BMC Anesthesiology

RESEARCH

Open Access

Risk factors for postoperative urinary retention in patients underwent surgery for benign anorectal diseases: a nested case–control study

Bin Liu[1,2†], Yali Chen[1†], Pei Zhang[1], Wei Long[3], Hongbo He[4], Xuehan Li[1] and Rurong Wang[1*]

Abstract

Background Postoperative urinary retention (POUR) is a common complication of anorectal surgery. This study was to determine the incidence of POUR in anorectal surgery for benign anorectal diseases, identify its risk factors, and establish a nomogram for prediction of POUR.

Methods A nested case–control study was conducted. The clinical data of patients were collected, and the incidence of POUR was analyzed. Univariate analysis was used to identify the risk factors associated with POUR, and multivariate logistic regression analysis was used to determine independent risk factors for POUR. A nomogram for the preoperative prediction of POUR using a logistic regression model was developed ($n=609$).

Results The incidence of POUR after anorectal surgery for benign anorectal diseases was 19.05%. The independent risk factors for POUR were: female ($P=0.007$); male with benign prostatic hyperplasia (BPH) ($P=0.001$); postoperative visual analogue scale (VAS) score > 6 ($P=0.002$); patient-controlled epidural analgesia (PCEA) ($P=0.016$); and a surgery time > 30 min ($P=0.039$). In the nomogram, BPH is the most important factor affecting the occurrence of POUR, followed by a postoperative VAS score > 6, PCEA, surgery time > 30 min, and sex has the least influence.

Conclusion For patients undergoing anorectal surgery for benign anorectal diseases, preventive measures can be taken to reduce the risk of POUR, taking into account the following risk factors: female or male with BPH, severe postoperative pain, PCEA, and surgery time > 30 min. Furthermore, we developed and validated an easy-to-use nomogram for preoperative prediction of POUR in anorectal surgery for benign anorectal diseases.

Trial registration China Clinical Trial Registry: ChiCTR2000039684, 05/11/2020.

Keywords Postoperative urinary retention, Anorectal surgery, Nomogram, Postoperative analgesia, Patient-controlled epidural analgesia

†Bin Liu and Yali Chen contributed equally to this study.

*Correspondence:
Rurong Wang
wangrurong@scu.edu.cn
Full list of author information is available at the end of the article

Introduction

Benign anorectal diseases have a high incidence. One third of Americans and 40% of Britons have been shown to hemorrhoids during colonoscopy [1, 2]. Hemorrhoids is the third most common outpatient gastrointestinal diagnosis in the United States, with nearly 2.5 million outpatient and emergency visits annually [3]. In Europe, the incidence of perianal abscess is about 16.1–30 per 100,000 [4]. Anal fistulas occur with an incidence of 5.5 per 100,000 women and 12.1 per 100,000 men [5]. Estimates of the frequency of anal fissures in the general population are 10–15% [6]. The true incidence of these diseases may well be higher. Surgery is an effective treatment for benign perianal diseases, and a growing number of patients are receiving appropriate surgical interventions.

Postoperative urinary retention (POUR) has been a common complication of surgery, with an incidence range from 3 to 52% [7–13]. The differences may be explained by the heterogeneity of patient populations, type of operation, type of anesthesia and the definition of POUR. The incidence of POUR after anorectal surgery is much higher than for other types of surgery [14, 15]. S2-S4 parasympathetic nerve injury, perianal pain and increased sphincter tension can partly explain the high incidence of POUR after anorectal surgery [15, 16].

In recent years, with the maturity of surgical technology, the introduction of comfortable medicine and enhanced recovery after surgery (ERAS), POUR has attracted more and more attention. POUR can increase the risk factors for discomfort and urinary tract infection, and delay the time of hospital discharge [17]. POUR was reported to be responsible for 20–25% of unexpected inpatient admissions following day general surgery [18, 19]. The key measure for managing POUR is urinary catheterization. However, catheterization is an invasive procedure with potential complications, including catheter-associated urinary tract infections, urethral trauma, prostatitis, pain, and discomfort [20, 21]. About 80% of all nosocomial urinary tract infections occur due to catheterization [22]. Thus, accurate identification of high-risk patients and taking preventive interventions, rather than for all patients, could optimize anesthesia and surgical pathways and improve patient satisfaction.

The purpose of the study was to determine the incidence of POUR after anorectal surgery for benign anorectal diseases, identify its independent risk factors, and establish a nomogram to preoperatively predict an individual's risk of POUR. The results will provide a useful reference for the clinical prevention and treatment of POUR after anorectal surgery for benign anorectal diseases. To the best of our knowledge, we have provided the first predictive model for POUR after anorectal surgery for benign anorectal diseases.

Materials and methods

Ethics approval and registration

A nested case–control study was conducted in a prospective cohort of 609 patients enrolled in the study, which was approved by the Ethics Committee of Cheng Du Shang Jin Nan Fu Hospital on 29/09/2020 (No. 2020092901). Written informed consent was obtained from each patient before study participation. The trial was registered prior to patient enrollment in the Chinese Clinical Trials Registry on 05/11/2020 (ChiCTR2000039684).

Patients population

We recruited 645 patients who underwent selective anorectal surgery for benign anorectal diseases in Cheng Du Shang Jin Nan Fu Hospital from November 9, 2020 to June 31, 2021. Our exclusion criteria were: (1) the patient had a catheter inserted before surgery; (2) the patient had complications of uremia and other renal diseases before surgery; (3) the patient had difficulty in language communication and was expected to have follow-up difficulties. The exit criteria were: (1) the surgeon ordered immediate catheterization after surgery according to the symptoms; (2) the patient refused to follow-up after entering the study (Fig. 1). One day before surgery, patients were visited and selected according to the inclusion and exclusion criteria of the study.

