

The Effect of Dexmedetomidine Nasal Spray on Extubation-Related Stress Response and Delayed Extubation After Laparoscopic Surgery: A Randomized Controlled Trial

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Purpose: Smooth removal of the tracheal tube post-laparoscopic surgery is crucial. Dexmedetomidine suppresses airway reflexes and mitigates stress responses. This study sought to assess the effect of dexmedetomidine nasal spray on extubation-related stress response and delayed extubation after laparoscopic surgery.

Patients and Methods: This study involved 124 patients scheduled for laparoscopic surgery, who were randomly allocated to one of two groups: the dexmedetomidine nasal spray group (Group D, n=62) and the control group (Group C, n=62). 30 min before the end of the surgery, Group D was administered 100 µg of the dexmedetomidine nasal spray, while Group C was given an equivalent volume of normal saline nasal spray. Extubation events and extubation time were documented. Hemodynamic data, Ramsay sedation scale (RSS), NRS scores, postoperative nausea and vomiting (PONV), and total recovery time were evaluated during medication administration and the subsequent postoperative recovery period.

Results: The rate of smooth tracheal extubation was significantly higher in Group D than in Group C (93.5% vs 64.5%, $p < 0.001$). Extubation time was markedly reduced in Group D compared to Group C ($p = 0.045$). Hemodynamic characteristics were comparable across the two groups, but MAP was higher in Group C at 1 and 10 min after extubation ($p < 0.05$), and HR was higher at 1 and 3 min after extubation ($p < 0.05$). More favorable sedation was achieved in Group D at 30 min postoperatively ($p = 0.025$). No significant changes were observed in postoperative PO₂ and PCO₂, NRS pain score, and the incidence of PONV between the groups.

Conclusion: Dexmedetomidine nasal spray safely and effectively ameliorated extubation-related stress response following laparoscopic surgery, resulting in smoother extubation. Furthermore, it facilitated the maintenance of hemodynamic stability, shortened extubation time, and provided better postoperative sedation.

Keywords: dexmedetomidine, tracheal extubation, general anesthesia, laparoscopic surgery

Introduction

Laparoscopic surgery, a minimally invasive method, is increasingly utilized in contemporary medical practice. Laparoscopic surgery presents advantages over conventional open surgery, including smaller incisions, reduced postoperative complications, and expedited recovery for patients.¹ However, during laparoscopic surgery, prolonged pneumoperitoneum and changes in body position may result in CO₂ retention and disruptions in the internal environment.² Patients may experience various pathophysiological changes, primarily including increased systemic vascular resistance and pulmonary vascular resistance, increased heart rate, and decreased cardiac output, as well as slowing down the elimination rate of inhaled anesthetics,³ which can significantly impact the postoperative extubation period: prolonging



postoperative awakening and extubation time, exacerbating cough reflexes and pharyngeal irritation, and causing dramatic hemodynamic fluctuations during the peri-extubation period.

Extubation-related stress responses and adverse events can be divided into three major categories: respiratory, traumatic, and hemodynamic. According to previous studies, the incidence of laryngeal irritation during extubation in patients undergoing tracheal intubation under general anesthesia ranges from 38% to 96%.⁴ Severe coughing during extubation can significantly increase intracranial pressure and intra-abdominal pressure, potentially resulting in grave postoperative complications such as wound dehiscence after abdominal surgery, and may exacerbate airway reflexes, leading to laryngeal spasm, hypoxemia, hypertension, and tachycardia.⁵ This occurrence is more prevalent following laparoscopic surgery. Delayed extubation is defined as the duration ≥ 15 minutes, from the conclusion of surgery to the tracheal tube's removal. It is affected by multiple factors, including the duration of surgery, type of surgery (eg, laparoscopic surgery, cervical spine surgery), age, BMI, and others.⁶ Delayed extubation may cause laryngeal injury, dysphagia, and other complications, hence impacting patients' prognosis. Consequently, it is imperative to implement effective strategies to suppress extubation-related stress response and reduce the incidence of delayed extubation. Several drugs have been used to prevent and reduce stress responses and delayed extubation during the extubation period, such as intravenous administration of remifentanyl, propofol, and lidocaine.⁷ Recently, α_2 agonists have gained broad adoption in anesthetic practice for their anxiolytic, sedative, sympatholytic and analgesic effects.

