Aquablation with subsequent selective bipolar cauterization versus holmium laser enucleation of the prostate (HoLEP) with regard to perioperative bleeding

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Introduction: *To compare the surgical methods of Aquablation followed by selective hemostasis by bipolar cauterization with holmium laser enucleation of the prostate (HoLEP) with regard to the risk of perioperative bleeding complications.*

Materials and methods: *A retrospective comparison was carried out on a total of 382 patients who had undergone either Aquablation (n = 167) or HoLEP (n = 215) at our hospital between April 2018 and July 2020. The following were studied: Hb loss, the need for packed red blood cell transfusions and surgical revisions due to bleeding from the prostatic fossa.*

Results: *Transfusions were not necessary in the Aquablation group, while one man who underwent HoLEP had to receive a transfusion. Revision surgery due to bleeding was necessary during the early postoperative course in 13.2% of Aquablations and in 9.8% of HoLEPs (statistically not significant; p = 0.329). The perioperative Hb loss was comparable in both entire collectives (Aquablation 1.37 ± 1.13 mg/dL, HoLEP 1.22 ± 1.03 mg/dL; statistically not significant; p = 0.353). For subgroup analysis the groups Aquablation and HoLEP were into three subgroups respectively according to sonographically determined preoperative prostate volume ("small" < 40 mL, "medium" 41-80 mL, "large" > 80 mL). There were no significant differences between the subgroups regarding need for transfusions and hematuria-related complications.*

Conclusions: *The rate of perioperative hematuria related complications of Aquablation with subsequent selective hemostasis equals those found after holmium laser enucleation.*

Key Words: benign prostate obstruction, Aquablation, hematuria, selective cauterization, HoLEP

Introduction

Aquablation is a novel method for subvesical desobstruction of the prostate. It is used in men who suffer from lower urinary tract syndrome (LUTS) due to benign prostate obstruction (BPO) and for whom drug therapy has failed. Usually, these men require surgical intervention, which enables urination by reducing the obstructing prostate tissue.

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The special feature of the surgical procedure in Aquablation compared to conventional, thermal procedures such as transurethral resection (TURP) or holmium laser enucleation of the prostate (HoLEP) consists firstly in using a surgical robot, which performs the actual resection after the surgeon has set the appropriate resection margins, and secondly in using a high-pressure water jet to remove the obstructing tissue. The method is of interest particularly because of the safety profile of Aquablation: it conserves the sphincter, prevents strictures of the bladder neck and urethra and preserves antegrade ejaculation in a very high proportion of men. The prospective randomized WATER and WATER II studies provided evidence that Aquablation led to significant improvements

in urine flow, International Prostate Symptom Score (IPSS) and quality of life, which are equivalent to those of TURP.[1,2]

It has been under debate whether athermal Aquablation on its own ensures adequate perioperative hemostasis in the resection bed. Some studies with entirely missing cautery have described bleeding complications of up to 10%.[2] Consequently, several working groups have switched over to selectively stopping bleeding sources at the bladder neck and in the prostate resection bed using conventional cauterization immediately after Aquablation. To ensure postoperative hemostasis, the selective cauterization was set up at the same time as Aquablation therapy in our hospital.

In this study, we retrospectively investigated the perioperative bleeding risks of Aquablation with subsequent selective hemostasis and compared them with consecutive HoLEPs from the same time period at our institution. HoLEP is regarded as one of the main methods of transurethral desobstruction surgery with few perioperative bleeding risks.[3,4]

Materials and methods

Between April 2018 and July 2020 in our hospital, a total of 187 men underwent Aquablation with subsequent selective cauterization to treat subvesical obstruction. To avoid potential bias due to the initial learning curve, we excluded the first 20 patients so that 167 patients were included in the analysis. This intervention group was compared with 215 patients who underwent HoLEP in our hospital over the same period.

Aquablation was performed using the Aquabeam system (PROCEPT BioRobotics, Redwood City, CA, USA) and followed the surgical procedure already described in the literature.[5,6] Briefly, the first step consisted in adjusting the prostate in the transversal and sagittal plane using transrectal ultrasound. A 24 Ch handpiece was then introduced transurethrally, its position correctly set with the aid of transrectal ultrasound and blocked with a hinged bracket. The resection margins were then marked in transverse and sagittal planes using a digital planning unit, with the maximum resection depth at 2.43 cm and the maximum resection angle at 225 degrees. The obstructive prostate tissue was then resected robotically by the handpiece under constant ultrasound monitoring.

Each patient in our hospital then received selective hemostasis on the bladder neck and in the prostate resection bed by means of bipolar cauterization while preserving the prostatic resection cavity as it had been previously carved by the Aquablation process. Although hemostasis time was not recorded separately, it had been agreed between surgeons, that a maximum time of 15 minutes would be acceptable and we used an alarm clock to remind the surgeon of this time limit. After completion of the surgery, an irrigation catheter was inserted, which was left in situ for at least 2 days.