Definition of POUR

The diagnostic criteria for POUR was the patient had not urinated 6 h after surgery and the urine volume after catheterization was > 600 mL, or the patient could not effectively empty their bladder and had a urine volume > 100 mL after catheterization [23, 24].

Study design

All patients managed by a standard protocol of preoperative fasting (12 h for solid foods, 4 h for fluids), and a routine liquid management at post-anesthesia care unit unless the patient had a special emergency. The patient was routinely monitored on entering the operation room, including electrocardiography, non-invasive blood pressure and pulse oximetry measurements. They were informed of the anesthesia plans before surgery, and independently chose tracheal intubation general anesthesia (GA) or ultrasound-guided caudal epidural block (CEB) combined with intravenous anesthesia (CEB + IA). If the effect of CEB was not satisfactory, such as anal sphincter failing to relax or the patient experienced pain, GA was used (CEB changed to GA). The patients under

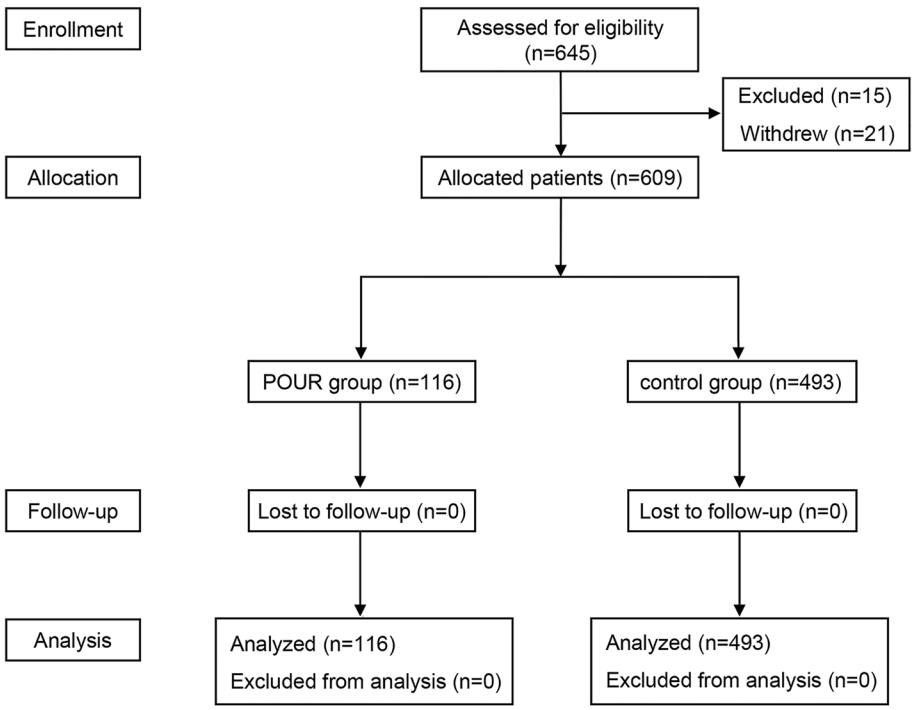

Fig. 1 Flow chart

GA were intravenously induced with 0.1 mg/kg penehyclidine hydrochloride, 0.02–0.04 mg/kg midazolam, 1.5–2.5 mg/kg propofol, 0.2–0.4 μg/kg sufentanil and 0.1–0.2 mg/kg cisatracurium. Anesthesia was maintained with 1–3% sevoflurane combined with 0.1–0.2 μg/kg/min remifentanil. For patients with CEB+IA, 14–16 mL of 0.4–0.5% ropivacaine was given under ultrasound-guided CEB, 0.02–0.04 mg/kg midazolam and 0.5 μg/kg/h dexmedetomidine to maintain sedation.

There were 3 types of postoperative analgesia options for patients to choose from, which were: (1) patient-controlled epidural analgesia (PCEA); (2) patient-controlled intravenous analgesia (PCIA); (3) no patient-controlled analgesia (NPCA). The PCEA system consisted of 600 mg ropivacaine and 300 mL normal saline, set at an administration rate of 4–8 mg/h, 10 mg/push, with a locking time of 60 min. The PCIA system was comprised of 200 μg sufentanil, 200 μg dexmedetomidine, 400 mg tramadol, 20 mg granisetron and normal saline 200 mL, set to an administration rate of 2 mL/h, 0.5 mL/push, and a locking time of 15 min. The NPCA patients, or those who could not achieve satisfactory the analgesia with PCEA or PCIA, were given intravenous injections of dezocine and oral oxycodone when appropriate.

Data collection

The patients were divided into POUR group and non-POUR group. Relevant clinical data were collected, including sex, age, body mass index (BMI), diagnosis, medical history, American Society of Anesthesiologists (ASA) grade, type of anesthesia, anesthesia time, type of surgery, surgery time, intraoperative infusion volume, type of postoperative analgesia, postoperative visual analogue scale (VAS) score, number of perianal incisions, etc. The VAS score was recorded at 2 h, 4 h, 6 h, 24 h, 48 h and 72 h, at the first dressing change and first defecation after surgery. The patient's maximum VAS score was used for analysis. Urination was recorded 6 h after the operation to evaluate whether POUR had occurred.

