

Predictors of Catheter-Related Bladder Discomfort After Surgery: A Literature Review

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Abstract

Background: Indwelling bladder catheters are routinely used in clinical practice. Patients may experience postoperative indwelling catheter-related bladder discomfort (CRBD). This study aimed to perform a literature review to identify predictors of postoperative CRBD.

Methods: We searched PubMed for relevant articles published between 2000 and 2020 using the search items “CRBD”, “catheter-related bladder discomfort”, and “prediction”. Additionally, we searched for articles that matched the research objectives from the references of the extracted articles. We included only prospective observational studies involving human participants and excluded interventional studies, observational studies that did not report sample sizes, or observational studies that did not research on predictors of CRBD. We narrowed our search to the keyword “prediction” and found five references. We selected five studies that met the objectives of the study as the target literature.

Results: Using the keywords “CRBD” and “catheter-related bladder discomfort”, we identified 69 published articles. The results were narrowed down by the keyword “prediction”, and five studies that recruited 1,147 patients remained. The predictors of CRBD can be divided into four factors: 1) patient factors; 2) surgical factors; 3) anesthesia factors; and 4) device and insertion technique factors.

Conclusion: Our study suggests that patients with predictors of CRBD should be closely monitored to reduce postoperative patient suffering, and their quality of life should be improved after anesthesia.

Keywords: Catheter-related bladder discomfort; Indwelling bladder catheters; Predictors; Perioperative; Postoperative

Introduction

Indwelling bladder catheters are routinely used in clinical practice. In the perioperative period, it is used to assess circulatory dynamics, maintain bed rest, and ensure urine drainage. Patients with perioperative indwelling bladder catheters may experience postoperative indwelling catheter-related bladder discomfort (CRBD), including pain and urinary urgency. These symptoms are often experienced after awakening from anesthesia and cause postoperative distress in patients. Patients may experience various types of discomfort other than pain immediately following surgery and anesthesia. A study reported that 43% of discomfort was related to an indwelling bladder catheter that had been inserted intraoperatively [1]. CRBD is unpleasant for patients after surgery, and it decreases patient satisfaction, causes postoperative complications, and significantly affects the patient’s recovery process. Indwelling bladder catheters are an important cause of postoperative agitation. Therefore, it is recommended that indwelling bladder catheters be removed as soon as possible [2]. Severe CRBD with behavioral responses, such as pulling out an indwelling bladder catheter, can also lead to urethral injury. Compared to a placebo drug, muscarinic antagonists, anesthetics, antiepileptics, and analgesics were reported to have greatly improved clinical symptoms and significantly reduced the incidence of CRBD [3]. Although CRBD has been studied extensively, because it is not a serious life-threatening complication, patients’ complaints of distress may not be properly addressed. A literature review has been published on interventions that may reduce the incidence and severity of CRBD; however, none has been published on predictors of CRBD. Therefore, the purpose of this study was to conduct a literature review of the predictors of CRBD and identify the predictors of CRBD. By preoperatively assessing the predictors of CRBD, appropriate interventions can be provided for patients at risk of CRBD.

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Table 1. Rating Scale for Catheter-Related Bladder Discomfort

No pain	No report from the patient after interviewing
Grade 1 (mild pain)	Revealed only by interviewing the patient
Grade 2 (moderate)	A spontaneous complaint by the patient
Grade 3 (severe discomfort)	Excitement, great frustration, and attempts to remove bladder catheter

Research Methods

Literature review methods

We searched PubMed for relevant articles published between 2000 and 2020 using search items.

Various algorithms, including the following terms: catheter-related bladder discomfort, risk factor, risk, and predictors were used. The results of the database search are summarized in ENDNOTE. Data from all selected studies were extracted and tabulated by one author and corroborated by another. Discrepancies were resolved by consensus by all authors. Information retrieved included the following: 1) author name and year of publication; 2) details of the study design (number of patients randomized, method of randomization, and duration of observation); 3) characteristics of the recruited patients; 4) details of interventions used (dosage and schedule); and 5) data on primary and secondary outcomes and P-values.

Definition of terms

CRBD is defined as urinary urgency and suprapubic discomfort [4, 5].

Rating scale for CRBD

CRBD was assessed using the four-point scale used by Agarwal et al [5] (Table 1).

Results

Literature to be analyzed

Using the keywords “CRBD” and “catheter-related bladder discomfort”, we identified 69 published articles. The results were narrowed down by the keyword “prediction”, and five studies that recruited 1,147 patients remained (Fig. 1) (Table 2).

