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ORIGINAL RESEARCH

Sufentanil-Dezocine Combination in Patient-Controlled Intravenous Analgesia for Postoperative Pain After Pancreatic Cancer Surgery: A Retrospective Propensity Score-Matched Study

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Purpose: This study evaluated the efficacy and safety of patient-controlled intravenous analgesia (PCIA) regimen combining sufentanil and dezocine versus sufentanil alone for postoperative pain relief in pancreatic surgery patients.

Methods: We conducted a retrospective study comparing perioperative outcomes, the postoperative incidence of moderate-severe pain at rest and during coughing, and adverse effects in patients undergoing pancreatic surgery who received sufentanil (sufentanil group, n=247) versus a combination of sufentanil and dezocine (combination group, n=704) for PCIA. Propensity score matching (1:3) was performed to balance the groups.

Results: There were no significant differences in the demographic or perioperative outcomes between the two groups after matching. Within 48 hours after surgery, the incidence of moderate-severe pain at rest was significantly lower in the combination group (2.8%) compared to the sufentanil group (7.7%, P<0.05). Similarly, pain during coughing was significantly higher in the sufentanil group (30.0%) than in the combination group (23.6%, *P*<0.05). No significant differences were observed in adverse effects, including vomiting, hypotension, dizziness, or delirium during the first two postoperative days. The levels of sedation (LOS) were comparable on the first postoperative day, but a higher proportion of patients in the combination group were fully alert on the second day.

Conclusion: The combination of sufentanil and dezocine provides superior postoperative analgesia without increasing clinically relevant adverse effects, making it a promising option for pain management in pancreatic surgery patients. Further research is warranted to validate its routine clinical use.

Keywords: sufentanil, dezocine, patient-controlled intravenous analgesia, postoperative pain, pancreatic surgery, propensity score matching

Introduction

Pancreatic cancer is one of the most aggressive malignancies, with only 20% of patients eligible for surgical resection at the time of diagnosis.[1–3] These patients often face prolonged hospitalization and significant postoperative challenges, among which pain control remains a major clinical concern. Poorly managed postoperative pain can stimulate catecholamine release, which may suppress natural killer cell activity—a component of innate immunity—and potentially influence anti-tumor responses.[4] Additionally, it is associated with increased psychological distress and reduced quality of life. Despite its clinical significance, current pain management strategies after pancreatic surgery are often suboptimal,

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underscoring the need for more effective analgesic approaches and further investigation into their impact on postoperative outcomes.

Patient-controlled intravenous analgesia (PCIA) with opioids is widely used for postoperative pain control.[5–8] Sufentanil, a selective potent μ-receptor agonist, is widely used for its efficacy in postoperative pain management.[9] Given the moderate to severe pain typically associated with pancreatic surgery, a potent analgesic strategy is essential. However, increasing the dosage of a single analgesic agent to achieve adequate pain relief may also elevate the risk of adverse effects, including respiratory depression, nausea, and vomiting. Dezocine, a partial μ-receptor agonist and κ-receptor antagonist, has emerged as a promising adjunct due to its analgesic and sedative effects, as well as its favorable safety profile compared to pure μ-receptor agonists.[10–12] By acting on κ-receptors in the spinal cord and brain, dezocine provides analgesic and sedative effects without the typical μ-receptor dependence, potentially reducing adverse reactions such as smooth muscle relaxation.[10] Previous studies have demonstrated that dezocine offers significant postoperative antihyperalgesic and analgesic effects, with benefits lasting up to 48 hours in patients undergoing open gastrectomy.[13]

Several studies have demonstrated that dezocine, when combined with morphine, enhances postoperative analgesia and reduces opioid-related side effects, such as nausea and pruritus, making it a valuable option in anesthesia practice.[14–16] At our institution, the combination of sufentanil and dezocine has been used in PCIA for pancreatic cancer patients for several years. However, the efficacy and safety of this combination have not been thoroughly investigated. To address this gap, we conducted a propensity score-matched (PSM) study at a high-volume pancreatic center to evaluate the role of dezocine as an adjunct to sufentanil in PCIA for postoperative pain management following pancreatic surgery, which, to our knowledge, is the first study to investigate the analgesic effects of this combination in PCIA for pancreatic surgery patients.

