

# Observation of complications assessed by Clavien-Dindo classification in different endoscopic procedures of benign prostatic hyperplasia

## An observational study

Ting-ting Pan, BD<sup>a,\*</sup> , Sheng-Qun Li, MD<sup>a</sup>, Ya Dai, BD<sup>a</sup>, Jia-Xian Qi, MD<sup>a</sup>

### Abstract

The Clavien-Dindo classification (CDC) was widely used in the assessment of surgical complications, but some inconsistencies always existed in urological literature. This study was aimed to report complications of the transurethral resection of the prostate (TURP), plasmakinetic resection of the prostate (PKRP), and holmium laser enucleation of the prostate (HoLEP) by using a more detailed way under the framework of CDC. A total of 623 eligible cases underwent endoscopic procedures from January 2018 and December 2020 were divided into the TURP group (212 cases), the PKRP group (208 cases), and the HoLEP group (203 cases) according to the surgical type. Patients' surgical complications assessed by the CDC were compared among the 3 groups. The operation time, intraoperative irrigation volume, postoperative irrigation time and volume, decrease in hemoglobin and sodium, postoperative catheterization time, visual analogue scale, hospital stay of the PKRP group and the HoLEP group were significantly less than those of the TURP group, and the decrease in hemoglobin and visual analogue scale in the HoLEP group were significantly lower than those in the PKRP group (all  $P < .05$ ). The electrolyte disturbance, urinary tract irritation, and patients with grade II of CDC in the PKRP group were significantly lower than those in the TURP group; The electrolyte disturbance, lower abdominal pain, urinary tract irritation, intraoperative hemorrhage, secondary hemorrhage, clot retention, patients with grade I, II, III of CDC in the HoLEP group were significantly lower than those in the TURP group, and the urinary tract irritation, grade I, II of CDC in the HoLEP group was significantly lower than that in the PKRP group (all  $P < .05$ ). The CDC should be recommended because of the enhanced insight into surgical complications, and the HoLEP should be given a priority for Benign prostatic hyperplasia (BPH) surgical treatment in terms of the merits in surgical characteristics and complications.

**Abbreviations:** BPH = Benign prostatic hyperplasia, CDC = Clavien-Dindo classification, HoLEP = holmium laser enucleation of the prostate, IPSS = International Prostate Symptom Score, PKRP = plasmakinetic resection of the prostate, TURP = transurethral resection of the prostate.

**Keywords:** Benign prostatic hyperplasia, Clavien-Dindo classification, complications, holmium laser enucleation of the prostate, plasmakinetic resection of the prostate, transurethral resection of the prostate

## 1. Introduction

Benign prostatic hyperplasia (BPH) is one of the common diseases in aging men. With an aging population in China, the incidence of BPH has been on the rise over the past decades. According to previous reports, the prevalence of BPH gradually increases after the age of 40 years, and the incidence of BPH was up to approximately 80% over the age of 80, nearly 100% in men over the age of 90.<sup>[1,2]</sup> Symptomatic BPH usually

causes a series of symptoms such as urinary tract obstruction, urinary retention, urinary tract infection, and others, which are highly hazardous to patients' psychological well-being and quality of life.<sup>[3]</sup> Current therapies can be mainly divided into pharmacological treatments and surgical procedures. After the failure of pharmacological treatments, endoscopic procedures are generally chosen by surgeons as the primary option for BPH. Among these endoscopic procedures, transurethral resection of the prostate (TURP), bipolar plasmakinetic

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The datasets generated during and/or analyzed during the current study are not publicly available, but are available from the corresponding author on reasonable request.

<sup>a</sup> Department of Urology, The First People's Hospital of Linping District, Hangzhou City, Zhejiang Province, China.

