2026 Volume 11, Issue 5
Advances in Precision Medicine
ISSN: 2424-9106 (Online)
ISSN: 2424-8592 (Print)

Effect of Individualized PEEP on Postoperative Pulmonary Complications in Elder Patients: A Meta-Analysis

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Abstract: *Objective:* To systematically evaluate the effect of individualized positive end-expiratory pressure (PEEP) during endotracheal general anesthesia on postoperative pulmonary complications (PPCs) in older surgical patients. *Methods:* Randomized controlled trials (RCTs) published from database inception to April 2026 were retrieved from PubMed, Web of Science, Embase, Cochrane Library, CNKI, Wanfang, and VIP. Meta-analysis was performed using RevMan 5.4 and Stata 17.0. *Results:* Fourteen studies involving 1, 028 patients (individualized PEEP group: n = 515; control group: n = 513) were included. Compared to controls, the individualized PEEP group significantly reduced PPC incidence (RR = 0.50, 95% CI 0.40 to 0.62, $P < 0.01$), lower postoperative lung ultrasound scores (LUS) (MD = –2.76, 95% CI –3.27 to –2.25, $P < 0.01$), reduced intraoperative driving pressure (MD = –3.29 mmHg, 95% CI –3.74 to –2.84, $P < 0.01$), shorter hospitalization duration (MD = –0.36 d, 95% CI –0.57 to –0.14, $P < 0.01$), improved intraoperative oxygenation index (OI) (MD = 37.44, 95% CI 25.40 to 49.47, $P < 0.01$), higher pulmonary compliance (MD = 5.32, 95% CI 4.59 to 6.06, $P < 0.01$) and no significant difference in mean arterial pressure (MAP) was observed. *Conclusion:* Individualized PEEP titration during general anesthesia in elderly patients improves intraoperative oxygenation and respiratory mechanics without compromising hemodynamic stability. This strategy reduces the incidence of PPCs, shortens hospital stays, and enhances clinical outcomes.

Keywords: Positive end-expiratory pressure; Elderly; Postoperative pulmonary complications; Meta-analysis

Online publication: May 26, 2026

1. Introduction

The incidence of postoperative pulmonary complications (PPCs) is about 10%–59%, which has become an important risk factor affecting the prognosis of patients and increasing the length of hospitalization [1–3]. In the context of global population aging, the proportion of older patients (≥ 60 years) is increasing year by year [4], and the probability of pulmonary atelectasis after general anesthesia increases with age, peaks at 50 years of age, and decreases thereafter [5]. Furthermore, elderly patients exhibit a higher prevalence of pre-existing pulmonary conditions such as chronic bronchitis and COPD due to physiological decline, thereby increasing their susceptibility to PPCs after surgery [6]. The expert consensus also suggests that reducing postoperative pulmonary complications in patients can be achieved by optimizing the patient's intraoperative ventilation strategy [7]. The use of pulmonary resuscitation and positive end-expiratory pressure (PEEP) can reopen collapsed lung tissue and maintain it, and it is more important to individualize PEEP settings according to individual differences and the type of surgery [8]. The purpose of this paper is to study the effects of individualized PEEP settings on intraoperative lung protection and postoperative complications in elderly patients, with a view to providing scientific references for the application of individualized PEEP to reduce the incidence of postoperative PPCs and improve the prognosis of patients in the clinical setting.

2. Information and methods

This study was based on the PRISMA 2020 guidelines [9]. Designed and conducted, the study protocol is registered with the International Prospective Register of Systematic Reviews (PROSPERO), registration number: CRD420261330029.

Search strategy: In this study, PubMed, Web of Science, Embase, Cochrane Library, China Knowledge Network, Wanfang Data, and Wipu were searched by computer. Through the MeSH function in PubMed, we identified the English subject terms as "Positive End-Expiratory Pressure, Aged, Postoperative Complications", recorded the free words corresponding to the subject terms, and searched the English database by combining the subject and free words. The English database was searched by the combination of subject and free words. The Chinese search terms were "positive end-expiratory pressure, elderly, postoperative pulmonary complications", and the search period was from the establishment of the database to April 2026. We also read the relevant reviews and references of the articles to supplement the relevant literature. The searches were conducted independently by two researchers, and any discrepancies between the two searches were resolved by a third researcher.

Inclusion and exclusion criteria: (1) Type of study: randomized controlled trial (RCT), (2) Subjects: elderly patients (age $\geq$ 60) undergoing general anesthesia, (3) Intervention versus control: individualized PEEP titration with or without pulmonary resuscitation maneuvers during the operation; controls with fixed PEEP or no PEEP with or without pulmonary resuscitation maneuvers, (4) Outcome indices: primary outcome indices The primary outcome index was the incidence of postoperative pulmonary complications (PPCs); secondary outcome indexes were intraoperative oxygenation index, lung ultrasound score (LUS), IL-6, pulmonary compliance, driving pressure (ΔP), plateau pressure (Pplat), mean arterial pressure (MAP), and hospitalization time. Exclusion criteria: (1) Repeatedly published studies, (2) Case reports, conference articles, and observational studies. (3) Cardiac surgery and lung transplantation

Literature screening: Based on the defined inclusion criteria, two researchers conducted literature screening. Duplicates were first removed, and then articles that did not meet the inclusion criteria were removed by reading the titles and abstracts of the remaining articles. The full text of the literature was read for final verification before inclusion was finalized. If there was a dispute between the two researchers about the inclusion of a paper, the two researchers discussed it first, and if there was still a dispute, a third researcher read the paper and made a final decision.

