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ERCP Sedation in a Tertiary Center: Anesthesia Management and Analysis of Factors Affecting Length of Hospital Stay in 341 Cases

Üçüncü Basamak Bir Merkezde ERCP Sedasyonu: 341 Vakada Anestezi Yönetimi ve Hastanede Kalış Süresini Etkileyen Faktörlerin Analizi

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Abstract

Background: This study aimed to investigate anesthesia management, peri-procedural complication profiles, and risk factors affecting hospital length of stay in patients undergoing Endoscopic retrograde cholangiopancreatography (ERCP) under sedation.

Materials and Methods: A total of 341 patients who underwent ERCP at our tertiary care hospital were retrospectively analyzed to address the study's objectives. The patients' demographic characteristics, comorbidities, doses of anesthetic agents used (midazolam, propofol, fentanyl), peri-procedural complications, and length of hospital stay were recorded. Data were analyzed using comparisons by age groups (<65 and ≥65 years), Spearman's correlation, and multiple linear regression analysis to identify predictors of length of hospital stay.

Results: The findings demonstrated that comorbidities were present in 62.5% of patients, and the overall complication rate was 8.2%. Although anesthetic drug consumption was significantly lower in patients aged 65 and older ($p<0.01$), complication rates were found to be higher. Regression analysis revealed that the development of perioperative complications, the need for intensive care, and a reduction in fentanyl dosage were factors independently prolonging the length of hospital stay ($p<0.05$).

Conclusions: Monitored anesthesia care used in ERCP procedures is safe in patients with high comorbidity. However, despite dose reduction, the increased risk of complications in geriatric patients warrants close monitoring. Our study further revealed that the primary factors prolonging hospital stay are perioperative complications, the need for intensive care, and low fentanyl dosing. Therefore, effective analgesia management-conducted in accordance with ERAS principles and led by an anesthesiologist-remains the most critical determinant of accelerating discharge.

Keywords: Endoscopic retrograde cholangiopancreatography, Monitored anesthesia care, Deep sedation, Postoperative complications, Length of stay

Öz

Amaç: Bu çalışmanın amacı, sedasyon altında Endoskopik Retrograd Kolanjiyopankreatografi (ERCP) uygulanan hastalarda anestezi yönetimini, işlem sırasındaki komplikasyon profillerini ve hastanede kalış süresini etkileyen risk faktörlerini araştırmaktı.

Materyal ve metod: Çalışmanın amaçlarını gerçekleştirmek üzere, üçüncü basamak hastanemizde ERCP uygulanan toplam 341 hasta retrospektif olarak analiz edildi. Hastaların demografik özellikleri, eşlik eden hastalıkları, kullanılan anestezik ajanların dozları (midazolam, propofol, fentanil), işlem sırasındaki komplikasyonlar ve hastanede kalış süresi kaydedildi. Veriler, hastanede kalış süresinin belirleyicilerini tespit etmek amacıyla yaş gruplarına göre (<65 ve ≥65 yaş) karşılaştırmalar, Spearman korelasyonu ve çoklu doğrusal regresyon analizi kullanılarak analiz edildi.

Bulgular: Hastaların %62,5'inde komorbiditelerin mevcut olduğunu ve genel komplikasyon oranının %8,2 olduğunu gösterdi. 65 yaş ve üstü hastalarda anestezik ilaç tüketimi anlamlı olarak daha düşük olmasına rağmen ($p<0,01$), komplikasyon oranlarının daha yüksek olduğu saptandı. Regresyon analizi, perioperatif komplikasyonların gelişmesi, yoğun bakım ihtiyacı ve fentanil dozunda azalmanın, hastanede kalış süresini bağımsız olarak uzatan faktörler olduğunu ortaya koydu ($p<0,05$).

Sonuç: ERCP prosedürlerinde kullanılan Monitörize Anestezi Bakımı, yüksek komorbiditeye sahip hastalarda güvenlidir. Ancak, doz azaltımına rağmen, geriatrik hastalarda komplikasyon riskinin artması, yakın izlemeyi gerektirmektedir. Çalışmamız ayrıca, hastanede kalış süresini uzatan başlıca faktörlerin perioperatif komplikasyonlar, yoğun bakım ihtiyacı ve düşük fentanil dozu olduğunu ortaya koymuştur. Bu nedenle, ERAS ilkelerine uygun olarak ve bir anestezi uzmanı tarafından yürütülen etkili analjezi yönetimi, taburculuğu hızlandırmanın en kritik belirleyicisi olmaya devam etmektedir.

