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# Research Progress on Catheter-Related Bladder Discomfort After General Anesthesia

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**Abstract:** Urinary catheterization is a common intervention for patients undergoing general anesthesia, especially for major surgeries. It plays an important role in the perioperative period in assessing renal function, avoiding renal impairment, and improving patient prognosis. However, for patients receiving urinary catheterization, catheter-associated bladder discomfort (CRBD) is a common complication after general anesthesia, accounting for a significant proportion. In mild cases, it may reduce the comfort of patients during the perioperative period; In severe cases, it may affect patient recovery, increase the hospitalization period, increase the medical burden, and decrease patient satisfaction. However, However, CRBD is often ignored by medical staff in clinical work. Prevention and treatment of CRBD are important for patients undergoing urinary catheterization under general anesthesia to accelerate rapid recovery. At present, there is still a lack of consensus on the prevention and treatment of CRBD. In recent years, scholars at home and abroad have conducted many studies on CRBD and provided many prevention and treatment measures, including pharmacological interventions, nerve blocks, and psychological interventions, which have provided more evidence for clinical work. The article mainly review the prevention and treatment of CRBD from the aspects of risk factors, mechanism, and intervention methods, and provides a reference for the prevention and treatment of CRBD under general anesthesia.

**Keywords:** General Anesthesia, Catheter-Related Bladder Discomfort (CRBD), Prevention and Treatment

## 1. Introduction

In patients undergoing elective surgery under general anesthesia, especially for more lengthy procedures, indwelling catheters are often a standard operation in the operating room to assess the patient's renal function and to avoid renal impairment. However, the urethral catheter may cause catheter-related bladder discomfort (CRBD), the main clinical symptoms of urinary frequency and urgency, and discomfort in the suprapubic region due to catheter irritation [1]. CRBD often occurs in the early postoperative period, especially when patients are in the post-anesthesia care unit (PACU), with an incidence of 47% to 90% [2,3]. CRBD is a distressing complication often overlooked in the clinical setting and can exacerbate postoperative pain and agitation, leading to more serious adverse events. Therefore, further attention to the early prevention and active treatment of CRBD by clinical staff is necessary. [4-6] Therefore, additional attention to clinical staff's early prevention and active treatment of CRBD is essential. This article reviews the current research progress in preventing and treating catheter-related bladder discomfort after general anesthesia to provide some reference for clinical work.

## 2. Risk Factors and Severity Grading

### *2.1. Risk Factors*

Risk factors for CRBD are three physiological strictures in the urethral anatomy that make them more likely to develop CRBD after urological surgery, especially after transurethral resection of the bladder tumor (TURBT), compared to non-neurosurgical procedures [3]. In a

descriptive study [7], A multifactorial regression analysis of 183 patients who underwent catheter placement and surgery indicated that male sex, catheter insertion after anesthesia, and iodophor lubricant were independent risk factors for postoperative CRBD. Timing of catheter insertion and type of catheter lubricant were significantly correlated with the severity of CRBD. An additional multifactorial logistic regression analysis showed that age ≥50 years and uterus-related laparoscopic surgery were independent predictors of CRBD incidence [8]. In conclusion, CRBD was associated with factors such as gender, age, surgical procedure, and timing and method of catheterization operation.

### *2.2. CRBD Severity Grading*

Score 0: patients complained of no bladder discomfort when asked; Score 1: patients complained of slight urethral discomfort only when they were asked; Score 2: patients actively expressed urethral discomfort when they were not asked, but they were able to comply with movements without abnormal physical behaviors; Score 3: patients were not asked, and they actively expressed urinary urge, urethral burning or foreign body sensation, Etc. Accompanied by behavioral reactions such as emotional irritability and limb movement [2]. In addition, there is a Numerical Rating Scale applied to the grading of CRBD [9]. However, this method can be easily confused with pain, which may affect clinical interventions.