\*Correspondence: Ting-ting Pan, Department of Urology, The First People's Hospital of Linping District, No.369, Yingbin Road, Nanyuan Street, Linping District, Hangzhou City 311100, Zhejiang Province, China (e-mail: 2300437163@qq.com)

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resection of the prostate (PKRP), and holmium laser enucleation of the prostate (HoLEP) were widely accepted in clinical practice.<sup>[4]</sup>

Many previous researchers have done a lot of work on the comparisons of TURP, PKRP, HoLEP, or other procedures, most of them considered that all had similar clinical efficacy, but the characteristics of complications and safety features among different procedures always keep controversial.<sup>[5-7]</sup> A possible reason for these discrepancies may be the lack of an uniform criterion for assessment in complications. The Clavien-Dindo classification (CDC), initiated in 1992 and revised in 2004, was used to assess the complication by 5 scale classification based on the therapy to the complication, which was regarded as a reliable and repeatable classification system.<sup>[8]</sup> As a standardized approach to grading and reporting surgical complications, the CDC was gradually used in urology and other surgical fields. However, the incidence of complications in the same procedure appeared to be some obvious deviations in many studies reported by different researchers, and these deviations may be caused by the selection of complications and researchers' personal applied habits.<sup>[9]</sup> In this study, surgical complications of TURP, PKRP, and HoLEP were strictly assessed under the framework of CDC, so as to provide more reference data for the evaluation and comparison of complications in endoscopic procedures.

## 2. Patients and methods

### 2.1. Patients

This study was carried out retrospectively and approved by the Medical Ethics Committee of The First People's Hospital of Linping (Approval No: LPY18015). From January 2018 to December 2020, a total of patients with BPH who received TURP, PKRP, or HoLEP in the endoscopic operation group of the urological department of our hospital were collected to perform a retrospective comparative analysis. A total of 730 cases initially were enrolled as candidates, and a number of 251, 245, and 234 cases were respectively included into the TURP, PKRP, and HoLEP group according to the surgical type. Inclusion criteria of this study were as follows: Patients with the typical symptom of lower urinary tract obstruction, and them diagnosed with BPH; Patients with international prostate symptom score > 12 points, postvoid residual urine > 100 mL, and maximum flow rate < 15 mL/s; Patients with previous failure of pharmacological treatments; Exclusion criteria were set as below: Patients with incomplete medical records; Patients with prostate-specific antigen > 10 ng/mL or prostate cancer; Patients with previous prostate surgery. By considering these above criteria, 41 cases (including 23, 11, and 7 cases with incomplete medical records, prostate-specific antigen > 10 ng/mL or prostate cancer, and previous prostate surgery) in the TURP group, 32 cases (including 18, 9, and 5 cases with concerns mentioned above) in the PKRP group, and 34 cases (including 23, 7, and 4 cases with concerns mentioned above) in the HoLEP group were excluded. Finally, a total of 623 eligible cases were included into this study, then 212, 208, and 203 cases were finally retained in the TURP, PKRP, and HoLEP group, respectively.

### 2.2. Procedures

Before operation, a consent for operation was obtained from patients or their authorized relatives. The operation was performed under spinal anesthesia or general anesthesia, with patients placed in a lithotomy position. The TURP was performed by using a resectoscope (Wolf, Germany) with a cutting power of 120-150 W and coagulation power of 70-80 W, and a 5% glucose solution was used for intraoperative

irrigation fluid. The PKRP was performed by using a plasmakinetic system (Gyrus, UK), with a cutting power of 120-160 W and a coagulation power of 80-100 W. The HoLEP was performed by using a holmium laser resectoscope device (Lumenis), with a frequency of 40-50 Hz, an energy of 1.5-2.0 J/s, and a power of 80-100 W. A 0.9% saline solution was used as irrigation fluid for PKRP and HoLEP. All patients were operated by the same team of endoscopic surgeons who were experienced in each technique with more than 300 cases. The procedures were similarly described by Habib E et al.<sup>[10]</sup> The cutting was started at 5 and 7 o'clock positions of the bladder neck after the confirmation of the bilateral lobes, bladder neck, and verumontanum, and the cutting depth till reaching the prostatic capsule. After cutting and hemostasis, the fragments of prostatic tissue were retrieved, then a 22-24 F 3-way Foley catheter was placed and followed by continuous bladder irrigation with a 0.9% saline solution. After the operation, patients were given an anti-infective regimen, and the catheter could be removed when catheter fluid remained for clear more than 6 h.