Sample size calculation

We found that there were 8 main risk factors for POUR and most studies reported its incidence after anorectal surgery for benign anorectal diseases to be about 15% [15, 25, 26]. The estimated sample size was at least 533 cases. The larger the sample size for multivariate logistic regression analysis, the more reliable the results are. Due to time constraints, we screened a total of 645 patients, excluded 15 patients, and withdrew 21 patients. Finally, the data of 609 patients were statistically analyzed.

Statistical analyses

Data was analyzed using SPSS (IBM Corp. Released 2015. IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.) and R software (R Core Team. Released 2020. R: A language and environment for statistical

computing, Version 4.0.1. R Foundation for Statistical Computing, Vienna, Austria. URL: https://www.R-project.org/). Categorical data was expressed as numbers or percentages and was compared using the Pearson chi-squared test or Fisher's exact test as appropriate. Mean ± SD was used for statistical descriptions and Student's *t*-test was used for analysis if the continuous data conformed to a normal distribution, while median and quaternary were used for descriptions and a Mann–Whitney U test was used for analysis if they did not. The variables of $P < 0.1$ in univariate analysis were selected for multivariate logistic regression analysis to determine the independent risk factors for POUR after anorectal surgery for benign anorectal diseases. The nomogram was drawn and analyzed using Regression Modeling Strategies package of R software. The nomogram for the preoperative prediction of POUR used the independent risk factors identified in the multivariable logistic analysis ($n = 609$). The predictive performance of the nomogram was measured by concordance index (C-index) and calibrated with 1,000 bootstrap samples to reduce the overfit bias. Calibration was evaluated by a calibration plot. The clinical usefulness of the nomogram was measured by decision curves analysis (DCA). The significance level was set to a *P*- value < 0.05.

Results

Incidence of POUR

During the period November 9, 2020 to June 31, 2021, a total of 609 patients with effective clinical data were collected, including 333 males and 276 females. POUR occurred in 116 patients and the incidence of POUR was 19.05%.

Univariate analysis of risk factors for POUR after anorectal surgery for benign anorectal diseases

There were no significant differences in BMI ($P = 0.094$), age ($P = 0.432$), and ASA grade ($P = 0.173$) between the POUR and non-POUR groups, but there was a significant difference in sex between the two groups ($P = 0.001$). We analyzed the patients' medical histories and found that the incidence of POUR in males with benign prostatic hyperplasia (BPH) was significantly higher than in non-POUR group (18.75% *vs.* 5.61%, $P = 0.004$). There was no significant difference between the POUR and non-POUR groups when the patients had hypertension (8.62% *vs.* 5.27%, $P = 0.169$), diabetes (1.72% *vs.* 1.83%, $P = 0.649$), a history of lower abdominal surgery (21.55% *vs.* 16.43%, $P = 0.191$) or uterine surgery (22.06% *vs.* 22.60%, $P = 0.972$) (Table 1).

We evaluated the relationship between anesthesia-related factors and POUR after anorectal surgery for benign anorectal diseases. In this study, 321 patients underwent CEB + IA, 262 underwent GA, and 26 with CEB changed to GA. There was no significant difference between the POUR and non-POUR group in the types of anesthesia ($P = 0.351$), intraoperative infusion volume ($P = 0.521$) or the types of postoperative analgesia ($P = 0.054$). The anesthesia time ($P = 0.010$) and VAS scores ($P = 0.037$) were statistically different between the two groups. However, when we divided the anesthesia time into ≤ 60 min and > 60 min periods for statistical analysis, here was no significant difference between the two groups ($P = 0.050$) (Table 1).

By analyzing the relationship between surgery-related factors and POUR, we found that the number of surgical incisions ($P = 0.005$), surgery time ($P = 0.001$) and type of surgery ($P = 0.023$) were risk factors for POUR after anorectal surgery for benign anorectal diseases, while the number of surgical procedures ($P = 0.391$) was not (Table 1).

Multivariate logistic regression analysis of risk factors for POUR after anorectal surgery for benign anorectal diseases

We performed multivariate logistic regression analysis on the variables $P < 0.1$ obtained from univariate analysis, including sex, male with BPH, BMI, anesthesia time, surgery time, postoperative VAS score, type of postoperative analgesia, number of surgical incisions and the type of surgery. The results showed that females ($P = 0.007$), males with BPH ($P = 0.001$), a postoperative VAS score > 6 ($P = 0.002$), PCEA ($P = 0.016$) and surgery time > 30 min ($P = 0.039$) were independent risk factors for POUR (Table 2).

Development and validation of a POUR-predicting nomogram

All independent risk factors were used to establish a POUR risk estimation nomogram for anorectal surgery for benign anorectal diseases (Fig. 2A). In this nomogram, BPH was the most important factor affecting the occurrence of POUR, followed by a postoperative VAS score > 6, PCEA, surgery time > 30 min, and sex has the least influence. Added the points of the above 5 independent risk factors for each patient, and the total points corresponded to the risk of POUR. The nomogram demonstrated good accuracy in predicting the risk of POUR, with an unadjusted C-index of 0.693 (95% CI = 0.640, 0.749) and a bootstrap corrected C-index of 0.680. The calibration plots of the nomogram revealed good agreement between the predicted and actual observations (Fig. 2B). The DCA for the prediction nomogram was shown in Fig. 2C.