## 3. Possible physiopathological Mechanisms of CRBD

### *3.1. Activation of Muscarinic Receptors*

Catheter placement and pulling after balloon injection stimulates cholinergic nerves, leading to local smooth muscle contraction. Different groups of M receptors exist in bladder smooth muscle, in particular M3 and M2 receptors, which are usually involved in the pathological mechanisms of bladder contractile disorders. M3 receptors are associated with direct contraction of the bladder, and M2 receptors are associated with indirect contraction of the bladder by enhancing the action of M3 or by reversing the relaxation induced by cyclic adenosine monophosphate (cAMP)-induced β-adrenergic activity, leading to overactive bladder syndrome or CRBD [10].

### *3.2. Release of Inflammatory Factors*

The presence of a catheter may damage the local mucosal barrier, which is more likely to lead to mucosal damage if a thick catheter is used, repeated operations or violent operations, Etc. Damage to the local mucosal barrier can lead to the release of prostaglandins, which in turn trigger bladder contraction due to increased prostaglandin levels, hence the symptoms of CRBD [11]. The damage to the local mucosal barrier can lead to the release of prostaglandins, which can increase the level of prostaglandins and trigger bladder contraction, hence the symptoms of CRBD.

Other mechanisms contributing to CRBD include susceptible populations, psychological factors in patients, and chemical irritation from local mucus and topical disinfectants.

## 4. Prevention and Treatment of CRBD

### *4.1. Antimuscarinic Drugs*

Antimuscarinic drugs are commonly used clinically as antispasmodics and are often used in diagnosing and treating acute abdominal cramps of various causes and possible spasm-inducing conditions. Butylscopolamine may also prevent and treat CRBD by blocking muscarinic receptor-mediated bladder contractions. Nam et al. [12] studied that 20 mg of scopolamine butylscopolamine administered intravenously immediately before the end of surgery in an experimental group resulted in a significant reduction in the incidence and severity of CRBD in the early postoperative period compared to the control group, with no significant side effects. Another group of pilot studies showed [13] that in patients with CRBD after urologic surgery, 20 mg of intravenous scopolamine butylscopolamine reduced the severity of CRBD and the need for analgesics with no significant side effects. Another antimuscarinic agent, trospium, prevents postoperative CRBD, and Srivastava et al. [14] in a trial of 64 adult patients scheduled for spinal surgery which required catheterization and were randomized into two groups, trospium extended-release tablets of 60 mg were administered orally 1 hour before induction of anesthesia, and trospium was found to reduce the incidence and severity of CRBD in the early postoperative period. However, the drug increased the incidence of postoperative dry mouth. Other antimuscarinic agents used in clinical studies to prevent or treat CRBD include tolterodine, darifenacin, and solifenacin. Antimuscarinic drugs have adverse effects such as postoperative dry mouth, facial flushing, and blurred vision, which need to be avoided during clinical use to prevent increasing patient discomfort and thus decrease patient satisfaction.

### *4.2. Analgesics*

#### *4.2.1. Opioid Analgesics*

Tramadol is a synthetic opioid with a potent analgesic mechanism that produces central analgesia primarily through stimulation of μ-opioid receptors but also activates pain inhibition at the spinal level by reducing the reuptake of norepinephrine and 5-hydroxytryptamine. Tramadol also inhibits muscarinic receptors and can inhibit the activity of the detrusor muscle by inhibiting M1 and M3 [15]. Agarwal et al. [15] intravenous tramadol 1.5 mg/kg 30 minutes before patient extubation reduced the incidence and severity of CRBD and postoperative fentanyl requirement.

Bladder spasm and urethral mucosal injury play an essential role in CRBD, and activation of κ-opioid receptors

by dezocine may improve CRBD by inhibiting injurious irritation caused by bladder neck spasm and urethral mucosal injury [16].

Other opioid analgesics that play a role in alleviating postoperative CRBD include oxycodone, nalbuphine, and pentazocine. However, opioids may cause adverse effects such as delayed awakening, nausea, vomiting, constipation, etc. Less opioid administration is mostly advocated in clinical practice, and opioids are mostly used as remedial medications.