Data collection: Two researchers collected data independently using a data extraction form, and the collected data were discussed with a third researcher. The following information was extracted: first author, date of publication, country, number of patients, population information (age, ASA classification, type of surgery, length of surgery), ventilation settings (tidal volume, inspiratory-expiratory ratio, respiratory rate, individualized PEEP settings, control PEEP values, and whether or not the lungs were reopened), and other data relevant to the results.

Risk of bias assessment: Two researchers assessed the risk of bias of the included studies using the Cochrane Risk Assessment Tool, which contains six categories and seven types of bias: selection bias (generation of randomized sequences, hidden allocation), reporting bias (selective reporting), implementation bias (staff-related blinding), detection bias (blinding of endpoints), and missing visit bias (incomplete endpoints data), Other bias (other sources of bias), and risk was categorized into three categories: high risk of bias, low risk of bias, and unclear risk of bias, which were listed as the basis for the assessment of bias, and any disagreement was resolved by discussion with a third researcher.

Statistical analysis: The data were analyzed using RevMan 5.4 and Stata 17.0 software, and the effect sizes of dichotomous and continuous data were expressed as the relative risk ratio (RR) and mean difference (MD) with 95% confidence intervals (CI), respectively. Continuous data expressed by median and interquartile spacing were transformed to mean and standard deviation, and Cochran's Q was used to test the heterogeneity between studies, and I^2quantified the degree of heterogeneity, according to the Cochrane Handbook. $I^2 \geq 50$ indicated that there was a significant difference between the studies, which were performed using a random-effects model, and vice versa. The sensitivity analysis was performed using Stata 17.0 to screen the literature that might affect the robustness of the analysis results, and itemized exclusion was performed by RevMan to observe the change in *P* value. When more than 10 papers were included, Stata 17.0 software was used to create a funnel plot to examine the publication bias, and if the funnel plot showed that there might be a publication bias, the Egger test was performed to further confirm the results. $P < 0.05$ was taken as the difference was statistically significant.

3. Results

3.1. Literature search results

A total of 1,216 studies were obtained after a computerized search of the database, and another 14 documents were obtained by reading the reference list. After deleting the duplicates, we read the titles and abstracts of the remaining literature, read the full text of 36 articles and contacted the authors to obtain the relevant information, and then screened and excluded 22 articles, and finally included a total of 14 articles with a total of 1, 028 patients, of which 515 patients were in the experimental group and 513 patients were in the control group. The specific literature screening process is shown in **Figure 1**.

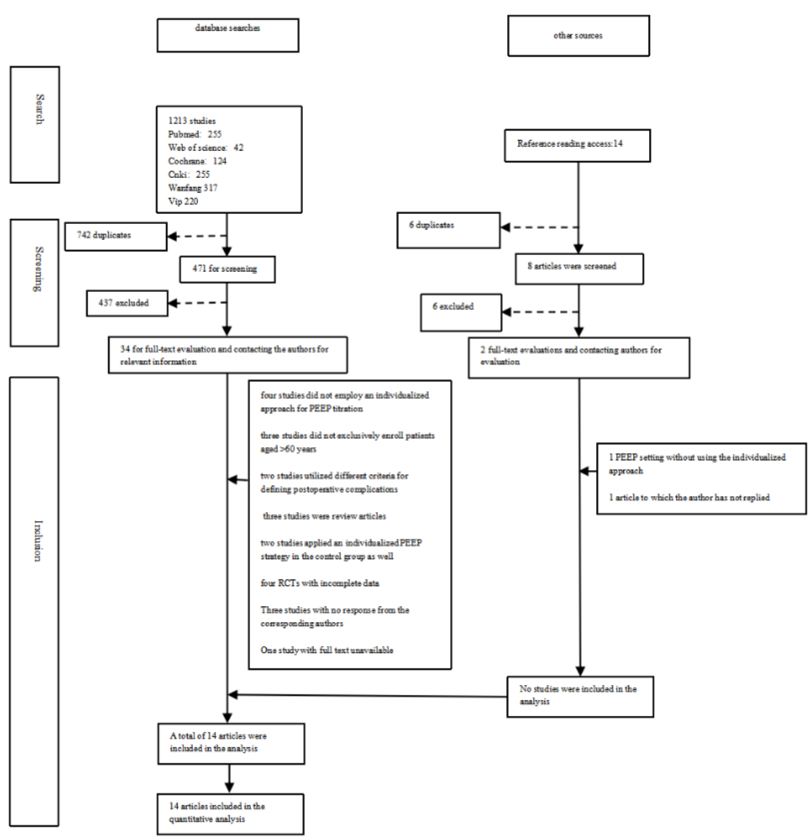

Figure 1. Literature screening flow diagram.