Table 1 Clinical characteristics of patients in POUR and control groups

Variable	POUR group ($n=116$)	Control group ($n=493$)	*P* value
Characteristics			
Sex			**0.001**
Male	48 (14.41%)	285 (85.59%)	
Female	68 (24.64%)	208 (75.36%)	
Age (years)	40.00 (32.25–52.75)	39.00 (32.00–50.00)	0.212
> 65	2 (13.33%)	13 (86.67%)	0.432
≤ 65	114 (19.19%)	480 (80.81%)	
BMI (kg/m^2)	22.29 (20.49–24.05)	22.86 (20.67–25.37)	0.225
≥ 28	7 (15.56%)	38 (84.44%)	0.094
24.0—27.9	22 (13.17%)	145 (86.83%)	
18.5—23.9	80 (22.16%)	281 (77.84%)	
≤ 18.4	7 (19.44%)	29 (80.56%)	
ASA grade			0.173
III	6 (37.50%)	10 (62.50%)	
II	48 (19.05%)	204 (80.95%)	
I	62 (18.18%)	279 (81.82%)	
Medical history			
Hypertension			0.169
Yes	10 (27.78%)	26 (72.22%)	
No	106 (18.50%)	467 (81.50%)	
Diabetes			0.647
Yes	2 (18.18%)	9 (81.82%)	
No	114 (19.06%)	484 (80.94%)	
Lower abdominal surgery			0.191
Yes	25 (23.58%)	81 (76.42%)	
No	91 (18.09%)	412 (81.91%)	
Uterine surgery			0.972
Yes	15 (24.19%)	47 (75.81%)	
No	53 (24.77%)	161 (75.23%)	
BPH			**0.004**
Yes	9 (36.00%)	16 (64.00%)	
No	39 (12.66%)	269 (87.34%)	
Anesthesia-related Factors			
Type of anesthesia			0.351
GA	43 (16.41%)	219 (83.59%)	
CEB + IA	68 (21.18%)	253 (78.82%)	
CEB changed to GA	5 (19.23%)	21 (80.77%)	
Anesthesia time (min)	80.00 (63.50–95.00)	70.00 (60.00–88.00)	**0.010**
≤ 60	25 (14.62%)	146 (85.38%)	0.050
> 60	91 (20.78%)	347 (79.22%)	
Intraoperative infusion volume (mL)	300 (200–400)	300 (200–400)	0.697
≥ 500	21 (19.27%)	88 (80.73%)	0.521
< 500	95 (19.00%)	405 (81.00%)	
VAS score			**0.037**
> 6	13 (35.14%)	24 (64.86%)	
4–6	70 (18.18%)	315 (81.82%)	
< 4	33 (17.65%)	154 (82.35%)	
Type of postoperative analgesia			0.054
PCEA	32 (26.67%)	88 (73.33%)	

Table 1 (continued)

Variable	POUR group ($n=116$)	Control group ($n=493$)	*P* value
PCIA	42 (16.41%)	214 (83.59%)	
NPCA	42 (18.03%)	191 (81.97%)	
Surgical-related Factors			
Number of surgical incisions			**0.005**
≥ 3	72 (23.53%)	234 (76.47%)	
< 3	34 (13.08%)	226 (86.92%)	
Annular incision	10 (23.26%)	33 (76.74%)	
Surgery time (min)	38.00 (30.00–50.00)	35.00 (25.00–45.00)	**< 0.001**
≤ 30	37 (13.41%)	239 (86.59%)	**0.001**
> 30	79 (33.91%)	254 (66.09%)	
Number of surgical procedures			0.391
≥ 3	47 (21.27%)	174 (78.73%)	
2	59 (17.15%)	285 (82.85%)	
1	10 (22.73%)	34 (77.27%)	
Type of Surgery			**0.023**
Hemorrhoids	90 (77.59%)	310 (62.88%)	
Anal fistula	29 (25.00%)	182 (36.92%)	
Perianal abscess	13 (11.21%)	89 (18.05%)	
Anal fissure	46 (39.66%)	154 (31.24%)	
Rectal polyp	44 (37.93%)	166 (33.67%)	

Values are expressed as the median (interquartile range) or as numbers (percent)

POUR Postoperative urinary retention, *BMI* Body mass index, *ASA* American Society of Anesthesiologists, *BPH* Benign prostatic hyperplasia, *GA* Endotracheal intubation general anesthesia, *CEB + IA* Ultrasound-guided caudal epidural block combined with intravenous anesthesia, *CEB changed to GA* Caudal epidural block changed to endotracheal intubation general anesthesia, *VAS* Visual analogue scale, *PCEA* Patient-controlled epidural analgesia, *PCIA* Ppatient-controlled intravenous analgesia, *NPCA* No patient-controlled analgesia

Table 2 The independent risk factors for POUR after anorectal surgery for benign anorectal diseases

Factors	OR (95% CI)	*P* value
Female	1.973 (1.200–3.244)	**0.007**
BPH	4.913 (1.955–12.345)	**0.001**
BMI ≤ 18.4	0.860 (0.369–2.002)	0.726
24 ≤ BMI < 27.9	0.611 (0.349–1.070)	0.085
BMI ≥ 28	0.893 (0.357–2.237)	0.810
PCIA	0.837 (0.508–1.379)	0.486
PCEA	2.141 (1.151–3.981)	**0.016**
4 ≤ VAS ≤ 6	1.358 (0.795–2.320)	0.262
VAS > 6	3.858 (1.636–9.098)	**0.002**
Number of surgical incisions ≥ 3	1.378 (0.781–2.433)	0.269
Annular incision	1.291 (0.507–3.291)	0.592
Surgery time > 30 min	1.755 (1.029–2.993)	**0.039**
Anesthesia time > 60 min	0.984 (0.544–1.781)	0.957
Hemorrhoidectomy	2.100 (0.994–4.441)	0.052
Anal fistula resection surgery	1.707 (0.820–3.551)	0.153