Dexmedetomidine: A selective α_2 adrenoceptor agonist with central sympatholytic properties and enhanced vagal activity.⁸ It maintains hemodynamic stability, attenuates stress response, and is frequently utilized for sedation and analgesia. Previous studies have shown that dexmedetomidine can provide high-quality general anesthesia emergence effects, including controlling cough, agitation, hypertension, and tachycardia.⁹ In addition, it has been proven to refine the emergence extubation process and shorten the overall extubation time.¹⁰ Dexmedetomidine administered via nasal spray is non-invasive, painless, and safer, with minimal risk of respiratory depression at clinical doses.¹¹ Although intravenous administration has a rapid onset of action and high plasma peak concentrations, it is more prone to induce bradycardia and elevated blood pressure.¹² To avoid this, the gradual onset of action achieved by nasal spray administration may be preferable.¹³

In this randomized controlled study, we hypothesized that the use of dexmedetomidine nasal spray before the conclusion of surgery would reduce extubation-related stress response and produce smooth extubation conditions in patients undergoing laparoscopic surgery. Additionally, we analyzed the extubation and recovery times, hemodynamic variables, postoperative sedation and pain, and the incidence of PONV between the two cohorts.

Materials and Methods

Ethics and Registration

This study, a prospective and randomized controlled trial, received formal clearance from the ethics committee of the Affiliated Hospital of Xuzhou Medical University (approval no. XYFY2024-KL367-01). The research protocol was formally registered on the Chinese Clinical Trials Registry (ChiCTR 2400093172) in accordance with international standards. This study complied with the Declaration of Helsinki. In compliance with CONSORT reporting requirements for clinical investigations, all participants were provided with detailed descriptions of the study objectives and signed informed consent forms.

Patients

In this study, we analyzed 140 patients, and after excluding 16 patients, the remaining 124 patients were included in the study. Inclusion criteria were: age ≥ 18 years, American Society of Anesthesiologists (ASA) physical status I–III, scheduled to undergo laparoscopic major abdominal surgery, BMI 18–28 kg/m², and expected surgical duration ≥ 2 h. Exclusion criteria included allergy to α adrenoceptor drugs, the use of a laryngeal mask, preoperative bradycardia (HR <50 beats/min), heart block and sick sinus syndrome, preoperative acute respiratory infection, chronic pharyngitis and asthma, regular use of sedatives (such as benzodiazepines or barbiturates), severe hepatic or renal impairment, and cognitive impairment or inability to communicate.

Randomization and Intervention

Previous studies have shown that an optimal intranasal dexmedetomidine (Dex) dosage of 1–2 µg/kg for both adult and pediatric populations.^{14,15} Consequently, the dosage of dexmedetomidine nasal spray was determined to be 100 µg (four sprays) in this study. Patients were assigned via computerized randomization to two groups, and the envelope approach was used to achieve allocation concealment. Dexmedetomidine nasal spray group (Group D, n=62): patients received 100 µg of the dexmedetomidine nasal spray approximately 30 min before the conclusion of the surgical procedure. Before using the nasal spray, both nasal cavities were cleaned, secretions were removed, and the nasal wings were pinched with fingers. The nozzle was aimed at the lateral turbinate of the nasal cavity to spray the drug. After one nostril was sprayed, the same procedure was repeated for the other nostril to ensure even distribution of the drug (two sprays in each nostril, for a total of four sprays). Then both sides of the nostrils were gently pressed for at least 2 seconds to ensure that the drug completely moistened the nasal cavity. The control group (Group C, n=62) received an equal volume of normal saline nasal spray in the same way 30 min before the end of surgery. An independent anesthesia nurse who was not involved in the follow-up study process prepared nasal spray medications (dexmedetomidine or normal saline) in identical bottles. The appearance of the bottles administered to both groups was indistinguishable because both medications are clear and colorless fluids. These bottles were then labeled only with a unique subject identification number according to a computer-generated randomization list held by the anesthesia nurse. The anesthesiologists who administered the nasal spray, the anesthesiologist managing the anesthesia, the patients, the surgeons, and the outcome assessors were all blinded to the group assignment throughout the entire study period. The randomization code was not unblinded until after all data analyses were completed.

