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ORIGINAL ARTICLE

Intraoperative administration of dexmedetomidine reduced the postoperative catheter-related bladder discomfort and pain in patients undergoing lumbar microdiscectomy

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Abstract
Purpose We aimed to evaluate the effect of the intraoperative dexmedetomidine (DEX) on the incidence and severity of catheter-related bladder discomfort (CRBD) after non-urologic surgery. The secondary aim was to find the correlation between the levels of CRBD and postoperative pain sensation.
Methods Adult male patients undergoing lumbar microdiscectomy were enrolled. Patients were randomized into two groups. After propofol administration, group D ($n = 35$) received DEX at a loading dose of 1 μg/kg over 10 min, followed by a continuous infusion of 0.3–0.5 μg/kg/h until the end of surgery. In group C ($n = 35$), an identical volume of 0.9% saline was infused in the same manner. Induction and maintenance of anesthesia were standardized. The incidence and severity of CRBD, postoperative pain, and adverse effects were assessed at 1, 3, and 6 h after surgery.
Results The incidence of CRBD was significantly lower in group D than in group C at 1 h (34.3 vs. 62.9%, $P = 0.017$), 3 h (25.7 vs. 60%, $P = 0.004$), and 6 h (17.1 vs. 54.3%. $P = 0.001$) postoperatively. The severity of CRBD at 1, 3, and 6 h postoperatively was less in group D than in group C. Postoperative pain score was significantly lower in group D than in group C at 3 and 6 h postoperatively. Adverse events were comparable between two groups. There was a significant correlation between the severity of CRBD and postoperative pain score.
Conclusions Intraoperative administration of DEX is a safe and effective practice for the prevention of CRBD after lumbar microdiscectomy and can reduce postoperative pain.

Keywords Dexmedetomidine · Catheter-related bladder discomfort · Postoperative pain

Introduction

Postoperative satisfaction is affected by various factors. Catheter-related bladder discomfort (CRBD) is one possible problem during the postoperative period and is experienced by 47–90% of patients in the post-anesthesia care unit [1]. Characteristics of CRBD include an urge to void or discomfort in the suprapubic area caused by stimulation of muscarinic receptors (particularly subtype M3) located in the bladder wall near the catheter [2]. Severe CRBD is associated with behavioral responses such as a strong vocal response, flailing extremities, and an attempt to pull out the urinary catheter [1]. Because CRBD can cause exacerbated postoperative pain and reduced patient satisfaction, early management is required [1, 3]. Although muscarinic antagonists are recommended for treatment [4, 5], they cause side effects and do not have analgesic effects. On the other hand, anesthetics, antiepileptics, and paracetamol can prevent CRBD [1].

Microdiscectomy, which is non-invasive and decreases postoperative pain, is a common surgery for lumbar disc herniation, necessitating intraoperative urinary catheterization. However, the primary concern of patients undergoing microdiscectomy back pain is CRBD, which can unexpectedly occur after surgery. Postoperative CRBD causes distress to patients and can decrease postoperative satisfaction [1].

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Dexmedetomidine (DEX), a selective α2-adrenoreceptor agonist, is a useful anesthetic adjuvant for general anesthesia with analgesic, sympatholytic, and sedative properties. In addition, it inhibits muscarinic type 3 receptors, which are associated with the pathophysiology of CRBD [6]. Many studies on CRBD have been performed during urologic surgery.

In this prospective study, we evaluated the effects of intraoperative DEX administration on the incidence and severity of CRBD after lumbar microdiscectomy. We also examined the postoperative pain and the correlation between CRBD and postoperative pain sensation.