Anahtar Kelimeler: Endoskopik retrograd kolanjiyopankreatografi, Monitörize anestezi bakımı, Derin sedasyon, Ameliyat sonrası komplikasyonlar, Hastanede kalış süresi

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Introduction

Endoscopic retrograde cholangiopancreatography (ERCP) is an invasive and technically complex procedure considered the "gold standard" for the diagnosis and treatment of diseases of the biliary tract and pancreatic system (1). Given the procedure's duration, the patient's need for absolute immobility, and the pain experienced, anesthesia management is indispensable for achieving high success rates and patient safety (2). However, the specific rationale for studying optimal anesthesia techniques for ERCP remains critical to further improving patient outcomes and procedural efficiency.

Evaluated within the scope of nonoperating room anesthesia (NORA) practices, ERCP presents unique challenges for anesthesiologists, such as limited airway access, the patient's prone or semi-prone position, and radiation exposure (3)The combinations of midazolam, propofol, and fentanyl, frequently preferred in current clinical practice, provide a rapid recovery profile and effective amnesia; however, they also carry the risk of cardiorespiratory depression while achieving the targeted depth of anesthesia (4). Especially in elderly patients and those with comorbidities, changes in the pharmacodynamic responses of anesthetic agents increase the incidence of complications such as hypoxia, bradycardia, and hypotension (5). Clinical experiences with NORA in our country (6) also highlight these specific risks and necessitate a multidisciplinary approach led by an anesthesiologist to ensure patient safety during complex procedures such as ERCP

For safe anesthesia management, meticulous titration of drug doses based on patient demographic characteristics is essential. Despite this, there is a lack of comprehensive clinical data on how specific agent doses affect peri-procedural complications and hospital stay length. Therefore, this study retrospectively analyzes data from 341 patients who underwent ERCP under sedation over a 1-year period at a tertiary care facility to address this gap. Specifically, the study aims to evaluate the relationships between the doses of midazolam, fentanyl, and propofol in relation to age and gender, the frequency of peri-procedural complications, and how these factors influence the length of hospital stay.

Materials and Methods

Study Design and Ethics Committee Approval

This retrospective and observational study was conducted in accordance with the principles of the Declaration of Helsinki, following approval by the Harran University Faculty of Medicine Clinical Research Ethics Committee (approval no: HRÜ/25.17.35, date: October 13, 2025).Due to the retrospective nature of the study, patient consent was evaluated using the general informed consent forms obtained prior to the procedure via the hospital information management system.

Patient Selection and Data Collection

A total of 341 patients who underwent ERCP under sedation for the diagnosis or treatment of biliary tract and pancreatic duct diseases at the endoscopy unit of our tertiary care hospital between January 1, 2024, and January 1, 2025, were included in the study. Patients aged 18 years and older with complete data were included in the study after retrospective review of the hospital information management system and anesthesia monitoring forms. Patients for whom complete records were unavailable, those who were switched to general anesthesia (endotracheal intubation) during the procedure, or those under 18 years of age were excluded from the study. For clinical evaluation and comparative analysis, patients were grouped by gender (female and male) and age (under 65 and 65 and older).

Anesthesia Management and Procedure

All patients underwent standard preoperative anesthesia preparation and NORA prior to the procedure. Patients admitted to the endoscopy unit routinely underwent electrocardiogram (ECG), non-invasive blood pressure (NIBP), and peripheral oxygen saturation (SpO_2) monitoring. During the procedure, patients received oxygen support via a nasal cannula at a flow rate of 2-4 L/min. Patients were positioned in the prone (face-down) or semi-prone (semi-face-down) position for the ERCP procedure. A combination of midazolam, propofol, and fentanyl was used as the sedation protocol for all patients. The depth of sedation was maintained by the anesthesiologist through titration of drug doses based on the patient's hemodynamic response, respiratory effort, and the level of immobility required for the endoscopist to work comfortably.

Evaluated Parameters

The medical records and anesthesia follow-up forms of the patients included in the study were retrospectively reviewed. Data extraction was structured under three main categories: baseline characteristics, perioperative/anesthetic parameters, and clinical outcomes.

