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REVIEW

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Comparison of intratracheal intubation or not during endoscopic retrograde cholangiopancreatography: a meta-analysis and systematic review

Binfeng Zhang[1,2†], Zekun Lang[2†], Lei Zhang[2], Boxiong Gao[2], Yutong Wang[2] and Yatao Liu[1,2*]

Abstract

Objectives In endoscopic retrograde cholangiopancreatography anesthesia, both intubation and non-intubation techniques have their own advantages and disadvantages. However, whether either approach is associated with postoperative and anesthesia-related adverse events remains controversial.

Methods We searched the literature in PubMed, Web of Science, Cochrane Library, Scopus, Ovid and Embase databases up to October 2024. All studies comparing intubated vs. non-intubation anesthesia for endoscopic retrograde cholangiopancreatography were included. The main outcome measures were sedation-related adverse events and death. Data were combined using risk ratio with 95% confidence intervals. The study protocol was prospectively registered with PROSPERO (CRD42024608807).

Results We finally included 8 studies with a total of 21,433 patients. Endotracheal intubation was associated with a lower risk of sedation-related adverse events (RR: 2.85, 95% CI 1.33–6.09, $p = 0.007$). However, the risks of death (RR: 0.59, 95% CI 0.36–0.96, $p = 0.03$) and intraoperative hypotension (RR: 0.43, 95% CI 0.26–0.69, $p = 0.0006$) were lower without intubation. In the trial-sequence analysis, the trial-sequence monitoring boundary is crossed, indicating conclusive evidence of a statistically significant effect.

Conclusions Our findings suggest that endotracheal intubation during endoscopic retrograde cholangiopancreatography is associated with a lower risk of sedation-related adverse events but a higher risk of mortality and intraoperative hypotension compared to non-intubation. However, these associations do not establish direct causality and should be interpreted with caution. Further high-quality randomized controlled trials are needed to validate these findings. Clinicians should adopt a patient-centered approach, carefully balancing the potential benefits and risks of intubation to optimize airway management strategies in endoscopic retrograde cholangiopancreatography.

Keywords Endoscopic retrograde cholangiopancreatography, Intratracheal intubation, General anesthesia

†Binfeng Zhang and Zekun Lang contributed equally to this work.

*Correspondence:
Yatao Liu
liuyt@lzu.edu.cn
Full list of author information is available at the end of the article

Introduction

Endoscopic Retrograde Cholangiopancreatography (ERCP) is a combination of endoscopy and imaging techniques used to diagnose and treat bile duct and pancreatic duct diseases. Since its introduction in the 1970 s, ERCP has played a key role in the treatment of diseases, such as gallstones, bile duct stenosis, pancreatitis, and pancreaticobiliary tumors [1, 2]. However, as an invasive procedure, ERCP may be accompanied by a variety of adverse reactions and postoperative complications, such as pancreatitis, bleeding, infection, and abnormal cardiopulmonary function [3, 4]. In addition, due to the presence of a certain degree of pain during the operation and the patient's comorbidities, it will affect the patient, which is not conducive to the patient's prognosis and also affects the doctor's operation. Therefore, the choice of anesthesia management during the operation has become one of the important factors affecting the safety of ERCP and the patient's prognosis [5].

During ERCP, the choice of anesthesia often involves whether to perform intratracheal intubation. Intratracheal intubation can provide better airway protection and ventilation support during surgery, reducing the risk of respiratory depression caused by sedatives, especially in cases of long-term operation or complicated patient basic conditions. However, intratracheal intubation also brings related complications, such as tracheal injury, aspiration, difficulty in intubation, and postoperative throat itching. In addition, intratracheal intubation may increase the use of muscle relaxants, affecting the patient's overall recovery experience [6].

In recent years, with the advancement of endoscopic technology and anesthesia management, some studies have explored whether anesthesia without intratracheal intubation during ERCP can reduce adverse reactions and postoperative complications while ensuring the safety of the operation. However, the existing research results are few and have great heterogeneity, and no unified clinical guidance has been formed. Therefore, systematically evaluating and comparing the effects of intratracheal intubation or not during ERCP on adverse reactions and postoperative complications is of great significance for optimizing anesthesia management strategies and improving the safety of ERCP and patient prognosis.

