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Original Research Article

A Comparative Study of Efficacy of Preoperative Dexmedetomidine Nebulization with Magnesium Sulphate Nebulization in Reducing Post-Operative Sore Throat in Patients Undergoing General Anaesthesia

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Conflict of interest: Nil

Abstract

Objective: Postoperative sore throat (POST) is a common complication following endotracheal intubation under general anaesthesia, contributing significantly to patient discomfort and dissatisfaction. Various pharmacological agents have been explored to reduce its incidence, including dexmedetomidine and magnesium sulphate. This study was undertaken to compare the efficacy of preoperative nebulized dexmedetomidine and magnesium sulphate in reducing POST.

Methods: This prospective, randomized, double-blind comparative study was conducted on 60 ASA I–II patients aged 18–60 years undergoing elective surgeries under general anaesthesia with endotracheal intubation. Patients were randomly allocated into two groups: Group D received dexmedetomidine nebulization (1 µg/kg in 4 ml normal saline) and Group M received magnesium sulphate nebulization (250 mg in 4 ml normal saline) for 15 minutes preoperatively. POST was assessed at 0, 2, 4, 6, 12, and 24 hours post-extubation using a four-point grading scale. Hemodynamic parameters and adverse effects were also recorded.

Results: Both groups were comparable in demographic and intraoperative variables ($p > 0.05$). The incidence of POST was significantly lower in Group D compared to Group M at 0 hour (26.66% vs 50%, $p = 0.004$), 2 hours (10% vs 33%, $p = 0.006$), and 4 hours (6.66% vs 26.33%, $p = 0.004$). After 6 hours, differences were not statistically significant. Group D also demonstrated better hemodynamic stability with significantly lower heart rate and blood pressure at key peri-intubation time points. No major adverse effects were observed in either group.

Conclusion: Preoperative nebulized dexmedetomidine is more effective than magnesium sulphate in reducing early postoperative sore throat and provides better hemodynamic stability with a good safety profile. Both agents are useful in improving postoperative patient comfort following general anaesthesia.

Keywords: Postoperative Sore Throat, Dexmedetomidine, Magnesium Sulphate, Nebulization, General Anaesthesia, Endotracheal Intubation.

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Introduction

Postoperative care in modern anaesthesia has evolved considerably, with a strong focus on patient safety, comfort, and quality of recovery. Despite advancements in anaesthetic techniques and airway management, certain complications continue to affect postoperative outcomes and patient satisfaction. One of the most frequently encountered complications is postoperative sore throat (POST), particularly following general anaesthesia (GA) with endotracheal intubation [1]. The reported incidence of POST varies widely, ranging from 6.6% to 90% [1]. This variability is attributed to several factors, including differences in airway management techniques, type and size of endotracheal tubes, cuff pressure, duration of intubation, anaesthetic agents used, and patient-related characteristics such as age, gender, and airway sensitivity [2]. Furthermore, inconsistencies in assessment methods and subjective reporting scales contribute to this wide variation [3,4]. Despite these differences, POST remains one of the most common postoperative complaints and has been ranked as the eighth most significant postoperative problem [3]. The pathophysiology of POST is multifactorial, with inflammation playing a pivotal role. Clinically, POST can range from mild throat irritation to severe pain that interferes with swallowing and speaking. It may also be accompanied by hoarseness of voice and cough. Although POST is often considered as a minor adverse event, these symptoms negatively impact patient comfort, satisfaction, and overall quality of recovery with increased duration of hospital stay indicating that its clinical relevance extends beyond being a minor complaint [4,5]. Therefore, prevention and effective management of POST are essential aspects of perioperative care. Various strategies have been explored to reduce the incidence and severity of POST, broadly classified into non-pharmacological and pharmacological approaches.

Non-pharmacological measures focus on minimizing airway trauma and include the use of appropriately sized endotracheal tubes, adequate lubrication with water-soluble gels, gentle airway manipulation, ensuring complete neuromuscular relaxation prior to intubation, maintaining cuff pressure below 20 mmHg, careful suctioning, and complete cuff deflation before extubation [6]. While these measures are beneficial, they are not entirely effective in preventing POST. Pharmacological interventions have therefore gained increasing importance. Several agents, including inhaled corticosteroids (beclomethasone, fluticasone), ketamine gargles, intracuff lignocaine, non-steroidal anti-inflammatory drugs, NMDA receptor antagonists, and α2-adrenergic agonists, have been studied for their efficacy in reducing POST [7]. These drugs can be administered through various routes such as nebulization, gargles, sprays, lubricants, intravenous infusion, and intracuff instillation, with varying degrees of success. Magnesium sulphate has emerged as a promising agent due to its analgesic and anti-inflammatory properties.

