

# Monopolar Transurethral Enucleo-Resection of the Prostate (TUERP) versus HoLEP: A Canadian Novel Experience

Khaled Ajib, MD<sup>ab</sup>; Joseph Zgheib, MD<sup>c</sup>; Noura Salibi<sup>d</sup>; Marc Zanaty, MD<sup>ab</sup>; Mila Mansour<sup>a</sup>,  
Abdullah Alenizi<sup>e</sup>, MD; Assaad El-Hakim, MD, FRCSC<sup>b</sup>

<sup>a</sup> Section of Urology, Department of Surgery, Centre Hospitalier de l'Université de Montréal, Montréal, QC, Canada

<sup>b</sup> Division of Robotic Urology, Department of Surgery, Hôpital du Sacré Cœur de Montréal, Montreal, QC, Canada

<sup>c</sup> Division of Urology, Saint George Hospital University Medical Center, Beirut, Lebanon

<sup>d</sup> Department of Epidemiology and Population Health, faculty of health sciences, American University of Beirut

<sup>e</sup> Division of Urology, Security Forces Hospital, Riyadh, Saudi Arabia

## Abstract

### Objective:

To study the functional outcome of patients undergoing transurethral enucleation of the prostate (TUERP) versus patients undergoing Holmium laser enucleation of the prostate (HoLEP) in men with bladder outlet obstruction.

### Materials and Methods:

We retrospectively analyzed our prospectively collected database of 2 groups of patients. 24 patients underwent TUERP (group 1), and 27 underwent HoLEP (group 2). Preoperative characteristics, intervention parameters, postoperative functional outcomes, uroflowmetry and complications were collected.

### Results:

Mean prostate size in groups 1 and 2 were 87.2cc and 93.5cc, respectively. The mean duration of surgery was 110 min in group 1 and 136 min in group 2. In group 1, PSA dropped from 4.4 ng/ml to 1.2 ng/ml after 12 months. IPSS was 3.75 at 12 months with a preoperative value of 20.9. With respect to Qmax, it increased to 21.8 ml/s from a preoperative value of 6.4 ml/s. In group 2, the PSA dropped from 7.6 ng/ml to 1.3 ng/ml. IPSS dropped from 22.3 to 3.8, Qmax increased from 7.7 mL/s to 22.5 mL/s.

Hemoglobin, complications, and all studied parameters were not statistically significant between both groups.

### Conclusion:

In this study, TUERP was safe and efficacious in BPH patients with large glands. Modifications can be implemented on the standard TURP technique to treat patients with prostate sizes more than 70 cc.

## Introduction

Bladder outlet obstruction secondary to benign prostatic hyperplasia (BPH) is a common condition diagnosed in men.<sup>1</sup> According to various guidelines, surgery should be provided for patients with: urinary symptoms refractory to medical treatment, gross hematuria, recurrent infections, bladder stones, or deterioration of kidney function.<sup>1, 2</sup> Transurethral resection of the prostate (TURP) remains the established gold standard surgical treatment for BPH.<sup>1</sup>

Alike other surgeries, TURP has its own limitations. Transfusion rates can reach up to 7.1% post TURP. Moreover, re-treatment rate ranges from 3 to 14.5%.<sup>3,4,5</sup> Furthermore, TURP is associated with safety issues particularly in patients with large prostates (>80g).<sup>6</sup> This has led to the development of many alternative procedures aiming at either reducing complications or improving the safety profile in larger prostates. One of these procedures is Holmium laser enucleation of the prostate (HoLEP), which has proven its efficacy and safety as an alternative to the conventional TURP.<sup>7</sup> Elhilali et al. stated that HoLEP is the new gold standard for any prostate size.<sup>8</sup> It has been reported that HoLEP offers shorter catheterization time, shorter hospital stay, and fewer complications when compared with TURP.<sup>9</sup> This has encouraged many surgeons to include enucleation as part of the well-known TURP technique in larger prostates creating a hybrid procedure, namely transurethral enucleation and resection of the prostate (TUERP). Plasmakinetic bipolar TUERP was shown to be safe and effective according to Yang et al.<sup>10</sup> However, given its relatively recent introduction in practice there is still lack of systematic clinical training.<sup>10</sup>

In view of the difficult learning curve of HoLEP and minimal market penetrance, we thought to evaluate the relatively new TUERP technique. We adopted monopolar TUERP as it combines standard TURP instrumentation with known enucleation technique. Our objective was to compare short-term results of TUERP to our contemporary HoLEP cohort. The main impetus was the perceived easier learning curve of TUERP as compared to HoLEP

especially for residents and HoLEP naïve surgeons. Additionally, TURP instrumentation is available in all urology services in Canada and worldwide.

