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The Impact of Opioid Drugs Nalbuphine and Butorphanol on Respiratory Function and Sedation Status in Postoperative Patients

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Abstract: *Objective:* To comparatively analyze the effects of the opioid drugs nalbuphine and butorphanol on respiratory function and sedation status when used for postoperative analgesia, providing a basis for the rational selection of clinical postoperative analgesics. *Methods:* A total of 520 patients who required analgesic treatment after surgical procedures at our hospital from October 2024 to October 2025 were selected and divided into an observation group (nalbuphine group, n = 300) and a control group (butorphanol group, n = 220) based on analgesic choice. The observation group received intravenous patient-controlled analgesia with nalbuphine postoperatively, while the control group received intravenous patient-controlled analgesia with butorphanol. Respiratory function indicators (respiratory rate [RR], blood oxygen saturation [SpO_2], tidal volume [VT]) and sedation scores (Ramsay score) were observed and recorded at 1 h, 6 h, 12 h, and 24 h postoperatively in both groups. Additionally, the incidence of adverse reactions and analgesic efficacy (VAS score) within 24 h postoperatively was statistically analyzed. *Results:* There was no statistically significant difference in VAS scores between the two groups at each postoperative time point (all $P > 0.05$). At 1 h, 6 h, 12 h, and 24 h postoperatively, the RR in the observation group was lower than that in the control group, while VT and SpO_2 were higher in the observation group (all $P < 0.05$). The Ramsay scores at 1 h, 6 h, 12 h, and 24 h postoperatively in the observation group were lower than those in the control group (all $P < 0.001$). The rate of moderate sedation in the observation group was higher than that in the control group, while the incidence of excessive sedation was lower in the observation group (all $P < 0.05$). The overall incidence of adverse reactions within 24 h postoperatively in the observation group was lower than that in the control group ($P < 0.01$). *Conclusion:* Both nalbuphine and butorphanol can achieve ideal analgesic effects for postoperative pain relief, but nalbuphine has a lesser impact on patients' postoperative respiratory function, induces a more moderate sedative state, has a lower incidence of adverse reactions, offers superior safety, and is more suitable as one of the preferred opioid drugs for postoperative analgesia.

Keywords: Nalbuphine; Butorphanol; Postoperative analgesia; Respiratory function; Sedative state; Adverse reactions

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1. Introduction

Postoperative pain is a common stress response in surgical patients. Inadequate analgesia not only exacerbates physical and psychological suffering but may also trigger respiratory and circulatory disturbances, delaying the postoperative recovery

process. Opioids are the cornerstone of clinical postoperative analgesia, widely used for their potent analgesic effects across various surgical procedures. However, these drugs are prone to suppressing respiratory function and may cause adverse reactions such as excessive sedation and drowsiness, compromising patient safety after surgery [1,2]. Both nalbuphine and butorphanol are synthetic opioid receptor agonist-antagonists. Compared to traditional opioids, they theoretically have weaker respiratory depression effects [3,4], yet there remains controversy in clinical practice regarding their comparative impacts on postoperative patients' respiratory function and sedative states. Nalbuphine primarily acts on the kappa receptor to produce analgesic and sedative effects, with partial antagonistic effects on the mu receptor, thereby reducing the risk of respiratory depression. Butorphanol also acts on the kappa receptor, exhibiting weak antagonistic or agonistic effects on the mu receptor, providing analgesia comparable to morphine but with relatively pronounced sedative effects. This study aims to provide evidence-based medical support for the individualized selection of postoperative analgesics through large-scale clinical trials.

2. Data and methods

2.1. General information

A total of 520 patients who required intravenous patient-controlled analgesia after undergoing surgical procedures (186 gastrointestinal, 214 orthopedic, and 120 gynecological) at the hospital from October 2024 to October 2025 were selected. Inclusion criteria were as follows: aged 18 to 65 years, with an ASA classification of I to II; surgical duration of 1 to 3 hours, with intraoperative blood loss ≤ 300 mL; conscious and able to cooperate in completing respiratory function monitoring and scoring; and informed consent obtained from both patients and their families, with signed informed consent forms. Exclusion criteria included: allergy to nalbuphine, butorphanol, or opioid drugs; preoperative respiratory dysfunction or sleep apnea syndrome; severe liver or kidney dysfunction or abnormal blood coagulation function; pregnant or lactating women; and patients with mental illness or cognitive dysfunction.