POUR Postoperative urinary retention, *BMI* Body mass index, *OR* Odds ratio, *CI* Confidence interval, *BPH* Benign prostatic hyperplasia, *PCIA* Patient-controlled intravenous analgesia, *PCEA* Patient-controlled epidural analgesia, *VAS* Visual analogue scale

Discussions

In the present study, the incidence of POUR after anorectal surgery for benign anorectal diseases was shown to be 19.05%. The independent risk factors for POUR were: female, male with BPH, postoperative VAS score > 6, PCEA and a surgery time > 30 min. We developed and validated an easy-to-use nomogram for the preoperative prediction of POUR after anorectal surgery for benign anorectal diseases, and we found that BPH had the largest weight, followed by severe postoperative pain, PCEA and surgery time > 30 min, sex had the least influence.

The incidence of POUR in this study was 19.05%, lower than reported in previous studies (22–52%) [7, 8, 10, 12, 13]. However, the etiology of POUR is multifactorial and may be influenced by sex, age, medical history, surgery-related factors, postoperative analgesia and the intraoperative infusion volume. Thus, the above factors may influence its incidence [15, 27]. In the present study, there were fewer elderly patients, less intraoperative infusion, and better postoperative pain control, all of which may have reduced the incidence of POUR after anorectal surgery for benign anorectal diseases.

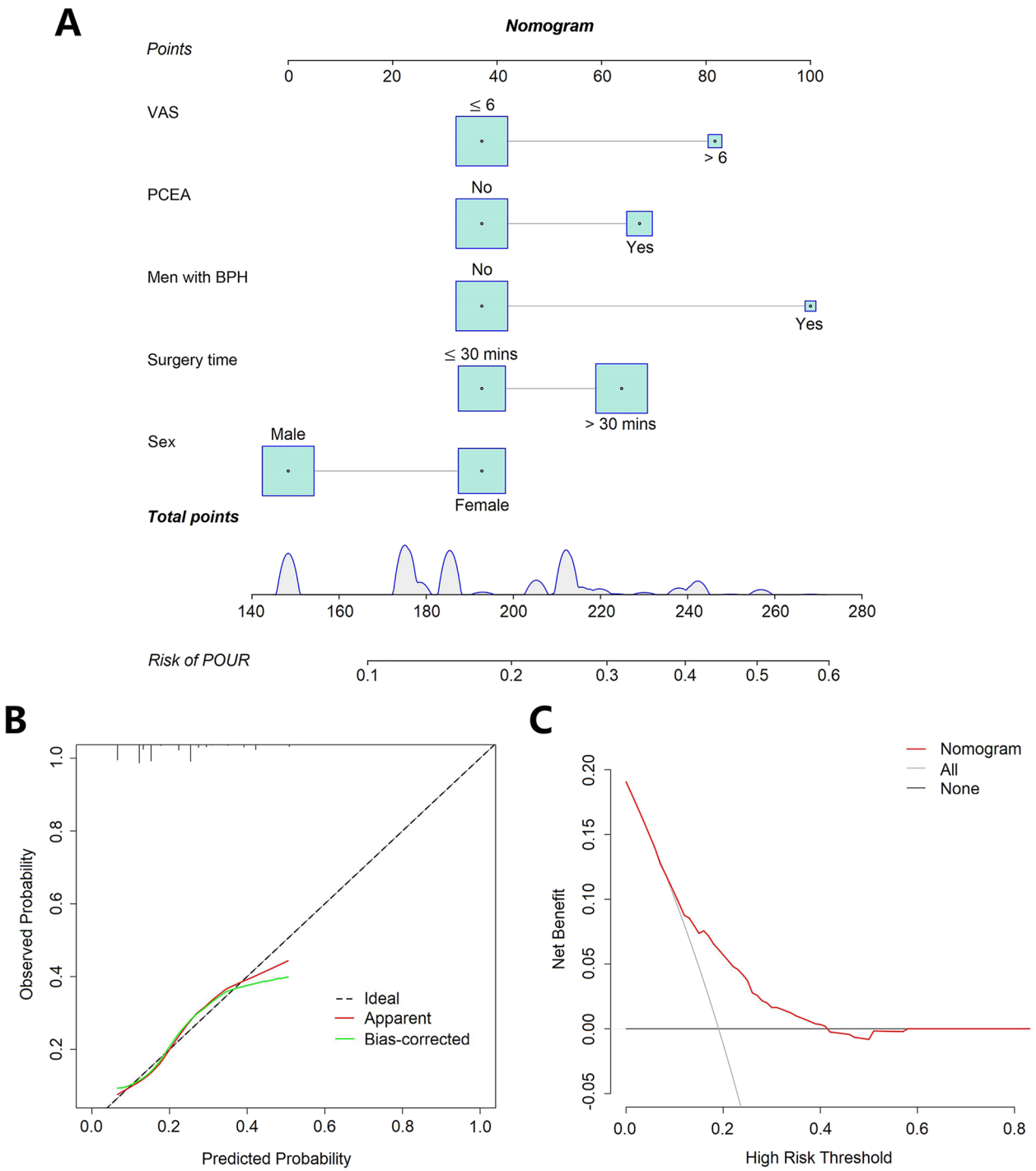

Fig. 2 The nomogram for the prediction of POUR after anorectal surgery for benign anorectal diseases (**A**), calibration plots for the prediction nomogram (**B**), decision curves analysis for the prediction nomogram (**C**)