HoLEP was performed according to the usual procedure[3,7,8] by enucleating the obstructing prostate tissue inside and along the surgical prostate capsule. The excised prostatic lobes were then morcellated in the bladder and suctioned off, and an irrigation catheter, similar as for Aquablation, was inserted and left in situ for 2 days.

We retrospectively collected the demographic parameters of the patient collective for data analysis. This included the prostate volumes measured preoperatively by ultrasound, PSA values, preoperative and postoperative hemoglobin concentrations, administration of oral anticoagulants and subjective voiding symptoms, which were objectified using the IPSS. Perioperative bleeding complications were defined as complications that occurred within the first 6 postoperative weeks from the date of surgery.

For the purpose of statistical analysis the patients were divided into three different groups according to the prostate volumes measured preoperatively by ultrasound - patients with prostates up to 40 mL ("small"), between 41 and 80 mL ("medium") and greater than 80 mL ("large").

The patient outcome investigated was perioperative bleeding complications, i.e. bleeding-induced surgical revisions for coagulation and tamponade evacuation, need for transfusions of packed red blood cells and perioperative drop in Hb.

For the statistical analysis, the data were then checked for normal distribution in each collective. If the normal distribution hypothesis was not rejected (p value ≥ 0.1), the comparison of two groups was carried out using the t-test. If the normal distribution hypothesis was rejected, the Mann-Whitney-U test was used for the two groups. Fisher's exact test was used to compare the frequency distributions of a categorical variable of independent groups. The statistical analyses were supported by an accredited biostatistician.

Results

There were no significant differences between the two groups HoLEP and Aquablation concerning preoperative symptoms regarding IPSS (Aquablation

TABLE 1. **Patient characteristics. The Aquablation collective was on average approximately 6.1 years younger than the men in the HoLEP group. The preoperative PSA values of the men in the Aquablation group were statistically significantly lower (approx. 4.4 ng/mL) and the prostate volume was smaller (38.8 mL)**

Characteristic	Aquablation (n = 167)	HoLEP (n = 215)	p value
Age, mean years (SD)	64.7 (9.3)	70.8 (8.6)	< 0.001
Mean perioperative PSA in ng/mL (SD)	4.317 (5.031)	8.716 (11.825)	< 0.001
Mean preoperative prostate volume in mL (SD)	56.2 (24.5)	95.0 (46.7)	< 0.001
Mean preoperative hemoglobin concentration in mg/dL (SD)	14.46 (1.27)	14.17 (1.45)	0.079
Administration of oral anticoagulants (%)	38 (22.8)	63 (29.3)	0.162

20.3 ± 6.7 points, HoLEP 17.8 ± 7.4 points). The preoperative Hb concentrations were also comparable (Aquablation 14.46 ± 1.27 mg/dL, HoLEP 14.17 ± 1.45 mg/dL). Thirty-eight men (22.8%) in the Aquablation collective took platelet aggregation inhibitors and 63 (29.3%) in HoLEP (p = 0.162), Table 1. Oral anticoagulants such as phenprocoumon or DOACs were stopped at the appropriate time before surgery and low-molecular weight/unfractionated heparins administered as a bridge.

However, both collectives showed statistically significant differences in mean age during treatment (Aquablation 64.7 ± 9.3, HoLEP 70.8 ± 8.6; p < 0.001) and preoperative PSA value (Aquablation 4.32 ± 5.03 ng/mL, HoLEP 8.72 ± 11.83 ng/mL; p < 0.001). The preoperative prostate volumes determined by ultrasound were statistically significantly greater in HoLEP as a whole than in Auablation (Aquablation 56.2 ± 24.5 mL, HoLEP 95 ± 46.7 mL; p < 0.001), Table 1.

Surgery time was statistically significantly shorter for Aquablation than for HoLEP (Aquablation 44.8 ± 17.1 min, HoLEP 80.5 ± 29.5 min).

Transurethral revision surgery due to bleeding was necessary within the first 6 postoperative weeks in 13.2% of Aquablations and in 9.8% of HoLEP operations (statistically not significant; p = 0.329). Approximately 91% of revisions in both groups were performed in the first 10 days after the intervention.