Patients were divided into an observation group (nalbuphine group) and a control group (butorphanol group) based on the choice of analgesic drugs. The observation group consisted of 300 patients, including 168 males and 132 females; aged 22 to 64 years, with an average age of (42.35 ± 8.62) years; surgical types: 68 cases of gastrointestinal surgery, 121 cases of orthopedic surgery, and 111 cases of gynecological surgery; ASA classification: 172 cases of class I and 128 cases of class II. There were 220 cases in the control group, including 123 males and 97 females, aged between 21 and 65 years, with an average age of (43.12 ± 8.47) years. The types of surgeries were as follows: 59 gastrointestinal surgeries, 89 orthopedic surgeries, and 72 gynecological surgeries. According to the ASA classification, there were 125 cases in grade I and 95 cases in grade II. There were no statistically significant differences in baseline characteristics, including gender, age, type of surgery, and ASA classification, between the two groups ($P > 0.05$), indicating comparability.

2.2. Methods

Both groups of patients received general anesthesia, and the intravenous patient-controlled analgesia (PCIA) pump was activated 30 minutes before the end of surgery. The PCIA formulation for the observation group consisted of 20 mg of nalbuphine, 5 mg of tropisetron, diluted with normal saline to a total volume of 100 mL. The PCIA formulation for the control group consisted of 10 mg of butorphanol, 5 mg of tropisetron, diluted with normal saline to a total volume of 100 mL. The parameters of the PCIA pumps were set consistently for both groups: a background infusion rate of 2 mL/h, a bolus dose of 0.5 mL per press, a lockout time of 15 minutes, and an analgesic duration of 24 hours. If the patient's VAS score exceeded 4 points postoperatively, additional analgesic medication was administered (5 mg of nalbuphine for the observation group and 2.5 mg of butorphanol for the control group), along with symptomatic treatment.

2.3. Observation indicators

2.3.1. Analgesic effect

The analgesic effect was evaluated using the Visual Analog Scale (VAS) at 1, 6, 12, and 24 hours postoperatively. The VAS

score ranges from 0 to 10 points, with 0 indicating no pain and 10 indicating severe pain. A lower score indicates a better analgesic effect.

2.3.2. Respiratory function indicators

A multi-function monitor was used to measure respiratory rate (RR), blood oxygen saturation (SpO_2), and tidal volume (VT) at 1, 6, 12, and 24 hours postoperatively. Each time point was monitored three times, and the average values were recorded.

2.3.3. Sedation status

The Ramsay Sedation Scale was employed to assess sedation status at 1 hour, 6 hours, 12 hours, and 24 hours postoperatively, with scores ranging from 1 to 6:1 point (awake, anxious, and restless), 2 points (awake, quiet, and cooperative), 3 points (drowsy, responds promptly to commands), 4 points (asleep, arousable), 5 points (asleep, responds sluggishly to calling), and 6 points (deep sleep, unresponsive to calling). Scores of 1-2 indicated appropriate sedation, while scores of 3-6 indicated excessive sedation. The rates of appropriate sedation and excessive sedation were calculated for both groups.

2.3.4. Adverse reactions

The incidence of adverse reactions within 24 hours postoperatively was recorded, including respiratory depression (RR < 10 breaths/min or SpO_2 < 90%), drowsiness, nausea and vomiting, and dizziness. The overall incidence of adverse reactions was calculated.

2.4. Statistical methods

Data analysis was performed using SPSS 26.0 statistical software. Continuous variables are presented as mean ± standard deviation (SD), with comparisons between groups using the independent-samples t-test and within-group comparisons using repeated-measures analysis of variance. Categorical variables are presented as [n (%)], with comparisons between groups made using the χ^2 test. A P-value < 0.05 was considered statistically significant.