3.2. Basic characteristics of the included literature

The 14 included studies were all RCTs, published in the last 5 years, except for the study by Liu et al. The age of the included patients was 65 years, except for the age limit of 60 years by Ma et al. The surgical methods were laparoscopic or prone spinal surgery, and the individualized PEEP methods included driving pressure, compliant method, and EIT method. Surgical procedures were either laparoscopic or prone spinal surgery, and the individualized PEEP methods included driving pressure, compliance, lung ultrasound, and EIT.11 studies also combined lung resuscitation, and 12 articles used fixed PEEP with 5 cmH2O in the control group, and 2 articles used fixed PEEP with 6 cmH2O. The basic information of the included literature is shown in **Table 1**.

Table 1. Characteristics of the included studies

Author, year, country	Type of surgery	Experimental/control group	Patient's age	Individualized PEEP titration method	Control group PEEP	Pulmonary resuscitation	Tidal volume	Ending indicators
Li Changsong et al., 2024, China[10]	Lumpectomy for colorectal cancer	37/38	65-85	lung ultrasound	5	yes	6	①②④⑦⑨
Wang JW et al., 2024, China[11]	laparoscopic surgery	71/72	≥ 65	Drive pressure	6	yes	6	①③④⑦⑨
Shen Pei et al., 2024, China[12]	Lumpectomy for colorectal cancer	40/40	65-80	Drive pressure	5	yes	6	①②③⑥⑦
Zhong, Xiaoqian et al., 2024, China[13]	Lumpectomy for gastric cancer	32/32	65-80	Drive pressure	5	yes	6	①②④⑥⑦⑧
Ma et al., 2024, China et al.[14]	Lumpectomy for colorectal cancer	37/36	≥ 60	lung ultrasound	5	yes	6	①②③④⑤⑥⑦⑧⑨
Wang, Liang et al., 2023, China[14]	Lumpectomy for colorectal cancer	30/30	65-85	Drive pressure	5	yes	7	①②③④⑤⑥⑦
Zhang, Qianqian et al., 2023, China[16]	Luminal prostate cancer	30/30	≥ 65	Drive pressure	5	no	6	①②④
Chen et al., 2023, China[17]	Robot-assisted prostate cancer	40/40	65-85	pulmonary static compliance	5	yes	6	①②⑥⑧⑨
Yao, Jing et al., 2022, China[17]	Robot-assisted prostate cancer	20/20	65-85	Drive pressure	5	no	6	①②④⑨
Xu et al., 2022, China[19]	laparoscopic surgery	17/16	＞ 65	Drive pressure	6	yes	6	①
Wang Zixuan et al., 2021, China[20]	Robot-assisted prostate cancer	25/25	65-80	Drive pressure	5	yes	7	①②③⑤⑥
Xie, Yang et al., 2021, China[21]	Prone spine	40/40	＞ 65	Cdyn	5	yes	6	①②④⑤⑥
Qian et al., 2021, China[22]	Prone spine	40/40	≥65	Cdyn	5	no	6	①②④⑤⑥⑦
Liu et al., 2019, China[23]	Thoracoscopic surgery	56/54	＞ 65	EIT	5	yes	6	①②④⑨

Note: (1) PPCs; (2) OI; (3) LUS; (4) Lung compliance; (5) MAP; (6) Pplat; (7) Driving pressure; (8) IL-6; (9) Mean length of hospitalization

3.3. Assessment of the risk of study bias

All the included studies stated that they were randomized, and the specific method was the random number table method, so all of them were rated as low risk; 3 studies were low risk because they had concealed the allocation, and the remaining 11 studies were rated as unknown because they were not mentioned in the text; the study in Ma was rated as high risk because it did not have blinding for the anesthesia and caregivers; 13 studies were low risk because they had a complete outcome and the number of lost visits was clear, and one study was not mentioned as unknown; 4 studies did not mention other risks of bias and were rated as unclear, and the risk of bias was detailed in **Figure 2**.

Figure 2. Risk of bias assessment for included studies.

3.4. PPCs

The incidence of PPCs was reported in 14 of the included literature [10–23]. There was no significant heterogeneity among the literature, $I^2 = 0\%$, using a fixed-effects model. The use of an individualized approach to set PEEP during surgery in elderly patients could effectively reduce the incidence of postoperative PPCs compared with the use of fixed PEEP, and the difference was statistically significant (RR = 0.5, 95% CI 0.40-0.62, $P < 0.01$), as shown in **Figure 3**.

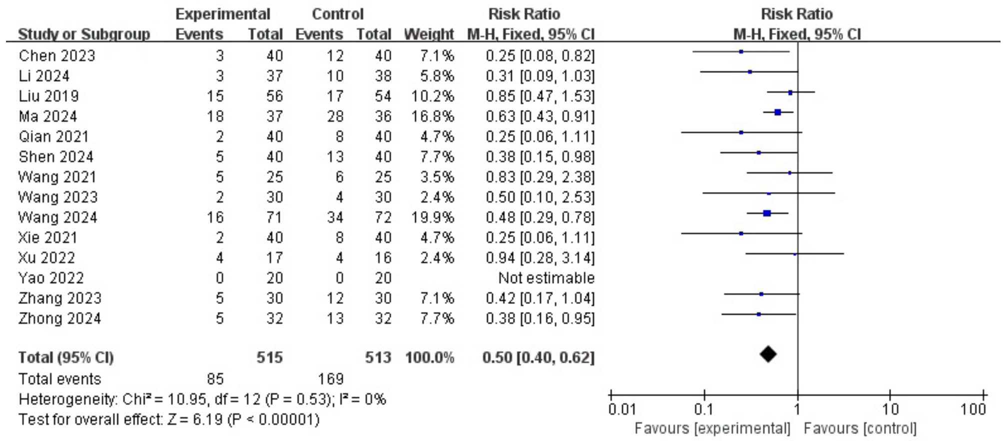

Figure 3. Forest Plot of PPCs Incidence Rate in the two groups of patients.