Incidence of CRBD

The incidence of CRBD in the five extracted studies ranged from 44.3% to 84.5% [4, 6-9]. The incidence of CRBD was the highest (84.5%) in a study that recruited patients who had undergone abdominal laparotomy in urological diseases [7] and the lowest (44.3%) in a study that recruited patients who had undergone obstetrical and gynecological surgery [4].

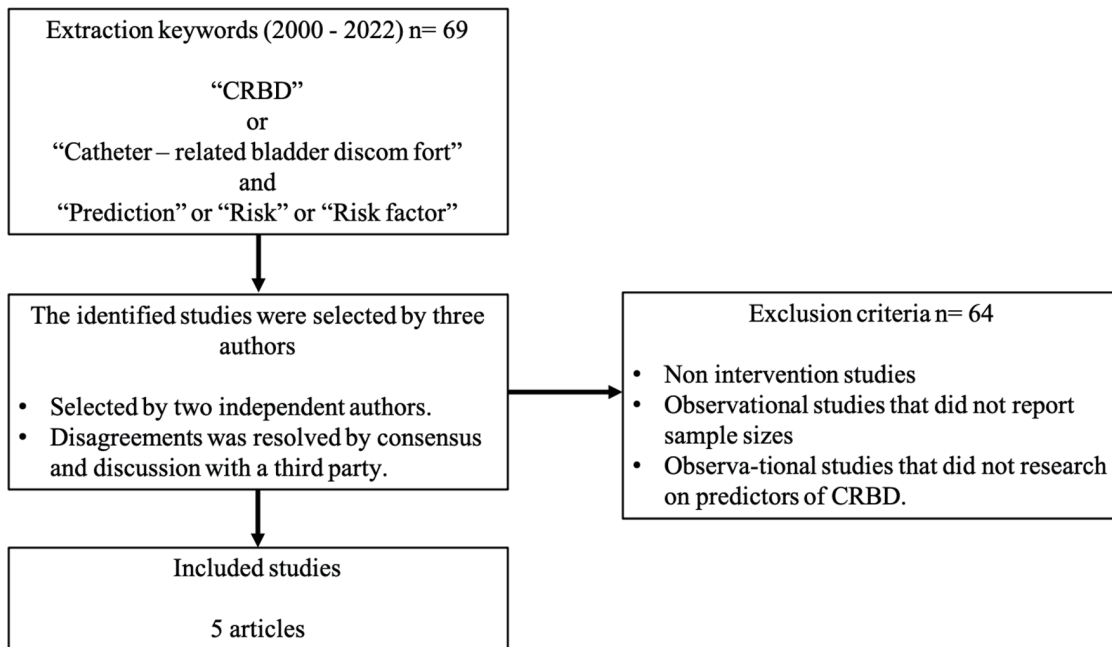


Figure 1. Flowchart of literature review.