Methods

The study was conducted following the guidelines outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols (PRISMA) statement [7]. In addition, the protocol was registered in the International Prospective Systematic Reviews Registry (PROSPERO) database under registration number CRD42024608807.

Data source and search strategy

PubMed, Embase, Scopus, Ovid, Web of Science, and Cochrane library were searched from inception to October 2024 for studies comparing different anesthetic methods in ERCP. Taking (Cholangiopancreatography, Endoscopic Retrograde), (Anesthesia, General), (Monitored Anesthesia Care), (Intubation, Intratracheal) and (Conscious Sedation) as keywords, the search method adopts medical subject headings (MeSH) search. The detailed search strategy is presented in the eAppendix in Supplement 1 as an editable word document.

Inclusion and exclusion criteria

The inclusion criteria for the study were as follows: (1) the patient population consisted of individuals without a specific need for ERCP at baseline; (2) the study compared anesthesia with and without intratracheal intubation; and (3) the study provided a comprehensive report of the patients'baseline characteristics, as well as surgery- and anesthesia-related adverse events.

Exclusion criteria included: (1) no ERCP was performed; (2) no comparison between intratracheal intubation and no intratracheal intubation; (3) non-clinical studies, such as conferences, abstracts, and letters; and (4) lack of relevant outcomes or inability to convert data into usable form.

Data collection and quality assessment

Data extraction was independently performed by two researchers, followed by cross-validation. Any disagreements were addressed through consultation with a third party. The extracted data encompassed information, such as the first author, publication year, sample size, participant demographics (age, BMI, gender), comorbidities, ASA (American Society of Anesthesiologists) score, anesthesia regimen, and primary and secondary outcomes.

According to the'Risk of Bias Assessment Tool'for randomized trials outlined in the Cochrane Handbook, the quality of the included randomized controlled trials (RCTs) was evaluated across several domains. These domains include allocation concealment, randomization methods, blinding of investigators and participants, blinding of outcome assessors, selective reporting, data completeness, and the identification of other potential biases. The overall risk of bias is categorized as low, unclear, or high based on the assessment of these factors [8].

For retrospective studies, quality assessment was conducted using the Newcastle–Ottawa Scale (NOS) by

two independent reviewers. The assessment focused on three key areas: selection, comparability, and exposure, each with specific evaluation criteria. Stars were assigned based on the quality of each aspect, with a maximum of two stars awarded for comparability.

Outcomes and definitions

Our primary outcomes were sedation-related adverse events and death, while our secondary outcomes included surgery-related complications, such as postoperative pancreatitis, major bleeding, perforation, as well as intraoperative hypotension and hypoxemia. Sedation-related adverse events were defined as any anesthesia-related event that led to interruption or premature termination of surgery. Death is defined as death within 30 days. Hypotension is defined as a decrease in systolic blood pressure of more than 25% from the baseline, requiring the use of vasopressors. Hypoxia is defined as a drop in blood oxygen saturation below 90% at any time.

Statistical analysis

All statistical analyses were performed using Review Manager (RevMan) version 5.4 (The Cochrane Collaboration, Copenhagen, Denmark) and Stata SE 16.0 (Stata Corporation, TX, USA). The risk ratio (RR) with 95% confidence intervals (CI) were used for dichotomous data. The Q test and I^2 statistic were calculated to assess the heterogeneity of studies. The fixed-effects model was used when $I^2 < 50\%$; otherwise, we would use random-effects model. Significant heterogeneity was considered when $p < 0.1$ or $I^2 > 50\%$. We used TSA 0.9.5.10 beta software to conduct trial sequential analysis (TSA) of clinical efficacy. This helped reduce the occurrence of random errors, determine the reliability of the conclusions, and estimate the sample size required for the meta-analysis. A significance level of $\alpha = 0.05$ was set for all analyses. Sensitivity analysis was used to assess whether the results were stable and also to assess sources of heterogeneity.

Results

Study selection

A total of 1026 articles were retrieved from various databases. After removing duplicates, 544 articles were screened based on their titles and abstracts. Of these, 523 were excluded, leaving 21 studies for full-text review. Four studies were excluded for not comparing endotracheal intubation with non-intubation, five were excluded due to unconvertible data, and another five were excluded for not being clinical studies. After identifying one additional Chinese article, a total of eight studies were included (Fig. 1) [9–16].

