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ORIGINAL ARTICLE

Prostate Disease

Retrospective analysis of the changes in the surgical treatment of benign prostatic hyperplasia during an 11-year period: a single-center experience

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The present study aimed to determine whether the number of patients with symptomatic benign prostatic hyperplasia (BPH) who preferred surgery decreased during the past 11 years at our center (West China Hospital, Chengdu, China), and whether this change affected the timing of surgery and the physical condition of surgical patients. This retrospective study included 57 557 patients with BPH treated from January 2008 to December 2018. Of these, 5427 patients were treated surgically. Surgical patients were divided into two groups based on the time of treatment (groups 8–13 and groups 13–18). The collected data comprised the percentage of all patients with BPH who underwent surgery, baseline characteristics of surgical patients, rehabilitation time, adverse events, and hospitalization costs. The surgery rates in groups 8–13 and groups 13–18 were 10.5% and 8.5% ($P < 0.001$), respectively. The two groups did not clinically differ regarding patient age and prostate volume. The rates of acute urinary retention and renal failure decreased from 15.0% to 10.6% ($P < 0.001$) and from 5.2% to 3.1% ($P < 0.001$), respectively. In groups 8–13 and groups 13–18, the mean catheterization times were 4.0 ± 1.7 days and 3.3 ± 1.6 days ($P < 0.001$), respectively, and the mean postoperative hospitalization times were 5.1 ± 2.4 days and 4.2 ± 1.8 days ($P < 0.001$), respectively. The incidences of unplanned second surgery and death reduced during the study period. The surgery rate decreased over time, which suggests that medication was chosen over surgery. However, the percentage of late complications of BPH also decreased over time, which indicates that the timing of surgery was not delayed.

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INTRODUCTION

Benign prostatic hyperplasia (BPH) is common in older men, with an incidence of 80% in men older than 70 years.¹ The treatment options for BPH with lower urinary tract symptoms (LUTS) include watchful waiting, drug therapy, and surgical intervention. Although the treatment selection is mainly based on the severity of the condition, the introduction of alpha-blockers and 5-alpha reductase inhibitors has led drug treatment become the first-line treatment for BPH.² However, there are concerns that drug treatment may delay the timing of surgical treatment and enable the progression of BPH, or that the importance of surgical treatment will be downgraded.

Surgical treatment for BPH is now rarely done via open surgery, as open surgery leads to a larger wound and more complications than transurethral surgery. The gold standard surgical method for BPH is transurethral resection of the prostate. However, surgery for BPH is also performed via a variety of laser types, such as holmium, green, and thulium lasers. Laser surgery for BPH is becoming increasingly popular, and is performed using techniques such as photoselective vaporization of the prostate (PVP) and holmium laser enucleation of the prostate (HoLEP). In addition, numerous minimally invasive operations are

being introduced for BPH, including Urolift, transurethral columnar balloon dilation of the prostate, and transurethral microwave therapy.³ Development of BPH treatment methods and equipment may change the timing of surgery, lower the preoperative physical standards, and shorten the postoperative recovery time. With surgical treatment for BPH becoming more minimally invasive and safer, surgery may be increasingly selected over drug therapy, especially in cases in which medication is ineffective.⁴ Recent studies have reported that the incidence of surgical treatment for BPH is only 4.9% in 5057 European patients⁵ and 9.1% in 994 Asian patients.⁶ The present study aimed to evaluate the changes in the surgery rate for BPH at our center (West China Hospital, Chengdu, China) to determine whether changes in the selections of first-line BPH treatment have affected the progression of BPH and the timing of surgery. Thus, we retrospectively reviewed the data from patients who underwent surgery for BPH at our center during the past 11 years.

PATIENTS AND METHODS

The data from outpatients with BPH and LUTS who were treated in our hospital from January 1, 2008, to December 31, 2018, were

retrospectively collected. The medical records of patients with BPH who underwent surgery were further analyzed. All surgeries were booked through our outpatient clinic. Patients diagnosed with prostate cancer were excluded from the study. The protocol was approved by the Ethics Committee on Biomedical Research, West China Hospital of Sichuan University (Approval No. 2020-704). Informed consent was waived because of the retrospective nature of the study, and the analysis used anonymous clinical data.

