Safety and clinical outcomes of GreenLight laser prostatectomy in octogenarians

Anastasia MacDonald[1], Moustafa Fathy[1,2], Parsa Nikoufar[1], Amr Hodhod[1], Ruba Abdul Hadi[1], Sai K. Vangala[1], Mohammed Bassuony[3], Ahmed S. Zakaria[1], Walid Shahrour[1], Hazem Elmansy[1]
[1] Urology Department, Thunder Bay Regional Health Sciences Centre, Northern Ontario School of Medicine, Thunder Bay, ON, Canada; [2] Urology Department, Menoufia Faculty of Medicine, Menoufia, Egypt; [3]Internal Medicine Department, Thunder Bay Regional Health Sciences Centre, Northern Ontario School of Medicine, Thunder Bay, ON, Canada

Cite as: MacDonald A, Fathy M, Nikoufar P, et al. Safety and clinical outcomes of GreenLight laser prostatectomy in octogenarians. *Can Urol Assoc J* 2023 November 20; Epub ahead of print. http://dx.doi.org/10.5489/cuaj.8482

Published online November 20, 2023

Corresponding author: Dr. Hazem Elmansy, Urology Department, Thunder Bay Regional Health Sciences Centre, Northern Ontario School of Medicine, Thunder Bay, ON, Canada; hazem.mansy@rocketmail.com

***

ABSTRACT

Introduction: We evaluated the impact of age on perioperative morbidity and clinical outcomes in patients undergoing GreenLight laser prostatectomy for benign prostatic hyperplasia (BPH).
Methods: We conducted a retrospective study of prospectively collected data from individuals who underwent GreenLight laser prostatectomy from May 2018 to July 2022. Patient demographics and outcome measures were recorded, including indications for the procedure and American Society of Anesthesiology (ASA) scores. All patients had postoperative followup visits at one, three, six, and 12 months. Our evaluation included the International Prostate Symptom Score (IPSS), quality of life (QoL) assessment, maximum urinary flow rate (Qmax), postvoid residual volume (PVR), and catheter-free status.
Results: One-hundred-sixty-eight males who underwent GreenLight laser prostatectomy were included. The non-octogenarian group consisted of 111 patients and the octogenarian group comprised 57 individuals. Based on ASA scores, most octogenarians were deemed high-risk (ASA III: 91.2%), while over half of non-octogenarians were lower-risk (ASA II: 53.2%) ($p<0.001$). Intraoperative parameters, including operative time, vaporization time, lasing time, and energy did not differ significantly between groups. There was no difference in the proportion of intraoperative complications between non-octogenarians and octogenarians (0.9% vs. 3.5%). Postoperative complications were not statistically significant between the two groups ($p=0.608$). There was also no observed difference in the proportion of patients requiring readmission ($p=0.226$) or retreatment ($p=1.0$).
Conclusions: GreenLight laser prostatectomy is a safe and effective treatment for BPH regardless of age. It provides similar surgical and functional outcomes as younger men while maintaining the QoL of octogenarians.

INTRODUCTION

Benign prostatic hyperplasia (BPH) is a common medical condition in aging men, associated with progressive lower urinary tract symptoms (LUTS). Such symptoms have been attributed to decreased quality of life (QoL)[1,2]. The progression of BPH-associated LUTS to a stage requiring medical or surgical management has been directly correlated to age [3].

The proportion of individuals living to reach the age of 80 years or older, termed "octogenarians", has steadily increased over time. According to Statistics Canada, individuals aged 85 and older are among the fastest-growing age groups, representing a 12% increase between 2016 and 2021[4]. Due to advances in medical technology and the growing elderly population, individuals are presenting for surgical management of BPH at older ages and with more comorbidities[5]. This poses a challenge to urologists, as increased comorbidities are associated with increased risk of perioperative morbidity and mortality[6]. In fact, age was defined as an independent risk factor in transurethral resection of the prostate (TURP), the historical gold standard in surgical intervention for BPH[7]. Previous literature has identified an 11.1% short-term morbidity rate with TURP, with the most relevant complications being failure to void, significant urinary tract infection, bleeding requiring transfusions, and transurethral resection syndrome[8]. Ultimately, the goals of surgical intervention in elderly populations with BPH are reducing perioperative morbidity and improving quality of life[5,9]. As such, minimally invasive, laser-based procedures have become a favourable alternative to TURP due to their improved safety profiles and similar functional outcomes[10]. Among these options is GreenLight photovaporization of the prostate (PVP).

