

One-Lung Ventilation

Intraoperative teaching · CA-2

THE QUESTION

Where the evidence disagrees

This topic was selected because an evidence synthesis beats a textbook on it: the trials disagree, or the guidance has moved recently.

THE EVIDENCE

What each source contributes, and how strong it is

Study design first — a cohort and a randomised trial do not carry the same weight.

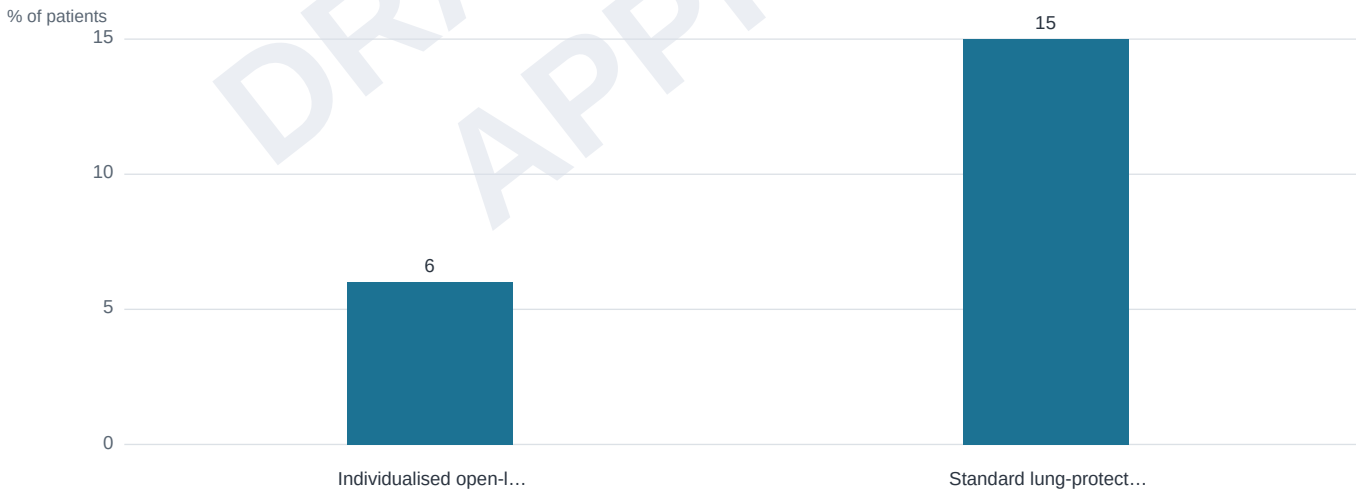
Design	Year	Journal	What it found
Meta-analysis	2025	England)	This meta-analysis found that during one-lung ventilation, individualized PEEP
Randomised trial	2026	The Lancet. Respiratory medicine	This randomised trial found higher PEEP of 10 cm H2O with periodic lung recruitment
Randomised trial	2025	British journal of anaesthesia	This randomised trial found intraoperative intravenous or paravertebral lidocaine
Randomised trial	2025	Journal of clinical anesthesia	This randomized trial found that during one-lung ventilation in elective thoracic
Randomised trial	2025	Korean journal of anesthesiology	This randomized controlled trial found no significant difference in PaO2 at 30
Randomised trial	2025	European journal of cardio-thoraci	This randomized trial found that preemptive lung-ultrasound-guided alveolar

6 resolved citations behind this deck; every point above traces to one of them.

THE NUMBERS

Individualised PEEP beat a fixed 4 cm H2O on complications that matter

The recruitment manoeuvre and titrated PEEP are the intervention, not the tidal volume alone.



Relative risk 0.39, absolute difference -9.2 percentage points across 1,308 patients. PEEP titrated to best compliance is doing the work here.

WHERE THE GUIDANCE SITS

This meta-analysis found that during one-lung ventilation, individualized PEEP

Meta-analysis · England)

This meta-analysis found that during one-lung ventilation, individualized PEEP titration by lung compliance was associated with a reduced risk of postoperative pulmonary complications compared with fixed PEEP, with a risk ratio of 0.55, especially in titration by dynamic compliance or stepwise decremental strategy.

Individualized PEEP titration by lung compliance during one-lung ventilation: a meta-analysis, *Critical care* (London, England) 2025 · PMID 39825438

WHAT THE TRIALS FOUND

Where randomised evidence moved the question

5 findings, each on the slide that follows.

THE LANCET. RESPIRATORY MEDICINE 2026

This randomised trial found higher PEEP of 10 cm H2O with periodic lung recruitment

This randomised trial found higher PEEP of 10 cm H2O with periodic lung recruitment manoeuvres did not reduce pulmonary complications yet increased...

