

ORIGINAL RESEARCH ARTICLE

Effects of transurethral Obipolar plasma prostatectomy on urodynamics and sexual function in patients with prostatic hyperplasia

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Abstract

This was an original article, and the objective of this study was to investigate the effects of bipolar transurethral plasma kinetic prostatectomy (TUPKP) on urodynamics and sexual function in benign prostatic hyperplasia (BPH) patients. One hundred and four BPH patients were divided into a control group and an intervention group. The control group received transurethral resection of prostate, while the intervention group received TUKEP. Relative to the control group, the intervention group presented less intraoperative blood loss and shorter bladder irrigation time, catheter retention time, and shorter hospital stay. Three months after surgery, the improvements of maximum urine flow rate (Qmax), pressure-flow rate (A-G) and residual urine volume (RV) in intervention group were more obvious than control group. One month after surgery, relative to control group, the intervention group had lower C-reactive protein (CRP), epinephrine (E) along with cortisol (Cor), cyclo-oxygenase 2 (COX-2) and vascular endothelial growth factor (VEGF) levels. On day 7 after surgery, PSA, EGF, and PGE2 levels in the intervention group were lower when compared to the control group. We conclude that TUKEP can diminish intraoperative blood loss, promote postoperative recovery, improve postoperative urodynamics and sexual function, and improve prognosis of BPH patients. (*Afr J Reprod Health* 2024; 28 [12]: 201-210).

Keywords: benign prostatic hyperplasia, bipolar transurethral plasma kinetic prostatectomy, urodynamics, sexual function

Résumé

Il s'agissait d'un article original et l'objectif de cette étude était d'étudier les effets de la prostatectomie cinétique plasmatisque transurétrale bipolaire (TUPKP) sur l'urodynamique et la fonction sexuelle chez les patients atteints d'hyperplasie bénigne de la prostate (HBP). Cent quatre patients atteints d'HBP ont été répartis en un groupe témoin et un groupe d'intervention. Le groupe témoin a reçu une résection transurétrale de la prostate, tandis que le groupe d'intervention a reçu TUKEP. Par rapport au groupe témoin, le groupe d'intervention présentait moins de pertes sanguines peropératoires, un temps d'irrigation de la vessie, un temps de rétention du cathéter et un séjour à l'hôpital plus courts. Trois mois après la chirurgie, les améliorations du débit urinaire maximal (Qmax), du débit pression-débit (A-G) et du volume urinaire résiduel (RV) dans le groupe d'intervention étaient plus évidentes que dans le groupe témoin. Un mois après la chirurgie, par rapport au groupe témoin, le groupe d'intervention présentait des taux de protéine C-réactive (CRP), d'épinéphrine (E) ainsi que de cortisol (Cor), de cyclo-oxygénase 2 (COX-2) et de facteur de croissance endothélial vasculaire (VEGF) plus faibles.) niveaux. Au jour 7 après la chirurgie, les niveaux de PSA, d'EGF et de PGE2 dans le groupe d'intervention étaient inférieurs à ceux du groupe témoin. Nous concluons que TUKEP peut diminuer la perte de sang peropératoire, favoriser la récupération postopératoire, améliorer l'urodynamique et la fonction sexuelle postopératoires et améliorer le pronostic des patients atteints d'HBP (*Afr J Reprod Health* 2024; 28 [12]: 201-210).

Mots-clés: hyperplasie bénigne de la prostate, prostatectomie cinétique bipolaire transurétrale par plasma, urodynamique, fonction sexuelle

Introduction

Benign prostatic hyperplasia (BPH) belongs to a progressive disease characterized by hyperplasia of prostatic interstitial and glandular components. The

incidence rate of BPH is as high as 50% in men more than 50 years old, and it is often manifested as lower urinary tract symptoms containing frequent urination, urgency of urination, along with urinary hesitancy. With the progression of BPH, it may

cause urination disorders, hydronephrosis, and renal function impairment, thereby endangering life and health¹. Currently, surgical treatment of BPH is recommended in clinical practice. Transurethral resection of prostate (TURP) belongs to the traditional surgical method, which can benefit about 90% of patients, but the incidence of several surgical bleeding is high. It is easy to cause incomplete gland resection, and also vascular and nerve tract damage. Combined with the risk of transurethral resection syndrome (TURS), clinical application is limited^{2,3}. Recently, with the continuous popularization and development of minimally invasive technologies, bipolar transurethral plasma kinetic prostatectomy (TUPKP), as well as its derived transurethral plasma kinetic enucleation of the prostate (TUKEP) have come into being¹.

The objective of this study was to assess the impact of TUKEP on urinary fluidity as well as sexual function in BPH patients. The novelty of our study is that we demonstrate that TUKEP can diminish intraoperative blood loss, promote postoperative recovery, improve postoperative urodynamics and sexual function, and improve prognosis of BPH patients, which might provide the clinical reference for treating BPH.

