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REVIEW

All you need to know about "Aquablation" procedure for treatment of benign prostatic obstruction

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ABSTRACT

INTRODUCTION: In recent years, technological advances and new approaches have been developed for the treatment of benign prostatic obstruction (BPO) in order to reduce complications like bleeding, retrograde ejaculation and risk of infection while obtaining an adequate disobstruction. The most recent surgical approach introduced is the Aquablation system (PROCEPT BioRobotics, Redwood Shores, CA, USA). This intervention is a robotically guided system that uses high-velocity water jets in order to ablate prostatic tissue, with real-time ultrasound guidance. The aim of this review is to summarize the current evidence on Aquablation and its results, compared to the reported outcomes of the gold standard treatment, the transurethral resection of the prostate (TURP).

EVIDENCE ACQUISITION: A systematic review of the Literature was performed in June 2019 using Medline (*via* PubMed), Embase (*via* Ovid), and Cochrane databases. The studies that compared the Aquablation to the standard TURP were included. Moreover, a critical review of the single arm studies was conducted.

EVIDENCE SYNTHESIS: The results of this systematic review, based on a single RCT that compared Aquablation *vs*. TURP in prostates 30-80 cc in size, confirmed that Aquablation has at least a similar efficacy as TURP, but has a better safety profile, allows shorter resection times, and has a lower risk of retrograde ejaculation. Moreover, in some subcategories of patients (*e.g.*, when prostate volume is >50 cc) functional outcomes of Aquablation are better than those of TURP. Evidence from non-comparative clinical studies and from real life scenarios have confirmed that Aquablation may be used effectively for prostate volumes up to 150 cc.

CONCLUSIONS: The Aquablation procedure for the treatment of BPO allows high clinical efficacy with an excellent safety profile. For prostate volume 30-80 cc, comparative studies demonstrated that this procedure offers clinical results at least comparable to those of conventional TURP. Latest evidence showed that Aquablation may be used effectively for prostate volumes up to 150 cc. The major strengths are its high-speed resection time, low complication rate, and potential for sexual function preservation.

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KEY WORDS: Robotic surgical procedures; Transurethral resection of prostate; Prostate.

Introduction

Benign prostatic obstruction (BPO) is a widely diffused condition in patients over 50 years old, and is the main cause of lower urinary tract symptoms (LUTS). Over the years, many types of treatments have been developed and implemented in order to resolve the prostatic obstruction. Among them, transurethral resection of prostate (TURP), although developed in the 1960s, still

remains the minimally invasive gold standard treatment for prostates <80 mL.[1, 2] However, this surgical approach is not devoid of complications, which include bleeding, retrograde ejaculation, and an increased risk of infection.[1, 3]

In recent years, technological advances and new approaches have been developed in order to reduce the invasiveness of TURP (in terms of postoperative complications), maximizing the functional outcomes.[4, 5]

The most recent surgical approach to BPO is the Aquablation system (PROCEPT BioRobotics, Redwood Shores, CA, USA). This intervention is a robotically guided system that uses high-velocity water jets in order to ablate prostatic tissue, with real-time ultrasound guidance.[6, 7] The patient, under anesthesia, is placed in lithotomic position. A robotically guided handpiece containing a sapphire nozzle is used to direct a pressurized water jet.[8] The whole procedure is monitored in real time with biplanar transrectal ultrasound. After the procedure, correct hemostasis is obtained, either by electrocautery or via traction of the catheter balloon.[9] This type of procedure seems to offer some advantages: shorter resection time, high chance of avoiding retrograde ejaculation, and automation of the procedure thanks to robotic guidance (Figure 1).

The aim of this review is to summarize the current evidence on Aquablation and its results, compared to the reported outcomes of the gold standard treatment, TURP.