#### *4.2.2. Non-Opioid Analgesics*

Ketorolac is a non-steroidal anti-inflammatory drug that has the property of inhibiting prostaglandin synthesis and may reduce CRBD by inhibiting bladder contraction mediated by inflammatory factors. Park et al. [17] evaluated the effectiveness of ketorolac in preventing the development of postoperative CRBD and showed that the incidence of moderate or greater CRBD was significantly lower in the ketorolac group at 0 hours postoperatively (21.5% vs. 50.8%) and 1, 2, and 6 hours compared with the intraoperative intravenous administration of ketorolac 30 mg versus the placebo group.

Lidocaine is a sodium channel blocker that acts on other receptors such as muscarinic and N-methyl-D-aspartate and has antimuscarinic and anti-inflammatory properties. Studies have shown that intravenous lidocaine is effective in preventing the development of postoperative CRBD, and Kim et al. [11] divided patients performing TURBT into a lidocaine group and a control group using a randomized grouping method. The lidocaine group received 1.5 mg/kg of lidocaine intravenously before induction of anesthesia, followed by continuous intravenous pumping at 2 mg/(kg-h) until 1 hour postoperatively, and the control group was given the same dose of saline. The results showed that the lidocaine group was more effective than the control group in terms of the incidence of moderate to severe postoperative CRBD, opioid requirements and improved patient satisfaction were statistically different compared to control patients.

Non-opioid analgesics, including NSAIDs, acetaminophen, calcium channel blockers (e.g., gabapentin, pregabalin), and sodium channel blockers, have been reported to reduce the occurrence of postoperative CRBD, and the mechanism may be related to the antimuscarinic and anti-inflammatory properties of non-opioid analgesics, which are widely used in clinical practice.

#### *4.2.3. Non-Narcotic Analgesics*

Nefopam has antimuscarinic and sympathomimetic activity. It is a new non-narcotic analgesic whose antimuscarinic properties may reduce the incidence of postoperative CRBD. In et al. [18] evaluated the effect of nefopam on postoperative CRBD and showed that intraoperative receipt of nefopam reduced the severity of postoperative CRBD and postoperative pain. Another group of randomized controlled trial studies showed that a single preoperative dose of intravenous nefopam reduced the incidence and severity of postoperative CRBD [19]. The clinical evidence is sparse, and substantial clinical evidence is needed to demonstrate its effectiveness.

### *4.3. Sedative Drugs*

Kim et al. [10] Sevoflurane was more effective than desflurane as a maintenance agent for general anesthesia in preventing early postoperative CRBD in TURBT patients. [20] Another study found that for patients undergoing TURBT, the incidence of CRBD at 1 hour postoperatively was lower with sevoflurane than with propofol (59% vs 85%), and the differences in CRBD at 0 and 6 hours postoperatively were 27% and 22%, respectively, with sevoflurane reducing the incidence of early postoperative CRBD and the need for tramadol in patients undergoing TURBT compared with propofol. For the use of sevoflurane, we need to consider other adverse effects, such as enhanced duration of action of inotropes, which may lead to postoperative complications such as respiratory depression.

Dexmedetomidine has sedative, analgesic, hypnotic, and anti-sympathetic effects and is often used as a perioperative agent and is a highly selective alpha2 adrenergic receptor agonist. A randomized controlled study found intraoperative dexmedetomidine to be feasible for preventing early postoperative CRBD and reducing severity in patients with TURBT, as well as reducing the need for intraoperative desflurane and postoperative opioids [21]. as demonstrated by Kwon et al. [22], that the use of dexmedetomidine in non-neurosurgical patients similarly reduces the incidence of postoperative CRBD and the use of opioids. More clinical evidence shows that dexmedetomidine is a good choice for preventing and treating CRBD [4].

It has been reported that sedative drugs that can reduce the incidence of postoperative CRBD also include ketamine. However, sedative drugs used to prevent the occurrence of postoperative CRBD may have adverse effects such as hypotension, bradycardia, and delayed awakening [23].