This article reports the efficacy and safety of monopolar TUERP versus HoLEP in a Canadian cohort over a 12-month period. Functional outcomes and complication rates are presented. To our knowledge, this is the first study comparing monopolar TUERP to HoLEP.

## **Methods:**

### **Patient characteristics**

After approval of the institutional review board, data was prospectively collected and retrospectively analyzed for 26 men who underwent TUERP, and 29 men who underwent HoLEP for BPH in 2015. To note, no nodules were encountered in the digital rectal examination preoperatively. Surgeries were done by a single surgeon at a single institution. Patients diagnosed with prostate cancer were excluded from the study, which was the case for 2 patients from each group (n = 4). Men who underwent TUERP or HoLEP had at least one of the indications listed in the AUA guidelines.<sup>1</sup> We had a protocol implemented at our hospital where the duration of catheterization and hospital stay is 2-3 days.

### **Surgical procedures**

HoLEP: Our technique has been previously published.<sup>11</sup> In summary, using a 26Fr resectoscope with a laser bridge and the 550µm Holmium laser fiber, the anterior commissure is divided and an incision is made at 5 and 7 o'clock from the bladder neck to the verumontanum and deepened down to the capsule. Afterwards, the median lobe is excised and enucleated. Then, the lateral lobes are enucleated starting at the level of the apex with low energy (70 watts). Both lobes were further enucleated with higher setting (100 watts) and dropped into the bladder.<sup>11</sup>

TUERP: Using the 26Fr resectoscope and monopolar electric current, resection of the median lobe is performed in a similar manner to TURP. Then, enucleation starts at the apex similarly to HoLEP by using a combination of blunt (tork) and sharp (electrical) dissection. Complete enucleation was attempted but was not successful in all cases therefore a combination of enucleation and resection was performed.

Morcellation: in all HoLEP and some TUERP cases, prostatic morcellation was needed to retrieve the prostatic adenomas.<sup>12</sup>

### Study design

Group 1 (n = 24) underwent TUERP and group 2 (n = 27) underwent HoLEP. Patients were assigned in both groups according to their PSA, International prostate symptom score (IPSS) scores, Quality of life (QoL), post void residual (PVR), and Maximum urinary flow rate (Qmax). Patients were followed at 3, 6, and 12 months. Parameters at each visit were compared to preoperative values.

Post-operative complications were described according to the Clavien-Dindo classification.<sup>13</sup>

### Statistical analyses

Mean and standard deviation were reported for continuous variables. Independent and paired t-tests were performed to compare mean differences between the two groups and pre and post data respectively. Chi-square test was performed for categorical variables. A p-value < 0.05 was considered as statistically significant. Analysis was conducted using Stata 13.

## Results:

Table 1 shows the baseline characteristics of group 1 (TUERP) and group 2 (HoLEP). The mean age was 68.5 years (95% CI [65.5 – 71.5]) in group 1 and 67 years [63.7 – 70.3] in group 2. Mean prostate volume was 87.2 cc [69.6 – 104.9] for group 1 and 93.5 [80.4 – 106.5] for group 2. In group 1, 9 patients (37.5%) were on anticoagulation treatment before surgery, 8 of whom were on Aspirin and 1 on Coumadin. With respect to group 2, 6 (22%) men were on anticoagulation; 4 on aspirin and 2 on aspirin and clopidogrel. All patients receiving anticoagulation had to stop their medication before the surgery in both groups.

Table 2 shows the operative parameters of both groups. Mean duration of surgery was 110 min [94.9 – 125.2] and 136 min [114.8 – 157.2] for groups 1 and 2 respectively. For the HoLEP group, the mean energy used and energy per cc were 244.3 kJ [201.8 – 286.9] and 2.2 kJ/cc [1.6 – 2.7] respectively. Of note, only 1 laser fiber was used in each HoLEP surgery. Moreover, the mean number of normal saline 3000 mL bag, for one surgery, was 18.3 [15.1 – 21.6]. 1 TUERP patient had to be converted to HoLEP, because of the inability to do a proper enucleation with the TUERP. Mean hospital stay was 3.1 days [1.8 – 4.3] in group 1 and 2.5 days [1.2 – 3.8] in group 2. Additionally, mean catheterization time was 2.6 days [2.1 – 3.1] in group 1 and 2.5 days [1.3 – 3.8] in group 2.