Evidence acquisition

Search strategy and article selection

After establishing an *a priori* protocol, a systematic electronic literature search was conducted in June 2019 using Medline (*via* PubMed), Embase (*via* Ovid), and Cochrane databases. The search strategy relied on the PICO (Patient–Intervention–Comparison–Outcome)[10] criteria, that is, on patients with lower urinary tract symptoms (P) who underwent Aquablation (I) or TURP (C) to evaluate surgical, perioperative, and functional outcomes (O). The following search terms were used: ("Prostatic Hyperplasia"[Mesh] OR prostat*) AND (aquablation OR aquabeam OR waterjet) AND ("Comparative Study" [Publication Type] OR compar* OR *versus* OR *vs.*).

The article selection proceeded in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines.

All studies reporting data of interest were collected. Only studies reporting the intraoperative, perioperative, and functional outcomes of both the procedures (Aquablation and TURP), were considered for inclusion.

Editorials, commentaries, abstracts, reviews, book chapters, and studies reporting experimental studies on animals or cadavers were excluded from the review. Two of the authors (EC and DA) independently reviewed the literature according to the inclusion and exclusion criteria. Title and abstracts were reviewed, in accordance with the inclusion criteria. After the screening, full text

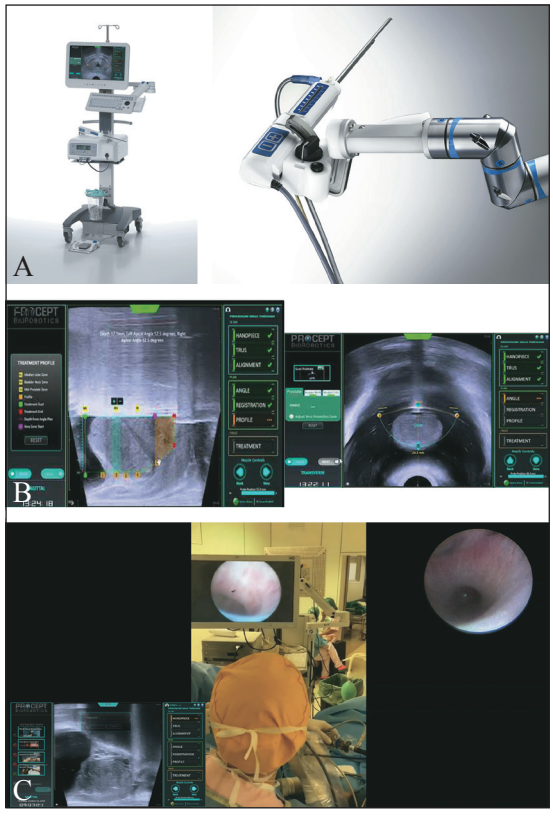

Figure 1.—A) Aquablation system conformal planning unit, console, and handpiece; B) Aquablation system display on CPU; C) Aquablation treatment is performed under ultrasound and transurethral endoscopic vision.

analysis was performed to confirm the selected articles' inclusion. References from the pooled articles were manually reviewed to identify additional studies of interest. Disagreements about eligibility were resolved by a third reviewer (CF) until consensus was reached.

Risk of bias assessment

The risk of bias and the quality of each included study were independently assessed using the standard Cochrane Collaboration risk-of-bias tool for single-arm studies,[11] and the Risk of Bias in Non-Randomized Studies - of Interventions (ROBINS-I) tool for comparative studies.[12]

Assessment of study quality

Study quality was assessed by the Newcastle-Ottawa scale (NOS) for non-randomized controlled trials (RCT),[13] with a total score of five or less being considered as low quality, 6-7 as intermediate quality, and 8–9 as high quality. The Jadad scale was used for RCT.[14] Studies were scored between zero (very poor quality) and five (rigorous quality).