Whether sex is a risk factor for POUR remains controversial [26, 28–34]. This diversity may be related to different types of operations. Our study showed that the incidence of POUR after anorectal surgery for benign anorectal diseases in female patients was 24.6%, which was significantly higher than for male patients (14.41%). Multivariate logistic regression analysis revealed that sex was an independent risk factor for POUR and the risk

of POUR in women was 1.973 times higher than that in men. This result is consistent with a previous study [26]. The possible reason is that the urethra of female patients is short and close to the anus, so they are more likely to be irritated during a perianal operation, which can easily lead to POUR.

In addition, we found that men with BPH is an independent risk factor for POUR (OR = 4.913). BPH is clearly a risk factor for lower urinary tract dysfunction and retention [27], and the first symptom for most BPH patients is acute urinary retention [35]. A meta-analysis (3,821 patients) revealed that BPH was significantly associated with an increased risk of POUR (OR = 2.83) [31]. And in the nomogram model, BPH was found to be the most important factor affecting the occurrence of POUR.

Numerous studies have identified diabetes as a risk factor for POUR after anorectal surgery for benign anorectal diseases [26, 36]. The proposed mechanism involved autonomic neuropathy affecting the bladder's autonomic nerves, leading to sensory loss and subsequent increased residual urine or urinary retention [37]. However, we did not find diabetes to be a significant risk factor for POUR. This discrepancy might be attributed to the relatively short duration of diabetes and good glycemic control among the participants in this study. Additionally, the number of patients with a history of diabetes in the cohort was low, comprising only 11 cases (1.81%). Therefore, further large-scale studies are necessary to elucidate the relationship between diabetes and POUR after anorectal surgery for benign anorectal diseases.

Pain is perhaps the most common complication after anorectal surgery, which not only makes patients suffer, but also increases complications, delays the recovery and increases medical costs. Consisted with a previous study [15], our findings clearly showed that postoperative VAS score > 6 was an independent risk factor for POUR, suggesting that effective postoperative analgesia can reduce the incidence of POUR. Severe postoperative pain was a significant predictor of POUR, second only to BPH. Previous studies have reported that long-acting local anesthetics, high doses of a local anesthetic, continuous epidural infusion and PCEA are risk factors for POUR [15]. In the present study, we found that PCEA was an independent risk factor for POUR. Therefore, when PCEA is used in patients undergoing anorectal surgery, we can take some preventive measures to prevent POUR, to achieve satisfactory analgesic effect and reduce the risk of POUR.

Since fluid administration is usually constant during an operation, longer procedures tend to require a greater intraoperative infusion volume. However, it remains controversial whether the increased incidence of POUR caused by a prolonged surgery time is related to the increased volume of intraoperative infusion [27, 38]. In our study, there was a significant difference in surgery time between the POUR and non-POUR groups, but there was no difference in the intraoperative infusion volume between the two groups, possibly because a preventive strategy was adopted in our study. The intraoperative infusion volume mostly ranged from 200 to 400 mL, and no correlation between injection volume and POUR was found. The findings suggested that the increase in the incidence of POUR caused by prolonged surgery time may be related to the type of surgery and the intraoperative operation procedures. We found that more than 3 incisions and the types of surgery increased the incidence of POUR. A previous study reported that the number of hemorrhoids > 3 and the severity of hemorrhoids > 4 are independent risk factor for POUR [30].

With the development of comfort medicine and ERAS, more and more patients are used CEB + IA for anorectal surgery in China. Compared with GA, CEB + IA has the advantages of less effects on general physiological functions, better postoperative analgesia and faster recovery. In addition, ultrasound-guided caudal epidural puncture greatly improves the success rate, which is favored by many anesthesiologists. Many previous studies have suggested that spinal anesthesia leads to a higher incidence of POUR than general anesthesia [34, 39]. However, some studies suggested the opposite [15, 40]. In the present study, there was no correlation between the types of anesthesia and POUR, but further studies are warranted.

To the best of our knowledge, we have developed the first predictive model for POUR after anorectal surgery for benign anorectal diseases. We evaluated the nomogram by C-index, a calibration plot and DCA, and found that it was a good evaluation model for POUR. Using the nomogram, we found that BPH had the largest weight for the occurrence of POUR after anorectal surgery for benign anorectal diseases, followed by severe postoperative pain, PCEA and surgery time > 30 min, sex had the least influence. Therefore, we recommend that physicians and anesthesiologists develop individualized treatment plans to prevent POUR in the patients who are male with BPH, have severe postoperative pain and/or PCEA. It can promote ERAS to some extent and improve patient satisfaction.

There are a number of limitations to our study. First, we only collected the patient's preoperative history of BPH, but no formal urinary system examination was conducted, so we could not evaluate the degree of preoperative urethral obstruction. Second, the study was a single center nested case–control study, and no preventive measures for POUR of anorectal surgery for benign anorectal diseases have been investigated. Third, we did

not perform postoperative bladder ultrasound. Therefore, further prospective randomized controlled studies are needed to find measures to prevent and manage POUR after anorectal surgery for benign anorectal diseases.