Materials and methods

Study design and patient selection

This study was approved by the Institutional Review Board and written informed consent was obtained from male patients (20–65 years) with American Society of Anesthesiologists physical status I and II undergoing elective microdiscectomy for lumbar herniated nucleus pulposus. Patients with a history of bladder outflow obstruction, transurethral resection of the prostate, overactive bladder, end-stage renal disease, chronic pain, cerebrovascular disease, cardiovascular disease, and psychiatric disease were excluded. The protocol of this study was registered at cris.nih.go.kr (KCT 0002369). Patients were randomly allocated to one of two groups by a computer-generated random number table. This assignment was concealed in an envelope and opened before the patient entered the operation room by a nurse who was blinded to the study and was responsible for preparing the study drug and placebo.

Anesthesia and hemodynamic management

No premedication was given. After arrival in the operating room, standard monitoring with electrocardiography, pulse oximetry, noninvasive blood pressure, and bispectral index (BIS) was performed. After propofol administration (2 mg/kg), group D received DEX at a loading dose of 1 μg/kg over 10 min, followed by a continuous infusion of 0.3–0.5 μg/kg/h before wound closing. In group C, an identical volume of 0.9% saline was infused in the same manner. Tracheal intubation was facilitated by rocuronium (0.8 mg/kg). Ventilation was mechanically controlled to maintain the end tidal carbon dioxide tension at 35–40 mmHg. Anesthesia was maintained using 50% oxygen in air mixture and desflurane. Opioids were not used during anesthesia. After anesthesia induction, urinary catheterization was performed using a 16-Fr Foley catheter, and the balloon was inflated with 10 ml distilled water and fixed to the leg without traction using adhesive tape. The inhalational desflurane concentration was controlled to maintain systolic blood pressure within ± 20% of the pre-anesthetic value and bispectral index (BIS) values at 40–60. Intraoperative hypotension was defined as a decrease in systolic blood pressure by more than 20% of the pre-anesthetic value or below 90 mmHg. Bradycardia was defined as a decrease in heart rate below 50 beats per minute. Hypotension was treated with phenylephrine, ephedrine, and intravenous fluid loading (4 ml/kg). Bradycardia was treated using intravenous atropine 0.5 mg. For postoperative pain control, before closing the operation site, triamcinolon acetonide 40 mg, morphine HCl 10 mg, and 0.5% bupivacaine 100 mg were injected in the epidural space and muscle layer by surgeon and DEX administration was stopped at this time. At the end of surgery, anesthesia was discontinued and the muscle relaxant was reversed. After achieving adequate awakening, patients were extubated and transported to the post-anesthesia care unit. The Foley catheter was removed 12 h postoperatively.

Measurement of incidence and severity of CRBD, postoperative pain at rest and side effects

Independent anesthesiologists blinded to the group allocation checked the incidence of and severity of CRBD, postoperative wound pain, level of sedation, side effects including postoperative nausea and vomiting (PONV), dry mouth, hypotension, and bradycardia at 1, 3, and 6 h after the operation. The incidence and severity of CRBD were evaluated by using a numerical rating scale (NRS) ranging from 0 (no discomfort) to 100 (most severe discomfort). CRBD was defined as an NRS score ≥ 30. When the NRS score of CRBD was ≥ 40, tramadol 50 mg was administered as a rescue drug. The severity of CRBD was also assessed using a three-point scoring system, as follows: 1 = comfortable, 2 = uncomfortable but bearable, and 3 = severely uncomfortable.

Postoperative wound pain at rest was assessed using NRS ranging from 0 (no discomfort) to 100 (most severe discomfort). The rescue analgesic (pethidine 25 μg) was administered when the NRS score of postoperative pain was ≥ 40. The level of sedation was evaluated based on the Ramsay sedation scale (1: anxious, agitated, or restless; 2: co-operative, oriented, and tranquil; 3: responds to commands but is asleep; 4: brisk response to glabellar tap or loud noise; 5: a sluggish response to light glabellar tap or loud noise; 6: no response).

