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Original Article

Comparison of nalbuphine and dezocine for postoperative analgesia in elderly patients undergoing laparoscopic radical gastric cancer surgery

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Abstract: Objective: Gastric cancer is a prevalent and significant malignancy that occurs throughout the world, with a particularly pronounced impact on the elderly population. This study aims to compare the efficacy of nalbuphine and dezocine in managing pain following laparoscopic radical gastrectomy. Method: Elderly patients undergoing laparoscopic radical gastrectomy were divided into a nalbuphine (n=50) group and a dezocine (n=50) group according to their anesthesia agent. Anesthesia methods included preoperative intravenous administration of either 0.15 mg/kg nalbuphine or 0.1 mg/kg dezocine, followed by continuous propofol infusion during surgery. Pain and sedation levels were assessed using the VAS and Ramsay Sedation Scale. Secondary indicators included postoperative pain indicators, hemodynamic parameters, recovery time, and adverse anesthetic reactions. Results: There were no significant differences in baseline data between the two groups, including gender, age, body weight, ASA classification, gastric cancer stage, and surgery duration (all $P > 0.05$). The nalbuphine group showed superior postoperative pain management compared to the dezocine group, with lower VAS, RSS, inflammatory levels (SP and IL-6) and stress response indicators (all $P < 0.05$). The nalbuphine group also had shorter awakening time, higher awakening quality, shorter surgery time, and earlier extubation time. Furthermore, the incidence of adverse events was lower in the nalbuphine group. Conclusion: Nalbuphine provides better postoperative pain relief and was associated with fewer adverse events in elderly patients undergoing laparoscopic radical gastrectomy. These findings suggest that nalbuphine is a safer and more effective analgesic option in this clinical context.

Keywords: Postoperative pain management, laparoscopic radical gastrectomy, elderly, gastric cancer, nalbuphine, dezocine

Introduction

Gastric cancer is a lethal malignancy seen worldwide, particularly affecting the elderly population. Radical gastrectomy, which involves the comprehensive removal of the tumor, offers a potential for curative treatment [1, 2]. Gastric cancer typically affects the original tumor, metastatic lymph nodes, and infiltrating tissues [3]. Surgical approaches for radical gastrectomy encompass conventional open surgery, laparoscopic-assisted gastrectomy, total laparoscopic radical gastrectomy, and robotic radical gastrectomy [4, 5]. Among these, the minimally invasive approach offers several advantages, including diminished postoperative pain, faster recovery, and better cosmetic outcomes [6, 7]. However, effective postoperative pain management remains crucial to ensure optimal recovery, minimize complications, and enhance overall quality of life [8].

Various analgesics have been used to manage postoperative pain [9, 10]. Opioid analgesics, such as nalbuphine and dezocine, are extensively used for pain control due to their efficacy [11, 12]. However, concerns about opioid-induced side effects and potential for depen-

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dency necessitate a careful assessment of their use in clinical practice [13, 14]. Therefore, understanding the comparative efficacy and safety of these analgesics is essential for optimizing postoperative pain management, particularly in vulnerable elderly patients. This study compares the analgesic efficacy and safety of nalbuphine and dezocine in elderly patients undergoing laparoscopic radical gastrectomy. By evaluating pain scores, sedation levels, inflammatory markers, stress responses, recovery time, and incidence of adverse events, we seek to offer valuable insights into the optimal use of these analgesics for adequate postoperative pain control in this patient population.

Materials and methods

General information

In this retrospective study, the clinical data of elderly patients undergoing laparoscopic gastrectomy for gastric cancer at Nanfang Hospital, Southern Medical University from September 2021 to October 2023 were collected and analyzed. Subjects were selected using propensity score matching (PSM) with SPSS software, matching elderly patients who underwent laparoscopic gastrectomy with either nalbuphine anesthesia (nalbuphine group) or dezocine anesthesia (dezocine group) in a 1:1 ratio. Matching criteria included age, gender, body weight, American society of Anesthesiologists (ASA) classification, gastric cancer stage, and surgery duration, with a balance test to ensure comparability between the groups after matching.

