

Targeted Low-Dose Dexmedetomidine Infusion Improves Early Recovery After Transurethral Resection of the Prostate by Reducing Catheter-Related Bladder Discomfort: A Retrospective Propensity Score-Weighted Study

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Abstract

Background

Catheter-related bladder discomfort (CRBD) is a common and distressing complication following transurethral resection of the prostate (TURP). Dexmedetomidine has been shown to reduce CRBD; however, its effectiveness under a targeted low-dose infusion strategy in routine clinical practice remains unclear. This study aimed to evaluate the impact of dexmedetomidine on CRBD and emergence profile in patients undergoing TURP.

Methods

In this retrospective cohort study, patients undergoing TURP were categorized into control and dexmedetomidine groups. The primary outcome was CRBD incidence and severity during early postoperative recovery. Secondary outcomes included emergence agitation assessed by the Richmond Agitation–Sedation Scale (RASS) and perioperative safety outcomes. Inverse probability of treatment weighting (IPTW) was applied to adjust for baseline differences.

Results

Among 754 patients with available postoperative CRBD assessment (control, $n = 491$; dexmedetomidine, $n = 263$), perioperative low-dose dexmedetomidine significantly reduced the incidence of CRBD (65.8% vs. 73.5%; $P = 0.026$), overall CRBD severity (0.92 ± 0.79 vs. 1.12 ± 0.82 , $P = 0.001$), and moderate-to-severe CRBD (24.7% vs. 36.3%, $P = 0.001$). The overall CRBD severity distribution also shifted toward milder grades ($P = 0.010$). As a secondary outcome, dexmedetomidine reduced the incidence of emergence agitation (RASS $\geq +1$) (8.0% vs. 17.3%, $P < 0.001$), although the mean RASS score did not differ significantly between groups ($P = 0.061$). After inverse probability of treatment weighting, dexmedetomidine remained associated with lower CRBD incidence (absolute risk reduction [ARR], – 7.9%; $P = 0.027$), reduced CRBD severity (average treatment effect [ATE], – 0.20 grades; $P < 0.001$), lower moderate-to-severe CRBD (ARR, – 11.6%; $P < 0.001$), and reduced emergence agitation (ARR, – 8.1%; $P < 0.001$).

Conclusions

Targeted low-dose dexmedetomidine infusion was associated with reduced catheter-related bladder discomfort and improved emergence profile without increasing hemodynamic adverse events in patients undergoing TURP. These associations remained significant after inverse probability of treatment weighting.

Background

Transurethral resection of the prostate (TURP) remains the standard surgical treatment for benign prostatic hyperplasia. Postoperatively, the use of a large-bore urinary catheter for continuous bladder irrigation is mandatory; however, catheter-related bladder discomfort (CRBD) is a frequent and clinically significant complication, with reported incidences ranging from 47% to 90% in urological surgery [1]. CRBD manifests as urinary urgency, suprapubic discomfort, and agitation, and has been increasingly recognized as a major contributor to emergence agitation and impaired recovery. Bibliometric analyses further indicate that CRBD research has expanded rapidly in recent years, with randomized trials comprising the majority of studies and pharmacological interventions — including dexmedetomidine — representing the primary focus, yet CRBD remains incompletely controlled, highlighting the need for optimized perioperative strategies targeting the early post-anesthesia care unit (PACU) phase [2].

The pathophysiology of CRBD is primarily mediated by involuntary detrusor muscle contraction through activation of muscarinic M3 receptors triggered by catheter-related mechanical stimulation [3–5]. Various pharmacological strategies, including opioids, antimuscarinic agents, and local anesthetics, have been investigated; however, these approaches are often limited by inconsistent efficacy or dose-related adverse effects [1, 2, 6–19]. Dexmedetomidine, a selective α_2 -adrenoceptor agonist, has emerged as a promising agent for CRBD prevention due to its dual mechanisms of central sympatholysis and peripheral modulation of bladder activity [20, 21]. Multiple randomized trials and meta-analyses have demonstrated that dexmedetomidine reduces both the incidence and severity of CRBD [9, 10, 13, 16–19, 22, 23]. However, most previous studies have employed bolus dosing or relatively high infusion regimens, which may lead to bradycardia, hypotension, and delayed recovery — particularly in elderly TURP patients [10, 18].