Preoperatively, all patients underwent imaging examination of the chest, electrocardiography, ultrasonographic examination of the urinary tract, urinalysis, serum prostate-specific antigen (PSA) testing, and routine blood testing. Surgery was performed under general or spinal anesthesia. The annual number of outpatients with BPH and patients with BPH who were treated surgically was counted. The BPH surgery rate was defined as the number of surgical patients divided by the number of outpatients with BPH. The data collected for surgical patients comprised age, prostate volume (measured by transabdominal ultrasonography), urinary tract infection (UTI; determined by urinalysis), bladder stones (determined by ultrasonographic examination), acute urinary retention (defined as the presence of an indwelling catheter before surgery), renal failure (defined as an elevated serum creatinine level), comorbidities (hypertension, diabetes mellitus, pulmonary disease, cardiac disease, and cerebral disease), surgery type, operation time, bladder irrigation time (from the end of surgery until irrigation was stopped), catheterization time (from the end of surgery until urinary catheter removal), hospitalization time, complications, pathology results, cost of hospitalization (it included all expenses incurred during hospitalization, such as tests, drugs, surgery, medical consumable materials, and nursing care, and cost was converted into US dollars), and unplanned second surgery (emergency surgery due to bleeding during hospitalization).

Surgery types included bipolar transurethral resection of the prostate (bTURP), PVP, and HoLEP. Laser surgery was introduced at our center in the second half of 2013. The sheath size was 26F in all surgeries. Urethral dilatation was performed if urethral stricture was present. The sizes of postoperative indwelling urinary catheters were 20F or 22F. All surgeries were performed by senior surgeons. Surgical specimens of each patient were partially chosen by the pathologist for examination.

All included surgical patients were divided into two groups based on the time in which they received treatment; groups 8–13 comprised patients who underwent surgery for BPH from January 1, 2008, to June 30, 2013, whereas groups 13–18 comprised patients who underwent surgery for BPH from July 1, 2013, to December 31, 2018. Continuous variables were presented as mean \pm standard deviation (s.d.). Categorical variables were presented as percentages. Statistical analyses were performed using SPSS version 21.0 (IBM Corp., Armonk, NY, USA). Analysis of variance was used for continuous variables. The Chi-squared test was used for categorical variables. For all statistical comparisons, two-sided *P* values of <0.05 were considered statistically significant.

RESULTS

A total of 57 557 outpatients with BPH and LUTS who were treated at our center from 2008 to 2018 were included. The number of patients who underwent surgery for BPH was 5427, giving a surgery rate of 9.4%. The baseline characteristics of surgical patients treated in the 11-year study period (2008–2018) are summarized in **Table 1**.

There were 2802 surgical patients in groups 8–13, and 2625 surgical patients in groups 13–18. The respective numbers of BPH outpatients

in the period from 2008 to 2013 and the period from 2013 to 2018 were 26 685 and 30 872, and the respective surgery rates were 10.5% and 8.5% ($P < 0.001$). The surgery rates for each year are shown in **Figure 1**.

The mean patient age in groups 8–13 (70.8 ± 7.5 years) did not significantly differ from that in groups 13–18 (70.5 ± 7.9 years; $P = 0.151$). The mean prostate volume slightly increased over time from 62.8 ± 31.7 ml in groups 8–13 to 67.8 ± 36.0 ml in groups 13–18 ($P < 0.001$).

The rate of preoperative UTI was higher in groups 8–13 (29.6%) than in groups 13–18 (27.1%; $P = 0.038$). Compared with groups 8–13, groups 13–18 had significantly lower rates of urinary retention (10.6% vs 15.0%; $P < 0.001$) and renal failure (3.1% vs 5.2%; $P < 0.001$), but a higher incidence of bladder stones (13.2% vs 11.3%; $P = 0.032$). The rate of other comorbidities (hypertension, diabetes mellitus, pulmonary disease, cardiovascular disease, and cerebral disease) tended to be higher in groups 13–18 than groups 8–13. The comorbidity rates for each year are shown in **Figure 2**. The mean PSA level was 7.9 ± 8.7 ng ml⁻¹ in groups 8–13 and 6.7 ± 10.7 ng ml⁻¹ in groups 13–18.

The main type of surgery performed for BPH at our center was bTURP. The respective proportions of bTURP, PVP, and HoLEP were 80.7%, 17.1%, and 2.2% in the past 5 years. However, laser surgery became more common over time. The proportions of laser surgery performed each year from 2014 to 2018 were 16.6%, 13.4%, 15.5%, 24.3%, and 27.0%, respectively. The proportions of each surgical approach performed each year are shown in **Figure 3**. The mean operation times of bTURP, PVP, and HoLEP in the years 2014–2018 were 59.5 ± 38.3 min, 62.1 ± 29.9 min, and 87.7 ± 31.7 min, respectively. The mean operation time of bTURP became shorter over time. The mean operation time of bTURP was 72.4 ± 35.4 min in groups 8–13 and 59.7 ± 38.5 min in groups 13–18 ($P < 0.001$). The mean operation times of PVP and HoLEP also decreased (**Figure 3**).