Baseline Demographic and Clinical Data

Patient demographics included age (years) and gender. Pre-existing comorbidities were documented as binary variables (presence/absence) based on pre-anesthetic evaluation forms and ICD codes, including Diabetes Mellitus, hypertension, coronary artery disease, and Chronic Obstructive Pulmonary Disease (COPD).

Anesthesia and Procedural Parameters

The total procedure duration was recorded in minutes, defined as the time from the insertion of the scope/instrument to its removal. Sedation management parameters included the total cumulative doses of midazolam (mg), propofol (mg), and fentanyl (µg) administered throughout the session.

Perioperative Complications and Clinical Outcomes

The occurrence of non-major cardiorespiratory complications during the perioperative period was identified based on standard clinical thresholds:

- Bradycardia: Heart rate < 60 beats per minute (bpm) or a >20% drop from baseline.
- Desaturation: SpO_2 < 90 % for more than 15 seconds, requiring supplementary oxygen or airway intervention.
- Hypotension: Systolic blood pressure <90 mmHg or a >20% decrease from baseline values.

Post-procedural outcomes included the requirement for post-procedure intensive care unit (ICU) admission and the total length of hospital stay (measured in days).

Statistical Analysis

The IBM SPSS Statistics (Version 27.0) software package was used to analyze the data. Descriptive statistics were presented as mean±standard deviation (SD) and median (minimum-maximum) for continuous (quantitative) variables, and as frequency (n) and percentage (%) for categorical (qualitative) variables. The normality of continuous variables was assessed using analytical (Shapiro-Wilk test) and visual (box plots) methods. In comparisons between two independent groups, the Independent Samples t-test (Student's t-test) was used for continuous variables meeting the normal distribution assumption, while the Mann-Whitney U test was used for continuous variables not meeting this assumption. For between-group analyses of categorical variables, the Pearson chi-square test was applied, and Fisher's Exact test was used when expected frequency values were low. To assess relationships among continuous variables, Spearman's correlation was preferred given the data's distribution. A backward multiple linear regression model was used to identify independent predictors (risk factors) of hospital length of stay. In all statistical analyses, results were presented with 95% confidence intervals, and p-values <0.05 were considered statistically significant.

Results

Of the 341 patients included in the study, 58.4% (n=199) were female, and 41.6% (n=142) were male, with a mean age of 55.70±18.47 years (range: 18-97). Most patients (65.4%) were under 65 years of age. Upon examining the distribution of diagnoses, the most common indication for ERCP was gallstones (84.2%, n=287), followed by common bile duct stones and pancreatic cancer. 67.2% of the cases were performed under elective conditions, and in the anesthesia risk assessment, more than half of the patients (52.2%) were classified as American Society of Anesthesiologists (ASA) 2 (Table 1).

Table 1. Demographic and basic clinical characteristics

		n (%)
Gender	Female	199 (58.4)
	Male	142 (41.6)
Age at onset	Mean±SD	55.70±18.47
	Median (Min-Max)	58 (18-97)
	<65 years	223 (65.4)
	≥65 years	118 (34.6)
Diagnosis	Acute pancreatitis	3 (0.9)
	Liver transplant	1 (0.3)
	Cholangiocellular carcinoma	1 (0.3)
	Common bile duct stone	26 (7.6)
	Pancreatic cancer	23 (6.7)
	Gallstone	287 (84.2)
Case type	Emergency	112 (32.8)
	Elective	229 (67.2)
ASA	ASA 1	114 (33.4)
	ASA 2	178 (52.2)
	ASA 3	49 (14.4)

Table 1. Continued		
•Comorbidities	None	128 (37.5)
	Present	213 (62.5)
	Diabetes mellitus	84 (24.6)
	Hypertension	127 (37.2)
	Coronary artery disease	41 (12)
	COPD	16 (4.7)
	Chronic heart failure	9 (2.6)
	Asthma	4 (1.2)
	Other	5 (1.5)
Intensive care	None	299 (87.7)
	Yes	42 (12.3)
Smoking	None	332 (97.4)
	Yes	9 (2.6)
Length of stay in intensive care (days) (n=42)	Mean±SD	1.19±0.49
	Median (Min-Max)	1 (1-2)
Hospital stay duration (days)	Mean±SD	4.21±1.26
	Median (Min-Max)	5 (2-7)
Complications	None	313 (91.8)
	Yes	28 (8.2)
	Bradycardia	4 (1.2)
	Desaturation	12 (3.5)
	Hypotension	12 (3.5)
Number of ERCPs	1	257 (75.4)
	2	75 (22.0)
	3	6 (1.8)
	4	3 (0.9)
	Mean±SD Median (Min-Max)	1.28±0.54 1 (1-4)
Procedure duration (min)	Mean±SD Median (Min-Max)	34.50±6.90 35 (20-45)
Midazolam (mg) Mean±SD Median (Min-Max)		1.56±0.60 2 (0-3)
Fentanyl (mcg) Mean±SD Median (Min-Max)		41.28±11.93 50 (25-50)
Propofol (mg) Mean±SD Median (Min-Max)		152.47±31.17 150 (100-200)
Outcome n (%)	Discharged	341 (100.0)