BRITISH JOURNAL OF ANAESTHESIA 2025

This randomised trial found intraoperative intravenous or paravertebral lidocaine

This randomised trial found intraoperative intravenous or paravertebral lidocaine reduced pulmonary complications to 22.3% versus 45.1% with...

JOURNAL OF CLINICAL ANESTHESIA 2025

This randomized trial found that during one-lung ventilation in elective thoracic

This randomized trial found that during one-lung ventilation in elective thoracic surgery, flow-controlled ventilation needed a minute volume of only...

KOREAN JOURNAL OF ANESTHESIOLOGY 2025

This randomized controlled trial found no significant difference in PaO2 at 30

This randomized controlled trial found no significant difference in PaO2 at 30 minutes of one-lung ventilation between remimazolam and sevoflurane in...

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Randomised trial · *The Lancet. Respiratory medicine*

This randomised trial found higher PEEP of 10 cm H2O with periodic lung recruitment manoeuvres did not reduce pulmonary complications yet increased intraoperative hypotension versus lower PEEP of 5 cm H2O without routine recruitment.

Effects of intraoperative higher versus lower positive end-expiratory pressure during one-lung ventilation for thoracic surgery on postoperative pulmonary complications (PROTHOR): a multicentre, international, randomised, controlled, phase 3 trial, *The Lancet. Respiratory medicine* 2026 · PMID 41240959

WHAT THE TRIALS FOUND

This randomised trial found intraoperative intravenous or paravertebral lidocaine

Randomised trial · *British journal of anaesthesia*

This randomised trial found intraoperative intravenous or paravertebral lidocaine reduced pulmonary complications to 22.3% versus 45.1% with remifentanyl in lung resection patients undergoing one-lung ventilation.

Effect of intraoperative paravertebral or intravenous lidocaine infusion on postoperative complications and inflammation after lung resection surgery: a randomised controlled trial, *British journal of anaesthesia* 2025 · PMID 40897588

WHAT THE TRIALS FOUND

This randomized trial found that during one-lung ventilation in elective thoracic

Randomised trial · *Journal of clinical anesthesia*

This randomized trial found that during one-lung ventilation in elective thoracic surgery, flow-controlled ventilation needed a minute volume of only 3.0 L/min versus 4.5 L/min to maintain comparable mild hypercapnia.

Flow-controlled versus pressure-controlled ventilation in thoracic surgery with one-lung ventilation - A randomized controlled trial, *Journal of clinical anesthesia* 2025 · PMID 40020438

WHAT THE TRIALS FOUND

This randomized controlled trial found no significant difference in PaO2 at 30

Randomised trial · *Korean journal of anesthesiology*

This randomized controlled trial found no significant difference in PaO2 at 30 minutes of one-lung ventilation between remimazolam and sevoflurane in adults undergoing thoracoscopic surgery.

Comparison of remimazolam and sevoflurane on arterial oxygenation during one-lung ventilation in thoracoscopic surgery: a randomized controlled trial, *Korean journal of anesthesiology* 2025 · PMID 41101786

WHAT THE TRIALS FOUND

This randomized trial found that preemptive lung-ultrasound-guided alveolar

Randomised trial · European journal of cardio-thoraci

This randomized trial found that preemptive lung-ultrasound-guided alveolar recruitment before one-lung ventilation reduced intraoperative hypoxaemia, defined as SpO₂ below 95%, to 1.2% versus 14.3% with conventional recruitment in patients aged 20-80 undergoing lung resection.

Effectiveness of ultrasound-guided alveolar recruitment in thoracic surgery with one-lung ventilation: a randomized-controlled trial, European journal of cardio-thoracic surgery : official journal of the European Association for Cardio-thoracic Surgery 2025 · PMID 40581064

INDICATIONS

When this is the right block

LUNG SEPARATION IN ADULT THORACIC ANESTHESIA, SAUDI J ANAESTH 2021

Lung separation for thoracic surgery

Indications for one-lung ventilation are classified as absolute or relative and cover both separation and isolation of the lungs. Modern double-lumen tubes are the most widely used device worldwide, and every general anaesthetist should be able to place a left-sided one.

LUNG SEPARATION IN ADULT THORACIC ANESTHESIA, SAUDI J ANAESTH 2021

A bronchial blocker when the airway is difficult or already intubated

Endobronchial blockers are a valid alternative to double-lumen tubes and the safest approach in predicted difficult airways or when the patient is already intubated, since the single-lumen tube and bronchoscope route avoids exchanging the airway. Extubation and re-intubation after a double-lumen tube can be difficult too.

