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Robot-assisted aquablation for resection of benign prostatic hyperplasia: A series of cases

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ABSTRACT

Objective. The objective of this study was to assess the surgical outcomes of aquablation for treatment of benign prostatic hyperplasia, especially on ejaculatory function and urinary continence.

Materials and Methods. A retrospective analysis was conducted, on patients >40 years, with lower urinary tract symptoms secondary to benign prostatic hyperplasia, and a prostate volume <100 mL. These patients were treated with aquablation, a minimally invasive, robot-assisted surgical technique that uses a high-speed water jet and no heat for prostate resection.

Results. Eight patients were included with mean age of 70 (range 50-82) years and a mean prostate volume of 51 (range 25-94) mL. Overall, the mean International Prostate Symptom Score decreased 76.7%. All patients had a >60% score reduction without losing their ejaculatory function and urinary continence. No serious adverse events were reported.

Conclusions. In our experience, aquablation is an efficient and safe method that offers high cut precision for prostate resection.

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Introduction

Benign prostatic hyperplasia (BPH) is the main cause of male lower urinary tract symptoms (LUTS). LUTS have an overall prevalence of 19%, increasing with age until reaching 27% in patients over 70 years old [1, 2]. This syndrome, which includes storage (irritative) symptoms, voiding (obstructive) symptoms and post urination, has a negative impact on quality of life and is associated with high costs, both personal and health-related [3].

Based on the recommendations by the European Association of Urology (EAU) concerning the evaluation of non-neurogenic LUTS, including BPH, the treatment of choice in patients with no response to pharmacological treatment is surgical resection. Currently, the reference surgical treatment is Transurethral Resection of the Prostate (TURP) [4]. This technique, historically associated with high morbidity [5, 6], currently presents very low perioperative morbidity rates, therefore any new surgical procedure for the treatment of BPH should reach similar results than that for TURP.

Due to the potential peri-, intra- and postoperative complications of surgery for the treatment of BPH, which may affect not only the bladder function but also the ejaculatory and erectile functions, a proper assessment of the risks and benefits of the intervention should be conducted from a multidisciplinary perspective, including both urologists and andrologists in the medical team [7].

In recent years, there has been an increasing interest in developing minimally invasive surgical procedures as an alternative to TURP and to open surgery based on different technologies, one of the latest being aquablation, also known as water-jet ablation. Aquablation is the ablation of the prostate by hydrodissection, using a robot-assisted, imaging-guided, high-speed, heat-free water jet [8-10]. The first human study, conducted on a series of 15 patients, was published in 2015 [9]. Compared with other endoscopic techniques, this procedure has the advantage of

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reducing resection time, as well as offer the possibility of preserving the sexual function and preventing urinary incontinence, minimizing potential side effects that other techniques, such as TURP, may cause [11, 12]. However, since it was recently implemented, there are still not enough data regarding its therapeutic outcome in daily clinical practice. This study describes the experience of a series of cases in which the effectiveness of aquablation for the treatment of LUTS secondary to BPH was assessed, as well as the side effects on ejaculatory function and urinary continence.

Materials and Methods

Study Design and Population

Retrospective analysis of a series of eight patients with BPH and LUTS, treated with aquablation in the context of daily clinical practice. All surgeries were conducted at the public management center of Hospital Plató in Barcelona, Spain. Patients were recruited between September and December 2017, and follow-up was conducted until September 2018.

Patients included in the study were men over 40 years old with moderate-to-severe LUTS secondary to Grade II BPH (20-100 mL) who met the requirements for surgical resection of the prostate using minimally invasive techniques. Patients with active urinary tract infection (UTI) or any other condition that, at the surgeon's discretion, advise against their inclusion in the study, were excluded. Patients were followed up for 6 months through in-person visits, and participants had a phone contact to report any potential complications.

Patients signed an informed consent relinquishing the use of their data for the study. Data collection and management was performed pursuant to Spanish Organic Law 15/1999 on the Protection of Personal Data and Directive 2016/679/EU of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data.