Procedures and Study Outcomes

All patients were provided with instructions to adhere to the ASA preoperative fasting guideline. Upon arrival in the operating room, the patient had an intravenous line insertion, followed by ongoing surveillance of arterial blood pressure, electrocardiogram (ECG), and oxygen saturation (SPO₂). A BIS monitor was routinely utilized to evaluate the depth of anesthesia. After a five-minute preoxygenation interval, anesthesia induction was accomplished with a combination of intravenous drugs: etomidate (0.3 mg/kg), sufentanil (0.3–0.5 µg/kg), midazolam (0.05 mg/kg), and vecuronium bromide (0.1 mg/kg). Tracheal intubation was completed under the laryngoscope. Anesthesia maintenance was managed with sevoflurane at a minimum alveolar concentration (MAC) of 1.3, while continuously administering propofol, remifentanyl, and vecuronium bromide via intravenous infusion. During surgery, the doses of propofol, remifentanyl, and vecuronium bromide should be adjusted based on the BIS Index, BP, and heart rate, to maintain the BIS value within the range of 40 to 60. Sevoflurane and neuromuscular blockers were discontinued at the time of skin suturing, and propofol and remifentanyl were discontinued at the end of surgery. After surgery, the patient was moved to the postanesthesia care unit (PACU) with a tube, and the transfer took no longer than one minute. In the PACU, anesthesiologists who did not know the administered study drug removed the tracheal tubes from all patients. Extubation was performed when the patient regained consciousness, could follow commands, maintained head elevation for ≥ 5 seconds in a supine position, had a tidal volume (VT) > 6 mL/kg, a respiratory rate (RR) ≥ 12 breaths/min, and a SpO₂ > 95% while breathing air. Oropharyngeal secretions were aspirated before extubation. Patients were then transferred to the ward as soon as they met the criteria for leaving the PACU.

The primary outcome was the rate of smooth tracheal extubation. Smooth tracheal extubation was defined as no purposeful muscular movement such as coughing, breath holding, or laryngospasm, within one minute post-extubation.¹⁶ Patients were deemed not to have a smooth tracheal extubation if they coughed, held their breath, or had laryngospasm immediately after tube removal. In the evaluation of the quality of extubation, a 5-point scale (extubation quality score) was applied. The scale ranged from 1 to 5, with 1 indicating no coughing at all. A score of 2 meant the patient coughed 1 or 2 times. A score of 3 indicated moderate coughing, which was characterized by 3 or 4 coughs. A score of 4 represented heavy coughing, ranging from 5 to 10 coughs. Lastly, a score of 5 signified either more than 10 coughs or the presence of laryngospasm.¹⁷

Delayed extubation was characterized as the removal of the tracheal tube occurring ≥ 15 minutes post-surgery.¹⁸ Hemodynamic variables, including mean arterial pressure (MAP) and heart rate (HR), were assessed at specified intervals: T0, before the administration of the study drugs; T1, 1 min after the administration of the study drugs; T2, 3 min after the administration of the study drugs; T3, 5 min after the administration of the study drugs; T4, at the time of extubation; T5, 1 min after extubation; T6, 3 min after extubation; T7, 5 min after extubation; T8, 10 min after extubation. Arterial blood gas analysis was conducted 10 min post-extubation to measure postoperative arterial oxygen partial pressure and carbon dioxide partial pressure. The Ramsay Sedation Scale (RSS) was evaluated at 15 and 30 min postoperatively (it is divided into six levels: 1, agitated; 2–3, calm; 4–6, excessive sedation).¹⁹ The NRS score was assessed 30 min after extubation (higher numbers denote more severe pain, and the numbers 0–10 represent the intensity of the pain). Postoperative nausea and vomiting (PONV), along with other complications, were documented. In addition, the duration of surgery and anesthesia, the dosage of propofol and remifentanyl during surgery, and the length of stay in the PACU were also recorded.

