Aquablation of the prostate: a review and update

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TOKARSKI AT, LEONG JY, ROEHRBORN CG, SHVERO A, DAS AK. Aquablation of the prostate: a review and update. *Can J Urol* 2021;28(Suppl 2): 17-21.

Introduction: *Historically, transurethral resection of the prostate (TURP) was considered the endoscopic "gold standard" surgical treatment of benign prostatic hyperplasia (BPH). Over the years, several other endoscopic procedures emerged, including the size-independent holmium laser enucleation of the prostate (HoLEP). In an effort to reduce the cost and morbidity associated with traditional endoscopic techniques, novel minimally invasive techniques have been developed, one of which is Aquablation. This review is an update of a previously published review article looking at the most recently published available data on Aquablation.*

Materials and methods: *This review article covers the technical aspects of Aquablation and provides an update on the recently published literature regarding Aquablation compared to TURP and HoLEP.*

Results: *At up to 3 years of follow up, Aquablation performs favorably when compared to TURP in terms of alleviation of lower urinary tract symptoms (LUTS) and preservation of sexual function compared to TURP. Safety profile was similar between Aquablation and TURP.*

Conclusions: *Aquablation is a safe and effective method of treating LUTS associated with BPH. At up to 3 years of follow up, it has shown a durable with efficacy similar to TURP.*

Key Words: Aquablation, minimally invasive therapy, lower urinary tract symptoms, benign prostatic hyperplasia

Introduction

Benign prostatic hyperplasia (BPH) is a common condition affecting approximately 25% of men at the age of 50, with almost 80% of men older than 70 affected.[1] BPH is caused by the unregulated proliferation of the transitional zone of the prostate, which leads to compression of the prostatic urethra. Physical compression of the urethra causes bladder outlet obstruction (BOO), and leads to the symptoms of BPH, known as lower urinary tract symptoms (LUTS).[2] The gold standard for endoscopic surgical treatment of this condition has historically been the transurethral resection of the prostate (TURP), which was first developed in the early 1920s.[3] The TURP technique, although effective, has well established morbidities, such as TUR-syndrome, infection, bleeding risk, sexual side effects, and others.[4]

Innovations in BPH managed have been targeted towards decreasing surgical morbidity and decreasing overall operative time while maintaining successful alleviation of the LUTS associated with BPH. One such technique is the ultrasound guided, robot assisted waterjet that can precisely target and ablate prostatic tissue, known as Aquablation. This technique is performed using the Aquabeam system (PROCEPT Biorobotics, Redwood Shores, CA, USA). This surgical intervention was developed with the aim to

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reduce operative time, relative to other widely used endoscopic techniques such as TURP and holmium laser enucleation of the prostate (HoLEP). This technique also shows promise in preserving sexual function, both erectile and ejaculatory, similar to the effects seen with prostatic urethral lift (Urolift, Neotract/Teleflex, Pleasanton, CA, USA) and convective water vapor therapy (Rezum, Boston Scientific, Marlborough, MA, USA) procedures.

This article updates a previous review,[5] examines the use of Aquablation and provides an update on the newer longer term data that recently became available.

Technique

The technique for this procedure was first described by Farber et al in 2015 using the Aquabeam system has been further described by several others.[6-8] The AquaBeam Aquablation system has three main components: the conformal planning unit (CPU); robotic 24 Fr handpiece; and a console. The procedure can be performed under general anesthesia or spinal anesthesia. From here the patient is placed in the dorsal lithotomy position, and the biplanar transrectal ultrasound (TRUS) is mounted into position. Next, the handpiece is used to gain access to the bladder to allow visualization with a cystoscope. The handpiece is positioned with the tip just inside the bladder before the scope is retracted to visualize the bladder neck, and placed proximal to the external sphincter. Once proper positioning is confirmed, the handpiece can be stabilized using an articulating attachment mounted to the bed. Once secured, the TRUS probe can be inserted until the center of the prostate is visualized. At this point, the surgeon can use the ultrasound probe to compress the prostate and improve visualization for the Aquabeam handpiece.

