusion rates under AP therapy did not exceed 3% (Table 2). Postoperative clot retention occurred in 12.5% of the patients maximum, while reintervention rates (RR) were reported in 3.7% of the cases maximum. The feasibility and safety of HoLEP in patients on AC/AP therapy were shown in patients with prostate sizes up to 105.8 ml [9–23]. However, a comparison of these studies is hindered by non-reporting of complication rates (CR) and bleeding-related CR (Table 2).

AEEP

The definition "AEEP" was introduced by the EAU Guidelines in 2016 to group all surgical procedures used to perform an anatomical enucleation of the prostate, in spite of the energy source employed [3]. Since then, AEEP have been used in literature reviews for standardization purposes [4, 24, 25]. Although 45% of the HoLEP and 60% of the GreenLEP cases were on AP/AC therapy, bleeding complications were low. 4% of the patients in each group had postoperative hematuria, requiring blood transfusions in 4% of the HoLEP and in 1% of the GreenLEP patients. The Clavien 3b CR was 5% and 3% after HoLEP and GreenLEP, respectively. The 3-month readmission rate did not differ between the groups (9% vs. 4%) [14] (Tables 2/3).

ThuVEP

ThuVEP was described by Bach et al. in 2009 [26]. Hauser et al. presented the first ThuVEP series of 39 patients treated whilst on AC/AP therapy and/or with bleeding disorders. One patient (2.6%) received a blood transfusion. Two patients (5.1%) developed postoperative bladder tamponade, and 5 patients (12.8%) were re-operated due to postoperative bleeding. It remains unclear whether AEEP or a vaporesection procedure was performed [27] (Table 3).

Table 1 Search terms, inclusion and exclusion criteria of the review

Search terms

The search terms included: anatomic filter for "benign prostate hyperplasia" OR "BPH", "benign prostatic obstruction" OR "BPO", treatment filter for "AEEP " OR "anatomic enucleation of the prostate ", "holmium laser enucleation" OR "HoLEP", "ThuLEP " OR "thulium laser enucleation of the prostate ", "ThuVEP " OR "thulium vapoenucleation of the prostate ", "GreenLEP " OR "GreenLight laser enucleation of the prostate ", "PVEP " or "photoselective vapo-enucleation of the prostate ", "DiLEP " OR "diode laser enucleation of the prostate ", "PkEP " OR „Plasmakinetic enucleation of the prostate " "ELEP " OR "ERASER laser enucleation of the prostate ", "MoLEP " OR "Moses laser enucleation of the prostate ", "BipolEP " OR "bipolar enucleation of the prostate ", "PkERP " OR "plasmakinetic enucleation and resection of the prostate ", "ThuFLEP " or "thulium fibre laser enucleation of the prostate ", "MEP " OR "monopolar enucleation of the prostate ", patient filter for "anticoagulation", "anticoagulant", "antiplatelet" OR "antithrombotic"

Inclusion criteria

1. Patients had to be treated with an AEEP procedure for BPO
2. In single-arm series the antithrombotic group had to be clearly defined (continuous intake of AC/AP drugs)
3. In case–control studies, patients had to be divided into either an antithrombotic group (continuous intake of oral AC/AP) or a non-antithrombotic group (patients naïve to or who discontinued oral antithrombotic drugs)

Exclusion criteria

1. Non-reported clinical complications
2. Review articles or case reports
3. Studies with less than 10 patients on AP/AC treatment

Table 2 Holmium laser enucleation of the prostate (HoLEP) in anticoagulated patients ($n=1966$ patients on AC/AP therapy)