Statistical Analysis

The sample size was calculated based on the results of the preliminary study. In the preliminary study, the rate of smooth tracheal extubation was 88% in the dexmedetomidine nasal spray group, compared to 62.5% in the control group. With an alpha level of 0.05 and a power of 0.90, the required sample size for each grouping was determined to be 55. To account for a 10% dropout rate, we enrolled 62 patients in each group, bringing the total enrollment target to 124 patients.

Data analysis was performed utilizing SPSS version 27.0. The Shapiro–Wilk test was employed to evaluate normality. Measurement data that are normally distributed are represented as mean \pm standard deviation ($x \pm s$), while non-normally distributed data are shown as median (M) and interquartile range (IQR). For normally distributed data, the two groups were compared using independent sample *t*-tests, and for non-normally distributed data, the Mann–Whitney *U*-test was utilized. Categorical data are presented as counts (percentages), and comparisons between groups were conducted using the chi-square test or Fisher’s exact test. A two-way ANOVA with repeated measurements was used to analyze differences in hemodynamic profiles (MAP and HR) in the two groups, and post hoc Bonferroni tests were used to compare differences in hemodynamic variables among groups at specific times. A *p*-value of less than 0.05 was considered to be statistically significant.

Results

Baseline Demographics and Perioperative Characteristics

A total of 140 patients slated for laparoscopic major abdominal surgery were assessed for eligibility. 16 patients were classified as ineligible according to the established exclusion criteria. Therefore, 124 patients were successfully enrolled and randomly divided into two groups (62 patients in each group). All enrolled patients completed the trial protocol without dropout, and their data were included in the final analysis. The detailed process of participants through the study is shown in [Figure 1](#).

As shown in [Table 1](#), the two groups’ demographic and clinical baseline characteristics were comparable. In addition, as detailed in [Table 2](#), there were no significant differences in the duration of surgery and anesthesia, the dosage of propofol and remifentanyl during surgery, the time from administration to completion of surgery, and the length of stay in the PACU between the two groups.

Primary Outcome

Compared with Group C, the rate of smooth tracheal extubation was significantly higher in Group D (93.5% vs 64.5%, $p < 0.001$). The distribution of extubation quality scores is comprehensively detailed in [Table 3](#). In Group D, 58 patients had smooth extubation (no coughing during extubation), while the remaining 4 patients had only slight coughing (1–2 coughs). In contrast, only 40 patients in Group C were successfully extubated, and 22 patients experienced coughing episodes during extubation, including 19 cases of slight coughing and 3 cases of moderate coughing. It is worth noting