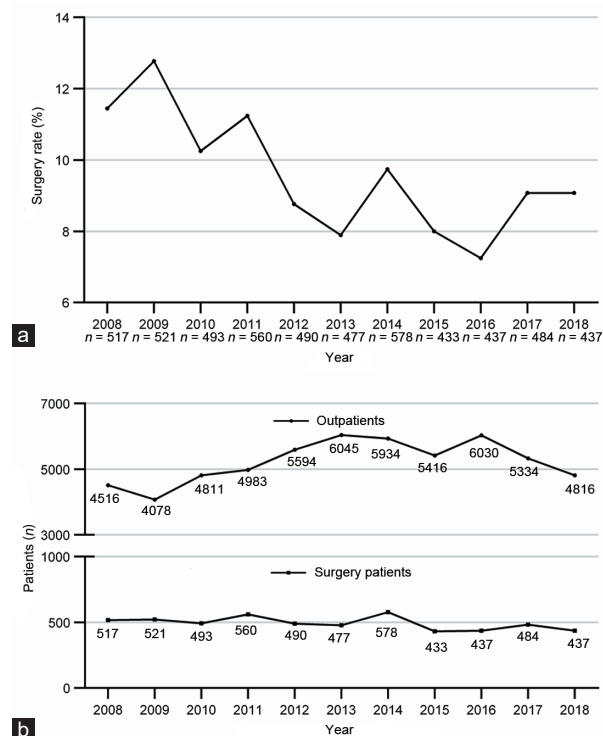


Figure 1: (a) The surgery rates of BPH patients from 2008 to 2018. (b) The number of outpatients and surgical patients from 2008 to 2018. BPH: benign prostatic hyperplasia.

Table 1: The baseline characteristics of surgical patients

Parameter	Overall (8–18), n=5427	Groups 8–13, n=2802	Groups 13–18, n=2625	P
Age (year), mean±s.d.	70.6±7.7	70.8±7.5	70.5±7.9	0.151
Prostate volume (ml), mean±s.d.	64.8±33.1	62.8±31.7	67.8±36.0	<0.001
PSA (ng ml ⁻¹), mean±s.d.	7.4±9.9	7.9±8.7	6.7±10.7	<0.001
Urinary tract infection, n (%)	1541 (28.4)	830 (29.6)	711 (27.1)	0.038
Bladder stones, n (%)	662 (12.2)	316 (11.3)	346 (13.2)	0.032
Acute urinary retention, n (%)	700 (12.9)	421 (15.0)	279 (10.6)	<0.001
Renal failure, n (%)	228 (4.2)	147 (5.2)	81 (3.1)	<0.001
Hypertension, n (%)	1536 (28.3)	757 (27.0)	779 (29.7)	0.030
Diabetes mellitus, n (%)	640 (11.8)	305 (10.9)	335 (12.8)	0.032
Pulmonary disease, n (%)	401 (7.4)	188 (6.7)	213 (8.1)	0.048
Cardiac disease, n (%)	341 (6.3)	161 (5.7)	180 (6.9)	0.092
Cerebral disease, n (%)	223 (4.1)	115 (4.1)	108 (4.1)	0.985

P values were determined by analysis of variance and Chi-square tests and compared between groups 8–13 and groups 13–18. PSA: prostate-specific antigen; s.d.: standard deviation