Study characteristics and quality evaluation results

A total of 8 studies were screened and included in this study, of which 5 were retrospective studies and 3 were RCTs. All experimental groups underwent endotracheal intubation and sedation, while the control group underwent general endotracheal anesthesia. This study involved 21,433 ERCP patients with an average age of 65.4 years. The demographics and comorbidities of the included population are shown in Table 1.

Following a comprehensive quality assessment of the three RCTs, one was determined to have a low risk of bias, while the other two were classified as having an unclear risk of bias (Figures S1, S2 in Supplement 2). For the retrospective studies, the NOS scores were all above average, with each study receiving more than five stars, meeting the inclusion criteria for the meta-analysis. The detailed findings are presented in Table S1.

Results of meta-analysis

Our results suggest that endotracheal intubation is associated with a lower risk of sedation-related adverse events than no intubation (Fig. 2A; RR, 2.85; 95% CI 1.33–6.09; $p = 0.007$; $I^2 = 78\%$). However, the risk of death (Fig. 2B; RR, 0.59; 95% CI 0.36–0.96; $p = 0.03$; $I^2 = 68\%$) and intraoperative hypotension (Fig. 2C; RR, 0.43; 95% CI 0.26–0.69; $p = 0.0006$; $I^2 = 64\%$) without endotracheal intubation was lower than with endotracheal intubation. There was no statistical difference between the two groups in postoperative pancreatitis, postoperative bleeding, perforation, and intraoperative hypoxemia (Figures S3–S6 in Supplement 2). The results of the sensitivity analysis indicate that our results are robust (Figures S7–S9 in Supplement 2).

Results of TSA

This study performed TSA analysis on sedation-related adverse events, death and hypotension to evaluate the effectiveness of endotracheal intubation and no endotracheal intubation in reducing the risk of adverse events of ERCP. The type I error rate α was set to 0.05, the information axis was the sample size, the statistical power was 80%, and the sample size was the required information size (RIS). We chose the random effects model as the primary analysis model to account for heterogeneity among studies. According to the analysis results, we observe that the Z-curves cross the traditional boundary and the TSA boundary, indicating that the result is statistically significant. In addition, the analysis pointed out that the current sample size has reached RIS and no further experiments are needed to verify the robustness of the conclusions (Fig. 3).