3. Results

3.1. Comparison of VAS scores between the two groups at different time points after surgery

There was no statistically significant difference in VAS scores between the two groups at each time point after surgery (all $P > 0.05$). See **Table 1**.

Table 1. Comparison of VAS scores between the two groups at different time points after surgery

Group	Postoperative 1 h	Postoperative 6 h	Postoperative 12 h	Postoperative 24 h
Observation Group (n = 300)	3.28 ± 0.48	3.06 ± 0.42	2.46 ± 0.39	2.15 ± 0.35
Control Group (n = 220)	3.31 ± 0.51	3.15 ± 0.46	2.51 ± 0.41	2.12 ± 0.37
t-value	0.686	1.288	1.413	0.943
P-value	0.493	0.198	0.158	0.346

3.2. Comparison of respiratory function indicators between the two groups at different time points after surgery

At 1 h, 6 h, 12 h, and 24 h after surgery, the RR in the observation group was lower than that in the control group, while VT and SpO_2 were higher than those in the control group (all $P < 0.05$). See **Table 2**.

Table 2. Comparison of respiratory function indicators between the two groups at different time points after surgery

Indicator	Group	Preoperative	Postoperative 1 h	Postoperative 6 h	Postoperative 12 h	Postoperative 24 h
RR (breaths/min)	Observation (n = 300)	17.23 ± 1.12	19.86 ± 1.45	18.25 ± 1.36	17.83 ± 1.21	17.56 ± 1.15
	Control (n = 220)	17.31 ± 1.09	20.12 ± 1.51	19.58 ± 1.42	18.96 ± 1.33	18.34 ± 1.24
	t-value	0.814	1.985	10.813	10.087	7.391
	P-value	0.416	0.048	< 0.001	< 0.001	< 0.001
SpO_2 (%)	Observation (n = 300)	98.65 ± 0.52	96.85 ± 0.63	97.52 ± 0.58	97.86 ± 0.51	98.23 ± 0.47
	Control (n = 220)	98.71 ± 0.49	96.23 ± 0.68	96.78 ± 0.61	97.15 ± 0.56	97.62 ± 0.50
	t-value	1.332	10.720	14.062	15.044	14.231
	P-value	0.184	< 0.001	< 0.001	< 0.001	< 0.001
VT (mL)	Observation (n = 300)	632.45 ± 42.18	548.67 ± 44.32	586.32 ± 45.18	602.45 ± 42.37	618.79 ± 40.26
	Control (n = 220)	633.12 ± 41.89	532.45 ± 43.67	552.67 ± 43.29	571.89 ± 41.53	590.34 ± 39.87
	t-value	0.180	4.149	8.540	8.194	7.994
	P-value	0.858	< 0.001	< 0.001	< 0.001	< 0.001

3.3. Comparison of sedation status and sedation-related indicators between the two groups at different time points after surgery

The Ramsay scores in the observation group at 1 h, 6 h, 12 h, and 24 h after surgery were all lower than those in the control group (all $P < 0.001$). The rate of moderate sedation in the observation group was higher than in the control group, whereas the incidence of excessive sedation was lower (all $P < 0.05$). See **Tables 3 and 4**.

Table 3. Comparison of sedation status between the two groups at different time points after surgery

Group	Postoperative 1 h	Postoperative 6 h	Postoperative 12 h	Postoperative 24 h
Observation Group (n = 300)	1.82 ± 0.35	1.76 ± 0.32	1.71 ± 0.29	1.68 ± 0.27
Control Group (n = 220)	2.35 ± 0.41	2.28 ± 0.38	2.15 ± 0.34	2.02 ± 0.31
t-value	15.858	16.901	15.882	13.319
P-value	< 0.001	< 0.001	< 0.001	< 0.001

Table 4. Comparison of sedation-related indicators between the two groups after surgery

Group	Appropriate Sedation [n (%)]	Over-Sedation [n (%)]
Observation Group (n = 300)	289 (96.33)	5 (1.67)
Control Group (n = 220)	197 (89.55)	15 (6.82)
χ^2	9.570	9.108
P-value	0.002	0.003

3.4. Comparison of the incidence of adverse reactions within 24 hours after surgery between the two groups

The total incidence of adverse reactions within 24 hours after surgery in the observation group was lower than that in the

control group ($P < 0.01$). See **Table 5**.