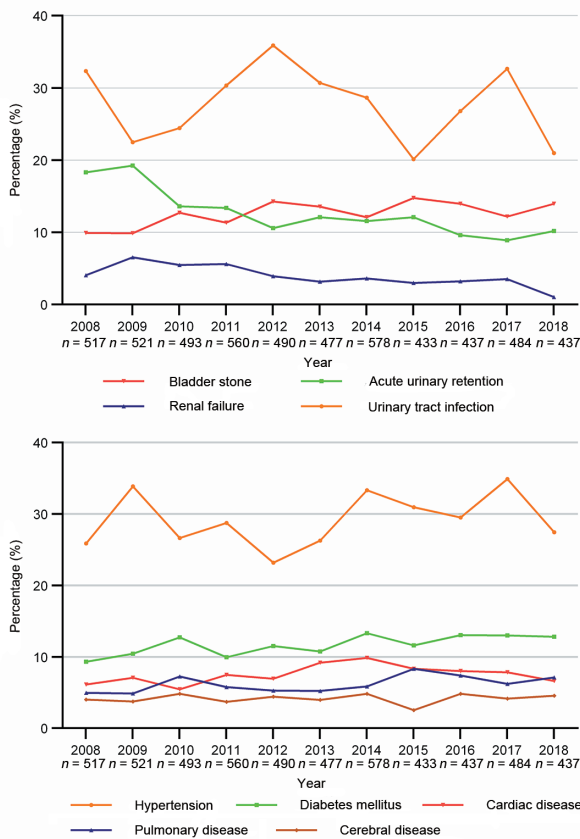


Figure 2: The comorbidity rates of surgical patients from 2008 to 2018.

The characteristics of the surgical patients in the two groups are shown in **Table 2**. The rehabilitation time of patients who underwent surgery for BPH decreased over time. Compared with groups 8–13, groups 13–18 had a significantly shorter mean bladder irrigation time (2.2 ± 1.3 days vs 2.3 ± 1.3 days; $P=0.004$), significantly shorter mean catheterization time (3.3 ± 1.6 days vs 4.0 ± 1.7 days; $P < 0.001$), significantly shorter mean postoperative hospitalization time (4.2 ± 1.8 days vs 5.1 ± 2.4 days; $P < 0.001$), and significantly shorter hospitalization time (8.4 ± 3.8 days vs 9.7 ± 4.4 days; $P < 0.001$). The rehabilitation times for each year are shown in **Figure 4**. The cost of hospitalization significantly increased over time from $\$1513 \pm \315 in groups 8–13 to $\$1755 \pm \409 in groups 13–18 ($P < 0.001$). Four

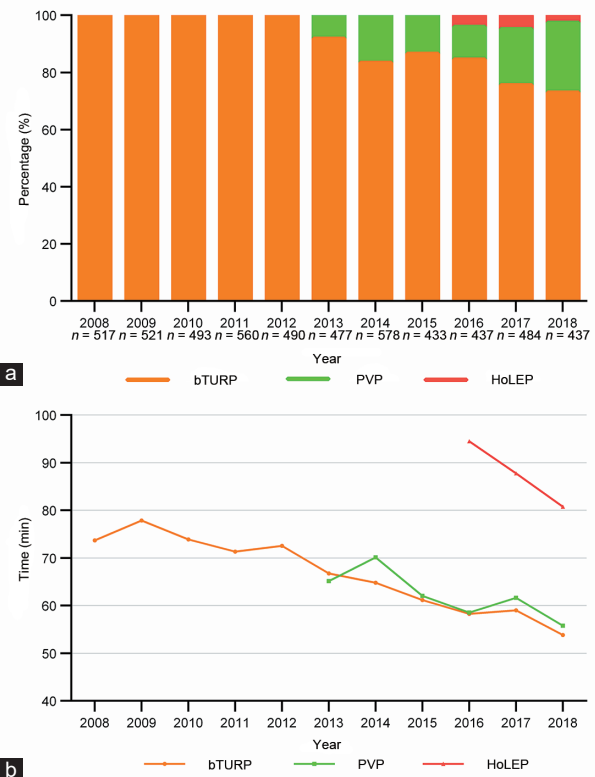


Figure 3: (a) The proportions of surgery type from 2008 to 2018. (b) The mean operation times of three surgery types from 2008 to 2018. bTURP: bipolar transurethral resection of the prostate; PVP: photoselective vaporization of the prostate; HoLEP: holmium laser enucleation of the prostate.

patients required blood transfusions in each group. The number of unplanned second surgeries was nine in groups 8–13 and three in groups 13–18. The number of deaths was four in groups 8–13 and two in groups 13–18. The rate of patients with prostate cancer detected via pathological examination was significantly lower in groups 8–13 (2.4%) than in groups 13–18 (3.3%; $P = 0.041$).

