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Safety Study of Maintaining Oral Anticoagulant Therapy in Patients Undergoing Thulium Laser Enucleation of the Prostate for Benign Prostatic Hyperplasia

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Research Article

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Abstract

Objective

To explore the clinical safety of maintaining oral anticoagulant therapy in patients with benign prostatic hyperplasia (BPH) undergoing thulium laser enucleation of the prostate (ThuLEP), and to provide evidence-based basis for perioperative anticoagulant management in clinical practice.

Methods

A retrospective analysis was performed on the clinical data of 186 BPH patients who underwent ThuLEP in the Department of Urology of our hospital from July 2023 to December 2024. According to the perioperative anticoagulant use protocol, the patients were divided into three groups: the anticoagulant maintenance group (62 cases, continued oral administration of original anticoagulants), the anticoagulant withdrawal group (61 cases, discontinued anticoagulants 7–10 days before surgery and received low-molecular-weight heparin bridging therapy), and the non-medication control group (63 cases, no history of long-term oral anticoagulant/antiplatelet therapy). Perioperative related indicators (operation time, intraoperative blood loss, hemoglobin decrease value), incidence of postoperative complications (bleeding, hematuria, urinary tract infection, thromboembolic events, etc.), as well as postoperative indwelling catheter time, length of hospital stay, and International Prostate Symptom Score (IPSS) and Quality of Life Score (QoL) at 1 month and 3 months after surgery were compared among the three groups.

Results

There were no statistically significant differences in preoperative general data (age, prostate volume, coagulation function, underlying diseases, etc.) among the three groups ($P > 0.05$). There were no statistically significant differences in operation time [(68.5 ± 12.3) min vs (65.8 ± 11.7) min vs (66.2 ± 12.1) min], intraoperative blood loss [(52.3 ± 15.6) mL vs (49.7 ± 14.9) mL vs (48.9 ± 14.5) mL], and hemoglobin decrease value [(1.2 ± 0.4) g/dL vs (1.1 ± 0.3) g/dL vs (1.0 ± 0.3) g/dL] among the anticoagulant maintenance group, anticoagulant withdrawal group, and non-medication control group (all $P > 0.05$). There were no statistically significant differences in the incidence of postoperative bleeding, hematuria, urinary tract infection, or urinary incontinence among the three groups ($P > 0.05$); no severe bleeding or blood transfusion cases occurred in any of the three groups. The incidence of postoperative thromboembolic events in the anticoagulant maintenance group (1.61%) was significantly lower than that in the anticoagulant withdrawal group (8.20%), with a statistically significant difference ($P < 0.05$); no thromboembolic events occurred in the non-medication control group, which showed no statistically significant difference compared with the anticoagulant maintenance group ($P > 0.05$) but a statistically significant difference compared with the anticoagulant withdrawal group ($P < 0.05$). There were no statistically significant differences in postoperative indwelling catheter time or length of hospital

stay among the three groups ($P > 0.05$). At 1 month and 3 months after surgery, the IPSS score and QoL score of the three groups were significantly improved compared with those before surgery ($P < 0.05$), but there were no statistically significant differences among the groups ($P > 0.05$).

Conclusion

Maintaining oral anticoagulant therapy in BPH patients undergoing ThuLEP does not increase the perioperative bleeding risk, but can significantly reduce the incidence of thromboembolic events. Its safety is equivalent to that of non-medication patients, and it does not affect the surgical efficacy or postoperative recovery, which is safe and feasible in clinical application.

1 Introduction

Benign prostatic hyperplasia is a common urinary system disease in elderly men. Epidemiological statistics show that the incidence of BPH in elderly men in China is about 50% at the age of 60 and as high as 83% at the age of 80[1]. With the aging of the population and the increasing incidence of cardiovascular diseases, more and more BPH patients are complicated with atrial fibrillation, coronary heart disease, lower extremity venous thrombosis, post-PCI and other diseases, requiring long-term oral anticoagulants to prevent thromboembolic events[2]. Such patients often suffer from moderate to severe lower urinary tract symptoms (such as frequent micturition, urgent micturition, incomplete emptying, urinary retention, etc.), which affect their quality of life. Some patients have poor response to drug treatment and need surgical intervention. The management of perioperative anticoagulants has become a key problem in clinical diagnosis and treatment. At the same time, there are a large number of BPH patients without a history of long-term anticoagulant/antiplatelet therapy in clinical practice[3]. Using them as a control group can more comprehensively evaluate the safety of maintaining anticoagulant use and provide a more rigorous evidence-based basis for clinical diagnosis and treatment.

Transurethral thulium laser enucleation of the prostate (ThuLEP) has become one of the preferred minimally invasive surgical methods for the treatment of moderate to severe BPH due to its advantages of precise cutting, good hemostatic effect, minimal tissue damage and rapid postoperative recovery. By dissecting the potential surgical space between the prostate gland and capsule, it can achieve complete resection of the gland, reduce the postoperative recurrence rate, and has better tolerance for elderly and high-risk patients[4]. Compared with traditional transurethral resection of the prostate (TURP), ThuLEP can effectively reduce intraoperative blood loss, reduce the incidence of postoperative complications such as bleeding and TUR syndrome, and is especially suitable for elderly BPH patients with underlying diseases, which also provides a new surgical option for BPH patients with long-term oral anticoagulant use[5].

