Section: Anaesthesia

Systematic Review Article

NON-SUPINE RECOVERY POSITIONING AFTER GENERAL ANAESTHESIA AND ITS EFFECT ON HYPOXEMIA AND AIRWAY COMPLICATIONS: A SYSTEMATIC REVIEW

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ABSTRACT

Background: Tracheal extubation and early post-anaesthesia recovery are important periods for airway and respiratory complications. Patient positioning is a simple intervention, but evidence is scattered across different non-supine positions. This systematic review assessed the effect of non-supine positioning during tracheal extubation and early recovery after general anaesthesia.

Material and Methods: PubMed/MEDLINE and Google Scholar were searched for English, open-access full-text articles published from January 2020 to March 2026. Study involving adult patients comparing non-supine positioning with supine or conventional recovery position during extubation or early PACU recovery were included. Randomised trials and prospective comparative studies were considered. Data were summarised narratively.

Results: Five studies with 3334 adult patients were included. Four were randomised studies and one was a prospective comparative study. Semi-Fowler's 30°, 30° semirecumbent, lateral and modified recovery positions were associated with better airway or respiratory outcomes in selected patients. Reported benefits included lower coughing, bucking, hypoxemia, severe hypoxemia, airway rescue, airway complications and early respiratory distress. Comfort and PACU recovery also favoured non-supine positioning in some studies. Risk of bias was variable, mainly because blinding was difficult and some studies were single-centre.

Conclusion: Non-supine positioning appears to be a useful low-cost measure during tracheal extubation and early recovery. The strongest direct support is for 30° semi-Fowler's or semirecumbent position after abdominal surgery. Positioning should be individualised according to airway risk, surgery type and haemodynamic status.

Keywords: tracheal extubation; semi-Fowler's position; semirecumbent position; supine position; postoperative hypoxemia; post-anaesthesia care unit.

INTRODUCTION

Tracheal extubation is a critical but often underestimated phase of anaesthesia care. It is performed during a dynamic period when airway reflexes return, spontaneous breathing resumes, pain response fluctuates and residual anaesthetic effects are diminish simultaneously. Airway obstruction, coughing, bucking, laryngospasm, aspiration and hypoxaemia may occur during this period or soon after arrival in the post-anaesthesia care unit.[1,2] The supine position is commonly used during extubation because it is simple and allows easy airway access. However, it may not be ideal for all patients. Supine posture can reduce functional residual capacity, promote airway closure and increase the chance of upper airway obstruction during recovery from anaesthesia.[3] This issue is more relevant after abdominal surgery, where pain, diaphragmatic dysfunction and reduced lung volume can affect early

breathing after extubation.[4] Non-supine positions are low-cost interventions and need no special equipment. Semi-Fowler's and semirecumbent positions may improve diaphragmatic movement, reduce abdominal wall tension and support gas exchange. Lateral and modified recovery positions may also help drainage of secretions and reduce upper airway obstruction in selected patients.[3-7] These physiological advantages make patient position a practical area for peri-extubation care.

Recent studies have evaluated different positions during extubation and early recovery. Zhu et al. found that semi-Fowler's position reduced severe coughing, bucking and wound pain after abdominal surgery compared with supine position.[4] Wang et al. reported that 30° semirecumbent position reduced postoperative hypoxaemia, severe hypoxaemia, coughing and airway rescue after laparoscopic upper abdominal surgery.[3] Ye et al. showed that lateral positioning reduced hypoxaemia and airway rescue in sedated adults in the post-anaesthesia care unit.[5] Hussain et al. reported fewer airway complications with a modified recovery position after ENT surgery.[6] Chinnasamy et al. also reported lower early respiratory distress with 30° semi-Fowler's position after abdominal surgery.[7] Although these studies support non-supine positioning, the interventions and outcomes are not uniform. Some studies focused on semi-Fowler's or semirecumbent position, while others assessed lateral or modified recovery positions. The surgical populations also differed. A practical synthesis of recent evidence is needed to understand whether non-supine positioning improves airway and respiratory outcomes during tracheal extubation and early post-anaesthesia recovery. Therefore, it is of interest to review the available evidence on non-supine positioning during tracheal extubation and early post-anaesthesia recovery after general anaesthesia.

MATERIALS AND METHODS

Study design

This systematic review was planned and written according to the PRISMA 2020 statement.[8] The review was designed to assess the effect of non-supine positioning during tracheal extubation and early post-anaesthesia recovery after general anaesthesia. As the included studies were clinically heterogeneous, a narrative synthesis was planned. The review question was: Does non-supine positioning during tracheal extubation or early post-anaesthesia recovery improve airway and respiratory outcomes compared with supine or conventional recovery position in adult patients after general anaesthesia?