Before matching, there were 62 patients in the nalbuphine group and 68 in the dezocine group. After matching, each group consisted of 50 patients. This study was approved by the Ethics Committee of Nanfang Hospital, Southern Medical University.

Inclusion criteria: 1. Patient with a diagnosis of gastric cancer [15]; 2. Patient who underwent laparoscopic gastrectomy for gastric cancer with clear surgical indications; 3. ASA classification I to II; 4. No history of anesthesia drug allergy.

Exclusion criteria: 1. Patients with a history of chronic pain; 2. Patients with severe liver or kidney dysfunction; 3. Patients with severe cardiovascular/cerebrovascular diseases or coagulopathy; 4. Patients with dependency on anesthetic drugs.

Anesthesia methods

Standard preoperative fasting and fluid restriction protocols were followed. An intravenous line was established upon entering the operating room, and cardiac monitoring was initiated. Fifteen minutes before the start of surgery, 0.1 mg/kg of Dezocine (Yangtze River Pharmaceutical Group Co., Ltd., H20080329) was slowly injected intravenously in the Dezocine group; while 0.15 mg/kg of Nalbuphine (Jiangsu Yangtze River Pharmaceutical Group Co., Ltd., H20213459) was slowly administered intravenously in the Nalbuphine group.

In both groups, Propofol (Xi'an Libang Pharmaceutical Co., Ltd., H19990281) was continuously infused during surgery at 6 mg/(kg/h) through a micro-infusion pump until the end of surgery. If patients showed limb movements due to surgical stimulation that interfered with the procedure, an additional intravenous dose of 0.5 mg/kg propofol was administered, and surgery resumed once the patient was calm. If the patient's heart rate dropped below 50 bpm during surgery, 0.3 mg of Atropine sulfate (Suicheng Pharmaceutical Co., Ltd., H41021256) was injected intravenously. If the patient's blood pressure dropped more than 20% below baseline during surgery, 6 mg of Ephedrine (Chengdu Brilliant Pharmaceutical Co., Ltd., H32021530) was injected intravenously. In the case of respiratory depression (SpO_2 < 95%), ventilation was improved by lifting the mandible or using a face mask with positive-pressure oxygen.

Observation indicators

Primary indicators: Pain and sedation levels were assessed before and after anesthesia in both groups using the Visual Analog Scale (VAS) [16] and the Ramsay Sedation Scale (RSS) [17]. The VAS score of 0-2 indicates mild pain, 3-5 for moderate pain, 6-8 for severe pain, and 8-10 for very severe pain. The RSS scores range from 1 for agitation to 6 for excessive sedation, with scores of 2-5 indicating appropriate sedation.

Table 1. Comparison of clinical data between the two groups

Group	Gastric cancer stage		Age (years)	Gender		Body Mass (kg)	ASA Classification	
	I	II		Male	Female		I	II
Nalbuphine group (n=50)	20 (40.00)	30 (60.00)	46.46 ± 10.16	31 (62.00)	19 (38.00)	55.34 ± 5.70	30 (60.00)	20 (40.00)
Dezocine group (n=50)	21 (42.00)	29 (58.00)	46.26 ± 12.02	29 (58.00)	21 (42.00)	55.32 ± 6.03	32 (64.00)	18 (36.00)
t/X^2	0.041		0.090	0.167		0.017	0.170	
P	0.839		0.929	0.683		0.986	0.680	

ASA: American society of Anesthesiologists.