Materials and Methods

Ethics Approval

This retrospective study was approved by the Ethics Committee of Ruijin Hospital, Shanghai Jiao Tong University School of Medicine (Ethics Approval Number: (2023) No. 48), with a waiver of patient written informed consent due to the use of de-identified, archival medical records (no active patient intervention). All patient identifiers were removed, and data were stored securely on encrypted servers accessible only to the research team, adhering to the Declaration of Helsinki (as revised in 2013).

Patients

A total of 1485 patients who underwent elective open or minimally invasive pancreatic tumor surgery and received patient-controlled intravenous analgesia (PCIA) for postoperative pain management at the Pancreas Center of Ruijin Hospital, Shanghai Jiao Tong University School of Medicine, between January 2022 and January 2023 were retrospectively enrolled. The center is one of the largest pancreatic surgery centers in Asia. Among them, 794 were male and 691 were female, with an age range of 18 to 85 years (mean age: 60.55 ± 12.55 years) and American Society of Anesthesiologists (ASA) physical status classification ranging from I to IV. Based on the PCIA regimen, patients were allocated into two groups: the sufentanil group (n = 251) and the sufentanil-dezocine combination group (n = 1234). Surgical approach (Laparotomy/Laparoscopic/Robotic) was documented based on the description of the surgical procedure in the operative notes. All operative notes were reviewed and signed off by the attending surgeon or a senior resident physician to ensure consistency in classification. To minimize confounding and selection bias, PSM was performed using a logistic regression model based on age, sex, BMI, surgical approach (laparotomy, laparoscopic, robotic), surgery type (pancreatoduodenectomy, total pancreatectomy, middle-preserving pancreatectomy, distal pancreatectomy, as different techniques may affect pain severity due to varying tissue trauma), and dexmedetomidine dose. A caliper of 0.02 and nearest-neighbor matching were applied in a 1:3 ratio using R software (v.4.3.1, The R Foundation for Statistical Computing, Vienna, Austria. http://www.r-project.org). Exclusion criteria included: (1) known allergies to study drugs; (2) inability to use patient-controlled intravenous analgesia (PCIA); (3) history of chronic pain or long-term use of analgesic medications; (4) requirement for reoperation due to postoperative bleeding or severe abdominal infection; (5) severe cardiopulmonary or hepatorenal insufficiency and (6) cognitive dysfunction.

Anesthesia Procedure

All patients fasted for 8 hours (solids) and 6 hours (clear liquids) preoperatively and were transferred to the operating room without premedication. Standard monitoring included electrocardiography (ECG), non-invasive blood pressure (BP), respiratory rate (RR), oxygen saturation (SpO_2), end-tidal carbon dioxide pressure ($PetCO_2$), and bispectral index (BIS). A uniform anesthetic regimen was administered to all patients, with surgeries performed by the same surgical team.

General anesthesia was induced with propofol (2–2.5mg/kg), sufentanil (0.3–0.5 μg/kg), rocuronium (0.6–0.8mg/kg) or cisatracurium (0.2–0.3mg/kg), dexamethasone 5 mg, and dexmedetomidine 0.6 μg/kg. Preoxygenation with 100% oxygen was administered for at least 3 minutes via a face mask. Anesthesia was maintained with sevoflurane (3vol%, 0.8–1.3MAC), remifentanil (0.2–0.4μg/kg/min), supplemental rocuronium (1/3–1/5 of the induction dose), and intermittent sufentanil (0.4 μg/kg). Ventilation was set at a tidal volume of 8 mL/kg, with respiratory frequency adjusted to maintain $PetCO_2$ at 35–45 mmHg. Anesthesia depth was titrated to maintain a BIS between 40 and 60, ensuring mean arterial pressure (MAP) and heart rate (HR) remained within 20% of baseline values. Patient temperature was maintained above 36°C using infusion heaters and warming blankets. A sufentanil loading dose (0.1 μg/kg) was administered 30 minutes before the end of surgery. Intraoperative fluid balance was defined as the net change in a patient's total body fluid volume during surgery, calculated as the difference between the total intraoperative fluids inputs and outputs. Postoperatively, patients were transferred to the post-anesthesia care unit (PACU), where residual neuromuscular blockade was reversed with neostigmine (40 μg/kg) and atropine (20 μg/kg).