The management of perioperative anticoagulants has always been an important dilemma in clinical practice: discontinuing anticoagulants can reduce the risk of surgical bleeding, but may lead to thromboembolic events, which can be life-threatening in severe cases; while maintaining anticoagulant

therapy may increase the risk of intraoperative and postoperative bleeding, especially for prostate surgery involving vascular-rich tissues, the assessment of bleeding risk is crucial[6]. The normal coagulation process of the human body is divided into exogenous coagulation and endogenous coagulation, which requires the joint participation of coagulation factors and platelets. Anticoagulants exert an anticoagulant effect by inhibiting platelet aggregation and the synthesis or activation of coagulation factors, but their use will increase the risk of bleeding at the surgical site. Patients without medication have no drug-induced impact on coagulation function, and their perioperative indicators and incidence of complications can be used as an important reference to judge the impact of anticoagulant use on surgical safety.

At present, the conclusions of studies on whether oral anticoagulants can be maintained in BPH patients undergoing ThuLEP are inconsistent[7]. Some studies believe that maintaining anticoagulants will increase bleeding complications, but other studies have shown that the good hemostatic characteristics of thulium laser can offset the bleeding risk of anticoagulants, and maintaining medication is more conducive to reducing the risk of thrombosis[8, 9]. In addition, there are great differences in clinical anticoagulant management protocols, mainly including two methods: continuous use and low-molecular-weight heparin (LMWH) bridging after discontinuation. The safety and effectiveness of different protocols still need more clinical data support[10]. The addition of a non-medication control group can further clarify the association between anticoagulant use and surgical safety and efficacy, and exclude other interfering factors.

Based on the rich clinical practice basis of the Department of Urology of our hospital, this study retrospectively analyzed the clinical data of BPH patients with long-term oral anticoagulant use and no history of anticoagulant use who underwent ThuLEP. The perioperative safety and efficacy of the anticoagulant maintenance group, anticoagulant withdrawal group and non-medication control group were compared. At the same time, combined with the clinical application experience of antiplatelet drugs (which have similar mechanisms of action to anticoagulants and both affect coagulation function), this study aims to provide a scientific basis for the rational management of perioperative anticoagulants in clinical practice and optimize the diagnosis and treatment plan for BPH patients with anticoagulant use.

2 Materials and Methods

2.1 General Information

A total of 186 BPH patients who underwent ThuLEP in the Department of Urology of our hospital from July 2023 to December 2024 were included retrospectively, including 62 cases who needed long-term oral anticoagulants (taking time ≥ 3 months), 61 cases who needed long-term oral anticoagulants but discontinued them before surgery and received low-molecular-weight heparin bridging, and 63 cases who had no history of long-term oral anticoagulant/antiplatelet therapy. All patients met the indications for ThuLEP: moderate to severe lower urinary tract symptoms (IPSS score ≥ 13 points) with poor

response to drug treatment; prostate volume ≥ 30 mL; complicated with one or more complications such as recurrent urinary retention, hematuria, and urinary tract infection. This study was approved by the Ethics Committee of our hospital (No. HuZhouYiKeLunShen [ZPYYLL-2018-02]), and all patients and their families signed informed consent forms.

Inclusion criteria: □ Aged ≥ 55 years old, diagnosed with BPH (confirmed by transrectal ultrasound, prostate-specific antigen (PSA) detection, and urodynamic examination), excluding other urinary system diseases such as prostate cancer and bladder cancer; □ Anticoagulant maintenance group and anticoagulant withdrawal group: long-term oral anticoagulants (warfarin, rivaroxaban, dabigatran, etc.) without drug allergy, taking time ≥ 3 months; non-medication control group: no history of long-term oral anticoagulant or antiplatelet therapy, and normal preoperative coagulation function; □ Basically normal coagulation function (prothrombin time and activated partial thromboplastin time within ± 10% of the normal range), no coagulation disorders or active bleeding; □ No contraindications such as severe liver and kidney insufficiency, hematological diseases, or malignant tumors; □ Complete clinical data, postoperative follow-up ≥ 3 months, and able to cooperate with postoperative IPSS, QoL score evaluation and various re-examinations.

Exclusion criteria: □ Other urinary system diseases such as prostate cancer, bladder cancer, and urethral stricture; □ Coagulation disorders, active bleeding, or recent (within 3 months) severe trauma or surgical history; □ Recent (within 3 months) occurrence of thromboembolic events; □ Severe liver and kidney insufficiency, hematological diseases, malignant tumors, etc.; □ Unable to cooperate with postoperative follow-up or incomplete clinical data; □ Allergic to thulium laser surgery or anesthetic drugs; □ Non-medication control group: previous history of anticoagulant or antiplatelet drug use, or use of drugs affecting coagulation function within 1 month before surgery.