Secondary indicators: 1. Postoperative pain indicators: Venous blood samples (3 ml) were collected 24 hours postoperatively, and the supernatant was retained after centrifugation. Levels of substance P (SP) (Thermo Fisher Scientific, USA, EEL013), interleukin (IL)-6 (Thermo Fisher Scientific, USA, 88-7066-88), prostaglandin E2 (PGE2) (Thermo Fisher Scientific, USA, EEL007), pain-related indicators, were measured using enzyme-linked immunosorbent assay (ELISA), following the instructions provided with the test kits. 2. Hemodynamic parameters: Mean arterial pressure (MAP), systolic blood pressure (SBP), peripheral capillary oxygen saturation (SpO_2), diastolic blood pressure (DBP), and heart rate (HR) were compared between the two groups at different time points: upon entering the operating room (T_0), immediately after anesthesia administration (T_1), at the start of laparotomy (T_2), at the end of surgery (T_3), and upon emergence from anesthesia (T_4). 3. Postoperative pain-related indicators: Cortisol (Cor), epinephrine (E), and norepinephrine (NE) levels were compared between the two groups. 4. Recovery time, quality of recovery, surgical time, and extubation time: Quality of recovery was assessed using the Steward Recovery Score [18], which evaluates patient recovery in terms of consciousness, airway patency, and limb movement, with each item scored from 0 to 2, yielding a total score of 6. Higher scores indicate better recovery quality. 5. Adverse anesthetic reactions: The frequency of adverse reactions was compared between the two groups.

Statistical methods

SPSS 22.0 software was utilized for data processing and statistical analysis. The Shapiro-Wilk test was employed to evaluate normality of data distribution. Normally distributed continuous variables were presented as mean ± standard deviation and compared using independent-sample t-tests. For non-normally distributed data, median (P25, P75) was reported, and the Mann-Whitney U test comparisons were made. One-way analysis of variance (ANOVA) was utilized for multiple group comparisons. Categorical data were expressed as number (%). When the sample size was 40 or greater and the theoretical frequency (T) was 5 or more, the χ^2 test was employed to compare groups. Continuity correction tests were used for sample sizes ≥ 40 and theoretical frequencies of $1 \leq T < 5$. Fisher's exact probability method was used for sample sizes < 40 or theoretical frequencies $T < 1$. A *P* value of < 0.05 was considered statistically significant.

Results

Comparison of clinical data between the two groups

There were no significant differences in the clinical data between the two groups, including gender, age, body weight, ASA classification, gastric cancer stage, and surgery duration (all $P > 0.05$), as shown in **Table 1**.

Comparison of analgesic effects between the two groups

Comparison of analgesic effects between the two groups revealed that patients in the nalbuphine group exhibited significantly lower VAS scores and Ramsay sedation scores than those in the dezocine group (all $P < 0.05$). Statistical analysis revealed a t/Z value of -6.522 for VAS scores and -3.706 for Ramsay sedation scores, yielding a significant *P* value of less than 0.001 (**Table 2**).

Comparison of postoperative pain indicators between the two groups

The analysis of postoperative pain indicators revealed notable differences between the nal-

Table 2. Comparison of VAS and RSS scores between the two groups

Group	VAS (scores)	RSS (scores)
Nalbuphine group (n=50)	2 (1, 2)	4 (3, 5)
Dezocine group (n=50)	3 (2, 3)	5 (3.5, 6)
Z	-6.522	-3.706
P	< 0.001	< 0.001

VAS: Visual Analog Scale; RSS: Ramsay Sedation Scale.

Table 3. Comparison of PGE2, IL-6, and SP Levels between the two groups

Group	PGE2 (pg/mL)	IL-6 (pg/mL)	SP (μg/mL)
Nalbuphine group (n=50)	93.58 ± 10.52	7.10 ± 2.85	4.53 ± 1.18
Dezocine group (n=50)	95.20 ± 12.07	9.23 ± 3.20	6.85 ± 2.06
t	-0.715	-3.52	-6.924
P	0.476	0.001	< 0.001

PGE2: prostaglandin E2; IL-6: interleukin-6; SP: substance P.

buphine and dezocine groups. Patients administered nalbuphine showed significantly lower levels of SP and IL-6 compared to the dezocine group (both $P < 0.05$), indicating a more effective pain management with nalbuphine. Specifically, the mean IL-6 level in the nalbuphine group was 7.10 pg/mL (standard deviation: 2.85 pg/mL), while in the dezocine group, it was 9.23 pg/mL (standard deviation: 3.20 pg/mL). Similarly, the mean SP level was 4.53 μg/mL (standard deviation: 1.18 μg/mL) in the nalbuphine group and 6.85 μg/mL (standard deviation: 2.06 μg/mL) in the dezocine group. Statistical analysis demonstrated a t value of -3.52 for IL-6 levels and -6.924 for SP levels, with corresponding *P* values of 0.001 and < 0.001, respectively (**Table 3**). These findings suggest that nalbuphine may offer superior postoperative pain relief and anti-inflammatory effects compared to dezocine.