Surgical Procedure

Participants underwent prostate resection through aquablation with AQUABEAM® Robotic System (PROCEPT BioRobotics, Redwood City, California, USA). The first stage of the process consists in mapping the exact contour of the treatment area and visualizing the prostate in multiple views on the AQUABEAM® Robot monitor. The length sweep angle and depth of treatment are adjusted to define the three-dimensional boundary for prostate tissue resection, while sparing the anatomical landmarks responsible for the bladder and ejaculatory functions.

Once the parameters are set, the AQUABEAM® Robotic System autonomously executes the predetermined treatment plan. The previously identified prostate tissue is resected with a high-speed, heat-free water jet. The various flow rates are estimated by the AQUABEAM® Robotic System software based on the length, depth, and width of resection required.

All procedures are performed by one surgeon, with the assistance of health personnel with experience in the surgical treatment of BPH. All patients were treated with aquablation under spinal anesthesia and sedation.

Variables and Measurements

Prior to surgery, a clinical history of each patient was prepared, in which comorbidities, anticoagulant or antiplatelet therapy, and drug treatment specific for BPH (alpha blockers, 5-α-reductase inhibitors, phytotherapy or anticholinergics) or for erectile dysfunction (phosphodiesterase-5 inhibitors, selective serotonin reuptake inhibitors -SSRIs or others) were included. Age, weight and height were recorded. Prostate volume was estimated in milliliters by vesicoprostatic ultrasound, and prostate-specific antigen (PSA) in blood was determined (normal reference value up to 4.0 ng/dL). The Charlson Comorbidity Index was estimated, and patients were classified based on the American Society of Anesthesiology (ASA) system to assess the risk for anesthesia.

Both at study start (baseline) and after six months, patients answered the following questionnaires: The International Prostate Symptom Score (IPSS) and the Erection Hardness Score (EHS). Ejaculation volume was assessed as: 1=None, 2=Low, 3=Some, or 4=Normal; pain during ejaculation was assessed using a Visual Analog Scale (VAS) for pain of 0-10 (0=No pain/10=Worst pain imaginable); male stress urinary incontinence was assessed; and the number of urinary infections prior to surgery requiring admission to the ER was recorded.

Finally, the number of reported adverse events (AEs) and their severity were recorded, as well as any immediate complications and the days that the patient remained in hospital after the treatment.

Assessment Criteria

Main efficacy results of this study were the changes in score from the IPSS and EHS questionnaires, as well as all the data regarding ejaculatory function and urinary continence (ejaculation volume, pain during ejaculation, SUI). Safety results included reported AEs during and after surgery, as well as those reported by patients throughout the follow-up period, which were classified as severe and not severe.

Statistical Analysis

Quantitative variables are described as mean and standard deviation (SD), and categorical variables as frequencies and percentages. Given the number of cases ($n<30$), no hypothesis tests were performed.

Results

Patient Characteristics

Eight patients were included with a mean age of 70 (range of 50-82) years, one of whom was wearing a bladder catheter. All patients presented with LUTS secondary to BPH. Mean prostate volume was of 51 (range of 25-94) mL. Table 1 shows patients' clinical and demographic data at baseline, and Table 2, patients' comorbidities and active treatments.

Table 1. Patients' clinical and demographic data at baseline.

Patient	Age	Weight	Height	PV	PSA	Charlson Comorbidity Index
1	65	129	1.74	94	4.8	2
2	82	71	1.72	45	2.1	6
3	51	63	1.63	25	0.23	1
4	72	71	1.64	35	2.4	3
5	80	82	1.67	50	1.1	6
6	75	83	1.73	45	0.29	4
7	64	90	1.74	86	4.7	2
8	73	81	1.71	28	2.6	3
Mean (SD)	70 (10)	84 (20)	1.70 (0.04)	51 (26)	2.28 (1.77)	3.4 (1.9)

SD: Standard deviation. **PSA**: Prostate-specific antigen. **PV**: Prostate volume.