Moreover, the level of evidence of each study was assessed according to the Oxford Centre for Evidence-Based Medicine 2011 Levels of Evidence.[15]

Data extraction and analysis

A dedicated data extraction form was used to collect the data of interest. Baseline demographics (age, Body Mass Index (BMI), PSA, International Prostate Symptoms Score (IPSS), IPSS-Quality of life (QoL), five items version of the International Index of Erectile Function (IIEF-5), maximum uroflow (Qmax), prostate volume, post voiding residual (PVR), perioperative variables (operative time, blood losses, complications, length of stay, duration of catheterization, retreatment), and functional outcomes (decrease in IPSS and PVR, improvement of IPSS-QoL, IIEF-5, Qmax, ejaculatory function assessed with Male Sexual Health Questionnaire – Ejaculatory Dysfunction (MSHQ-EjD)[16]) were recorded whenever available. Postoperative complications according to the Clavien-Dindo classification were analyzed.[17]

Papers excluded from the systematic analysis but considered highly interesting were analyzed and discussed separately to offer to the reader a comprehensive review of the current literature on this topic.

Evidence synthesis

The initial electronic search identified a total of 114 records.

After the removal of duplicates, we screened the titles and abstracts of the remaining 66 records, of which we excluded 60.

Only one study, reported in six records,[7, 18-22] ultimately met the inclusion criteria for the assessment of the review question. There were no ongoing studies that met the inclusion criteria, or that were relevant to the review question (Figure 2).

In fact, all the records included came from the same population, but with a different follow-up or different sub-analysis of reported outcomes.

Study quality and risk of bias assessment

The included RCT was found to be of "acceptable" quality (>3 points). Quality assessment and the level of evidence are also summarized in Table I.[7, 18-22]

The risk of bias assessment of the RCT included in our analysis was revealed to have an overall low risk of bias (Table II).[7, 18-22] Participants were blinded, but personnel (surgeons) were not blinded. We, therefore, rated the performance risk of bias as high.

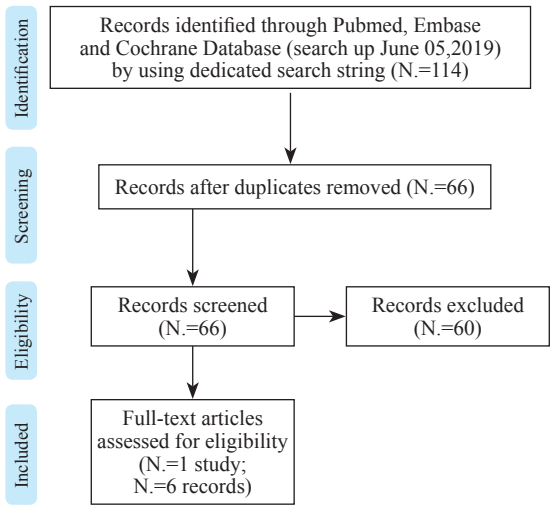

Figure 2.—PRISMA flow diagram.

TABLE I.—*Characteristics of included study and methodological assessment.*

Study	Year	Type of study	N. patients		Outcomes evaluated	SQ	LE
			Aquablation	TURP			
Water Study*	2018	Prospective	117	67	• Operative time • Resection time • Estimated blood losses • Intra\perioperative complications • Hospital stay • Catheterization time • Postoperative functional outcomes (continence, potency and ejaculation)	3†	1B

WATER Study: Waterjet Ablation Therapy for Endoscopic Resection of Prostate Tissue (ClinicalTrials.gov NCT02505919).
SQ: study quality; LE: level of evidence.
*All six included records[7, 18-22] referred to the same randomized controlled trial; †Jadad Scale for RCTs.

TABLE II.—*Risk of bias assessment for RCT.*

	Selection bias	Performance bias	Detection bias	Attrition bias	Reporting bias	Other bias
Water Study	Green	Red	Green	Green	Yellow	Green

Red: high risk of bias; green: low risk of bias; yellow: unclear risk of bias.
*All six included records[7, 18-22] refer to the same randomized controlled trial.