Methods

One hundred and four patients diagnosed with BPH in 363 Hospital from January 2021 to June 2023 were included. The inclusion criteria included the following: (1) BPH confirmed by laboratory, imaging, and digital rectal examination in accordance with the diagnostic criteria of "Clinical Diagnosis and Treatment Guidelines for Benign Prostatic hyperplasia⁴." (2) age <75 years; (3) All patients being treated for BPH for the first time. (4) patients generally in good condition and could tolerate surgery; and (5) informed consent signed.

The exclusion criteria: (1) urethral stenosis. (2) severe organ insufficiency; (3) coagulation dysfunction; (4) blood pressure >140/90 mmHg (1 mmHg=0.133 kPa); (5) unstable bladder and neurogenic bladder; (6) detrusor weakness of the bladder; and (7) prostate cancer.

Based on random number table method, the patients were divided into two groups, with each group consisting of 52 cases. The control group (CG) was aged 45-74 years, with an average age of (65.24±6.22) years. The course of disease ranged 2-11 years, with an average course of (4.94±0.32) years. The prostatic volume was 37 ~ 103 mL, with an average volume of (72.95±6.43) mL. The International Prostate Symptom Score (IPSS)⁵ ranged 9-34 points, with an average score of (25.85±2.17) points. The intervention group (IG) was aged 42-73 years, with an average age of (65.59±6.17) years. The mean course of disease was (5.01±0.35) years, ranging 3-12 years, and the average prostate volume was (73.21±7.04) mL, ranging 35-105 mL. IPSS scores ranged 17-34 points, with an average score of (25.22±2.26) points. The general data of two groups were comparable (P>0.05).

The CG received TURP: epidural anesthesia was used and the procedure was carried out in the lithotomy position. Transurethral WOLF electroscope (Wolf AG, Germany) was inserted to observe bladder and the prostate. The hyperplastic lesions were excised at a power of 150 W from 6 o'clock, and the blood was stopped by electrocoagulation. F20 three-cavity catheter was inserted, 40 mL water capsule was injected, and the bladder was irrigated with normal saline.

The IG was treated with TUKEP: After anesthesia, the patients were placed in the lithotomy position. The Olympus plasma electric endoscopic F26 electric endoscopic outer sheath was placed into the bladder to observe whether there were any abnormalities in the bladder and the urethra. The scope was removed to the verticulae position, which was used as the distal marker point. The prostate was incised longitudinally at 5 and 7 points of the bladder neck to form two "V" shaped furrows that reached the surgical envelope. At this level, the middle lobe of the hyperplasia was removed, the prostate was cut into the surgical envelope at 12:00, the left lobe was removed counterclockwise at 5:00, and the right lobe was removed clockwise at 7:00, and the apex of the prostate was pruned at 12:00. After no obvious active bleeding was observed, the gland fragments

were sucked out with an Elic rinse and sent for pathological examination.

Observed indicators

The following indicators were observed and measured in the control and intervention groups:

(1) Surgical resection effect and postoperative recovery index: including intraoperative blood loss, weight of removed prostate, bladder irrigation time, catheter retention time, hospital stay, IPSS score 3 months after surgery, IPSS score ranged 0 ~ 35 points, with higher score representing more serious urinary tract symptoms.

(2) Urodynamic index detection: The maximum urine flow rate (Qmax), pressure-flow rate (A-G) and residual urine volume (RV) were detected by Nidoc-970A ultra-luxury urodynamic analyzer (Chengdu Weisen Medical) before and 3 months after surgery⁶.

(3) Detection of serum prostate-specific antigen (PSA), epidermal growth factor (EGF) and prostaglandin E2 (PGE2) levels: Before surgery and 7 days after surgery, 3 mL of peripheral venous blood was gathered, centrifuged, and serum was gathered. Shanghai Jianglai bio-ELISA kit was used to detect PSA levels, and Hangzhou Lianke bio-radioimmunoassay kit was used to detect EGF and PGE2 levels.

(4) Statistics of complications: the incidence of hematuria, bladder spasm, urethral stricture, urinary retention, urinary incontinence, and TURS within 7 days after surgery was analyzed. Hematuria is defined as ≥ 3 red blood cells per high magnification field in centrifuged precipitated urine, or more than 1 in non-centrifuged urine, or 1 hour urine red blood cell count of more than 100,000, or 12 hours urine sediment count of more than 500,000, indicating an abnormal increase in red blood cells in urine, which is a common urinary system symptom. Bladder spasm is a sudden involuntary contraction of the bladder muscles, resulting in symptoms such as urgency, frequent urination or incontinence. Urethral stricture is a condition in which the inner urethra narrows, blocking the flow of urine. Urinary

retention refers to the retention of urine in the bladder when it is not fully excreted. Urinary incontinence refers to the inability to control the flow of urine and can be caused by muscle weakness, nerve damage or other health problems. TURS is caused by increased bladder pressure during electrotony, and a large amount of lavage fluid enters the blood circulation through the surgical wound veins, resulting in hyponatremia, hypochloremia, confusion, nausea and vomiting, hypertension, bradycardia, visual impairment, and oliguria. In the diagnosis of complications, it is necessary to make a comprehensive judgment based on medical history, clinical manifestations, urine routine examination and imaging examination.