ASA: American Society of Anesthesiologists, ERCP: Endoscopic Retrograde Cholangiopancreatography, COPD: Chronic Obstructive Pulmonary Disease, SD: Standard deviation, n: Number of patients. Data are presented as n (%) and mean±SD.
•Multiple comorbidities were observed.(Other comorbidities: SVO, Alzheimer's, arrhythmia)

Upon evaluation of the patients' clinical histories, at least one additional systemic disease (comorbidity) was present in 62.5% (n=213) of the patients, with hypertension (37.2%) and diabetes mellitus (24.6%) being the most common comorbidities. Furthermore, upon reviewing the patients' ERCP histories, it was observed that ERCP was performed for the first time in 75.4% of cases, while 24.6% had previously undergone the procedure at least once (mean number of ERCPs: 1.28±0.54) (Table 1).

During ERCP procedures, which lasted an average of 34.50±6.90 minutes, patients received an average of 1.56±0.60 mg of midazolam, 41.28±11.93 mcg of fentanyl, and 152.47±31.17 mg of propofol for sedation. Minor peri-procedural complications (bradycardia, desaturation, hypotension) occurred in only 8.2% of cases (n=28) during the procedure. Post-procedure, 12.3% of patients (n=42) were monitored in the ICU for an average of 1.19±0.49 days; the average hospital stay for all patients was 4.21±1.26 days, and all patients (100%) were discharged in good health (Table 1).

A combination of midazolam, propofol, and fentanyl was used for sedation in all patients, and the doses of the administered agents and the rates of peri-procedural complications were analyzed according to the patients' demographic characteristics. When parameters were evaluated by gender, no statistically significant difference was found between female and male patients in terms of the mean doses of midazolam, propofol, and fentanyl used or the incidence of perioperative complications ($p > 0.05$) (Table 2).

Table 2. Comparison of anesthetic drug doses and complication rates by age and gender groups

Parameters	**< 65 Years (n=223)**	**≥65 Years (n=118)**	**p-value (Age)**	**Female (n=199)**	**Male (n=142)**	**p-value (Gender)**
Medications used and dosages						
Midazolam (mg) Mean±SD	1.74±0.45	1.21±0.70	[c] 0.001**	1.56±0.60	1.56±0.58	[c] 0.948
Propofol (mg) Mean±SD	164.55±27.97	129.75±23.22	[d] 0.001**	152.98±31.33	151.76±31.04	[d] 0.723
Fentanyl (mcg) Mean±SD	43.39±11.05	37.29±12.55	[c] 0.001**	41.71±11.80	40.67±12.13	[c] 0.428
Development of complications						
Present n (%)	3 (1.3)	25 (21.2)	[a] 0.001**	17 (8.5)	11 (7.7)	[a] 0.792
None n (%)	220 (98.7)	93 (78.8)		182 (91.5)	131 (92.3)	

SD: Standard Deviation, mg: Milligram, mcg: Microgram, p: Statistical significance value. p-values in bold are statistically significant ($p<0.05$). [a] Pearson's Chi-Square Test
[c]Mann-Whitney U Test, dStudent's t-Test

However, when patients were examined by age group, statistically significant differences were observed in both anesthetic drug requirements and complication rates. It was found that the average doses of midazolam, propofol, and fentanyl required to maintain sedation in the 65 years and older (geriatric) group were significantly lower compared to patients under 65 years of age ($p=0.001$, $p=0.002$, and $p=0.001$, respectively). Despite the significant reduction in drug doses in the older age group, the incidence of complications in patients aged 65 and older was found to be statistically significantly higher than in the group of adults under 65 years of age ($p<0.05$)(Table 2).