In group 1, PSA dropped from 4.4 ng/mL [3.1 – 5.8] to 1.2 ng/mL [0.6 – 1.8] after 12 months. IPSS dropped to 3.8 [0.6 – 6.8] from a preoperative value of 20.9 [16.4 – 25.4] (81.8% decrease). With respect to the Qmax, it increased from 6.4 ml/s [4.3 – 8.5] to 21.8 ml/s [12.9 – 30.6] (240.6% increase). PVR decreased from 53.5 [22.8 – 84.2] to 354.2 ml [219.3 – 489.1] (84.9% decrease).

In comparison, group 2 men had a PSA drop from 7.6 ng/ml [5.1 – 10.1] to 1.3 ng/ml [0.7 – 1.9] after 12 months. Additionally, Qmax increased from 7.7 ml/s [5.3 – 10] to 22.5 ml/s [18.2 – 33.6] (192.2% increase). Furthermore, PVR dropped from 145.6 ml [71.2 – 219.9] to 13 ml [3.4 – 22.6] (91.1% decrease). All differences were not statistically significant.

Table 4 shows the change in serum sodium (Na), and hemoglobin between preoperative and postoperative day 1 in both groups. Differences between groups 1 and 2 were not statistically significant.

Complications were reported in this study (table 5) and classified according to the Clavien-Dindo classification. Post-operatively, the most common reported symptom in group 1 was dysuria (58%) compared to only 26% in group 2. 3 patients (12.5%) had gross hematuria in group 1, 2 of which required blood transfusion. On the other hand, only 2 patients (7%) had gross hematuria in group 2 without the need for transfusion. 2 patients (7%) in group 2 had persistent signs of OAB 3 months after the surgery.

Only 1 patient had a urethral stricture 3 months after HoLEP. 1 patient required a TURP redo 3 months after his TUERP surgery.

## Discussion

Lower urinary tract symptoms are common in men above the age of 50. These symptoms are often secondary to bladder outlet obstruction caused by benign prostatic hyperplasia.<sup>3,14</sup> Despite the increasing popularity of laser prostate surgery, TURP remains the gold standard surgical treatment for BPH.<sup>1</sup> Morbidity associated with TURP has led to the development of several less invasive procedures.<sup>3</sup> HoLEP has fewer post-operative complications and longer durability when compared to TURP.<sup>9</sup> Patients who underwent HoLEP benefited from shorter catheterization time and hospital stay.<sup>9</sup> The hospitalization time in this study was 2.5 days [1.2 – 3.8] compared to 1.3 days in Krambeck study.<sup>15</sup> This has been the routine in our hospital to remove foley catheters on day 2 for all transurethral prostate surgeries.

Patients undergoing HoLEP have the advantage of receiving a complete prostatic enucleation.<sup>16</sup> The procedure involves a blunt dissection between the adenoma and the surgical capsule, and it is the only endoscopic technique similar to the traditional open prostatectomy.<sup>17,18</sup> The advantages of HoLEP are clear in patients with large prostates.<sup>9</sup> In this study, the mean prostatic size was 93.5 cc. Additionally, Michalak et al. recommends

that the urological community should embrace HoLEP as the new gold standard especially in patients with large prostates.<sup>9</sup> Among 1065 patients enrolled in the study, Krambeck et al. reported significant improvements in Qmax, PVR volume, QoL, IPSS, and PSA levels.<sup>15</sup> With respect to our study, all functional outcomes improved 12 months after surgery. Qmax increased by 192% and PVR decreased by 91%. These results are similar to the 133% increase in Qmax reported by Krambeck study.<sup>15</sup> Since the majority of patients had chronic obstruction and neurogenic bladder, urodynamic studies were not indicated in the follow-up. After analysis, there was no statistically significant difference between the two groups in terms of complications. Moreover, PSA drop is another marker used to assess the success of BPH surgery. Herein, we had a drop to 1.4 ng/mL from a preoperative value of 7.6 ng/mL. This is similar to the PSA drop reported in the Gilling et al. study where the PSA dropped to 1.8 ng/mL from a preoperative value of 4.6 ng/mL.<sup>19</sup>