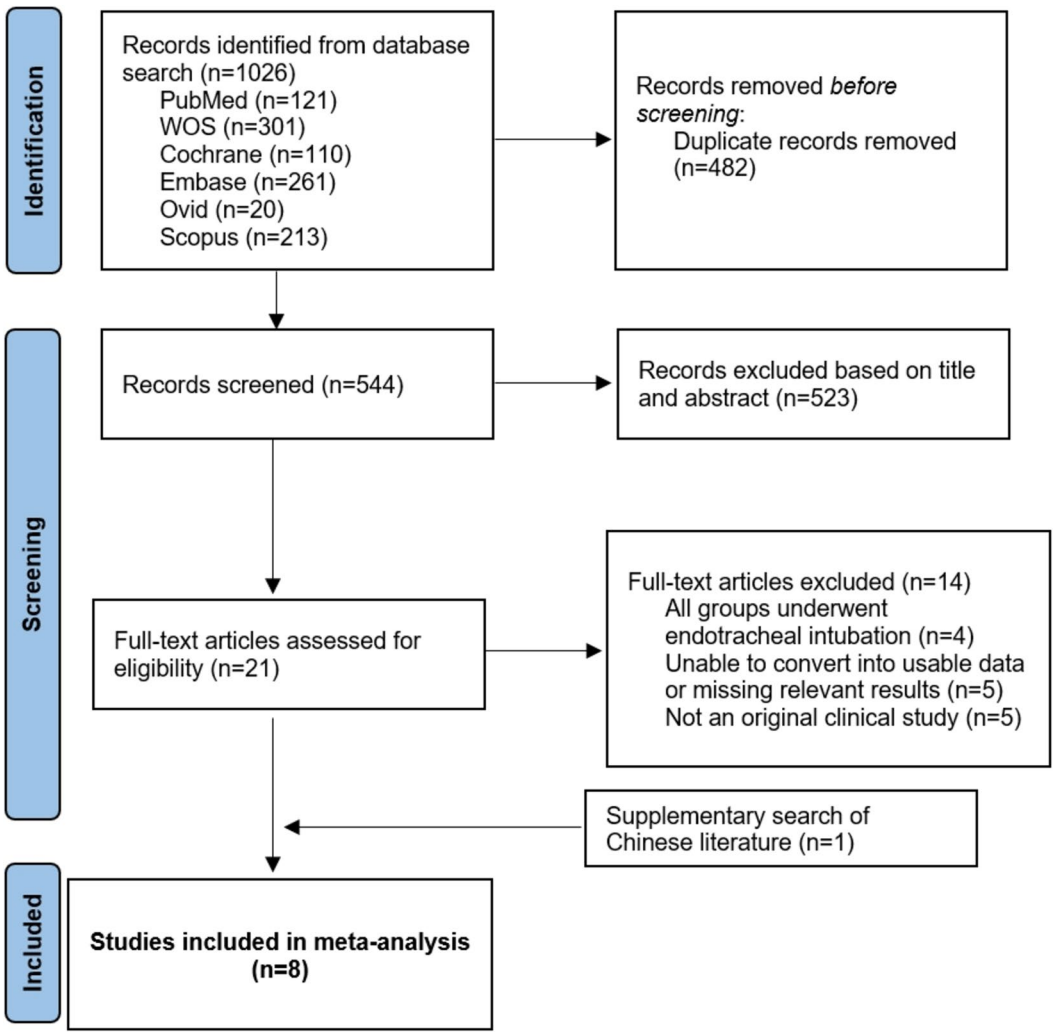

Fig. 1 Preferred reporting items for systematic reviews and meta-analyses (PRISMA) flowchart of selection

Table 1 Demographic data and basic information of included studies

Reference	Sample size	Age (year)	Male	DM	HT	Type of anesthesia in non-GA group
Althoff 2021	17,538	65.0	8223 (46.9)	3088 (17.6)	NA	MAC: Unknown drug
Alzanbagi 2022	203	50.3	96 (47.3)	37 (18.2)	39 (19.2)	MAC: Propofol
Barnett 2013	438	63.7	208 (47.5)	NA	255 (58.2)	DS: FT, MZ, Propofol and KT
Elif 2023	1885	76.4	841 (44.6)	NA	NA	DS: FT, KT and Propofol
Hu 2014	100	60.7	45 (45.0)	NA	NA	CS: DZ and Pethidine
Liang 2019	507	64.9	285 (56.2)	154 (30.4)	209 (41.2)	NS: Pethidine
Raymondos 2002	562	50.2	320 (56.9)	NA	NA	CS: MZ, Pethidine and Propofol
Smith 2019	200	61.1	121 (60.5)	NA	NA	MAC: FT, MZ and Propofol

BMI, Body Mass Index; DM, diabetes mellitus; HT, hypertension; ASA, American Society of Anesthesiologists; GA, general anesthesia; NA, not applicable; MAC, monitored anaesthesia care; FT, fentanyl; MZ, midazolam; DH, diphenhydramine; DS, deep sedation; KT, ketamine; CS, conscious sedation; DZ, diazepam; NS, no-sedation

