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Original Article

Application value and safety advantages of remimazolam tosilate in sedation for emergency rescue endotracheal intubation

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Abstract: Objectives: Emergency tracheal intubation is a high-risk, life-support procedure that requires rapid and safe sedation. This study aimed to evaluate the clinical effectiveness and safety of remimazolam tosilate compared to propofol for sedation during emergency resuscitation intubation. Methods: This retrospective cohort study included adult patients who underwent sedation-assisted emergency intubation between June 2022 and June 2025. Patients were grouped according to the primary sedative administered: propofol or remimazolam. Sedation depth was assessed using the Ramsay score, and intubation success rates were recorded. Hemodynamic indices and respiratory rates were documented pre- and post-intubation. The incidence of adverse events and cognitive function at postoperative 72 hours were also evaluated. Results: A total of 216 patients were included (104 in the propofol group and 112 in the remimazolam group). Propofol demonstrated a faster onset of sedation (42.12 ± 6.63 vs. 95.12 ± 10.17 seconds, P < 0.001), whereas remimazolam achieved a significantly higher first-attempt intubation success rate (87.50% vs. 66.35%, P < 0.001). After intubation, patients in the remimazolam group maintained higher systolic blood pressure (122.20 ± 9.77 vs. 116.42 ± 17.38 mmHg, P=0.003) and mean arterial pressure, as well as a lower rate-pressure product (10395.81 ± 928.89 vs. 10754.15 ± 1168.58 mmHg/min, P=0.014). The remimazolam group also exhibited lower incidences of hypotension (9.82% vs. 20.19%, P=0.032) and respiratory depression (5.36% vs. 17.31%, P=0.005), and experienced less injection pain (5.36% vs. 27.88%, P < 0.001). Conclusions: In emergency intubation, compared to propofol, remimazolam tosilate demonstrated a slower onset of sedation but offers better hemodynamic stability, higher first-attempt success rates, more favorable respiratory profiles, and improved early cognitive recovery, making it a valuable alternative sedative.

Keywords: Remimazolam, emergency intubation, propofol, sedation, critically patients

Introduction

Emergency tracheal intubation is a commonly used and essential life-support intervention in the resuscitation of patients in critical condition [1, 2]. It is indicated in various acute critical conditions, including respiratory failure, airway obstruction, and severe hypoxemia [3]. The rapid onset and progression of these conditions require immediate intervention to secure the airway safety and restore adequate ventilation [4]. Tracheal intubation with invasive mechanical ventilation can protect the airway and ensure adequate oxygenation; however, the intubation process itself also carries significant risks [5]. The success and safety of intubation largely depend on effective sedation, which aims to suppress conscious physiological responses, facilitate intubation, while maintaining hemodynamic and respiratory stability [6]. Appropriate sedation also helps improve laryngoscopic exposure, increase intubation success rate, and reduce procedure-related complications [7]. Critically ill patients

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often present with hemodynamic instability, making the selection of sedative agents particularly important.

Propofol is one of the most commonly used sedatives for emergency intubation due to its rapid onset and predictable pharmacokinetic characteristics [8]. However, propofol is associated with dose-dependent hypotension and respiratory depression, which may exacerbate hemodynamic instability in critically ill patients and increase the risk of adverse events during intubation [9]. This highlights the clinical need for alternative sedatives with more favorable safety profiles. Benzodiazepines, such as remimazolam, primarily exert their effects by enhancing γ-aminobutyric acid (GABA) activity at γ-aminobutyric acid type A (GABAA) receptors, leading to neuronal inhibition [10]. Remimazolam offers fast recovery, minimal cardiovascular suppression, and metabolism independent of organ function, which may be beneficial for patients with impaired cardiopulmonary reserve [11]. Previous studies have shown that during procedural sedation, remimazolam provides more stable hemodynamic profiles compared to propofol [12]. Understanding how these pharmacologic differences manifest in the high-risk setting of emergency intubation is crucial for optimizing patient outcome.