Citation	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]
No. of patients [*n*]	157	83	38	125	116	100	1124	963	2178	296	268	73	111	955	1816
Study design	RCS-SC	RCS-SC	RCS-SC	RCS-SC	RCS-SC	RCS-SC	RCS-SC	RCS-MC	RCS-CC	RCS-MC	RCS-SC	PRT	RCS-MP	RCS-MC	RCS-SC
No of. surgeons [*n*]	NA	1	1	1	1	1	2	NA	NA	NA	3	1	2	NA	7
No. full anticoagulation	19	14	38	52	30[a]	45	128	376	245	74	104	24	111	248	458
Aspirin	–	–	25	11	9	33	72	270	–	46	69	24	47	176	43
Clopidogrel	–	–	–	16	10	–	–	?	–	?	?	?	?	57	–
Aspirin + dipyridamol	–	–	–	3	1	–	56	?	–	?	?	–	14	26	–
Vitamin K (INR)/LMWH[c]	19 (2.7)/–	14 (2)/34	13 (1.5)/–	22 (2.6)/?	15 (1.5)/No	12 (–)/12	–	106 (?)/?	– (< 2)/151	–/28	–/13	–	–/13	3	–/135
NOAC	–	–	–	–	5[f]	–	–	–	94[f]	–	22[f]	–	30[f]	4	55[f]
Bleeding disorder	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–
Age [years]	69	76.6	69.4; 70.6	75.1	NA	67	70.8–72.4	72	71	69	70	65.96	75	70.4	71
Pat. urinary retention [%]	NA	39 (47)	NA	NA	NA	18 (18)	NA	343 (35.7)	846 (38.8)	NA	NA	30 (41.1)	35 (31.5)	NA	641 (35)
Prostate volume [ml]	–	82.4	57.7	NA	NA	70[d]	67.5–77.7	91[d]	70; 65	85	73	105.8	50	71.7	80
Operative time [min]	62	NA	150; 169	90.3	NA	90	NA	77	60.3	68	87.5	71.43	60	55.2	NA
Morcellation time [min]	–	20.1	NA	NA	13	NA	10.6–13.6	25	NA	NA	NA	NA	NA	9.6	10
Resected weight [g]	–	54.7	NA	28	55.5	48[d]	37–38	73[d]	NA	NA	51.3	81.98	34	23.2	50
Hb decrease [g/dl]	–	1.3	NA	1.6	NA	NA	0.97–1.6	1.15[d]	1.1; 0.9	1.5	–	0.337	NA	NA	1.2
Catheter time [days]	2	2.2	2.1	NA	0.68	1[d]	NA	1.3[d]	2; 2	1.5	2	18.2[e]	NA	1.4	2
Hospital stay [days]	NA	2.5	1.2	2	27.8[e]	1	1.3–1.4	4	4	3	NA	19.73[e]	NA	NA	NA
Clot retention/bleeding	2 (10.5)	5 (6)[b]	0 (0)	NA	NA	4 (4)[d]	1 (0.8)	6 (10.7)	16 (6.5)	?	10 (3.7)	0 (0)	0 (0)	9 (3.6)	NA
Bleeding: reoperation	0 (0)	3 (3.6)[b]	3 (7.9)	0 (0)	1 (3.7)	1 (1)[d]	0 (0)	NA	9 (3.6)	4 (1.4)	9 (3.4)	0 (0)	2 (1.8)	6 (2.4)	61 (3.3)

Table 2 (continued)

Citation	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]	[23]
No. transfusion	0 (0)	7 (8.4)	0 (0)	4 (7.7)	2 (6.7)	4 (4) [d]	1 (0.1)	48 (5) [d]	4 (1.6)	5 (1.7)	1 (0.4)	0 (0)	4 (3.6)	1 (0.4)	44 (2.4)
Aspirin	–	–	0 (0)	0 (0)	NA	NA		8 (3)	–		–				11 (2.4)
Clopidogrel	–	–	–	1 (6.3)	NA	NA		?	–		–				3 (7)
Aspirin + dipyridamol	–	–	–	1 (33.3)	NA	NA		?	–		–				–
Vitamin K/ LMWH	0 (0)	1(7)/5(15)	–	2 (9.1)	NA	NA		10 (9.4)	3 (2)		1 (7.7)				–/15(11)
NOAC	–	–	–	–	NA	NA		?	1 (1)		–				3 (5.5)
Readmission: bleeding	NA	3 (3.6)[b]	0 (0)	NA	NA	2 (2) [d]	0 (0)	NA	16 (6.5)	NA	NA	0 (0)	NA		NA
Complications	NA	1 (1.2)[b]	0 (0)	0 (0)	2 (1.6)	NA	NA	NA	NA	NA	1 (0.4)	NA	NA	1 (0.4)	NA
Myocardial infarction		1 (1.2)			1 (0.8)									1 (0.4)	
Urosepsis					1 (0.8)										
Death											1 (0.4)				
Follow–up [months]	24	12	3	NA	6	6	12	NA	3	2	NA	24	NA	6	NA
% patients at FU	NA	100	–	NA	33.3	–	NA	NA	–	NA	NA	100	NA	NA	NA
Urodynamic data (FU)	Yes	Yes	No	No	No	Yes	Yes	NA	Yes	NA	NA	Yes		NA	NA
Reop. residual tissue	NA	0 (0)	0 (0)	NA	NA	2 (2) [d]	0 (0)	NA	4 (1.6)	NA	NA	0 (0)	NA	0 (0)	NA
Bladder neck contracture	NA	1 (1.2)	0 (0)	NA	NA	0 (0)	11 (1)	NA	1 (0.4)	NA	NA	0 (0)	NA	1 (0.4)	NA
Urethral stricture	NA	1 (1.2)	0 (0)	NA	NA	0 (0)	0 (0)	NA	1 (0.4)	NA	NA	1 (1.4)	NA	3 (1.2)	NA
PSA [ng/ml] at FU (mos)	NA	1.45 (6)	NA	NA	0.7 (6)	0.73 (6)	NA	NA	NA	NA	NA	1.7 (24)	NA	NA	NA
ASA–Score	NA	NA	NA	3	NA	2	NA	NA	NA	NA	NA	NA	NA	NA	NA