3.5. Oxygenation index

Oxygenation index (OI) was reported in 12 out of 14 papers[10, 12-18, 20-23]. According to the analysis results, $I^2 = 90\%$, the random effect model was used. Compared with the fixed PEEP group, intraoperative oxygenation was significantly increased in the individualized PEEP group, and the difference was statistically significant (MD = 37.44, 95% CI 25.40-49.47, $P < 0.01$), as shown in **Figure 4**. Due to the obvious inter-study heterogeneity, a sensitivity analysis was performed on the studies, which is shown in **Figure 5**, and the result was robust with $P < 0.01$ after the exclusion of each study one by one.

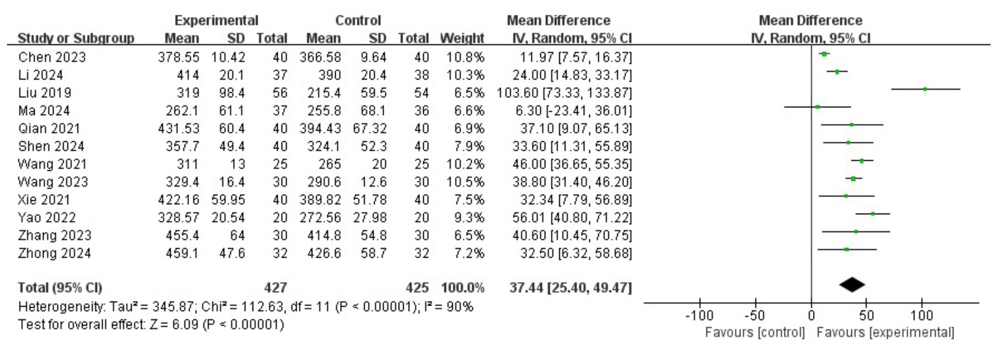

Figure 4. Forest plot of the oxygenation index in the two patient groups.

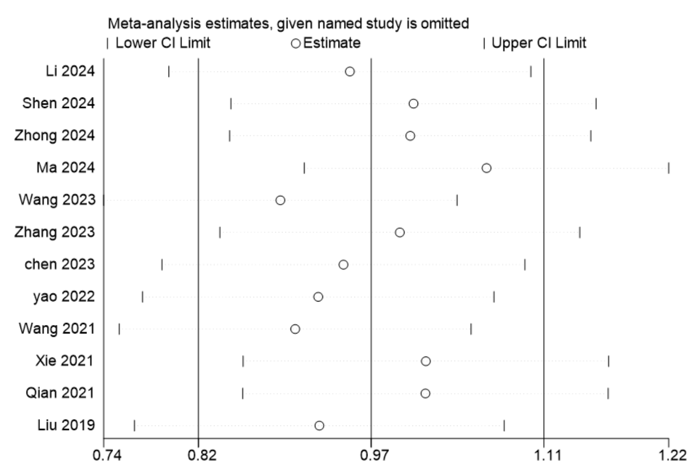

Figure 5. Sensitivity analysis of the effect of individualized PEEP versus fixed PEEP on patient oxygenation index.

3.6. LUS

LUS was performed on patients after completion of surgery in 5 studies [11,12,14,15,20]. The total number of patients in the individualized PEEP group was 203, and the total number of patients in the control group was 203. Meta-analysis was performed using the random effect model, and the results showed that compared with the fixed PEEP group, the individualized PEEP setup had a positive effect on the postoperative LUS of the elderly, and was able to significantly reduce the LUS, and the difference was statistically significant (MD = -2.76, 95% CI - 3.27–-2.25, $P < 0.01$), see **Figure 6** for details. As for the sensitivity analysis of the results (**Figure 7**), there was no significant difference in the combined results, $P < 0.01$, after excluding each study one by one; the results were robust.

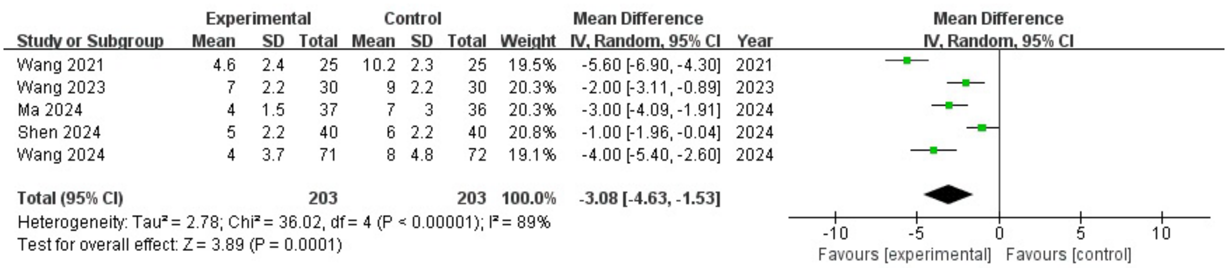

Figure 6. Forest plot of LUS in the two patient groups.