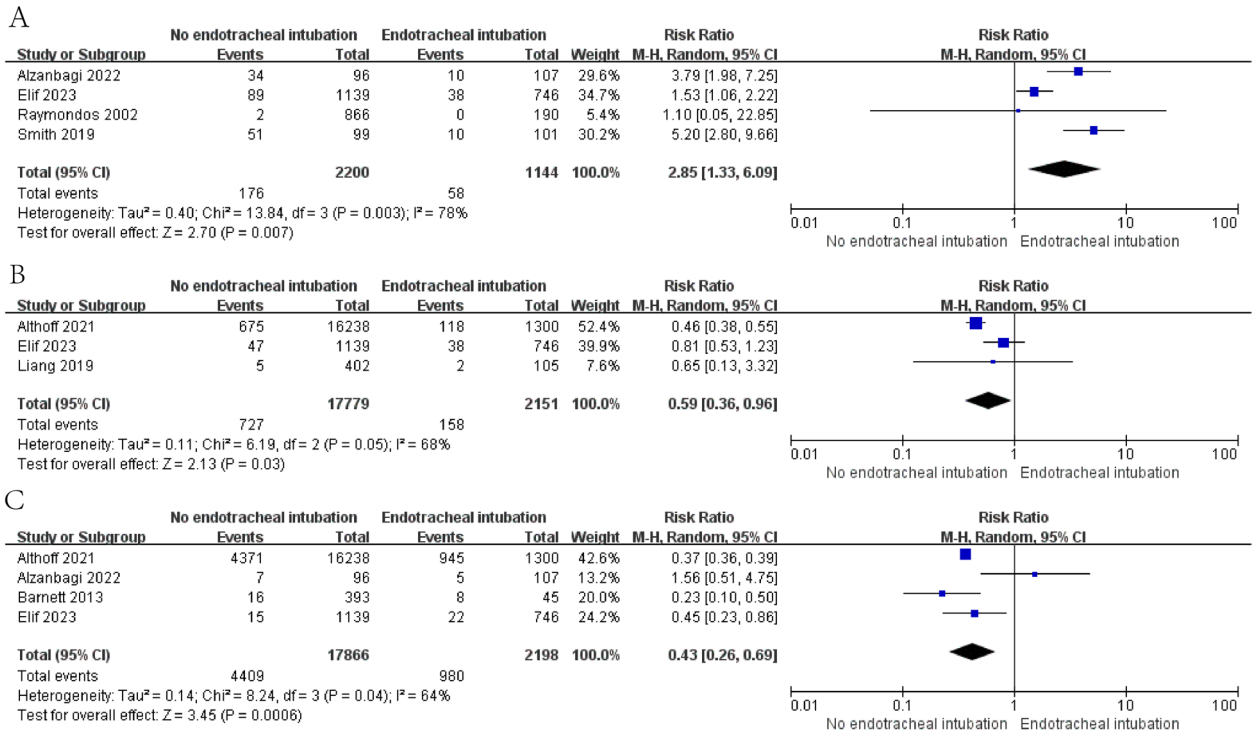

Fig. 2 Forest plot of **A** sedation-related adverse events. **B** Death. **C** Intraoperative hypotension

Discussion

Our meta-analysis offers crucial insights into the comparative outcomes of endotracheal intubation vs. non-intubation during endoscopic retrograde cholangiopancreatography (ERCP). The results suggest a nuanced interplay between the two approaches, with implications for clinical practice, particularly in the context of patient safety and individualized treatment planning.

First, the finding that endotracheal intubation is associated with a lower risk of sedation-related adverse events is consistent with the understanding that airway protection plays a critical role in preventing complications, such as aspiration and hypoventilation. ERCP procedures, which typically involve deep sedation or general anesthesia, pose inherent risks related to airway compromise, especially in patients with significant comorbidities or respiratory challenges [17]. Intubation provides a controlled environment, reducing the likelihood of complications arising from inadequate airway management. This aligns with the increased use of intubation in higher-risk populations to ensure optimal oxygenation and ventilation during complex procedures. However, the elevated risks of mortality and intraoperative hypotension observed in the intubated group raise important considerations about the balance of benefits and risks associated with this intervention [18]. The reduced risk of death and intraoperative hypotension in non-intubated patients may be explained by the physiological impacts of intubation, which can exacerbate hemodynamic instability, particularly in vulnerable patients. Intubation requires the use of anesthetic agents and muscle relaxants, which can lower blood pressure and increase the risk of hypotension. In addition, the process of intubation itself, including laryngoscopy and the insertion of the tube, can induce sympathetic stimulation, further complicating hemodynamic control. Thus, in patients without significant airway concerns, avoiding intubation may lead to more stable intraoperative conditions. Our results highlight the need to carefully assess each patient's cardiovascular status and sedation requirements before deciding on airway management [19, 20].