### 2.3. Study parameters

Preoperative baseline data of patients, intra- and postoperative complications were collected, including general complications (electrolyte disturbance, abdominal pain, nausea and vomiting, and others), urinary complications (urinary tract irritation, clot retention, bladder spasm, and others). When a patient felt almost recovered after operation, an inform of leave hospital would be sent to this patient after doctor's assessment. Prostate volume was assessed by transrectal ultrasonography, and urinary tract infection was diagnosed by urine culture. All these complications were collected from medical documents and examined by 2 medical staff. The CDC was used to assess the complications among the 3 groups. The definition of each grade was as follows<sup>[11]</sup>: Grade I: Any deviation from the normal course without need for pharmacotherapy, surgery, endoscopic and radiological interventions except for general drugs such as antiemetics, antipyretics, electrolytes, analgesics, diuretics, physiotherapy, and local wound infection. Grade II: Requiring pharmacological treatment with drugs other than such allowed in grade I, including blood transfusions and total parenteral nutrition. Grade III: Requiring surgical, endoscopic, or radiological intervention under/ not general anesthesia, including grade IIIa (intervention not under general anesthesia) and grade IIIb (intervention under general anesthesia). Grade IV: Life-threatening complication requiring ICU management, including grade IVa (single organ dysfunction) and grade IVb (multiple organ dysfunction). Grade V: Death of a patient. If a patient had 2 or more kinds of complications, the highest one was deemed as the grade of patient's complication.

### 2.4. Data analysis

All the data were processed by SPSS22.0 software. The measurement data were presented as mean  $\pm$  standard deviation ( $\bar{x} \pm s$ ), analyzed by 1-way ANOVA and SNK-*q* test. The categorical data were presented as percentage (%), analyzed by  $\chi^2$  test or Fisher's exact test.  $P < .05$  was considered statistically significant.

## 3. Results

### 3.1. Comparison of baseline data among the 3 groups

There were no significant differences in baseline data among the 3 groups (all  $P > .05$ ). As presented in Table 1.

### 3.2. Comparison of surgical characteristics among the 3 groups

The operation time, intraoperative irrigation volume, postoperative irrigation time and volume, decrease in hemoglobin, decrease in sodium, postoperative catheterization time, visual analogue scale, and hospital stay of the PKRP group and HoLEP group were significantly less than those of the TURP group (all  $P < .05$ ), and the decrease in hemoglobin and visual analogue scale (1 d after operation) in the HoLEP group were significantly lower than those in the PKRP group (all  $P < .05$ ). No significant differences were observed in anesthetic types and resected tissue weight among the 3 groups (all  $P > .05$ ). As presented in Table 2.

### 3.3. Distribution and grade of each complication among the 3 groups

The distribution of complications in the 3 groups largely concentrated on grade I of CDC. The electrolyte disturbance, urinary tract irritation in the PKRP group were significantly lower than those in the TURP group (all  $P < .05$ ). The electrolyte disturbance, lower abdominal pain, urinary tract irritation, intraoperative hemorrhage, secondary hemorrhage, and clot retention in the HoLEP group were significantly lower than those in the TURP group, and the urinary tract irritation in the HoLEP group was significantly lower than that in the PKRP group (all  $P < .05$ ). As presented in Table 3.