Once the hand piece and TRUS probe are positioned, the software must be adjusted to confirm appropriate planning for the tissue ablation, which is performed using the mapping software. The software allows for changes in depth up to 25 millimeters, and the angle of resection up to 225 degrees. Complete ablation of the transition zone is performed by outlining the prostate with the Aquabeam software. A high velocity jet of physiologic saline is then initiated under the control of a foot pedal. The computer system automatically adjusts the flow rate in each direction to alter the depth of penetration and remove the tissue as outlined in the mapping stage. There are safety mechanisms in place to ensure only the outlined tissue is ablated, and the external sphincter remains protected. Once resection is complete, hemostasis can be completed either through electrocautery or balloon catheter tamponade, with expert opinion favoring balloon tamponade.[9] The balloon remains in place for 2 hours to ensure hemostasis. Post procedure, a 3-way catheter is inserted and bladder irrigation is commenced and patients can be discharged the following day after the catheter has been removed.

Outcomes and safety of Aquablation

While this procedure is relatively new, several authors have been able to publish medium term follow up data for their cohorts. Some of the earliest outcomes were reported by Gilling et al, who published their findings in a prospective, multicenter trial at three Australian centers which included 21 men.[10] All patients were between the ages of 50 and 80 years and had prostate volumes ranging from 30 to 102 mL. The results from this study showed an average procedural duration of 38 minutes and a mean resection time of 5 minutes, with an average hemoglobin drop of 0.8 gr/dL after the operation. Subjective and objective findings were also reported, with data from 1, 3, 6, and 12 months. Average international prostate symptom scores (IPSS) were significantly decreased down to an average of 6.8 from pretreatment values. Maximum flow rate (Qmax) increased to 18.3 mL/second at 12 months follow up. Post void residual (PVR) volume decreased down to an average of 31 mL, and quality of life subjective scores improved significantly as well. The authors obtained urodynamics studies after the operation for comparison to baseline and found that detrusor pressure at maximum flow was decreased by 40% on average. Prostate volume reduced by 39% on average as well. Finally, no adverse events were reported, there were no reports of incontinence, and sexual function was preserved in all patients.

The WATER trial was able to directly compare Aquablation to TURP in a prospective manner across 17 different centers.[11] This double blind, randomized controlled trial include 181 patients. The goal of the trial was to assess Aquablation and TURP in a non-inferiority trial using composite endpoints for safety and efficacy. There was no significant difference seen in overall mean operative time, but resection time was significantly less with Aquablation. The group looked at 3 months postoperative safety data as well as 6 months postoperative IPSS scores. The primary safety endpoint was defined as a persistent Clavien-Dindo grade one event, or a Clavien-Dindo grade two or higher event. At 3 months, safety data showed Aquablation to be non-inferior to TURP. Additional analysis showed Aquablation to be superior to TURP

with regards to safety with 26% of the cohort meeting the safety endpoint, while 42% of patients undergoing TURP met these criteria. Importantly, all of the persistent Clavien-Dindo grade one events were due to retrograde ejaculation which was seen in 6.9% of Aquablation patients and 24.6% of TURP patients. To further assess ejaculatory function, MSHQ-EjD self-reported data was collected, showing that 90 days after the procedure, the Aquablation patients had a slight improvement overall in ejaculatory scores while the TURP group had a significant decrease in scores.

A similar analysis was done to assess incontinence using the incontinence severity index, which is also self-reported. Results of this analysis showed significant improvement in the Aquablation group. The change in IPSS scores overtime was used to determine the efficacy endpoint. The Aquablation cohort had an average IPSS score of 6.0 at 6 months, compared to an average of 6.7 for the TURP group, demonstrating non-inferiority. Lastly, Qmax and PVR volumes were assessed at 30-day postoperative intervals up to 180 days. This analysis showed similar results for PVR in both groups with slightly improved Qmax at 180 days for the Aquablation group relative to those patients who had undergone TURP.