Importantly, CRBD is not a static phenomenon but occurs predominantly during the transition from anesthesia to consciousness, when dynamic interactions between arousal, nociception, and autonomic regulation take place. Despite this, most existing studies have focused on intraoperative or single-dose administration and have not addressed the high-risk early postoperative period [9, 10, 13, 16–19, 22, 23]. Furthermore, maintaining a stable pharmacological effect across both intraoperative and immediate postoperative phases may be critical for optimal symptom control.

At our institution, a standardized protocol using targeted low-dose dexmedetomidine infusion (plasma concentration, C_p 0.1–0.2 ng/mL), initiated after induction and continued for 30 minutes in the PACU, has been implemented to provide a continuous pharmacological “bridge” across the emergence period while minimizing dose-related adverse effects. To our knowledge, this combined intraoperative and early postoperative infusion strategy has not been systematically evaluated in TURP patients.

The present study aimed to evaluate the effectiveness and safety of this targeted low-dose dexmedetomidine protocol in reducing CRBD incidence and severity and its impact on emergence quality using a retrospective propensity score-weighted analysis.

Methods

Study design and data source

This retrospective cohort study was conducted at Kaohsiung Medical University Hospital using a comprehensive electronic medical record database. The study protocol was approved by the Institutional Review Board of Kaohsiung Medical University Hospital (IRB No. KMUHIRB-E(I)-20260241). The requirement for written informed consent was waived because of the retrospective observational design and use of anonymized clinical data. The study was performed in accordance with the Declaration of Helsinki and its later amendments. Data were extracted for male patients who underwent elective TURP requiring postoperative urinary catheterization between March 1, 2024, and October 31, 2026.

Anesthesia management and intraoperative care

All patients received standard anesthesia monitoring. General anesthesia was maintained using either total intravenous anesthesia (TIVA) or volatile anesthesia (VA) to maintain BIS between 40 and 60. Airway management was performed via laryngeal mask airway (LMA) insertion following induction to minimize airway irritation.

Targeted low-dose dexmedetomidine protocol

Patients in the Dexmedetomidine group received the drug as part of institutional standardized care. Following induction, dexmedetomidine was administered via target-controlled infusion (TCI) based on the Dyck model. The target C_p was strictly maintained between 0.1 and 0.2 ng/mL, with titration based on the patient's real-time heart rate and blood pressure. As per routine practice, the infusion was continued for 30 minutes in the PACU. Patients in the control group received standard care without dexmedetomidine.

Outcome assessment and rescue therapy

Postoperative recovery variables were assessed in the PACU by trained nursing staff according to standardized institutional protocols. The Aldrete score was recorded on arrival at the PACU to reflect immediate recovery status. CRBD was assessed at predefined time points during the first postoperative hour and classified as none, mild, moderate, or severe based on clinical symptoms. To capture clinically relevant symptom burden, the highest (worst) CRBD severity recorded within the first postoperative hour was used for analysis. Pain intensity was evaluated using the numeric rating scale (NRS, 0–10), and the highest NRS score within the first postoperative hour was used for analysis. To ensure temporal alignment between sedation and discomfort, the corresponding Richmond Agitation–Sedation Scale (RASS) score recorded at the same time point as the peak CRBD severity was used for analysis. Rescue tramadol was administered to patients with severe CRBD according to institutional practice.

Statistical analysis and propensity score weighting

Statistical analyses were performed using SPSS version 26.0 and R version 4.2.1. Continuous variables are presented as mean $\pm$ standard deviation and were compared using Student's *t*-test. Categorical variables are presented as counts and percentages and were compared using the chi-square test or Fisher's exact test, as appropriate. All tests were two-sided, and a *P* value < 0.05 was considered statistically significant.