(5) Sexual function evaluation. The International Erectile Function Index (IIEF-5) was used before and 3 months after surgery⁷, with a score ranging 0-25, with higher score representing better erectile function.

(6) The levels of inflammatory markers and stress indexes before and one month after surgery were compared between 2 groups. 4 mL of fasting venous blood was gathered from patients, centrifuged, separated serum, and stored at -40 °C for testing, centrifuged for 10 min at a speed of 3000 r/min. The levels of C-reactive protein (CRP), epinephrine (E) along with cortisol (Cor) were determined by enzyme-linked immunosorbent assay with automatic biochemical analyzer⁸.

(7) The levels of cyclo-oxygenase 2 (COX-2) and vascular endothelial growth factor (VEGF) were compared between 2 groups. COX-2 levels were measured by automatic biochemical analyzer and double antibody sandwich method, and VEGF levels were detected by electrochemical luminescence method.

Statistical analysis

SPSS 21.0 statistical software was adopted for data analysis. Counting and measurement data were represented by (n/%) and ($\bar{x} \pm s$), respectively, followed by χ^2 test and t test analysis. $P < 0.05$ meant the difference was statistical significance.

Ethical consideration

All patients and their families knew the purpose and methods of this study, and voluntarily participated in this study, and signed the informed consent. This study was approved by the Ethics Committee of 363 Hospital in December 2020.

Results

Surgical resection effect and postoperative recovery of 2 groups

Relative to the CG, the IG had less intraoperative blood loss, shorter bladder flushing time, catheter retention time and hospital stay, as well as heavier weight of the resected prostate ($P < 0.05$, Figure 1).

Urinary dynamics of patients in the two groups

The values of Qmax, A-G and RV were detected by Nidoc-970A ultra-luxury urodynamic analyzer. Three months after surgery, Qmax was increased and A-G value and RV were decreased in both groups, and Qmax in the IG was higher than the CG, while A-G value and RV in the IG were lower than the CG ($P < 0.05$, Figure 2).

Levels of inflammatory markers and stress indicators between the two groups

The levels of CRP, E and Cor were examined by enzyme-linked immunosorbent assay with automatic biochemical analyzer. One month after surgery, CRP, E and Cor levels in both groups were elevated, but those in the IG presented lower values than the CG ($P < 0.05$, Table 1).

COX-2 and VEGF levels between 2 groups

One month after surgery, COX-2 and VEGF levels were decreased in both groups, and those in the IG presented lower than the CG ($P < 0.05$, Figure 3).

Serum PSA, EGF and PGE2 levels in the two groups

PSA, EGF, and PGE2 levels in the two groups decreased 7 days after surgery, but those in the IG presented lower values than the CG ($P < 0.05$, Figure 4).

Comparison of complications between the two groups

No significant difference was seen in the complication rate between the IG and CG ($P > 0.05$, Table 2).

Sexual function between 2 groups

No significant difference was seen in IEF-5 scores between 2 groups prior to surgery ($P > 0.05$). Three months after surgery, IEF-5 scores in both groups were decreased ($P < 0.05$), but those in the IG presented higher than the CG ($P < 0.05$, Figure 5).

Discussion

BPH belongs to a frequent urinary system disorder, and is caused by the enlargement of the prostate together with the compression of the bladder neck and urethra, resulting in compensatory hypertrophy and unstable contraction of the detrusor muscle. This causes resulting in lower urinary tract manifestations containing frequent and urgent urination. TURP is a commonly applied surgical procedure for BPH treatment. It mainly uses high-frequency electricity to flow through tungsten alloy to form high heat, vaporize tissues, remove glands, and effectively relieve lower urinary tract symptoms. However, during the intraoperative irrigation process, the body will absorb a large body of flushing liquid in a short period of time, inducing TURS, which can lead to coma or even death of patients⁹⁻¹¹.