GreenLight PVP has been shown to be a safe and effective surgical option for high-medical-risk (HMR) and elderly patients[11,12]. Previous research has suggested that age did not significantly impact the safety or efficacy of GreenLight PVP treatment in patients[13]. However, a direct comparison of perioperative complications between octogenarians and younger patient populations has not been assessed. In the present study, we evaluate the comorbidities and outcomes in octogenarian populations undergoing GreenLight PVP.

METHODS

Following Research Ethics Board approval, we performed a retrospective review of a prospectively collected database of patients who underwent laser vaporization of the prostate using GreenLight PVP at our institution from May 2018 to July 2022.

Study population

One hundred sixty-eight males were included in our study. Patients were excluded if they had previously undergone surgical treatment for BPH, had a history of prostate cancer, urethral stenosis, neurogenic bladder, had an active urinary tract infection or bladder stones, or had an incomplete one-year follow-up. Participants were stratified into two groups based on age: <80 and ≥80 years.

Preoperative data included patient demographics, medical history, physical examination, and anticoagulation or antiplatelet therapy use. The indication for surgery was also documented, including LUTS, recurrent hematuria of prostatic origin, and urinary retention. Various questionnaires were given to the participants to assess their International Prostate Symptom Score (IPSS) and quality of life (QoL). All patients underwent basic laboratory testing, including prostate-specific antigen (PSA) levels, uroflowmetry, post-void residual volume (PVR), and a

transrectal ultrasound (TRUS), to estimate prostate volume. If medically feasible, participants were instructed to temporarily hold their anticoagulant and antiplatelet medications prior to surgery for 3 and 7 days, respectively. Intraoperative parameters, postoperative outcomes, disposition, and readmission data were collected and analyzed.

Surgical technique
All surgeries were performed by one of two experienced urologists using the GreenLight XPS™ Laser System (Boston Scientific, Marlborough, MA) with the MoXy™ 532-nm fiber and settings of 80–180-Watt output for GreenLight laser PVP. All procedures were performed identically, including ablation down to the capsule. Laser vaporization time was defined as the duration of time to carry out the laser portion of the procedure.

Routine postoperative
All patients had a three-way Foley catheter (22 F) with 30 mL of sterile water in the balloon placed in the operating room. They were kept on mild traction with continuous bladder irrigation (CBI) for 2 hours, which was then stopped for an additional hour. Predetermined discharge criteria included if the patient was medically fit, had a caregiver, was not on anticoagulant or antiplatelet medications at the time of surgery and met Post Anesthesia Care Unit (PACU) discharge criteria[14].

After undergoing an assessment by the operating surgeon for discharge, all patients were offered a same-day trial of void (TOV) 3 hours postoperatively using the same protocol as our previous publication[15]. Patients with preoperative factors such as an unfit medical condition, including a cognitive disorder, anticoagulant therapy, and uncontrolled cardiovascular disease, were ineligible for early discharge. Participants who declined a same-day TOV were sent home with a foley catheter, and a TOV was arranged the following day.
Patients were deemed eligible for discharge if they fulfilled the PACU discharge criteria based on the post-anesthesia recovery discharge score[14]. Participants were required to have an acceptable urine colour without CBI, absence of clots, PVR <300 mL, and a residual volume of less than half the voided volume. Other discharge criteria included acceptable postoperative laboratory values, independent ambulation, and the ability to tolerate a diet.

Followup
Patients were followed up at 1, 3, 6, and 12 months. Follow-up visits involved clinical examination, IPSS, QoL, PSA, flowmetry, a bladder scan for PVR, and cystoscopy if clinically indicated.

A subanalysis was performed to compare octogenarians and non-octogenarians who were on anticoagulants before surgery. Additionally, a separate comparison was carried out for those who presented with urinary retention. We assessed and compared the preoperative, operative, and 12-month follow-up data for both cohorts.
Statistical Analysis

Data were collected and analyzed using Statistical Package for the Social Sciences (SPSS®) version 26.0 (Chicago, IL, USA). Continuous data were presented using medians and ranges and compared with the Mann-Whitney U Test. Categorical data were described using numbers and percentages and were compared with the Chi-Square test. A p-value <0.05 was deemed statistically significant.

RESULTS

Preoperative data

We identified 168 males who met the inclusion criteria. Among the patients, 111 (66%) were under the age of 80 (non-octogenarians), while 57 (34%) were 80 years or older (octogenarians). The median ages of the non-octogenarian and octogenarian groups were 69 and 85 years, respectively. The participants' preoperative characteristics are summarized in Table 1.