Focusing on reporting bias assessment, notwithstanding the availability of the protocol and the outcomes measured, the secondary outcomes were not prespecified. Therefore, we assigned a judgment of unclear risk of reporting bias.

Comparative outcomes

We identified only one RCT.[18] The population of this study was analyzed for the six records included in our review. WATER (Waterjet Ablation Therapy for Endoscopic Resection of Prostate Tissue) (ClinicalTrials.gov NCT02505919) is a prospective, double-blind, multicenter, international clinical trial comparing the safety and efficacy of Aquablation and TURP as surgical treatments of LUTS due to BPE in men 45 to 80 years old with a prostate between 30 and 80 g as measured by transrectal ultrasound, and with moderate-to-severe symptoms as indicated by IPSS.

In all six records we examined, the two study groups (Aquablation *vs*. TURP) were comparable in terms of patient and baseline characteristics (Table III).[7, 18-22]

Surgical and perioperative outcomes

In the first paper published on the WATER study, Gilling *et al.*[18] reported data from 116 patients who underwent Aquablation, and 65 who underwent TURP according to randomized allocation.

When they considered operative time as a pretreatment visualization to indwelling catheter insertion after resection was complete, no significant difference was found between the two groups (33 and 36 min, for Aquablation and TURP respectively; P=0.2752). Whilst a statistically significant difference was revealed if the time of resection from first pedal activation to the end of pedal use was considered (4 min for Aquablation *vs*. 27 min for TURP, P<0.0001), resection time strongly depended on prostate size. With Aquablation, time increased at 0.04 minutes per additional gram, whilst with TURP it increased at 0.3 minutes per additional gram.

Kasivisvanathan *et al.*[20] recently reported the same outcomes in a subgroup analysis of the patients enrolled in the WATER protocol in USA. In this subpopulation not only the resection time, but also the operative time, resulted in being significantly shorter for Aquablation than TURP (P<0.0001 and P=0.0037, respectively).

Hemoglobin change was 1.9 and 1.0 for Aquablation and TURP respectively (P=0.0002).[18] Again, different findings were reported in the USA population; no difference in hemoglo-

TABLE III.—*Baselines characteristics of the patients included in the studies of our analysis.*

Outcomes	Gilling[7, 18, 21]	Pimentel*[19]	Kasivisvanathan[20]	Plante†[23]
Age, mean (SD); years		66.2 (7.5)		
• Aquablation	66 (7.3)	65 (7.5)	64.5 (7.4)	66 (7.3)
• TURP	65.8 (7.2)		65.3 (7.1)	65.8 (7.2)
BMI, mean (SD)		28.7 (4.5)		
• Aquablation	28.4 (4.1)	27.4 (4)	28.2 (4.3)	28.4 (4.1)
• TURP	28.2 (4.5)		29.6 (4.8)	28.2 (4.5)
PSA, mean (SD); ng/mL		3.3 (2.5)		
• Aquablation	3.7 (3.0)	3.5 (1.9)	3.5 (3.2)	3.7 (3.0)
• TURP	3.3 (2.3)		2.9 (2.3)	3.3 (2.3)
IPSS, mean (SD)		23.7 (6.1)		
• Aquablation	22.9 (6.0)	21.9 (6.4)	22.1 (6.2)	22.9 (6.0)
• TURP	22.2 (6.1)		21.7 (6.6)	22.2 (6.1)
QoL, mean (SD)		4.8 (1.2)		
• Aquablation	4.8 (1.1)	4.7 (1.1)	4.7 (1.1)	4.8 (1.1)
• TURP	4.8 (1.0)		4.9 (0.8)	4.8 (1.0)
Qmax, mean (SD); mL/sec		8.4 (4.1)	NA	
• Aquablation	NA	7.7 (3.8)		NA
• TURP				
IEEF-5, mean (SD)		17.4 (5)		
• Aquablation	17.2 (6.5)	20.3 (4.7)	16.2 (6.4)	17.2 (6.5)
• TURP	18.2 (7.0)		16.2 (7)	18.2 (7.0)
Prostate volume, mean (SD); cc		52.6 (14.7)		
• Aquablation	54.1 (16.2)	53.8 (13.5)	54.2 (16.3)	54.1 (16.2)
• TURP	51.8 (13.8)		50.8 (13.9)	51.8 (13.8)
PVR, mean (SD); mL		108.9 (138.2)	NA	
• Aquablation	NA	132.7 (174.2)		NA
• TURP				