Eligibility Criteria

Studies were included if they met the following criteria: adult patients, general anaesthesia, tracheal extubation or early post-anaesthesia recovery, comparison of any non-supine position with supine or conventional recovery position, and reporting of airway or respiratory outcomes. Non-supine positions included semi-Fowler's, semirecumbent, head-up, lateral and modified recovery positions. Randomised controlled trials and prospective comparative clinical studies were included. Only English language and open-access full-text articles published from January 2020 to March 2026 were considered. Studies were excluded if they were paediatric studies, animal studies, case reports, case series, review articles, editorials, letters or conference abstracts. Studies were also excluded if they assessed preoxygenation, intubation position, intraoperative surgical position, ventilation mode, nerve block, ICU transport or general airway management without an extubation or PACU positioning comparison.

Information sources and search strategy

The literature search was performed using PubMed/MEDLINE and Google Scholar. The reference lists of eligible full-text articles were also checked manually. Scopus and Embase were not searched due to institutional access restrictions, whichi is acknowledged as a limitation. The search terms included combinations of the following words: extubation, tracheal extubation, post-anaesthesia care unit, PACU, recovery, general anaesthesia, anaesthesia, semi-Fowler, semi Fowler, semirecumbent, semi-recumbent, head-up, lateral position, recovery position, modified recovery position and supine.

The PubMed search string used was:

(("semi-Fowler" OR "semi Fowler" OR semirecumbent OR "semi-recumbent" OR "head-up" OR "head up" OR "lateral position" OR "recovery position" OR "modified recovery position") AND (supine OR conventional) AND (extubation OR "tracheal extubation" OR recovery OR PACU OR "post-anaesthesia care unit" OR "post-anaesthesia care unit") AND (anaesthesia OR anaesthesia OR "general anaesthesia" OR "general anaesthesia"))

Study selection

All records identified from the search were screened by title and abstract. Clearly unrelated studies were removed. Full texts of potentially eligible articles were assessed against the inclusion and exclusion criteria. Duplicate articles were removed. Articles that did not match the population, intervention, comparator, outcome or study design criteria were excluded. Reasons for full-text exclusion were recorded.

Data Extraction

Data were extracted in a predefined format. The extracted details included author name, year, country, study design, sample size, type of surgery, patient population, intervention position, comparator position, timing of position, main outcomes and important findings.

The main outcomes were coughing, bucking, hypoxemia, severe hypoxemia, airway rescue, airway complications, respiratory distress, comfort score, pain score, PACU stay and adverse events.

Risk of bias assessment

Randomised controlled trials were assessed using the RoB 2 approach.[9] The domains considered were randomisation process, allocation concealment, deviations from intended intervention, missing outcome data, outcome measurement and selective reporting.

The prospective comparative non-randomised study was assessed using the ROBINS-I approach.[10] The domains considered were confounding, participant selection, intervention classification, deviation from intervention, missing data, outcome measurement and selective reporting.

Data Synthesis

A meta-analysis was not performed because the included studies differed in population, surgical setting, intervention position, comparator group and outcome definitions. Findings were summarised narratively. The results were grouped under airway reflex outcomes, oxygenation outcomes, airway rescue and complications, comfort and recovery outcomes and safety outcomes.