**Table 1**  
Comparison of baseline data among the 3 groups [n(%), ( $\bar{x} \pm s$ )].

Items	TURP group (212)	PKRP group (208)	HoLEP group (203)	P value
Age (yr)	64.26 ± 8.38	66.13 ± 10.22	65.87 ± 10.06	.096
Body mass index (kg/m <sup>2</sup> )	25.84 ± 4.02	26.33 ± 3.28	26.52 ± 3.59	.146
Duration of BPH (year)	10.02 ± 3.57	9.48 ± 2.96	9.72 ± 3.43	.251
Prostate volume (mL)	69.25 ± 16.49	68.72 ± 17.75	70.36 ± 15.38	.593
Duration of medications (mo)	40.45 ± 7.83	41.11 ± 9.64	39.97 ± 8.55	.411
Preoperative hemoglobin (g/L)	131.40 ± 14.66	129.90 ± 12.87	132.50 ± 14.49	.202
Prostate-specific antigen (ng/mL)	2.62 ± 0.85	2.75 ± 1.03	2.80 ± 0.91	.127
Preoperative urinary catheter	47(22.17%)	41(19.71%)	37(18.23%)	.598
Preoperative Q <sub>max</sub> (mL/s)	8.10 ± 3.05	7.85 ± 3.13	8.08 ± 3.32	.670
Preoperative PVR (mL)	172.82 ± 51.77	174.60 ± 50.68	180.28 ± 48.56	.291
Preoperative IPSS score	18.72 ± 5.35	19.62 ± 5.74	19.50 ± 4.96	.176
Preoperative quality of life	4.60 ± 0.75	4.48 ± 0.92	4.42 ± 0.87	.089
Preoperative comorbidities				
Hypertension	62(29.25%)	67(32.21%)	56(27.59%)	.582
Diabetes	35(16.51%)	31(14.90%)	29(14.29%)	.808
Coronary heart disease	29(13.68%)	33(15.87%)	27(13.30%)	.723
Other general diseases	23(10.85%)	21(10.10%)	26(12.81%)	.668
ASA grades				
I	117(55.19%)	109(52.40%)	122(60.10%)	.637
II	72(33.96%)	75(36.06%)	62(30.54%)	
III	23(10.85%)	24(11.54%)	19(9.36%)	

Other general diseases included chronic obstructive pulmonary disease, gastrointestinal disease, arthritis, and others.

ASA = American Society of Anesthesiologists, BPH = Benign prostatic hyperplasia, HoLEP = holmium laser enucleation of the prostate, IPSS = International Prostate Symptom Score, PKRP = plasmakinetic resection of the prostate, PVR = postvoid residual urine, Q<sub>max</sub> = maximum flow rate, TURP = transurethral resection of the prostate.

**Table 2**  
Comparison of surgical characteristics among the 3 groups [( $\bar{x} \pm s$ )].

Items	TURP group (212)	PKRP group (208)	HoLEP group (203)	P value
Anesthetic types				
General anesthesia	146(68.87%)	160(76.92%)	153(75.37%)	.138
Spinal anesthesia	66(31.13%)	48(23.08%)	50(24.63%)	
Operation time (min)	72.35 ± 20.37	66.65 ± 18.74*	67.42 ± 20.25*	.006
Intraoperative irrigation volume (L)	15.18 ± 4.98	13.17 ± 4.33*	14.00 ± 5.02*	<.001
Postoperative irrigation time (h)	33.09 ± 10.14	26.44 ± 7.27*	25.86 ± 8.20*	<.001
Postoperative irrigation volume (L)	30.01 ± 8.28	24.82 ± 6.84	23.96 ± 7.32	<.001
Decrease in hemoglobin (g/L)	7.89 ± 2.23	5.40 ± 1.86*	4.36 ± 1.79*#	<.001
Decrease in sodium (mmol/L)	1.96 ± 0.57	1.46 ± 0.45*	1.39 ± 0.43*	<.001
Resected tissue weight (g)	50.67 ± 17.25	49.81 ± 16.82	53.12 ± 19.28	.149
Postoperative catheterization time (h)	65.39 ± 18.45	47.77 ± 16.05*	46.92 ± 16.86*	<.001
Visual analogue scale	5.14 ± 1.56	4.65 ± 1.32*	3.82 ± 1.27*#	<.001
Hospitalization costs (USD)	2340.65 ± 403.87	2296.70 ± 395.92	2352.43 ± 412.06	.336
Hospital stay (d)	6.70 ± 1.54	5.64 ± 1.43*	5.82 ± 1.66*	<.001

Abbreviations as presented in Table 1.