Comparison of vital signs between the two groups at different time points

Both groups exhibited lower MAP, HR, SpO_2, SBP, and DBP levels at time points T_1, T_2, T_3, and T_4 compared to baseline (T_0) levels (all $P < 0.05$). Furthermore, patients in the nalbuphine group demonstrated more stable vital sign levels throughout the perioperative period than those in the dezocine group.

In the nalbuphine group, the mean MAP decreased from 105.44 ± 8.19 mmHg at T_0 to 96.22 ± 5.62 mmHg at T_4, while in the dezocine group, it decreased from 105.26 ± 8.20 mmHg at T_0 to 96.80 ± 5.64 mmHg at T_4. Similarly, the mean HR decreased from 94.54 ± 6.83 bpm at T_0 to 66.34 ± 7.41 bpm at T_4 in the nalbuphine group and from 93.58 ± 6.47 bpm at T_0 to 65.88 ± 6.61 bpm at T_4 in the dezocine group.

Regarding SpO_2 levels, the nalbuphine group exhibited a decrease from (99.20 ± 2.63)% at T_0 to (97.98 ± 5.11)% at T_4, while the dezocine group showed a decline from (99.22 ± 2.68)% at T_0 to (97.20 ± 2.65)% at T_4. Moreover, SBP and DBP followed similar trends, with gradual decreases observed over the monitored time points in both groups. Statistical analysis revealed significant differences between T_0 and other time points (T_1, T_2, T_3, T_4) for all vital signs in both groups (all $P < 0.05$). Additionally, intergroup comparisons showed more stable vital sign levels in the nalbuphine group. Detailed data are presented in **Table 4**, and changes in vital signs over time are illustrated in **Figure 1**.

Comparison of stress response indicators between the two groups at different time points

The evaluation of stress response indicators revealed significant differences between the nalbuphine and dezocine groups. Both groups exhibited elevated Cor, E, and NE at time points T_1, T_2, T_3, and T_4 compared to baseline (T_0) levels (all $P < 0.05$). Moreover, patients in the nalbuphine group demonstrated lower levels of Cor, E, and NE at these time points than those in the dezocine group.

In the nalbuphine group, Cor levels increased from 198.80 ± 20.36 nmol/L at T_0 to 310.85 ± 35.60 nmol/L at T_4, while in the dezocine group, they increased from 199.02 ± 22.36 nmol/L at T_0 to 442.62 ± 38.60 nmol/L at T_4. Similarly, E levels increased from 46.58 ± 5.86 ng/mL at T_0 to 65.30 ± 6.80 ng/mL at T_4 in the nalbuphine group and from 46.42 ± 5.22 ng/mL at T_0 to 96.30 ± 9.62 ng/mL at T_4 in the dezocine group. Additionally, NE levels showed similar patterns, with gradual increases observed over the monitored time points in both groups.