BMI: Body Max Index; PSA: prostate specific antigen; IPSS: International Prostate Symptoms Score; IIEF-5: international index of erectile function; QoL: quality of life; Qmax: maximum flow at uroflowmetry; PVR: post voiding residual.
*Data were requested to the Authors; †Gilling *et al.* same population.

bin drop was reported between the two groups (P=0.011).[20] In both studies[18, 20] no-TURP required transfusion, meanwhile in the Gilling report, one patient treated with Aquablation required a postoperative transfusion.

Mean hospital stay was 1.4 days in each group with no geographic variation, and the urinary catheter was removed a median of one day after surgery in each group.

Micturition outcomes

Focusing on functional outcomes, the first aim of the studies included in this review was to evaluate the decrease in IPSS. At one month postoperatively, Aquablation already showed a similar IPSS decrease compared to TURP, relative to baseline. The drops recorded were 18.9 and 15.1 points respectively. A further decrease was noted at up to six months of follow-up. The mean difference in score change at six months was 1.8 points greater for Aquablation (noninferiority P<0.0001 and superiority P=0.1347). Moreover, a further benefit with Aquablation was recorded in a man with a prostate greater than 50 mL relative to TURP (P=0.019).[18]

The IPSS QoL Score improved similarly in the Aquablation and TURP groups at six months, with a decrease of 3.5 *vs*. 3.3 points (P=0.4582). At month three, the decrease was statistically larger in the Aquablation group.[18]

In the USA population, the IPSS QoL score improved similarly in both groups at one year (decreases of 3.1 points *vs*. 3.4 points, respectively, P=0.5760).[20]

In both groups, the Qmax improved significantly relative to baseline during all the six months of follow-up, but without differences between Aquablation and TURP (P=0.1).[18] Similar results were found in PVR (P=NS).[18]

Exploratory analyses showed, in favor of Aquablation group, larger six-month IPSS improvements in men with a middle lobe (P=0.005), men

with severe middle lobe obstruction (P=0.077), men with baseline Qmax<9 cc/s P=0.029), men without bladder obstruction at baseline (P=0.032) and men with an elevated PVR (P=0.006).[22]

In a recent review published by Cochrane,[23] a preplanned sub-group analysis (stratified by age and severity of lower urinary tract symptoms (LUTS) based on IPSS and prostate volume) was performed, evaluating outcomes at six months of follow-up. Patients aged under or over 65 years old showed no differences between Aquablation or TURP, in terms of decreased IPSS and improvement of QoL. Although based on prostate volume (greater or less than 50 mL) the test for interaction was significant in terms of IPSS reduction (P=0.03). For prostate volume of less than 50 mL, the MD was 0.90 (95% CI: -2.12 to 3.92), and for prostate volume of 50 mL or more, the MD was -4.10 (95% CI: -7.45 to -0.75).

Pimentel *et al.*[19] evaluated urodynamic outcomes at six months of follow-up between the two groups.

At mean baseline, detrusor pressure at maximal flow rates was 71 and 73 cmH_2O in the Aquablation and TURP groups, respectively (P=0.7031). At six-month follow-up, this value decreased by 35 and 34 cmH_2O, respectively (P<0.0001 compared to baseline for both groups) with no significant difference in decrease across groups (P=0.8919). A large negative shift in Bladder Outlet Obstruction Index was observed, consistent with a large reduction in the proportion of subjects with obstruction at follow-up compared to baseline (79% to 22% in Aquablation and 96% to 22% in TURP).