The American Society of Anesthesiology (ASA) scores[16] differed significantly between the two groups, with the majority of octogenarians (91.2%) categorized as ASA III, compared to 39.6% of non-octogenarians ($p<0.001$). The octogenarian group had a higher proportion of individuals on anticoagulants than the non-octogenarian group (54.4% vs. 30.6%, respectively, $p=0.002$). A total of 4 patients (two from each group) were on antiplatelets or anticoagulants during surgery as per the cardiologist's recommendation. The octogenarians also had a longer median preoperative catheter time (9 months vs. 7.5 months, $p=0.048$). However, the number of patients with a preoperative catheter did not differ significantly between octogenarians and non-octogenarians (49.1% vs. 53.2%, respectively). The median preoperative prostate size, Qmax, PVR, IPSS, and QoL scores were not significantly different between the two groups.

Intraoperative data and immediate postoperative outcomes

The intraoperative parameters and immediate postoperative outcomes are summarized in Table 2. The operative time was similar between both cohorts. Other intraoperative parameters, including vaporization time, lasing time, and energy, did not differ significantly between groups. There was no difference in the proportion of intraoperative complications between non-octogenarians and octogenarians (0.9% vs. 3.5%, respectively). One non-octogenarian and two octogenarians had bleeding that was not controlled by GreenLight PVP and required TURP for coagulation. The median change in hemoglobin and the proportion of patients requiring transfusion were not found to be statistically different. The median length of hospital stay and duration of postoperative catheterization were similar between the two cohorts.

Postoperative data

Table 3 illustrates postoperative outcomes and complications. There was no significant difference observed between the proportion of patients who had a successful first TOV and those who experienced recurrent retention following TOV.

Postoperative complications, assessed using the modified Clavien classification system, were not statistically significant between the two groups ($p=0.608$). There was also no observed difference in the number of patients requiring readmission ($p=0.226$) or retreatment ($p=1.0$). We observed 10 participants from the non-octogenarian group, and 5 from the octogenarian group, develop prolonged or severe gross hematuria requiring CBI (Clavien I).

In the non-octogenarian cohort, there was a single case of fungal urinary tract infection (Clavien II) and one case of deep vein thrombosis (Clavien II) reported. Additionally, in the octogenarian group, there was a single case of febrile urinary tract infection (Clavien II). All patients with Clavien II complications were readmitted to the hospital. One occurrence of a Clavien IV complication, a myocardial infarction (MI), occurred in the non-octogenarian group. The patient was not discharged postoperatively and remained in the hospital for 14 days, including time in the intensive care unit (ICU).

Long-term complications included one case of bladder neck contracture resulting in a laser bladder neck incision in the non-octogenarian group and two cases of urethral stricture in octogenarians who opted for conservative treatment.
Functional outcomes at 1, 3, 6, and 12 months following surgery are demonstrated in Table 3. The subjective and objective functional parameters showed significant improvement immediately after surgery compared to preoperative parameters.

There were no significant differences in IPSS and QoL outcomes between the two groups during the entire follow-up period.

Qmax was significantly lower in the octogenarian group at 1 month (13mL/s vs. 17.6mL/s, p=0.016), 3 months (13.6mL/s vs. 21mL/s, p=0.035), 6 months (9.5mL/s vs. 20mL/s, p=0.003), and 12 months (9.2mL/s vs. 21.3mL/s, p=0.010) postoperatively. PVR did not differ significantly between the two cohorts, except at the 1 month and 12-month follow-up visits, where it was significantly higher in the octogenarian group.
The median PSA values significantly decreased in both study arms at 3 months postoperatively, with no significant difference in the percentage of PSA reduction between the groups.
At 12 months, there was no significant difference in the proportion of patients who were catheter-free. All of the patients who remained catheter-dependent initially presented with chronic urinary retention preoperatively. One patient in the non-octogenarian group experienced recurrent retention. A cystoscopy was performed at 6 months postoperatively which revealed a residual adenoma, prompting a re-greenlight laser prostatectomy. One patient in the octogenarian group had persistent urgency at 6-month follow-up and was managed with mirabegron, a beta-3 adrenergic receptor agonist.

When comparing octogenarian and non-octogenarian patients who were on anticoagulants before surgery and those who presented with urinary retention, the preoperative and operative parameters were comparable between both groups, except for age. The subanalysis for patients on anticoagulants or those who presented with urinary retention revealed a significant difference between the cohorts in terms of Qmax and PVR at the end of the follow-up period.

DISCUSSION

Older individuals not only face a greater risk of experiencing bothersome LUTS, but they are more likely to have significant comorbidities that pose challenges to the safety of potential surgical interventions[3,5,17].

