Editorial

HE Breathing: a new ventilation mode in airway surgery

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Complex airway surgery, particularly tracheal/carinal resection and reconstruction, is still considered as the “crown jewel” of video-assisted thoracoscopic surgery (VATS). Notably, during these procedures, maintaining adequate oxygenation and preventing hypercapnia, while simultaneously ensuring optimal surgical conditions, remains a formidable challenge (1,2). Drawing on prior clinical experience, successful airway surgery hinges on close collaboration with a skilled anesthesia team, where the choice of ventilation mode—intubated or non-intubated (tubeless)—plays a critical role in achieving optimal procedural outcomes (3-5).

Intubated ventilation for airway surgery

Traditionally, airway surgery is performed under intubated general anesthesia with cessation of spontaneous breathing. However, this approach presents several significant challenges (*Figure 1*), primarily including: (I) mechanical ventilation may lead to complications, such as airway pressure-induced trauma, lung overdistension, repetitive alveolar collapse and reopening, and the release of pro-inflammatory mediators, all of which may cause lung injury and postoperative respiratory impairment (6-9). (II) After tracheal transection, endotracheal intubation with cross-field ventilation is necessary for distal airway ventilation. However, it may complicate end-to-end anastomosis by obstructing the view of surgical field and may require intermittent withdrawal to improve exposure (2,10). (III) To avoid airway resistance and ensure a stable operative environment during the mechanical ventilation, deep anesthesia—often achieved through opioids and muscle relaxants—are employed. However, its related postoperative adverse effects may be unavoidable, like nausea, vomiting, residual neuromuscular blockade or myasthenia, cognitive dysfunction and some life-threatening events (11-14).

Although high-frequency jet ventilation, an alternative airway management allowing for control of oxygenation with minimal interference of surgical exposure and lower peak inspiratory pressure, has been applied in airway surgery, it still needs intubated general anesthesia with possible CO_2 retention, barotrauma, and hypothermia due to high rate of gas flow (15,16).

Non-intubated ventilation for airway surgery

During the last decade, non-intubated VATS is one of the most impressive advancements in thoracic surgery and anesthesia, which is performed safely under spontaneous ventilation anesthesia (through regional anesthesia and minimal sedation while avoiding opioids and muscle relaxants) (17,18). In 2016, Prof. He’s team reported the first large-scale comparative study on non-intubated versus intubated VATS for lung resection,

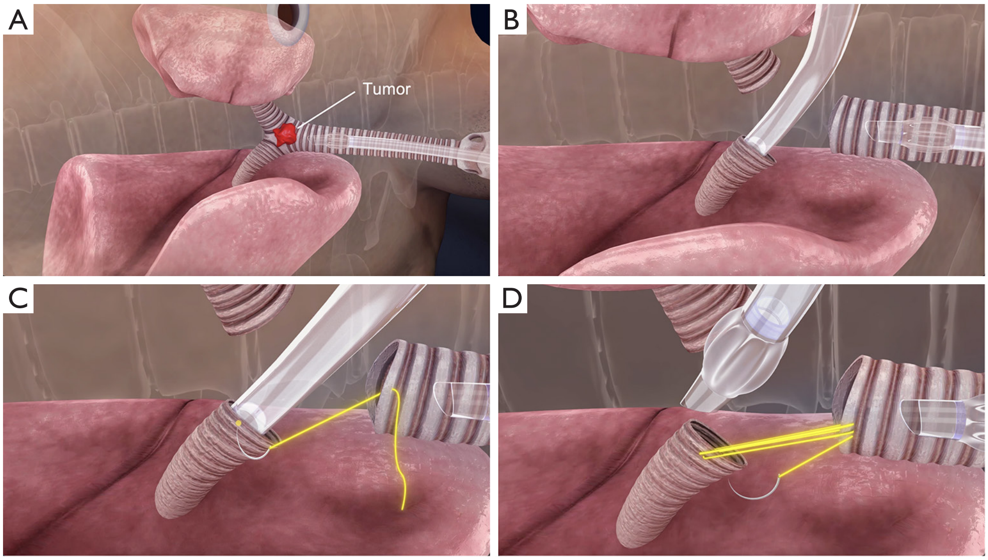
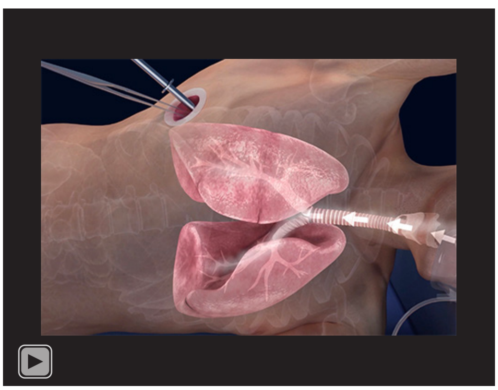