After the WATER trial, the WATER II trial was conducted to assess the safety and feasibility of Aquablation in larger prostates, those measuring between 80-150 mL.[12] This was also a prospective multicenter study. In total 101 men were included in the final cohort. Despite larger prostate sizes, average operating time was 37 minutes with an average resection time of 8 minutes. A total of 66.3% of patients included required additional passes with the machine to complete the resection, but all were completed in a single setting. Again, composite endpoints were used for both safety and efficacy. At 3 months, safety was assessed using the same safety endpoints as described in the original WATER trial. For efficacy, the change in IPSS scores at 3 months from baseline was used. Both the safety and efficacy endpoints were then compared to an objective performance criterion (OPC) which allowed for assessment of non-inferiority. Operative reports showed that 82% of these procedures were done under spinal anesthesia. Safety endpoints at 3 months were met in 44.5% of patients well below the OPC of 65%. These results reached statistical significance, and the procedure was non-inferior when compared to the OPC. When assessing efficacy, Aquablation greatly exceeded the OPC set for the change in IPSS score, demonstrating non-inferiority. Additionally, prostate volume reduction was measured, showing a 44% reduction in size at 3 months post procedure. Hemostasis was achieved for the majority of patients using a Foley catheter placed in the bladder under traction overnight using a device from PROCEPT BioRobotics. Three patients did require a catheter balloon being inflated in the prostatic fossa. The average length of catheter duration was 94 hours with an average of 18 hours under traction when this method of achieving hemostasis was used. There was an average hemoglobin drop of 2.9 g/dL when comparing baseline values to discharge lab values. Of the 101 patients, there are a total of 10 transfusions required between the completion of the operation and 1 month, with one patient requiring a return to the operating room.

While there is no trial that directly compares newer minimally invasive surgical techniques for the management of BPH (Rezum, Urolift, and Aquablation), Tanneru et al performed a meta-analysis of the available data to compare the three techniques.[13] This study included outcome reports among patients with prostates up to 80 mL. Follow up data was available up to 24 months across all three interventions. At 1 month, Aquablation showed higher improvement in IPSS scores compared to Rezum and Urolift. Aquablation and Rezum continued to showed improvement up to 6 months, whereas Urolift showed improvement up to 3 months with a steady decline thereafter. In terms of quality of life (QoL) scores, Aquablation and Urolift showed a greater improvement than Rezum. Aquablation continues to be superior to both at 6 months, a trend which persisted up to 24 months. Aquablation showed further improvement in Qmax at time intervals assessed, with an average improvement of 6.3 mL/s higher improvement compared to Rezum and Urolift. Improvement in PVR favored Aquablation out to 24 months. In terms of sexual function, Male Sexual Health Questionnaire – Ejaculatory Domain (MSHQ-EjD) scores showed a greater improvement in Urolift compared to Aquablation and Rezum at 6 and 12 months, though patients who underwent Aquablation, showed continued improvement beyond this point, which was not seen after the other two interventions. Aquablation patients were more likely to experience postoperative urinary retention. At 2 years follow up, the retreatment rates for Aquablation, Rezum, and Urolift were 4.3%, 4%, and 7.5% respectfully.

One concern over Aquablation would be the relative lack of control of postoperative bleeding, as the water jet does not have the same coagulative properties as monopolar and bipolar electrocautery and the various laser modalities used (holmium, thulium, and photovaporization) in the surgical treatment of

BPH. Some authors have advocated for selective electrocauterization in conjunction to Aquablation to minimize postoperative bleeding. Gloger et al performed a retrospective review of patients who underwent Aquablation followed by selective cauterization of the bladder neck and resection bed and compared them to those patients undergoing HoLEP.[14] They found that despite the added step of electrocauterization, operative times were still shorter in the Aquablation group compared to the HoLEP cohort. Return to the OR for bleeding within 6 weeks was similar between the two groups at 13.6% and 9.8% for Aquablation and HoLEP respectively. The average drop in Hgb was also similar between the two groups (1.3 mg/dL for Aquablation and 1.22 mg/dL for HoLEP), with no patients undergoing Aquablation requiring blood transfusion and one patient in the HoLEP group requiring transfusion.

Durability and adverse events

The same cohort used in the original WATER trial was followed out to 12 months post procedure with a purpose of investigating the safety and efficacy of this procedure compared to TURP.[15] The notable findings of this study were that TURP and Aquablation had similar improvements in Qmax, similar decrease in serum PSA levels, and similar low re-treatment rates at 12 months. The Aquablation cohort had 2.6% of patients who underwent reoperation compared to 1.5% in the TURP group which was not statistically significant. The study also analyzed results in patients who had larger than 50 mL prostates before treatment.[16] This subgroup analysis favored Aquablation for both the safety and efficacy endpoints. There was no difference in average procedure time (33 minutes for Aquablation versus 36 minutes for TURP), but Aquablation did have a significant difference in resection time (4 minutes versus 27 minutes). Additional analysis of this larger prostate size subgroup showed that on average, there was a greater drop in postoperative hemoglobin in the Aquablation group compared to those patients undergoing TURP, which was statistically significant. The Aquablation group had one patient that required blood transfusion with, no patients requiring transfusion in the TURP group.