Subsequently, Gilling *et al.*[21] published data at one year of follow-up. Mean IPSS reduction at 12 months was 15.1 (SD=7.0) in the Aquablation group and 15.1 (SD=8.3) in the TURP group (P=0.98). The mean percent reduction in IPSS score was 67% in both groups; 93.0% and 86.7%, respectively, had improvements of at least five points from baseline. Mean IPSS QoL score improvement was also similar in both groups (3.2 (1.7) *vs*. 3.5 (1.6), P=0.3179).

Urinary flow rates increased markedly postoperatively in both groups, with mean improvements of 10.3 (11) cc/s for Aquablation *vs*. 10.6 (SD=11) cc/s for TURP (P=0.86). The mean 12-month reduction in postvoid residual was 52 (SD=79) and 63 (SD=97) cc (P=0.46).

Recently, Gilling *et al.*[7] published the results of a WATER study at two years of follow-up.

IPSS reduction at two years was 14.7 (7.1) in the Aquablation group and 14.9 (7.3) in the TURP group (P=0.83); 89% and 95% of each group had an improvement of at least five points from baseline IPSS, respectively. Mean two-year IPSS QoL score improvement was also similar in both groups (P=0.70). The improvement in Qmax was maintained up to two years of follow-up for both groups. Mean improvements were 11.2 (11) cc/s for Aquablation *vs*. 8.6 (12.2) cc/s for TURP; differences were found in PVR (P=0.38). At two years, PSA was reduced significantly in both groups by one point (P=0.01).

Ejaculation outcomes

In men without preoperative ejaculatory dysfunction, anejaculation was less common after Aquablation than after TURP (2% *vs*. 41%, P=0.0001) at six months of follow-up.

There were threshold decreases in MSHQ-EjD or IIEF-5 scores in 33% of Aquablation and 56% of TURP cases (P=0.0268). In sexually active men, mean erectile function scores according to IIEF-15 were stable after Aquablation but decreased slightly after TURP except for overall sexual satisfaction, for which Aquablation was significantly better (P=0.049). Ejaculatory function scores on MSHQ-EjD were stable after Aquablation, but significantly worse after TURP (P=0.0254).[18]

Similar results were recorded by Kasivisvanathan *et al.*[20] Amongst sexually active subjects, the rate of anejaculation was lower in patients treated with Aquablation than TURP (9% *versus* 45%, respectively, P=0.0006).

At two years of follow-up[7] anejaculation was less common after Aquablation (10%) *vs*. TURP (36%), P=0.0003. The rate of anejaculation after Aquablation was somewhat lower when post-Aquablation cautery was avoided (7% *vs*. 16%, P=0.1774). Moreover, ejaculatory function as assessed by MSHQ-EjD was better in Aquablation compared with TURP through two years. There were no *de novo* erectile dysfunction events in either arm.

Safety

Safety evaluation was one of the primary endpoints of the WATER study. The three-month primary safety endpoint rate was lower in the Aquablation group than in the TURP group (26% *vs*. 42%, P=0.0149).[18]

The rate of persistent grade 1 events at month three was also lower after Aquablation (7% *vs.* 25%, P= 0.0004) and the rate of grade 2 and greater events was similar in the two groups at 20% for Aquablation and 23% for TURP (P=0.3038).[18]

In a subgroup analysis, in men with a prostate greater than 50 mL, the primary safety endpoint was lower after Aquablation than after TURP (20% *vs*. 46%, P=0.0111).[18]

Between month three and month six, 13 additional urologic adverse events occurred. The most frequent was urinary urgency, which was recorded in 2.6% and 3.1% for Aquablation and TURP respectively. Safety results remained consistent after six months, and were deemed unrelated to the study procedure.[21]

During the first year of follow-up, one TURP subject (1.5%) and three Aquablation subjects (2.6%) underwent surgical retreatment for BPH (P=1). In all cases, additional surgery consisted of TURP.