Table 2. Studies on Predictors of CRBD

No.	Title	Year	Method	Participants	Incidence of CRBD	Predictors of CRBD (OR (95% CI), P value)
A	Predictors of catheter-related bladder discomfort in the post-anaesthesia care unit [6]	2011	Prospective observational study	Groups: no CRBD group (none, mild): n = 120; CRBD group (moderate and severe): n = 44. Surgical operation: adult patients undergoing surgery under general anesthesia requiring intraoperative urinary catheterization. Observation period: 6 months	No CRBD group (mild: 20%). CRBD group (moderate and severe: 27%)	Diameter of indwelling bladder catheter above 18 Fr: 2.2 (1.0 - 5.1), P = 0.06. Male: 3.2 (1.0 - 10.5), P < 0.06
B	Predictors of catheter-related bladder discomfort after urological surgery [7]	2014	Prospective observational study	Groups: no CRBD group (none, mild), day 1: n = 65, day 3: n = 113; CRBD group (moderate/severe), day 1: n = 51, day 3: n = 3. Surgical operation: patients undergoing transurethral, laparoscopic, or open urological surgery; adult patients undergoing surgery under general or epidural anesthesia. Observation period: 3 months	CRBD on day 1 (mild CRBD: 40.5%, moderate or severe CRBD: 44.0%). CRBD on day 3 (mild CRBD: 29.3%, moderate and severe CRBD: 2.6%)	Open abdominal surgery: 3.074 (1.3 - 7.4), P < 0.05. Previous catheter insertion: 2.458 (1.1 - 5.9), P < 0.05
C	Predictors of catheter-related bladder discomfort after gynaecological surgery [8]	2020	Prospective observational study	Groups: CRBD ≥ 1 point or higher group (mild 1 point = 93, moderate 2 points = 139, severe 3 points = 31); n = 263; CRBD ≥ 2 points group (moderate 2 points = 139, severe 3 points = 31); n = 170. Surgical operation: general anesthesia patients for gynecological surgery (all patients with 16 Fr indwelling bladder catheters). Observation period: 1 month	Mild CRBD: 22.8%, moderate CRBD: 34.2%, severe CRBD: 7.6%	50 years and older: 2.106 (1.2 - 3.8), P = 0.013. Uterus-related laparoscopic surgery: 1.863 (1.1 - 3.1), P = 0.019. Lack of additional analgesics: 0.408 (0.2 - 0.9), P = 0.032
D	Factors predicting catheter-related bladder discomfort in surgical patients [9]	2016	Prospective observational study	Groups: CRBD 1 or less group (none 0 = 15, mild CRBD 1 = 74): n = 89; CRBD ≥ 2 points group (moderate 2 points = 51, severe 3 points = 20); n = 71. Surgical operation: patients who underwent surgery (excluding urologic patients). Observation period: 4 months	Moderate or severe: CRBD occurred in 44.3% of patients with indwelling bladder catheters.	Under 50 years old: 4.79 (1.62 - 14.09), P = 0.005. Male gender: 7.07 (1.47 - 34.17), P = 0.015. Obstetrics and gynecology surgery: 11.07 (1.06 - 115.7), P = 0.045. Indwelling bladder catheter-related pain (UCRP: assessed by NRS) ≥ 4: 132.3 (24.6 - 690.4), P < 0.001
E	Predictors of catheter-related bladder discomfort [9]	2020	Prospective observational study	Groups: no CRBD group (none, mild): n = 243; CRBD group (moderate and severe): n = 57. Surgical operation: adult patients undergoing surgery under general anesthesia requiring intraoperative urinary catheterization. Observation period: 6 months	59% presented with symptoms of CRBD. More than 92% occurred on the first day of indwelling bladder catheter insertion.	Diameter of indwelling bladder catheter above 18 Fr: 0.9 (0.08 - 1.1), P = 0.012. Lack of lubricant: 0.1 (0.05 - 1.1), P = 0.008. Laparotomy: 0.5 (0.1 - 1.9), P = 0.02. Under 50 years old: 0.4 (0.08 - 9), P = 0.006. Previous cesarean section: 0.2 (0.04 - 1.3), P = 0.032. Previous catheter insertion: 0.3 (0.06 - 2.1), P = 0.005

CI: confidence interval; CRBD: catheter-related bladder discomfort; NRS: Numeric Rating Scale; OR: odds ratio; UCRP: urinary catheter-related pain.

Table 3. Predictors of Catheter-Related Bladder Discomfort

Patient factors	Surgical factors	Anesthetic factors	Device and insertion technique factors
Male gender (A) (D); Age \geq 50 years (C); Age < 50 years (D) (E); History of indwelling bladder catheters (B) (E); History of cesarean section (E)	Abdominal open surgery (B) (E); Uterus-related laparoscopic surgery (C); Obstetrical and gynecological surgery (D)	Lack of postoperative analgesics (C)	A urinary catheter size of \geq 18 Fr (A) (E); Lack of lubrication of a catheter (E)

Predictors of CRBD

The predictors of CRBD that were extracted from the five studies are presented in Table 3.

Patient factors

The following patient factors were extracted: male sex, age \geq 50 years, age < 50 years, history of indwelling bladder catheters, and history of cesarean section.

Binhas et al classified postoperative patients into two groups: with and without CRBD. Male sex (odds ratio (OR) = 3.2; 95% confidence interval (95% CI), 1.0 - 10.5; $P < 0.06$) was a predictor of CRBD [6].

Lim et al classified postoperative patients into two groups: with a CRBD grade of 1 or less and those with a CRBD grade of 2 or more [4]. Male sex (OR = 7.07; 95% CI, 1.47 - 34.17; $P = 0.015$) and age < 50 years (OR = 4.79; 95% CI, 1.62 - 14.09; $P = 0.005$) were predictors of CRBD.