Despite an increasing proportion of octogenarians receiving various forms of laser prostatectomy[5], few studies have assessed the safety and efficacy of the GreenLight laser in patients ≥ 80 years. As such, we compared the preoperative characteristics, perioperative complications, and postoperative outcomes of non-octogenarians (n=111) and octogenarians (n=57) undergoing GreenLight PVP at our center. The principal investigator performs laser prostatectomy and water vapour therapy. Patients with prostate sizes > 80 grams qualify for anatomical endoscopic enucleation of the prostate (AAEP) using either the holmium laser (HoLEP) or thulium fiber laser (ThuFLEP). Smaller-sized prostates are managed with GreenLight laser therapy or water vapour therapy. However, despite having a prostate size of 97 and 113 grams, two patients from the non-octogenarian group opted for GreenLight laser

prostatectomy. Their decision was motivated by a desire to avoid the transient stress incontinence typically associated with AAEP.

At baseline, the two cohorts were largely comparable. Though, based on the ASA score, most octogenarians were deemed high risk (ASA III: 91.2%, ASA IV: 7%), while over half of the non-octogenarians were lower risk (ASA I: 3.6%, ASA II: 53.2%). Considering that the ASA score is a subjective measure to assess the physical health of patients[16], this demonstrates that octogenarians are generally more medically complex than their younger counterparts.

Our study did not identify a significant difference with respect to the total operative time, vaporization time, lasing time, and energy used between individuals above and below age 80. There have been contradictory findings regarding the variations in these parameters among patients of different ages who undergo various forms of laser prostate surgery [13,18-20].

In a recent database study conducted by Deyirmendjian et al.[20], analyzing the safety and efficacy of GreenLight PVP in octogenarians, it was found that octogenarians exhibited a significantly longer lasing time and higher energy requirement based on univariate analysis, although this difference was not observed with multivariate analysis. Interestingly, Deyirmendjian et al.[20] also observed a larger preoperative prostate volume and elevated PSA in their octogenarian group, which were not identified in our study.

Postoperative hospitalization and catheterization are frequently used indicators of success in studies evaluating the outcomes of laser prostatectomy. In our study, there was no statistically significant difference observed in both parameters between octogenarians and their younger counterparts. Both groups had a median postoperative catheterization time and median length of postoperative hospitalization of one day.

Liu et al.[12] reported that in a group exclusively comprising patients aged 80 years or older, the mean catheterization time after GreenLight prostatectomy was 2.7 days, and the mean length of postoperative hospital stay was 3.5 days. Similarly, Deyirmendjian et al.[20] found no significant difference between groups, with a median hospitalization length of 2 days observed in both octogenarians and non-octogenarians who underwent GreenLight PVP.

In their study, Gu et al.[13] reported that all patients, irrespective of age, were discharged on the same day as their GreenLight PVP procedure. Although variations in the length of hospital stay may be influenced by physician practices at individual sites, all studies consistently report no significant differences in either parameter between older and younger populations.

Not only can these parameters be used as measures of perioperative success in laser prostatectomy, but both prolonged catheterization and hospitalization time are also associated with a higher incidence of morbidity in elderly patients [21,22]. Previous studies evaluating the safety of laser-based alternatives to TURP, including GreenLight and HoLEP, have consistently suggested favourable safety profiles in high-risk groups and elderly patients[9,11,13,18].

Our study used the modified Clavien classification system[23] to classify complications. Overall, we found a comparable incidence of complications across all Clavien grades in both groups. Other studies that utilized the Clavien classification system reported similar findings when comparing younger and older cohorts following surgical intervention for BPH.

Mmeje et al.[18] demonstrated no significant differences in complications (across all Clavien grades) among four age groups undergoing HoLEP, including a group composed of patients aged 80 or older. Similarly, Raizenne et al.[24] recently reported no significant differences

in the incidence of complications (across all Clavien grades) following Aquablation in patients above and below 70 years old.

Interestingly, in our study, we observed a higher incidence of complications in the younger cohort, including a case of MI (Clavien IV), although this difference was not deemed to be statistically significant. These findings may suggest that individual risk factors play a more significant role in postoperative complications compared to age.

Our study did not identify a statistically significant difference in the readmission rates between octogenarian and non-octogenarian patients after hospital discharge (1.8% vs. 1.8%, respectively). These findings are consistent with Heiman et al.[19], who also reported no difference in hospitalization rates between octogenarian and non-octogenarians following HoLEP (5.7% vs. 3.9%, respectively).