The effect of patients' demographic, clinical, and anesthetic data on hospital stay duration (days) was comprehensively evaluated using univariate comparisons (Table 3) and multivariate backward linear regression analysis (Table 4).

Table 3. Comparison of demographic characteristics with length of hospital stay				
		Length of stay		**p**
		Mean±SD	**Median (Min-Max)**	
Gender	Female	4.08±1.27	4 (2-7)	d 0.031*
	Male	4.38±1.24	5 (2-7)	
Age at onset	<65 years	4.17±1.31	5 (2-7)	d 0.485
	≥65 years	4.27±1.17	5 (2-7)	
Diagnosis	•Acute pancreatitis	6.33±1.15	7 (5-7)	e 0.209
	•Liver transplant	5.00±0.00	5 (5-5)	
	•Cholangiocellular carcinoma	5.00±0.00	5 (5-5)	
	Choledochal stone	4.27±1.15	5 (2-6)	
	Pancreatic cancer	3.74±1.39	4 (2-5)	
	Gallstones	4.21±1.25	5 (2-7)	
Case type	Emergency	4.22±1.22	5 (2-7)	d 0.893
	Normal	4.20±1.29	5 (2-7)	
ASA	1	4.16±1.28	5 (2-7)	e 0.063
	2	4.15±1.32	5 (2-7)	
	3	4.53±0.98	5 (2-6)	
Cigarette	None	4.21±1.27	5 (2-7)	d 0.821
	Present	4.11±1.17	5 (2-5)	
Comorbidities	None	4.20±1.25	5 (2-7)	d 0.981
	Present	4.21±1.28	5 (2-7)	
Intensive care	None	4.22±1.31	5 (2-7)	d 0.422
	Present	4.10±0.88	4 (2-6)	
Length of stay in the ICU Complications	‡r	0.349	0.023*	
	None	4.15±1.28	5 (2-7)	d 0.022*
	Present	4.79±0.92	5 (2-7)	
Number of ERCPs	‡r	0.096	0.075	
Procedure duration (min)	r	0.012	0.829	
Midazolam (mg)	‡r	0.069	0.206	
Fentanyl (mcg)	‡r	-0.301	0.001**	
Propofol (mg)	r	0.114	0.035*	

r: Spearman correlation coefficient, p: Statistical significance value. As the r value approaches +1, it indicates a strong positive relationship; as it approaches -1, it indicates a strong negative relationship.
•Not included in the analysis due to insufficient data.
Student's t-test, eOne-way ANOVA, r: Pearson's correlation coefficient
‡r: Spearman's Correlation Coefficient, **p<0.01, *p<0.05

Table 4. Effects of risk factors related to patients on length of hospitalization					
Dependent variable	**Independent variable**	**ß**	**t**	**p**	**%95 CI**
(Lower-Upper)					
Dwell time	Constant		2.900	0.006**	0.555-3.121
	Gender (Male)	0.135	0.964	0.342	-0.264-0.741
	ASA	0.187	1.167	0.251	-0.164-0.609

Table 4. Continued					
	Length of stay in the ICU	0.422	3.133	0.003**	0.330-1.534
	Complication (present)	0.431	3.028	0.004**	0.316-1.589
	Fentanyl	0.305	2.141	0.039*	0.001-0.044
	Propofol	0.300	1.787	0.083	-0.001-0.020
Method: Backward **p<0.01 *p<0.05, CI: Confidence interval					

When demographic data were analyzed using univariate analysis, it was found that the mean length of hospital stay for male patients (4.38±1.24 days) was statistically significantly longer than that for female patients (4.08±1.27 days) (p=0.031) (Table 3). However, when the gender variable was included in a multivariate regression model along with all other clinical risk factors, it was observed that male gender had no independent (direct) effect on length of stay (p=0.342) (Table 4). When patients were analyzed by age group (<65 and ≥65 years), no significant difference was found in length of hospital stay (p=0.485) (Table 3).

When evaluated in terms of clinical course and complications, the hospital stay durations of patients who developed periprocedural complications during the procedure (4.79±1.50 days) were significantly longer than those of patients without complications (4.15±1.28 days) (p=0.022) (Table 3). Additionally, a positive and significant correlation (r=0.349; p=0.023) was observed between ICU length of stay and total hospital length of stay (Table 3). These two clinical variables remained significant in the multivariate regression model; increased ICU length of stay (ß=0.422; p=0.003) and the presence of complications (ß=0.431; p=0.004) were the strongest independent risk factors for prolonging the hospital stay following ERCP (Table 4).