To reduce confounding related to the nonrandomized administration of perioperative dexmedetomidine, propensity score-based inverse probability of treatment weighting (IPTW) was used to estimate the average treatment effect in the study population. Propensity scores were estimated using multivariable logistic regression, with dexmedetomidine exposure as the dependent variable. Prespecified baseline covariates included age, body mass index, ASA physical status (III–IV vs. I–II), operating-room duration, anesthetic technique, and surgical procedure category. Missing values for continuous covariates were imputed using the cohort median, with corresponding missingness indicators included in the propensity score model.

Stabilized inverse probability weights were calculated and truncated at the 1st and 99th percentiles to limit the influence of extreme weights. Covariate balance before and after weighting was assessed using standardized mean differences, with an absolute standardized mean difference < 0.10 considered indicative of adequate balance.

IPTW-adjusted treatment effects were expressed as absolute risk differences for binary outcomes, including CRBD incidence, moderate-to-severe CRBD, and emergence agitation, and as the average treatment effect for CRBD severity measured on the ordinal grading scale. Robust sandwich standard errors were used to derive 95% confidence intervals and two-sided *P* values.

Results

Study population and baseline characteristics

A total of 770 patients undergoing TURP were screened for eligibility. After excluding 16 patients with incomplete outcome data, 754 patients were included in the final analysis, comprising 491 patients in the control group and 263 patients in the dexmedetomidine group (Figure 1). Baseline characteristics were comparable between groups (Table 1). There were no significant differences in age, height, body weight, ASA physical status, surgical time, anesthesia time or PACU stay time. The incidence of bradycardia and hypotension was numerically higher in the dexmedetomidine group but did not reach statistical significance.

Primary outcomes: catheter-related bladder discomfort

Perioperative low-dose dexmedetomidine was associated with significant improvements in postoperative CRBD during the first postoperative hour (Figure 2). The incidence of CRBD was

significantly lower in the dexmedetomidine group than in the control group (65.8% vs. 73.5%, $P = 0.026$; Figure 2A). In addition, patients receiving dexmedetomidine experienced lower overall CRBD severity, with a reduced mean severity score (0.92 ± 0.79 vs. 1.12 ± 0.82 , $P = 0.001$; Figure 2B).

The incidence of moderate-to-severe CRBD (severity grade ≥ 2) was also significantly reduced in the dexmedetomidine group compared with the control group (24.7% vs. 36.3%, $P = 0.001$; Figure 2C). Analysis of the overall severity distribution demonstrated a significant shift toward milder CRBD in patients receiving dexmedetomidine ($P = 0.010$; Figure 2D), with a greater proportion of patients reporting no discomfort or only mild symptoms and fewer experiencing moderate or severe CRBD.

Secondary outcome: emergence profile and RASS

The overall distribution of RASS categories differed significantly between the two groups during the first postoperative hour ($P < 0.001$; Table 2). Patients receiving dexmedetomidine were less likely to experience emergence agitation (RASS $\geq +1$) than those in the control group (8.0% vs. 17.3%) and were more frequently calm (RASS = 0; 70.3% vs. 56.8%). The proportions of patients with light sedation (RASS = -1) and deep sedation (RASS ≤ -2) were comparable between groups. Although the mean RASS score was numerically lower in the dexmedetomidine group (-0.29 ± 1.06 vs. -0.13 ± 1.23), the between-group difference did not reach statistical significance (mean difference, -0.16 ; 95% CI, -0.33 to 0.01 ; $P = 0.061$).

IPTW-adjusted analysis

After inverse probability of treatment weighting (IPTW), baseline covariates were well balanced between the treatment groups, with all standardized mean differences below 0.10, indicating adequate covariate balance.