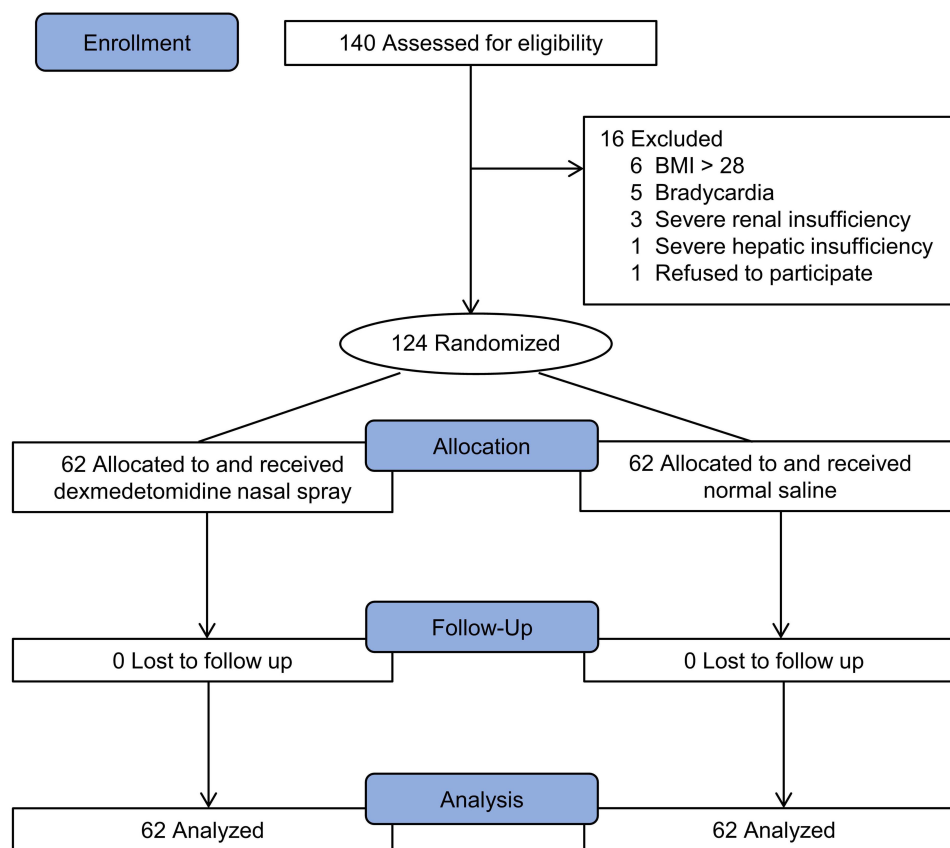


Figure 1 Flow chart of patient enrollment in this study.

that no severe respiratory complications such as breath-holding, laryngospasm, bronchospasm, or hypoxemia were observed post-extubation in either group. Additionally, no coughing was observed during postoperative transport.

Secondary Outcomes

The incidence of delayed extubation in Group D was 66.1%, while that in Group C was 75.8%. Although the incidence of delayed extubation (defined as ≥ 15 minutes) did not differ significantly between the two groups ($p = 0.235$), the median extubation time itself was significantly shorter in Group D than in Group C (20 [13, 27.5] vs 25.5 [14.5, 37.25], $p = 0.045$).

Table 1 Patient Demographic and Baseline Characteristics

Characteristic	Group D (n=62)	Group C (n=62)	P Value
Age, years	50.4±6.9	50.3±6.2	0.881
Male sex, n (%)	37(59.7)	32(51.6)	0.366
BMI, kg/m ²	24.2±2.2	23.4±2.4	0.058
ASA Physical Status, n (%)			0.886
I	11(17.7)	9(14.5)	
II	46(74.2)	48(77.4)	
III	5(8.1)	5(8.1)	
Surgery type, n (%)			0.938
Gastric	8(12.9)	9(14.5)	
Hepatobiliary	13(21.0)	10(16.1)	

(Continued)

Table 1 (Continued).

Characteristic	Group D (n=62)	Group C (n=62)	P Value
Colorectal	20(32.3)	17(27.4)	
Urologic or renal	14(22.6)	17(27.4)	
Gynecologic	5(8.1)	6(9.7)	
Other	2(3.2)	3(4.8)	
Comorbidities, n (%)			
Hypertension	13(21.0)	17(27.4)	0.402
Diabetes	6(9.7)	5(8.1)	0.752
Coronary artery disease	3(4.8)	5(8.1)	0.715
Anemia	2(3.2)	4(6.5)	0.676
Drinking status	7(11.3)	4(6.5)	0.343
Smoking status	7(11.3)	5(8.1)	0.544

Note: Data are expressed as mean \pm standard deviation or number (%).

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index (calculated as weight in kilograms divided by height in meters squared).

Table 2 Perioperative Data

	Group D (n=62)	Group C (n=62)	P Value
Duration of surgery (min)	200 (160, 237.5)	182.5 (143.8, 240)	0.287
Duration of anesthesia (min)	230 (188.5, 256.3)	202.5 (167.5, 261.3)	0.151
Remifentanyl dosage (mg)	3.5(2.6, 3.7)	3 (2.4, 3.4)	0.088
Propofol dosage (g)	0.5 (0.4, 0.6)	0.5(0.3, 0.6)	0.076
Time from administration to completion of surgery (min)	30 (29, 31)	30 (29, 31)	0.487
Time in PACU (min)	47 (38, 60)	53 (39.8, 69)	0.144

Note: Data are expressed as median (interquartile range, IQR).