Between years one and two, the rate of most individual events was low and similar across groups. Two Aquablation subjects (1.7%) and zero TURP subjects underwent surgical retreatment for BPH between one and two years of index treatment (P=1). Overall, two-year retreatment rates were 4.3% and 1.5% (P=0.4219), respectively.[7]

Discussion

In recent decades, many innovative technologies have been developed for the treatment of BPO, and incorporated into the daily practice of urology.[24-26] Meanwhile, robotic systems have gained widespread acceptance in urologic surgery, especially in the oncologic field.[27-29] The introduction of the Aquablation system represents the unification of the technology for BPO surgery and for robotic systems, because Aquablation allows for high-velocity robot-assisted ablation of prostatic tissue.

The results of this systematic review, based on a single RCT that compared Aquablation *vs*. TURP in prostates 30-80 cc in size, confirmed that Aquablation has at least a similar efficacy as TURP, but has a better safety profile, allows shorter resection times, and has a lower risk of retrograde ejaculation.

Moreover, in some subcategories of patients (*e.g.*, when prostate volume is >50 cc) functional outcomes of Aquablation are better than those of TURP.

Besides comparative studies, some papers have been published recently with the results of this new approach. To give to the reader an overview of the current Literature, we have decided to consider the most important of these studies as an "appendix" of our review.

In an interesting, prospective single-center experiment using non-selected patients, Bach *et al.*[30] give us a snapshot of the use of Aquablation in daily practice. In the frame time September 2017 to August 2018, the authors treated 118 patients; the only exclusion criterion was anticoagulation therapy, while no other inclusion or exclusion criteria were defined, to ensure "real-life" criteria. At baseline, prostate volume was between 20 and 150 cc (mean 32 cc), IPSS score was 21, and Qmax was 10.75 mL/sec.

The Aquablation procedure was performed successfully in all patients. Mean operative time, from TRUS until urinary catheter placement, was 20 min Intraoperatively, bleeding requiring electrocautery occurred in four patients (3.4%). The catheter time was 2.2 days, and all patients but six were discharged without catheter, and the catheter was removed successfully in all those six patients during follow-up.

Adverse events occurred in eight (10.5%) patients; the Dindo Clavien Grade was >3 in only four (3.3%) cases. These patients underwent endoscopic bleeding control, due to delayed hematuria.

Three months after surgery, IPSS score dropped to seven, while Qmax increased to 21mL/sec.

According to those authors, the results of this study lead to the conclusion that Aquablation is safe and efficient, and that it should be included into clinical routines.

Similar results came from the First French Aquablation Clinical Registry.[31] These authors treated 30 patients who had small to medium prostate volume, with a median operative time and resection time of 30.5 and 4 min, respectively. The median catheterization time was 43 hours. The IPSS score decreased dramatically, while Qmax increased up to 20.4 mL/s. Functional results were stable until the twelfth month after surgery. Complication rate (Clavien-Dindo grade 2 or 3) was 13.3%. Interestingly, ejaculatory dysfunction was observed in eight (26.7%) patients. Even if the rate of ejaculatory dysfunction is lower than those reported after TURP in the vast majority of Literature, it is higher than those reported in WATER Study. In the Authors opinion, the lost of anterograde ejaculation could be influenced by the preoperative prostate size: the smaller the prostate, the more difficult the ultrasound mapping.

Notably, procedures were performed by multiple surgeons (in three different centers) without previous experience with this technique, suggesting that the learning curve for Aquablation procedure is not steep.

The authors concluded that Aquablation procedure was feasible, safe, and effective, and provided immediate good functional results, despite the lack of surgeons' specific expertise.