Table 2. Comorbidities and treatments prior to the procedure

Comorbidities and Medication	N	%
Comorbidities		
Diabetes	1	12.5
Hypertension	7	87.5
Neuropathies	0	-
Vasculopathies	1	12.5
Urologic pathology requiring bladder catheter	1	12.5
Benign Prostatic Hyperplasia Treatment		
Antiplatelets	0	-
Anticoagulants	1	12.5
Alpha blockers	8	100
5-α-reductase inhibitors	3	37.5
Phytotherapy	0	-
Anticholinergics	2	25.0
Erectile Dysfunction Treatment		
Phosphodiesterase-5 inhibitors	0	-
SSRIs	1	12.5
Other	0	-
ASA		
1	1	12.5
2	6	75.0
3	1	12.5

ASA: American Society of Anesthesiology. **SSRIs**: Selective serotonin reuptake inhibitors.

Experience of the Procedure

All eight patients were successfully treated with AQUABEAM® under spinal anesthesia and sedation. The procedure did not exceed 45 minutes, with a mean time variation of aquablation of 3-7 minutes. All procedures were technically satisfactory. After two days of the procedure, 62.5% (n=5/8) of patients were discharged, 25% (n=2/8) after three days, and only one (n=1/8; 12.5%) was in hospital for five days (mean days of hospitalization: 2.6) for hematuria, but did not require another intervention or a blood transfusion.

Safety and Feasibility

No serious or unexpected complications for a minimally invasive transurethral procedure were recorded. Only one (n=1/8, 12.5%) patient had to be readmitted for hematuria. None of the patients required a blood transfusion. During the 6-month follow-up, two (25%) patients had mild UTI and required a visit to the Emergency Room. They were later controlled with anticholinergics to improve the contractility of the bladder involved following the guidelines of the International Continence Society (ICS). None of the patients had presented with UTI prior to the procedure.

Functional Results

Table 3 shows the results regarding score variations in the IPSS and EHS scales. There was no variation between mean EHS results before (n=7) and after 6 months of treatment. Two (n=2/8, 25%) patients had no sexual activity prior to or after the aquablation procedure.

Table 3. Score results from the IPSS and EHS scales.

	IPSS			EHS		
Patient	**Baseline**	**At 6 Months**	**% Decrease**	**Baseline**	**At 6 Months**	**% Decrease**
1	25	2	92.0	3	3	-
2	14	5	64.3	2	2	-
3	17	3	82.4	4	4	-
4	20	5	75.0	4	4*	-
5†	‡	2	-	-	-	-
6	15	3	80.0	3	3	-
7	18	6	66.7	4	4	-
8†	25	-	-	-	-	-
Mean (SD)	19.1 (4.5)	3.7 (1.6)	76.7 (10.3)	3.33 (0.82)	3.33 (0.82)	-

SD: Standard deviation. **EHS**: Erection Hardness Score. **IPSS**: International Prostate Symptom Score.
*Mild new-onset, non-organic psychological erectile dysfunction
†Patient without sexual activity.
‡Bladder catheter.

Table 4 shows the results regarding ejaculation volume, pain during ejaculation, and SUI measured before the procedure and at 6 months of follow-up. During the 6-month follow-up, one of the patients experienced mild new-onset, psychological erectile dysfunction, with a time of coitus of five minutes, which he ruled out as organic erectile dysfunction. After the procedure, no cases of urinary incontinence, organic erectile dysfunction or a decrease of or pain during ejaculation were reported.

Table 4. Changes in the ejaculatory and bladder functions.