Abbreviation: PACU, postanesthesia care unit.

Table 3 Extubation Characteristics

Study Group	Group D (n=62)	Group C (n=62)	P Value
Smooth extubation	58(93.5)	40(64.5)	< 0.001
Extubation Quality Score			
No coughing	58(93.5)	40(64.5)	
Slight coughing	4(6.5)	19(30.6)	
Moderate coughing	0	3(4.8)	
Heavy coughing	0	0	
Severe coughing or laryngospasm	0	0	
Delayed extubation	41(66.1)	47(75.8)	0.235
Extubation time (min), median (IQR)	20 (13, 27.5)	25.5 (14.5, 37.3)	0.045

Notes: Data are expressed as median (interquartile range, IQR) or number (%).

The hemodynamic profiles of mean arterial pressure (MAP) and heart rate (HR) at various time points are illustrated in [Figure 2](#). Although the two groups were comparable at most time points, significant differences occurred during the emergence period. MAP was significantly higher at 1 and 10 min after extubation in Group C than in Group D ($p < 0.05$). HR was significantly higher in Group C than in Group D at 1 and 3 min after extubation ($p < 0.05$).

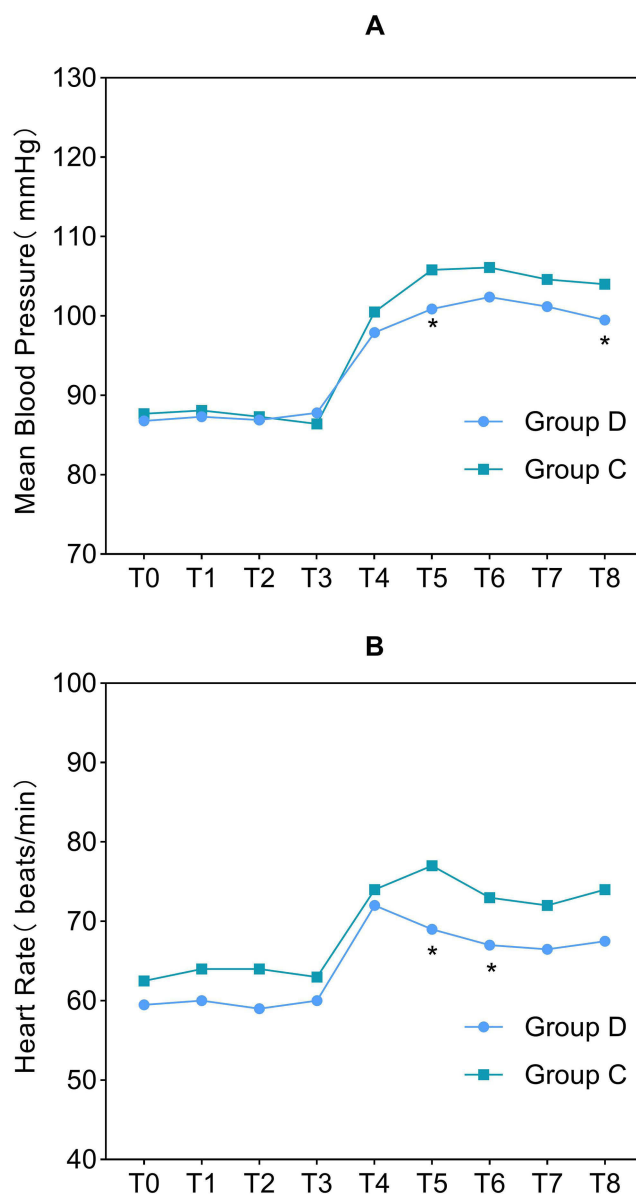


Figure 2 Hemodynamic changes. Hemodynamic changes during the administration of the study drugs and emergence from anesthesia. **(A)** mean blood pressure and **(B)** heart rate measured. T0, before the administration of the study drugs; T1, 1 min after the administration of the study drugs; T2, 3 min after the administration of the study drugs; T3, 5 min after the administration of the study drugs; T4, at the time of extubation; T5, 1 min after extubation; T6, 3 min after extubation; T7, 5 min after extubation; T8, 10 min after extubation. Group D was administered dexmedetomidine nasal spray (100 µg); Group C was administered normal saline as a control. * $P < 0.05$ compared with Group C.