The heterogeneity observed in our analysis, particularly with regard to sedation-related adverse events ($I^2 = 78\%$) and mortality ($I^2 = 68\%$), warrants further investigation. The heterogeneity observed in our meta-analysis, particularly for sedation-related adverse events, suggests variability among the included studies. Several factors may contribute to this heterogeneity, including differences in study design (prospective vs. retrospective), variations in anesthesia protocols, patient demographics, and procedural complexity. In addition to the reasons mentioned above, we believe that the heterogeneity of mortality rates may also be related to the different timepoints of mortality in different studies. In addition, the definitions and reporting criteria for

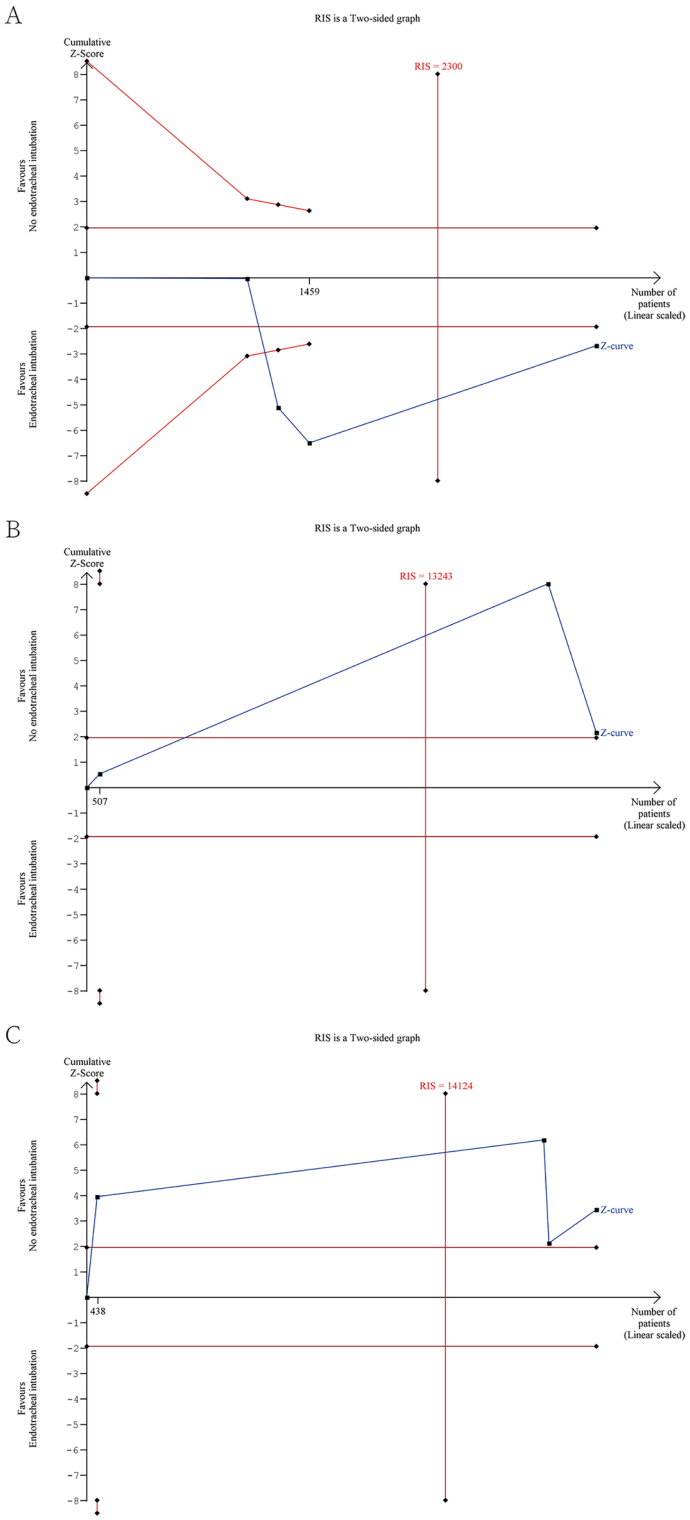

Fig. 3 Trial sequential analysis of **A** sedation-related adverse events. **B** Death. **C** Hypotension

sedation-related adverse events were not entirely consistent across studies, which may have influenced the overall variability. To better understand these sources of heterogeneity, future studies should aim to standardize reporting criteria and conduct subgroup analyses based on procedural risk stratification, anesthesia depth, and patient comorbidities.

In the context of personalized medicine, our results underscore the importance of tailoring airway management strategies to individual patient profiles. For high-risk patients, such as those with respiratory or cardiac comorbidities, intubation may provide critical protection against sedation-related adverse events. However, in patients with stable hemodynamics and low risk of airway compromise, non-intubation may offer a safer alternative by minimizing the risks of hypotension and mortality. Shared decision-making between anesthesiologists, gastroenterologists, and patients is essential to optimizing outcomes, taking into account the patient's overall condition, procedural risks, and the expertise of the clinical team [21].