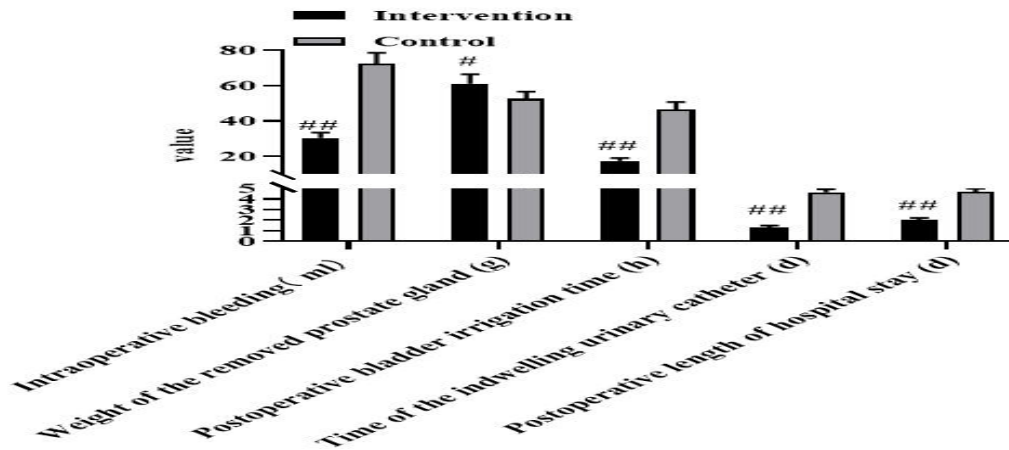


Figure 1: Results of surgical resection and postoperative recovery of two groups. Compared with the control group, # was $P < 0.05$, ## was $P < 0.01$.

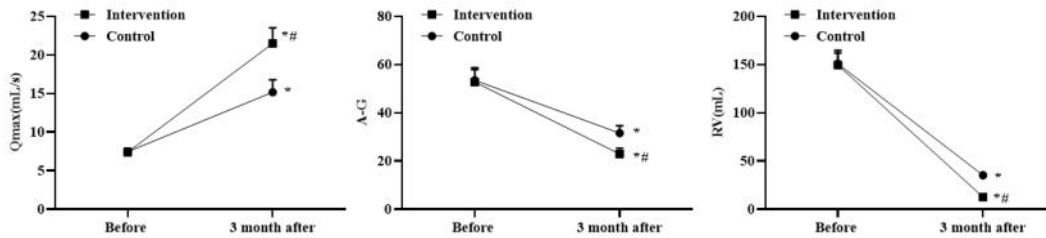


Figure 2: Urinary dynamics of patients in two groups. Compared with before treatment, * was $P < 0.05$; Compared with the control group, # was $P < 0.05$

Table 1: Levels of inflammatory factors and stress indexes after surgery between 2 groups

| Group | Cases | CRP (mg/L) | | E (ng/mD) | | Cor (ng/mL) | |
|--------------------|-------|----------------|-----------------------|----------------|-----------------------|----------------|-----------------------|
| | | Before surgery | 1 month after surgery | Before surgery | 1 month after surgery | Before surgery | 1 month after surgery |
| Intervention group | 30 | 11.87±1.59 | 12.43±1.61* | 0.19±0.04 | 0.22±0.06* | 208.34±14.92 | 211.69±17.58* |
| Control group | 30 | 12.03±1.48 | 13.45±1.53* | 0.18±0.05 | 0.26±0.04* | 209.08±15.48 | 220.37±15.24* |
| t | | 0.403 | 2.515 | 0.855 | 3.038 | 0.189 | 2.043 |
| P | | 0.688 | 0.015 | 0.396 | 0.004 | 0.851 | 0.046 |

Note: Compared with pre-operation, * was $P < 0.05$

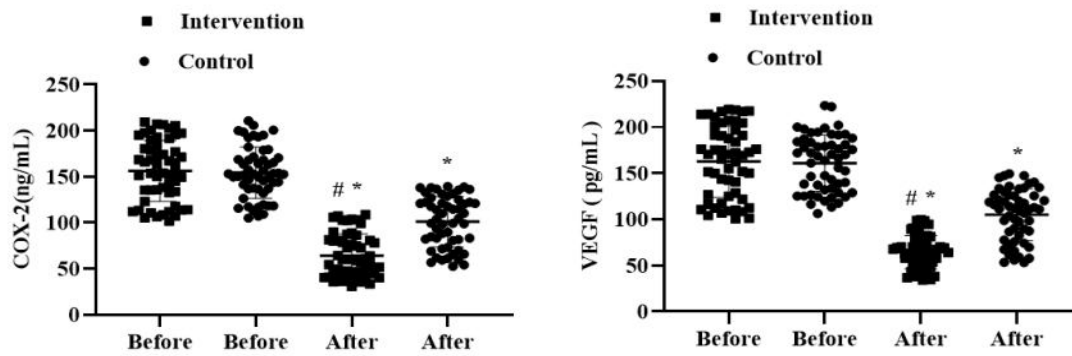


Figure 3: COX-2 and VEGF levels between 2 groups. Compared with before treatment, * was P<0.05; Compared with the control group, # was P<0.05.