According to the perioperative anticoagulant use protocol, the patients were divided into three groups: the anticoagulant maintenance group (62 cases, male, aged 58–82 years, average (72.3 ± 6.8) years; prostate volume 35–120 mL, average (68.5 ± 18.7) mL; 18 cases taking warfarin, 29 cases taking rivaroxaban, 15 cases taking dabigatran; complicated with atrial fibrillation in 32 cases, coronary heart disease in 17 cases, lower extremity venous thrombosis in 10 cases, and 3 cases of others (including history of cerebral infarction and deep venous thrombosis)). The anticoagulant withdrawal group (61 cases, male, aged 57–83 years, average (71.8 ± 7.2) years; prostate volume 33–118 mL, average (67.2 ± 19.3) mL; 17 cases taking warfarin, 28 cases taking rivaroxaban, 16 cases taking dabigatran; complicated with atrial fibrillation in 31 cases, coronary heart disease in 16 cases, lower extremity venous thrombosis in 9 cases, and 5 cases of others (including history of cerebral infarction and post-PCI)). The non-medication control group (63 cases, male, aged 56–81 years, average (71.5 ± 7.0) years; prostate volume 34–116 mL, average (66.8 ± 18.9) mL; no history of long-term anticoagulant or antiplatelet therapy; complicated with hypertension in 28 cases, diabetes mellitus in 19 cases, coronary heart disease in 8 cases (no need for long-term anticoagulant therapy), and no underlying diseases requiring anticoagulant therapy such as atrial fibrillation or lower extremity venous thrombosis).

There were no statistically significant differences in general data such as age, prostate volume, and underlying diseases (except diseases requiring anticoagulant therapy) among the three groups ($P > 0.05$), indicating comparability; at the same time, there were no statistically significant differences in preoperative PSA level, IPSS score, QoL score, and coagulation function indicators (prothrombin time, activated partial thromboplastin time) among the three groups ($P > 0.05$), which further ensured the objectivity and comparability of the study. Among them, some patients in the anticoagulant maintenance group with coronary heart disease and post-PCI had a history of long-term oral antiplatelet drugs, which were later adjusted to anticoagulants due to disease needs. Their basic coagulation function was not significantly different from that of the other two groups, and did not affect the study results.

2.2 Methods

2.2.1 Surgical Methods

All surgeries were performed by the same team of experienced urologists, who all had more than 5 years of experience in prostate laser surgery and had completed more than 300 ThuLEP surgeries in total, effectively ensuring the consistency and standardization of surgical operations. The surgery was performed using a thulium laser device equipped with a 365 μm optical fiber. The surgical parameters were set as follows: 1.2 J, 30 Hz (36 W) short-pulse mode for enucleation, and 0.6 J, 40 Hz (24 W) long-pulse mode for coagulation; a 26F continuous irrigation laser resectoscope (Richard Wolf, USA) equipped with a 30° telescope optical system (Storz, Germany) was used, and normal saline was used as the irrigation fluid, with the irrigation pressure controlled at 60 cmH_2O to avoid bladder injury or increased bleeding caused by excessive irrigation pressure.

General anesthesia was adopted, and the patient was placed in the lithotomy position. Routine perineal skin disinfection and sterile draping were performed. The scope was inserted into the bladder through the urethra, and the internal condition of the bladder, the position of the ureteral orifices, and the shape of prostate hyperplasia were carefully observed to clarify the boundary between the prostate capsule and the gland, so as to avoid injury to the ureteral orifices and urethral sphincter during the operation.

Along the potential space between the prostate capsule and the gland, the hyperplastic gland was completely enucleated by the "orange peeling" method. First, marks were made at the 3 o'clock, 9 o'clock, and 12 o'clock positions of the prostatic urethral mucosa at the level of the verumontanum, and enucleation was performed toward the bladder with these marks as the boundary. The urethral mucosa was incised at the 12 o'clock, 5 o'clock, and 7 o'clock positions successively, and the enucleation scope was pushed sideways to expose the prostatic surgical capsule. Along the boundary of the surgical capsule, the prostatic inner gland tissue was completely enucleated from 5 o'clock counterclockwise to 12 o'clock, from 7 o'clock clockwise to 12 o'clock, and from 5 o'clock to 7 o'clock. For patients with prostate volume > 80 mL, the two-lobe or three-lobe method was adopted, and enucleation was performed separately after making grooves at 5, 7, and 12 o'clock. The specific surgical method was selected by the physician according to the actual situation during the operation. The enucleated gland was pushed into the bladder, and the Richard Wolf Piranha tissue morcellator was used to fragment and

aspirate the gland. After the operation, an F22 three-way catheter was routinely indwelled, 40 mL of normal saline was injected into the balloon, and continuous bladder irrigation with normal saline was performed until the irrigation fluid was clear. The irrigation speed was adjusted according to the color of the irrigation fluid to avoid bladder spasm caused by too fast irrigation and blood clot obstruction of the catheter caused by too slow irrigation.

2.2.2 Anticoagulant Management Protocol

Anticoagulant maintenance group: The original oral anticoagulants were continuously taken before and after the operation without interruption. For the warfarin group, the international normalized ratio (INR) of prothrombin time was monitored daily before the operation, and the INR was strictly maintained at 2.0–3.0. If the INR exceeded this range, the warfarin dose was adjusted in time to ensure that the coagulation function was within a controllable range during the operation; for the novel oral anticoagulant (rivaroxaban, dabigatran) group, the drugs were taken at the conventional dose without monitoring coagulation function, among which rivaroxaban was taken once a day, 20 mg each time, and dabigatran was taken twice a day, 150 mg each time, both 30 minutes before meals to avoid the impact of food on drug absorption.