Table 4. Comparison of MAP, HR, SpO_2, SBP, and DBP between the two groups

Group	Indicator	T_0	T_1	T_2	T_3	T_4
Nalbuphine group	MAP (mmHg)	105.44 ± 8.19	100.66 ± 6.92*	98.56 ± 8.02*	97.66 ± 6.00*	96.22 ± 5.62*
	HR (bpm)	94.54 ± 6.83	66.60 ± 7.34***	67.58 ± 6.53***	66.40 ± 7.72***	66.34 ± 7.41***
	SpO_2 (%)	99.20 ± 2.63	94.86 ± 4.28*	95.24 ± 4.44*	96.48 ± 5.39*	97.98 ± 5.11
	SBP (mmHg)	132.82 ± 8.51	111.58 ± 7.85***	116.62 ± 10.36***	121.18 ± 12.59**	122.60 ± 14.52**
	DBP (mmHg)	86.88 ± 5.89	72.46 ± 6.76***	74.58 ± 6.59**	76.24 ± 6.85**	76.08 ± 7.55**
Dezocine group	MAP (mmHg)	105.26 ± 8.20	100.56 ± 7.87*	99.48 ± 7.63*	103.54 ± 5.83	96.80 ± 5.64*
	HR (bpm)	93.58 ± 6.47	65.06 ± 8.64***	67.84 ± 7.24***	64.50 ± 6.38***	65.88 ± 6.61***
	SpO_2 (%)	99.22 ± 2.68	95.24 ± 4.26*	95.64 ± 4.58*	96.32 ± 5.48*	97.20 ± 2.65*
	SBP (mmHg)	133.22 ± 8.23	110.84 ± 8.67**	115.80 ± 9.66**	123.58 ± 10.78*	123.72 ± 13.29*
	DBP (mmHg)	85.56 ± 6.92	71.48 ± 6.83**	74.42 ± 6.97**	75.24 ± 8.55**	76.68 ± 7.25**

MAP: Mean arterial pressure; HR: heart rate; SpO_2: Peripheral capillary oxygen saturation; SBP: systolic blood pressure; DBP: diastolic blood pressure; *Compared to T_0, $P < 0.05$, **Compared to T_0, $P < 0.01$, ***Compared to T_0, $P < 0.001$.

Statistical analysis revealed significant differences between T_0 and other time points (T_1, T_2, T_3, T_4) for all stress response indicators in both groups (all $P < 0.05$). Furthermore, intergroup comparisons demonstrated lower levels of Cor, E, and NE in the nalbuphine group compared to the dezocine group at all time points. Detailed data are presented in **Table 5**, and changes in stress response indicators over time are illustrated in **Figure 2**.

Comparison of recovery time, quality of recovery, surgery time, and extubation time between the two groups

Patients treated with nalbuphine exhibited a significantly shorter recovery time (10.50 ± 2.28 min) than the dezocine group (14.64 ± 2.37 min). Additionally, the Steward Recovery Score was higher in the nalbuphine group than in the dezocine group. Surgery time was similar between the groups. However, extubation time was significantly earlier in the nalbuphine group (12.02 ± 3.33 min) compared to the dezocine group (15.70 ± 3.49 min). These findings suggest that nalbuphine administration is associated with faster recovery and earlier extubation following surgery. Complete data are summarized in **Table 6**.

Comparison of adverse reactions between the two groups

The incidence of adverse reactions was significantly lower in the nalbuphine group compared to the dezocine group ($P < 0.05$). Specifically, patients receiving nalbuphine reported fewer cases of nausea and vomiting (2.00%), headache and dizziness (2.00%), and drowsiness (0.00%) compared to those in the dezocine group (16.00%, 4.00%, and 2.00% respectively). However, both groups had a similar incidence of respiratory depression (2.00%). The adverse reaction incidence was 6.00% in the nalbuphine group and 24.00% in the dezocine group. Complete data are summarized in **Table 7**.

Discussion

Radical gastrectomy is a major surgical procedure that can significantly impact the immune system. Advances in minimally invasive techniques have optimized surgical methods and minimized the wound area [19]. However, effectively alleviating or eliminating acute pain caused by surgical trauma while minimizing side effects remains a topic of interest. Adequate postoperative pain relief can accelerate recovery by improving the patient's sleep quality, reducing postoperative pain, and aiding coughing and expectoration. It also helps mitigate complications related to surgical trauma. Rose and Kam highlighted that postoperative complications are primarily linked to immune system suppression, often due to excessive activation, which is exacerbated by postoperative pain stimulation and release of hormones that further suppress the immune response [20]. This study evaluated postoperative pain management and associated disease outcomes. We focused on comparing the efficacy and safety of nalbuphine and dezocine, two opioid analgesics commonly used for postoperative pain relief. Our results indicate that nalbuphine is superior to dezocine in controlling pain and reducing inflammatory responses.