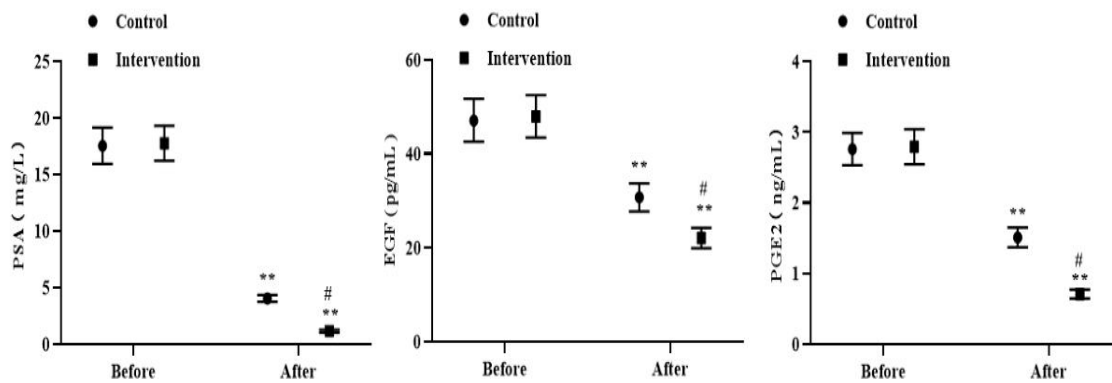


Figure 4: Serum PSA, EGF and PGE2 levels of 2 groups. Compared with before treatment, ** was P<0.01; Compared with the control group, # was P<0.05.

Table 2: Complications in two groups

| Groups | Hematuresis | Cystospasm | Urethrostenosis | Uroschesis | Uroclepsia | TURS | Total incidence rate |
|---------------------------|-------------|------------|-----------------|------------|------------|----------|----------------------|
| Intervention group (n=52) | 1 (1.92) | 1 (1.92) | 1 (1.92) | 2 (3.85) | 2 (3.85) | 0 (0.00) | 9 (17.31) |
| Control group (n=52) | 4 (7.69) | 2 (3.85) | 2 (3.85) | 1 (1.92) | 1 (1.92) | 2 (3.85) | 12 (23.08) |
| χ^2 value | | | | | | | 0.53 |
| P value | | | | | | | 0.46 |

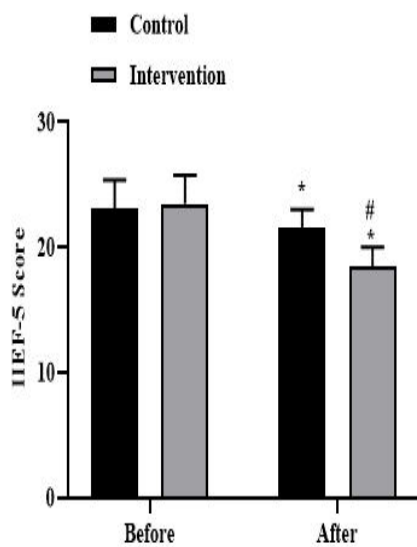


Figure 5: Sexual function between 2 groups. Compared with before treatment, * was $P < 0.05$; Compared with the control group, # was $P < 0.05$.

In addition, TURP has other shortcomings such as large trauma, strong thermal penetration effect, excessive bleeding, and incomplete resection¹². TUKEP is an emerging procedure for the treatment of BPH, which can penetrate tissues to a depth of 0.4 mm.

It can be highly absorbed by the water in the tissue, resulting in vaporization, and the bubbles generated after vaporization separate the prostate capsule from the gland, thereby removing the gland and cleaning the adhesion fibrous tissue in the capsule, and the surgical anatomical level is similar to that of open surgery, and the enucleation is more complete¹³. Simultaneously, the wound surface removed by this operation is smooth, easy to stop bleeding, and the heat generated can be absorbed and carbonized by hemoglobin, playing a hemostatic effect and reducing bleeding. In addition, because the penetration depth of the tissue is shallow, the thermal damage generated is concentrated in the surface tissue, and there is basically no damage to the deep tissue. This study manifested that relative to the CG, the OG presented less intraoperative blood loss, shorter bladder flushing time, catheter

retention time and hospital stay, as well as heavier weight of the resected prostate. Simultaneously, 3 months after surgery, the improvements of Qmax, A-G value and RV in the OG were more significant than the CG. All above findings were in accordance with the results of previous studies^{14,15}. These outcomes implied that TUKEP was more thorough in the treatment of BPH, less bleeding, faster postoperative recovery, and more obvious improvement in postoperative urodynamic indexes. The consideration is that TUKEP excises the tissue within the prostate envelope, which is similar to open surgery, can achieve complete excision of the tissue, reduce the residual gland, and has less trauma, less bleeding, which is beneficial for postoperative recovery and improvement of urodynamic indexes.