Postoperative PCIA Regimen

After meeting extubation criteria, patients were extubated and connected to an Artificial Intelligence Patient-Controlled Analgesia (AI-PCA) system (Model ZZB-IB, Nantong AIPU Medical Inc., China). Patients were divided into two groups based on the PCIA solution: the sufentanil group received sufentanil (1.0 μg/mL), and the combination group received sufentanil (1.0 μg/mL) plus dezocine (2.5 mg/mL). Group allocation was guided by clinical judgment of the anesthesiologist considering factors reflected in our dataset such as patient demographics, surgical complexity, intraoperative management details.

The Acute Pain Service team prepared the PCIA solution in 100 mL normal saline bags, containing either sufentanil alone or the combination and monitored patients. If the Numerical Rating Scale (NRS) at rest was ≥4, a 2 mL bolus of PCIA solution was administered at 15-minute intervals until NRS <4. Patients were then encouraged to self-administer PCIA as needed.

The PCIA pump was set to a background infusion rate of 2 mL/h, with a 2 mL bolus dose and a 15-minute lockout interval. PCIA was maintained for 48 hours postoperatively, during which vital signs including respiratory rate, oxygen saturation, and sedation scores were closely monitored.

Outcome Measures

Demographic and intraoperative data, including surgery type, site, anesthetic drug dosages, blood loss, transfusion, and fluid balance, were recorded. Postoperative data included PCIA pump usage duration, total input, cumulative and effective press counts, rescue analgesia, and adverse events (eg, vomiting, pruritus, respiratory depression, hypotension, dizziness, delirium). We assessed Functional Activity Score (FAS) and Level of Sedation (LOS) at 1 and 2 days post-surgery. FAS (1–3 grades) quantifies pain impact on daily functions: 1=no limitation (normal coughing/limb movement despite pain); 2=mild limitation (slight difficulty/slower actions), and 3=severe limitation (struggles with basic activities). LOS (0–3 grades) evaluates consciousness via responsiveness: 0=alert (follows instructions), 1=somnolent (wakes to calls but drifts off), 2=stuporous (brief pain wakefulness), 3=comatose (no response to calls or pain). Both were graded during routine checks to guide pain management and monitor recovery. Pain intensity was evaluated using the NRS at rest (NRSR) and during coughing (NRSC) at 24, 48, and 72 hours post-surgery. The NRS ranges from 0 (no pain) to 10 (worst imaginable pain). Moderate-to-severe pain was defined as NRS ≥4. Mild pain (NRS 1–3) was also recorded in postoperative data. Adverse events were recorded based on routine clinical documentation in the hospital's electronic medical records (EMR) and nursing care logs.

Primary endpoints were the incidence of moderate-to-severe pain at rest and during coughing within 48 hours post-surgery. Secondary endpoints included the incidence of moderate-severe pain at rest and during coughing at 24 hours and 72 hours post-surgery, LOS, FAS, and adverse events.

Statistical Analysis

Continuous variables were first assessed for normality, those with normal distribution were expressed as mean ± standard deviation (SD) and compared using independent *t*-tests. Skewed distributed continuous variables were presented as median (Q1, Q3) and analyzed with the Mann–Whitney *U*-test. Categorical variables were expressed as frequencies and percentage, and compared using Pearson's chi-square or Fisher's exact test. Missing data for demographic characteristics, intraoperative and postoperative data were imputed using the expectation-maximization algorithm. Univariate and multivariate logistic regression models, alongside with post-PSM analysis and inverse probability weighting (IPW) analysis were conducted to calculate odds ratios (OR) and 95% confidence intervals (CI). Analyses were performed using SAS (v.9.2, SAS Institute Inc., USA). All tests were two-sided, and statistical significance was set at the 5% level. No adjustments have been made for multiple testing.

Results

Patient Characteristics

Before PSM, the sufentanil group comprised 251 patients, while the combination group included 1234 patients. The sufentanil group was older (mean age 63.73 ± 13.69 years vs 59.90 ± 13.44 years, P< 0.05), had a higher proportion of pancreatoduodenectomy (PD) procedures (55.8% vs 44.8%, P< 0.05), and a greater rate of laparotomy (80.5% vs 73.9%, P < 0.05). Additionally, the sufentanil group had a lower BMI (22.25 ± 3.30 vs 22.73 ± 3.31, P < 0.05) and received a lower dexmedetomidine dosage (16.85 ± 15.75 μg vs 22.50 ± 16.32 μg, P < 0.05) compared to the combination group. No significant difference was observed in sex distribution. After PSM, the study included 247 patients in the sufentanil group and 704 in the combination group, with all baseline variables balanced between the two groups (Table 1).