The IPTW-adjusted analysis demonstrated that perioperative low-dose dexmedetomidine remained significantly associated with improved postoperative outcomes (Table 3). Compared with the weighted control group, patients receiving dexmedetomidine had a lower incidence of CRBD (65.5% vs. 73.4%), corresponding to an absolute risk reduction (ARR) of **7.9%** (95% CI, -14.8% to -0.9% ; $P = 0.027$). Dexmedetomidine was also associated with a significant reduction in overall CRBD severity, with an average treatment effect (ATE) of **-0.20 grades** (95% CI, -0.32 to -0.08 ; $P < 0.001$). Furthermore, the incidence of moderate-to-severe CRBD was reduced by **11.6%** after weighting (95% CI, -18.4% to -4.9% ; $P < 0.001$). In addition, dexmedetomidine significantly decreased the incidence of emergence agitation, with an ARR of **8.1%** (95% CI, -12.9% to -3.4% ; $P < 0.001$).

Overall, IPTW analysis confirmed that the beneficial effects of perioperative low-dose dexmedetomidine on CRBD and emergence agitation were robust after adjustment for measured baseline confounders.

Discussion

These findings suggest that the beneficial effects of dexmedetomidine extend beyond simple sedation and may reflect both modulation of bladder afferent signaling and attenuation of sympathetic activation during emergence.

The dexmedetomidine regimen used in this study differs substantially from those employed in most previous randomized trials, which typically involved a loading dose of 0.5–1.0 µg/kg followed by maintenance infusions of 0.2–0.7 µg/kg/h [9, 18, 19]. While such regimens have consistently demonstrated efficacy in reducing CRBD and emergence agitation, they are also associated with dose-dependent adverse effects, including bradycardia, hypotension, and delayed recovery, which are particularly relevant in elderly TURP populations [9, 18, 19]. In contrast, our protocol utilized a target-controlled infusion approach with a low plasma concentration (Cp 0.1–0.2 ng/mL) without a loading dose, aiming to maintain stable drug exposure during the critical emergence phase. Despite this markedly lower dosing, clinically meaningful reductions in CRBD were achieved without an increase in hemodynamic complications, supporting the feasibility of a precision dosing strategy.

These findings may suggest a dose-dependent dissociation in the pharmacodynamic effects of dexmedetomidine. Lower concentrations appear sufficient to attenuate bladder afferent signaling and visceral discomfort, whereas higher concentrations may be required to exert a more pronounced central sedative effect capable of suppressing cortical arousal and emergence agitation. This interpretation is supported by the IPTW-adjusted results, in which CRBD reduction persisted while the effect on agitation did not: if the benefit were primarily driven by sedation, a parallel and sustained reduction in emergence agitation would be expected. The absence of such an effect strengthens the hypothesis that dexmedetomidine exerts a specific modulatory effect on bladder-related pathways rather than nonspecific central depression.

Mechanistically, an indwelling Foley catheter stimulates bladder afferent nerves, leading to increased acetylcholine release and activation of muscarinic receptors — particularly the M3 subtype — which mediates involuntary detrusor muscle contraction and contributes to CRBD [24]. Experimental studies have demonstrated that dexmedetomidine can inhibit M3 receptor-mediated responses and suppress afferent neural transmission from the bladder [3–5, 20], providing a plausible biological basis for the observed clinical effects. This dual mechanism — central sympatholysis and peripheral modulation of bladder activity — may explain why dexmedetomidine consistently reduces CRBD across different surgical settings [9, 10, 13, 16–19, 22, 23], and independently of its sedative effects.

From a broader clinical perspective, the present study highlights the importance of temporal targeting in addition to dose optimization. CRBD is most prominent during the transition from anesthesia to consciousness, a period characterized by dynamic interactions between arousal, nociception, and autonomic activation. Most previous studies have focused on intraoperative administration or single bolus dosing without specifically addressing this high-risk recovery window [8, 9, 16, 18, 19, 22]. By extending dexmedetomidine infusion into the early PACU period, our protocol provides a pharmacological “bridging effect,” stabilizing this transition and improving symptom control during the

most vulnerable phase of recovery. To our knowledge, this intraoperative-to-PACU continuous low-dose strategy has not been systematically evaluated in TURP patients and represents a novel perioperative approach.