It acts primarily by blocking NMDA receptors, thereby inhibiting calcium influx and preventing central sensitization induced by nociceptive stimuli. Additionally, its sympatholytic effect helps attenuate the hemodynamic response to laryngoscopy and intubation. Several studies have demonstrated its efficacy in reducing perioperative pain and postoperative analgesic requirements, suggesting a potential role in reducing POST [8–11]. Dexmedetomidine, a highly selective α2-adrenergic receptor agonist, has also gained attention due to its sedative, analgesic, and anti-inflammatory properties. It produces sedation resembling natural sleep, reduces anaesthetic requirements, and is associated with minimal respiratory depression. Its anti-inflammatory effects may help reduce airway irritation, thereby decreasing the incidence and severity of POST [12,13]. In recent years, nebulization has been explored as an effective route for delivering these pharmacological agents directly to the airway mucosa. This method enhances local drug delivery while minimizing systemic side effects, making it a promising approach for preventing POST. However, there is limited evidence directly comparing the efficacy of nebulized magnesium sulphate and dexmedetomidine in reducing POST. Therefore, the present study was designed to evaluate and compare the effectiveness of preoperative nebulization with dexmedetomidine and magnesium sulphate as pre-emptive interventions in reducing the incidence and severity of postoperative sore throat in patients undergoing general anaesthesia with endotracheal intubation. We also assessed the haemodynamic changes caused by these drugs and their side effects. So the study aims to identify an effective, safe and patient-friendly strategy to improve postoperative comfort and overall patient satisfaction.

Materials and Methods

This prospective, randomized, double-blind, comparative study was conducted in the Department of Anaesthesiology at Krishna Rajendra Hospital attached to Mysore Medical College and Research Institute, Mysore from November 2022 to July 2024 after getting Institutional Ethical Committee approval. The study included a total of 60 patients aged between 18 and 60 years, belonging to American Society of Anesthesiologists (ASA) physical status grade I and II, with a body mass index (BMI) between 20–30 kg/m² who were scheduled for elective surgeries under general anaesthesia with endotracheal intubation. Patients with Mallampatti grade III and above, anticipated difficult airway, respiratory diseases, head and neck surgeries, emergency surgeries, history of recent intake of NSAIDs or any other anti-inflammatory drugs and those surgeries requiring nasogastric tube insertion, more than 2 attempt of intubation or intubation lasting more than 20seconds were excluded from the study.

Patients were randomly allocated into two groups of 30 each using a shuffled, closed opaque envelope technique. Both the patient and the observer assessing postoperative outcomes were blinded to the group allocation.

- Group D (Dexmedetomidine group): Received nebulization with dexmedetomidine 1 μg/kg diluted in 4 ml normal saline over 15 minutes.
- Group M (Magnesium sulphate group): Received nebulization with magnesium sulphate 250 mg diluted in 4 ml normal saline over 15 minutes.

Preoperative Preparation: All patients underwent pre-anaesthetic evaluation on the day prior to surgery, and written informed consent was obtained. Patients were premedicated with oral alprazolam 0.5 mg and pantoprazole 40 mg the night before surgery. Standard fasting guidelines were followed - 6 hours for solids and 2 hours for clear fluids.

Anaesthetic Technique: On arrival in the operating theatre, intravenous access was secured with an 18G cannula, and Ringer lactate infusion was initiated. Patients were connected to a multiparameter monitor (EDAN iM80), and baseline heart rate (HR), systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), oxygen saturation (SpO_2) and ECG were recorded. Following baseline measurements, patients received nebulization with the assigned study drug using a compressor nebulizer for 15 minutes. Hemodynamic parameters were recorded during nebulization. General anaesthesia was induced 10 minutes after completion of nebulization.