Therefore, this study aimed to evaluate the efficacy and safety of remimazolam tosilate versus propofol for emergency intubation. The key innovation and clinical significance of this study lie in its focus on the specific high-risk scenario of emergency resuscitation intubation, systematically assessing the application value of remimazolam in this extreme environment. Beyond conventional measures such as sedation depth and hemodynamic indicators, this study includes key indicators such as glottic opening status, body movement during intubation, and early postoperative cognitive function, all of which directly influence procedural conditions and patient outcome. This study seeks to address the gap in evidence for the use of remimazolam in through data from the field of emergency medicine. These findings are expected to provide valuable evidence for guiding the selection of sedatives, potentially offering a safer alternative that minimizes cardiovascular and respiratory complications in critically ill patients while maintaining procedural efficacy.

Materials and methods

Study design and ethical statement

This retrospective cohort study included adult patients who admitted to the emergency department of our hospital between June 2022 and June 2025 and underwent sedation-induced tracheal intubation due to acute respiratory failure or the need for airway protection. Patients were categorized according to the main sedative drug used during the intubation process: the propofol group (n=104) and the remimazolam tosilate group (n=112).

This study was conducted in compliance with the Declaration of Helsinki. The study protocol was approved by the Medical Ethics Committee of The Third People's Hospital of Cangnan County. Given the retrospective nature of the study and the use of fully anonymized patient data, written informed consent was waived. All patient records were anonymized before analysis to protect privacy and ensure confidentiality.

Inclusion and exclusion criteria

Inclusion criteria: age ≥ 18 years; receipt of emergency resuscitative tracheal intubation under sedation; complete clinical records with clear documentation of the use of propofol or remimazolam tosilate as the primary sedative/analgesic drug.

Exclusion criteria: Known severe allergy to propofol or remimazolam; Known difficult airway or absolute contraindications to tracheal intubation; Pregnancy or breastfeeding; Prior administration of deep sedation or analgesic agents prior to the planned intubation that could affect the evaluation of the study drugs' efficacy and safety; Incomplete clinical records, (e.g., missing critical sedation process, vital signs, or medication information); and elective intubation cases not performed under emergency or resuscitative circumstances.

Sedation methods and tracheal intubation procedures

All patients received pre-treatment with 3-5 ml of 2% lidocaine, either sprayed or locally applied to the oropharynx, to achieve surface anesthesia of the throat. On this basis, patients were categorized into two groups according to the

primary sedative drug chosen by the attending emergency physician at the time of intubation and received corresponding sedative induction protocols. Individuals in the propofol group received a single intravenous bolus of propofol at 0.5-1.0 mg/kg. Patients in the remimazolam tosilate group received a single intravenous bolus of remimazolam tosilate at 0.2-0.3 mg/kg. If the initial dose did not achieve adequate sedation for intubation, additional small doses of the original drug (propofol or 2.5-5 mg remimazolam) could be titrated by the operating physician according to the patient's circulatory status, age, and immediate response, to reach the desired level of sedation.

Once the patient lost consciousness and achieved adequate sedation, tracheal intubation was performed by an experienced emergency physician or anesthesiologist under direct laryngoscopy. The glottis was visualized, and the endotracheal tube was smoothly inserted into the trachea through the mouth. The intubation procedure was carried out swiftly and accurately.

After tube placement, multiple methods were immediately employed to confirm correct position, including auscultation of bilateral breath sounds for symmetry, observation of thoracic movement, and monitoring of end-tidal carbon dioxide waveform. Once proper placement was confirmed, the cuff was inflated, and the tube was securely fixed. The patient was subsequently connected to a mechanical ventilator. Throughout the intubation and subsequent ventilator connection, continuous close monitoring of vital signs, including heart rate, blood pressure, and oxygen saturation was conducted. Ventilator parameters as well as subsequent sedation and analgesia were dynamically adjusted based on changes in the patient's condition and respiratory mechanics.

Data collection

All data were retrospectively collected through review of patients' electronic medical records, anesthesia records, and intensive care unit (ICU) monitoring systems. Demographic and clinical information, including age, sex, body mass index (BMI), American Society of Anesthesiologists (ASA) classification, Acute Physiology and Chronic Health Evaluation II (APACHE II) score, Sequential Organ Failure Assessment (SOFA) score, primary indications for tracheal intubation, and comorbidities, were extracted from the medical record system. The APACHE II score quantifies the severity of illness, ranging from 0 to 71 points, with higher scores indicating worse prognosis [13]. The SOFA score assesses the degree of organ dysfunction or failure, ranging from 0 to 24 points, with higher scores implying more severe organ failure [14].