PSA is mainly expressed in prostatic vesicles and ductal epithelial cells. Prostatic hyperplasia leads to the destruction of the anatomical structure and physiological barrier between prostate and blood circulation, resulting in the release of PSA into the blood. With the progression of BPH, the degree of prostate damage increases, the PSA level increases more significantly, and the serum PAS content is positively correlated with the prostate volume¹⁶. EGF is a peptide growth factor, which can promote cell mitosis and proliferation. When EGF is highly expressed in the prost gland, it can induce the abnormal proliferation of prostate cells and the formation and development of mesenchyma and angiogenesis, thus promoting the formation and development of BPH¹⁷. PGE2 is a kind of detrusor contraction control medium, which is mainly produced by epithelial tissue and detrusor muscle of bladder, and is implicated in the regulation of lower urinary tract function. With the progression of BPH, the enlarged prostate will press the urethra, resulting in increased urethral resistance, resulting in increased detrusor tension compensation, resulting in increased secretion of PGE2, and PGE2 level is positively related to detrusor tension and the severity of urinary tract obstruction symptoms¹⁸. This study showed that relative to the CG, the OG presented lower serum levels of PSA, EGF and PGE2 7 days after surgery, which was similar to previous reports,

indicating that PSA, EGF and PGE2 were decreased more significantly after TUKEP treatment of BPH. The reason may be that TUKEP treatment of BPH can achieve more thorough resection of hyperplastic prostate tissue, relieve the adverse stimulation of BPH to the bladder, restore the normal anatomical relationship and physiological barrier between prostate and blood circulation, and thus reduce the production and release of PSA, EGF and PGE2.

Surgery is a common stressor, which can cause the body's stress response and aggravate the inflammatory response, and the trauma caused by it can promote metabolic disorders and a large release of inflammatory mediators through the thalamic-pituitary-adrenal axis, which is not conducive to postoperative rehabilitation, while CRP, E, and Cor are common inflammatory factors and stress indicators, and their increased expression often predicts increased inflammation and stress response¹⁹⁻²¹. The results of this study displayed that relative to the CG, the OG presented lower CRP, E as well as Cor levels, indicating that TUKEP can reduce inflammation and stress response. This may be because TUKEP can maintain the integrity of the surgical envelope, accurate and reliable hemostasis, clear marks on the distal end of the operation, clear relationship between the prostate tip and the sphincter, and no need to trim the prostate tip, which can avoid or alleviate the injury, thus reducing the stress response of the body and alleviating the aggravation of inflammation mediated by stress state.

COX-2, as a membrane binding protein, is in a state of low or no expression in the case of normal physiological conditions, but significantly elevated under pathological conditions. Studies have revealed that COX-2 level is elevated in BPH patients²². VEGF is a common factor in blood vessels, which can facilitate cell proliferation and accelerate blood production. Studies have shown that elevated VEGF level in human body is likely to lead to prostate hyperplasia, so VEGF is implicated in the development of prostate hyperplasia²³. The results of this study revealed that one month after surgery, the IG presented lower COX-2 and VEGF levels than

the CG, indicating that TUKEP can also help reduce COX-2 and VEGF levels, and thus improve the surgical effect. This may be due to the fact that TUKEP can more completely remove prostate hyperplasia glands, which helps to further reduce the activation rate of COX-2 and to some extent alleviate the up-regulation of COX-2-induced VEGF expression. At the same time, TUKEP can also decrease the impact on the body tissue, lessen the stress response of the body, and then weaken the inflammatory response mediated by stress response, avoid the pathological state caused by inflammation to increase the level of COX-2, and further induce the up-regulation of VEGF expression.

The penile erection nerve is connected with the prostate tissue, and has a regulatory effect on the penis erection and ejaculation. While removing urinary obstruction, BPH surgery may also cause damage to blood vessels and nerves, thus adversely affecting penile erectile function²⁴. Studies²⁵ suggest that the decline of sexual function after BPH surgery is largely related to the damage of prostate capsule, erectile-related blood vessels and nerves during the operation. Therefore, the kind of operation that has limited effects on patients' sexual function is also of concern. In this study, the effects of different surgical methods on erectile function were compared. The results showed that IIEF-5 scores in both groups decreased 3 months after surgery, but those in the IG presented were higher than the CG, implying that TUKEP had adverse effects on erectile function, while bipolar plasma prostate enucleation had little effect. The reason may be that TURP carpet electrocoagulation hemostasis and tissue bleeding, increases the probability of prostate capsule and erectile related blood vessels, nerves and other heat loss, and the high temperature of electroincision, the lateral prostate, collumbic nerve and other peripheral nerve heat loss, so it has a greater impact on sexual function.