\*Compared with the TURP group,  $P < .05$ ;

#Compared with the PKRP group,  $P < .05$ .

### 3.4. Distribution and patients' complication grade among the 3 groups

Only 1 case of grade V complication occurred in the PKRP group, and the cause of death was multiple organ failure. The patients with grade II complication in the PKRP group were significantly lower than those in the TURP group ( $P < .05$ ). The patients with grade I, II, III complication in the HoLEP group were significantly lower than those in the TURP group, and the patients with grade I, II complication in the HoLEP group were significantly lower than those in the PKRP group (all  $P < .05$ ). As presented in Table 4.

### 4. Discussion

BPH is not deemed as a life-threatening disease, but it does have an apparently negative impact on patient's quality of life. In the last decades, the TURP was usually taken as the "gold standard" in surgical treatment for patients with BPH. Nowadays, compared with the TURP, a well-known viewpoint is that the PKRP, HoLEP have comparable clinical outcomes in terms of maximum flow rate, postvoid residual urine, inter-national prostate symptom score, and quality of life, the discrepancies often existed in their complications and surgical characteristics.<sup>[12–14]</sup>

**Table 3**

**Distribution and grade of each complication among the 3 groups (n).**

Items	TURP group (212)						PKRP group (208)						HoLEP group (203)						P value
	I	II	III	IV	V	total	I	II	III	IV	V	total	I	II	III	IV	V	total	
General complications																			
Electrolyte disturbance	50	0	0	0	0	50	21	0	0	0	0	21*	23	0	0	0	0	23*	<.001
Lower abdominal pain	33	0	0	0	0	33	25	0	0	0	0	25	14	0	0	0	0	14*	.021
Nausea and vomiting	21	0	0	0	0	21	17	0	0	0	0	17	15	0	0	0	0	15	.641
Fever (>38.5°C)	20	0	0	0	0	20	22	0	0	0	0	22	18	0	0	0	0	18	.836
Back pain	17	0	0	0	0	17	18	0	0	0	0	18	21	0	0	0	0	21	.695
Gastric stress ulcer	4	2	1	0	0	7	6	3	1	0	0	10	2	2	1	0	0	5	.426
Pulmonary infection	0	7	2	1	0	10	0	7	0	0	0	7	0	5	0	1	0	6	.607
Hemorrhagic shock	0	2	0	1	0	3	0	0	0	1	0	1	0	1	0	0	0	1	.469
Cardiovascular accident	0	0	0	2	0	2	0	0	0	1	0	1	0	0	1	0	0	1	.795
Cerebrovascular accident	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	1	.604
Delirium	0	2	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	1	.377
Deep vein thrombosis	0	1	1	0	0	2	0	0	1	0	0	1	0	0	0	0	0	0	.382
Pulmonary embolism	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	.368
Multiple organ dysfunction	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.368
Death	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	.379
Urinary complications																			
Urinary tract irritation	68	13	0	0	0	81	46	13	0	0	0	59*	31	2	0	0	0	33*,#	<.001
Transient incontinence	23	0	0	0	0	23	19	0	0	0	0	19	22	0	0	0	0	22	.803
Intraoperative hemorrhage	10	6	0	0	0	16	3	3	0	0	0	6	3	1	0	0	0	4*	.009
Bladder spasm	9	6	0	0	0	15	7	5	0	0	0	12	5	3	0	0	0	8	.380
Secondary hemorrhage	7	5	2	0	0	14	3	2	1	0	0	6	2	1	0	0	0	3*	.016
Dysuria	5	7	0	0	0	12	8	2	0	0	0	10	4	2	0	0	0	6	.399
Clot retention	4	1	4	0	0	9	2	0	1	0	0	3	0	1	0	0	0	1*	.020
Capsular perforation	4	2	0	0	0	6	1	1	0	0	0	2	0	1	0	0	0	1	.212
Bladder injury	2	0	0	0	0	2	2	0	1	0	0	3	2	0	0	0	0	2	.866
Urinary tract infection	0	5	0	0	0	5	0	3	0	0	0	3	0	2	0	0	0	2	.524
Acute epididymitis	0	2	0	0	0	2	0	1	0	0	0	1	0	2	0	0	0	2	.815
TURS	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	.379