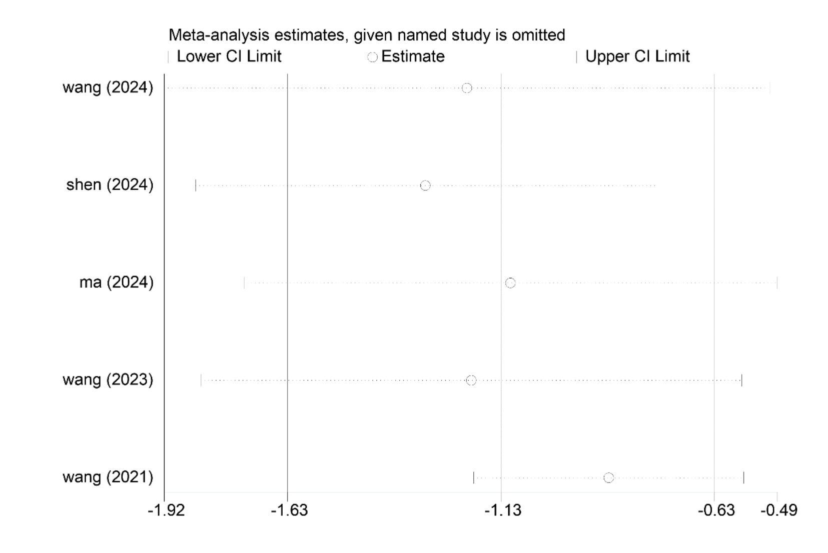

Figure 7. Sensitivity analysis of the effect of individualized PEEP versus fixed PEEP on patient LUS.

3.7. Pulmonary compliance

A total of 10 studies have collected information on the intraoperative pulmonary compliance of patients [10,11,13–16,18,21–23]. Most of the studies were divided into multiple time periods intraoperatively, and the lung compliance at 1h after the start of anesthesia was uniformly selected for Meta-analysis. Liu et al.'s study was one-lung ventilation for thoracic surgery, and the remaining studies were two-lung, and therefore were not included in their study. There was a significant heterogeneity of the studies, and a significant decrease in heterogeneity was observed after removing one study. Using the with-fixed-effects model analysis, the difference in intraoperative lung compliance was statistically significant when compared with the fixed PEEP compared to the fixed PEEP compared to the individualized group. Intraoperative pulmonary compliance was significantly increased in elderly patients in the individualized group, and the difference was statistically significant (MD = 5.32, 95% CI 4.59–6.06 , $P < 0.01$), see **Figure 8**.

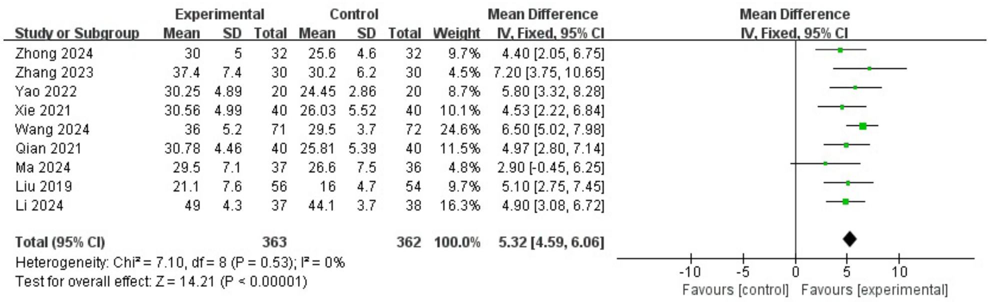

Figure 8. Forest plot of lung compliance in the two patient groups.

3.8. IL-6

Three studies included patients' postoperative IL-6 levels (ng/mL) [14,17,18]. A total of 97 patients in the individualized group and 96 patients in the control group showed significant inter-study variability (I^2 = 99%). Sensitivity analyses were carried out, and no source of heterogeneity was found; therefore, quantitative analyses were not performed.

3.9. Drive pressure

A total of 6 studies examined intraoperative drive pressure in patients [10–15,22]. The difference between studies was significant. After performing sensitivity analysis to remove one study, the significance of the difference decreased, I^2 = 39%, using the fixed effect model. Compared with the control group, intraoperative drive pressure was significantly lower in the individualized PEEP group, and the difference was significant (MD = -3.29, 95% CI -3.74–-2.84, $P < 0.01$), as shown in **Figure 9**.