On the other hand, the main disadvantage of HoLEP is its steep learning curve that is estimated between 20 and 50 cases.<sup>11,20</sup> This has prevented its widespread use. Furthermore, HoLEP requires high energy (80 – 100 watts) Holmium laser machine along with disposable laser fibers. This can impose more expenses on small centers. For these reasons TUERP was designed and implemented in some centers. TUERP can be performed without any extra cost since it is a modification of the conventional TURP.<sup>21</sup> It can be achieved with monopolar or bipolar energy. Salam et al. adds that it has a minimal complication risk and blood loss.<sup>21</sup> Moreover, Zuo et al. stated that TUERP was better than TURP in terms of higher resection rate, shorter operation time, less intraoperative blood loss, and faster recovery.<sup>22</sup> One of the theoretical advantages of TUERP is that it minimizes the risk of capsular perforation because it defines the depth of resection after detaching the adenoma.<sup>23</sup> Nevertheless, this procedure lacks systemic preclinical training and is taught in centers mainly in china.<sup>10</sup> Yang et al. reported that surgical skills are improved with experience.<sup>10</sup> Among 47 patients who underwent TUERP, one study has shown a decrease of 76%, 68%, and 68% in IPSS, QoL, and PVR volume respectively. This same study has shown an increase of 263% in the Qmax with a preoperative value of 5.9 ml/s.<sup>23</sup> A Chinese study including 620 patients who underwent TURP or TUERP showed a better improvement in IPSS, QoL, and Qmax in the TUERP group.<sup>22</sup> Our study marked an increase

of 240% in Qmax. The same improvement was seen in the PVR with a drop of 85% from a preoperative value of 354.2 mL.

In our study, the drop in Hemoglobin was higher in the TUERP group (18.0 g/dl drop) compared to the HoLEP group (9.5) (p-value 0.184). Moreover, 2 patients undergoing HoLEP had gross hematuria but none required blood transfusion knowing that the prostate size for these patients was 131 cc and 104 cc. On the other hand, 3 TUERP patients had gross hematuria 2 of whom required transfusion. It has been stated that PSA value and prostate volume are significant parameters to estimate the number of bleeding vessels.<sup>24</sup> In TUERP, Palaniappan et al. mentioned that the rate of blood transfusion was around 3%.<sup>25</sup> On the other hand, another study showed a lower transfusion rate when comparing TUERP to TURP.<sup>26</sup> To add, El Tayeb et al. mentioned that the use of anticoagulant therapy did not adversely affect the outcomes of HoLEP.<sup>27</sup> The drop in sodium with TUERP was not significant according to our results, which shows that the risk of TUR syndrome is low.

One of the main complaints reported by TUERP patients was dysuria up to 3 months postoperatively (58%). However, only 7 HoLEP patients (26%) had dysuria postoperatively for a period of less than 3 months. With respect to urinary incontinence, it was not reported in the HoLEP group compared to 13.6% in the Palaniappan study.<sup>25,28</sup> In the TUERP group, 17% of the patients had incontinence at 3 months compared to 8% at 6 months. Another undesirable complication is urethral strictures, which was reported in 1 HoLEP patient (3.7%) at 3 months compared to 2.5% in the Palaniappan study.<sup>25</sup> Additionally, 1 TUERP patient required a TURP redo 3 months after surgery for persistent adenoma with obstructive LUTS.

The mean prostate size in the TUERP group was 87.2 cc. It was shown that a size greater than 80 cc could be a challenge to TURP.<sup>4,29</sup> Hence, we can say that TUERP can be a good alternative to HoLEP in moderate to severe benign prostatic enlargement.

A proper approach to the capsular plane of the prostate will facilitate hemostasis since most bleeders are at the level of the capsule, and 2-5 and 7-10 o'clock positions close to the bladder neck.<sup>24</sup> It was reported that only 0.43% required re-operation for a residual adenoma.<sup>29</sup> Furthermore, enucleation techniques offer good speed, good cutting, and little

penetration during prostatic adenoma resection.<sup>30</sup> In our series, only 1 case of TUERP had to be converted to HoLEP for better enucleation and another patient required a TURP 3 months after the surgery. Instruments used in the traditional monopolar TURP can be modified for better enucleation. However, in some cases there is a need for morcellation, which requires extra equipment.

Despite its merits, this study has several limitations. The results were evaluated retrospectively and patients were not randomized to the surgical options. Moreover, the number of patients in both groups is low. The study was performed in a single center with by a single surgeon. Despite these limitations, it has an added value because it compares monopolar TUERP to HoLEP. This study showed the importance of introducing modifications to the TURP technique to facilitate surgery in large adenomas.

## Conclusion

TURP can be modified into TUERP in centers with no HoLEP experience. Monopolar TUERP is a viable alternative to HoLEP in moderate to large prostate sizes in which regular TURP poses a technical challenge.