Li et al classified postoperative urological surgery patients into two groups: with and without CRBD [7]. History of indwelling bladder catheters (OR = 2.458; 95% CI, 1.1 - 5.9; $P < 0.05$) was a predictor of CRBD [7].

Li et al classified postoperative gynecological surgery patients into two groups: with a CRBD grade of \geq 1 point (mild, moderate and severe) and those with a CRBD grade of \geq 2 points (moderate and severe) [8]. Age \geq 50 years (OR = 2.106; 95% CI, 1.2 - 3.8; $P = 0.013$) was a predictor of CRBD [8].

Moataz et al classified postoperative patients into two groups: with a first group (none and mild) and those with a second group (moderate and severe) [9]. Age < 50 years (OR = 0.4; 95% CI, 0.08 - 9.00; $P = 0.006$), history of indwelling bladder catheters (OR = 0.2; 95% CI, 0.04 - 1.30; $P = 0.032$), and history of cesarean section (OR = 0.3; 95% CI, 0.06 - 2.10; $P = 0.005$) were predictors of CRBD.

Surgical factors

The following surgical factors were extracted: abdominal laparotomy in urological diseases, uterus-related laparoscopic surgery, and obstetric and gynecological surgery.

Abdominal laparotomy in urological diseases was a predictor of CRBD in the studies by Li et al (OR = 3.074; 95% CI, 1.3 - 7.4; $P < 0.05$) [7] and Moataz et al [9] (OR = 0.5; 95% CI, 0.1 - 1.9; $P = 0.02$).

Uterus-related laparoscopic surgery (OR = 1.863; 95% CI, 1.1 - 3.1; $P = 0.019$) was reported to be a predictor of CRBD [8],

and obstetrical and gynecological surgery (OR = 11.07; 95% CI, 1.06 - 115.70; $P = 0.045$) was a predictor of CRBD [4].

Anesthetic factors

Lack of postoperative analgesics (OR = 0.408; 95% CI, 0.2 - 0.9; $P = 0.032$) was a predictor of CRBD [8].

Device and insertion technique factors

The following device and insertion technique factors were extracted: a urinary catheter size of $18 \geq$ Fr and lack of lubrication of a catheter.

The studies by Binhas et al [6] and Moataz et al [9] reported that a urinary catheter size of $18 \geq$ Fr was a predictor of CRBD (OR = 2.2; 95% CI, 1.0 - 5.1; $P = 0.06$ and OR = 0.9; 95% CI, 0.08 - 1.1; $P = 0.012$, respectively). Moataz et al [9] further reported that lack of lubrication of a catheter (OR = 0.1; 95% CI, 0.05 - 1.1; $P = 0.008$) was a predictor of CRBD.

Overlap between each of the studies on CRBD

Four patient factors associated with CRBD had one or two items of overlap among the five studies. Three surgical factors associated with CRBD had one or two items of overlap among the five studies. One anesthetic factor associated with CRBD had one item of overlap among the five studies. Lack of lubrication of a catheter associated with CRBD had one or two items of overlap among the five studies (Table 4).

Discussion

We conducted a literature review of five articles on the predictors of CRBD. The predictors of CRBD can be divided into four factors including patient factors, surgical factors, anesthetic factors, and device and insertion technique factors. By identifying the predictors of CRBD, unpleasant patient experiences and decreased patient satisfaction associated with CRBD can be reduced.

Incidence of CRBD

According to Bai et al [3], CRBD is frequent and occurs immediately after urological surgeries, especially after transurethral resection of the bladder tumor (TURBT). To date, TURBT

Table 4. Overlap Between Each of the Studies on CRBD

No.	Title	Patient factors				Surgical factors		Anesthetic factors	Lack of lubrication of a catheter
		Male gender	Age ≥ 50 years	Age < 50 years	History of indwelling bladder catheters	History of cesarean section	Abdominal open surgery		
A	Predictors of catheter-related bladder discomfort in the post-anaesthesia care unit [6]	•							•
B	Predictors of catheter-related bladder discomfort after urological surgery [7]		•						
C	Predictors of catheter-related bladder discomfort after gynaecological surgery [8]			•					•
D	Factors predicting catheter-related bladder discomfort in surgical patients [4]	•							•
E	Predictors of catheter-related bladder discomfort [9]				•	•			•

CRBD: catheter-related bladder discomfort.

is the most refractory surgical procedure among all urological surgical procedures because most patients who undergo TURBT are men and many have large indwelling bladder catheters (≥ 18 Fr) after the procedure. TURBT may increase the incidence of CRBD due to resection of the bladder wall and continued irritation of the bladder wall by reflux fluid.