All patients were pre-medicated with intravenous midazolam (0.02 mg/kg), glycopyrrolate (0.01 mg/kg), fentanyl (2 µg/kg), and ondansetron (0.1 mg/kg). Patients were preoxygenated with 100% oxygen for 3 minutes. Anaesthesia was induced with propofol (2 mg/kg), and neuromuscular blockade was achieved using vecuronium (0.1 mg/kg).

After 3 minutes of mask ventilation, endotracheal intubation was performed by an experienced anaesthesiologist using appropriately sized cuffed endotracheal tubes (7–7.5 mm for females and 8–8.5 mm for males). Cuff pressure was maintained at 20 cm H_2O using a cuff pressure manometer. Anaesthesia was maintained with a mixture of oxygen (33%), nitrous oxide (66%), isoflurane (0.5–1%), and intermittent doses of vecuronium (0.02 mg/kg).At the end of surgery, neuromuscular blockade was reversed using neostigmine (0.05 mg/kg) and glycopyrrolate (0.01 mg/kg), and patients were extubated after meeting standard extubation criteria. Hemodynamic parameters (HR, SBP, DBP, MAP, SpO_2) were recorded at the following time points: baseline before nebulization, 15 minutes after nebulization, before induction, 1 minute after induction, 1, 2, 5 and 10 minutes after intubation, at extubation, 2 and 5 minutes after extubation. Postoperative sore throat (POST) was assessed at 0 hour (immediately after recovery), 2, 4, 6, 12, and 24 hours postoperatively using a four-point grading scale:

- 0: No sore throat
- 1: Mild (less than common cold)
- 2: Moderate (similar to common cold)
- 3: Severe (more than common cold)

Additional postoperative complications including cough, hoarseness of voice, dysphagia, nausea, and vomiting were also recorded at the same time intervals.

Statistical Analysis: Data were analysed using SPSS software version 28. Descriptive statistics were expressed as mean ± standard deviation, frequency and percentage. Inferential statistics included paired and unpaired t-tests, repeated measures ANOVA, and Chi-square test as appropriate. A p-value <0.05 was considered statistically significant.

Results

The demographic characteristics of study population such as age, gender, ASA physical status were comparable between the two groups. Anthropometric parameters including height, weight, and BMI were also similar between the two groups with no statistical significance as shown in table 1.

Table 1: Baseline Characteristics of Study Population (n = 60)

Parameter	Group D (n=30)	Group M (n=30)	p-value
Age (years) (Mean ± SD)	41.6 ± 11.63	43.66 ± 8.85	0.408
Sex: Female n(%)/Male n(%)	14 (46.66)/16(53.33)	17 (56.66)/13(43.33)	0.473
ASA Grade I n (%)/Grade II n(%)	14 (46.66)/16(53.33)	16 (53.33)/14(46.66)	0.338
Height (cm) (Mean ± SD)	167.4 ± 10.15	165.2 ± 10.26	0.383
Weight (kg) (Mean ± SD)	66.14 ± 7.48	65.06 ± 6.68	0.524
BMI (kg/m^2) (Mean ± SD)	23.71 ± 2.88	24.04 ± 3.44	0.644

The mean duration of surgery, intubation attempts and the endotracheal tube cuff pressures among the study groups were shown in table 2.

Table 2: Intraoperative Characteristics

Parameter	Group D (n=30)	Group M (n=30)	p-value
Duration of Surgery (min) (Mean ± SD)	68.74 ± 13.63	65.16 ± 11.85	0.164
Intubation Attempt n (%) 1/2	28 (93.33)/2(6.66)	28 (93.33)/2(6.66)	1.00
Cuff Pressure (cm H_2O) Median (IQR)	21 (20–22)	21 (20.5–22)	0.78

The number of intubation attempts was similar in both groups, with 93.33% of patients requiring only one attempt and 6.66% requiring two attempts in each group, with no statistically significant difference (p = 1). The mean duration of surgery was also comparable between the groups (68.74 ± 13.63 minutes in Group D vs 65.16 ± 11.85 minutes in Group M; p = 0.164).

Intraoperative hemodynamic parameters showed that mean heart rate (HR) was significantly lower in Group D than group M at certain time points, including 15 minutes after nebulization (p = 0.014), before induction (p = 0.031), after induction (p = 0.043), and at 1 minute after intubation (p = 0.007). However, at most other time intervals, the difference in HR between the groups was not statistically significant as shown in figure 1.