Statistical analysis

The calculation of sample size was based on previous study results [7]. Assuming that DEX administration decreases the NRS score of CRBD by 20, power analysis

with $\alpha = 0.05$ and $1 - \beta = 0.9$ showed 34 patients were needed in each group. Dropout rates were set to 10%, and a total of 76 subjects were studied. Statistical analyses were performed using SPSS version 19.0 (SPSS Inc., Chicago, IL, USA). Numerical variables (age, weight, height, duration of operation, duration of anesthesia) were analyzed using Student's *t* test. The incidence and grade of CRBD, PONV, dry mouth, bradycardia, hypotension, sedation levels, and the number of patients administered pethidine and tramadol were compared using the Chi-squared test or Fisher's exact test (cell size ≤ 5). The postoperative pain score was compared using the *t* test. *P* values less than 0.05 were considered statistically significant. The correlation between severity of CRBD and postoperative pain score was analyzed without distinction between the two groups based on Spearman's rho correlation coefficient test.

Results

A total of 76 patients were enrolled; six patients were excluded, and the remaining 70 patients were for analysis (Fig. 1). Demographic features of the analyzed patients are provided in Table 1. The incidence of CRBD was significantly lower in group D than in group C at 1, 3, and 6 h postoperatively. The NRS score of CRBD was significantly high in group C at all time points. The grade of CRBD at 1, 3, and 6 h postoperatively was less in group D than in group C ($P = 0.004$, $P = 0.002$, and $P = 0.001$, respectively). The