The patients in the WATER II trial were followed up to 6 months.[17] When analyzing adverse events at 6 months, 22% of the patients had experienced a Clavien-Dindo grade II event, 14% a grade III event, and 5% a grade IV event. Qmax increased from 8.7 cc/s at baseline to 18.8 cc/s at 6 months. PVR decreased from 131 mL to 47 mL at 6 months. QoL scores decreased from 4.6 at baseline to 1.4 by 6 months. PSA showed a 44% reduction on average while TRUS volume showed a 42% reduction compared to baseline. With regard to the patients' postoperative sexual function, MSHQ-EjD scores at 6 months continued to show slight improvement compared to baseline though not as pronounced as at 3 months. IIEF-5 scores improved by an average of 0.1 at 3 months and an average of 0.7 at 6 months.

Nguyen et al compared the results of the original WATER trial with those of WATER II once 12 month data was available.[18] Specifically they stratified patients into prostate sizes between 30 g and 80 g and those patients with prostates between 80 g and 150 g. These authors noted that there was no relationship between IPSS scores and prostate volume across both studies. They did however note that there was an inverse relationship between prostate size and Qmax at baseline and patients had higher PVRs with increased prostate size. There was no difference between the two groups when comparing postoperative IPSS scores or Qmax at 1, 3, 6, or 12 months. There was a significantly higher decrease in PVR when comparing the two groups, however this could be attributed to the larger prostates seen in the WATER II trial. Transient Clavien-Dindo I events were similar between both groups. Persistent Clavien-Dindo I events were more common in the WATER II trial (16% versus 8%) and were mostly related to anejaculation. Clavien-Dindo grade II or higher events were more common in WATER II. Operative times were 4 minutes longer in the cohort of patients with larger prostates. Based on this comparison the authors were able to conclude that with short term follow up Aquablation provides a safe and efficacious treatment for both small to moderate gland as well as large gland BPH.

Recently, 3-year follow up data has become available for the patients in the original WATER trial. Three years of follow up was achieved in 87% of Aquablation patients and 85% of TURP patients from the original study. The mean percent reduction in IPSS scores was 64% and 61% in the Aquablation and TURP groups respectively. In patients with prostates larger than 50 mL, there was an average of 3.5 points greater reduction in IPSS for those who underwent Aquablation. Changes in ejaculatory function, measured by MSHQ-EjD, also favored Aquablation as seen in the original study. At 3 years, the improvement from baseline in Qmax, PVR, and reduction in PSA persisted and were statistically similar between both groups. The 3-year retreatment rates were 4.3% and 1.5% in the Aquablation and TURP groups respectively, with no interventions happening beyond 20 months. The results of this continued follow up study demonstrate the durability of Aquablation compared to TURP at medium term follow up.

To specifically study the effect of novel BPH surgical techniques on sexual function, Bhojani et al assesses three FDA clinical trials (WATER for Aquablation, LIFT for Urolift, and REZUME II for Rezum) and compared IIEF and MSHQ-EjD scores at 3 years.[19] With regards to MSHQ-EjD scores, Aquablation and Urolift showed a positive change at 3 years, with Rezum showing a negative change in that time frame. None of the interventions studied showed a change in IIEF scores from baseline at 3 years. This group demonstrated similar results to other authors, showing a positive association between Aquablation and preserved sexual function, specifically with regards to ejaculatory function.

Future research

While Aquablation has been directly compared to TURP, little research has compared the safety as efficacy of Aquablation to HoLEP. Currently, a prospective, randomized, controlled trial is being undertaken at a Swiss tertiary care center to assess non inferiority of Aquablation compared to HoLEP.[20] This study will be an important comparison, as HoLEP is consider a size independent method for the surgical treatment of BPH per current AUA guidelines.