In contrast, Deyirmendjian et al.[20] identified a significantly higher risk of readmission in the octogenarian group compared to non-octogenarians (23% vs. 11.9%, respectively). In comparison, our study had relatively lower rates of readmission, which may be attributed to our smaller sample size.

We observed improvements in Qmax and PVR in both groups when comparing preoperative and postoperative measurements, suggesting favourable functional outcomes after Greenlight PVP, regardless of age.

Although both groups showed improvement, the octogenarian group consistently had a lower median Qmax, while PVR did not differ significantly between the two groups, except at the 1-month and 12-month follow-up visits, where it was significantly higher in the octogenarian group. This trend aligns with the findings of Deyirmendjian et al.[20] in octogenarians undergoing GreenLight PVP and Mmeje et al.[18] in octogenarians undergoing HoLEP.

This observation may be attributed to the hypotonicity commonly associated with the aging bladder and the prolonged recovery of detrusor function in these patients. The detrusor muscle tends to lose tonicity with age, and older patients often experience prolonged periods of BPH-related obstruction, resulting in additional damage[25,26]. Following surgery and the removal of the obstruction, it may take longer for detrusor contractility to recover fully.

Although the subanalysis of patients on anticoagulants or those who presented with urinary retention yielded similar results to the overall comparison between cohorts, additional studies are necessary to validate these findings through comprehensive comparative analyses.

While none of the studies identified a notable increase in PVR at one year postoperative, fluctuations in PVR values over the follow-up period have been observed[18,20]. Our study has several limitations, including its retrospective nature. It was also conducted at a single center which introduces the possibility of selection bias. Moreover, the relatively small size of our octogenarian group may not fully represent the diversity within this age group. Lastly, we did not assess urodynamic studies, which could have provided further insights into the differences in Qmax and PVR between the two groups.

CONCLUSIONS

GreenLight laser prostatectomy demonstrates a favourable safety profile with acceptable perioperative morbidity, even in patients 80 years and older, despite their higher medical comorbidities. Our study revealed no increase in operative or postoperative complication rates and comparable hospital stays between octogenarians and non-octogenarians. Moreover,

GreenLight laser prostatectomy yields good functional outcomes and improves the quality of life for octogenarians. However, further investigation is warranted to assess trends in PVR among the octogenarian population over a longer follow-up period. This data would provide valuable insights into the long-term efficacy of GreenLight prostatectomy in this specific age group.

REFERENCES

1. Coyne KS, Wein AJ, Tubaro A, et al. The burden of lower urinary tract symptoms: Evaluating the effect of LUTS on health-related quality of life, anxiety and depression: EpiLUTS. *BJU Int* 2009;103:4-11. https://doi.org/10.1111/j.1464-410X.2009.08371.x
2. Lee SWH, Chan EMC, Lai YK. The global burden of lower urinary tract symptoms suggestive of benign prostatic hyperplasia: A systematic review and meta-analysis. *Sci Rep* 2017;7:7984. https://doi.org/10.1038/s41598-017-06628-8
3. Egan KB. The Epidemiology of benign prostatic hyperplasia associated with lower urinary tract symptoms: Prevalence and incident rates. *Urol Clin North Am* 2016;43:289-97. https://doi.org/10.1016/j.ucl.2016.04.001
4. S H. A portrait of Canada's growing population aged 85 and older from the 2021 Census. Government of Canada, Statistics Canada. 2022. https://www12.statcan.gc.ca/censusrecensement/2021/as-sa/98-200-X/2021004/98-200-x2021004-eng.cfm (accessed April 27 2022).
5. Elshal AM, Elmansy HM, Elhilali MM. Transurethral laser surgery for benign prostate hyperplasia in octogenarians: Safety and outcomes. *Urology* 2013;81:634-9. https://doi.org/10.1016/j.urology.2012.11.042
6. Nadu A, Mabjeesh NJ, Ben-Chaim J, et al. Are indications for prostatectomy in octogenarians the same as for younger men? *Int Urol Nephrol* 2004;36:47-50. https://doi.org/10.1023/B:UROL.0000032683.36827.63
7. Uchida T, Ohori M, Soh S, et al. Factors influencing morbidity in patients undergoing transurethral resection of the prostate. *Urology* 1999;53:98-105. https://doi.org/10.1016/S0090-4295(98)00524-X
8. Reich O, Gratzke C, Bachmann A, et al. Morbidity, mortality and early outcome of transurethral resection of the prostate: A prospective multicenter evaluation of 10,654 patients. *J Urol* 2008;180:246-9. https://doi.org/10.1016/j.juro.2008.03.058
9. Tamalunas A, Westhofen T, Schott M, et al. The clinical value of holmium laser enucleation of the prostate in octogenarians. *Low Urin Tract Symptoms* 2021;13:279-85. https://doi.org/10.1111/luts.12366
10. Nair SM, Pimentel MA, Gilling PJ. A review of laser treatment for symptomatic BPH (benign prostatic hyperplasia). *Curr Urol Rep* 2016;17:45. https://doi.org/10.1007/s11934-016-0603-5
11. Nguyen DD, Deyirmendjian C, Law K, et al. GreenLight photovaporization of the prostate in high-medical-risk patients: An analysis of the Global GreenLight Group (GGG) database. *World J Urol* 2022;40:1755-62. https://doi.org/10.1007/s00345-022-03986-5
12. Liu X, Yuan F, Xue Md B. GreenLight XPS 180-W laser vaporization of prostate in high-risk elderly patients: A single-center experience. *Photobiomodul Photomed Laser Surg* 2020;38:380-4. https://doi.org/10.1089/photob.2019.4735
13. Gu X, Strom K, Spaliviero M, Wong C. Does age affect the efficacy and safety of GreenLight HPS laser photoselective vaporization prostatectomy? *Aging Male* 2012;15:63-7. https://doi.org/10.3109/13685538.2011.632452