Postoperative blood gas analysis indicated no statistically significant differences between the groups in either PO_2 ($p = 0.117$) and PCO_2 ($p = 0.894$) (Table 4). No notable variations were detected between the groups in the RSS scores at 15 min postoperatively ($p > 0.05$). However, at 30 min postoperatively, the RSS scores exhibited a significant difference between the two groups ($p = 0.025$), indicating a more favorable sedation profile in Group D, with a higher proportion of patients in a calm state (RSS 2–3).

No significant differences were observed in the NRS pain scores ($p = 0.107$) and incidence of PONV ($p = 0.676$) between the two groups (Table 4).

Table 4 Recovery Variables in the Postanesthetic Care Unit and Postoperative Pain Score

Study Group	Group D (n=62)	Group C (n=62)	P Value
PO ₂	93.3±14.2	89.4±13.7	0.117
PCO ₂	43.5±4.9	43.3±5.4	0.894
Classified RSS			
15 min after the operation			0.181
Agitated (RSS 1)	0	0	
Calm (RSS 2–3)	24(38.7)	17(27.4)	
Sedated (RSS 4–6)	38(61.3)	45(72.6)	
30 min after the operation			0.025
Agitated (RSS 1)	0	0	
Calm (RSS 2–3)	51(82.3)	40(64.5)	
Sedated (RSS 4–6)	11(17.7)	22(35.5)	
NRS score, median (IQR)	3 (2, 4)	3 (2, 5)	0.107
Incidence of PONV	2 (3.2)	4(6.5)	0.676

Notes: Data are expressed as mean±standard deviation, median (interquartile range, IQR) or number (%).

Abbreviations: RSS, Ramsay Sedation Scale; NRS, numeric rating scale; PONV, postoperative nausea and vomiting.

Discussion

This study demonstrated that administering a 100 µg dose of dexmedetomidine nasal spray 30 min prior to the conclusion of surgery helped to improve extubation-related stress response following laparoscopic surgery and facilitate smoother extubation without prolonging extubation time or increasing the incidence of other complications. In addition, the administration of dexmedetomidine nasal spray during surgery resulted in more stable hemodynamic changes during the recovery period and provided favorable sedative effects.

Manipulations such as endotracheal intubation and extubation during general anesthesia can elicit considerable stress responses.²⁰ During awakening, tracheal tube removal often triggers reflexive responses, predominantly coughing. Coughing during extubation is a typical manifestation of airway hyperresponsiveness, which is essentially a reflex response mediated by the vagus nerve in response to stimulation of the airway mucosa by the endotracheal tube. Coughing elevates the risk of airway spasm and leads to consequences including dramatic hemodynamic fluctuations, wound rupture, and hemorrhage. Several studies have consistently demonstrated that intravenous administration of dexmedetomidine can diminish airway and circulatory reflexes, hence enabling smooth extubation.^{21,22} Furthermore, some studies also indicate that intranasal administration of dexmedetomidine is highly effective in improving sedation and analgesia.²³ This study found that dexmedetomidine nasal spray markedly reduced the incidence of coughing during the extubation period (6.5% in Group D and 35.5% in Group C), facilitating a smoother extubation process. This phenomenon may be associated with the subsequent mechanisms. Firstly, previous studies have suggested that peripheral α_2 receptors may be involved in the suppression of coughing. Dexmedetomidine inhibits the signal transmission in the central cough reflex pathway by activating the α_2 receptor in the locus coeruleus, thereby reducing the occurrence of the coughing response.²⁴ Secondly, dexmedetomidine nasal spray acts directly on the mucous membrane of the nasopharynx, inhibiting the release of inflammatory factors such as histamine that cause bronchoconstriction, thus reducing the cough impulse induced by mechanical stimulation.²⁵ Thirdly, the analgesic properties of dexmedetomidine may attenuate the pain-cough chain reaction induced by the friction of the tracheal tube.