Conclusions

In conclusion, the incidence of POUR after anorectal surgery for benign anorectal diseases was 19.05%. The independent risk factors for POUR after anorectal surgery for benign anorectal diseases were: female, male with BPH, a postoperative VAS score > 6, PCEA and a surgery time > 30 min. We constructed and validated a nomogram for the preoperative individualized prediction of POUR after anorectal surgery for benign anorectal diseases. For these high-risk patients, early preventive measures against POUR can be taken to reduce the risk of its occurrence.

Acknowledgements
We are grateful to Dr. Mingan Yang for the assistance with statistical analysis, Division of Biostatistics & Epidemiology, School of Public Health, San Diego State University, San Diego, CA, United States of America.

Authors' contributions
Investigation: BL, PZ; Project administration: BL, WL; Data curation: BL, WL; Software: BL, YC; Formal analysis: YC; Visualization: YC; Methodology: PZ, XL; Funding acquisition: RW, XL; Resources: HH, RW; Supervision: RW; Writing—original draft: YC; Writing – review & editing: RW.

Funding
This work was supported by 1, 3, 5 Project for Disciplines of Excellence Clinical Research Incubation Project, West China Hospital, Sichuan University [grant number: 2018HXFH029]; the National Natural Science Foundation of China [grant number: 81900064]; and the Science and Technology Support Project of Sichuan Province [grant number: 2018SZ0113].

Availability of data and materials
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The study was approved by the Ethics Committee of Cheng Du Shang Jin Nan Fu Hospital on 29/09/2020 (No. 2020092901). Written informed consent was obtained from each patient before study participation. The trial was registered prior to patient enrollment in the Chinese Clinical Trials Registry on 05/11/2020 (ChiCTR2000039684).

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Author details
[1]Department of Anesthesiology, West China Hospital of Sichuan University, Chengdu 610041, China. [2]Department of Anesthesiology, Panzhihua Central Hospital, Panzhihua 617067, China. [3]Department of Anesthesiology, Chengdu Second People's Hospital, Chengdu 610016, China. [4]Benign Coloproctological Diseases Center, West China Hospital of Sichuan University, Chengdu 610041, China.

Received: 5 January 2024 Accepted: 22 July 2024
Published online: 05 August 2024

References

1. Everhart JE, Ruhl CE. Burden of digestive diseases in the United States part II: lower gastrointestinal diseases. Gastroenterology. 2009;136(3):741–54.
2. Jacobs DO. Hemorrhoids: what are the options in 2018? Curr Opin Gastroenterol. 2018;34(1):46–9.
3. Peery AF, Crockett SD, Murphy CC, Lund JL, Dellon ES, Williams JL, Jensen ET, Shaheen NJ, Barritt AS, Lieber SR, et al. Burden and cost of gastrointestinal, liver, and pancreatic diseases in the United States: Update 2018. Gastroenterology. 2019;156(1):254–272.e211.
4. Sahnan K, Adegbola SO, Tozer PJ, Watfah J, Phillips RK. Perianal abscess. BMJ (Clinical research ed). 2017;356:j475.
5. Cirocchi R, Trastulli S, Morelli U, Desiderio J, Boselli C, Parisi A, Noya G. The treatment of anal fistulas with biologically derived products: is innovation better than conventional surgical treatment? An update. Techniq Coloproctol. 2013;17(3):259–73.
6. Lyle V, Young CJ. Anal fissures: An update on treatment options. Australian J Gen Pract. 2024;53(1–2):33–5.
7. Cataldo PA, Senagore AJ. Does alpha sympathetic blockade prevent urinary retention following anorectal surgery? Dis Colon Rectum. 1991;34(12):1113–6.
8. Salvati EP, Kleckner MS. Urinary retention in anorectal and colonic surgery. Am J Surg. 1957;94(1):114–7.
9. Hu Y, Craig SJ, Rowlingson JC, Morton SP, Thomas CJ, Persinger MB, Isbell J, Lau CL, Kozower BD. Early removal of urinary catheter after surgery requiring thoracic epidural: a prospective trial. J Cardiothorac Vasc Anesth. 2014;28(5):1302–6.
10. Poylin V, Curran T, Cataldo T, Nagle D. Perioperative use of tamsulosin significantly decreases rates of urinary retention in men undergoing pelvic surgery. Int J Colorectal Dis. 2015;30(9):1223–8.
11. Balderi T, Carli F. Urinary retention after total hip and knee arthroplasty. Minerva Anestesiol. 2010;76(2):120–30.
12. Lu M, Yang B, Liu Y, Liu Q, Wen H. Procedure for prolapse and hemorrhoids vs traditional surgery for outlet obstructive constipation. World J Gastroenterol. 2015;21(26):8178–83.
13. Petros JG, Bradley TM. Factors influencing postoperative urinary retention in patients undergoing surgery for benign anorectal disease. Am J Surg. 1990;159(4):374–6.
14. Knight JS, Senapati A, Lamparelli MJ. National UK audit of procedure for prolapsing haemorrhoids on behalf of the Association of Coloproctology of Great Britain and Ireland. Colorect Dis. 2008;10(5):440–5.
15. Baldini G, Bagry H, Aprikian A, Carli F. Postoperative urinary retention: anesthetic and perioperative considerations. Anesthesiology. 2009;110(5):1139–57.
16. Choi S, Awad I. Maintaining micturition in the perioperative period: strategies to avoid urinary retention. Curr Opin Anaesthesiol. 2013;26(3):361–7.
17. Wu AK, Auerbach AD, Aaronson DS. National incidence and outcomes of postoperative urinary retention in the Surgical Care Improvement Project. Am J Surg. 2012;204(2):167–71.
18. Awan FN, Zulkifli MS, McCormack O, Manzoor T, Ravi N, Mehigan B, Reynolds JV. Factors involved in unplanned admissions from general surgical day-care in a modern protected facility. Ir Med J. 2013;106(5):153–4.
19. Lau H, Brooks DC. Predictive factors for unanticipated admissions after ambulatory laparoscopic cholecystectomy. Archives Surg (Chicago, Ill : 1960). 2001;136(10):1150–3.
20. Hollingsworth JM, Rogers MA, Krein SL, Hickner A, Kuhn L, Cheng A, Chang R, Saint S. Determining the noninfectious complications of indwelling urethral catheters: a systematic review and meta-analysis. Ann Intern Med. 2013;159(6):401–10.
21. Magill SS, Edwards JR, Bamberg W, Beldavs ZG, Dumyati G, Kainer MA, Lynfield R, Maloney M, McAllister-Hollod L, Nadle J, et al. Multistate point-prevalence survey of health care-associated infections. N Engl J Med. 2014;370(13):1198–208.
22. Steggall M, Treacy C, Jones M. Post-operative urinary retention. Nurs Standard (Royal College of Nursing (Great Britain):1987). 2013;28(5):43–8.