Table 1 Demographic Characteristics and Perioperative Outcomes of Patients Between the Sufentanial Group and the Combination Group

Characteristics	Before Propensity Score Matching			After Propensity Score Matching		
	Sufentanil (n=251)	Sufentanil+Dezocine (n=1234)	P	Sufentanil (n=247)	Sufentanil+ Dezocine (n=704)	P
Male, n (%)	136 (54.2)	658 (53.3)	0.803	133 (53.8)	370 (52.6)	0.727
Age, mean (SD)	63.73 ± 13.69	59.90 ± 13.44	<0.001	63.65 ± 13.78	63.08 ± 12.73	0.297
BMI	22.25 ± 3.30	22.73 ± 3.31	0.036	22.25 ± 3.31	22.50 ± 3.20	0.553
Surgery type, n (%)			0.003			0.919
PD	140 (55.8)	553 (44.8)		138 (55.9)	387 (55.0)	
DP	70 (27.9)	479 (38.8)		70 (28.3)	212 (30.1)	
TP	22 (8.8)	84 (6.8)		20 (8.1)	58 (8.2)	
MPP	19 (7.6)	118 (9.6)		19 (7.7)	47 (6.7)	
Surgery approach, n (%)			0.049			0.796
Laparotomy	202 (80.5)	912 (73.9)		199 (80.6)	554 (78.7)	
Laparoscopic	11 (4.4)	50 (4.1)		10 (4.0)	34 (4.8)	
Robotic	38 (15.1)	272 (22.0)		38 (15.4)	116 (16.5)	
Dexmedetomidine, mean (SD)	16.85 ± 15.75	22.50 ± 16.32	<0.001	16.90 ± 15.77	17.71 ± 15.24	0.476
Intraoperative sufentanil, mean (SD)	69.35 ± 15.88	68.90 ± 17.51	0.703	69.40 ± 15.74	69.94 ± 16.36	0.652
Rocuronium bromide, mean (SD)	80.14 ± 44.15	84.42 ± 46.42	0.180	80.50 ± 44.34	85.81 ± 48.74	0.133
Blood transfusion volume, median [Q1, Q3]	800 [0, 1400]	300 [0, 1100]	0.001	800 [0, 1400]	400 [0, 1200]	0.066
Blood loss, median [Q1, Q3]	400 [200, 600]	300 [150, 550]	0.012	400 [200, 600]	375 [200, 600]	0.473
Fluid balance, median [Q1, Q3]	3100 [2400, 3700]	2650 [2248–3250]	<0.001	3100 [2400, 3700]	2700 [2300, 3350]	0.001
Effective press counts, median [Q1, Q3]	4 [1.5, 13]	4 [1, 12]	0.297	5 [2, 13]	4 [1, 12]	0.269
Cumulative press counts, median [Q1, Q3]	5 [2, 16]	4 [1, 14]	0.300	5 [2, 16.5]	5 [1, 14]	0.274
Total input, (mL)	76.6 ± 19.55	79.72 ± 20.0	0.028	77.13 ± 18.88	78.32 ± 20.64	0.425
Duration of pump usage, (hr)	52.71 ± 18.1	47.12 ± 11.41	<0.001	52.22 ± 17.08	47.36 ± 11.08	<0.001

Notes: "+" indicates the combined use of two analgesic regimens (sufentanil + dezocine) in the "Combined Group".

Perioperative Outcomes

After PSM, no significant differences were observed in blood loss, blood transfusion volume, or total PCIA input between the two groups, despite differences before matching. The dosages of sufentanil and rocuronium bromide, as well as effective and cumulative PCIA press counts, showed no significant differences before or after PSM. However, the sufentanil group exhibited greater fluid balance difference and longer pump usage duration, which were statistically significant both before and after PSM (Table 1).

Primary Endpoint

The incidence of moderate-to-severe pain at rest and during coughing within 48 hours post-surgery is summarized in Table 2. After PSM, 19 patients (7.7%) in the sufentanil group experienced moderate-to-severe pain at rest, compared to 20 patients (2.8%) in the combination group ($P < 0.05$). Similarly, the incidence of pain during coughing was significantly higher in the sufentanil group (74 patients, 30.0%) than in the combination group (166 patients, 23.6%) during the same period ($P < 0.05$). These differences were also observed before PSM.