These findings are consistent with prior meta-analyses demonstrating that dexmedetomidine significantly reduces both the incidence and severity of CRBD and is among the most effective pharmacologic options when balancing efficacy and safety [6–19, 22]. Other pharmacologic interventions — including antimuscarinic agents, gabapentin, tolterodine, oxybutynin, pregabalin, nefopam, lidocaine, ketamine, peripheral nerve block, and tramadol — have also demonstrated benefit but are often limited by variable efficacy or side-effect profiles [9–11, 14, 16, 18]. Notably, network meta-analyses suggest that dexmedetomidine and gabapentin rank among the top interventions for CRBD prevention [8, 11], and specific-dose studies indicate that both bolus (0.5–1 µg/kg) and continuous intraoperative infusion strategies reduce early postoperative CRBD with acceptable adverse effects [9, 16, 18, 19, 22], further supporting dexmedetomidine's clinical utility across dosing approaches.

Importantly, the current study extends this body of evidence by demonstrating that effective CRBD reduction can be achieved with substantially lower drug exposure when administration is temporally optimized. This shift from “dose intensity” to “timing precision” may be particularly relevant in ERAS-oriented perioperative care, where minimizing adverse effects while maintaining efficacy is a central goal. This low-dose strategy may offer a favorable balance between efficacy and safety, particularly in elderly patients undergoing TURP, who are more susceptible to dexmedetomidine-related hemodynamic instability; avoiding loading doses while maintaining a stable low plasma concentration appears to minimize cardiovascular adverse effects without compromising clinical benefit.

Several limitations should be acknowledged. First, the retrospective design introduces the possibility of residual confounding despite the use of IPTW adjustment. Second, outcome assessment was based on available-case data, which may introduce selection bias. Third, although the dosing strategy reflects real-world practice and enhances external validity, variability in drug titration may affect reproducibility. Finally, the generalizability of these findings to other surgical populations or anesthesia techniques requires further prospective validation.

In conclusion, a targeted low-dose dexmedetomidine infusion strategy extending from intraoperative care into the early postoperative period was associated with a lower incidence and reduced severity of catheter-related bladder discomfort in patients undergoing transurethral resection of the prostate, without increasing hemodynamic adverse events. These associations remained significant after inverse probability of treatment weighting, supporting the feasibility of a precision, low-dose dexmedetomidine strategy to improve early postoperative recovery.

Abbreviations

- ARR
absolute risk reduction

- ATE
average treatment effect
- BIS
Bispectral index
- CI
confidence interval
- Cp
plasma concentration
- CRBD
catheter-related bladder discomfort
- IPTW
inverse probability of treatment weighting
- LMA
laryngeal mask airway
- NRS
numeric rating scale
- PACU
post-anesthesia care unit
- RASS
Richmond Agitation–Sedation Scale
- TCI
target-controlled infusion
- TIVA
total intravenous anesthesia
- TURP
transurethral resection of the prostate
- VA
volatile anesthesia

Declarations

Ethics approval and consent to participate

This retrospective cohort study was approved by the Institutional Review Board of Kaohsiung Medical University Hospital (IRB No. KMHIRB-E(I)-20260241). The requirement for written informed consent was waived because of the retrospective observational design and the use of anonymized clinical data. The study was conducted in accordance with the Declaration of Helsinki and its later amendments.

Consent for publication

Not applicable.

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Author Contribution

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Not applicable.

Availability of data and materials

The datasets generated and/or analyzed during the current study are not publicly available because they contain patient-level clinical data but are available from the corresponding author on reasonable request and with permission from Kaohsiung Medical University Hospital.

Competing interests

The authors declare that they have no competing interests.