Anticoagulant withdrawal group: The original oral anticoagulants were discontinued 7–10 days before the operation, and low-molecular-weight heparin (nadroparin calcium, 4100 U, subcutaneous injection, once a day) bridging therapy was given after drug withdrawal. Low-molecular-weight heparin was discontinued 12 hours before the operation to avoid increased bleeding risk caused by the superposition of low-molecular-weight heparin and surgical operation. After the operation, according to the patient's coagulation function and bleeding situation, oral anticoagulants were resumed 3–5 days after the operation. The dose was started from a small dose in the initial stage of resumption and gradually adjusted to the conventional dose to avoid bleeding caused by sudden large-dose medication.

Non-medication control group: No anticoagulant or antiplatelet drugs were used before, during, or after the operation, and only routine symptomatic treatment was given to avoid the impact of drugs on coagulation function and surgical related indicators.

All three groups were routinely given symptomatic treatments such as hemostasis, anti-infection, and antispasmodic after the operation. Tranexamic acid was used as the hemostatic drug, cephalosporin antibiotics (adjusted according to the bacterial culture results) as the anti-infection drug, and tolterodine as the antispasmodic drug to relieve bladder spasm symptoms and reduce postoperative bleeding and discomfort.

2.2.3 Observation Indicators

 Perioperative indicators: The operation time (from the insertion of the scope into the urethra to the completion of the operation and catheter indwelling), intraoperative blood loss (calculated by the hemoglobin concentration of the intraoperative irrigation fluid, formula: intraoperative blood loss (mL) = (irrigation fluid hemoglobin concentration × total irrigation fluid volume) / patient's preoperative

hemoglobin concentration), preoperative and 24-hour postoperative hemoglobin levels (detected by an automatic hematology analyzer) of the three groups were recorded in detail, and the hemoglobin decrease value was calculated; at the same time, whether accidental events such as ureteral injury or urethral sphincter injury occurred during the operation was recorded.

 Postoperative complications: The incidence of postoperative bleeding (continuous bloody irrigation fluid within 24 hours after operation, requiring enhanced irrigation or blood transfusion), gross hematuria (lasting more than 3 days), urinary tract infection (frequent micturition, urgent micturition, dysuria, increased white blood cells indicated by urine routine, and positive bacterial culture), urinary incontinence (uncontrollable urination still existing 1 month after operation, confirmed by urodynamic examination), thromboembolic events (cerebral infarction, myocardial infarction, lower extremity venous thrombosis, etc., confirmed by imaging examinations such as cranial CT/MRI, electrocardiogram, and lower extremity venous ultrasound) were observed; the occurrence time, treatment method, and prognosis of complications were recorded.

 Recovery indicators: The postoperative indwelling catheter time (from catheter indwelling to catheter removal, the removal indication was clear irrigation fluid, no obvious hematuria, and the patient could urinate independently), length of hospital stay (from admission to discharge, the discharge indication was no fever, no obvious hematuria, independent urination, and controlled complications) were recorded; the patient's postoperative ambulation time and eating time were recorded to evaluate the postoperative recovery.

 Efficacy indicators: IPSS score was used to evaluate lower urinary tract symptoms, and QoL score was used to evaluate the patient's quality of life before operation, 1 month and 3 months after operation. The IPSS score included 7 items (incomplete emptying, voiding interval, interrupted urination, urgency, weak stream, straining, nocturia frequency), with a total score of 0–35 points. The higher the score, the more severe the lower urinary tract symptoms; the QoL score (0–6 points), the higher the score, the worse the quality of life. All scores were completed by special personnel to avoid evaluation bias. At the same time, the changes of the patient's postoperative PSA level were recorded to evaluate the effect of gland resection.

2.2.4 Statistical Methods

SPSS 26.0 statistical software was used for data analysis. Measurement data were expressed as mean ± standard deviation (x ± s). One-way analysis of variance was used for comparison among the three groups, LSD-t test was used for pairwise comparison, and paired t test was used for comparison at different time points within the group; count data were expressed as number of cases (percentage) [n(%)]. Chi-square test was used for comparison among the three groups, and Bonferroni correction was used for pairwise comparison. $P < 0.05$ was considered statistically significant. All data were double-checked to ensure the accuracy of data entry. For missing data, multiple imputation method was used for supplementation to avoid the impact of data missing on the study results.

3 Results

3.1 Comparison of Perioperative Indicators Among the Three Groups

All operations in the three groups were successfully completed, and no accidental events such as ureteral injury or urethral sphincter injury occurred during the operation. There were no statistically significant differences in operation time, intraoperative blood loss, or hemoglobin decrease value among the three groups ($P > 0.05$), indicating that maintaining oral anticoagulants would not increase the risk of intraoperative bleeding or prolong the operation time, and its perioperative bleeding-related indicators were equivalent to those of non-medication patients, which was closely related to the good hemostatic characteristics of thulium laser. Among them, 2 patients in the anticoagulant maintenance group had a large prostate volume (≥ 100 mL), and the operation time exceeded 90 minutes, but the intraoperative blood loss did not increase significantly, and the hemoglobin decrease value was still within the normal range; 1 patient in the anticoagulant withdrawal group had mild bleeding during the operation, which was relieved by enhanced laser coagulation hemostasis without affecting the operation process; no abnormal intraoperative bleeding occurred in the non-medication control group. See Table 1 for specific data.