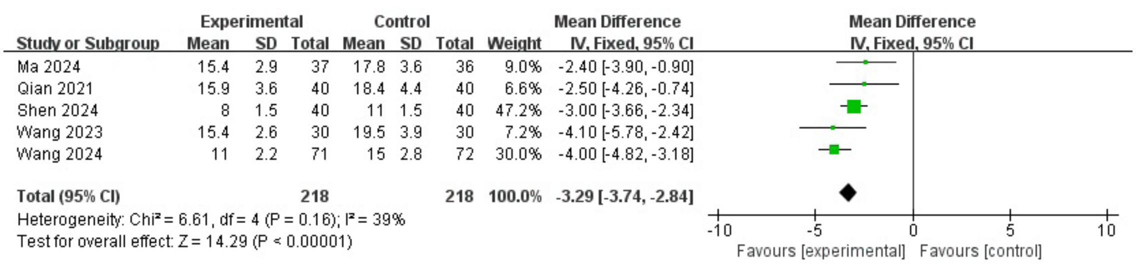

Figure 9. Forest plot of intraoperative driving pressure in the two patient groups.

3.10. MAP

5 studies documented intraoperative MAP [14,15,20–22]. There was no significant inter-study variability (I^2 = 16%), and using a fixed-effects model, there was no statistically significant difference in mean arterial pressure in the individualized PEEP group compared with the control group ($P = 0.21$), as shown in **Figure 10**.

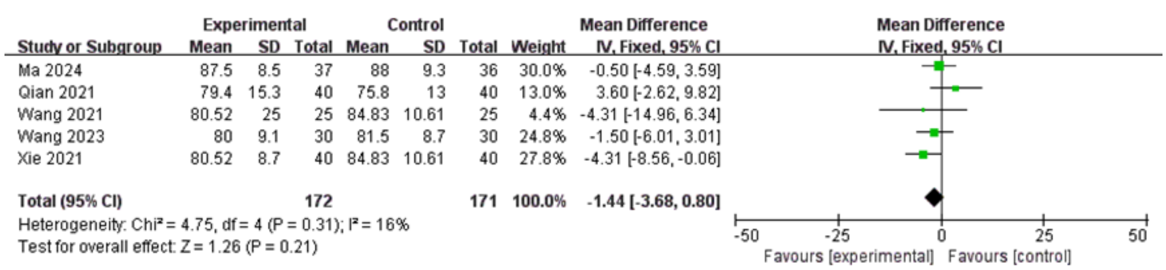

Figure 10. Forest plot of MAP in two patient group.

3.11. Plat

8 of 14 articles examined intraoperative Plat values in elderly patients [12–15,17,20–22]. There were 284 patients in the individualized group, and 283 patients in the control group; and the difference between the studies was significant. According to the results of Meta-analysis, the difference in the increase in intraoperative Plat value of elderly patients in the individualized PEEP group was statistically significant when compared with that of the control group (MD = 1.22, 95% CI 0.81–1.62, P < 0.01). Sensitivity analysis was performed, and after each study was excluded one by one, all of them were P < 0.01, and the outcome was robust, as shown in **Figure 11**.

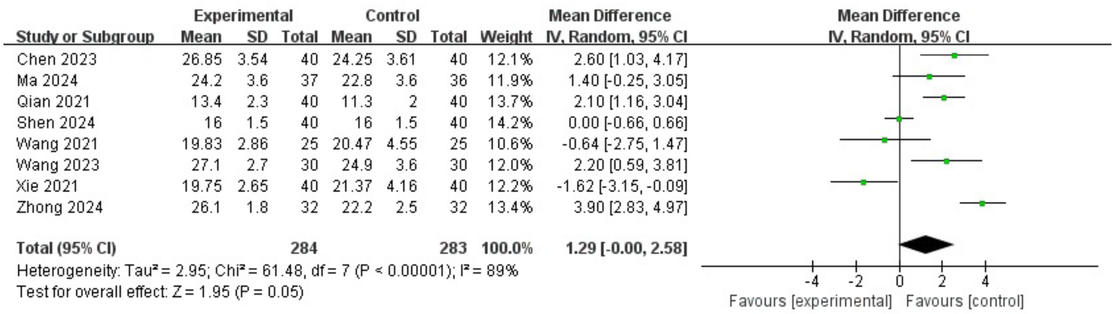

Figure 11. Forest plot of Plat in two patient groups.

3.12. Length of hospitalization

6 papers examined the length of hospitalization of patients [10,11,14,17,18,23]. The difference between studies was significant (I^2 = 92%). Sensitivity analysis was performed, and the difference decreased significantly after removing one study. Using the fixed effect model, the use of individualized PEEP could significantly reduce the length of hospital stay compared with the fixed PEEP group; the difference was statistically significant. (MD = -0.36, 95% CI -0.57–-0.14 , P < 0.01) (**Figure 12**).

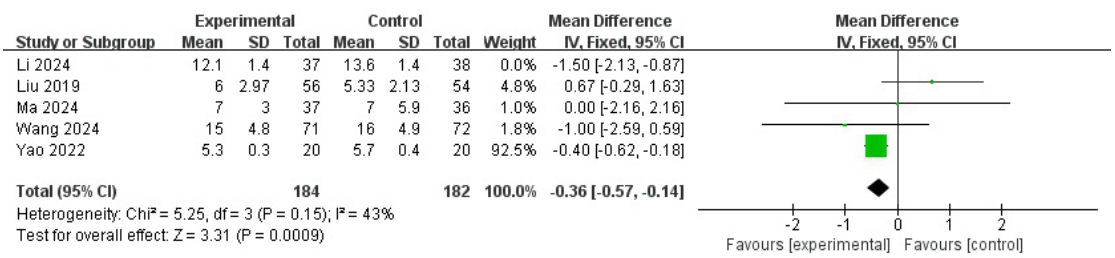

Figure 12. Forest plot for length of hospital stay in two groups of patients.