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Tables

Table 1. Demographics, Baseline Characteristics, and Safety Profiles

Characteristic	Control group (n = 491)	Dexmedetomidine group (n = 263)	P value
Age (years), mean ± SD	72.2 ± 8.0	71.6 ± 8.4	0.34
Height (cm), mean ± SD	164.6 ± 14.3	165.5 ± 9.4	0.42
Weight (kg), mean ± SD	67.1 ± 11.5	68.6 ± 12.2	0.21
ASA physical status, n (%)	0.38		
ASA II	192 (38.9%)	113 (42.2%)	
ASA III	302 (61.1%)	155 (57.8%)	
ASA IV	5 (1.0%)	0 (0.0%)	
Surgical time (min), mean ± SD	102.4 ± 48.4	100.6 ± 47.5	0.65
Anesthesia time (min), mean ± SD	126.7 ± 52.7	121.7 ± 50.0	0.28
Bradycardia, n (%)	10 (2.0%)	10 (3.8%)	0.16
Hypotension, n (%)	18 (3.7%)	14 (5.3%)	0.34
PACU stay time (min), mean ± SD	58.7± 16.9	57.4 ± 16.0	0.321

Data are presented as mean $\pm$ standard deviation (SD) or number (percentage), as appropriate. ASA = American Society of Anesthesiologists; PACU = post-anesthesia care unit. Bradycardia was defined as heart rate < 60 beats per minute. Hypotension was defined as systolic blood pressure < 90 mmHg. P-values were calculated using the independent t-test for continuous variables and the chi-square test or Fisher's exact test for categorical variables, as appropriate. All tests were two-sided, and a P-value < 0.05 was considered statistically significant.

Table 2. Richmond Agitation–Sedation Scale (RASS) Scores During the First Postoperative Hour in the Post-Anesthesia Care Unit

RASS outcome	Control (n = 491)	Dexmedetomidine (n = 263)	<i>P</i> value
Mean RASS $\pm$ SD	-0.13 $\pm$ 1.23	-0.29 $\pm$ 1.06	0.061
Mean difference (Dexmedetomidine – Control)	-0.16 (95% CI, -0.33 to 0.01)		
RASS category, n (%)	<0.001		
Agitated ($\geq +1$)	85 (17.3%)	21 (8.0%)	
Calm (0)	279 (56.8%)	185 (70.3%)	
Light sedation (-1)	72 (14.7%)	25 (9.5%)	
Deep sedation (≤ -2)	55 (11.2%)	32 (12.2%)	

Values are presented as mean $\pm$ standard deviation (SD) or number (%), as appropriate. Mean RASS scores were compared using Student's *t*-test. The overall distribution of RASS categories was compared using the chi-square test. Agitation was defined as a Richmond Agitation–Sedation Scale (RASS) score $\geq +1$. RASS values represent the assessment recorded at the time corresponding to the highest catheter-

related bladder discomfort (CRBD) severity during the first postoperative hour in the post-anesthesia care unit (PACU).

Table 3. IPTW-Adjusted Treatment Effects of Perioperative Low-Dose Dexmedetomidine on Postoperative Catheter-Related Bladder Discomfort and Emergence Agitation

Outcome	Weighted control	Weighted dexmedetomidine	Effect estimate	95% CI	P value
CRBD incidence	73.4%	65.5%	ARR -7.9%	-14.8 to -0.9%	0.027
CRBD severity	1.12	0.91	ATE -0.20 grades	-0.32 to -0.08	<0.001
Moderate-to-severe CRBD	35.9%	24.3%	ARR -11.6%	-18.4 to -4.9%	<0.001
Emergence agitation	16.6%	8.5%	ARR -8.1%	-12.9 to -3.4%	<0.001

Values are IPTW-weighted estimates unless otherwise indicated. Propensity scores were estimated using multivariable logistic regression including age, body mass index, ASA physical status, operating-room duration, anesthetic technique, and surgical procedure category. Stabilized inverse probability of treatment weights were applied and truncated at the 1st and 99th percentiles. Binary outcomes are presented as absolute risk reduction (ARR), whereas CRBD severity is expressed as the average treatment effect (ATE). Confidence intervals and *P* values were calculated using robust sandwich standard errors.