## References

1. American Urological Association Education and Research Inc. American Urological Association Guideline: Management of benign prostatic hyperplasia (BPH) 2010. <https://www.auanet.org/common/pdf/education/clinical-guidance/Benign-Prostatic-Hyperplasia.pdf>. Accessed February 1, 2017.
2. Nickel JC, Mendez-Probst CE, Whelan TF, Paterson RF, Razvi H. 2010 Update: Guidelines for the management of benign prostatic hyperplasia. *Can Urol Assoc J.* 2010;4(5):310-6.
3. Tasci, A. Ihsan, Y. Ozlem Ilbey, V. Tugcu, O. Cicekler, C. Cem, and Z. Fatih. "112 Transurethral Resection Of The Prostate With Conventional Monopolar Resectoscope: Single-Surgeon Experience And Long-Term Results Of After 3.589 Procedures." *European Urology Supplements*10.2 (2011): 60-61. Web.
4. Mordasini L, Di Bona C, Klein J, Mattei A, Wirth G, Iselin CE. 80-W GreenLight Laser Vaporization Versus Transurethral Resection of the Prostate for Treatment of Benign Prostatic Obstruction: 5-Year Outcomes of a Single-Center Prospective Randomized Trial. *Urology.* 2018.
5. Thomas JA, Tubaro A, Barber N, d'Ancona F, Muir G, Witzsch U, et al. A Multicenter Randomized Noninferiority Trial Comparing GreenLight-XPS Laser Vaporization of the Prostate and Transurethral Resection of the Prostate for the Treatment of Benign Prostatic Obstruction: Two-yr Outcomes of the GOLIATH Study. *Eur Urol.* 2016;69(1):94-102.

6. Reich O, Gratzke C, Bachmann A, Seitz M, Schlenker B, Hermanek P, 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(1):246-9.
7. Shishido, Toshihide, Kaori Enomoto, Naoyuki Fujita, Atsushi Suzuki, Kenjiro Hayashi, Masafumi Nomura, Naoshi Itaya, Mitsuhiro Tanbo, Kazuyoshi Watanabe, Haruhisa Noda, Takatsugu Okegawa, Kikuo Nutahara, and Eiji Higashihara. "COMPARISON OF CLINICAL RESULTS BETWEEN TUR-P AND HOLMIUM LASER ENUCLEATION OF THE PROSTATE (HoLEP) BASED ON THE INITIAL EXPERIENCE." *The Japanese Journal of Urology* 99.3 (2008): 543-50. Web.
8. Elzayat, E., E. Habib, and M. Elhilali. "Holmium laser enucleation of the prostate (HoLEP): a size independent new gold standard." *Urology* 66.3 (2005): 20. Web.
9. Michalak, J., Tzou, D., & Funk, J. (2015). HoLEP: the gold standard for the surgical management of BPH in the 21st Century. *American Journal of Clinical and Experimental Urology*, 3(1), 36–42.
10. Yu, Yang, Guantao Lou, Chen Shen, Sheng Guan, Wei Wang, and Bo Yang. "Technical aspects of transurethral plasmakinetic enucleation and resection of the prostate for benign prostatic hyperplasia." *Minimally Invasive Therapy & Allied Technologies* 26.1 (2016): 44-50. Web.
11. El-Hakim, A., and M.m. Elhilali. "Holmium laser enucleation of the prostate can be taught: the first learning experience." *BJU International* 90.9 (2002): 863-69. Web.

12. Gilling, Peter. "Holmium Laser Enucleation of the Prostate (HoLEP)." *BJU International* 101.1 (2007): 131-42. Web.
13. Peyronnet B, Pradere B, Brichart N, Bodin T, Bertrand P, Members of French Group of GreenLight U, et al. Complications associated with photoselective vaporization of the prostate: categorization by a panel of GreenLight users according to Clavien score and report of a single-center experience. *Urology*. 2014;84(3):657-64.
14. Peyronnet, Benoit, et al. "Trends in the Use of the GreenLight Laser in the Surgical Management of Benign Prostatic Obstruction in France Over the Past 10 Years." *European Urology*, vol. 67, no. 6, 2015, pp. 1193 – 1195., doi:10.1016/j.eururo.2015.01.003
15. Krambeck, Amy E., Shelly E. Handa, and James E. Lingeman. "Experience With More Than 1,000 Holmium Laser Prostate Enucleations for Benign Prostatic Hyperplasia." *The Journal of Urology* 183.3 (2010): 1105-109. Web.
16. Gilling, Peter J., et al. "Holmium Laser Enucleation of the Prostate (HoLEP) Combined with Transurethral Tissue Morcellation: An Update on the Early Clinical Experience." *Journal of Endourology*, vol. 12, no. 5, 1998, pp. 457–459., doi:10.1089/end.1998.12.457.
17. Martin, A. D., Nunez, R. N., & Humphreys, M. R. (2010). Bleeding after holmium laser enucleation of the prostate: Lessons learned the hard way. *BJU International*, 107(3), 433-437. doi:10.1111/j.1464-410x.2010.09560.