3.13. Publication bias

The funnel plot was drawn according to the incidence of PPCs in the patients, and it was found that there might be publication bias, see **Figure 13a** for details, therefore, further egger test was performed, P = 0.205, and it was considered that there was a low possibility of publication bias; the funnel plot of the patients was drawn according to the effect of the two modalities on the oxygenation index of the patients, and it was found that there might be publication bias, see **Figure 13b** for details, and further egger test was performed, P = 0.751, so the risk of publication bias in the included literature was low.

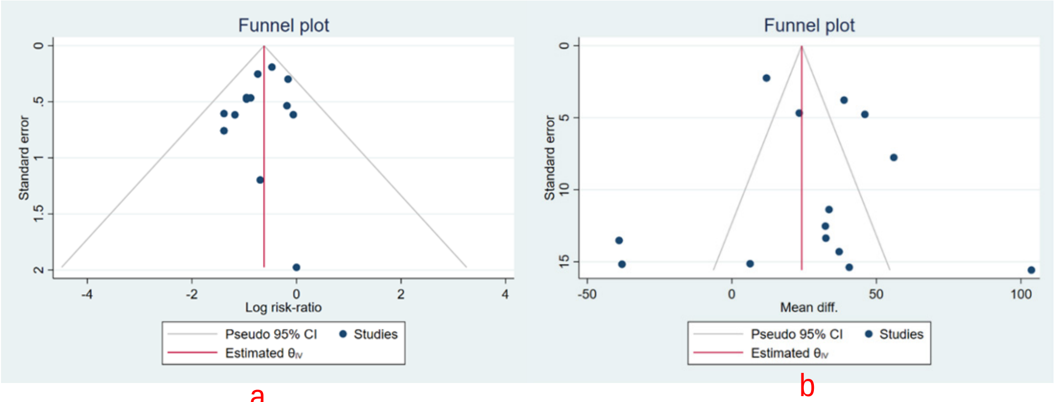

Figure 13. Funnel plot for the incidence of PPCs and OI in the two groups of patients.

4. Conclusion

Elderly patients with varying degrees of respiratory disease due to the deterioration of their physiological functions are more likely to develop PPCs after receiving general anesthesia [24]. Once it occurs, it often affects the patient's prognosis or even death, so how to perform intraoperative lung-protective ventilation is very important. It is still controversial whether the use of individualized PEEP can reduce the occurrence of postoperative PPCs in patients [25,26], and there are even fewer studies focusing on individualized PEEP in elderly patients. In this study, we conducted a Meta-analysis of 14 RCTs involving 1028 patients over 5 years from 2019–2024, and found that for elderly patients undergoing general anesthesia, intraoperative administration of individualized PEEP, compared with fixed PEEP, can reduce the occurrence of postoperative PPCs, increase the patients' intraoperative oxygenation index, pulmonary compliance, and plateau pressure, decrease intraoperative driving pressure, and have no significant effect on the patients' intraoperative MAP values, reduce patients' postoperative LUS and decrease patients' hospitalization time. It has no significant effect on the intraoperative MAP value of the patients, reduces the postoperative LUS of the patients and decreases the hospitalization time of the patients.

The 14 articles included in the literature included a variety of postoperative surgeries in which PPCs often occurred, including various types of laparoscopic surgeries and prone surgeries, all of which were long and adversely affected pulmonary ventilation, such as thoracoscopic surgeries requiring one-lung ventilation, various types of laparoscopic surgeries that often required the establishment of the Trendelenburg position, and prone surgeries in which the administration of muscle relaxation often resulted in thoracic contour deformation and adversely affected respiratory function. The use of muscle relaxation in the prone position often results in thoracic deformities that adversely affect breathing. Five of the 14 included studies concluded that individualized PEEP settings did not reduce the incidence of postoperative PPCs in patients, while the remainder concluded that they had a positive effect on PPCs. Positive end-expiratory pressure (PEEP) is often used in combination with small tidal volumes, and large tidal volumes are often associated with ventilator/ventilation-induced lung injuries (VILI) and postoperative pulmonary complications compared with small tidal volumes (6–8 mL/kg PBW) [27,28]. Due to the individualization of patients, the use of fixed PEEP cannot provide fine lung protection and may even cause alveolar hyperinflation and thus lead to the occurrence of VILI. Therefore, the use of individualized PEEP can achieve a good state of maintaining alveolar expansion without causing mechanical damage, and reduce the occurrence of postoperative PPCs in patients. The decrease in the occurrence of PPCs can reduce the incidence of poor prognosis of patients, and through the study of the length of hospitalization of patients, we found that the length of hospitalization in the group of individualized PEEP was shorter, and this further confirmed the positive effect of individualized PEEP on perioperative lung protection. The positive effect of individualized PEEP on perioperative lung protection can be further confirmed.