Sedation onset time was defined as the interval from the initiation of intravenous administration of sedative drugs to the loss of consciousness and disappearance of the eyelash reflex. Sedation depth was evaluated using the Ramsay Sedation Scale at three timepoints: before intubation, during intubation, and 5 minutes after successful intubation [15]. The Ramsay scale ranges from 1 to 6: 1, anxious or restless; 2, cooperative, oriented, and calm; 3, responding only to commands; 4, brisk response to light tap on the eyebrow or loud auditory stimulus; 5, sluggish response to light tap on the eyebrow or loud auditory stimulus; 6, no response to any stimulus. First-attempt intubation success was obtained from procedural notes documented by the operating physician.

Mean arterial pressure (MAP), heart rate, respiratory rate, oxygen saturation, systolic and diastolic blood pressure (SBP/DBP) values were recorded using monitors (IntelliVue MX series, Philips, Netherlands) before intubation (within 1 minute before sedative administration) and immediately after successful intubation and ventilator connection. The rate-pressure product (RPP) was calculated based on concurrent heart rate and SBP.

Vocal cord position and response to stimulation during the intubation process were assessed and recorded by the operating physician and obtained from anesthesia records.

Postoperative delirium was determined based on acute changes or fluctuations in mental status documented in medical records, consistent with the Confusion Assessment Method for the ICU (CAM-ICU) criteria, including inattention, disorganized thinking, and altered level of consciousness [16]. Cognitive function at 72 hours postoperatively was evaluated using the Mini-Mental State Examination (MMSE) scale, which scores orientation, memory, attention and cal-

Table 1. Comparison of baseline characteristics between the propofol and remimazolam groups

Index	Propofol group (N=104)	Remimazolam group (N=112)	t/χ^2	P
Age (years)	58.74 ± 7.38	59.02 ± 7.73	0.266	0.790
Sex (female/male)	56 (53.85%)/48 (46.15%)	63 (56.25%)/49 (43.75%)	0.126	0.723
BMI	24.12 ± 3.31	23.84 ± 3.19	0.634	0.527
ASA Classification (I/II)	61 (58.65%)/43 (41.35%)	63 (56.25%)/49 (43.75%)	0.127	0.721
APACHE II Score	22.56 ± 5.64	21.86 ± 5.61	0.914	0.362
SOFA Score	7.84 ± 1.29	7.69 ± 1.27	0.834	0.405
Indications for Intubation			0.790	0.940
Tube Replacement	5 (4.81%)	8 (7.14%)		
CO_2 Retention	14 (13.46%)	17 (15.18%)		
Hypoxemia	29 (27.88%)	31 (27.68%)		
Airway Obstruction	26 (25.00%)	27 (24.11%)		
Respiratory Distress	30 (28.85%)	29 (25.89%)		
Advanced-stage Cancer	14 (13.46%)	12 (10.71%)	0.384	0.535
Acute Myocardial Infarction	13 (12.50%)	15 (13.39%)	0.038	0.845
Multiple Trauma	14 (13.46%)	12 (10.71%)	0.384	0.535
Hypertension	37 (35.58%)	43 (38.39%)	0.183	0.668
Diabetes	21 (20.19%)	24 (21.43%)	0.050	0.823
Post-cardiac Surgery	36 (34.62%)	37 (33.04%)	0.060	0.806
Post-biliary Surgery	17 (16.35%)	24 (21.43%)	0.906	0.341

BMI: Body Mass Index; ASA: American Society of Anesthesiologists; APACHE II: Acute Physiology and Chronic Health Evaluation II; SOFA: Sequential Organ Failure Assessment.

culation, recall, and language abilities from 0 to 30 points, with higher scores indicating better cognitive function [17].