No patient in the Aquablation group required a postoperative blood transfusion while one patient in

TABLE 2. **Operative data for the total collective. There was no significant difference between the study groups based on the perioperative Hb loss and the bleeding-related re-intervention rates. No transfusions were necessary in the Aquablation group, while one patient in the HoLEP collective required a transfusion**

Characteristic	Aquablation (n = 167)	HoLEP (n = 215)	p value
Mean perioperative Hb drop in mg/dL (SD)	-1.37 (1.13)	-1.22 (1.03)	0.353
Need for transfusions (%)	0 (0.0)	1 (0.5)	1.0
Bleeding-related revision operations overall (% of collective)	22 (13.2)	21 (9.8)	0.329
Bleeding-related revision operations in 2 days (% of all revisions)	15 (68.2)	9 (40.9)	
Bleeding-related revision operations in 10 days (% of all revisions)	20 (90.9)	19 (90.4)	
Bleeding related rehospitalization (% of collective)	6 (3.6)	12 (5.6)	0.468
Hospital time in days (SD)	3.9 (2.0)	3.4 (1.6)	0.001
Catheter time in days (SD)	4.2 (4.8)	3.0 (2.5)	0.002

the HoLEP group received a blood transfusion on Day 2 post-surgery, Table 2.

In the Aquablation group as a whole, Hb dropped during postoperative hospitalization by an average of 1.37 ± 1.13 mg/dL, whereas Hb dropped 1.22 ± 1.03 in the HoLEP collective (statistically not significant; p = 0.353). Hospitalization time was 3.9 ± 2.0 days for the Aquablation group and 3.4 ± 1.6 days for the HoLEP group (p = 0.001). Catheter time was significantly longer in Aquablation than in HoLEP (Aquablation 4.2 ± 4.8 days, HoLEP 3.0 ± 2.5 days; p = 0.002).

Aquablation group and HoLEP were divided into three subgroups according to their preoperative prostate volume for a subgroup analysis according to size: "small" subgroup (≤ 40 mL; HoLEP 9 patients, Aquablation 55 patients), "medium" (41-80 mL; HoLEP 94 patients, Aquablation 89 patients) and "large" (> 80 mL; HoLEP 87 patients, Aquablation 23 patients), Table 3. The "small" subgroup contained predominantly Aquablations and the "large" subgroup HoLEPs. The groups were almost equally distributed in the "medium" subgroup.

Even in these subgroup analyses, there were no significant differences between Aquablations and HoLEPs for revision surgery due to bleeding. Only the Hb value, measured during hospitalization, dropped significantly more in the group of patients with large prostate ("large") in Aquablation, Table 3.

Discussion

Prospective randomized studies have already shown the effectiveness of Aquablation in subjective symptom improvement of patients with LUTS when compared to established procedures such as TURP. Urine flow improves postoperatively to a similar degree, and post-void residual urine volume is also reduced statistically significant similar to TURP.[1,9,10] Other advantages of Aquablation that emerge are very high rates of postoperative preservation of antegrade ejaculation up to 90%, a steeper learning curve for the surgeon and short resection times virtually independent of the prostate volumes. While leading to good desobstruction and urine flow, the robot-assisted method has a very high safety profile for sphincter protection and preventing incontinence.[1,2,11]

Due to the newness of the method, there are no long term results yet. However, existing evidence already shows that functional improvements for the patients are lasting at least 36 months following the intervention and continue to be comparable to TURP.[12,13]

Compared to other established methods for removal of parenchymal tissue such as TURP and HoLEP, Aquablation is a purely athermal procedure based on a high-pressure water jet and therefore does not involve any hemostasis in the prostate resection bed.

TABLE 3. **Operative data for the subgroups. There were no significant differences in any of the subgroups for bleeding-related revisions. The transfusion in the HoLEP group occurred in the "large" subgroup. There were no significant differences in the "small" and "medium" subgroups for Hb drop, but the Hb drop was statistically significantly greater in the Aquablation group in the "large" subgroup**

Characteristic	**Aquablation (n = 167)**	**HoLEP (n = 215)**	**p value**
Small (< 40 mL)	**(n = 55)**	**(n = 9)**	**s.**
Mean perioperative Hb drop in mg/dL (SD)	-0.89 (0.89)	-0.62 (0.66)	0.411
Need for transfusions (%)	0 (0)	0 (0)	
Bleeding-related revision operations (%)	6 (10.9)	0 (0)	0.582
Medium (41-80 mL)	**(n = 89)**	**(n = 94)**	**n. s.**
Mean perioperative Hb drop in mg/dL (SD)	-1.55 (1.15)	-1.21 (0.98)	0.06
Need for transfusions (%)	0 (0)	0 (0)	
Bleeding-related revision operations (%)	12 (13.5)	11 (11.7)	0.824
Large (> 80)	**(n = 23)**	**(n = 87)**	**s.**
Mean perioperative Hb drop in mg/dL (SD)	-1.83 (1.17)	-1.26 (0.96)	0.011
Need for transfusions (%)	0	1 (1.1)	1.0
Bleeding-related revision operations (%)	4 (17.4)	8 (9.2)	0.217

In the WATER II study, a transfusion rate of 5.9% was reported in men with prostate volumes > 80 mL during hospitalization. A further 5.9% of patients had to be admitted again for hospitalization within 1 month after surgery for further treatment for postoperative bleeding.[2] Although other studies have described lower transfusion rates between 1.3% and 4% and the transfusion rate was reported 3.9% across the studies,[1,10,14,15] intense efforts have been made to develop bleeding management strategies to further reduce both perioperative bleeding from the prostate resection bed and transfusion rates.