	EV		PdE		SUI		UIER	
P	**Baseline**	**6 m**	**Baseline**	**6 m**	**Baseline**	**6 m**	**Baseline**	**6 m**
1	No	L	0	0	0	0	0	Mild*
2	S	S	0	0	0	0	0	0
3	N	N	0	0	0	0	0	0
4	N	N	0	0	0	0	0	0
5†	-	-	-	-	0	0	0	Mild*
6	L	L	0	0	0	0	0	0
7	N	N	0	0	0	0	0	0
8†	-	-	-	-	0	0	0	0

IICC: Immediate complications. **PdE**: Pain during ejaculation. **DH**: Days of hospitalization. **SUI**: Male stress urinary incontinence. **UIER**: Urinary infection requiring a visit to the ER. **P**: Patient. **EV**: Ejaculation volume.
Ejaculation volume scale: No=None; L=Low; S=Some; N=Normal.
*Hematuria.
†Patient without sexual activity.

Discussions

Results obtained with this series of patients confirm the safety and efficacy of aquablation described before by other investigators [13-17], and that outcomes could be compared with those obtained with TURP. In our experience, the most notable results of using this technique were the following: (1) Improvement of LUTS after 6 months of the procedure, recorded as a decrease in mean IPSS scores of 76.7% (>60% of all patients that completed the questionnaire); (2) absence of serious or unexpected complications; (3) preservation of ejaculatory function—the only erectile dysfunction reported after the procedure was ruled out as of organic origin—; (4) preservation of bladder function.

TURP and laser prostate resection are the most commonly used surgical procedures to treat LUTS secondary to BPH, when the size of the prostate does not exceed 100 mL [18, 19]. They are both effective to remove hyperplastic tissue, but there still could be side effects, including erectile dysfunction [11] and urinary incontinence [5]. Besides the usual cystoscopy camera, the technology associated with aquablation includes an ultrasound system for prior mapping of the exact treatment area [20], although, in our experience, this feature does not differentiate it from other procedures. Regardless of the guiding method, the fact of mapping the area before starting the resection enables to optimize the amount of tissue removed, which contributes to minimize the risk of complications on the ejaculatory [13, 21] and bladder functions [13, 22].

In previous studies in sexually active patients with normal ejaculatory function, after aquablation there was no decrease in the ejaculation volume associated with retrograde ejaculation in the bladder [10]. With aquablation, anejaculation rates were lower than with TURP, still more so in the absence of cauterization after treatment [13]. This preservation of the ejaculation volume or lower anejaculation rates might be explained by a prior mapping of the contour of the tissue to be resected and the absence of heat during the cut, which, to a great extent, may contribute to prevent injuries around the verumontanum [13, 23]. In fact, the absence of heat during the cut is, in our opinion, one of the advantages over other conventional techniques, which present some risk of thermal injury to the surrounding tissue due to the heat generated during the cut [24]. In the case of aquablation, the absence of heat during the procedure eliminates the possibility of complications derived from a thermal injury [10, 22]. Another notable characteristic of aquablation related with this technology is its high cutting speed (the water jet reaches a speed similar to that of sound), shortening surgery time. Lastly, having a robot-assisted technology drastically minimizes the learning time, therefore conferring it an advantage over other techniques for which a significant learning curve has been described [25].

Despite that the manufacturer indicates that aquablation can be performed on prostates with a volume of 80-150 mL, there are currently no conclusive data on the feasibility of this technique in prostates with a size larger than 100 mL [9]. Based on this limited information, aquablation is not routinely used in large prostates in our site, so all the patients of our series had prostates with a size lower than 100 mL. Another limitation of our study is the reduced number of cases, which prevented to conduct inferential analyses to validate the statistical significance of the results. However, the positive results obtained to date encourage us to gradually keep including this technology in our daily practice.

Conclusions

Since it is a robot-assisted process that uses water as a resection tool, aquablation is a safe and promising method to treat LUTS secondary to BPH, with minimum complications (including those related with the sexual function) and enabling to make cuts with great precision and high speed. Besides conducting studies in larger cohorts, it is necessary to explore the efficacy and safety of this method in large prostates.

Conflict of interest disclosure

There are no known conflicts of interest in the publication of this article. The manuscript was read and approved by all authors.

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