Similarly, systolic blood pressure (SBP), DBP were significantly lower in Group D at 15 minutes after nebulization (p = 0.002), before induction (p = 0.007), after induction (p = 0.005), and at 1 and 2 minutes after intubation (p = 0.004 and p = 0.003, respectively). No significant differences were observed at later time points. Mean arterial pressure (MAP) showed a statistically significant reduction in Group D after induction (p = 0.049), while other time points did not show significant differences as shown in figure 2.

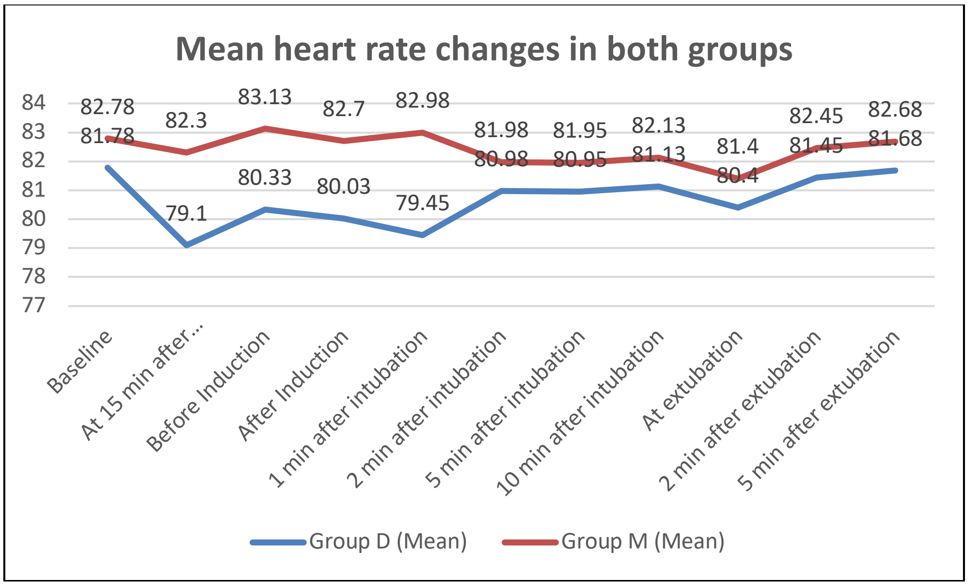

Figure 1: Mean heart rate changes in both groups

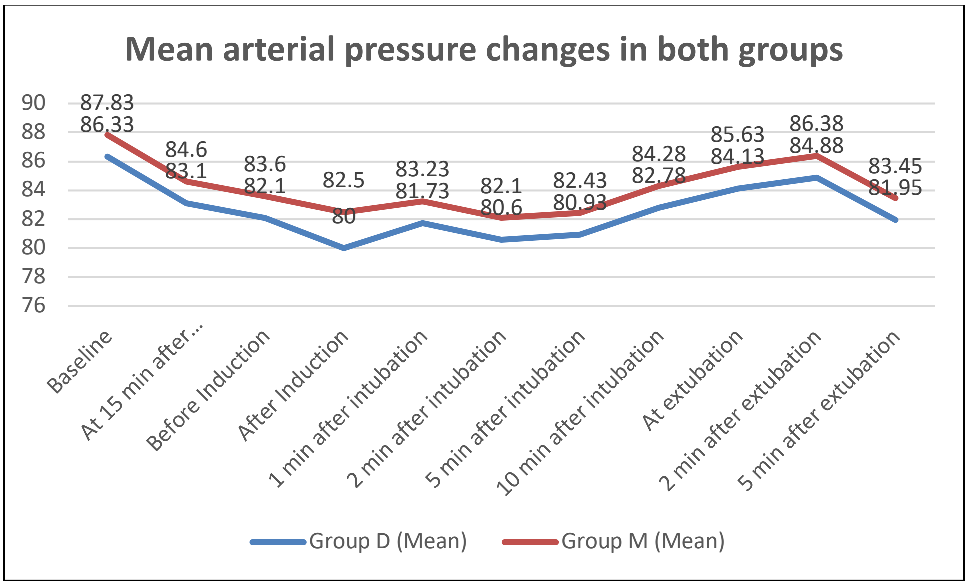

Figure 2: Mean arterial pressure changes in both groups

The primary outcome, postoperative sore throat (POST), showed a statistically significant reduction in Group D compared to Group M, particularly in the early postoperative period as shown in table 3.