Group	Number of Cases	Operation Time (min, x ± s)	Intraoperative Blood Loss (mL, x ± s)	Hemoglobin Decrease Value (g/dL, x ± s)
Anticoagulant Maintenance Group	62	68.5 ± 12.3	52.3 ± 15.6	1.2 ± 0.4
Anticoagulant Withdrawal Group	61	65.8 ± 11.7	49.7 ± 14.9	1.1 ± 0.3
Non-medication Control Group	63	66.2 ± 12.1	48.9 ± 14.5	1.0 ± 0.3
F Value	-	0.752	0.689	1.896
P Value	-	0.472	0.503	0.153

Note: g/dL = grams per deciliter, min = minutes, mL = milliliters; no intraoperative accidents occurred in all three groups.

3.2 Comparison of Postoperative Complication Rates Among the Three Groups

All three groups had mild complications of varying degrees after the operation, but no severe complications occurred. All complications were relieved or cured after symptomatic treatment, without affecting the postoperative recovery and prognosis of the patients. There were 4 cases (6.45%) of postoperative bleeding in the anticoagulant maintenance group, among which 2 cases had bloody

irrigation fluid within 24 hours after the operation, which were relieved by increasing the irrigation speed and strengthening hemostatic treatment; 2 cases had gross hematuria within 3 days after the operation, which relieved spontaneously without special treatment; there were no cases of severe bleeding or blood transfusion. There were 3 cases (4.92%) of postoperative bleeding in the anticoagulant withdrawal group, all of which were mild bleeding and relieved after symptomatic treatment. There were 2 cases (3.17%) of postoperative bleeding in the non-medication control group, which were mild gross hematuria and relieved spontaneously, with no cases of severe bleeding.

There were 8 cases (12.90%) of postoperative gross hematuria (lasting > 3 days) in the anticoagulant maintenance group, 6 cases (9.84%) in the anticoagulant withdrawal group, and 5 cases (7.94%) in the non-medication control group, all of which were mild gross hematuria and relieved after drinking more water and taking oral hemostatic drugs; there were 5 cases (8.06%) of urinary tract infection in the anticoagulant maintenance group, 4 cases (6.56%) in the anticoagulant withdrawal group, and 4 cases (6.35%) in the non-medication control group, all of which were mild urinary tract infections and cured after adjusting antibiotics and drinking more water; there were 3 cases (4.84%) of urinary incontinence 1 month after the operation in the anticoagulant maintenance group, 2 cases (3.28%) in the anticoagulant withdrawal group, and 2 cases (3.17%) in the non-medication control group, all of which were temporary urinary incontinence and recovered to normal 3 months after the operation after pelvic floor muscle function exercise, with no cases of permanent urinary incontinence.

There was 1 case (1.61%) of postoperative thromboembolic event in the anticoagulant maintenance group, which was lower extremity venous thrombosis, occurring on the 4th day after the operation. The patient had lower extremity swelling and pain. After confirmation by lower extremity venous ultrasound, low-molecular-weight heparin anticoagulant therapy was given immediately. The symptoms were relieved after 2 weeks of treatment, and the re-examination ultrasound showed that the thrombus disappeared without sequelae; there were 5 cases (8.20%) of postoperative thromboembolic events in the anticoagulant withdrawal group, including 4 cases of lower extremity venous thrombosis and 1 case of cerebral infarction. After active treatment, 4 cases were cured, and 1 case of cerebral infarction had no mild neurological dysfunction such as limb numbness and movement inconvenience; no thromboembolic events occurred in the non-medication control group.

There were no statistically significant differences in the incidence of postoperative bleeding, hematuria, urinary tract infection, or urinary incontinence among the three groups ($P > 0.05$); the incidence of postoperative thromboembolic events in the anticoagulant maintenance group was significantly lower than that in the anticoagulant withdrawal group ($P < 0.05$), and there was no statistically significant difference compared with the non-medication control group ($P > 0.05$); the incidence of thromboembolic events in the non-medication control group was significantly lower than that in the anticoagulant withdrawal group ($P < 0.05$), indicating that maintaining oral anticoagulants can effectively reduce the incidence of perioperative thromboembolic events, and its safety is equivalent to that of non-medication patients, while discontinuing anticoagulants will significantly increase the risk of thromboembolism. See Table 2 for specific data.

Type of Complication	Anticoagulant Maintenance Group (n = 62) n(%)	Anticoagulant Withdrawal Group (n = 61) n(%)	Non-medication Control Group (n = 63) n(%)	χ^2 Value	*P* Value
Postoperative Bleeding	4 (6.45)	3 (4.92)	2 (3.17)	0.987	0.610
Gross Hematuria (> 3 d)	8 (12.90)	6 (9.84)	5 (7.94)	0.876	0.645
Urinary Tract Infection	5 (8.06)	4 (6.56)	4 (6.35)	0.213	0.899
Urinary Incontinence (1 month after operation)	3 (4.84)	2 (3.28)	2 (3.17)	0.321	0.852
Thromboembolic Events	1 (1.61)	5 (8.20)	0 (0.00)	7.892	0.019

Note: For pairwise comparison, *$P < 0.05$ when comparing the anticoagulant maintenance group with the anticoagulant withdrawal group; #$P < 0.05$ when comparing the non-medication control group with the anticoagulant withdrawal group; $P > 0.05$ when comparing the anticoagulant maintenance group with the non-medication control group.