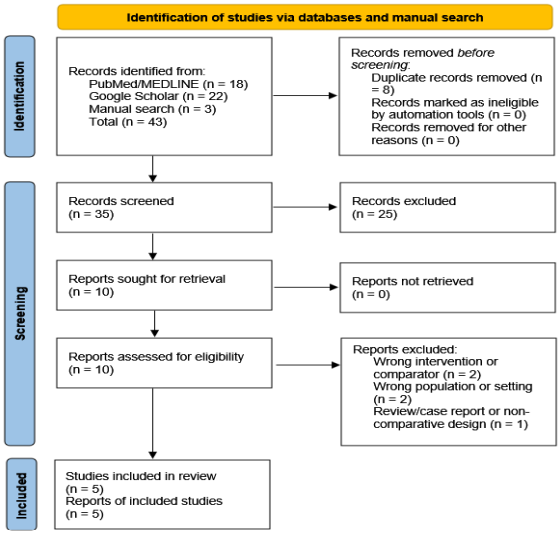

Figure 1: PRISMA flow diagram of study selection

RESULTS

Table 1: Basic clinical profile of included positioning studies

Author, year	Country	Design	Sample size	Population	Position compared	Main outcome
Zhu et al., 2020.[4]	China	Randomised clinical trial	141	Adults undergoing abdominal surgery under general anaesthesia	Semi-Fowler's 30° versus supine	Comfort score after extubation
Wang et al., 2024.[3]	China	Randomised clinical trial	700	Adults undergoing laparoscopic upper abdominal surgery under general anaesthesia	Supine versus 15° and 30° semirecumbent position	Postoperative hypoxemia
Ye et al., 2025.[5]	China	Multicentre randomised clinical trial	2143 analysed	Adults extubated in PACU after general anaesthesia and sedation	Lateral position versus supine position	Hypoxemia within 10 minutes after positioning
Hussain et al., 2024.[6]	Pakistan	Prospective comparative study	200	Adults undergoing elective ENT surgery under general anaesthesia	Conventional recovery position versus modified recovery position	Airway complications after extubation
Chinnasamy et al., 2026.[7]	India	Randomised controlled study	150	Adults undergoing elective abdominal surgery under general anaesthesia	Semi-Fowler's 30° versus supine	Respiratory distress within 30 minutes after extubation

Five studies were included in the review. The total analysed sample was 3334 adult patients. Three studies were from China, one was from Pakistan and one was from India. Four studies were randomised clinical trials and one was a prospective comparative study. The included positions were semi-Fowler's 30°, semirecumbent 15° and 30°, lateral position and modified recovery position. The comparator was supine position in most studies, while one study compared modified recovery position with conventional recovery position. The main outcomes were comfort after extubation, postoperative hypoxemia, airway complications and respiratory distress.

Table 2: Main airway and recovery outcomes in included studies

Author, year	Coughing / bucking	Hypoxemia	Airway rescue / complications	Comfort / recovery	Main result
Zhu et al., 2020.[4]	Severe coughing and bucking were lower in semi-Fowler's group	No fall in SpO_2 was reported in either group	Airway rescue was rare and comparable	Comfort score was better and wound pain was lower in semi-Fowler's group	Semi-Fowler's position gave smoother extubation and better comfort
Wang et al., 2024.[3]	Coughing was lowest in 30° semirecumbent group	Hypoxemia and severe hypoxemia were lower in 30° semirecumbent group	Airway rescue was lower in 30° semirecumbent group	Respiratory comfort was better and PACU stay was shorter	30° semirecumbent position improved oxygenation and recovery
Ye et al., 2025.[5]	Not the main outcome	Hypoxemia was lower in lateral group than supine group	Airway rescue and severe hypoxemia were lower in lateral group	PACU stay was shorter in lateral group	Lateral position reduced early hypoxemia after extubation
Hussain et al., 2024.[6]	Persistent coughing was included in airway complications	Desaturation was included in airway complications	Total airway complications were lower in modified recovery position	Recovery comfort was not separately assessed	Modified recovery position reduced airway complications after ENT surgery
Chinnasamy et al., 2026.[7]	Not reported as main separate outcome	Hypoxemia showed lower trend in semi-Fowler's group	Respiratory distress was lower in semi-Fowler's group	PACU SpO_2 profile favoured semi-Fowler's group	Semi-Fowler's position reduced early respiratory distress

Most studies showed favourable outcomes with non-supine positioning. Zhu et al. reported lower severe coughing and bucking with semi-Fowler's position. Wang et al. reported lower hypoxemia, severe hypoxemia, coughing and airway rescue with 30° semirecumbent position. Ye et al. found lower hypoxemia, severe hypoxemia and airway rescue with lateral positioning. Hussain et al. reported fewer total airway complications with modified recovery position after ENT surgery. Chinnasamy et al. reported lower respiratory distress with semi-Fowler's position. Comfort and recovery outcomes also favoured non-supine positioning in the studies where these were assessed.

Table 3: Risk of bias and clinical value of included studies

Author, year	Randomization	Blinding	Main limitation	Risk judgement	Clinical value
Zhu et al., 2020.[4]	Yes	Patient blinding reported; staff blinding not feasible	Single-centre study with subjective comfort outcome	Some concern	Direct evidence for semi-Fowler's extubation
Wang et al., 2024.[3]	Yes	Outcome assessors and analysts were blinded	Single-centre study and limited to upper abdominal laparoscopy	Low to some concern	Strong evidence for 30° semirecumbent recovery
Ye et al., 2025.[5]	Yes	Blinding not feasible due to visible position	Included broader sedated PACU population, not only semi-Fowler's	Some concern	Large evidence that non-supine position reduces hypoxemia
Hussain et al., 2024.[6]	Not clearly randomised	Blinding not clear	Comparator was another recovery position, not supine	Some concern to high concern	Supportive evidence for extubation position effect
Chinnasamy et al., 2026.[7]	Yes	Blinding not clearly described	Single-centre study and limited reporting of some outcomes	Some concern	Direct Indian evidence for semi-Fowler's extubation