BRONCHIAL BLOCKER VERSUS LEFT DOUBLE-LUMEN TUBE IN VATS RCT, CAN J ANAESTH 2016

Blockers also collapsed the lung faster in VATS

In 38 analysed patients randomised for elective video-assisted thoracic surgery, time from pleural opening to complete lung collapse was 7.5 minutes with a bronchial blocker versus 36.6 minutes with a left-sided double-lumen tube, and complete collapse at 20 minutes was achieved in 100% versus 25%.

CONTRAINDICATIONS

When it is not

BRONCHIAL BLOCKERS VERSUS DOUBLE-LUMEN TUBES RCT, J CARDIOTHORAC VASC ANESTH 2023

Accepting a device position you have not re-checked

In a randomised comparison of the EZ-Blocker, the Fuji Uniblocker and a left-sided double-lumen tube in 89 patients, intraoperative repositioning was needed in 50.0% of Uniblocker cases, difficult placement occurred in 23.3% of them, and 13.3% of EZ-Blocker cases needed more than two repositions. Malposition is the expected state, not the exception.

LUNG SEPARATION IN ADULT THORACIC ANESTHESIA, SAUDI J ANAESTH 2021

A double-lumen tube as the first move in a difficult airway

Blockers are described as mandatory teaching for lung separation and the safest approach in predicted difficult airways, with awake intubation using a single-lumen tube over a bronchoscope as the route. The exchange a double-lumen tube demands is the part that goes wrong.

LOW TIDAL VOLUME DURING ONE-LUNG VENTILATION META-ANALYSIS, J CARDIOTHORAC VASC ANESTH 2018

Treating low tidal volume as free

Across 14 randomised trials, low tidal volume during one-lung ventilation was associated with lower arterial oxygen tension and higher arterial carbon dioxide tension at specific time points, alongside lower airway pressures. It preserved gas exchange after one-lung ventilation and reduced infiltrates and ARDS, but pulmonary complications and hospital stay were unchanged.

DRIVING PRESSURE AND POSTOPERATIVE PULMONARY COMPLICATIONS, LANCET RESPIR MED 2016

Adding PEEP without watching driving pressure

In an individual patient data meta-analysis of 17 randomised trials and 2250 surgical patients, driving pressure was associated with postoperative pulmonary complications (OR 1.16 per unit) while tidal volume was not, and an increase in PEEP that raised driving pressure was associated with more complications (OR 3.11, 95% CI 1.39 to 6.96).

PEARLS

What experience adds

The protective bundle did not beat the simpler setting in lung resection

In 880 patients randomised during major lung resection to 4 mL/kg with PEEP 5 and recruitment manoeuvres or 6 mL/kg with neither, in-hospital ARDS occurred in 0.7% versus 0.2% and pulmonary complications in 28.5% versus 30.8%, with no difference in major complications, mortality, unplanned ICU admission or length of stay.

LUNG ISOLATION, ONE-LUNG VENTILATION AND HYPOXAEMIA, INDIAN J ANAESTH 2015

Hypoxia has a stepwise drill

Management of hypoxaemia during lung isolation is a stepwise sequence: raise the inspired oxygen, add positive end-expiratory pressure to the ventilated lung, then continuous positive airway pressure to the non-ventilated side.

Ask what needs to be collapsed, and when, before you pick the device

Thirty seconds with the surgeon about which lobe, which side, and how soon they want the lung down settles the choice between tube and blocker better than any preference does. Have that conversation before the patient is asleep, not after the pleura is open.

IN THE ROOM

What this changes about the next case

Colour is the strength of the evidence behind each step, not the urgency.

- 1** This meta-analysis found that during one-lung ventilation, individualized PEEP titration by lung compliance was associated with a reduced risk of postoperative pulmonary complications compared with fixed PEEP, with a risk ratio of 0.55, especially in titration by dynamic compliance or stepwise decremental strategy.
- 2** This randomised trial found higher PEEP of 10 cm H₂O with periodic lung recruitment manoeuvres did not reduce pulmonary complications yet increased intraoperative hypotension versus lower PEEP of 5 cm H₂O without routine recruitment.
- 3** This randomised trial found intraoperative intravenous or paravertebral lidocaine reduced pulmonary complications to 22.3% versus 45.1% with remifentanyl in lung resection patients undergoing one-lung ventilation.
- 4** This randomized trial found that during one-lung ventilation in elective thoracic surgery, flow-controlled ventilation needed a minute volume of only 3.0 L/min versus 4.5 L/min to maintain comparable mild hypercapnia.
- 5** This randomized controlled trial found no significant difference in PaO₂ at 30 minutes of one-lung ventilation between remimazolam and sevoflurane in adults undergoing thoracoscopic surgery.