TURS = transurethral resection syndrome, Other abbreviations as presented in Table 1.

\*Compared with the TURP group,  $P < .05$ .

#Compared with the PKRP group,  $P < .05$ .

**Table 4**

**Distribution of grade of patients' complication among the 3 groups (n/%).**

Items	TURP group (212)	PKRP group (208)	HoLEP group (203)	P value
CDC grade of complication ( $\leq 90$ d)				
I	109(51.42%)	101(48.56%)	75(36.95%)*,#	.008
II	54(25.47%)	35(16.83%)*	20(9.85%)*,#	<.001
III	10(4.72%)	4(1.92%)	2(0.99%)*	.043
IIIa	8(3.77%)	3(1.44%)	1(0.49%)	
IIIb	2(0.94%)	1(0.48%)	1(0.49%)	
IV	6(2.83%)	2(0.96%)	1(0.49%)	.106
IVa	5(2.36%)	2(0.96%)	1(0.49%)	
IVb	1(0.47%)	0(0.00%)	0(0.00%)	
V	0(0.00%)	1(0.48%)	0(0.00%)	.368

CDC = Clavien-Dindo classification, Other abbreviations as presented in Table 1.

\*Compared with the TURP group,  $P < .05$ .

#Compared with the PKRP group,  $P < .05$ .



For the comparison of surgical characteristics among the 3 groups, our results showed that many parameters in the PKEP group and HoLEP group were superior to those of the TURP group, and the decrease in hemoglobin and visual analogue scale after operation in the HoLEP group were obviously lower than those in the PKEP group. These results suggested that HoLEP has less blood loss in operation and more comfort after operation. Compared with the TURP, the PKRP and HoLEP both belong to a low temperature cutting technique that have an advantage of less thermal damage. Moreover, the thermal penetration depths of PKRP are between 0.5 and 1.0 mm, and even that of HoLEP is less than 0.5 mm, which can achieve more accurate tissue cutting and less thermal damage, subsequently improving patients' comfort after operation.<sup>[15]</sup> HoLEP is known as "bloodless cutting," less intraoperative bleeding is one of the remarkable advantages over TURP and PKRP, this merit would be beneficial to the decrease in hemoglobin in HoLEP.<sup>[16]</sup> After discharge, no significant difference in hospitalization costs were observed in contrast to the significant difference in hospitalization stay among the 3 groups. From our perspective, TURP has a slightly lower cost in operation, but the total hospitalization costs are offset by longer hospital stay. Furthermore, China was a developing country in the past decades, and it has a low-cost medical service. Most Chinese patients leave hospital until they have recovered entirely, which makes a longer hospitalization stay compared with other developed countries.