It was noteworthy that although dexmedetomidine nasal spray markedly shortened extubation time, it did not substantially diminish the occurrence of delayed extubation. This effect likely stems from the arousable sedative properties of dexmedetomidine: it can exert its sedative and hypnotic effects by activating α_2 receptors in the locus coeruleus, thereby sustaining patients in a non-rapid eye movement (NREM) sleep state. Its unique feature is that patients can be easily aroused by stimulation or verbal commands.²⁶ This avoids the occurrence of respiratory depression and

preserves the patient's ability to comply with instructions, making the decision to extubate more reliant on clinical judgment rather than drug metabolism time. The prerequisites for extubation include meeting criteria such as being conscious, being able to follow commands, and having robust spontaneous breathing. Therefore, Dexmedetomidine nasal spray can promote a more stable and cooperative awakening, allowing for earlier and safer extubation. Delayed extubation usually occurs as a result of the combined impact of several causes rather than being caused by a single event. The risk of delayed extubation due to patient-related factors, surgical complexity, or residual neuromuscular blocking drugs cannot be eliminated by dexmedetomidine nasal spray. Consequently, its capacity to reduce the incidence of delayed extubation is considered to be restricted.

Hemodynamic fluctuations are also one of the most common complications during extubation. Moreover, the pneumoperitoneum required for laparoscopic surgery can cause a surge of norepinephrine and epinephrine in the bloodstream, which induces hemodynamic instability and potentially leads to severe complications.²⁷ A previous study demonstrated that intranasal administration of dexmedetomidine (1 µg/kg) can attenuate hemodynamic surges during intubation. Furthermore, several studies have shown that intravenous administration of dexmedetomidine prior to the conclusion of surgery can mitigate hemodynamic fluctuations following extubation.^{28,29} In this study, Group D showed significantly lower MAP at 1 and 10 min post-extubation and lower HR at 1 and 3 min post-extubation in comparison to Group C. This was mainly attributed to the sedative properties of dexmedetomidine: dexmedetomidine reduces the release of catecholamines from the hypothalamic preoptic region, consequently inhibiting sympathetic nervous activity and buffering the abrupt elevation in blood pressure and heart rate triggered by the stimulation of extubation. The aforementioned effects endured for up to 10 min after extubation, potentially due to the slow absorption of the drug into the bloodstream and the maintenance of effective concentrations for a longer period after nasal mucosal administration.

In this study, no patient exhibited agitation in the PACU. At 30 min postoperatively, Group D showed superior sedation, with Ramsay scores maintained at 2–3, which may also be attributable to its arousable sedation properties. In contrast to conventional sedatives, dexmedetomidine emulates the physiological processes associated with natural sleep, thereby inducing a state of sedation characterised by comfort and relaxation, as opposed to a dazed one. In addition, dexmedetomidine has been shown to provide adjunctive analgesia, thereby reducing the necessity for opioids and consequently circumventing the associated side effects, including excessive sedation and respiratory depression. In this study, the high-quality sedative effects provided by dexmedetomidine nasal spray postoperatively met the dual needs of postoperative patients for comfort and safety.

There were no significant differences in postoperative NRS scores and incidence of PONV between the two groups, which may be associated with the limitations of the analgesic target and the lack of an anti-vomiting pathway.

Conclusion

In conclusion, this study demonstrated that the use of dexmedetomidine nasal spray 30 min before the end of surgery can effectively improve the extubation-related stress response and allow patients to undergo a smoother extubation. In addition, it facilitated the maintenance of hemodynamic stability, shortened extubation time, and provided better postoperative sedation.

Data Sharing Statement

The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding author.

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Disclosure

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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