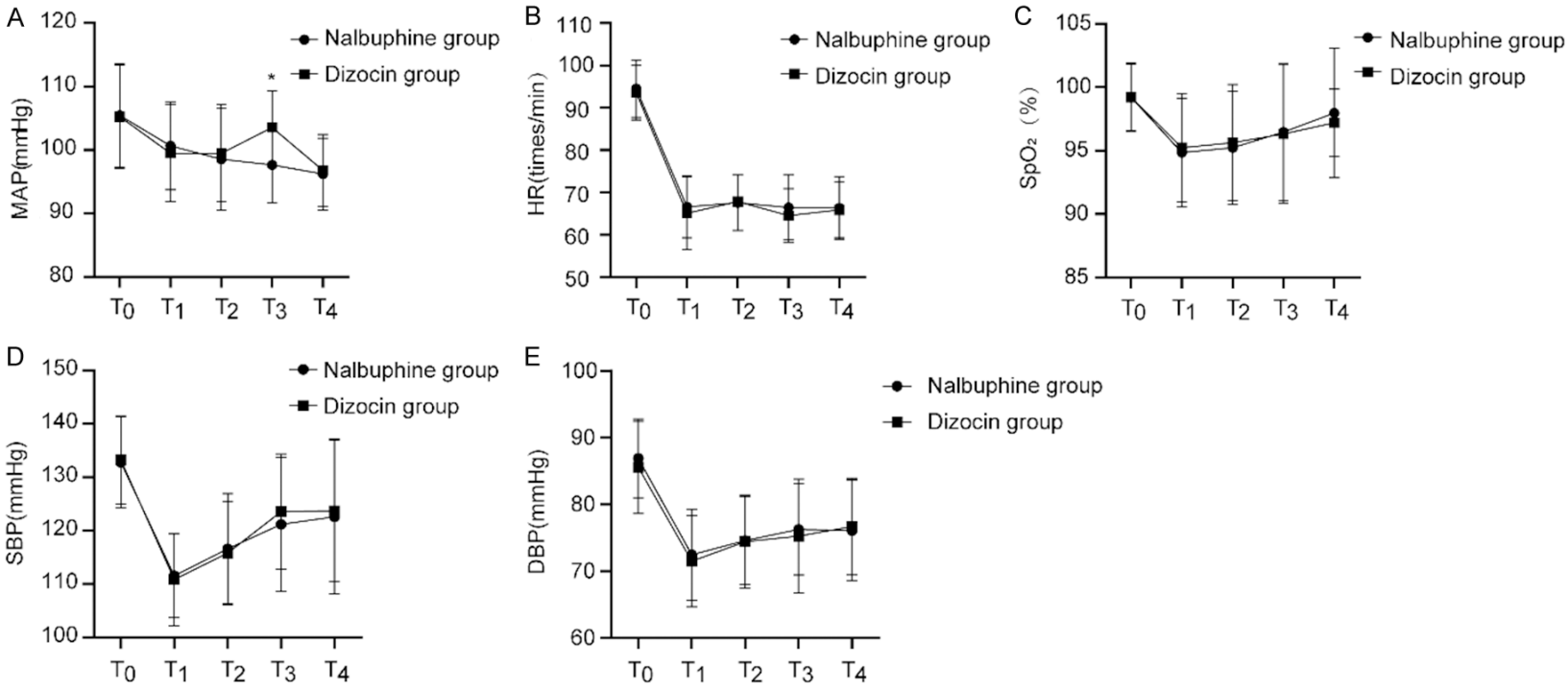

Figure 1. Changes in vital signs across different time points. A: Mean Arterial Pressure (MAP); B: Heart Rate (HR); C: Oxygen Saturation (SpO_2); D: Systolic Blood Pressure (SBP); E: Diastolic Blood Pressure (DBP). *P < 0.05.