At 48 hours post-surgery, NRSR was significantly higher in the sufentanil group (1.97 ± 1.26) compared to the combination group (1.77 ± 0.91) (P= 0.018). Similarly, NRSC at 48 hours was higher in the sufentanil group (3.13 ± 1.57) than in the combination group (2.89 ± 1.17) (P= 0.022). All four analytical approaches including univariate and multivariate logistic regression analyses, post- PSM analysis and IPW analysis consistently identified sufentanil monotherapy as an independent predictor of moderate-to-severe pain, with odds ratios (ORs) and 95% confidence intervals (CIs) presented in Table 3.

Table 2 Moderate-Severe Pain at Rest and During Coughing After Surgery Between the Sufentanial Group and the Combination Group

Characteristics	Before Propensity Score Matching			After Propensity Score Matching		
	Sufentanil (n=251)	Sufentanil+Dezocine (n=1234)	P	Sufentanil (n=247)	Sufentanil+Dezocine (n=704)	P
Pain at rest 24hr after surgery	38 (15.1)	102 (8.3)	0.001	38 (15.4)	70 (9.9)	0.02
Pain during cough 24hr after surgery	114 (45.4)	424 (34.4)	0.001	114 (46.2)	266 (37.8)	0.021
Pain at rest 48hr after surgery	19 (7.6)	27 (2.2)	0.001	19 (7.7)	20 (2.8)	0.001
Pain during cough 48hr after surgery	75 (29.9)	271 (22.0)	0.007	74 (30.0)	166 (23.6)	0.047
Pain at rest 72hr after surgery	8 (3.2)	9 (0.7)	0.001	8 (3.2)	6 (0.9)	0.007
Pain during cough 72hr after surgery	33 (13.1)	112 (9.1)	0.048	33 (13.4)	66 (9.4)	0.078

Notes: "+" indicates the combined use of two analgesic regimens (sufentanil + dezocine) in the "Combined Group".

Table 3 Logistic Regression Results for Moderate-Severe Pain at Rest and During Coughing After Surgery Between the Sufentanial Group and the Combination Group

Characteristics	Method	Level	β	OR (95% CI)	P
Pain at rest 48hr after surgery	Crude analysis	Sufentanil	1.298	3.661 (2.002–6.694)	<0.001
		Sufentanil+ Dezocine	Reference		
Pain during cough 48hr after surgery	Crude analysis	Sufentanil	0.415	1.514 (1.120–2.048)	0.007
		Sufentanil+ Dezocine	Reference		
Pain at rest 48hr after surgery	Multivariate*	Sufentanil	1.314	3.719 (2.018–6.856)	<0.001
		Sufentanil+ Dezocine	Reference		
Pain during cough 48hr after surgery	Multivariate*	Sufentanil	0.377	1.458 (1.055–2.015)	0.022
		Sufentanil+ Dezocine	Reference		
Pain at rest 48hr after surgery	Post-PSM	Sufentanil	1.047	2.85 (1.494–5.435)	0.001
		Sufentanil+ Dezocine	Reference		

(*Continued*)

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Table 3 (Continued).

Characteristics	Method	Level	β	OR (95% CI)	P
Pain during cough 48hr after surgery	Post-PSM	Sufentanil	0.327	1.386 (1.004–1.915)	0.048
		Sufentanil+ Dezocine	Reference		
Pain at rest 48hr after surgery	With inverse probability weighting	Sufentanil	1.311	3.711 (1.964–7.011)	<0.001
		Sufentanil+ Dezocine			
Pain during cough 48hr after surgery	With inverse probability weighting	Sufentanil	0.387	1.473 (1.064–2.038)	0.020
		Sufentanil+ Dezocine	Reference		

Notes: *Adjusted by: sex, age, BMI, surgery site, surgery type, dexmedetomidine, intraoperative sufentanil, rocuronium bromide, effective press counts, cumulative press counts, total input, pump use time. "+" indicates the combined use of two analgesic regimens (sufentanil + dezocine) in the "Combined Group".