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

FU, follow-up; RCS-SC, retrospective case series-single-center; RCS-MP, retrospective case series-matched paired, RCS-CC, case control; RCS-MC, retrospective case series-multicentric;

[a]Including combination therapy;

[b]Not clearly defined in which patients bleeding occurred; ASA, American Society of Anaesthesiologists; LMWH, low molecular weight heparin; Hb, haemoglobin; INR, international normalized ratio

[c]If switch to LMWH

[d]Not differentiated between with/without AP/AC regimen

[e]In hours; NA, not analysed; NOAC, new oral anticoagulants

[f]New oral anticoagulants stopped

Table 3 Different techniques for anatomic endoscopic enucleation of the prostate (AEEP) in anticoagulated patients

Citation	[14]	[42]	[43]	[44]	[27]	[5]	[28]	[29]	[30]	[32]	[37]	[46]	[18]
Technique	GreenLEP	GreenLEP	GreenLEP	PVEP	ThuVEP	ThuVEP	ThuVEP	ThuVEP	ThuVEP	ThuLEP	DiLEP	PkERP	BipolEP
No. of patients [*n*]	100	60	204	53	39	56	26	1382	88	412	49	91	142
Study design	RCS-SC	RCS-SC	RCS-SC	PRT	RCS-SC	RCS-SC	RCS-MP	RCS-MS	RCS-SC	RSC-SC	RCS-SC	RCS-SC	RCS-SC
No of. surgeons [*n*]	1	1	1	1	NA	3	3	NA	NA	NA	1	1	3
No. full anticoagulation	60	31	99	28	36	56	26	237	88	46	49	91	39
Aspirin	57	27	86 (AP)	11	19	32	16	NA	39	NA	38	56	24
Clopidogrel	–	2	–	–	6	8	3	NA	10, 4 (Ticlop.)	NA	5	3	–
Aspirin + clopidogrel	–	–	–	–	–	–	–	NA	–	NA	4	11	–
Vitamin K (INR)/ LMWH	3 (–)/3	2 (–) / 2	13 (–) / 13	– (?)/15	5 (NA)	16 (1.9)/–	7 (NA)/?	NA	35 (–)/35	NA	2 (NA)/–	15 (1.3)/15	15 (NA)/15
NOAC	–	–	–	–	–	–	–	NA	–	NA	–	*n* = 6 AP + AC	
Bleeding disorders	–	–	–	2	3	–	–	NA	–	NA	–		
Age [years]	67	68	68	74.1	71	75	73	NA	74.7	69.8	77.3	65	71
Pat. urinary retention [%]	18 (18)	12 (20)	18 (26)	23 (43.4)	NA	13 (32.2)	9 (34.6)	NA	21 (23.9)	91 (22.1)	NA	NA	NA
Prostate volume [ml]	100	100	100	83.3	50.3	50	62.5	NA	66.5	58	76.4	80.9	80
Operative time [min]	90	60	60	103	92	61.5	72	NA	65	55	77.9	66.87	115
Morcellation time [min]	NA	NA	5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Resected weight [g]	62	63	60	11.6	NA	32	43	NA	NA	NA	NA	NA	NA