Table 5. Comparison of Cor, E, and NE Levels between the two groups

Group	Indicator	T_0	T_1	T_2	T_3	T_4
Nalbuphine group	Cor (nmol/L)	198.80 ± 20.36	320.85 ± 25.60***	410.62 ± 30.68***	350.20 ± 30.16***	310.85 ± 35.60***
	E (ng/mL)	46.58 ± 5.86	56.80 ± 6.42**	76.84 ± 8.56***	74.00 ± 8.12***	65.30 ± 6.80***
	NE (ng/mL)	200.52 ± 42.65	300.58 ± 44.80***	350.68 ± 44.28***	310.74 ± 40.66***	300.55 ± 32.45***
Dezocine group	Cor (nmol/L)	199.02 ± 22.36	385.60 ± 45.62***	520.20 ± 55.69***	500.55 ± 50.30***	442.62 ± 38.60***
	E (ng/mL)	46.42 ± 5.22	75.60 ± 8.54***	98.35 ± 9.68***	100.54 ± 10.52***	96.30 ± 9.62***
	NE (ng/mL)	200.88 ± 20.22	395.65 ± 45.50***	455.30 ± 52.40***	430.55 ± 44.22***	410.60 ± 30.20***

Cor: cortisol; E: epinephrine; NE: norepinephrine; **Compared to T_0, P < 0.01, ***Compared to T_0, P < 0.001.

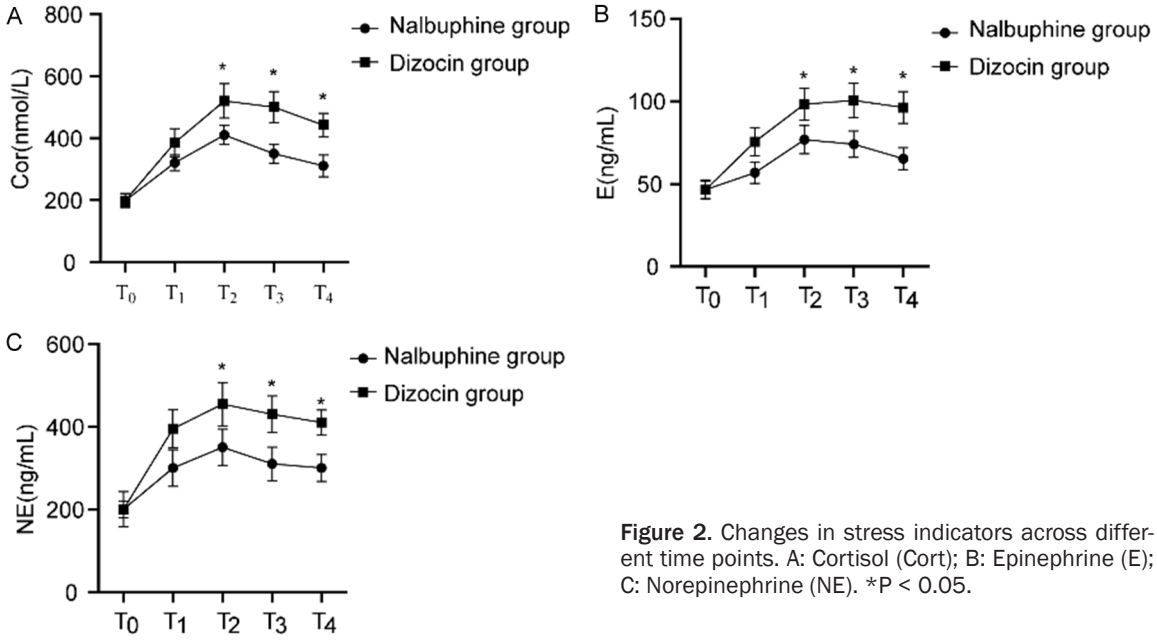

Figure 2. Changes in stress indicators across different time points. A: Cortisol (Cort); B: Epinephrine (E); C: Norepinephrine (NE). *P < 0.05.