Hypotension, respiratory depression, bradycardia, and other complications were identified through comprehensive review of continuous vital sign data and physician progress notes. Hypotension was defined as MAP below 65 mmHg or a reduction exceeding 20% from baseline. Respiratory depression was characterized by a respiratory rate below 12 breaths per minute or the occurrence of apnea or severe hypoventilation requiring urgent intervention. Bradycardia was defined as a heart rate lower than 50 beats per minute. Other adverse events, including injection pain, nausea, and vomiting, were extracted from nursing records, post-anesthesia follow-up records, and adverse event reports.

Statistical analysis

All statistical analyses for this study were performed using R language (version 4.3.2; R Foundation for Statistical Computing, Austria). Continuous variables were first assessed for normality using the Shapiro-Wilk test. Variables that followed a normal distribution were presented as mean ± standard deviation (SD), and group comparisons were conducted using independent samples t-tests. Categorical variables were presented as number (percentage) [n (%)], and group comparisons were conducted using the chi-square test. A two-sided P value < 0.05 was considered significant.

To verify whether remimazolam independently influences first-pass intubation success, a logistic regression analysis was performed with first-pass intubation success as the dependent variable and sedation drug group as the primary independent variable. Results were presented as odds ratios (OR) along corresponding 95% confidence intervals (CI).

Results

Patient baseline characteristics

Baseline characteristics of the propofol and remimazolam groups are compared in **Table 1**. No significant differences were observed between the two groups in terms of age, sex distribution, BMI, ASA classification, APACHE II

Table 2. Comparison of sedation profiles and intubation success rates between the two groups

Index	Propofol group (N=104)	Remimazolam group (N=112)	t/χ^2	P
Sedation Onset Time (seconds)	42.12 ± 6.63	95.13 ± 10.17	45.690	< 0.001
Ramsay Score Before Intubation	2.07 ± 0.12	2.09 ± 0.12	1.578	0.116
Ramsay Score During Intubation	3.54 ± 0.58	3.69 ± 0.71	1.712	0.088
Ramsay Score After Intubation	2.80 ± 0.41	2.75 ± 0.48	0.734	0.464
Number of Successful Intubations			13.759	< 0.001
First Attempt Success	69 (66.35%)	98 (87.50%)		
Second Attempt Success	35 (33.65%)	14 (12.50%)		

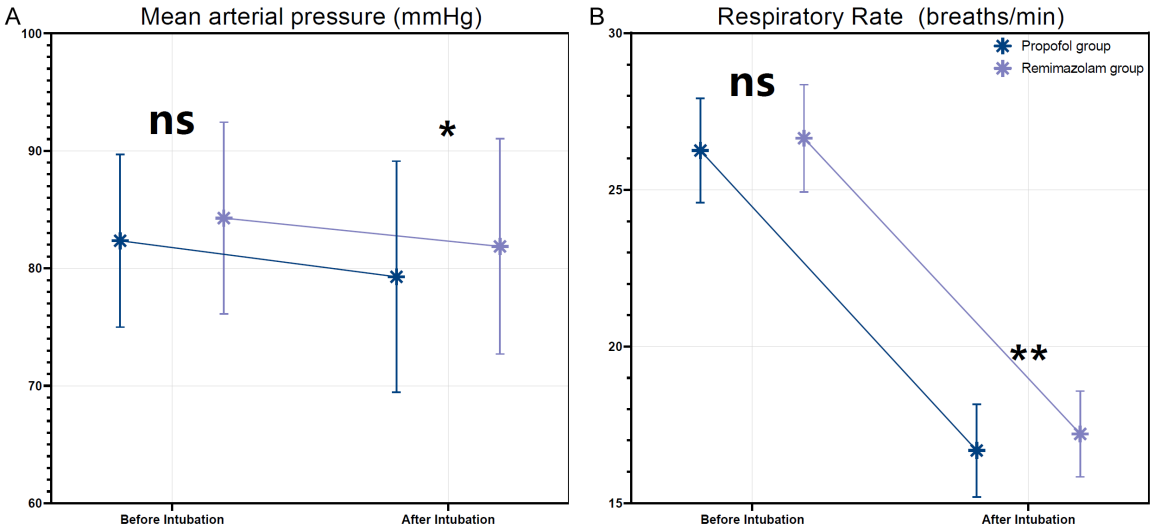

Figure 1. Comparison of mean arterial pressure and respiratory rate between the two groups before and after treatment. A: Mean arterial pressure; B: Respiratory Rate; ns: no significant (P > 0.05); *: P < 0.05; **: P < 0.01.

score, SOFA score, indications for intubation, or medical history (all P > 0.100).