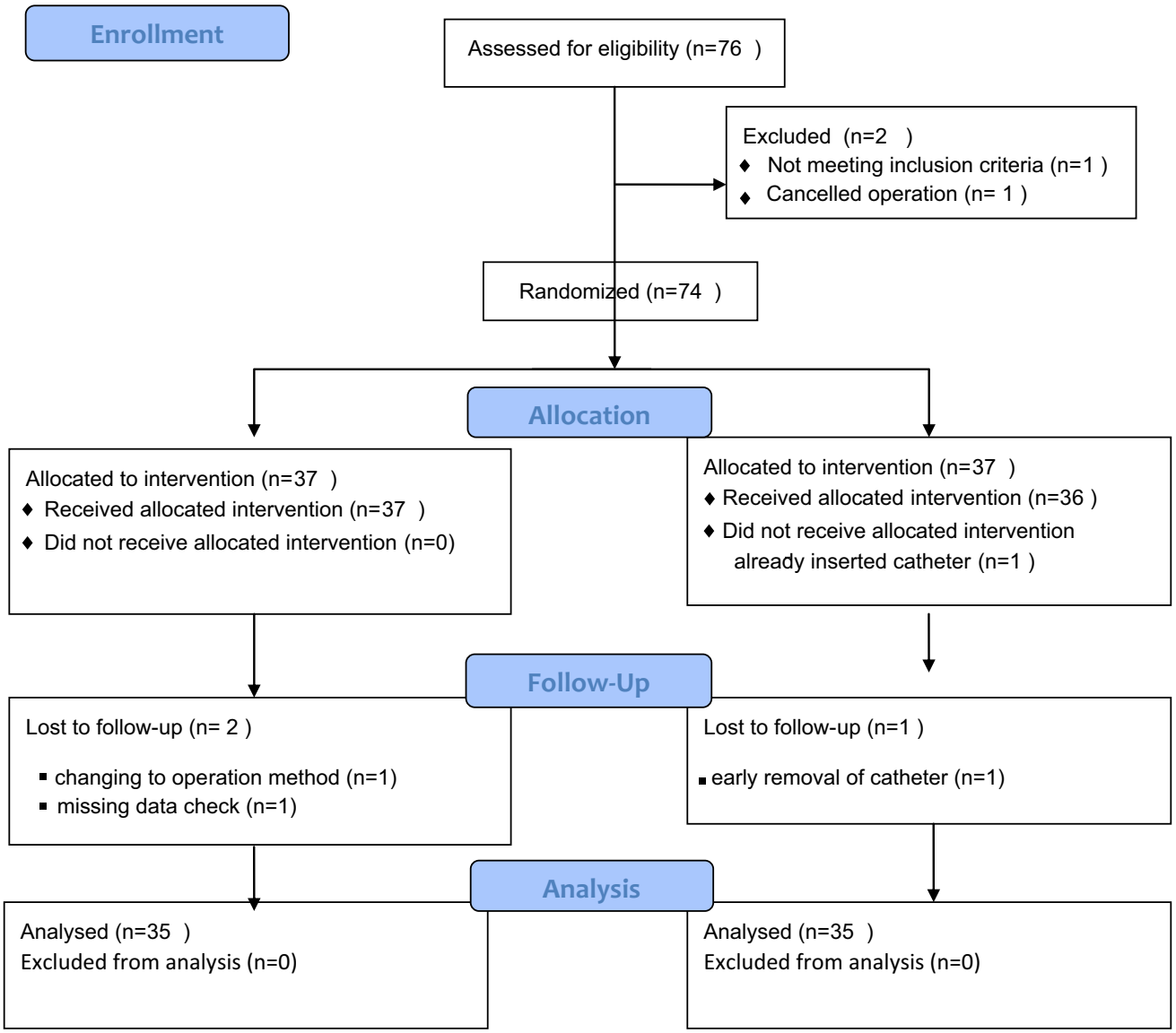

Fig. 1 Flow chart of patients analyzed

Table 1 Demographic data

	Group C ($n = 35$)	Group D ($n = 35$)
Age (year)	51.3 ± 12.3	49.0 ± 12.6
Height (cm)	171.6 ± 4.9	169.9 ± 5.5
Weight (kg)	74.2 ± 8.1	72.6 ± 7.8
Duration of operation (min)	103.2 ± 20.4	100.8 ± 20.7
Duration of anesthesia (min)	129.2 ± 17.7	128 ± 21.6

Values are expresses as mean ± SD

use of tramadol was significantly higher in group C than in group D (Table 2).

The postoperative pain score was significantly lower in group D than in group C at 3 and 6 h postoperatively (Table 3). The use of pethidine was higher in group C but not significant (Table 3). However, there were significant correlations between the NRS scores of CRBD and postoperative pain scores at 1, 3, and 6 h ($r = 0.718$, 0.738, and 0.622, respectively) (Fig. 2). Table 4 shows the incidence of adverse effects. There were no significant differences between the two groups. The two groups showed similar sedation scores over time. There was no desaturation (oxygen saturation < 90%) or deep sedation (Ramsay sedation scale ≥ 4) (Table 5).

Discussion

The incidence of CRBD after urological surgery has been reported according to methods of premedication, anesthetic agent, reverse agent of the muscle relaxant, and adjuvant drug use [1, 8–10]. Independent predictors of CRBD include male sex, use of a Foley catheter greater than 18 Fr, and urologic surgery [1, 11]. In a previous study after spine surgery, the incidence of CRBD was reported to be 70% [12].

Although muscarinic receptor antagonists are recommended as a treatment [4, 5, 13], they have adverse effects including dry mouth, nausea, vomiting, and sedation, and do not have analgesic effects. In addition, anesthetics,

Table 2 Incidence and severity of postoperative catheter-related bladder discomfort and the use of rescue analgesics

Time	1 h		3 h		6 h	
	Group C ($n = 35$)	Group D ($n = 35$)	Group C ($n = 35$)	Group D ($n = 35$)	Group C ($n = 35$)	Group D ($n = 35$)
Incidence	22 (62.9%)	12 (34.3%)*	21 (60%)	9 (25.7%)*	19 (54.3%)	6 (17.1%)*
P value	0.017		0.004		0.001	
NRS score	36.2 (19.8)	22.8 (21.2)	31.7 (19.8)	16.8 (16.9)	26.5 (14.5)	12.0 (12.0)
P value	0.008		0.001		0.0001	
Grade						
1	9 (25.7%)	21 (60%)	10 (28.6%)	24 (68.6%)	12 (34.3%)	26 (74.3%)
2	20 (57.1%)	12 (34.3%)	23 (65.7%)	10 (28.6%)	22 (62.9%)	9 (25.7%)
3	6 (17.1%)	2 (5.7%)	2 (5.7%)	1 (2.9%)	1 (2.9%)	0
P value	0.004		0.002		0.001	
Tramadol	19 (54.3%)	8 (22.9%)	17 (48.6%)	7 (20%)	11 (31.4%)	1 (2.9%)
P value	0.007		0.012		0.002	