DISCUSSION

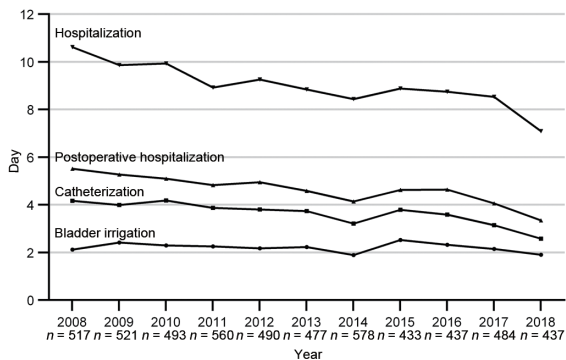
Drug therapy is more commonly and widely considered as the first choice in patients with symptomatic BPH, for its good safety and efficacy.⁷ The present study aimed to determine whether the number of patients with symptomatic BPH who preferred surgery



Table 2: The characteristics of surgical patients

Parameter	Overall (8–18), n=5427	Groups 8–13, n=2802	Groups 13–18, n=2625	P
Rehabilitation time (day), mean±s.d.				
Bladder irrigation	2.2±1.3	2.3±1.3	2.2±1.3	0.004
Catheterization	3.7±1.7	4.0±1.7	3.3±1.6	<0.001
Postoperative hospitalization	4.7±2.2	5.1±2.4	4.2±1.8	<0.001
Hospitalization	9.0±4.2	9.7±4.4	8.4±3.8	<0.001
Intraoperative complications, n (%)				
Blood transfusion	8 (0.2)	4 (0.1)	4 (0.2)	NA
Unplanned second surgery	12 (0.2)	9 (0.3)	3 (0.1)	NA
Death	6 (0.1)	4 (0.1)	2 (0.1)	NA
Expenses (US dollar), mean±s.d.				
Cost of hospitalization	1630±400	1513±315	1755±409	<0.001

P values were determined by analysis of variance and Chi-square tests and compared between groups 8–13 and groups 13–18. s.d.: standard deviation; NA: not analyzed.

**Figure 4:** The rehabilitation time of surgical patients from 2008 to 2018.

decreased, and whether there was any change of timing of surgery and condition of surgical patients. We retrospectively reviewed the data from patients with BPH who underwent surgery at our center during the past 11 years. The percentage of patients with BPH who underwent surgery from 2008 to 2018 was 9.4%, indicating that surgery remains one of the main methods of BPH management at our center. However, the number of patients who underwent surgery for BPH did not increase in tandem with the increase in the total number of outpatients with BPH. A nationwide study conducted in Australia found that the number of BPH surgery increased, while the rate of BPH drug therapy increased much higher than that of BPH surgery. Moreover, BPH-related admissions in private hospitals increased obviously.⁸ These results were consistent with those of ours. The reasons for this in our study may be multifactorial. First, drug therapy is more common than surgery, particularly for patients with mild-to-moderate symptoms.⁹ Second, because of the implementation of a hierarchical medical system and the development of primary hospitals,^{10,11} an increasing number of patients chose to undergo surgery in local primary hospitals or private hospital. Third, the annual number of surgeries that was able to be performed at our center might have already been reached, even though the number of patients with BPH continued to increase.¹²

The present study found that the mean prostate volume increased over time; however, this increase was mild and was unlikely to be clinically significant. The mean age of patients undergoing surgery for BPH did not significantly change during the 11-year study period. The mean patient age at our center was 70.6 ± 7.7 years, which is similar to the mean age of approximately 70 years reported in other studies.^{13–15}

A study in Australia found that the median age of TURP patients increased around 3 years.⁸ However, we did not find a marked change over time in the age at the time of surgery in our study. It was worth noting that the timing of surgery was not only decided based on the age of the patient, but also by the progress of the disease.

In the present study, the rates of acute urinary retention and renal failure significantly decreased in recent years, which suggests that the incidence of late complications of BPH decreased over time. Therefore, we speculate that timely treatment was more readily available in recent years than in earlier years, which indicates that patient preference for drug treatment over surgery did not lead to the delay of timely surgery. There are many potential reasons for this. The main causes might involve the improvement of quality of life and concerns regarding health issues, particularly for people in rural areas.¹⁶ Other reason might be the wide use of 5-alpha reductase inhibitors, which slowed down the progression of BPH.⁷ However, the number of patients with bladder stones increased slightly over time. One possible reason for this increase in the incidence of bladder stones in patients with BPH is that the bladder stones did not cause obvious symptoms, and so the patients did not seek examination. The rate of preoperative UTI in the present study was 28.4%, which was much higher than expected. However, as the rate of preoperative UTI in patients undergoing surgery for BPH has not been reported in other studies, there are no rates available for comparisons. UTI was routinely treated with antibiotics before surgery. The high rate of preoperative UTI suggests that patients should be checked for UTI before undergoing surgery for BPH.