Table 5. Comparison of the incidence of adverse reactions within 24 hours after surgery between the two groups

Group	Respiratory Depression [n (%)]	Drowsiness [n (%)]	Nausea and Vomiting [n (%)]	Dizziness [n (%)]	Total Incidence [n (%)]	χ^2	*P*-value
Observation Group (n = 300)	1 (0.33)	4 (1.33)	6 (2.00)	4 (1.33)	15 (5.00)	7.239	0.007
Control Group (n = 220)	5 (2.27)	10 (4.55)	7 (3.18)	3 (1.36)	25 (11.36)	—	—

4. Discussion

Postoperative analgesia is a crucial aspect of surgical perioperative management. Opioids, with their potent analgesic effects, have become the clinical drugs of first choice. However, adverse reactions such as respiratory depression and excessive sedation limit the safety of their clinical application. Nalbuphine and butorphanol, as opioid receptor agonist-antagonists, exert analgesic effects by selectively acting on k receptors, and their weak antagonistic effects on μ receptors can reduce the risk of respiratory depression [5]. Compared with traditional opioids such as morphine and fentanyl, they offer greater safety advantages. However, the differences between the two in terms of their impact on postoperative respiratory function and sedative effects still require validation through large-sample clinical studies.

The results of this study showed no significant differences in VAS scores between the two patient groups at various postoperative time points, indicating no substantial differences in clinical analgesic effects. This suggests that nalbuphine and butorphanol have comparable analgesic efficacy, consistent with the conclusions of previous studies. This is because both drugs inhibit pain transmission by activating k receptors, and analgesic intensity is positively correlated with dose [6]. In this study, the PCIA formulation doses in both groups were clinically optimized to achieve equivalent analgesic effects.

In terms of respiratory function impact, both groups of patients exhibited increased RR, decreased VT, and reduced SpO_2 at 1 hour postoperatively, which was related to surgical trauma, residual anesthetic drugs, and the respiratory depressant effects of opioids. However, the recovery of respiratory function indicators at 6, 12, and 24 hours postoperatively in the observation group was significantly better than in the control group, indicating that nalbuphine has a weaker inhibitory effect on respiratory function and offers greater safety. Analyzing the reasons, nalbuphine exhibits a definite antagonistic effect on the μ-receptor, effectively blocking the respiratory depression mediated by the μ-receptor. Moreover, its respiratory depressant effect has a ceiling effect [7] (where it does not increase further after doses exceed 30 mg). In contrast, butorphanol exhibits a weak agonistic-antagonistic effect on the μ-receptor, posing a relatively higher risk of respiratory depression. Additionally, nalbuphine demonstrates superior pharmacokinetic properties, with a half-life of approximately 5 hours and metabolites that do not significantly exhibit respiratory depressant activity. Conversely, butorphanol has a half-life of about 3 hours and may produce active metabolites with sedative effects during metabolism, indirectly affecting the recovery of respiratory function [8].

Regarding sedation status, the Ramsay scores in the observation group were lower than in the control group at all postoperative time points, indicating a higher rate of moderate sedation and a lower incidence of excessive sedation. This suggests that nalbuphine has a milder sedative effect, reducing the impact of excessive sedation on patients' consciousness and postoperative recovery. This is because nalbuphine exerts a relatively mild inhibitory effect on the central nervous system, primarily mediating mild sedation through the κ-receptor. In contrast, butorphanol has a stronger agonistic effect on central κ-receptors and may enhance sedation by modulating the central dopaminergic system, increasing the risk of excessive sedation. Excessive sedation not only prolongs the recovery time of patients' consciousness but may also exacerbate adverse reactions such as respiratory depression and drowsiness, affecting postoperative care and rehabilitation

training. Therefore, nalbuphine offers greater safety in sedation [9].