Sedation efficacy and intubation success

As shown in **Table 2**, the sedation onset time in the propofol group was significantly shorter than that of the remimazolam group (P < 0.001), indicating a more rapid achievement of a sedated state with propofol. In terms of first-attempt intubation success rate, the remimazolam group was significantly higher than the propofol group (P < 0.001). No significant variations were found in Ramsay scores before intubation, during intubation, or 5 minutes after successful intubation between the two groups (all P > 0.05), suggesting that the depth of sedation was comparable between the two groups.

Hemodynamic and respiratory stability

As shown in **Figure 1**, no significant differences were observed in MAP or respiratory rate between the two groups before intubation (all P > 0.05). After intubation, MAP was significantly higher in the remimazolam group than in the propofol group (P=0.047), indicating that the remimazolam group maintained relatively higher blood pressure levels after intubation. Additionally, the respiratory rate in the remimazolam group was lower than that in the propofol group after intubation (P=0.007), implying that remimazolam may have a less respiratory suppression effect.

As demonstrated in **Table 3**, no significant differences were observed between the two groups in heart rate or oxygen saturation before intubation, or in oxygen saturation after intubation (all P > 0.05). After intubation, heart rate was significantly higher in the propofol group than in the remimazolam group (P= 0.003), indicating a more pronounced sympathetic response in the propofol group.

As shown in **Table 4**, no significant differences were observed between the two groups in

Table 3. Comparison of heart rate and oxygen saturation between the two groups

Index	Propofol group (N=104)	Remimazolam group (N=112)	t	P
Heart rate before intubation (beats/min)	90.26 ± 9.78	92.57 ± 9.14	1.793	0.074
Heart rate after intubation (beats/min)	91.06 ± 10.59	86.87 ± 9.57	3.054	0.003
Oxygen saturation before intubation (%)	91.66 ± 10.37	93.73 ± 10.42	1.457	0.147
Oxygen saturation after intubation (%)	98.60 ± 11.12	97.81 ± 10.15	0.546	0.585

Table 4. Comparison of systolic, diastolic blood pressure and rate-pressure product between the two groups

Index	Propofol group (N=104)	Remimazolam group (N=112)	t	P
SBP Before Intubation (mmHg)	120.02 ± 10.13	118.14 ± 9.70	1.392	0.165
SBP After Intubation (mmHg)	116.42 ± 17.38	122.20 ± 9.77	2.983	0.003
DBP Before Intubation (mmHg)	75.83 ± 8.15	75.77 ± 7.73	0.055	0.956
DBP After Intubation (mmHg)	74.08 ± 8.05	76.62 ± 7.76	2.356	0.019
RPP Before Intubation (mmHg/min)	9717.75 ± 1181.10	9912.74 ± 1115.48	1.248	0.213
RPP After Intubation (mmHg/min)	10754.15 ± 1168.58	10395.81 ± 928.89	2.483	0.014

SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; RPP: Rate-Pressure Product.