Values are expresses as number of patients (%) or mean (standard deviation)

Time means postoperative time

* $P < 0.05$ vs. group C

Table 3 Postoperative pain score and the use of rescue analgesics

Time	1 h		3 h		6 h	
	Group C ($n = 35$)	Group D ($n = 35$)	Group C ($n = 35$)	Group D ($n = 35$)	Group C ($n = 35$)	Group D ($n = 35$)
Pain score	40.8 (16.3)	34.6 (18.8)	36 (15.7)	27 (17.1)	31.7 (12.9)	20.8 (12.4)
P value	0.159		0.025		0.001	
Pethidine	20 (57.1%)	14 (40%)	15 (42.9%)	8 (22.9%)	13 (37.1%)	5 (14.3%)
P value	0.151		0.075		0.029	

Values are expresses as mean (standard deviation) or number of patients (%)

Time means postoperative time

* $P < 0.05$ vs. group C

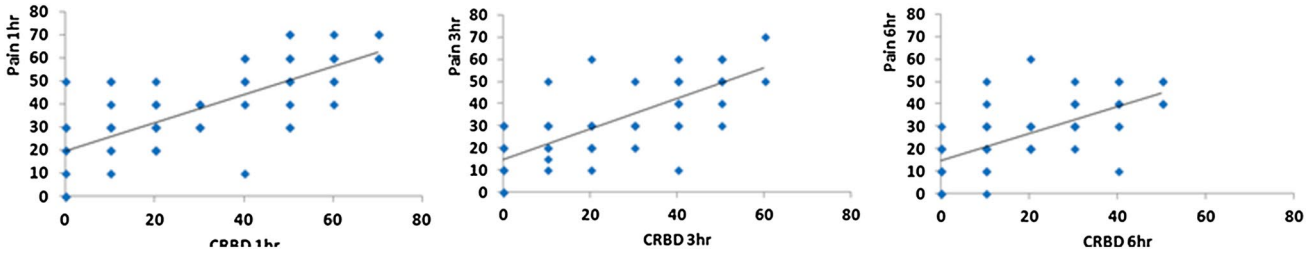

Fig. 2 Correlation of catheter-related bladder discomfort and postoperative pain. The figure shows a significant correlation between the NRS score of CRBD and postoperative pain score ($r = 0.718$, 0.738, and 0.622, respectively). CRBD 1, 3, 6 h means the NRS score of the CRBD after 1, 3, 6 h postoperatively. Pain 1, 3, 6 h means the NRS score of the postoperative pain after 1, 3, 6 h postoperatively

Table 4 Incidence of adverse effects

	Group C ($n = 35$)	Group D ($n = 35$)	*P* value
Intraoperative			
Hypotension	2	6	0.25
Bradycardia	1	5	0.198
Postoperative			
Nausea	5	3	0.71
Dry mouth	4	3	1.0
Bradycardia	1	2	1.0
Hypotension	1	3	0.614
SpO2 < 90	0	0	

Values are number of patients

antiepileptics, tramadol, and paracetamol can prevent CRBD but still have adverse effects [1, 8, 9, 14]. Despite various treatment and prevention options for CRBD, there are no specific clinical practices. It is important to distinguish between the CRBD and operation wound pain. Therefore, each individual needs to be treated accordingly.

In this study, we enrolled male patients who underwent lumbar microdiscectomy and used a 16-Fr Foley catheter. The CRBD and wound pain were assessed separately. The incidence of CRBD 1 h after the operation was 62.9% in the control group. Intraoperative DEX infusion decreased the incidence of CRBD to 34.3%. This result was similar to the effect of the above-mentioned drugs including tolterodine [2, 13], glycopyrrolate [10, 15], pregabalin [12], and tramadol [14].

