**Perioperative lung protection: general mechanisms and protective approaches**

*Online Supplement*

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# Search strategy

In order to identify relevant articles to be included for the purpose of this systematic review with meta-analysis. The following keywords and MeSH terms were used: “protective ventilation”, “recruitment maneuvers”, “positive end-expiratory pressure”, “low tidal volume”, “physiotherapy”, “prehabilitation”, “postoperative pulmonary complications”, “surgery”, “intraoperative”. Two authors (LB and CA) independently assessed the results of the primary search, including the references, to identify studies for potential inclusion.

# efigure 1 – Study inclusion flow

A screenshot of a cell phone

Description automatically generated

# efigure 2 – Forest plot for PPCs and preoperative physiotherapy



# efigure 3 – Funnel plot for PPCs and preoperative physiotherapy



# eTable 1 – Studies investigating intraoperative ventilation

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | **Protective ventilation** | | | | **Control group** | | | | **Outcomes of interest** | **Main findings** |
| **Study** | **Type of surgery** | **Study population** | **N** | **Tidal volume (mL/kg predicted body weight)** | **PEEP (cmH2 O)** | **ARM** | **N** | **Tidal volume (mL/kg predicted body weight)** | **PEEP (cmH2 O)** | **ARM** |  |  |
| **Weingarten 2010** | Open abdominal | > 65 years old | 40 | 6 | 12 | yes | 20 | 10 | 0 | no | Pneumonia atelectasis  pulmonary edema  pleural effusions ALI | Protective strategy improved intraoperative oxygenation, no decrease in PPCs |
| **Futier 2013** | Open abdominal | Moderate to high risk of PPC assessed with the Postoperative Pneumonia Risk Index | 200 | 6-8 | 6-8 | no | 200 | 10-12 | 0 | no | Pneumonia, atelectasis,  ALI | Decreased incidence of PPCs and length of stay with protective ventilation |
| **Soh 2017** | Spinal | Patients at risk of PPC assessed with the Postoperative Pneumonia Risk Index, surgery in the prone position >2 hours | 39 | 6 | 6 | yes | 39 | 10 | 0 | no | Atelectasis pneumonia  Pulmonary oedema | No differences in the incidence of PPCs |
| **Treschan 2012** | Open abdominal | Duration >3h | 50 | 6 | 5 | no | 51 | 12 | 5 | no | Pneumonia, respiratory failure | No differences in the incidence of PPCs |
| **Kuzkov 2016** | Open pancreatoduodenal | Duration >2 h | 20 | 6 | 4 | no | 20 | 10 | 4 | no | Atelectasis, pneumonia | Reduced incidence of atelectasis |
| **Karalapillai 2020** | Major non-cardiothoracic, non-intracranial surgery | > 40 years or older | 614 | 6 | 5 | no | 592 | 10 | 5 | no | Pneumonia, bronchospasm, atelectasis, pulmonary congestion, respiratory failure, pleural effusion, pneumothorax | No differences in the incidence of PPCs |
| **Hemmes 2014** | Open abdominal surgery | Moderate to high risk of pulmonary complications assessed with the ARISCAT score | 447 | 8 | 12 | yes | 453 | 8 | 2 | no | Hypoxemia, bronchospasm, pneumonia, ARDS, atelectasis, pleural effusion, pulmonary edema, pneumothorax | No differences in the incidence of PPCs |
| **Nestler 2017** | Laparoscopic surgery | Obese patients | 25 | 8 | Individualized based on electrical impedance tomography | yes | 25 | 8 | 5 | no | Atelectasis, pneumonia | Improved intraoperative oxygenation but not postoperative outcomes |
| **Ferrando 2018** | Abdominal | Surgery >2 h Intermediate-to-high  risk for PPCs, assessed with the ARISCAT score | 238  (OLA-CPAP group) | 8 | Individualized based on the lowest driving pressure | no | 244  (Standard-CPAP group) | 8 | 5 | no | Aspiration pneumonitis, bronchospasm, pleural effusion, atelectasis, hypoxemia, pneumothorax, pneumonia, ARDS | No differences in the incidence of postoperative complications |
| **Wei 2018** | Bariatric (sleeve gastrectomy) | Obese patients ASA II-III between 20 and 65 years | 12 | 8 | 8 | yes | 12 | 8 | 0 | no | Postoperative oxygenation,  PPCs | Improved postoperative oxygenation |
| **Bluth 2019** | Abdominal | Obese patients, intermediate to  high risk of PPCs assessed with the ARISCAT score | 987 | 7 | 4 | yes | 989 | 7 | 12 | no | Pneumonia, ARDS, respiratory failure, pleural effusion, bronchospasm, atelectasis | No differences in the incidence of PPCs |

Characteristics of studies comparing intraoperative-operative lung protective strategies. PEEP: positive end-expiratory pressure, ZEEP: zero end-expiratory pressure, ARM: alveolar recruitment maneuver, ALI: acute lung injury, ARISCAT: Assess Respiratory risk In Surgical patients in CATalonia score, OLA: open lung approach.

# efigure 4 – Forest plot for PPCs and intraoperative ventilation



# efigure 5 – Funnel plot for PPCs and intraoperative ventilation



# efigure 6 – Forest plot for PPCs and postoperative physiotherapy



# efigure 7 – Funnel plot for PPCs and postoperative physiotherapy



# efigure 8 – Forest plot for PPCs and postoperative CPAP



# efigure 9 – Funnel plot for PPCs and postoperative CPAP