Hb decrease [g/dl]	NA	NA	NA	0.74	1.2	1.15	1.5	NA	NA	1.1	1.49	0.74	1.5
Catheter time [days]	2	2	2	2.3	4.8	2	2	NA	2	2	3.5	1.14	2
Hospital stay [days]	1	2	2	1.5	5	4	NA	NA	3	3	8.7	1.79	4
Clot retention/bleeding	4 (4)	1 (1.6)	NA	4 (7.5)	2 (5.1)	6 (10.7)	1 (3.9)	NA	4 (4.5)	NA	2 (4.1)	2 (2.2)	NA
Bleeding: reoperation	1 (1)	2 (3.3)	9 (4.4)	1 (1.8)	0 (0)	4 (7.1)	1 (3.9)	13 (5.5)	2 (2.2)	5 (1.2)	0 (0)	0 (0)	NA
No. transfusion	1 (1)	1 (1.6)	1 (0.5)	1 (1.8)	1 (2.6)	4 (7.1)	1 (3.9)	0.9–14.9***	2 (2.2)	NA	1 (2)	2 (2.2)	4 (2.8)
Aspirin	–	–	–	–	NA	NA	NA	NA	NA	–	–	–	–
Clopidogrel	–	–	–	–	NA	NA	NA	NA	NA	–	–	–	–
Aspirin + dipyridamol	–	–	–	–	NA	NA	NA	NA	NA	–	–	–	–
Vitamin K/LMWH	0 (0)	–	–	–	NA	NA	NA	NA	NA	–	–	–	–
NOAC	–	–	–	–	NA	NA	NA	NA	NA	–	–	–	–
Readmission: bleeding	0 (0)	0 (0)	NA	NA	5 (12.8)	4 (7.1)	1 (3.9)	NA	NA	NA	2 (4.1)	3 (3.3)	NA
Complications	NA	NA	Cl I (5.4)	1 (1.8)	0 (0)	4 (7.1)	0 (0)	NA	4 (4.4)	3 (0.7; Cl. 4a)	0 (0)	0 (0)	Cl I (4.2)
Heart failure (edema)			Cl II (10.8)	–					1 (1.1)				Cl II (13.2)
Pulmonary edema			Cl III (4.4)	–					1 (1.1)				Cl III (1)
Myocardial infarction				–		2 (3.6)			1 (1.1)				
Urosepsis				1 (1.8)		2 (3.6)							
Death during FU				–		1 (1.8)			1 (1.1)				
Follow–up [months]	6	6	6	12	NA	12	6	NA	12	12	12	6	2

Table 3 (continued)

Citation	[14]	[42]	[43]	[44]	[27]	[5]	[28]	[29]	[30]	[32]	[37]	[46]	[18]
% patients at FU	–	NA	NA	100	NA	63	NA	NA	77.3	NA	NA	NA	NA
Urodynamic data (FU)	Yes	No	Yes	Yes	NA	Yes	Yes	No	Yes	Yes	Yes	Yes	No
Reop. residual tissue	0 (0)	0 (0)	0 (0)	2 (3.7)	NA	0 (0)	1 (3.9)	NA	2 (2.2)	NA	0 (0)	0 (0)	NA
Bladder neck contracture	0 (0)	0 (0)	0 (0)	0 (0)	NA	0 (0)	0 (0)	NA	1 (1.1)	NA	0 (0)	0 (0)	NA
Urethral stricture	0 (0)	0 (0)	3 (1.4)	0 (0)	NA	0 (0)	0 (0)	NA	1 (1.1)	NA	0 (0)	1 (1.1)	NA
PSA [ng/ml] at FU (mos)	NA	0.66 (6)	0.6 (6)[c]	45.9 (12)	NA	0.93	NA	NA	0.8 (12)	NA	NA	47 (6)[c]	NA
ASA-Score	0.6	NA		NA	2.9	3	NA	NA	2	NA	NA	NA	NA

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

FU, follow-up; RCS-SC, retrospective case series-single-center; RCS-MP, retrospective case series-matched paired, RCS-CC, case–control; RCS-MC, retrospective case series-multicentric