Secondary Endpoints

Significant differences in the incidence of pain at rest and during coughing were observed at 24 and 72 hours post-surgery before PSM ($P < 0.05$). After PSM, these differences remained significant, except for pain during coughing at 72 hours (Table 2). No significant inter-group differences were noted in vomiting, hypotension, dizziness, delirium, or rescue analgesia on the first and second postoperative days, either before or after PSM. However, the functional activity scale (FAS) scores on the first and second postoperative days revealed significant differences between the two groups. Additionally, the proportion of fully alert patients on the second postoperative day was significantly higher in the combination group compared to the sufentanil group, both before and after PSM (Table 4).

Table 4 Adverse Events Between the Sufentanial Group and the Combination Group

Characteristics	Before Propensity Score Matching			After Propensity Score Matching		
	Sufentanil (n=251)	Sufentanil+ Dezocine (n=1234)	P	Sufentanil (n=247)	Sufentanil+ Dezocine (n=704)	P
1st day after surgery						
LOS			0.136			0.137
0	240 (95.6)	1204 (97.6)		236 (95.5)	686 (97.4)	
1	11 (4.4)	28 (2.3)		11 (4.5)	18 (2.6)	
2	0 (0)	2 (0.2)		0 (0)	0 (0)	
3	0 (0)	0 (0)		0 (0)	0 (0)	
FAS			<0.001			<0.001
1	50 (19.9)	9 (0.7)		50 (20.2)	5 (0.7)	
2	190 (75.7)	1213 (98.3)		186 (75.3)	692 (98.3)	
3	11 (4.4)	12 (1.0)		11 (4.5)	7 (1.0)	
Vomit	94 (37.5)	415 (33.7)	0.249	94 (38.1)	238 (33.8)	0.228
Pruritus	0 (0)	0 (0)	/	0 (0)	0 (0)	/
Respiratory depression	5 (2.0)	3 (0.2)	0.001	5 (2.0)	2 (0.3)	0.006
Hypotension	1 (0.4)	2 (0.2)	0.448	1 (0.4)	1 (0.1)	0.438
Dizzy	47 (18.7)	211 (17.1)	0.539	47 (19.0)	118 (16.8)	0.418
Delirium	2 (0.8)	19 (1.5)	0.363	2 (0.8)	15 (2.1)	0.178
Rescue analgesic	47 (18.7)	295 (23.9)	0.075	47 (19.0)	158 (22.4)	0.261
2nd day after surgery						
LOS			0.007			0.019
0	241 (96.0)	1219 (98.8)		237 (96.0)	694 (98.6)	
1	10 (4.0)	14 (1.1)		10 (4.0)	10 (1.4)	
2	0 (0)	0 (0)		0 (0)	0 (0)	
3	0 (0)	1 (0.1)		0 (0)	0 (0)	

(*Continued*)

Table 4 (Continued).

Characteristics	Before Propensity Score Matching			After Propensity Score Matching		
	Sufentanil (n=251)	Sufentanil+ Dezocine (n=1234)	P	Sufentanil (n=247)	Sufentanil+ Dezocine (n=704)	P
FAS			<0.001			<0.001
1	54 (21.5)	8 (0.6)		54 (21.9)	3 (0.4)	
2	196 (78.1)	1221 (98.9)		192 (77.7)	697 (99.0)	
3	1 (0.4)	5 (0.4)		1 (0.4)	4 (0.6)	
Vomit	57 (22.7)	208 (16.9)	0.027	57 (23.1)	127 (18.0)	0.085
Pruritus	0 (0)	0 (0)	/	0 (0)	0 (0)	/
Respiratory depression	5 (2.0)	3 (0.2)	0.001	5 (2.0)	1 (0.1)	0.001
Hypotension	0 (0)	0 (0)	/	0 (0)	0 (0)	/
Dizziness	48 (19.1)	177 (14.3)	0.054	48 (19.4)	112 (15.9)	0.203
Delirium	4 (1.6)	22 (1.8)	0.835	4 (1.6)	17 (2.4)	0.464
Rescue analgesic	41 (16.3)	261 (21.2)	0.084	41 (16.6)	150 (21.3)	0.112

Notes: "+" indicates the combined use of two analgesic regimens (sufentanil + dezocine) in the "Combined Group".
Abbreviations: LOS, levels of sedation; FAS, functional activity scale.