23. Pavlin DJ, Pavlin EG, Fitzgibbon DR, Koerschgen ME, Plitt TM. Management of bladder function after outpatient surgery. Anesthesiology. 1999;91(1):42–50.
24. Boulis NM, Mian FS, Rodriguez D, Cho E, Hoff JT. Urinary retention following routine neurosurgical spine procedures. Surg Neurol. 2001;55(1):23–7 discussion 27–28.
25. Kunitake H, Poylin V. Complications Following Anorectal Surgery. Clin Colon Rectal Surg. 2016;29(1):14–21.
26. Toyonaga T, Matsushima M, Sogawa N, Jiang SF, Matsumura N, Shimojima Y, Tanaka Y, Suzuki K, Masuda J, Tanaka M. Postoperative urinary retention after surgery for benign anorectal disease: potential risk factors and strategy for prevention. Int J Colorectal Dis. 2006;21(7):676–82.
27. Kowalik U, Plante MK. Urinary Retention in Surgical Patients. Surg Clin North America. 2016;96(3):453–67.
28. Griesdale DE, Neufeld J, Dhillon D, Joo J, Sandhu S, Swinton F, Choi PT. Risk factors for urinary retention after hip or knee replacement: a cohort study. Canadian J Anaesthesia. 2011;58(12):1097–104.
29. Ruiz-Castro M, San José Santos M, Rodríguez-Miguel A, de Abajo Iglesias FJ. Intraspinal administration of morphine hydrochloride combined with low doses of bupivacaine in hemorrhoidectomy: a clinical randomized trial. Minerva Anestesiologica. 2017;83(9):930–8.
30. Qi-Ming X, Jue-Ying X, Ben-Hui C, Jing W, Ning L. Risk Factors for Postoperative Retention After Hemorrhoidectomy: A Cohort Study. Gastroenterology nursing : the official journal of the Society of Gastroenterology Nurses and Associates. 2015;38(6):464–8.
31. Mason SE, Scott AJ, Mayer E, Purkayastha S. Patient-related risk factors for urinary retention following ambulatory general surgery: a systematic review and meta-analysis. Am J Surg. 2016;211(6):1126–34.
32. Lin YH, Liu KW, Chen HP. Haemorrhoidectomy: prevalence and risk factors of urine retention among post recipients. J Clin Nurs. 2010;19(19–20):2771–6.
33. Sivasankaran MV, Pham T, Divino CM. Incidence and risk factors for urinary retention following laparoscopic inguinal hernia repair. Am J Surg. 2014;207(2):288–92.
34. Lamonerie L, Marret E, Deleuze A, Lembert N, Dupont M, Bonnet F. Prevalence of postoperative bladder distension and urinary retention detected by ultrasound measurement. Br J Anaesth. 2004;92(4):544–6.
35. Verhamme KM, Dieleman JP, van Wijk MA, Bosch JL, Stricker BH, Sturkenboom MC. Low incidence of acute urinary retention in the general male population: the triumph project. Eur Urol. 2005;47(4):494–8.
36. Rashidi L, Gajjar AH. Identification of risk factors for postoperative urinary retention after various hemorrhoid-related procedures. J Am Coll Surg. 2014;219(4):e79–80.
37. Alam U, Asghar O, Azmi S, Malik RA. General aspects of diabetes mellitus. Handb Clin Neurol. 2014;126:211–22.
38. Pavlin DJ, Pavlin EG, Gunn HC, Taraday JK, Koerschgen ME. Voiding in patients managed with or without ultrasound monitoring of bladder volume after outpatient surgery. Anesth Analg. 1999;89(1):90–7.
39. Hansen BS, Søreide E, Warland AM, Nilsen OB. Risk factors of post-operative urinary retention in hospitalised patients. Acta Anaesthesiol Scand. 2011;55(5):545–8.
40. Jensen P, Mikkelsen T, Kehlet H. Postherniorrhaphy urinary retention–effect of local, regional, and general anesthesia: a review. Reg Anesth Pain Med. 2002;27(6):612–7.

Publisher's Note