When the relationship between anesthetic agents and length of stay was examined, a weak positive correlation was found between propofol doses and length of stay (r=0.114; p=0.035), while a significant negative correlation was observed between fentanyl doses and length of stay (r=-0.301; p=0.001) (Table 3). When these variables were subjected to regression analysis, the effect of propofol on the duration of recovery lost statistical significance (p=0.083); however, the fentanyl dose (p=0.039) remained an independent determinant of the duration of recovery (Table 4).

On the other hand, no statistically significant relationship was found between patients' initial age (p=0.485), procedure diagnoses (p=0.209), case type (emergency/elective, p=0.893), ASA scores (p=0.063), smoking status (p=0.821), presence of comorbidities (p=0.981), number of ERCPs (p=0.075), and total procedure duration (p=0.829) were found to have no statistically significant association with hospital stay duration (Table 3).

Discussion

The primary objective of this study is to retrospectively evaluate the risk factors affecting anesthesia management, peri-procedural complication rates, and length of hospital stay in patients undergoing ERCP under sedation at a tertiary care facility. According to the descriptive findings of our study (Table 1); although 62.5% of the patients had at least one additional systemic disease (hypertension, diabetes, COPD, etc.) and the majority of cases were classified in the ASA II-III risk group, the rate of non-major peri-procedural complications remained at a very low level of 8.2%, and all patients (100%) were discharged in good health. The results of the multivariate regression analysis in our study (Table 4) revealed that the presence of periprocedural complications, prolonged ICU stay, and low fentanyl dose were the most significant independent predictors of prolonged hospital stay.

Monitored Anesthesia Care (MAC), as applied in our study, is an anesthesia strategy in which the patient remains pain-free and immobile under continuous monitoring of hemodynamic and respiratory parameters by an anesthesiologist, without requiring endotracheal intubation to maintain the airway and preserve spontaneous breathing (7). ERCP is one of the procedures with the highest anesthetic risk due to limited airway access, the patient's prone or semi-prone position, and prolonged procedure duration (2). Despite these challenges, the MAC strategy applied in our study was found to be extremely safe even in patients with high comorbidity (Table 3). Current consensus guidelines and recent meta-analyses emphasize that MAC performed under the supervision of an experienced anesthesiologist results in less hemodynamic instability (particularly intraoperative hypotension) and facilitates faster recovery compared to general anesthesia (1,8,9). Additionally, the synergistic use of propofol with fentanyl, midazolam, or other agents reduces total propofol

consumption while minimizing the risk of respiratory depression and hypoxemia, thereby ensuring optimal surgical/procedural conditions (4,10).

When examining the effects of demographic factors on anesthesia management, gender did not significantly affect drug doses (Table 2), whereas age was a key pharmacological determinant. According to our findings (Table 2), while the consumption of midazolam, propofol, and fentanyl was statistically significantly lower in patients aged 65 and older, the complication rates in this group were higher compared to adults under 65 years of age. Studies in the literature also support our findings (11), demonstrating that the dosage requirement for propofol and other sedative agents is inversely proportional to age (12) and that complications such as desaturation and the need for postoperative intensive care increase significantly in the elderly group (≥65 years). Decreasing physiological reserves, increasing cardiopulmonary comorbidities, and altered pharmacodynamic responses associated with aging render geriatric patients much more vulnerable to the respiratory and cardiovascular depressant effects of anesthetics (11,13). In our study, the significant reduction in drug doses in the elderly group demonstrates the success of the meticulous titration strategy implemented to maintain cardiorespiratory stability and minimize adverse effects such as hypoxia and hypotension caused by deep sedation in this high-risk population.

In our study, patients' current smoking status was also evaluated (Table 1). It is known from the literature that current smoking increases airway reactivity, thereby increasing secretion volume, and significantly elevates the risk of laryngospasm and desaturation, particularly during procedures performed in the prone position (14,15). Nevertheless, we found that smoking did not affect intubation duration (Table 3).