18. Krambeck, Amy E., Shelly E. Handa, and James E. Lingeman. "Holmium Laser Enucleation of the Prostate for Prostates Larger Than 175 Grams." *Journal of Endourology* 24.3 (2010): 433-37. Web.
19. Gilling, Peter J., Tevita F. Aho, Christopher M. Frampton, Colleen J. King, and Mark R. Fraundorfer. "Holmium Laser Enucleation of the Prostate: Results at 6 Years." *European Urology* 53.4 (2008): 744-49. Web.
20. Elzayat, E. A., & Elhilali, M. M. (2007). Holmium Laser Enucleation of the Prostate (HoLEP): Long-Term Results, Reoperation Rate, and Possible Impact of the Learning Curve. *European Urology*, 52(5), 1465-1472. doi:10.1016/j.eururo.2007.04.074
21. Salam, Muhammad, Jahangir Kabir, Ehetesham Haque, Faisal Islam, Ghazi Shahinul Islam, and Ibrahim Kaiser. "Mp3-11 Results Of Trans Urethral Enucleation And Resection Of Prostate (Tuerp) Using Unipolar Resectoscope: A Cost Effective New Technique!" *The Journal of Urology* 193.4 (2015): n. pag. Web. Monopolar
22. Zuo W., Wang Z. Z. & Xue J. Transurethral enucleative resection of the prostate versus transurethral resection of the prostate for benign prostate hyperplasia. *Zhonghua Nan Ke Xue*. 20, 812–815 (2014).
23. Ou, Rubiao, Xiangrong Deng, Wenjun Yang, Xinghua Wei, Hui Chen, and Keji Xie. "Transurethral enucleation and resection of the prostate vs transvesical prostatectomy for prostate volumes >80 mL: a prospective randomized study." *BJU International* 112.2 (2013): 239-45. Web.

24. Choo, Min Soo, Hahn-Ey Lee, Jungbum Bae, Sung Yong Cho, and Seung-June Oh. "Transurethral Surgical Anatomy of the Arterial Bleeder in the Enucleated Capsular Plane of Enlarged Prostates During Holmium Laser Enucleation of the Prostate." *International Neurourology Journal* 18.3 (2014): 138. Web.

25. Palaniappan, S., Tl Kuo, Cw Cheng, and Kt Foo. "Early outcome of transurethral enucleation and resection of the prostate versus transurethral resection of the prostate." *Singapore Medical Journal* 57.12 (2016): 676-80. Web. Bipolar

26. Wei, Yong, Ning Xu, Shao-Hao Chen, Xiao-Dong Li, Qing-Shui Zheng, Yun-Zhi Lin, and Xue-Yi Xue. "Bipolar transurethral enucleation and resection of the prostate versus bipolar resection of the prostate for prostates larger than 60gr: A retrospective study at a single academic tertiary care center." *International braz j urol* 42.4 (2016): 747-56. Web.

27. Tayeb, M. M., Jacob, J. M., Bhojani, N., Bammerlin, E., & Lingeman, J. E. (2016). Holmium Laser Enucleation of the Prostate in Patients Requiring Anticoagulation. *Journal of Endourology*, 30(7), 805-809. doi:10.1089/end.2016.0070

28. Cho MC, Song WH, Park J, Cho SY, Jeong H, Oh SJ, et al. Long-term outcomes of laser prostatectomy for storage symptoms: Comparison of serial 5-year follow-up data between 120W HPS photo-selective vaporization of the prostate and holmium laser enucleation of the prostate. *J Urol*. 2018.

29. Ahyai SA, Gilling P, Kaplan SA, Kuntz RM, Madersbacher S, Montorsi F, et al. Meta-analysis of functional outcomes and complications following transurethral procedures for

lower urinary tract symptoms resulting from benign prostatic enlargement. *Eur Urol.* 2010;58(3):384-97.