Predictors of CRBD

Patient factors

The male sex was reported as a predictor of CRBD [4, 6] because anatomically, the male urethra is longer than the female urethra and is bent in an S-shape. This is because the indwelling bladder catheter stimulates a larger area of the urethra in men than in women, and the urethra is more strongly stimulated due to its S-shaped bend. In addition, men are more likely than women to complain of pain and use painkillers [10], indicating a lower pain tolerance. Male patients were more dissatisfied than their female counterparts with transurethral catheterization (satisfaction score: 4.18/10 vs. 2.75/10; $P = 0.05$) [11].

The controversies surround age factor of CRBD. Age ≥ 50 years and < 50 years were reported as predictors of CRBD [4, 8, 9]. Gynecological surgery studies have reported that an age of ≥ 50 years is a predictor of CRBD [8]. In gynecological surgery, the older the patient, the higher the possibility of that patient undergoing hysterectomy due to malignancy, and since hysterectomy, which irritates the bladder, is performed for patients ≥ 50 years, an age of ≥ 50 years is a predictor of CRBD. As we age, our pain threshold increases [12], we become more insensitive to pain stimuli, and we are less likely to complain of CRBD. In a study of female patients, higher pain scores with indwelling bladder catheters were recorded for younger women, which could be explained by better urethral sphincter muscle tone compared to that of older women [13]. Different studies have reported different results [4, 8, 9], and further research is needed.

History of indwelling bladder catheters was reported as a predictor of CRBD [7, 9]. Emotional distress and anxiety have been shown to be associated with severe acute pain [14]. Patients' past experience with placement of a retained catheter might psychologically mitigate the fear of urinary catheters, thereby lowering the incidence of CRBD [7]. Preoperative education can effectively reduce anxiety regarding catheterization [15], and preoperative education on CRBD using illustrations, which is simple and inexpensive, is effective in reducing both the incidence and severity of CRBD [16].

History of cesarean section was a predictor of CRBD [9]. Compared with patients with a history of vaginal delivery, patients with a history of cesarean section were significantly more likely to develop CRBD. To date, no study has established an association between CRBD and the method of delivery.

Surgical factors

Obstetrical and gynecological surgery and, specifically, uterus-related laparoscopic surgery were reported as predictors of

CRBD [4, 8]. This is because uterine contraction or irritation during laparoscopic surgery may irritate the bladder. Furthermore, postoperative neuropathy can induce bladder paralysis.

Anesthetic factors

Lack of postoperative analgesics was reported as a predictor of CRBD [8]. Inadequate postoperative analgesia increases incidence of CRBD. CRBD is similar to overactive bladder and is caused by involuntary contraction of the bladder smooth muscle due to muscarinic receptor stimulation. There are five subtypes of muscarinic receptors, M1 to M5. Bladder smooth muscle assembles M2 (70-80%) and M3 (20-30%) receptors, and M3 receptors are responsible for the contraction of bladder smooth muscle [17]. Therefore, muscarinic receptor antagonists such as tolterodine, oxybutynin, and butyl scopolamine are effective in preventing CRBD [4]. Tramadol and ketamine are centrally acting opioid analgesics with antimuscarinic effects that effectively prevent CRBD when administered intravenously [3]. Intravenous paracetamol has been shown to be effective in the prevention of CRBD [18]. The mechanism of CRBD is related to prostaglandin E2 (PGE2) in urine. PGE2 is produced in the bladder and acts on bladder smooth muscle contraction. Stimulation of bladder smooth muscles by indwelling bladder catheters promotes PGE2 synthesis and induces contraction of the bladder smooth muscles, resulting in CRBD. Paracetamol, an inhibitor of PG synthesis and cyclooxygenase-2, reduces the incidence and symptoms of CRBD [3].

In a study that compared the effects of sevoflurane and desflurane inhalant anesthetics on CRBD, sevoflurane, when compared with desflurane, reduced the incidence of CRBD in patients who underwent TURBT. CRBD in the first 24 h postoperatively occurred in 34/45 (76%) patients receiving sevoflurane compared to 41/44 (93%) patients receiving desflurane [19]. In another study that compared the effects of sevoflurane and propofol on CRBD, CRBD in the first 1 h postoperatively was lower in the sevoflurane group than in the propofol group (59% vs. 85%; $P = 0.007$) [20]. This is thought to be due to the ability of sevoflurane to block M3 receptors, which cause CRBD [21].