The risk of bias was variable. Randomisation was reported in four studies. Blinding of staff was not feasible because the intervention was patient position. Wang et al. had stronger methodology because outcome assessors and analysts were blinded. Zhu et al. and Chinnasamy et al. gave direct evidence for semi-Fowler's extubation but were single-centre studies. Ye et al. provided large multicentre evidence for lateral position but included a broader PACU population. Hussain et al. was supportive but had higher concern because randomisation and blinding were not clearly described.

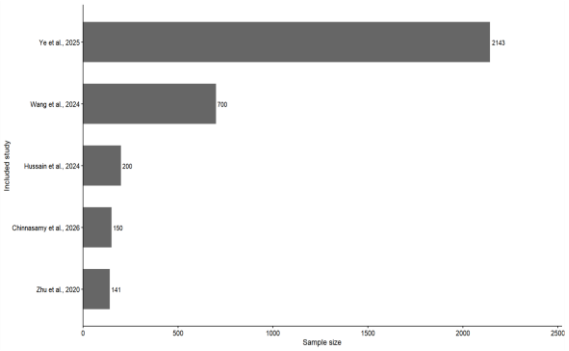

Figure 2: Sample size distribution of included positioning studies

DISCUSSION

This systematic review found that non-supine positioning during tracheal extubation and early post-anaesthesia recovery was generally associated with better airway and respiratory outcomes. The benefit was seen for coughing, bucking, hypoxemia, airway rescue, airway complications and early respiratory distress. The direction of effect was favourable in most included studies, though the position used and outcome definitions were not uniform.[3-7]

Tracheal extubation is a vulnerable period of anaesthesia care. Airway tone is still recovering. Protective reflexes may be incomplete. Pain, secretions, residual anaesthetic effect, residual neuromuscular block and surgical factors can act together. Coughing, bucking, laryngospasm, aspiration and hypoxemia may occur during this phase.[1,2] These risks support the use of simple preventive steps during extubation and early recovery. The most direct evidence came from studies using semi-Fowler's or semirecumbent positions. Zhu et al. reported lower severe coughing and bucking with 30° semi-Fowler's position after abdominal surgery.[4] Wang et al. showed that 30° semirecumbent position reduced hypoxemia, severe hypoxemia, coughing and airway rescue after laparoscopic upper abdominal surgery.[3] Chinnasamy et al. also reported lower early respiratory distress with 30° semi-Fowler's position after abdominal surgery.[7] These findings support 30° head-up positioning during extubation and early recovery in selected adult surgical patients. The likely mechanism is physiological and practical. Head-up and semirecumbent positions may improve diaphragmatic movement and reduce cephalad pressure of abdominal contents. This may improve lung volume during early recovery. Supine position can reduce functional residual capacity and promote airway closure, especially after abdominal surgery and in obese patients.[11,12] This is clinically important because oxygenation may worsen during emergence even when intraoperative oxygenation was satisfactory.[13]

The lateral-position evidence also supports the role of body position in PACU respiratory safety. Ye et al. reported that, compared with supine posining, lateral Positioning, lateral positioning was associated with lower incidence of hypoxemia, severe hypoxemia, and airway rescue interventions in adults in PACU.[5] This study was large and multicentre. It did not test semi-Fowler's position, but it showed that avoiding a flat supine posture can reduce early airway obstruction and hypoxemia after anaesthesia. Hussain et al. found fewer airway complications with modified recovery position compared with conventional recovery position after ENT surgery.[6] This study had a different comparator and a different surgical population. Still, it adds useful clinical evidence that extubation position can influence coughing, breath holding, desaturation and laryngospasm. This is relevant after ENT surgery where secretions, bleeding and airway irritation are common.

The findings are consistent with wider airway literature. Safe extubation depends on planning, risk assessment, monitoring and readiness for airway rescue.[1,2,14] Positioning alone cannot replace these steps. However, it is simple, low-cost and easily applied. In obese patients, head-up or semi-sitting positioning is often recommended during airway management because it improves respiratory mechanics and may prolong safe apnoea time.[11,12,15] This supports the biological basis of the results seen in the included studies. Postoperative hypoxemia is a common PACU problem. Andualem and Yesuf reported postoperative hypoxemia in adult elective surgical patients.[16] Taye et al. reported early postoperative hypoxemia in 45.8% of patients after general anaesthesia and identified obesity, chronic disease, smoking, low pre-induction SpO_2 , emergency surgery and lack of oxygen therapy as important predictors.[17] Berhanu et al. also reported a high magnitude of early postoperative hypoxemia after emergency surgery under general anaesthesia.[18] These studies show that early recovery hypoxemia is not rare in routine anaesthesia practice.