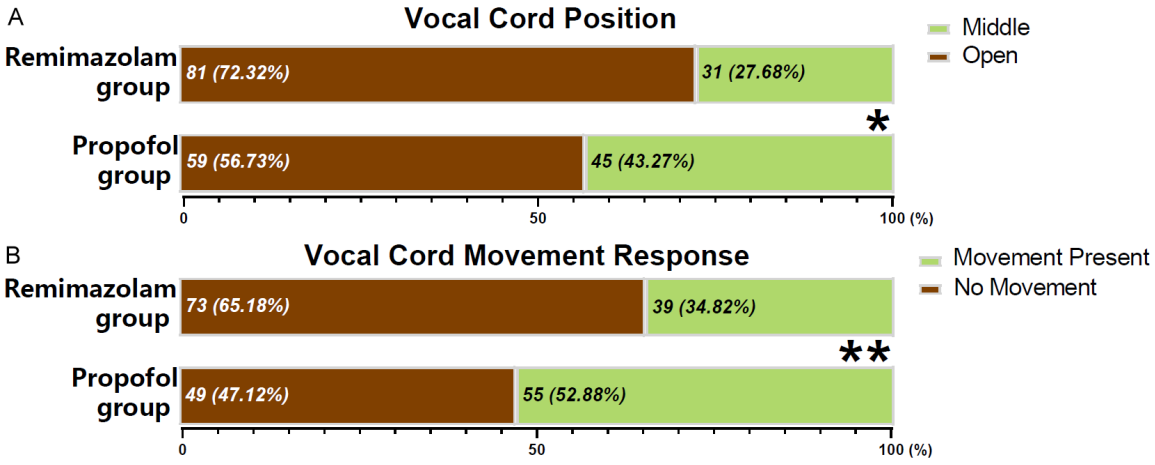

Figure 2. Vocal cord status and responsiveness during intubation. A: Vocal Cord Position; B: Vocal Cord Movement Response. *: P < 0.05; **: P < 0.01.

SBP, DBP, or RPP before intubation (all P > 0.05). After intubation, SBP and DBP were significantly higher in the remimazolam group than in the propofol group (SBP, P=0.003; DBP, P=0.019), suggesting superior blood pressure stability with remimazolam. Additionally, RPP values were significantly higher in the propofol group after intubation (P=0.014), indicating a relatively higher cardiac workload under the combined influence of heart rate and blood pressure.

Conditions for intubation

Figure 2 shows the comparison of vocal cord status and reactivity during the intubation process between the propofol group and the remimazolam group. The proportion of patients with open vocal cords was significantly higher in the remimazolam group than in the propofol group (P=0.017), indicating that remimazolam tends to maintain the vocal cords in an open position, which is advantageous for the intuba-

Table 5. Comparison of incidence of postoperative delirium and cognitive scores between the two groups

Index	Propofol group (N=104)	Remimazolam group (N=112)	t/χ^2	P
Postoperative Delirium Incidence	10 (9.62%)	7 (6.25%)	0.842	0.359
MMSE Score at 72 Hours Postoperatively	26.93 ± 1.59	27.57 ± 1.43	3.141	0.002

MMSE: Mini-Mental State Examination.

Table 6. Comparison of incidence of sedation and intubation-related adverse events between the two groups

Index	Propofol group (N=104)	Remimazolam group (N=112)	χ^2	P
Hypotension	21 (20.19%)	11 (9.82%)	4.596	0.032
Respiratory Depression	18 (17.31%)	6 (5.36%)	7.798	0.005
Injection Pain	29 (27.88%)	6 (5.36%)	20.155	< 0.001
Bradycardia	9 (8.65%)	5 (4.46%)	1.562	0.211
Nausea and Vomiting	10 (9.62%)	7 (6.25%)	0.842	0.359

Table 7. Univariate and multivariate logistic regression analyses of factors associated with first-attempt intubation success

Index	Univariate Regression		Multivariate Regression	
	P	OR (95% CI)	P	OR (95% CI)
Remimazolam vs. Propofol	< 0.001	3.551 (1.811-7.288)	< 0.001	3.884 (1.848-8.163)
Age	0.004	0.929 (0.881-0.976)	0.021	0.937 (0.886-0.990)
BMI	0.037	0.903 (0.819-0.993)	0.063	0.901 (0.807-1.006)
APACHE II score	0.001	0.873 (0.803-0.946)	0.002	0.867 (0.794-0.947)

OR: odds ratios; CI: confidence intervals.

tion procedure. Additionally, the proportion of patients without movement reactions was higher in the remimazolam group compared to the propofol group (P=0.007), suggesting that remimazolam may reduce vocal cord movement during intubation, potentially enhancing procedural safety.

Postoperative cognitive function

As shown in **Table 5**, no significant difference was observed in the incidence of postoperative delirium between the two groups (P=0.359). However, the MMSE score at 72 hours postoperatively was significantly higher in the remimazolam group than in the propofol group (P=0.002), suggesting better early cognitive function recovery in patients receiving remimazolam.

Safety profiles

As shown in **Table 6**, the propofol group demonstrated significantly higher rates of hypotension (P=0.032) and respiratory depression (P=0.005) compared to the remimazolam group, suggesting a stronger respiratory depressant effect of propofol. Injection pain was also more prevalent in the propofol group (P < 0.001). No significant differences were observed between the two groups regarding bradycardia (P=0.211) or nausea/vomiting (P=0.359).