Complications are important indicators in evaluation of strengths and weaknesses of surgical outcomes among different procedures, so the description of surgical complications in the same structured way will make it easy to compare different procedures. In this study, we focused on the differences and distribution of complications among TURP, PKRP, and HoLEP procedures, and an attempt to quantify these complications was made under the CDC. Our results showed that the incidence of several complications in the PKRP group were lower than those in the TURP group, while those in the HoLEP group were lower than those in the PKRP group. Among these complications, the incidence of electrolyte disturbance may be associated with intraoperative reabsorption of glucose solution, and excessive reabsorption can cause transurethral resection syndrome, which is one of the well-known disadvantages of TURP.<sup>[17]</sup> Urinary tract irritation was caused by thermal damage, tissue scab, and slow healing of high cutting temperature in TURP.<sup>[18]</sup> After the operation, the tissue scab caused by thermal damage will induce a postoperative secondary hemorrhage when it sheds off. Furthermore, secondary hemorrhage can result in blood clot formation and deciduous scab aggregation, followingly leading to urinary tract obstruction and clot retention.<sup>[19,20]</sup>

The CDC was usually used to classify the grade of complications within 90 days after the operation.<sup>[21]</sup> Our results showed that the patients with grade I, II, III complication in the HoLEP group were significantly lower than those in the TURP group, and the patients with grade I, II complication in the HoLEP group were significantly lower than those in the PKRP group. These findings suggested that HoLEP had less incidence of complications and better safety features, which were consistent with other previous studies.<sup>[22,23]</sup> On the other hand, a heterogeneous finding should be pointed out that the overall rate of each grade of CDC in the TURP, PKRP, and HoLEP were 84.43% (179/212), 68.27% (142/208), 48.28% (98/203), respectively, which were much higher than the rate of 5.7% ~7.8% reported by Tamalunas A et al.<sup>[24]</sup> In their study, many generally minor complications such as fever, nausea and vomiting, and back pain with grade I-II were not included as study parameters, but their distribution of grade III, IV complication were consistent with our results.

In clinical practice, clinicians and nurses generally tend to ignore some minor complications that do not require particular treatment, and this selective tendency will result in a lower

rate of complication due to the exclusion of numerous grade I to II complication in the statistic. In our study, all documented minor complications with grade I to II were recorded in detail and evaluated strictly according to the CDC. Thus, a higher rate of the complication was displayed in our results, which were similar to the results of 77.3% in grade I and 12.7% in grade II from a study performed by Bansal A et al.<sup>[25]</sup> Although the CDC was proposed over 3 decades, its increasing popularity and wide application started at several years ago. Because of the lack of previous reference criteria for the assignment of CDC in some specific parameters, there remained some ambiguous concepts regarding its application. For example, a lower incidence of complications was observed in a study because only urological complications with  $\geq$  grade III were included to analyze as the study parameters.<sup>[26]</sup> While, a much higher overall incidence of complication was presented in another study owing to the inclusion of many minor complications with grade I to II.<sup>[27]</sup> These deviations in the selection and definition of complications frequently appeared in many literature reports, so how to identify and involve grade I to II still requires to be explored in future studies.

Some limitations of this study include the retrospective design and some possible inconsistencies with categorizing complications. Although our study included 2 medical staff were responsible for data collection with cross-checking, it may be possible that there was a slight data missing in complications. Additionally, we still lack a detailed consensus on how to define and grade surgical complications, which potentially hampers the interpretation of surgical outcomes. In consideration of these above concerns, selection bias cannot be absolutely avoided in this observational study. Finally, the relatively short duration of follow-up could also be considered as a limitation, and the long-term complications of endoscopic procedures were failed to compare. Despite these limitations mentioned above, we believe that it is a promotion for presently diverse outcomes with standardized reporting in urological procedures.

## 5. Conclusions

The CDC should be recommended because of the enhanced insight into surgical complications, and the HoLEP should be given a priority for BPH surgical treatment in terms of the merits in surgical characteristics and complications. However, a more detailed protocol complemented in future studies would be in favor of standardization and manipulability of CDC.

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## Author contributions

**Conceptualization:** Ting-ting Pan. **Formal analysis:** Sheng-qun Li.

**Data curation:** Ting-ting Pan, Sheng-qun Li, and Ya Dai.

**Supervision:** Sheng-qun Li.

**Writing – original draft:** Ting-ting Pan, Jia-xian Qi.

**Writing – review & editing:** Jia-xian Qi.

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