A recent systematic review also supports this burden. Bizuneh et al. reported a pooled postoperative hypoxemia prevalence of 20.62%, which became 16.76% after adjustment for publication bias.[19] Xiong et al. found that advanced age, high BMI, low preoperative oxygen saturation, smoking, longer surgery and opioid use were associated with postoperative hypoxemia in PACU.[20] These risk factors are common in adult surgical patients. They also explain why one intervention alone may not be sufficient in all cases. Other recent studies have shown similar risk patterns in specific surgical groups. Luo et al. found PACU hypoxemia in patients after thoracoscopic lung cancer surgery and identified age, BMI, ASA class, hypertension, diabetes and awakening time as predictors.[21] Wang et al. developed a nomogram to predict PACU hypoxemia after laparoscopic bariatric surgery.[25] These studies are not positioning trials, but they show that hypoxemia in recovery is a frequent and predictable clinical problem in high-risk groups.

Management of PACU hypoxemia needs a bundle approach. Liu et al. described postoperative hypoxemia as multifactorial and discussed conventional oxygen therapy, high-flow nasal cannula, CPAP and non-invasive ventilation as treatment options.[22] Turner et al. showed the value of portable pulse oximetry for detecting postoperative hypoxemia in a resource-limited setting.[23] Chen et al. reported that THRIVE reduced postoperative hypoxemia in elderly patients undergoing laparoscopic surgery in PACU.[24] These studies support close monitoring and early respiratory intervention. Positioning should be seen as one component of this wider recovery strategy.

The present review is different from the above studies because it specifically evaluates body position during extubation and early recovery. The available evidence suggests that a flat supine position may not be the best default position for all patients. A 30° head-up or semirecumbent posture appears useful after abdominal and laparoscopic upper abdominal surgery.[3,4,7] Lateral or modified recovery positions may be useful when airway obstruction, secretions or blood in the airway are expected.[5,6] The clinical decision should remain individualised. Semi-Fowler's or semirecumbent position may be preferred after abdominal surgery if airway access is adequate and haemodynamics are stable. Lateral or modified recovery position may be more useful in selected ENT cases or in patients with secretion-related airway risk. Supine position may still be required when airway manipulation is expected, when haemodynamic instability is present, or when the surgical condition does not allow another position.

This review has limitations. The included studies used different positions, different comparators and different definitions of outcomes.[3-7] Some studies measured comfort, while others measured hypoxemia or composite airway complications. Blinding was difficult because patient position is visible. Some evidence came from single-centre studies. One study was prospective comparative but not clearly randomised.[6] These issues reduce the certainty of the evidence. Another limitation is the broadening of the review topic. Semi-Fowler's, semirecumbent, lateral and modified recovery positions were grouped under non-supine positioning. This increased the number of eligible studies but also increased clinical heterogeneity. The results should not be interpreted as proof that all non-supine positions are equally useful. The best direct evidence remains for 30° semirecumbent or semi-Fowler's position after abdominal surgery.[3,4,7] Overall, non-supine positioning appears to be a useful and low-cost measure during tracheal extubation and early post-anaesthesia recovery. The evidence supports better airway smoothness, lower hypoxemia and reduced airway rescue in selected groups. It should be used along with standard extubation planning, oxygen therapy, monitoring and airway rescue readiness. Larger multicentre trials are still needed using uniform outcomes for coughing, bucking, hypoxemia, airway rescue, aspiration and reintubation.

CONCLUSION

Non-supine positioning during tracheal extubation and early post-anaesthesia recovery appears to improve airway and respiratory outcomes in selected adult surgical patients. The available evidence supports the implementation of a 30° semi-Fowler's or semirecumbent position to reduce coughing, bucking, hypoxaemia, airway rescue interventions, and early respiratory distress, particularly following abdominal and laparoscopic upper abdominal surgeries. Additionally, lateral and modified recovery positions may mitigate early airway complications in targeted PACU and ENT settings. While these findings offer valuable clinical utility, the inherent heterogeneity of the data dictates that positioning must be individualised based on the specific type of surgery, baseline airway and aspiration risks, body habitus, and haemodynamic status.

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