When factors prolonging hospital stay were evaluated in a regression model, male gender—which appeared significant in univariate analysis (p=0.031) (Table 3)—was found not to be an independent risk factor in multivariate analysis (p=0.342). This suggests that prolonged hospital stays in male patients are likely due to more severe comorbidities (higher ASA scores) or more complex biliary pathologies in men, rather than biological differences related to gender (16). It was determined that the primary factors prolonging hospital stay were complications arising during or after the procedure (17). Adverse events occurring during the procedure, such as bradycardia and desaturation, were shown to directly prolong the length of stay (p=0.004) (Table 4). The literature confirms that even non-major sedation-related events and procedural difficulties significantly increase clinical resource utilization, thereby substantially raising hospital costs and length of stay (3,18)

No statistically significant relationship was found between the number of previous ERCPs our patients had undergone and their length of hospital stay (p=0.075) (Table 3). Repeated ERCP procedures have a dual effect in clinical practice; while previous sphincterotomies may facilitate cannulation, they can significantly increase procedural difficulty, the risk of complications, and anesthesia duration due to developing tissue hyperplasia (fibrosis) and altered anatomy (2,17). Nevertheless, the finding that a history of repeated ERCP procedures did not prolong the hospital stay is quite significant. This demonstrates that our clinic's standard anesthesia and endoscopy protocols are successfully applied even in repeated procedures, and that patients can be discharged rapidly within safety margins comparable to those of their first ERCP.

When examining the effect of anesthetic pharmacology on hospital length of stay, regression analysis (Table 4) revealed that a decrease in fentanyl dose was associated with a longer length of stay (p=0.039), which is clinically and pharmacologically noteworthy. This situation may stem from anesthesiologists' tendency to restrict opioid doses to avoid respiratory depression in elderly, frail, and hemodynamically unstable patients; it may also be explained by inadequate analgesia increasing surgical stress during the procedure, thereby delaying recovery and discharge (2,13). The accumulation of endogenous opioids in biliary pathologies such as obstructive jaundice and impaired liver metabolism, which alter patients' sensitivity to anesthetics and analgesics, is also an important pharmacodynamic factor underlying this dose restriction (19). On the other hand, it is known that opioids such as fentanyl and morphine can increase the basal pressure of the sphincter of Oddi, the amplitude of phasic contractions, and the pressure in the common bile duct (20). However, current evidence indicates that the synergistic use of short-acting opioids like fentanyl in appropriate doses in combination with propofol preserves airway reflexes compared to propofol alone, significantly reduces the risk of adverse events such as hypoxia/desaturation, and provides an extremely safe ERCP sedation by enhancing procedural comfort (10).

Consistent with the existing literature, our findings demonstrated that the administered fentanyl dosage was maintained at a lower threshold in the elderly cohort. Aging is inherently associated with a reduction in hepatic blood flow and a decline in renal function, which collectively impair fentanyl clearance and significantly prolong its elimination half-life (21). Furthermore, age-related pharmacodynamic alterations increase central nervous system

sensitivity to opioid-induced effects, elevating the susceptibility of older patients to critical complications such as postoperative respiratory depression and prolonged sedation. Consequently, the clinical reflex of anesthesiologists to meticulously titrate and downscale fentanyl doses is highly justified, driven by a vital imperative to mitigate respiratory depression and ensure patient safety in this vulnerable population.

In conclusion, Monitored Anesthesia Care (MAC) applications, when combined with effective local or regional analgesia, align seamlessly with the core tenets of Enhanced Recovery After Surgery (ERAS) protocols by minimizing postoperative physiological stress and opioid consumption (22). This multimodal, opioid-sparing approach circumvents the recovery delays often associated with general anesthesia, thereby facilitating early patient mobilization and directly contributing to a significant reduction in the postoperative length of stay (LOS) (23).

Limitations: Our study has a single-center, retrospective design; this may limit the generalizability of the findings. Second, objective monitoring methods, such as the BIS (Bispectral Index), were not routinely used to assess sedation depth; clinical assessment was relied on. Finally, the absence of a control group comparing different sedation regimens (e.g., propofol-ketamine combinations) makes it difficult to clearly distinguish the specific advantages of the protocol used.

Conclusion

MAC used in ERCP procedures is safe in patients with high comorbidity; however, it requires close monitoring in geriatric patients due to an increased risk of complications despite dose reduction. Our study identified the primary factors prolonging hospital stay as perioperative complications, the need for intensive care, and low fentanyl dosing. Accordingly, effective analgesia management, conducted under the leadership of an anesthesiologist and in accordance with ERAS principles, is the most critical determinant for accelerating discharge.

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