Table 3: Comparison of Postoperative Sore Throat (POST)

Time	Severity	Group D n (%)	Group M n (%)	p-value
0 hr	Nil	22 (73.33)	15 (50.00)	0.004
	Mild	6 (20.00)	11 (36.66)	0.003
	Moderate	2 (6.66)	4 (13.33)	0.07
2 hr	Nil	27 (90.00)	23 (76.33)	0.006
	Mild	3 (10.00)	5 (26.33)	0.062
	Moderate	0 (0.00)	2 (6.66)	0.001
4 hr	Nil	28 (93.33)	22 (66.66)	0.004
	Mild	2 (6.66)	8 (26.33)	0.005
6 hr	Nil	29 (96.66)	25 (83.33)	0.050
12 hr	Nil	30 (100)	29 (96.66)	0.153
24 hr	Nil	30 (100)	30 (100)	NS

At 0 hour, 73.33% of patients in Group D had no sore throat compared to 50% in Group M ($p = 0.004$). At 2 hours, 90% of patients in Group D had no POST compared to 76.33% in Group M ($p = 0.006$). At 4 hours, 93.33% of patients in Group D had no POST compared to 66.66% in Group M ($p = 0.004$), with significantly fewer cases of mild POST in Group D ($p = 0.005$). At 6 hours, a higher proportion of patients in Group D remained free from POST (96.66% vs 83.33%, $p = 0.050$).

However, by 12 hours and 24 hours postoperatively, the incidence of POST was minimal and comparable between both groups, with no statistically significant differences. No cases of severe POST were observed in either group at any time interval. Adverse effects such as hypotension was noted in two patients and bradycardia in one patient in group D, which were effectively managed with standard treatment. None of the patients in both groups had arrhythmias or bronchospasm. Postoperatively, no significant complications such as respiratory depression, nausea, vomiting, or hemodynamic instability were reported in either group.

Discussion

Postoperative sore throat (POST) remains one of the most frequent complications following general anaesthesia with endotracheal intubation. Although usually self-limiting, it significantly affects patient comfort, satisfaction, and overall quality of recovery. In the present study, we compared the efficacy of preoperative nebulized dexmedetomidine and magnesium sulphate in reducing the incidence and severity of POST in patients undergoing elective surgeries under general anaesthesia.

Both groups were comparable in demographic variables including age, sex, BMI, ASA grade, height, and weight, with no statistically significant differences ($p > 0.05$). This ensured homogeneity between groups and eliminated confounding bias. Similar emphasis on baseline comparability has been highlighted in previous studies, as patient-related factors significantly influence POST development [3,4]. Airway related factors such as multiple attempts at intubation, longer duration of surgery and higher endotracheal tube cuff pressure increases the occurrence of POST (pradian E). Higher endotracheal tube cuff pressure affects the tracheal mucosal capillary perfusion pressure and may increase POST occurrence. So, we have monitored endotracheal cuff pressure throughout surgery and was maintained within normal limits (<20cm H_2O) in both groups to avoid bias.

Sore throat is caused by mechanical irritation of the airway mucosa during laryngoscopy and endotracheal intubation leading to the release of inflammatory mediators from the tracheal epithelium. This inflammatory response results in mucosal edema, erythema, and pain, which clinically manifest as sore throat after surgery [2]. Literature reveals that both Magnesium sulphate and Dexmedetomidine by nebulisation are effective in reducing the incidence and severity of POST when compared with normal saline. We chose to administer the drug by nebulisation as it is better tolerated by the patient, have good bioavailability and was associated with less systemic side effects.