Although we used a random-effects model to account for heterogeneity, we were unable to perform meaningful meta-regression or subgroup analyses due to the limited number of included studies and the lack of detailed stratification variables in the original reports. Future studies with more comprehensive data reporting and larger sample sizes are needed to explore potential sources of variability more effectively. Due to the limited number of included studies ($n = 8$), we did not conduct funnel plot analysis or Egger's test for publication bias, as these methods are generally unreliable when fewer than ten studies are analyzed. Future meta-analyses incorporating a larger number of studies may allow for a more accurate assessment of potential publication bias.

In conclusion, this meta-analysis emphasizes the need for a balanced, patient-specific approach when considering intratracheal intubation during ERCP. While intubation offers protection against sedation-related complications, it also introduces hemodynamic risks that must be weighed carefully. By integrating patient characteristics and clinical context, healthcare providers can enhance procedural safety and align treatment strategies with the principles of individualized care.

Limitations

This meta-analysis has several limitations that should be acknowledged. First, the scarcity of high-quality RCTs limits the robustness of the conclusions. A large proportion of the included studies were retrospective, which inherently carries the risk of selection bias and confounding. Retrospective studies rely on existing clinical records that may not comprehensively capture all relevant perioperative details, leading to potential misclassification bias. Despite efforts to account for these biases using statistical methods (e.g., sensitivity testing), the risk of residual bias remains. In addition, retrospective studies lack randomization, limiting the ability to control for confounding factors, such as patient frailty, anesthesia provider experience, or differences in institutional protocols. Although our meta-analysis provides valuable insights, these limitations should be acknowledged when interpreting the results. Future high-quality RCTs are needed to validate our findings with more methodological rigor. Second, there is significant heterogeneity across the included studies, in terms of patient populations, procedural techniques, anesthesia protocols, and outcome definitions. Although we employed random-effects models to mitigate the impact of heterogeneity, this variability might have influenced our findings and complicates the generalizability of the results. A key limitation of our meta-analysis is the lack of detailed patient severity stratification (e.g., ASA classification) in the included studies, which precluded further subgroup analyses based on patient risk profiles. In addition, as a meta-analysis, this study was dependent on the reporting practices of the original studies, and we were unable to address missing baseline data beyond what was available in the published literature. Future studies should aim to provide more comprehensive baseline characteristics and standardized reporting to enhance the robustness of pooled analyses. Finally, the reporting quality and sample sizes of the included studies varied considerably. Several studies had small sample sizes, which could lead to type II errors, while others lacked detailed information on key outcomes or procedural techniques, limiting our ability to perform comprehensive subgroup analyses. In summary, while this review provides valuable insights into the comparison of intratracheal intubation or not during endoscopic retrograde cholangiopancreatography, the limitations highlight the need for larger, high-quality RCTs to validate our findings.

Conclusion

Our findings highlight that endotracheal intubation during ERCP is associated with a reduced risk of sedation-related adverse events, while non-intubation appears to be linked with lower risks of mortality and intraoperative hypotension. However, these observed associations do not imply direct causation and warrant further investigation through well-designed randomized controlled trials. These results emphasize the importance of tailoring airway management to each patients' individual risk profile. In the era of personalized medicine, clinicians should carefully evaluate the trade-offs between the protective benefits of intubation and its potential hemodynamic risks to optimize patient outcomes in ERCP procedures.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s40001-025-02558-8.

Additional file 1.

Additional file 2.

Additional file 3.

Additional file 4.

Author contributions
Binfeng Zhang and Zekun Lang designed the study, Lei Zhang and Boxiong Gao was responsible for the main statistical analysis, Binfeng Zhang and Zekun Lang were responsible for most of the manuscript writing, Boxiong Gao and Yutong Wang were respectively responsible for part of the manuscript writing, data extraction and literature screening. Yatao Liu was responsible for reviewing the article and providing comments.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Author details
[1]Department of Anesthesia and Surgery, First Hospital of Lanzhou University, No. 1 Donggang West Road, Chengguan District, Lanzhou, Gansu 730000, People's Republic of China. [2]The First Clinical Medical College, Lanzhou University, Lanzhou 730000, Gansu, People's Republic of China.

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