In TUKEP surgery, laser vaporization and enucleation of prostate tissue has good tissue ablation ability, can achieve accurate hemostasis, has little heat loss to surrounding tissues, and can reduce the loss of prostate envelope and the damage

of blood vessels and nerves related to penile erection, so it has little impact on the postoperative erectile function of patients²⁶.

Study strengths and limitations

Strengths of the study were that it was a randomized clinical trial that included multiple measures related to postoperative urodynamics and sexual function. Limitation was the limited study cohort. Our study might provide the clinical reference for treating BPH.

Conclusion

TUKEP treatment of BPH can diminish intraoperative blood loss, more thorough tissue enucleation, promote postoperative recovery, improve postoperative urodynamics and sexual function, and improve prognosis.

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Contribution of authors

Yao XJ, Deng QP, Li GQ, and Guo YB: conceived and designed the study, collected and analysed the data, and prepared the manuscript. All authors mentioned in the article approved the manuscript.

References

1. Geavlete B, Stanescu F, Iacoboaie C and Geavlete P. Bipolar plasma enucleation of the prostate vs open prostatectomy in large benign prostatic hyperplasia cases - a medium term, prospective, randomized comparison. *BJU Int.* 2013; 111(5):793-803.
2. Wei Z, Tao Y, Gu M, Liu C, Chen Q, Cai Z, Chen Y and Wang Z. Plasma Kinetic Enucleation vs Holmium Laser Enucleation for Treating Benign Prostatic Hyperplasia: A Randomized Controlled Trial with a 3-Year Follow-Up. *J Endourol.* 2021; 35(10):1533-1540.
3. Gan Y, Deng L, He Q, Li C, He L and Long Z. Immediate Transurethral Plasma Kinetic Enucleation of the Prostate Gland for Treatment of Benign Prostatic Hyperplasia-Associated Massive Hemorrhage: A Single-Center Experience. *Front Surg.* 2021; 8:810175.
4. Zeng XT, Li S, Gong K, Guo ZZ, Liu TZ, He DL and Wang XH. [Evidence-based evaluation of recent clinical practice guidelines for the diagnosis and treatment of benign prostatic hyperplasia]. *Zhonghua Yi Xue Za Zhi.* 2017; 97(22):1683-1687.
5. Silang J, Cai Z, Wang J, Gazang C, Zheng L, Gu Y, Luo F, Zhang B, Fan Y and Wang F. Reliability and validity of the Tibetan version of the International Prostate Symptom Score. *World J Urol.* 2023; 41(5):1389-1394.
6. Yang J, Song H, Zhan H, Ding M, Luan T, Chen J, Wei H and Wang J. The influence of preoperative urodynamic parameters on clinical results in patients with benign prostatic hyperplasia after transurethral resection of the prostate. *World J Urol.* 2023; 41(12):3679-3685.
7. van Kollenburg RAA, de Bruin DM and Wijkstra H. Validation of the Electronic Version of the International Index of Erectile Function (IIEF-5 and IIEF-15): A Crossover Study. *J Med Internet Res.* 2019; 21(7):e13490.
8. Firoozi D, Masoumi SJ, Mohammad-Kazem Hosseini Asl S, Labbe A, Razeghian-Jahromi I, Fararouei M, Lankarani KB and Dara M. Effects of short-chain fatty acid-butyrate supplementation on expression of circadian-clock genes, sleep quality, and inflammation in patients with active ulcerative colitis: a double-blind randomized controlled trial. *Lipids Health Dis.* 2024; 23(1):216.
9. Meng Q, Li J, Li M and Qiu R. Evaluation of efficacy and safety of improved transurethral plasma kinetic enucleation of the prostate in high-risk patients with benign prostatic hyperplasia and coronary artery disease. *J Int Med Res.* 2021; 49(11):3000605211060890.
10. Lombardo R, Zarranonandia Andraca A, Plaza Alonso C, González-Dacal JA, Rodríguez Núñez H, Barreiro Mallo A, Gentile BC, Tema G, Albanesi L, Mavilla L, Baldassarri V, De Nunzio C, Tubaro A, Ruibal Moldes M and Giulianelli R. Laparoscopic simple prostatectomy vs bipolar plasma enucleation of the prostate in large benign prostatic hyperplasia: a two-center 3-year comparison. *World J Urol.* 2021; 39(7):2613-2619.
11. Liu C, Zheng S, Li H and Xu K. Transurethral enucleation and resection of prostate in patients with benign prostatic hyperplasia by plasma kinetics. *J Urol.* 2010; 184(6):2440-5.
12. Huang J, Fan Y, Wang K, Ding H, Mao D, Zhao L and Tai S. Transurethral 1470 nm diode laser vaporization versus plasma kinetic enucleation of the prostate for the treatment of benign prostatic hyperplasia: A retrospective study. *Medicine (Baltimore).* 2023; 102(34):e35031.