Figure 1 Intubated ventilation for airway surgery. This figure illustrates video-assisted thoracoscopic surgery for carinal resection and reconstruction under intubated general anesthesia. (A) Before carinal resection, oxygenation is maintained through endotracheal intubation with mechanical ventilation. (B) After carinal resection, cross-field ventilation through endotracheal intubation is necessary. (C) During carinal reconstruction, the presence of the endotracheal tube obstructs the surgical field, complicating end-to-end anastomosis. (D) To improve exposure and maintain oxygenation during carinal reconstruction, intermittent withdrawal and reinsertion of the endotracheal tube are performed.



Video 1 "HE Breathing" ventilation mode for airway surgery. This video illustrates non-intubated video-assisted thoracoscopic surgery for carinal resection and reconstruction under spontaneous ventilation anesthesia.

demonstrating that the non-intubated approach was feasible and effective, with fewer postoperative complications and faster recovery (19). Subsequently, Prof. He's team extended this technique from these basic thoracic procedures to complex airway surgeries (20-22), developing a ventilation strategy in which patients maintain spontaneous breathing even after the airway is opened—referred to as "HE Breathing".

HE Breathing ventilation mode is typically characterized by two distinct non-physiological airflow pathways: the contralateral airway stump ⇄ the main bronchial stump or the chest wall incision, and here, the surgical pleural cavity functions as a temporary transitional reservoir (*Video 1*). The opening of one pleural cavity results in the loss of its negative pressure, while the contralateral cavity preserves it. Within this structure, the ongoing spontaneous respiratory muscle movements and the pressure gradient across the opened trachea generate a driving force for breathing. Moreover, according to Bernoulli's principle, the addition of a chest wall incision pathway significantly reduces airflow resistance, thereby enhancing gas exchange efficiency.

Advantages of HE Breathing ventilation mode for airway surgery

In a comparative study, Prof. He's team successfully performed thoracoscopic carinal (4 patients) and tracheal (14 patients) resections under the HE Breathing ventilation mode, achieving shorter anastomosis times (22.5–40 *vs.*

45–86 minutes), operative duration (162.5 *vs.* 260 minutes) and potentially postoperative hospital stays (11.5±4.3 *vs.* 13.2±6.3 days), compared with the conventional intubated ventilation method (4). These results underscore the significant advantages of HE Breathing ventilation mode in enhancing surgical safety, reducing perioperative mortality and promoting faster recovery. Key contributing factors include:

(I) Spontaneous breathing minimizes lung injury and infection risks associated with mechanical ventilation. The naturally regulated rhythm and depth of spontaneous breathing may enhance respiratory efficiency and oxygenation. Although it is known that hypercapnia may occur, permissive hypercapnia can improve hemodynamics, enhance ventilation-perfusion matching, and provide protective effects against inflammatory responses (23).

(II) Using a laryngeal mask instead of an endotracheal tube avoids intubation-related injuries (e.g., throat pain, mucosal ulceration and airway rupture). The associated reduction in reflexive coughing may also help prevent early anastomotic rupture.

(III) The absence of a tube within the surgical area optimizes visualization and precision during resection and anastomosis, vastly simplifying this technically demanding procedure. Accordingly, the ischemia-reperfusion time of the airway is reduced, facilitating more efficient anastomotic reapproximation and recovery.

(IV) The combination of local anesthesia (e.g., infiltration of the vagus nerve, extensive intercostal nerves and lung surface) and mild intravenous anesthesia, rather than general deep anesthesia, reduced postoperative adverse effects related to muscle relaxants, as well as heavy sedatives and analgesics, particularly in the prolonged airway surgeries.

With the collaborative efforts of surgeons and anesthesiologists, HE Breathing ventilation mode has emerged as an innovative technique in airway surgery, offering significant advantages. Further investigations into its respiratory dynamics and other underlying mechanisms are warranted. Prof. He's team has successfully extended its application to robotic-assisted VATS (24), and it is anticipated that this technique will achieve broader adoption and benefit a wider range of patients in the future.

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Footnote

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