Recently, several working groups have introduced selective electrocoagulation of the prostate resection bed immediately after Aquablation. We started doing this systematically with our third Aquablation patient. To ensure hemostasis, selective bipolar cauterization was used to stop active bleeding at the bladder neck and in the prostate bed after washing out blood clots. Thus, the Aquablation profile, which is planned by the surgeon and generated using a high-velocity water jet under robotic assistance, is conserved in the prostate bed. The selective cauterization was limited to a maximum 15 minutes in this study. At the end of the procedure a transurethral irrigation catheter was inserted, which was left indwelling for 2 days routinely. If necessary, continuous bladder irrigation was carried out. Under this regime we did not have to transfuse any patients in our Aquablation group (0%), although catheter time and hospitalization were significantly longer in the Aquablation group, Table 2.

As far as we know, our study is the first that compares HoLEP and Aquablation with routinely subsequent selective cauterization for bleeding complications from the prostatic resection fossa. None of the 167 consecutive Aquablation patients in our study required a transfusion, whereas one patient in the HoLEP group had to receive a transfusion (0.5%). Other HoLEP studies reported a transfusion risk of 0.2 and 2.2%.[16,17] Thus, the tranfusion rate in our HoLEP group lies within the range of the reports in the literature.

A gauge for postoperatively achieved hemostasis in the prostate resection bed is the need for secondary transurethral coagulation treatment. Bach et al recently reported transurethral reinterventions due to hematuria in 7.9% of Aquablations,[10] occurring in 13.2% in our study.

For HoLEP, secondary bleeding related reintervention rates have been reported with 1,9% to 5,1% in contemporary series.[18-21] In our study, 9,8% of HoLEP patients underwent a secondary transurethral coagulation of the prostatic resection cavity, Table 2.

The fact, that we report higher reintervention rates for both Aquablation and HoLEP than in the current literature may reflect our specifically aggressive strategy for the treatment of postoperative hematuria and may also explain a comparably low overall transfusion rate of 0.26% in 382 surgeries for BPH in our study.

In both groups, more than 90% of the transurethral revisional surgery took place within the first 10 days following initial treatment. Two patients in each group received late coagulation treatment after postoperative day 10 (Aquablation 1.2%, HoLEP 0.9%). Hematuria related rehospitalization was necessary for 5.6% of HoLEP and 3.6% of Aquablation patients (statistically not significant, p = 0.468).

We found no statistically significant differences between Aquablation and HoLEP regarding postoperative secondary interventions or transfusions. This was also true for bleeding related rehospitalizations, Table 2.

As expected, our Aquablation patients were on average younger and had a lower preoperative prostate volume than our HoLEP patients. Therefore, we carried out subgroup analyses according to prostate size. Between subgroups of small (< 40 mL), medium (41-80 mL) and large (> 80 mL) prostates there were no statistically significant differences regarding transfusion risk or secondary transurethral coagulation of the prostatic resection cavity within the first 6 postoperative weeks, Table 3. In the Aquablation group, a statistically significantly greater drop in serum hemoglobin was only found in the group of prostates over 80 mL, but is probably clinically insignificant.

It is of interest that systematic, selective electrocauterization has not yet been reported in any of the existing Aquablation studies. We were able to show in this study that the combination of Aquablation with subsequent selective cauterization produces the same perioperative bleeding risk as for that of a HoLEP collective and that no patient was transfused. The amount of time for cauterization was limited to 15 minutes in our study. It seems to us that the additional time spent on hemostasis by cauterization is manageable and acceptable.

Aquablation is a modern and, compared to HoLEP, prostate parenchymal sparing resection method with good desobstruction of the prostate bed. It has a good safety profile for sphincter preservation, learning curve and maintaining antegrade ejaculation. We found that the systematic combination of Aquablation with selective cauterization led to a transfusion risk of 0% in our study and to rates of secondary transurethral coagulations equivalent to HoLEP.

Limitations

This was a retrospective, monocentric design. Differences between Aquablation and HoLEP regarding prostate volume, PSA values and age were addressed by comparing prostate volume dependent subgroups. These demonstrated no differences in subgroup "small" and "medium" while subgroup "large" only differed in perioperative Hb loss.

Conclusions

The results of this retrospective study indicate that the risk of perioperative blood loss, postoperative reinterventions or blood transfusions after Aquablation followed by selective transurethral hemostasis is equivalent to HoLEP. Nevertheless, prospective randomized, controlled trials need to be carried out to confirm the results of our study and must be related to efficacy data. □

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