13. Giulianelli R, Gentile BC, Mirabile G, Tema G, Albanesi L, Tariciotti P, Rizzo G, Falavolti C, Aloisi P, Vincenti G and Lombardo R. Bipolar plasma enucleation of the prostate vs. open prostatectomy in large benign prostatic hyperplasia: a single centre 3-year comparison. *Prostate Cancer Prostatic Dis.* 2019; 22(1):110-116.
14. Xie L, Mao Q, Chen H, Qin J, Zheng X, Lin Y, Wang X and Liu B. Transurethral vapor enucleation and resection of the prostate with plasma vaporization button electrode for the treatment of benign prostatic hyperplasia: a feasibility study. *J Endourol.* 2012; 26(10):1264-6.
15. Mian A, Pachorek M, Sam AP, Ruel NH, Yang D, Kohler TS and Warner JN. Predictors of Storage Symptom Improvement After Plasma Kinetic Enucleation of the Prostate. *Urology.* 2022; 160:182-186.
16. Bhat A, Blachman-Braun R, Herrmann TRW and Shah HN. Are all procedures for benign prostatic hyperplasia created equal? A systematic review on post-procedural PSA dynamics and its correlation with relief of bladder outlet obstruction. *World J Urol.* 2022; 40(4):889-905.
17. Lin J, Zhou J, Xu W, Zhong X, Hong Z and Peng J. Qianliening capsule treats benign prostatic hyperplasia via suppression of the EGF/STAT3 signaling pathway. *Exp Ther Med.* 2013; 5(5):1293-1300.
18. Abo-El Fetoh ME, Abdel-Fattah MM, Mohamed WR, Ramadan LAA and Afify H. Cyclooxygenase-2 activates EGFR-ERK1/2 pathway via PGE2-mediated ADAM-17 signaling in testosterone-induced benign prostatic hyperplasia. *Inflammopharmacology.* 2023; 31(1):499-516.
19. Inamura S, Ito H, Shinagawa T, Tsutsumiuchi M, Taga M, Tsuchiyama K, Kobayashi M and Yokoyama O. Serum C-reactive protein level is not associated with prostatic inflammation but with overactive detrusor in patients with benign prostatic hyperplasia. *Neurourol Urodyn.* 2019; 38(6):1728-1736.
20. Yang M, Zhu X, Shen Y, He Q, Qin Y, Shao Y, Yuan L and Ye H. GPX2 predicts recurrence-free survival and triggers the Wnt/ β -catenin/EMT pathway in prostate cancer. *PeerJ.* 2022; 10:e14263.
21. Basha SZ, Mohamed GA, Abdel-Naim AB, Hasan A and Abdel-Lateff A. Cucurbitacin E glucoside from *Citrullus colocynthis* inhibits testosterone-induced benign prostatic hyperplasia in mice. *Drug Chem Toxicol.* 2021; 44(5):533-543.
22. Raafat M, Kamel AA, Shehata AH, Ahmed AF, Bayoumi AMA, Moussa RA, Abourehab MAS, El-Daly M. Aescin Protects against Experimental Benign Prostatic Hyperplasia and Preserves Prostate Histomorphology in Rats via Suppression of Inflammatory Cytokines and COX-2. *Pharmaceuticals (Basel).* 2022; 15(2)
23. Trujillo-Rojas L, Fernández-Novell JM, Blanco-Prieto O, Rigau T, Rivera Del Álamo MM and Rodríguez-Gil JE. The onset of age-related benign prostatic hyperplasia is concomitant with increased serum and prostatic expression of VEGF in rats: Potential role of VEGF as a marker for early prostatic alterations. *Theriogenology.* 2022; 183:69-78.
24. Montiel-Jarquín Á J, Gutiérrez-Quiroz CT, Pérez-Vázquez AL, Ortiz-Agustín JJ, García-Galicia A and Loría-Castellanos J. Quality of life and erectile dysfunction in patients with benign prostatic hyperplasia. *Cir Cir.* 2021; 89(2):218-222.
25. Xing N, Guo Y, Yang F, Tian L, Zhang J, Yan Y, Kang N, Xin Z and Niu Y. Laparoscopic simple prostatectomy with prostatic urethra preservation for benign prostatic hyperplasia. *Transl Androl Urol.* 2012; 1(1):9-13.
26. Wang XY, Zong HT and Zhang Y. Efficacy and safety of prostate artery embolization on lower urinary tract symptoms related to benign prostatic hyperplasia: a systematic review and meta-analysis. *Clin Interv Aging.* 2016; 11:1609-1622.