With the development of surgical techniques for BPH, laser surgery has become more common in China.¹⁷ Our center began performing laser surgery for BPH in the second half of 2013. PVP was the most common type of laser surgery performed at our center during the study period. As surgeons became more familiar with laser surgery techniques, the number of PVP surgeries increased in recent years. In 2018, more than 25% of patients with BPH underwent PVP at our center. However, medical insurance policies classify the optical fibers used in PVP as high-value medical consumables, and these must be paid for by the patients themselves,¹⁸ which caused the hospitalization costs of PVP to be one-third more than the hospitalization costs of bTURP. This relatively high cost of PVP may be one of the main reasons for the slow increase in the performance of laser surgery for BPH at our center.¹⁹ In our study, the cost of hospitalization increased year by year. It was similar to the cost reported in another study in China.²⁰

Due to our relatively conservative postoperative management, the postoperative hospitalization time in our study was longer than that reported in previous studies.^{21,22} We used to keep the

catheter in place for 3–5 days postoperatively, even if the urine of patient was clear. However, the rehabilitation time for BPH surgery significantly shortened during the study period, especially regarding catheterization time and postoperative hospitalization time, because of the development of surgical techniques and devices that promoted surgical efficacy and safety.²³ Moreover, the enhanced recovery after surgery procedure was applied to some patients in recent years. The postoperative hospitalization time of patients who followed the enhanced recovery after surgery protocol was approximately 2 days because of the optimized BPH surgery management strategy, including perioperative fasting, pain management, and catheter size.

In both groups, the incidence of serious adverse events comprising unplanned second surgeries due to bleeding reduced over time, although the hospitalization time was significantly shortened over the study period. The rate of blood transfusion was similar in both groups. The overall mean rates of transfusion, reoperation, and death were 0.1%, 0.2%, and 0.1%, respectively; these rates of perioperative complications are lower than those reported in previous studies.^{24,25}

The mean preoperative PSA level decreased from 7.9 ng ml⁻¹ in groups 8–13 to 6.7 ng ml⁻¹ in groups 13–18, whereas the rate of postoperatively detected prostate cancer increased from 2.4% in groups 8–13 to 3.3% in groups 13–18. One possible reason for this is that the patients received long-term treatment with 5- α reductase inhibitors, which significantly decreases the PSA level,²⁶ and so the preoperative detection rate of prostate cancer was reduced.

To the best of our knowledge, the present study is the largest single-center study to evaluate the therapy trends over time in patients with BPH. As the present study was conducted at a single center, the results are probably more accurate and more comparable than the results of multicentric studies. However, our study has several limitations. First, it was a retrospective study covering a time period of 11 years, which made it difficult for us to collect data on long-term efficacy and complications, such as the postoperative International Prostate Symptom Score, erectile function, and presence of urethral stricture. As we could not acquire accurate long-term results for all patients, the long-term outcomes were not reported in the present study. The rate of prostate cancer detected postoperatively in the present study was 2.6%, which is lower than that reported in previous studies of 6.2%²⁷ and 5.2%.²⁸ This relatively low incidence of postoperatively detected prostate cancer in the present study may be because not all surgical specimens were pathologically examined. Therefore, the actual rate of incidental prostate cancer could not be acquired in our study. Finally, as the present study was a single-center study, the results only reveal the trends of BPH treatment at our center, and cannot be generalized to other patient populations.

CONCLUSIONS

The present study evaluated the changes in treatments for BPH over time, and reported the information related to the surgical treatment of BPH. Although the surgery rate of patients with BPH decreased over the 11-year study period, an increasing number of patients with BPH underwent surgery before the occurrence of late complications. The patients recovered more quickly after BPH surgery in recent years compared with earlier years, without an associated increase in the incidence of severe adverse events. The rehabilitation time significantly shortened over the 11-year study period, especially the catheterization time and postoperative hospitalization time. However, with the increasing use of laser surgery for BPH, the hospitalization costs increased. The limitations of our study were that it was a single-center

study that lacks long-term outcome data. Therefore, more prospective and multicentric studies are needed to confirm the present findings.

AUTHOR CONTRIBUTIONS

ZFP participated in the study design and drafted the manuscript. JZ helped to draft the manuscript and analyze the data. LCW and ZJR participated in the data collection. BY and LCY analyzed the data. PS and QW carried out the critical revision of the manuscript. QD conceived of the study and participated in its design. All authors read and approved the final manuscript.

COMPETING INTERESTS

All authors declared no competing interests.

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