30. Kahokehr, Arman, and Peter J. Gilling. "Enucleation techniques for benign prostate obstruction." *Current Opinion in Urology* 24.1 (2014): 49-55. Web.

## Abbreviations

**BOO: Bladder outlet obstruction**

**BPH: Benign prostatic hyperplasia**

**HoLEP: Holmium laser enucleation of the prostate**

**IPSS: International prostate symptom score**

**LUTS: Lower urinary tract symptoms**

**PSA: Prostate-specific antigen**

**Q<sub>max</sub>: Maximum urinary flow rate**

**QoL: Quality of life**

**TUERP: Transurethral enucleation and resection of the prostate**

**TURP: Transurethral resection of the prostate**

**Table 1: Baseline characteristics**

	<b>TUERP (n = 24)</b>	<b>HoLEP (n = 27)</b>	<b>p-value</b>
	<b>Mean [Confidence Interval]</b>	<b>Mean [Confidence Interval]</b>	
<b>Age (years)</b>	<b>68.5 [65.5 – 71.5]</b>	<b>67.0 [63.7 – 70.3]</b>	<b>0.487</b>
<b>BMI (kg/m<sup>2</sup>)</b>	<b>29.8 [27.6 – 31.9]</b>	<b>29.6 [27.4 – 31.8]</b>	<b>0.687</b>
<b>Prostate Volume (cc)</b>	<b>87.2 [69.6 – 104.9]</b>	<b>93.5 [80.4 – 106.5]</b>	<b>0.544</b>
<b>Median lobe (pre-op ultrasound or cystoscopy) n (%)</b>	<b>11/24 (45.8)</b>	<b>15/27 (55.6)</b>	<b>0.674</b>
<b>α-adrenergic blockers use n (%)</b>	<b>24/24 (100)</b>	<b>27/27 (100)</b>	<b>0.14</b>
<b>5-alpha reductase inhibitors use n (%)</b>	<b>7/24 (29.2)</b>	<b>12/27 (44.4)</b>	<b>0.351</b>
<b>Retention with urethral catheter at time of surgery n (%)</b>	<b>6/24 (25)</b>	<b>3/27 (11.1)</b>	<b>0.338</b>
<b>Anticoagulation stopped before surgery and resumed immediately</b>	<b>9/24 (37.5%)</b>	<b>6/27 (22.2)</b>	<b>0.236</b>

thereafter n (%)			
PSA (ng/mL)	4.4 [3.1 – 5.8]	7.6 [5.1 – 10.1]	0.071
IPSS	20.9 [16.4 – 25.4]	22.3 [18.1 – 26.4]	0.656
QOL	4.1 [3.5 – 4.8]	3.9 [3.1 – 4.6]	0.652
Qmax (mL/s)	6.4 [4.3 – 8.5]	7.7 [5.3 – 10]	0.395
PVR (mL)	354.2 [219.3 – 489.1]	145.6 [71.2 – 219.9]	0.026

**Table 2: Peri and Post-operative parameters**

	TUERP (n = 24)	HoLEP (n =27)	p-value
	Mean [Confidence Interval]	Mean [Confidence Interval]	
Duration of Surgery (min)	<b>110.1 [94.9 – 125.2]</b>	<b>136.1 [114.8 – 157.2]</b>	<b>0.059</b>
Total Energy used (kJ)		<b>244.3 [201.8 – 286.9]</b>	
Energy per g (kJ/cc)		<b>2.2 [1.6 – 2.7]</b>	
Number of fibers used		<b>1</b>	
Number of 3000 ml NS bags used	<b>NA</b>	<b>18.3 [15.1 – 21.6]</b>	
Pathological specimen weight of retrieved tissue removed (g)	<b>52.8 [38.0 – 67.6]</b>	<b>61.6 [48.5 – 74.6]</b>	<b>0.360</b>
Hospital stay (days)	<b>3.1 [1.8 – 4.3]</b>	<b>2.5 [1.2 – 3.8]</b>	<b>0.523</b>
Foley catheterization (days)	<b>2.6 [2.1 – 3.1]</b>	<b>2.5 [1.3 – 3.8]</b>	<b>0.923</b>