Conclusions

Aquablation is one of the novel surgical techniques that has been developed for the treatment of BPH. Current studies report on medium-term follow up for patients undergoing this procedure. Aquablation provides comparable operative times to TURP and shorter operative times to HoLEP while having a similar efficacy and safety profile. Newer data has shown that alleviation of LUTS and preservation of sexual function persisted up to 3 years after the procedure. As the technique continues to become more refined and experience further gained, Aquablation will be more widely available and provide a safe and efficacious alternative to TURP and other surgical treatments for the management of LUTS associated with BPH. □

References

1. Wei JT, Calhoun E, Jacobsen SJ. Urologic diseases in america project: benign prostatic hyperplasia. *J Urol* 2008;179(5 Suppl): S75-S80.
2. Patel ND, Parsons JK. Epidemiology and etiology of benign prostatic hyperplasia and bladder outlet obstruction. *Indian J Urol* 2014;30(2):170-176.
3. Parsons JK, Dahm P, Köhler TS, Lerner LB, Wilt TJ. Surgical management of lower urinary tract symptoms attributed to benign prostatic hyperplasia: AUA guideline amendment 2020. *J Urol* 2020;204(4):799-804.
4. Michalak J, Tzou D, Funk J. HoLEP: the gold standard for the surgical management of BPH in the 21(st) Century. *Am J Clin Exp Urol* 2015;3(1):36-42.
5. Roehrborn CG, Teplitsky S, Das AK. Aquablation of the prostate: a review and update. *Can J Urol* 2019;26(4 Suppl 1):20-24.
6. Faber K, de Abreu ALC, Ramos P et al. Image-guided robot-assisted prostate ablation using water jet-hydrodissection: initial study of a novel technology for benign prostatic hyperplasia. *J Endourol* 2015;29(1):63-69.
7. Taktak S, Jones P, Haq A, Rai BP, Somani BK. Aquablation: a novel and minimally invasive surgery for benign prostate enlargement. *Ther Adv Urol* 2018;10(6):183-188.
8. MacRae C, Gilling P. How I do it: Aquablation of the prostate using the AQUABEAM system. *Can J Urol* 2016;23(6):8590-8593.
9. Aljuri N, Gilling P, Roehrborn C. How I do it: Balloon tamponade of prostatic fossa following Aquablation. *Can J Urol* 2017;24(4):8937-8940.
10. Gilling P, Anderson P, Tan A. Aquablation of the prostate for symptomatic benign prostatic hyperplasia: 1-year results. *J Urol* 2017;197(6):1565-1572.
11. Gilling P, Barber N, Bidair M et al. WATER: a double-blind, randomized, controlled trial of Aquablation® vs transurethral resection of the prostate in benign prostatic hyperplasia. *J Urol* 2018;199(5):1252-1261.
12. Desai M, Bidair M, Bhojani N et al. WATER II (80-150 mL) procedural outcomes. *BJU Int* 2019;123(1):106-112.
13. Tanneru K, Jazayeri SB, Alam MU et al. An indirect comparison of newer minimally invasive treatments for benign prostatic hyperplasia: a network meta-analysis model. *J Endourol* 2021;35(4):409-416.
14. Gloger S, Schueller L, Paulics L, Bach T, Ubrig B. Aquablation with subsequent selective bipolar cauterization versus holmium laser enucleation of the prostate (HoLEP) with regard to perioperative bleeding. *Can J Urol* 2021;28(3):10685-10690.
15. Gilling PJ, Barber N, Bidair M et al. Randomized controlled trial of Aquablation versus transurethral resection of the prostate in benign prostatic hyperplasia: one-year outcomes. *Urology* 2019;125:169-173.
16. Plante M, Gilling P, Barber N et al. Symptom relief and anejaculation after aquablation or transurethral resection of the prostate: subgroup analysis from a blinded randomized trial. *BJU Int* 2019;123(4):651-660.
17. Desai M, Bidair M, Zorn KC et al. Aquablation for benign prostatic hyperplasia in large prostates (80-150 mL): 6-month results from the WATER II trial. *BJU Int* 2019;124(2):321-328.
18. Nguyen D-D, Barber N, Bidair M et al. Waterjet ablation therapy for endoscopic resection of prostate tissue trial (WATER) vs. WATER II: comparing Aquablation therapy for benign prostatic hyperplasia in 30-80 and 80-150 mL prostates. *BJU Int* 2020;125(1):112-122.
19. Bhojani N, Yafi FA, Misrai V et al. Review of sexual preservation after novel benign prostatic hyperplasia surgical treatment modalities from Food and Drug Administration clinical trials. *Sex Med Rev* 2021;9(1):169-173.
20. Müllhaupt G, Güsewell S, Schmid H-P et al. Aquablation versus holmium laser enucleation of the prostate in the treatment of benign prostatic hyperplasia in medium-to-large-sized prostates (ATHLETE): protocol of a prospective randomised trial. *BMJ Open* 2021;11(5):e046973.