In the present study, dexmedetomidine (Group D) showed significantly lower incidence of POST compared to magnesium sulphate (Group M) in the early postoperative period. However, after 6 hours, the difference between groups was not statistically significant, indicating comparable efficacy in later phases. These findings suggest that dexmedetomidine provides superior early protection against airway irritation and inflammatory response. Our study results are consistent with Pradian E et al. who demonstrated that dexmedetomidine nebulization significantly reduces both incidence and severity of POST [14]. Similarly, Vazhakalayil et al. reported reduced POST with dexmedetomidine (1 µg/kg), supporting its anti-inflammatory and analgesic properties [15]. Dexmedetomidine acting via α2-adrenergic receptor agonism, leads to decreased sympathetic outflow and suppression of inflammatory mediators. Li B et al. demonstrated reduced IL-6, IL-8, and TNF-α levels with dexmedetomidine, while Zhang et al. reported reduced CRP and systemic inflammatory markers, supporting its anti-inflammatory airway protective role [22,23].

Magnesium sulphate also reduced POST compared to expected baseline, but its efficacy was comparatively less in the early postoperative period. This is consistent with findings by Chakole et al. [16], Yadav et al. [17], and Padma T et al. [18], who reported better efficacy of magnesium sulphate after 4–12 hours rather than immediate postoperative period. In our study, similar delayed effectiveness was observed, with higher early POST incidence in Group M. various comparative studies comparing magnesium sulphate with other agents also support these observations. Sharma G et al. and Kamel et al. found magnesium sulphate was effective in reducing POST, particularly after 4 hours, and comparable to lignocaine [19,20]. Kumar GM et al. [21] even reported superiority of magnesium sulphate over dexamethasone [21]. Magnesium sulphate acts through NMDA receptor antagonism and calcium channel blockade, reducing central sensitization and nociceptive transmission. Rajan et al. [24] and Segaran et al. [25] reported its effectiveness in reducing POST, though higher doses showed better outcomes. Rajan et al. [24] also noted dose-dependent efficacy, suggesting that the fixed dose used in our study may have limited early effectiveness. In comparison with ketamine, Jain et al. [26] and Sudjud et al. [27] demonstrated that both ketamine and magnesium sulphate reduce POST, with ketamine showing superior efficacy in some intervals. This further indicates that magnesium sulphate has moderate potency among NMDA antagonists for early airway protection. However, our study findings suggest that dexmedetomidine offers better early-phase protection than magnesium sulphate.

Hemodynamically, both Dexmedetomidine and Magnesium sulphate are effective in attenuation of stress response to intubation and extubation. Our study results showed that dexmedetomidine provided better attenuation of heart rate, systolic, diastolic and mean arterial pressure at critical peri-intubation time points. These findings are consistent with Kumar RR et al. [28] and Shrivastava P et al. [29], who reported effective blunting of intubation stress response with dexmedetomidine nebulization. The effect is attributed to reduced norepinephrine release via presynaptic α2 receptor activation [12,13]. Choudhary et al. [30] and Jaisawal et al. [31] also reported superior stress attenuation and reduced biochemical stress markers such as cortisol and TNF-α with dexmedetomidine compared to magnesium sulphate. In contrast, magnesium sulphate demonstrates less consistent sympatholytic action despite its NMDA-mediated analgesic effects [30]. Regarding safety, we noticed bradycardia in one patient and hypotension in two patients in group D which was managed conservatively. Similar safety profiles of Dexmedetomidine were reported by Pradian E et al. [14] and Kumar RR et al. [28], supporting its safe use in nebulised form with minimal systemic side effects. Similarly, our study showed good tolerability of Magnesium sulphate in nebulised form without significant adverse effects, which is consistent with study by Borazan et al. [32].

Limitations of the Study: The study was conducted on a relatively small sample size (n = 60), which may limit the generalisability of the findings. Subjective assessment of POST using a grading scale may introduce observer variability despite blinding measures. Our study lacks a control group. Adding a control group and comparing it with Dexmedetomidine and magnesium sulphate would have allowed us for better interpretation of results, further strengthening the study. The observation period was limited to 24 hours postoperatively; late or persistent postoperative sore throat beyond this period was not assessed which may delay discharge of patient from the hospital.

Conclusion

Preoperative nebulization with dexmedetomidine is more effective than magnesium sulphate in reducing the incidence and severity of early postoperative sore throat following endotracheal intubation. Dexmedetomidine also provides better attenuation of peri-intubation hemodynamic responses with minimal side effects. Both agents are safe, simple and useful adjuncts in reducing POST and improving overall patient comfort and recovery.

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