Discussion

Pancreatic surgery is a critical intervention for pancreatic cancer, yet patients often experience prolonged postoperative pain, which can hinder physical and mental recovery. Effective pain management is therefore essential for improving patient outcomes and has garnered significant clinical attention. Opioid-based analgesia, particularly sufentanil, is widely used in patient-controlled intravenous analgesia (PCIA). However, the adverse effects of opioids, such as addiction, respiratory depression, pruritus, and sedation, have driven the search for alternative strategies to reduce opioid dosages and minimize side effects.[17] Multimodal analgesia has emerged as a promising approach.[18]

In this propensity score-matched study, we evaluated the efficacy of combining sufentanil with dezocine in PCIA for postoperative pain management in patients undergoing pancreatic surgery. After matching, baseline characteristics and perioperative outcomes were comparable between the groups. Our findings demonstrated that the sufentanil-dezocine combination significantly reduced the incidence of moderate-to-severe pain at rest and during coughing within the first 48 hours postoperatively, without increasing the risk of clinically relevant side effects such as vomiting, hypotension, dizziness, delirium, or the need for rescue analgesia. Patients in the combination group exhibited significantly lower NRSR and NRSC at 48 hours post-surgery compared to the sufentanil group. Multivariate logistic regression analysis identified sufentanil monotherapy as an independent predictor of postoperative pain, suggesting that the addition of dezocine enhances analgesic efficacy, consistent with previous findings.[16] These findings align with dezocine's proposed mechanism: by targeting κ-receptors (which modulate pain perception) and partially activating μ-receptors (avoiding overstimulation), the combination may enhance analgesia while mitigating pure μ-agonist-related side effects. Notably, the reduction in pain during coughing–a high-pain activity critical for pancreatic surgery recovery–suggests the combination may be particularly beneficial for patients requiring early mobilization.

A primary concern with combining dezocine and sufentanil in PCIA is the potential for excessive sedation. However, our study found no evidence of increased sedation in the combination group during the 48-hour postoperative period. While sedation levels on the first postoperative day did not differ significantly, the proportion of fully alert patients was significantly higher in the combination group on the second postoperative day. This finding suggests that dezocine may enhance patient alertness while maintaining effective analgesia–Its ability to improve alertness and reduce sedation-related complications supports its value as a "balanced" adjunct in postoperative pain management[19–21] likely due to κ-receptor activation inducing lighter sedation compared to μ-agonists.

Postoperative adverse events, such as vomiting, hypotension, and dizziness, can negatively impact patient satisfaction and prolong hospital stays.[10] Our study found that the addition of dezocine to sufentanil did not exacerbate these side effects. Notably, the combination group had a significantly lower incidence of respiratory depression compared to the

sufentanil group, with no significant differences in vomiting, hypotension, dizziness, or delirium. These results align with previous research[22–25] and further support the safety profile of the sufentanil-dezocine combination.

Despite these promising findings, several limitations should be acknowledged. First, the retrospective design of the study introduces potential for selection bias, although this was mitigated by propensity score matching and the uniformity of our surgical team, Sensitivity analyses using alternative matching strategies (eg inverse probability weighting, multivariate logistic regression) yielded consistent results, suggesting no major residual confounding affected our conclusions. Second, generalizability of our findings may be limited. Due to our single-center design, even though our cohort meets high-volume criteria. As emphasized in a recent review on gastric cancer surgery outcomes, institutional factors can create variability in textbook outcomes (TOs) even among high-volume centers, highlighting the need for cross-institutional validation.[26] Future multi-center collaborations will compare textbook outcomes across 10+ high-volume centers using a pragmatic, standardized protocol to address this gap. Third, retrospective data precluded optimization of sufentanil/dezocine dosing. Prospective dose-response studies are needed to refine postoperative pain management in high-risk surgical populations.

In conclusion, our study demonstrates that the sufentanil-dezocine combination in PCIA significantly reduces moderate-to-severe pain at rest and during coughing within the first 48 hours after pancreatic surgery, without increasing the incidence of clinically relevant adverse effects, which has not been previously reported in the context of pancreatic surgery, suggesting it as a promising and safe approach for postoperative pain management in pancreatic cancer patients. Future research should focus on optimizing dosing strategies and confirming these results in prospective, multicenter trials.

Data Sharing Statement

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

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Disclosure

The authors declare that they have no conflicts of interest in this work.

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