Table 3: Outcomes of TUERP and HoLEP

Outcomes	Preoperative			Months								
	TUERP	HoLEP	p-value	3			6			12		
				TUER P	HoLEP	p-value	TUER P	HoLEP	p-value	TUERP	HoLEP	p-value
	24	27		17	21		15	14		8	7	
PSA (ng/mL)	4.4 [3.1 – 5.8]	7.6 [5.1 – 10.1]	0.07 1	1.5 [0.9 – 2.1]	1.4 [0.6 – 3.4]	0.89 8	1.3 [0.8 – 1.7]	1.5 [0.9 – 2.0]	0.56 5	1.2 [0.6 – 1.8]	1.3 [0.7 – 1.9]	0.784
IPSS	20.9 [16.4 – 25.4]	22.3 [18.1 – 26.4]	0.65 6							3.8 [0.6 – 6.8]	3.8 [2.1 – 5.6]	
QOL	4.1 [3.5 – 4.8]	3.9 [3.1 – 4.6]	0.65 2							0.9 [0.6 – 1.1]	0.7 [0.2 – 1.1]	
Qmax	6.4	7.7	0.39	23.3	23.3	0.99	20.9	25.9	0.32	21.8	22.5	0.599

(mL/s)	[4.3 – 8.5]	[5.3 – 10]	5	[16.5 – 30.1]	[17.7 – 28.9]	2	[13.8 – 28.1]	[18.2 – 33.6]	5	[12.9 – 30.6]	[18.5 – 26.5]	
PVR (mL)	354.2 [219.3 – 489.1]	145.6 [71.2 – 219.9]	0.02 6	91.1 [65.7 – 116.6]	74.8 [47.5 – 102.1]	0.37 2	46.8 [14.9 – 78.6]	60 [6.6 – 126.6]	0.70 4	53.5 [22.8 – 84.2]	13.0 [3.4 – 22.6]	0.557

Table 4. Change in serum Na and Hb

	Na (mEq/L)			Hemoglobin (g/dL)			Hematocrit		
	Pre- op	Post- op	p- value	Pre- op	Post- op	p- value	Pre- op	Post- op	p- value
<b>TUERP</b>	137.5 [136.5 – 138.5]	137.1 [135.9 – 138.3]	0.460 2	132.1 [125.7 – 138.4]	115.2 [102.9 – 127.4]	0.004 8	0.39 [0.37 – 0.41]	0.36 [0.33 – 0.38]	0.000 2
<b>HoLEP</b>	138.1 [136.8 – 139.3]	138.1 [136.9 – 139.1]	1.00	140.7 [136.4 – 145.1]	131.2 [125.6 – 136.9]	0.000 1	0.43 [0.41 – 0.44]	0.39 [0.37 – 0.41]	0.000 0
	$\Delta$ Na			$\Delta$ Hemoglobin			$\Delta$ Hematocrit		
<b>TUERP</b>	-0.5 [-3.9 – 2.8]		0.542	-18.0 [-45.6 – 9.52]		0.184	-0.04 [-0.08 – 0]		0.527
<b>HoLEP</b>	0 [-2.8 – 2.8]			-9.48 [-20 – 1.04]			-0.03 [-0.06 – 0]		

Table 5. Complications of TUERP &amp; HoLEP

		0 – 3 months		> 3 months	
		TUERP	HoLEP	TUERP	HoLEP
<b>Clavien-Dindo</b>					
<b>Grade</b>					
<b>Minor: I/II</b>					
	<b>OAB (%)</b>	<b>0</b>	<b>2 (7.4)</b>	<b>0</b>	<b>2 (9.5)</b>
	<b>Dysuria (%)</b>	<b>14 (58.3)</b>	<b>7 (25.9)</b>	<b>0</b>	<b>2 (9.5)</b>
	<b>Urinary Incontinence (%)</b>	<b>4 (16.7)</b>	<b>0</b>	<b>2 (11.8)</b>	<b>0</b>
	<b>Bladder Underactivity/retention (%)</b>	<b>1 (4.2)</b>	<b>1 (3.7)</b>	<b>0</b>	<b>0</b>
	<b>Hematuria (%)</b>	<b>3 (12.5)</b>	<b>2</b>	<b>0</b>	<b>0</b>
	<b>Afib (%)</b>	<b>0</b>	<b>1 (3.7)</b>	<b>0</b>	<b>0</b>
<b>Major: IIIa/IIIb</b>					
	<b>Incomplete Resection (%)</b>	<b>1 (4.2)</b>	<b>0</b>	<b>0</b>	<b>0</b>
	<b>CAD (%)</b>	<b>1 (4.2)</b>	<b>0</b>	<b>0</b>	<b>0</b>
	<b>Urethral stricture (%)</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1 (4.8)</b>