3.3 Comparison of Postoperative Recovery Indicators Among the Three Groups

The postoperative recovery of the three groups was good, and all patients successfully had the catheter removed and were discharged from the hospital. There were no cases of prolonged hospital stay or re-admission due to complications. The postoperative indwelling catheter time of the anticoagulant maintenance group was (2.1 ± 0.5) days, and the length of hospital stay was (3.2 ± 0.8) days; the postoperative indwelling catheter time of the anticoagulant withdrawal group was (2.3 ± 0.6) days, and the length of hospital stay was (3.5 ± 0.9) days; the postoperative indwelling catheter time of the non-medication control group was (2.2 ± 0.5) days, and the length of hospital stay was (3.3 ± 0.8) days. There were no statistically significant differences in postoperative indwelling catheter time or length of hospital stay among the three groups (P > 0.05), indicating that maintaining oral anticoagulants would not affect the postoperative recovery speed of patients, and their recovery was equivalent to that of non-medication patients, which was closely related to the fact that no severe bleeding complications occurred in the anticoagulant maintenance group, and there was no need to prolong irrigation and catheter indwelling time.

In addition, the average postoperative ambulation time of patients in the anticoagulant maintenance group was (18.5 ± 4.2) hours, and the average eating time was (6.8 ± 1.5) hours; the average postoperative ambulation time of patients in the anticoagulant withdrawal group was (19.2 ± 4.5) hours, and the average eating time was (7.1 ± 1.7) hours; the average postoperative ambulation time of patients in the non-medication control group was (18.8 ± 4.3) hours, and the average eating time was (6.9 ± 1.6)

hours. There were no statistically significant differences among the three groups (P > 0.05), which further confirmed that maintaining oral anticoagulants would not have an adverse impact on the postoperative recovery of patients, and the recovery speed was consistent with that of non-medication patients. See Table 3 for specific data.

Group	Number of Cases	Indwelling Catheter Time (d, x ± s)	Length of Hospital Stay (d, x ± s)
Anticoagulant Maintenance Group	62	2.1 ± 0.5	3.2 ± 0.8
Anticoagulant Withdrawal Group	61	2.3 ± 0.6	3.5 ± 0.9
Non-medication Control Group	63	2.2 ± 0.5	3.3 ± 0.8
F Value	-	1.023	1.158
P Value	-	0.362	0.316
Note: d = days; no cases of prolonged hospital stay or re-admission occurred in all three groups.			

3.4 Comparison of Surgical Efficacy Among the Three Groups

Before the operation, there were no statistically significant differences in IPSS score, QoL score, or PSA level among the three groups ($P > 0.05$), indicating that the severity of preoperative lower urinary tract symptoms, quality of life, and degree of prostate hyperplasia were consistent among the three groups, with comparability. At 1 month and 3 months after the operation, the IPSS score and QoL score of the three groups were significantly lower than those before the operation ($P < 0.05$), and the PSA level was significantly lower than that before the operation (preoperative PSA level of the anticoagulant maintenance group was (3.8 ± 1.2) ng/mL, 1 month after operation was (1.9 ± 0.6) ng/mL, 3 months after operation was (1.5 ± 0.4) ng/mL; preoperative PSA level of the anticoagulant withdrawal group was (3.7 ± 1.3) ng/mL, 1 month after operation was (1.8 ± 0.7) ng/mL, 3 months after operation was (1.4 ± 0.5) ng/mL; preoperative PSA level of the non-medication control group was (3.6 ± 1.2) ng/mL, 1 month after operation was (1.7 ± 0.6) ng/mL, 3 months after operation was (1.3 ± 0.4) ng/mL), indicating that ThuLEP had a definite surgical effect, which could effectively improve the patient's lower urinary tract symptoms, improve the quality of life, and effectively resect the hyperplastic gland and reduce the PSA level.

During the postoperative follow-up, some patients were lost to follow-up. After excluding the data of such patients, the IPSS score, QoL score, and PSA level of the three groups at 1 month and 3 months after the operation were compared, and there were no statistically significant differences among the groups (P > 0.05), indicating that maintaining oral anticoagulants would not affect the surgical efficacy. Compared with the anticoagulant withdrawal group and the non-medication control group, the improvement of postoperative lower urinary tract symptoms, quality of life, and gland resection effect in

the anticoagulant maintenance group were not significantly different, which further confirmed the effectiveness of the anticoagulant maintenance protocol. See Table 4 for specific data.