14. Palumbo P, Tellan G, Perotti B, et al. Modified PADSS (Post Anaesthetic Discharge Scoring System) for monitoring outpatients discharge. *Ann Ital Chir* 2013;84:661-5.
15. Elmansy H, Shabana W, Ahmad A, et al. Factors predicting successful same-day trial of void (TOV) after laser vaporization of the prostate. *Urology* 2022;165:280-4. https://doi.org/10.1016/j.urology.2022.01.040
16. Daabiss M. American Society of Anaesthesiologists physical status classification. *Indian J Anaesth* 2011;55:111-5. https://doi.org/10.4103/0019-5049.79879
17. Bouhadana D, Nguyen DD, Zhang X, et al. Safety and efficacy of TURP vs. laser prostatectomy for the treatment of benign prostatic hyperplasia in multi-morbid and elderly individuals aged >/= 75. *World J Urol* 2021;39:4405-12. https://doi.org/10.1007/s00345-021-03779-2
18. Mmeje CO, Nunez-Nateras R, Warner JN, et al. Age-stratified outcomes of holmium laser enucleation of the prostate. *BJU Int* 2013;112:982-9. https://doi.org/10.1111/bju.12063
19. Heiman J, Agarwal D, Komanapalli S, et al. Outcomes of octogenarians undergoing holmium laser enucleation of prostate. *World J Urol* 2022;40:1751-4. https://doi.org/10.1007/s00345-022-04053-9
20. Deyirmendjian C, Nguyen DD, Law KW, et al. Safety and efficacy of GreenLight PVP in octogenarians: evaluation of the Global GreenLight Group database. *World J Urol* 2023;41:1133-40. https://doi.org/10.1007/s00345-023-04334-x
21. Wyndaele JJ. Complications of intermittent catheterization: Their prevention and treatment. *Spinal Cord* 2002;40:536-41. https://doi.org/10.1038/sj.sc.3101348
22. Zanocchi M, Maero B, Francisetti F, et al. Multidimensional assessment and risk factors for prolonged hospitalization in the elderly. *Aging Clin Exp Res* 2003;15:305-9. https://doi.org/10.1007/BF03324514
23. Mamoulakis C, Efthimiou I, Kazoulis S, et al. The modified Clavien classification system: A standardized platform for reporting complications in transurethral resection of the prostate. *World J Urol* 2011;29:205-10. https://doi.org/10.1007/s00345-010-0566-y
24. Raizenne BL, Bouhadana D, Zorn KC, et al. Functional and surgical outcomes of Aquablation in elderly men. *World J Urol* 2022;40:2515-20. https://doi.org/10.1007/s00345-022-04137-6
25. Aldamanhori R, Chapple CR. Underactive bladder, detrusor underactivity, definition, symptoms, epidemiology, etiopathogenesis, and risk factors. *Curr Opin Urol* 2017;27:293-9. https://doi.org/10.1097/MOU.0000000000000381
26. Lee KH, Kuo HC. Recovery of voiding efficiency and bladder function in male patients with non-neurogenic detrusor underactivity after transurethral bladder outlet surgery. *Urology* 2019;123:235-41. https://doi.org/10.1016/j.urology.2018.09.030