***depending on size of the prostate

[a]including combination therapy; ASA, American Society of Anaesthesiologists; LMWH, low molecular weight heparin; Hb, haemoglobin; INR, international normalized ratio; NA, not analysed; NOAC, new oral anticoagulants

[b]new oral anticoagulants stopped

[c]PSA reduction in %; GreenLEP, GreenLight laser enucleation of the prostate; PVEP, photoselective vapoenucleation of the prostate; ThuVEP; thulium vapoenucleation of the prostate; ThuLEP, thulium laserenucleation of the prostate; DiLEP, diode laser enucleation of the prostate; PKERP, plasmakinetic enucleation and resection of the prostate; BipolEP, bipolar enucleation of the prostate

Netsch et al. evaluated the safety of ThuVEP on 56 patients with high cardiopulmonary risk who were on AC/AP therapy at the time of surgery. Four patients needed blood transfusions (7.1%) and four patients (7.1%) required immediate re-operation. They also provided the first 24-month follow-up in high-risk patients, showing a significant relief of obstructive symptoms with a PSA-reduction of 81.04% during follow-up [5] (Table 3).

The same study group performed a retrospective matched-paired analysis on 26 patients on AC/AP therapy treated with ThuVEP. One patient each required either a blood transfusion or immediate re-operation due to bleeding or had postoperative clot retention. Urodynamic parameters were significantly improved at 6-month follow-up. One patient was re-treated for residual prostatic tissue [28] (Table 3).

Bach et al. prospectively analyzed 2648 patients from four urological departments who underwent TURP, GreenLight Vaporisation, or ThuVEP. 237 patients treated with ThuVEP were on AC/AP treatment. The transfusion rate was 5.5% for prostates < 40 ml, 0.9% for prostates between 40 and 80 ml and 14.9% for prostates > 80 ml. This paper was the first to present large "real life", multicentric, routine data from patients on AP/AC therapy who underwent ThuVEP. Bach stated that the learning curve and the influence of high-risk patients on perioperative bleeding and transfusion rates seem to be underestimated in RCT [29] (Table 3).

Castellani et al. retrospectively analyzed 88 patients treated with ThuVEP between 2015 and 2019 on AP/AC therapy. Clot retention (2.2%), blood transfusions (2.2%), reintervention (4.5%) and intensive care unit treatment (2.2%) were the most important complications. PSA drop and urodynamic improvements at 12-month follow-up were comparable to previous ThuVEP series. No differences in CR and functional outcomes after ThuVEP were found, regardless of AP regimens. Patients on LMWH also demonstrated comparable results [30] (Table 3).

ThuLEP

ThuLEP was described in 2010 by Herrmann and colleagues [31]. Castellani et al. retrospectively evaluated 412 patients who underwent en-bloc ThuLEP [32]: 46 patients were on AC/AP therapy at time of surgery. The Clavien I (9.2%), II (2.7%), III (1.2%), and IV (0.7%) CR was very low. Urodynamic parameters were significantly improved at 1-year follow-up. Vartak et al. reported a series of 109 high-risk patients who were treated with ThuLEP. Of these 109 patients, 19 were treated whilst on aspirin and 3 under the combination of aspirin and clopidogrel. Perioperative data were, however, not reported [33] (Table 3).

DiLEP

DiLEP was introduced by Buisan et al. using a 980-nm diode-pulsed laser at 100-W [34]. In most DiLEP papers, the 980-nm diode laser is utilized for DiLEP, showing significant RR compared to other lasers [35].

Zhang and co-workers published a RCT comparing DiLEP (1470-nm diode laser) with plasmakinetic resection of the prostate [36]. They also published a retrospective study comparing DiLEP (1470 nm diode laser) on 49 patients under AP/AC therapy with 95 patients not taking AP/AC therapy. No differences in terms of bleeding complications and perioperative data were reported. CR in patients on AP/AC therapy were: transfusions (2%), secondary bleeding (4.1%), clot retention (4.1%). No re-intervention was necessary in this high-risk group during follow-up. At 12-month follow-up, urodynamic parameters had improved significantly and were not different between the two groups [37] (Table 3).

GreenLEP

The first abstract on 180-W XPS GreenLEP was presented at the EAU 2010 [38]. The first paper was published in 2014 [39, 40] followed by a description of the surgical steps [41].