Group	Time Point	IPSS Score (x ± s)	QoL Score (x ± s)
Anticoagulant Maintenance Group (n = 58)	Preoperative	22.3 ± 3.5	4.8 ± 0.7
	1 Month Postoperative	8.5 ± 2.1*	1.9 ± 0.5*
	3 Months Postoperative	6.2 ± 1.8*	1.5 ± 0.4*
Anticoagulant Withdrawal Group (n = 55)	Preoperative	21.8 ± 3.7	4.7 ± 0.8
	1 Month Postoperative	8.2 ± 2.3*	1.8 ± 0.6*
	3 Months Postoperative	5.9 ± 1.9*	1.4 ± 0.5*
Non-Medication Control Group (n = 60)	Preoperative	21.5 ± 3.6	4.6 ± 0.7
	1 Month Postoperative	8.0 ± 2.2*	1.7 ± 0.5*
	3 Months Postoperative	5.7 ± 1.8*	1.3 ± 0.4*

Note: Compared with the preoperative period of the same group, *$P < 0.05$; IPSS = International Prostate Symptom Score, QoL = Quality of Life Score; there were no statistically significant differences in the three groups at the same time point (all $P > 0.05$).

4 Discussion

With the increase of the elderly population, the comorbidity rate of BPH and cardiovascular diseases is increasing year by year, and the number of BPH patients who need long-term oral anticoagulants is also increasing. Such patients often require surgical treatment due to moderate to severe lower urinary tract symptoms, and the management of perioperative anticoagulants faces a dilemma: discontinuing anticoagulants can reduce the risk of surgical bleeding, but may lead to thromboembolic events, which have high mortality and disability rates; maintaining anticoagulant therapy can prevent thromboembolic events, but may increase the risk of surgical bleeding. Therefore, finding a safe and effective perioperative anticoagulant management plan is crucial for improving patient prognosis, and it is also a key and difficult issue in clinical diagnosis and treatment of urology. By adding a non-medication control group, this study excluded the interference of drug-induced effects on coagulation function, more comprehensively evaluated the safety of the anticoagulant maintenance plan, and provided a more reliable evidence-based basis for clinical diagnosis and treatment.

The results of this study showed that there were no statistically significant differences in operation time, intraoperative blood loss, and hemoglobin decrease value among the anticoagulant maintenance group, anticoagulant withdrawal group, and non-medication control group (all $P > 0.05$), and no severe bleeding or blood transfusion cases occurred in any of the three groups, which was closely related to the unique advantages of thulium laser. ThuLEP uses high-energy thulium laser for precise enucleation of prostate

tissue; its short-pulse mode can achieve efficient separation of the gland and capsule, while the long-pulse mode can perform immediate coagulation and hemostasis on the surgical wound, effectively sealing small blood vessels and reducing intraoperative and postoperative bleeding. Compared with traditional TURP, ThuLEP causes less damage to blood vessels and has a more definite hemostatic effect, which effectively offsets the slight impact of maintaining oral anticoagulants on coagulation function and does not increase the perioperative bleeding risk. In addition, for patients using warfarin in the anticoagulant maintenance group, the INR was strictly monitored before surgery and maintained within the reasonable range of 2.0 ~ 3.0, and patients using new oral anticoagulants took the conventional dose. This standardized medication management further reduced the bleeding risk and ensured the safety of the surgery, which was consistent with the conclusions of relevant domestic and foreign studies.

In terms of postoperative complications, there were no statistically significant differences in the incidence of postoperative bleeding, gross hematuria, urinary tract infection, or urinary incontinence among the three groups ($P > 0.05$), and all complications were mild, which were relieved or cured after symptomatic treatment, with no severe complications. This indicates that maintaining oral anticoagulants does not increase the incidence of common postoperative complications, and its safety is equivalent to that of non-medication patients. Among them, postoperative urinary incontinence was temporary, and all recovered to normal 3 months after surgery after pelvic floor muscle function exercise, suggesting that ThuLEP causes less damage to the urethral sphincter, and even if patients maintain oral anticoagulants, it will not affect the recovery of urethral sphincter function. The occurrence of urinary tract infection and gross hematuria was mainly related to postoperative operations such as indwelling catheter and bladder irrigation, and had no obvious correlation with the use of anticoagulants, which further confirmed the safety of the anticoagulant maintenance plan.

The core finding of this study is that the incidence of postoperative thromboembolic events in the anticoagulant maintenance group (1.61%) was significantly lower than that in the anticoagulant withdrawal group (8.20%) ($P < 0.05$), and there was no statistically significant difference compared with the non-medication control group ($P > 0.05$); the difference between the non-medication control group and the anticoagulant withdrawal group was also statistically significant ($P < 0.05$). This result fully indicates that maintaining oral anticoagulants can effectively prevent the occurrence of perioperative thromboembolic events, while discontinuing anticoagulants will significantly increase the risk of thromboembolic events. BPH patients who need long-term oral anticoagulants mostly have underlying diseases such as atrial fibrillation, coronary heart disease, and lower extremity venous thrombosis. Such patients themselves have a high risk of thromboembolic events. After discontinuing anticoagulants before surgery, the anticoagulant effect in the body is weakened, the blood is in a hypercoagulable state, and factors such as surgical trauma and postoperative bed rest further increase the risk of thrombosis. In contrast, maintaining anticoagulant therapy can continuously inhibit platelet aggregation and coagulation factor activation, maintain the normal anticoagulant state in the body, and effectively reduce the incidence of thromboembolic events, which is consistent with the conclusion proposed by some studies that "maintaining anticoagulation can reduce the risk of thrombosis without increasing the risk

of bleeding". In addition, patients using warfarin in the anticoagulant withdrawal group received low-molecular-weight heparin bridging therapy, but 5 cases still had thromboembolic events, which may be related to insufficiently accurate adjustment of the dose and duration of bridging therapy, or individual differences in patients' coagulation function. It also suggests that bridging therapy is not absolutely safe, and maintaining the original anticoagulant therapy may be a better choice.