A study examining the effects of magnesium's smooth muscle relaxant effects on CRBD reported that magnesium reduced the incidence of CRBD grade of ≥ 2 points (above a moderate grade) and increased patient satisfaction after TURBT [22].

To prevent CRBD, intraoperative and postoperative pain management are important. Each drug has complications, such as anticholinergic effects, sedation, nausea and vomiting, and respiratory depression; however, multimodal pain management can reduce the incidence of these complications.

Device and insertion technique factors

A urinary catheter size of $18 \geq$ Fr was reported as a predictor of CRBD [6, 9]. The incidence of CRBD is less in nonurological postoperative patients with indwelling bladder catheters of 12 - 14 Fr [23]. Reducing the size of the indwelling bladder catheter reduces mechanical irritation to the urethra, leading to

a reduction in the CRBD.

Lack of lubrication of a catheter was reported as a predictor of CRBD [9]. If an indwelling bladder catheter is inserted without lubrication, the urethral mucosa is damaged by friction during insertion [13]. When lubricants containing local anesthetics are used, they can reduce trauma to the urethra and minimize pain and discomfort. Local anesthetics, such as lidocaine or prilocaine cream injected into the urethra or applied to the catheter as a lubricant, have been shown to reduce the incidence and severity of CRBD [24]. In addition, indwelling bladder catheters coated with analgesics are effective in preventing CRBD [25], and some indwelling bladder catheters for men are made such that they can be used to inject a local anesthetic into the urethra, which provides surface anesthesia for the urethral mucosa [26].

The balloon volume of an indwelling bladder catheter affects the occurrence of CRBD. In a study of patients who underwent urological surgery, a 50% reduction in the balloon volume of the indwelling bladder catheter reduced CRBD incidence [27]. The pain was mostly reported when the balloon of the urinary catheter contacts the bladder triangle or when the balloon volume of the indwelling bladder catheter is too large. Balloon catheters of 5 - 10 mL should be selected [28]. Reducing the balloon volume reduces the stimulation of the bladder induced by the balloon, thereby reducing the symptoms of CRBD. A comparison of the effects of indwelling bladder catheter insertion and suprapubic bladder drainage on CRBD after robot-assisted laparoscopic radical prostatectomy showed a decrease in postoperative CRBD in patients who underwent suprapubic bladder drainage [29]. The use of appropriate devices and insertion methods can help to reduce the incidence of CRBD.

Limitations

In this study, a literature review was conducted to identify patient factors associated with the occurrence of CRBDs: surgical factors, anesthetic factors, device and insertion technique factors and patient-related factors. However, these factors were not independent of each other, but combined to cause CRBD. However, it was not clear how many of these factors combined to cause CRBD and whether the combination of factors affected the severity and duration of CRBD. In addition, it was not clear if patient factors were responsible for causing CRBD or if they affected severity and duration. The current review found no reports related to CRBD or patient factors. Therefore, further research on CRBD and patient factors is warranted. There were few studies on CRBD, and thus only 1 - 2 studies overlapped items for each factor. Therefore, a meta-analysis could not be performed.

Conclusion

Predictors of CRBD included: 1) patient factors (male sex, age \geq 50 years, age $<$ 50 years, history of indwelling bladder catheters, and history of cesarean section); 2) surgical factors

(abdominal laparotomy in urological diseases, uterus-related laparoscopic surgery, and obstetrical and gynecological surgery); 3) anesthetic factors (lack of postoperative analgesics); and 4) device and insertion technique factors (a urinary catheter size of \geq 18 Fr, lack of lubrication of a catheter, and urinary catheter-related pain (UCRP) \geq 4).

Our study suggests that patients with predictors of CRBD should be closely monitored to reduce postoperative patient suffering, and their quality of life should be improved after anesthesia.

Acknowledgments

None to declare.

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Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

TY designed the study. KN, TI, and YY participated in data acquisition, extraction, and analysis, and drafted the final work. KK, YM and YB supervised this manuscript's preparation and writing. The authors reviewed the final version of the manuscript and approved it for publication.

Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Abbreviations

CRBD: catheter-related bladder discomfort; UCRP: urinary catheter-related pain; TURBT: transurethral resection of the bladder tumor; PG: prostaglandin

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