Misrai et al. presented a series of 60 consecutive GreenLEP surgeries, 31 of which were performed on patients under AP/AC therapy. Intraoperative conversion rate to TURP was 16.6%. Hematuria occurred in 5% of the patients. Transfusion rate was 1.6% and RR was 3.3%. At 6-month follow-up, urodynamic parameters had significantly improved. PSA-reduction was 67% [42]. In another study, 99 out of 204 patient were on AP/AC therapy. Overall CR was low: Clavien I, II, IIIa and IIIb CR were 5.4%, 10.8%, 0.98%, and 3.4%, respectively. Transfusion rate was 0.5%. Urodynamic parameters as well as PSA were significantly improved at 6-month follow-up [43] (Table 3).

PVEP

PVEP, using the 180-W XPS GreenLight laser, is less radical than GreenLEP due to its vapoenucleation. A RCT comparing PVEP with HoLEP was published in 2015 [44]. Of the 53 patients in the PVEP arm, 53% were on AP/AC therapy or had bleeding disorders at the time of surgery. A higher intraoperative conversion to TURP was found (24.5% vs. 4%) compared to HoLEP. Postoperative hematuria, blood transfusions, immediate reoperation due to bleeding were reported in 3.7%, 1.8% and 1.8% of the patients. The 1-year RR was 5.7%, which was not significantly different compared to HoLEP (4%). Micturition parameters after PVEP were non-inferior to HoLEP at 12-months, but the PSA drop was significantly lower after PVEP compared to HoLEP (45.9 vs. 82.6%) (Table 3).

BipolEP or PkEP

Since the first published RCT comparing HoLEP with PkEP in 2006 [45], a plethora of different acronyms describing BipolEP has been published [4, 18]. El-Shaer and colleagues published a retrospective analysis of 91 patients on AC/AP therapy who underwent plasmakinetic enucleation and resection of the prostate. The rate of blood transfusions, clot retention, and secondary hemorrhage was 2.2% each. At 6-month follow-up, micturition had improved significantly. PSA drop was only 47%, which indicated that removal of the adenomatous tissue was inferior with PkEP [46]. Boeri et al. compared HoLEP and BipolEP in patients on AP/AC therapy. In the BipolEP group, 15 patients were on AC and 24 on AP therapy. No significant differences between the study arms with regard to bleeding complications and 2-month IPSS were found. The transfusion rate was 2.8%. The Clavien I, II, and III CR was 4.2%, 13.3%, and 0.7%, respectively [18].

Other AEEP techniques

The principles of AEEP were first published in the 1980ies utilizing monopolar energy for MEP [47, 48]. Other AEEP techniques were: ELEP [49–51], ThuFLEP [52], and MoLEP [53–55]. However, no studies analyzing the impact of AC/AP therapy on perioperative MEP, ELEP, ThuFLEP or MoLEP outcomes have been published so far.

Conclusions

The main issues with most AEEP studies are that almost all of them have a retrospective study design or originate from a single center. Therefore, outcomes are almost exclusively based on procedures performed by expert hands.

In most of the studies, AP/AC therapy was not distinguished. This is a particular weakness for the analysis since in clinical routine aspirin is often not interrupted, whereas, phenprocoumon and new oral anticoagulants are bridged with LMWH. Although data show fewer bleeding-related complications in patients under AP therapy, compared to those under AC therapy and LMWH, these complications only count for prostate glands between 50 and 110 ml. Patients taking both AP and AC therapy are associated with increased bleeding complications.

However, all of the studies show that AEEP is feasible in patients under AC/AP therapy and that functional

results do not differ from those of patients not taking AC/AP therapy.

Authors' contributions Benedikt Becker 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. Becker: Project development, Data collection, Data analysis, Manuscript writing/editing. Herrmann: Manuscript writing/editing. Bozzini: Manuscript writing/editing. Berti: Manuscript writing/editing. Gross: Project development, Manuscript writing/editing. Netsch: Project development, Data collection, Data analysis, Manuscript writing/editing.

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Declaration

Conflict of interest Our research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest. The authors report no conflict of interest.

Ethics approval This is a review article, ethical approval is therefore not relevant.

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Availability of data and material The data is available for requests.

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