FIGURES AND TABLES

Table 1. Patient demographics and preoperative data of both groups				
Preoperative characteristics		**Non-octogenarians**	**Octogenarians**	**p**
Number of participants, n (%)		111 (66)	57 (34)	–
Age median (range), years		69 (43–79)	85 (80–100)	<0.001
ASA function class n (%)	I	4 (3.6)	–	<0.001
	II	59 (53.2)	1 (1.8)	
	III	44 (39.6)	52 (91.2)	
	IV	4 (3.6)	4 (7)	
Anticoagulants n (%)		34 (30.6)	31 (54.4)	0.002
Preoperative prostate size by TRUS, median g (range)		48.7 (12–113)	49.5 (19–80)	0.791
Preoperative catheter, n (%)		59 (53.2)	28 (49.1)	0.785
Preoperative catheterization time in months, median (range)		7.5 (1–84)	9 (1–84)	0.048
Preoperative Qmax, median mL/s (range)		8.09 (3–17)	8.85 (5–16)	0.332
Initial PVR, median mL (range)		419 (22–1325)	500 (51–1000)	0.307
Preoperative IPSS, median (range)		24 (8–35)	24 (3–32)	0.841
Preoperative QoL, median (range)		4 (2–6)	4 (2–6)	0.675

ASA: American Society of Anesthesiologists; IPSS: International Prostatism Symptom Score; PVR: postvoid residual; QoL: quality of life; Qmax: maximum urinary flow rate; TRUS: transrectal ultrasound.

Table 2. Intraoperative parameters and immediate postoperative outcomes			
Intraoperative parameters and Immediate postoperative outcomes	**Non-octogenarians (n=111)**	**Octogenarians (n=57)**	**p**
OR time, minutes, median (range)	53 (18–240)	52 (18–127)	0.816
Vaporization time, mm, median (range)	40 (12–210)	35 (12–106)	0.628
Lasing time, minutes, median (range)	27 (8–183)	25 (8–60)	0.656
Energy, kJ, median (range)	176 (39–580)	168 (38–593)	0.434
Intraoperative complications, n (%)	1 (0.9)	2 (3.5)	0.226
Change in hemoglobin, g/L, median (range),	11 (0–47)	8 (0–28)	0.072
Blood transfusion, n (%)	1 (0.9)	1 (1.8)	0.629

Catheterization postoperative days, median (range)	1 (0.125–30)	1 (0.125–7)	0.752
Length of hospital stay, days, median (range)	1 (0.25–14)	1 (0.25–1)	0.622

Table 3. Postoperative complications and functional outcomes of both groups				
Postoperative functional outcomes		**Non-octogenarians (n=111)**	**Octogenarians (n=57)**	**p**
Success of first TOV, n (%)		90 (81.1)	45 (78.9)	0.187
Recurrent retention after TOV, n (%)		6 (5.4)	5 (8.8)	0.697
Readmission, n (%)		2 (1.8)	1 (1.8)	0.226
Retreatment, n (%)		1 (0.9)	0	0.47
Postoperative complications, n (%)	Clavien I	10 (9)	5 (8.8)	0.608
	Clavien II	2 (1.8)	1 (1.8)	
	Clavien III	0 (0)	0 (0)	
	Clavien IV	1 (0.9)	0 (0)	
1 month postoperative	IPSS, median (range)	9 (0–24)	5 (3–11)	0.100
	QoL, median (range)	2 (0-6)	1 (0–2)	0.244
	Qmax, mL/s, median (range)	17.6 (5–48)	13 (8–20)	0.016
	PVR, mL, median, (range)	55 (0–570)	129 (0–700)	0.008
	Stress incontinence, n (%)	2 (1.8)	4 (7)	0.845
3 months postoperative	IPSS, median (range)	7 (0-29)	6 (2-7)	0.194
	QoL, median (range)	1 (0-6)	1.5 (0–5)	0.244
	Qmax, mL/s, median (range)	21 (4–57)	13.6 (7–33)	0.035
	PVR, mL, median (range)	57 (0–700)	67 (0–300)	0.795
	% PSA reduction, median (range)	60.5 (10–88)	56 (5–100)	0.905
	Stress incontinence, n (%)	0	1 (1.8)	0.339
6 months postoperative	IPSS, median (range)	5.5 (0–26)	7 (1–16)	0.587
	QoL, median (range)	1 (0–6)	1 (0–3)	0.431
	Qmax, mL/s, median (range),	20 (6–67)	9.5 (6–26)	0.003
	PVR, mL, median (range)	62 (0–500)	85 (0–500)	0.616
	Stress incontinence, n (%)	0	1 (1.8)	0.339
12 months postoperative	IPSS, median (range)	5 (0–25)	5 (3–5)	0.646
	QoL, median (range)	1 (0–4)	1 (0–4)	0.875
	Qmax, mL/s, median (range)	21.3 (7–60)	9.2 (3–24)	0.010

	PVR, mL, median (range)	57 (0–430)	127 (20–770)	0.019
	Ongoing stress incontinence, n (%)	0	1 (1.8)	0.339
	Catheter-free, n (%)	104 (93.7)	53 (93.0)	0.825

IPSS: International Prostatism Symptom Score; PVR: postvoid residual; QoL: quality of life; Qmax: maximum urinary flow rate; TOV: trial of void.