KEY TAKEAWAYS

What to carry into the next case

This meta-analysis found that during one-lung ventilation, individualized PEEP

England) 2025

This randomised trial found higher PEEP of 10 cm H₂O with periodic lung recruitment

The Lancet. Respiratory medicine 2026

This randomised trial found intraoperative intravenous or paravertebral lidocaine

British journal of anaesthesia 2025

This randomized trial found that during one-lung ventilation in elective thoracic

Journal of clinical anesthesia 2025

This meta-analysis found that during one-lung ventilation, individualized PEEP

QUESTIONS I'LL ASK YOU IN THE ROOM

1. How does your plan change if the patient is not optimised?
2. What is the physiology behind what we just did?
3. Talk me through the trade-off you made there.
4. What would make you abandon this plan and do something else?

BOARD QUESTIONS

1. In the iPROVE-OLV trial of 1,308 patients undergoing lung resection with one-lung ventilation, what was the rate of severe postoperative pulmonary complications with an individualised open-lung approach versus standard lung-protective ventilation with PEEP 4?
 - A. 6% versus 15%
 - B. 15% versus 6%
 - C. 12% versus 14%
 - D. 2% versus 20%
2. Describe precisely what the individualised open-lung strategy consisted of in iPROVE-OLV, and why the comparator matters when interpreting the result.
3. The iPROVE-OLV primary outcome was a composite. What components made it up, and what caution does a composite endpoint impose on how you quote the result?

ANSWER KEY

1. A. 6% versus 15%

Relative risk 0.39, absolute risk difference -9.2 percentage points. The intervention was a recruitment manoeuvre to 40 cm H₂O followed by PEEP titrated to best compliance, plus postoperative high-flow oxygen — individualised PEEP, not simply a low tidal volume.

iPROVE-OLV, *Lancet Respir Med* 2024 · PMID 38065200

2. It was a bundle: an alveolar recruitment manoeuvre to 40 cm H₂O end-inspiratory pressure, then individualised PEEP titrated to best respiratory system compliance, plus individualised postoperative respiratory support with high-flow oxygen therapy. The comparator received a fixed intraoperative PEEP of 4 cm H₂O and conventional postoperative oxygen. Two cautions follow: the trial tests titrated PEEP against fixed low PEEP rather than protective against injurious ventilation, and because the intervention also changed postoperative oxygen therapy, the benefit cannot be attributed to intraoperative PEEP alone. It is evidence for the whole bundled strategy.

Read both the control arm and the full intervention before deciding what a positive trial proved. A bundle that changes two things cannot tell you which one worked.

iPROVE-OLV, *Lancet Respir Med* 2024 · PMID 38065200

3. The composite of severe postoperative pulmonary complications within 7 days included atelectasis requiring bronchoscopy, severe respiratory failure, contralateral pneumothorax, early extubation failure requiring CPAP, non-invasive or invasive ventilation or reintubation, acute respiratory distress syndrome, pulmonary infection, bronchopleural fistula and pleural empyema. A composite pools events of very different severity, so a difference can be driven by the least severe component. The honest statement is that the strategy reduced this composite, not that it prevented ARDS or reintubation specifically.

Name the composite's components before quoting its effect size. Recruitment-manoeuve-related adverse events were reported in five patients, which also belongs in the conversation.

iPROVE-OLV, *Lancet Respir Med* 2024 · PMID 38065200

This meta-analysis found that during one-lung ventilation, individualized PEEP

SOURCES

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- [2] Effects of intraoperative higher versus lower positive end-expiratory pressure during one-lung ventilation for thoracic surgery on postoperative pulmonary complications (PROTHOR): a multicentre, international, randomised, controlled, phase 3 trial, *The Lancet. Respiratory medicine* 2026 · PMID 41240959
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- [4] Flow-controlled versus pressure-controlled ventilation in thoracic surgery with one-lung ventilation - A randomized controlled trial, *Journal of clinical anesthesia* 2025 · PMID 40020438
- [5] Comparison of remimazolam and sevoflurane on arterial oxygenation during one-lung ventilation in thoracoscopic surgery: a randomized controlled trial, *Korean journal of anesthesiology* 2025 · PMID 41101786
- [6] Effectiveness of ultrasound-guided alveolar recruitment in thoracic surgery with one-lung ventilation: a randomized-controlled trial, *European journal of cardio-thoracic surgery : official journal of the European Association for Cardio-thoracic Surgery* 2025 · PMID 40581064
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- [14] Lung isolation, one-lung ventilation and hypoxaemia, *Indian J Anaesth* 2015 · PMID 26556920