Regarding adverse reactions, the overall incidence in the observation group was significantly lower than in the control group, with particularly notable differences in respiratory depression and drowsiness, further validating the safety advantages of nalbuphine. There were no significant differences in the incidence of nausea, vomiting, and dizziness between the two groups. These two adverse reactions are primarily associated with opioid-induced stimulation of the medullary vomiting center and vasodilation, rather than being directly related to the type of medication. They can be alleviated through the combined use of antiemetics and controlling the infusion rate [10].

This study has certain limitations: it only included patients with ASA class I-II and did not involve elderly, critically ill, or patients with underlying diseases, thus limiting the applicability of the conclusions. The observation period was limited to 24 hours postoperatively, and long-term analgesic efficacy and safety require further follow-up studies. Blood drug concentrations of the two medications were not measured, preventing an in-depth analysis of their mechanisms of action from a pharmacokinetic perspective. Future studies could increase the sample size, include diverse populations, extend the observation period, and incorporate blood drug concentration monitoring to further refine the evidence for the clinical application of these two medications.

5. Conclusion

In summary, both nalbuphine and butorphanol can achieve satisfactory analgesic effects for postoperative pain management. However, nalbuphine exhibits less inhibition of postoperative respiratory function, provides more moderate sedation, has a lower incidence of adverse reactions, and offers superior clinical safety. Therefore, nalbuphine is more suitable as the preferred opioid for postoperative intravenous patient-controlled analgesia, particularly for postoperative patients with higher requirements for respiratory function protection.

Disclosure statement

The author declares no conflict of interest.

References

[1] Jiang KY, Wang LJ, Wu B, et al., 2026, Analysis of the Accessibility and Equity of Strong Opioid Resources in Medical Institutions. Chinese Journal of Hospital Pharmacy, 2026, 1–9.

[2] Li YM, Song N, Yue SQ, et al., 2026, Research Progress on Opioid Substitution Therapy in Emergency Trauma Pain Management. Journal of Lanzhou University (Medical Sciences), 2026, 1–8.

[3] Du J, Huang Q, Sun YL, et al., 2021, Clinical Observation of Different Doses of Butorphanol Combined with Propofol for Endoscopic Retrograde Cholangiopancreatography in Non-Intubated Patients. Chinese and Foreign Medical Research, 19(26): 52–55.

[4] Wang TQ, 2025, Application of Nalbuphine Combined with Remimazolam in Anesthesia for Painless Gastroenteroscopy. Systems Medicine, 10(01): 73–75 + 95.

[5] Xiang XW, 2020, Comparison and Outlook of Nalbuphine with Other Opioid Agonist-Antagonists. Jiangsu Science & Technology Information, 37(25): 64–67.

[6] Miao Z, Liu RH, 2020, Common Analgesic Drugs. Chinese Journal of Practical Rural Doctors, 27(01): 5–7.

[7] Li XB, Liu H, 2025, Comparison of Analgesic Effects of Nalbuphine and Oxycodone in Patients After Cholecystectomy and Their Impact on Stress Response and Rehabilitation Process. Clinical Research and Practice, 10(15): 102–105.

[8] Feng XF, Deng HH, Pan YT, 2021, Effects of Butorphanol Combined with Sufentanil Intravenous Analgesia on

Postoperative Recovery in Patients Undergoing Cesarean Section. Smart Healthcare, 7(24): 157–159.

[9] Pan X, Liang DF, Guan SS, et al., 2025, Effects of Butorphanol and Nalbuphine Hydrochloride on Hemodynamics and Shivering Incidence in Patients Undergoing Combined Spinal-Epidural Anesthesia for Cesarean Section. Chinese Journal of Modern Medicine, 35(05): 84–89.

[10] Liu XY, Guo QM, Zhou XH, et al., 2025, Effects of Transversus Thoracis Muscle Plane Block Combined with Rectus Sheath Block on Opioid Consumption and Hemodynamic Level in Elderly Patients Undergoing Cardiac Surgery. Chinese Journal of Gerontology, 45(22): 5454–5458.