Abbreviations: IPTW, inverse probability of treatment weighting; ARR, absolute risk reduction; ATE, average treatment effect; CI, confidence interval; CRBD, catheter-related bladder discomfort.

Figures

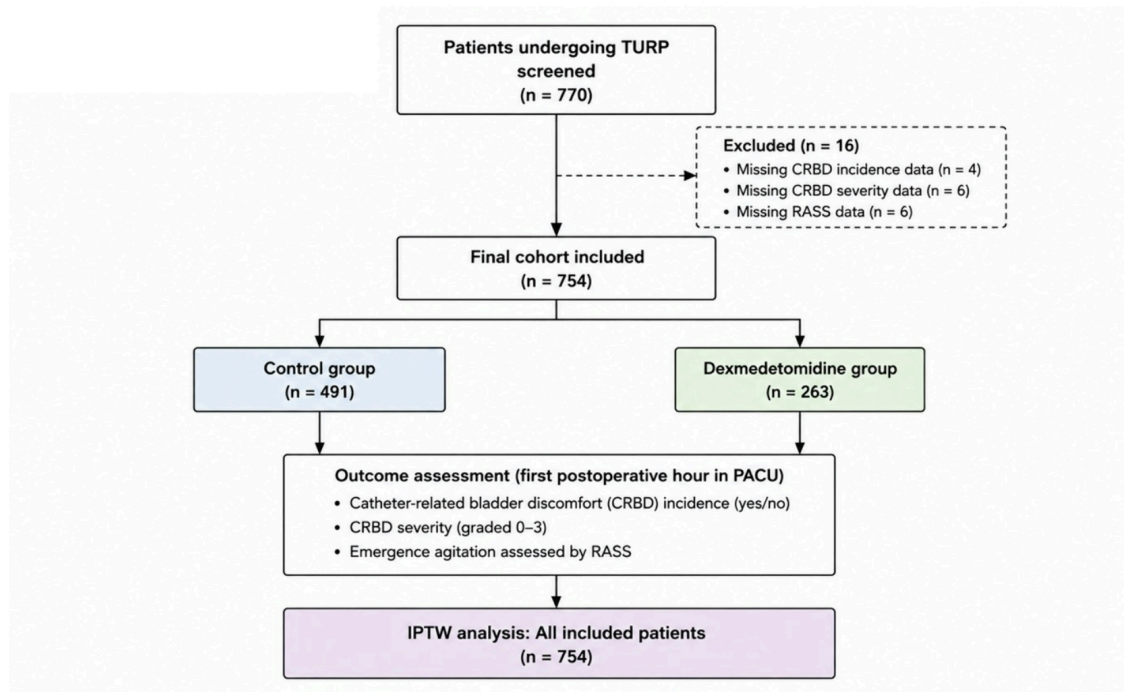


Figure 1

Flow diagram of patient selection and outcome assessment.

A total of 770 patients undergoing transurethral resection of the prostate (TURP) were screened for eligibility. Sixteen patients were excluded because of missing outcome data, including missing CRBD incidence (n = 4), CRBD severity (n = 6), or Richmond Agitation–Sedation Scale (RASS) data (n = 6). The final cohort comprised 754 patients, including 491 in the control group and 263 in the dexmedetomidine group. Postoperative outcomes were assessed during the first postoperative hour in the post-anesthesia care unit (PACU), including catheter-related bladder discomfort (CRBD) incidence, CRBD severity, and emergence agitation assessed using the RASS. All included patients underwent inverse probability of treatment weighting (IPTW) analysis.

Abbreviations: CRBD, catheter-related bladder discomfort; IPTW, inverse probability of treatment weighting; PACU, post-anesthesia care unit; RASS, Richmond Agitation–Sedation Scale; TURP, transurethral resection of the prostate.