Different papers came from the WATER II study, a prospective multicenter trial of the Aquablation procedure in men with symptomatic BPO and prostate volumes between 80 and 150 cc. The most recent and comprehensive data set is reported by Bhojani *et al.*[32]

The authors reported data from 101 patients, treated by 24 surgeons at 16 different centers; mean age was 67 years, mean prostate volume was 107 cc, and in 83% of cases, a middle lobe was evident at ultrasound. Baseline IPSS Score was 23, Qmax was 8.7 mL/s, and 77 patients were sexually active.

In terms of intraoperative data, mean procedure duration was 37 minutes, and all procedures were completed successfully. Interestingly, no intraoperative electrocoagulation was required. Postoperatively, mean length of stay was 1.6 days, but two patients (2%) went home the same day of surgery, and 59 pts were discharged within one day. The majority of patients (68) were discharged with a catheter, which was removed four days after surgery. Mean hemoglobin level drop was 2.9 g/dL, 10 patients required transfusions, and 5 patients required reintervention (endoscopic bleeding control – Clavien-Dindo grade 3 complication). Five Dindo Clavien grade 4 complications were recorded, mainly cardiovascular events.

Twelve months after surgery, the authors declared a 17-point decrease in IPSS score, and a Qmax improvement of 12.5 mL/s; ejaculatory dysfunction was reported by only 19% of sexually active patients. Three patients had incontinence requiring the use of a pad, and one patient underwent artificial urinary sphincter for persistent stress incontinence. Interestingly, two out of four patients with incontinence had incontinence symptoms at baseline. These authors concluded that Aquablation is safe and effective, even for large prostate glands, with durable outcomes at one year. Moreover, the authors highlighted the quick operative times, short hospital stay, and low rate of retrograde ejaculation. Finally, in these authors' opinion, Aquablation results are at least comparable with those of Holmium Laser Enucleation of the Prostate (HoLEP) for large prostate, whilst the learning curve, even for large prostate volumes, is remarkably short.

Despite the Authors' opinion, the safety profile of Aquablation procedure for large prostate deserves attention as transfusion rate of 10% (more than 5% of reintervention) is not trivial, suggesting that more data are needed to assess the safety of the procedure in this subset of patients.

In a sub-analysis of WATER II data, Bhojani *et al.* compared the results of a subgroup of patients with a baseline prostate volume <100 cc *versus* those with a prostate volume >100 cc.[33] In general, postoperative results between the two groups were comparable. Thus, the authors concluded that Aquablation clinically normalizes outcomes between patients with <100 cc and >100 cc prostate volumes, and highlighted that the learning curve is smooth, even in cases of larger prostate.

Taken together, the literature confirms both the effectiveness and the acceptable safety profile of Aquablation procedure in the treatment of BPO.

Nevertheless, Literature data are still scarce:

only a few comparative studies with standard procedures are available, and none of these compares Aquablation with laser-based endoscopic interventions (such as HoLEP,) especially for large prostates. Moreover data from "real-life" scenario are lacking.

Finally, the available follow-up is limited to 2 years and indubitably; longer follow-ups are needed to corroborate these findings.

Conclusions

Based on the evidence of our systematic review, the Aquablation procedure for the treatment of BPO allows high clinical efficacy with an good safety profile. For prostate volume 30-80 cc, comparative studies demonstrated that this procedure offers clinical results at least comparable to those of conventional TURP. The major strengths are its high-speed resection time, low complication rate, and potential for sexual function preservation.

Evidence from non-comparative clinical studies and from real life scenarios is scarce but suggested that Aquablation may be used effectively for prostate volumes up to 150 cc, even if more data about safety profile are needed.

Moreover, at the moment, the lack of mid/long term follow-up data is an issue.

Future studies and long-term results from ongoing studies are required to secure Aquablation's position and acceptance as a true competitor to conventional TURP and other minimally invasive surgical techniques.

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