Oxygenation index is one of the commonly used indices to assess the respiratory function of patients, and it also has a certain predictive effect on the prognosis of patients. The differences between the studies included in the literature of the present study are quite obvious, which may be related to the differences in the types of surgeries performed on the patients, e.g., thoracoscopic surgeries may differ from the rest of the surgeries due to the one-lung ventilation. The use of individualized PEEP has a positive effect on pulmonary ventilation and ventilatory function because it opens and maintains the collapsed lung tissue [29]. The driving pressure and lung compliance, as easily accessible parameters of respiratory mechanics, are important references for anesthesiologists to judge ventilation. Driving pressure and lung compliance, as easily accessible respiratory mechanics parameters, are important reference indices for anesthesiologists to judge ventilation. In this study, we found that the use of individualized PEEP compared with fixed PEEP in elderly patients can effectively increase the lung compliance and reduce the drive pressure, optimize the respiratory mechanics of ventilation, and thus may play a role in reducing the incidence of PPCs.

Lung ultrasound is a well-researched imaging tool for lung assessment in recent years, and it is increasingly being used for lung status assessment because of its high diagnostic yield and flexible and easy-to-use operation [30]. Mongodi et al. proposed a modified lung ultrasound score, which is widely used, in which the chest wall is divided into twelve zones bilaterally, bounded by the anterior axillary line, the posterior axillary line, and the bi-nipple line, and ultrasound scores are assigned to each zone according to the signs of the A line, the B line, and the subpleural solids, etc., and the scores of the twelve zones are summed up to give an overall score with a view to evaluating the patient's pulmonary atelectasis[31], the heterogeneity between the LUS performed by the RCTs included in this study was obvious, which may be related to the different types of surgery and time of LUS performed in the patients, but the use of individualized PEEP can significantly reduce the postoperative LUS in the patients, and the individualized PEEP was confirmed to play a positive role in the intraoperative lung protection in the elderly patients since the imaging aspect.

Inadequate intraoperative mechanical ventilation can cause damage to alveolar tissue and lead to the release of various inflammatory factors. Three studies included the results of IL-6, but there were significant differences between the studies and because of the small number of studies, they were not quantitatively analyzed in this paper. However, two of them confirmed that the levels of IL-6 after extubation in the individualized PEEP group were significantly decreased compared with those in the fixed PEEP group, and the difference was statistically significant, while in the study by Ma et al, although the levels in the individualized group after extubation were higher than those in the fixed group, from the first postoperative day onwards, the levels of IL-6 in the individualized group were lower than that in the fixed group. In the study of Ma et al, although the level of individualized PEEP group was higher than that of the fixed PEEP group after extubation, the level of IL-6 in the individualized PEEP group was lower than that of the fixed PEEP group since the first day of the postoperative period. Therefore, although the results of several articles were different after extubation, the use of individualized PEEP may have a positive impact on the reduction of postoperative inflammation in the long run, and more studies are needed to prove it.

Excessive PEEP causes a decrease in diastolic and systolic blood flow to the left coronary artery and the right echogenic branch, which in turn causes LV diastolic and RV systolic dysfunction [32]; it can also lead to redistribution of blood in the lungs, resulting in ventilatory blood dead zones and affecting lung ventilation function [34], and can affect cerebral, hepatic, and renal perfusion by influencing hemodynamics, central venous pressure, inflammation, and hormones [35]. In this study, we found that individualized PEEP did not adversely affect patients' MAP compared with fixed PEEP. Although the judgment of the patients' circulatory system by MAP value alone is one-sided, it can be used for reference, and it is necessary to incorporate more studies to make a comprehensive judgment by combining other parameters, such as cardiac output.

Currently, there are various protocols for individualized PEEP settings, but individualized management of each patient is a common goal of all studies. Because of the type of surgery and the position of the patient during the operation, it is also important to perform a second PEEP titration after position adjustment or other operations that may affect mechanical ventilation. Especially for the elderly patients, the lung compliance is already reduced, and they are more sensitive to the ventilation changes caused by PEEP adjustment. The use of various advanced technologies, such as EIT and lung ultrasound, allows us to have a more concrete understanding of the patient's lung ventilation and guides us to individualize PEEP titration.

Although this study was conducted in strict accordance with the PRISMA 2020 guidelines, there are some limitations in this study: (1) Most of the countries included in the published literature are China, and there are fewer studies on elderly patients in other countries, and most of the studies were at unclear or high risk of bias, which may affect the results of the study (2) Not all studies performed intraoperative lung resuscitation or multiple PEEP titration, which may result in greater heterogeneity among studies, affecting our discussion of the results (3) There are differences in the time of collection of intraoperative outcome indicators in different studies, and we took the 1h node of the start of anesthesia for data collation in most studies, which may affect our discussion of the results. (4) Some of the outcome indexes had fewer studies with smaller sample sizes, and false-positive results may occur. Results.

In conclusion, compared with the traditional intraoperative fixed PEEP, individualized PEEP settings can play a positive role in lung protection of elderly patients undergoing general anesthesia, improve intraoperative oxygenation and respiratory mechanics, and have no adverse effect on intraoperative blood pressure, reduce the incidence of PPCs, decrease the length of hospital stay, and improve the prognosis of patients.

Disclosure statement

The authors declare no conflict of interest.

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