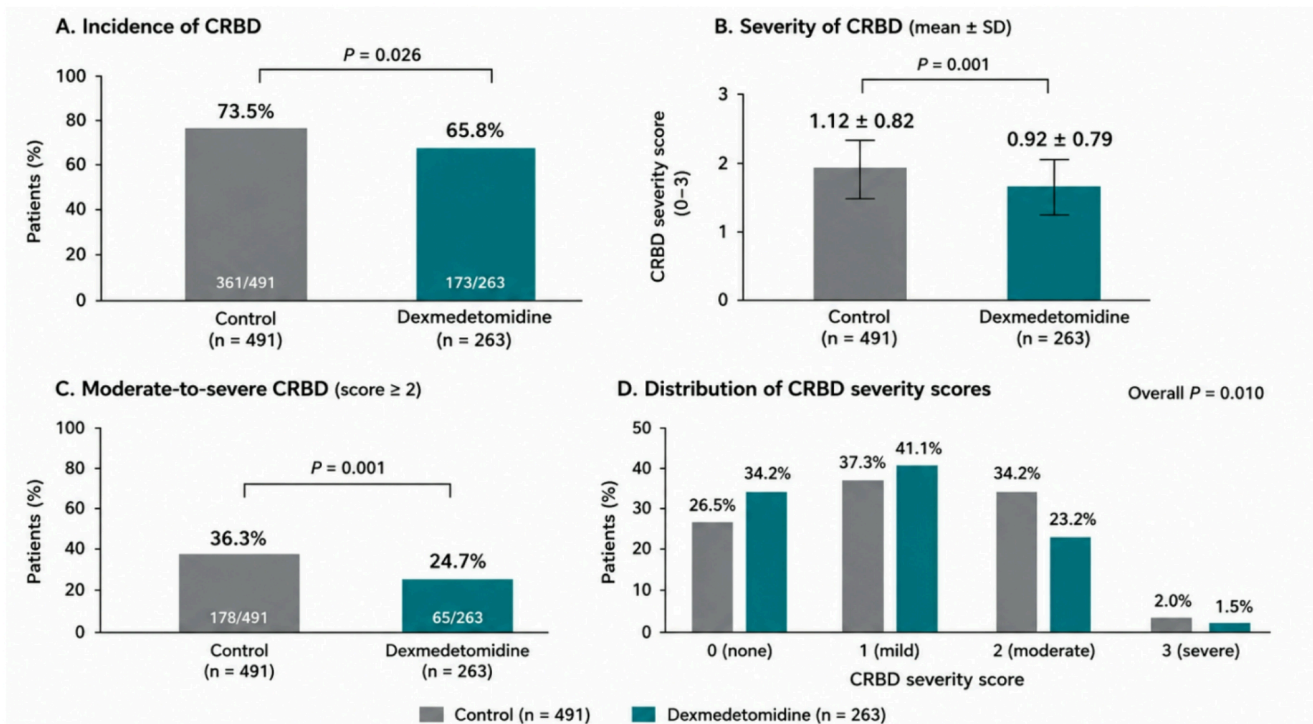


Figure 2

Effect of perioperative low-dose dexmedetomidine on catheter-related bladder discomfort (CRBD) during the first postoperative hour.

- (A)** Incidence of CRBD in the control and dexmedetomidine groups. Dexmedetomidine significantly reduced the overall incidence of CRBD (73.5% vs. 65.8%, $P = 0.026$).
- (B)** Mean CRBD severity score (0–3 scale). Patients receiving dexmedetomidine had significantly lower CRBD severity than controls (0.92 ± 0.79 vs. 1.12 ± 0.82 , $P = 0.001$).
- (C)** Incidence of moderate-to-severe CRBD (severity grade ≥ 2). Dexmedetomidine significantly decreased the proportion of patients experiencing clinically significant CRBD (24.7% vs. 36.3%, $P = 0.001$).
- (D)** Distribution of CRBD severity grades (0 = none, 1 = mild, 2 = moderate, 3 = severe). Overall CRBD severity distribution differed significantly between groups (chi-square test, $P = 0.010$).

Abbreviations: CRBD, catheter-related bladder discomfort.