Logistic regression analysis for first-attempt intubation success

In the logistic regression analysis of factors related to first-pass intubation success, remimazolam significantly increased the odds of first-pass intubation success compared to propofol (univariate P < 0.001, OR=3.551; multivariate P < 0.001, OR=3.884), indicating that remimazolam acts as a protective factor for first-pass intubation success (**Table 7**).

Age was identified as a risk factor, with each additional year associated with reduced odds

of first-pass intubation success (univariate P=0.004, OR=0.929; multivariate P=0.021, OR=0.937), suggesting that age is a risk factor. Similarly, an increase in APACHE II score significantly reduced the odds of first-pass intubation success (univariate P=0.001, OR=0.873; multivariate P=0.002, OR=0.867). However, BMI showed no significant association with first-pass intubation success (univariate P=0.037, OR=0.903; multivariate P=0.063, OR=0.901).

Discussion

This retrospective cohort study compared the sedative effects of remimazolam tosilate and propofol during emergency resuscitation tracheal intubation. The results indicate that these drugs exhibit different pharmacological characteristics in a high-sensitivity environment, with remimazolam showing several potential advantages related to intubation conditions, hemodynamic and respiratory stability, and recovery characteristics, despite a slower onset of sedation. The findings support the use of remimazolam tosilate as a superior alternative to propofol for sedation during emergency intubation, particularly in patients at higher risk of hemodynamic impairment.

The observed difference in the sedation onset time highlights a key pharmacokinetic difference between the two drugs. The shortened onset time of propofol is consistent with its recognized pharmacokinetic profile as an ultra-short-acting intravenous drug with rapid tissue redistribution [18]. Traditionally, this characteristic makes it the preferred choice in emergencies requiring immediate loss of consciousness. Compared to propofol, benzodiazepines generally exhibit a slightly slower onset, which is consistent with their pharmacologic class [19]. Importantly, despite the slower onset of remimazolam, the depth of sedation, as measured by the Ramsay score, was comparable between the two groups at all assessed time points. More importantly, the remimazolam group achieved a higher first-attempt intubation success rate. This advantage may be due to the observed differences in vocal cord status and reactivity. A greater proportion of patients in the remimazolam group exhibited open vocal cords and absence of movement reactions during laryngoscopy, which likely facilitated glottic exposure. These effects may be related to the mechanism of action of remimazolam as a GABA-a receptor agonist, thereby providing effective muscle relaxation and suppression of laryngeal reflexes, improving glottic exposure, and possibly creating a more stable view [20]. This finding complements existing literature, which suggests that adequate sedation with benzodiazepines can facilitate intubation and extends the evidence supporting its superiority over propofol with respect to first-pass success in emergencies [21].

The hemodynamic findings from this study provide compelling evidence for the cardiovascular safety advantages of remimazolam. Following intubation, SBP, DBP, and MAP were higher in the remimazolam group than in the propofol group. In critically ill patients, who frequently experience or are prone to hypotension, such relative hemodynamic stability is of particular importance. Propofol's known dose-dependent vasodilatory effect and mild cardiac depression can exacerbate hemodynamic instability, as reflected in the greater incidence of hypotension in the propofol group [22]. Its mechanism may involve propofol-induced relaxation of vascular smooth muscle and a reduction of sympathetic outflow [23]. These findings are consistent with previous clinical studies comparing propofol with other anesthetics. For instance, in patients undergoing esophagectomy, propofol was associated with a significantly greater reduction in cardiac index and right ventricular ejection fraction, as well as higher systemic vascular resistance index, compared to sevoflurane anesthesia [24]. Such observations support the notion that propofol's hemodynamic effects are not limited to systemic hypotension but may also involve direct myocardial depression, which is particularly relevant in critically ill patients requiring emergency intubation. In contrast, remimazolam appears to exert minimal direct cardiovascular effects, allowing it to maintain vascular tone [25]. Previous comparative studies on procedural sedation have consistently reported superior hemodynamic stability with remimazolam [26]. Additionally, the lower RPP observed in the remimazolam group after intubation suggests reduced myocardial oxygen demand, which may be particularly beneficial for patients with underlying coronary artery disease or heart failure, common comorbidities in this cohort.