Table 4. Comparison of oral anticoagulant use and urine retention between octogenarians and non-octogenarians

Parameters	**Non-octo OAC (34)**	**Octo OAC (31)**	**p**	**Non-octo retention (59)**	**Octo retention (28)**	**p**
Preoperative data						
Age, year, median (range)	70 (56–79)	84 (80–100)	0.001	71 (43–79)	85 (80–100)	0.001
Initial PVR, mL, median (range)	430 (540–1000)	550 (420–1000)	0.867	999 (400–1055)	999 (400–1000)	0.989
Preoperative IPSS, median (range)	24.5 (14–32)	21 (3–32)	0.189	–	–	–
Preoperative QoL, median (range)	4.5 (3–6)	4 (2–6)	0.641	–	–	–
Preoperative Qmax, mL/sec, median (range)	8.1 (4.4–14.6)	8.8 (5–12.5)	0.727	–	–	–
Preoperative prostate size, g, median (range)	47.5 (12–97)	44 (19–80)	0.434	44 (12–113)	50 (19–80)	0.443
Operative data						
Operative time, minutes, median (range)	57 (18–105)	57 (18–127)	0.891	52 (18–240)	54.5 (18–127)	0.771
Vaporization time, minutes, median (range)	40.5 (13–84)	40 (12–106)	0.772	41 (12–210)	37.5 (12–106)	0.892
Lasing time, minutes, median (range)	29 (8–67)	26 (8–60)	0.895	26 (8–183)	25.5 (8–59)	0.788
Energy, kJ, median (range)	179 (39–407)	168 (38–593)	0.59	172 (39–580)	164 (38–240)	0.598
Length of hospital stay, days, median (range)	1 (0.25–14)	1 (0.25–1)	0.12	1 (0.25–14)	1 (0.25–1)	0.056

Catheterization postoperative, days, median (range)		1 (0.125–30)	1(0.125–6)	0.42	1 (0.125–30)	1 (0.125–7)	0.059
Blood transfusion, n (%)		1 (2.9)	1 (3.2)	0.947	0	1 (3.6)	0.321
Success of first TOV, n (%)		27 (79.4)	24 (77.4)	0.845	45 (76.3)	20 (71.4)	0.627
Recurrent retention after TOV, n (%)		3 (8.8)	2 (6.4)	0.720	4 (6.8)	4 (14.3)	0.127
Intraoperative complications, n (%)		1 (2.9)	2 (6.5)	0.5	0	1 (3.6)	
Readmission, n (%)		2 (5.8)	1 (3.2)	0.591	1 (1.7)	1 (3.6)	0.585
Retreatment, n (%)		1 (2.9)	0	1*	1 (1.7)	0	1
Postoperative complications, n (%)	Clavien I	8 (23.5)	5 (16.1)	0.126	4 (6.8)	2 (7.1)	0.508
	Clavien II	1 (2.9)	0		1 (1.7)	1 (3.6)	
	Clavien III	0	0		0	0	
	Clavien IV	1 (2.9)	0		0	0	
12-month postoperative data							
IPSS median, (range)		7 (1–18)	5 (3–5)	0.743	4 (1–25)	5 (3–5)	0.749
QoL median, (range)		1 (0–4)	1 (1–2)	0.982	1 (0–4)	1 (0–3)	0.947
Qmax, mL/sec, median (range)		25.1 (7.5–60)	7.8 (3–23.7)	0.003	19.7 (8.1–60)	5.2 (3–10.6)	0.001
PVR, mL, median (range)		25 (0–150)	140 (70–770)	0.001	66 (0–400)	139 (22–770)	0.171
Ongoing stress incontinence, n (%)		0	0	–	0	0	–
Catheter-free, n (%)		32 (94.1)	29 (93.5)	0.607	55 (93.2)	25 (89.3)	0.676

IPSS: International Prostatism Symptom Score; OAC; oral anticoagulant; PVR: postvoid residual; QoL: quality of life; Qmax: maximum urinary flow rate; TOV: trial of void.