Table 6. Comparison of recovery time, quality of recovery, surgery time, and extubation time between the two groups

Group	Recovery Time (min)	Steward Recovery Score (score)	Surgery Time (h)	Extubation Time (min)
Nalbuphine group (n=50)	10.50 ± 2.28	5 (3.75, 6)	3 (3, 3)	12.02 ± 3.33
Dezocine group (n=50)	14.64 ± 2.37	4 (3, 4)	3 (3, 4)	15.70 ± 3.49
t/Z	-8.85	-3.833	-2.141	-5.391
P	< 0.001	< 0.001	0.032	< 0.001

Table 7. Comparison of incidence of adverse reactions between the two group

Group	Nausea and Vomiting	Respiratory Depression	Headache and Dizziness	Drowsiness	Total Incidence
Nalbuphine group (n=50)	1 (2.00)	1 (2.00)	1 (2.00)	0 (0.00)	3 (6.00)
Dezocine group (n=50)	8 (16.00)	1 (2.00)	2 (4.00)	1 (2.00)	12 (24.00)
X^2					5.02
P					0.025

Compared to traditional pain management methods, patient-controlled intravenous analgesia (PCIA) allows patients to self-administer medication, resulting in more precise dosing

and avoiding significant fluctuations in blood drug concentrations for optimal analgesic effects in a shorter period [21]. PCIA also offers individualized dosing and significantly reduces the workload of medical staff [22]. In contrast, epidural anesthesia may not guarantee optimal analgesia for all patients, as the dosage cannot be fully individualized [23]. In emergencies, such as inadequate depth of anesthesia, anesthesia management becomes passive, and lower anesthesia levels may significantly impact blood pressure and other hemodynamic factors [24, 25]. While nerve blocks, a standard method for pain relief, require high skills and can result in costly anesthesia. Minor errors may cause nerve stimulation symptoms or severe complications, particularly in inexperienced hands. Therefore, patient-controlled intravenous analgesia is a good way for postoperative pain relief.

The lower VAS scores in the nalbuphine group demonstrated superior pain alleviation with nalbuphine. This may be due to nalbuphine's mixed agonist-antagonist activity at opioid receptors, providing balanced analgesia without the side effects observed with other opioids [26]. Reduced pain in elderly surgical patients may contribute to improved recovery and decreased risk of complications.

Another notable finding was lower inflammatory markers such as IL-6 and SP in patients treated with nalbuphine. These findings suggest nalbuphine may help regulate inflammation associated with surgery. This aligns with previous studies showing nalbuphine inhibits inflammation following orthognathic surgery [27]. Additionally, nalbuphine has a favorable safety profile with fewer side effects [28].

Furthermore, nalbuphine's ability to reduce inflammation may contribute to faster recovery time and better patient outcomes. Structurally similar to naloxone, nalbuphine primarily acts on kappa receptors to produce analgesia, and its effects can be reversed dose-dependently with naloxone [29]. Nalbuphine exhibits a capping effect, resulting in less respiratory depression than morphine.

The favorable side effect profile of nalbuphine is another important finding. The incidence of adverse events, such as nausea and vomiting, was lower in the nalbuphine group compared to the dezocine group. Minimizing side effects is crucial, as it can enhance patient comfort and satisfaction while reducing the risk of complications during recovery. These results suggest nalbuphine may be a safer, more tolerable option for pain management.

The findings also emphasize the importance of carefully considering the anesthesia way. The choice of anesthetic and analgesic agents influences intraoperative hemodynamic stability and postoperative pain control. Using nalbuphine may provide more stable intraoperative conditions, leading to better overall outcomes. Future research should explore the long-term impact of different pain management regimens on patient recovery, including cognitive function and overall quality of life [30]. Additionally, studies examining the optimal dosing and administration protocols for nalbuphine in elderly patients are needed to maximize its potential benefits.

Our study had several limitations, including a small sample size and a focus on a specific surgical population. Future studies involving larger cohorts and a broader range of surgical procedures are needed to confirm our findings and assess the generalizability of our results. In summary, this study provides valuable insights into using nalbuphine for postoperative pain management. Its efficacy in reducing pain and inflammation, combined with a lower incidence of side effects, makes it a promising option in this clinical setting. Future studies should aim to expand upon these findings and further explore the potential of nalbuphine in other surgical contexts.

Disclosure of conflict of interest

None.

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