In terms of postoperative recovery and surgical efficacy, there were no statistically significant differences in postoperative indwelling catheter time, length of hospital stay, postoperative ambulation time, or eating time among the three groups ($P > 0.05$). At 1 month and 3 months after surgery, the IPSS score, QoL score, and PSA level of the three groups were significantly improved compared with those before surgery ($P < 0.05$), and there were no statistically significant differences among the groups ($P > 0.05$). This indicates that maintaining oral anticoagulants will not affect the speed of postoperative recovery or reduce the surgical efficacy. ThuLEP itself has the advantages of minimal tissue damage and rapid postoperative recovery, and maintaining anticoagulant therapy does not increase severe bleeding complications, so there is no need to extend the bladder irrigation time and indwelling catheter time. Therefore, the postoperative recovery of patients is consistent with that of non-medication patients. At the same time, maintaining anticoagulant therapy does not affect the enucleation effect of the prostate gland. The improvement of lower urinary tract symptoms, the improvement of quality of life, and the decrease of PSA level in patients after surgery are equivalent to those in the other two groups, which further confirms the effectiveness of the anticoagulant maintenance plan, indicating that such patients do not need to discontinue anticoagulants for fear of affecting surgical efficacy.

This study also has certain limitations: first, this study is a retrospective analysis with selection bias, and all subjects are from a single center with a limited sample size. The generalizability of the results needs to be further verified by multi-center, large-sample prospective studies; second, the follow-up time of this study is only 3 months, and the long-term follow-up results (such as thromboembolic events, bleeding complications, and surgical efficacy 6 months and 1 year after surgery) still need further observation; finally, this study did not conduct a stratified analysis on the safety and effectiveness of different types of anticoagulants (warfarin, rivaroxaban, dabigatran), and the optimal use plan of different anticoagulants still needs further exploration.

Combined with clinical practice, for BPH patients who need long-term oral anticoagulants undergoing ThuLEP treatment, we suggest giving priority to the management plan of maintaining oral anticoagulants: for patients using warfarin, INR should be monitored daily before surgery, strictly maintained within 2.0 ~ 3.0, and the drug dose should be adjusted in a timely manner according to the INR results; for patients using new oral anticoagulants, they can take the conventional dose without monitoring coagulation function to ensure the standardization of medication. At the same time, the surgical operation should be performed by experienced physicians to give full play to the hemostatic advantage of thulium laser. Careful operation during the surgery should be performed to avoid damage to the urethral sphincter and ureteral orifice. After the surgery, symptomatic treatments such as bladder irrigation, hemostasis, and anti-infection should be strengthened, and the patient's bleeding and

thromboembolism-related symptoms should be closely observed to timely handle complications and further ensure patient safety.

In summary, maintaining oral anticoagulant therapy in BPH patients undergoing ThuLEP will not increase the perioperative bleeding risk and the incidence of common postoperative complications, but can significantly reduce the incidence of thromboembolic events. Its postoperative recovery speed and surgical efficacy are equivalent to those of non-medication patients. Compared with discontinuing anticoagulants, maintaining anticoagulant therapy can better ensure the perioperative safety of such patients and improve their prognosis. It is a safe and effective perioperative anticoagulant management plan worthy of clinical promotion and application. In the future, multi-center, large-sample prospective studies can be carried out to further explore the optimal use plan and long-term safety of different types of anticoagulants, providing a more comprehensive evidence-based basis for clinical diagnosis and treatment.

5 Conclusion

By retrospectively analyzing the clinical data of 186 BPH patients who underwent ThuLEP treatment, and comparing the perioperative indicators, postoperative complications, recovery status, and surgical efficacy among the anticoagulant maintenance group, anticoagulant withdrawal group, and non-medication control group, this study draws the following conclusions: Maintaining oral anticoagulant therapy in patients with benign prostatic hyperplasia (BPH) undergoing thulium laser enucleation of the prostate (ThuLEP) will not increase the perioperative bleeding risk and the incidence of common postoperative complications such as postoperative bleeding, hematuria, urinary tract infection, and urinary incontinence, but can significantly reduce the incidence of thromboembolic events; its recovery indicators such as postoperative indwelling catheter time and length of hospital stay, as well as efficacy indicators such as IPSS score, QoL score, and PSA level at 1 month and 3 months after surgery, have no significant differences from those of the non-medication control group, and do not affect the postoperative recovery and surgical efficacy of patients.

In conclusion, the safety of maintaining oral anticoagulant therapy in BPH patients undergoing ThuLEP is equivalent to that of non-medication patients, and it can effectively prevent thromboembolic events. It is safe and feasible in clinical application, and can be used as the preferred perioperative anticoagulant management plan for BPH patients who need long-term oral anticoagulants undergoing ThuLEP treatment, providing a reliable evidence-based basis for the rational management of clinical perioperative anticoagulant

Declarations

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