Regarding respiratory safety, the lower respiratory rate observed in the remimazolam group

after intubation, coupled with a reduced incidence of respiratory depression, highlights its advantage in maintaining respiratory drive. A lesser degree of respiratory drive suppression before securing the airway can provide a slightly wider safety margin during the apneic period of intubation [27]. This observation is consistent with pharmacologic expectations; propofol is well-known for its dose-dependent respiratory depression, which can be harmful to patients already experiencing respiratory failure [28]. The mechanism by which remimazolam enhances GABAergic inhibition does not translate into the same level of central respiratory depression as seen with propofol [29].

In the postoperative period, our study provides preliminary insights into recovery characteristics. Patients in the remimazolam group exhibited significantly higher MMSE scores at 72 hours postoperatively, indicating better preservation of early cognitive function. Remimazolam is metabolized by tissue esterases into inactive metabolites, whereas propofol undergoes hepatic metabolism and complex tissue redistribution, especially in patients with organ dysfunction [30, 31]. Such rapid, organ-independent metabolism may contribute to faster and clearer cognitive recovery. Preclinical evidence provides a mechanistic support for these clinical observations. Studies have demonstrated that propofol-induced cognitive deficits are mediated, at least in part, through suppression of cAMP response element-binding protein (CREB) signaling [32]. Our clinical findings align with this mechanistic framework, suggesting that propofol's detrimental effects on early postoperative cognitive function may stem from similar neurobiological pathways. Although no significant difference was observed in the occurrence of postoperative delirium, the trend favored remimazolam, and the objective differences in MMSE scores are noteworthy. These results contribute to the accumulating evidence linking sedative choice with ICU cognitive outcomes, suggesting that remimazolam may be a favorable drug in this context [33].

Safety profiles further distinguish these two drugs. The reduced frequency of injection pain in the remimazolam group is a well-documented and practically advantage over propofol, which is formulated in a lipid emulsion and often associated with painful infusions that can cause distress and patient movement during critical induction periods [34]. As mentioned previously, remimazolam was also associated with lower rates of hypotension and respiratory depression, enhancing its potential safety advantages in vulnerable populations.

This study has several limitations that must be recognized. First, the single-center design may limit the generalizability of the findings, as clinical practice patterns, patient demographics, and resource availability can differ across various institutions and regions. Second, the retrospective nature introduced inherent biases, including selection bias and information bias, which may affect the validity of the results. In the emergency setting, it is difficult to obtain complete information on past disease control due to incomplete medical records, which is an inherent data limitation of such studies. Third, although the sample size was adequate to detect major differences, it may have been insufficient for rarer adverse events. Fourth, the follow-up period was relatively short, focusing primarily on immediate and short-term outcomes; long-term outcomes, including the incidence of chronic cognitive impairment or effects on overall survival, remain unknown. Fifth, although known airway issues were excluded, emergency settings prevent quantitative assessments (e.g., mouth opening) due to non-cooperation. Exclusion of such factors may reduce - but does not eliminate - concerns about unmeasured factors affecting intubation success.

Future studies should aim to validate these findings through large, multicenter, randomized controlled trials. Investigation into the optimal dosing regimen for remimazolam in emergency intubation, including potential co-administration with opioid analgesics, is warranted. Furthermore, while this study focused on immediate peri-intubation outcomes, future research should explore whether these short-term benefits - such as improved hemodynamic stability and reduced respiratory depression - translate into longer-term clinical advantages, including reduced duration of mechanical ventilation, shorter ICU stay and improved cognitive recovery.

Conclusion

In emergency tracheal intubation, remimazolam appears to provide a favorable safety profile

compared with propofol. Its lower inhibitory effects on the respiratory and cardiovascular systems are associated with reduced incidence of hypotension and respiratory depression, improved hemodynamic stability, and enhanced early cognitive recovery. Although its sedative onset is slower, remimazolam exhibited clear safety advantages in the sedation management of critically ill, high-risk patients.

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Disclosure of conflict of interest

None.

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