An indwelling urinary catheter can stimulate the afferent nerve of the bladder, leading to acetylcholine release and causing muscarinic receptor-mediated involuntary contraction of the detrusor muscle of the bladder. The muscarinic subtype M3 receptors are primarily responsible for bladder contraction. Patients complain of symptoms such as a burning sensation in the suprapubic area and an urge to void due to stimulation. Some patients show behavioral responses such as shaking their arms and legs, strong vocal response, and trying to pull out the catheter. CRBD can be a risk factor for agitation during anesthetic recovery [16], and should be distinguished from postoperative wound pain. Various treatments such as muscarinic receptor antagonists have been implemented for CRBD management [1, 2]. CRBD can lead to patient dissatisfaction during the postoperative period and increase postoperative complications [1]; thus, surgeons and anesthesiologists have explored methods to decrease this discomfort before the end of surgery.

Investigations on intraoperative DEX, a selective α2-adrenoreceptor agonist, have shown that intraoperative DEX administration decreased postoperative pain, opioid consumption, and postoperative nausea and vomiting without affecting recovery time. Based on these results, it has been used as an adjuvant drug during general anesthesia [17, 18]. In addition, DEX inhibits muscarinic subtype M3 receptors in dorsal root ganglia [6]. The main adverse effects of DEX administration are bradycardia and sedation. However,

Table 5 Sedation level

Time	1 h		3 h		6 h	
	Group C ($n = 35$)	Group D ($n = 35$)	Group C ($n = 35$)	Group D ($n = 35$)	Group C ($n = 35$)	Group D ($n = 35$)
Grade						
1	0	0	1	0	0	0
2	35	32	34	35	35	35
3	0	3	0	0	0	0

Values are expresses as number of patients. Time means postoperative time

bradycardia was transient and well reversed by atropine injection and sedated patients could be easily awakened [19, 20].

In this study, DEX administration was stopped before the end of surgery. This early stop may explain the similar result of postoperative sedation level between two groups.

In this study, before closing the operation site, triamcinolone acetamide 40 mg, morphine HCl 10 mg, and 0.5% bupivacaine 100 mg were injected into the epidural space and muscle layer by the surgeon to control postoperative pain. The postoperative pain score was low over the time and significantly lower in group DEX than group C at 3 and 6 h after postoperatively. This may be due to the synergic effects of the drugs. This multimodal management of postoperative pain can improve patient satisfaction.

We observed a significant correlation between the severity of CRBD and postoperative pain scores. Thus, in combination with the surgeon's management for operation wound pain, DEX administration for preventing CRBD during anesthesia can also decrease postoperative pain and increase patient satisfaction after the operation.

Glycopyrrolate as an adjuvant to reverse muscle relaxant decreases the incidence of CRBD [15]. However, sugammadex is commonly used instead of glycopyrrolate. Thus, glycopyrrolate is recommended as a premedication [10]. Intraoperative DEX administration can decrease the incidence of CRBD when sugammadex is used for reversing muscle relaxants without using glycopyrrolate.

There were some limitations in this study. First, desflurane concentration during surgery was not evaluated. The concentration of desflurane was controlled as a routine anesthetic practice. Second, the continuous infusion dose of DEX was not fixed. After loading dose administration (1 μg/kg over 10 min), DEX was controlled based on blood pressure, heart rate, and BIS values.

In conclusion, intraoperative DEX administration decreased the incidence and severity of postoperative CRBD without significant adverse effects and reduced the postoperative pain score. In addition, the decreased level of CRBD correlated with reduced postoperative pain. Therefore, intraoperative administration of DEX is a safe and effective adjuvant practice for preventing CRBD and decreasing postoperative pain sensation after lumbar microdiscectomy.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflicts of interest.

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