### *4.4. Other Types of Drugs*

Antihistamines Chlorpheniramine maleate is a classic, first-generation antihistamine commonly used to relieve histamine-induced allergy symptoms. Because it is not selective in its action, it inhibits both peripheral and central muscarinic and 5-hydroxytryptamine receptors, so it also has anticholinergic effects [24]. In a clinical study, patients undergoing elective ureteroscopic lithotomy under general anesthesia were randomly divided into two groups: the control group was given a placebo before induction of anesthesia, and the experimental group was given chlorpheniramine maleate 8 mg intravenously before induction of anesthesia, and the results showed that chlorpheniramine maleate given before induction of anesthesia had little effect on the incidence and severity of postoperative CRBD, but reduced the amount of tramadol required for postoperative control of CRBD dose [25]. However, in another randomized controlled study of patients undergoing TURBT with 100 ml of saline containing

chlorpheniramine maleate 0.1 mg/kg after induction of anesthesia, it was found that chlorpheniramine maleate significantly reduced the incidence and severity of CRBD in patients with TURBT [9]. However, chlorpheniramine maleate may cause drowsiness, dizziness, constipation, anxiety, nausea, restlessness, dry mouth, shallow breathing, memory or concentration problems, tinnitus, and difficulty in urination [24].

Local anesthetics The standard practice of catheterization requires the catheter to be coated with a lubricant, which often contains a local anesthetic. Mu et al. [26] demonstrated that applying lidocaine-procaine cream to the surface of the catheter is a safe and effective way to reduce the incidence and severity of postoperative CRBD. Lidocaine with atropine in the catheter has also been studied for treating CRBD in patients in the PACU after anesthesia, and its clinical effects were observed. [27] The results showed that using lidocaine with atropine via catheter was effective in treating CRBD in PACU patients.

Magnesium agents Magnesium ions relax smooth muscle and, therefore, may relieve catheter-related bladder discomfort caused by non-random muscle contractions. In a randomized, double-blind, placebo-controlled study, patients were randomly assigned to either the magnesium group or the control group. The magnesium group was given a loading dose of magnesium sulfate 50 mg/kg intravenously over 15 minutes and pumped continuously at 15 mg/(kg-h) intraoperatively. Patients in the control group also received saline, and the results showed that magnesium reduced the incidence of moderate and above catheter-related bladder discomfort and improved patient satisfaction in patients undergoing transurethral bladder tumor electrosurgery [28]. Clinical evidence for the clinical use of magnesium in the prevention and treatment of CRBD is scarce, and further studies are needed to confirm its effectiveness.

### *4.5. Non-Pharmacological Prevention and Treatment*

Nerve block Goger et al. [29] evaluated the effect of the dorsal penile nerve on CRBD, 80 patients were dorsally randomized into two groups, with the experimental group undergoing ultrasound-guided dorsal penile nerve block and the control group without any treatment. The results showed that penile nerve block effectively reduced postoperative urological pain, CRBD; it also reduced the need for analgesics and provided pain-free treatment for postoperative patients. It has also been reported that pubic nerve block plays a positive role in preventing the occurrence of postoperative CRBD [30].

Preoperative Education Preoperative education is provided to patients as part of standard clinical practice. In a clinical study of 60 patients with elective colorectal tumors who underwent catheterization, preoperative education was found to enhance the effect of bupivacaine plasma in reducing the incidence and severity of CRBD [31]. Preoperative education is vital in the clinical process and should be given enough attention in the standard operating procedure.

Clinical studies have also included measures such as transcutaneous electrical acupoint stimulation, intensive care, modified catheter fixation, and new catheters to reduce the incidence of postoperative CRBD.

## 5. Summary

CRBD is a common postoperative complication in clinical practice. There are more measures have been used for the prevention and treatment of postoperative CRBD based on the possible activation of muscarinic receptors and the release of inflammatory factors in CRBD. However, most of them are focused on patients undergoing TURBT, and more clinical evidence is still needed for its applicability. There is also less clinical evidence for treating CRBD, so that further studies are required. A portion of clinical studies has shown adverse effects of the drugs, and their safety needs to be further evaluated. But most of the measures taken in the studies have played a positive role in preventing and treating the occurrence of postoperative CRBD. In conclusion, clinicians should not ignore the event of postoperative CRBD, and taking active preventive measures for patients at high risk is necessary. And if patients develop CRBD after surgery, choose appropriate modalities for active treatment.

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