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Tubeless Anesthesia with Spontaneous Respiration in Thoracic Surgery

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Abstract: In recent years, with the promotion of enhanced recovery after surgery (ERAS) protocols and the advancement of minimally invasive techniques in thoracic surgery, non-intubated anesthesia with spontaneous ventilation has emerged as a research hotspot. The tubeless technique, which maintains spontaneous breathing while avoiding the insertion of various tubes, has been increasingly supported by clinical studies for its safety and feasibility. This review systematically summarizes recent progress in the application of tubeless anesthesia in thoracic surgery.

1. Background

Double-lumen tube general anesthesia (DLT) has become the predominant anesthetic modality in thoracic surgery. By enabling single-lung ventilation (OLV), DLT facilitates collapse of the operative lung and provides surgical field isolation, thus laying the foundation for the advancement of thoracoscopic and minimally invasive techniques. However, tracheal intubation may result in airway trauma, leading to postoperative sore throat, persistent cough, and other airway complications. Mechanical ventilation increases the risk of ventilator-induced lung injury, ventilator-associated pneumonia (VAP), and pain or infection associated with chest drains. Studies have also shown that OLV increases the risk of atelectasis, potentially resulting in ventilation-perfusion mismatch and complications such as acute lung injury (ALI) and acute respiratory distress syndrome (ARDS), which impede recovery. The use of neuromuscular blockers may impair respiratory and gastrointestinal recovery and extend hospital stays. With the rise and rapid implementation of enhanced recovery after surgery (ERAS) protocols, minimizing perioperative invasiveness has gained attention. Advances in surgical and anesthetic technologies have broadened the concept of minimal invasiveness from surgical incisions to anesthesia. Tubeless procedures, preserving spontaneous respiration during surgery, have gained increasing recognition. This technique reduces physiological disruption, avoids invasive airway instrumentation, decreases postoperative pain and complications, shortens hospitalization, and accelerates recovery. Tubeless anesthesia exemplifies the integration of minimally invasive and ERAS principles in thoracic surgery. This review systematically outlines progress in Tubeless anesthesia with preserved spontaneous respiration.

2. Key Techniques of Tubeless Anesthesia with Spontaneous Respiration

2.1 Non-intubated Anesthesia

Tubeless anesthesia refers to maintaining oxygenation during surgery without tracheal intubation while preserving spontaneous respiration. It eliminates intraoperative use of urinary catheters, chest drains, central venous lines, and nasogastric tubes, thus minimizing iatrogenic trauma and preserving physiological functions.

Regional anesthesia plays a key role, including epidural anesthesia, paravertebral block, local infiltration anesthesia, intercostal nerve block, and newer approaches like erector spinae plane block, serratus anterior plane block, and pectoral nerve block. Multimodal anesthesia tailored to the surgical procedure can provide effective analgesia and reduce opioid requirements. Epidural anesthesia was initially considered the primary modality for Tubeless techniques. Buckingham [1] first reported thoracic epidural anesthesia in awake thoracic surgery in 1950. In 2004, Pompeo [2] used epidural anesthesia for wedge resection.

However, epidural anesthesia carries risks such as epidural hematoma, nerve root injury, systemic toxicity, post-dural puncture headache, respiratory depression, and hypotension. Paravertebral block, often guided by ultrasound, has become a favorable alternative for patients with contraindications to epidural anesthesia. Recent practice increasingly favors combining paravertebral block with intravenous anesthesia for optimal analgesia and minimal systemic impact. Piccioni [3] reported satisfactory unilateral anesthesia using only paravertebral block without sedation. Studies suggest paravertebral block enhances analgesia, improves respiratory recovery, reduces cognitive impairment, and lowers infection risk.

Initially applied to simpler surgeries such as lung biopsy or bullectomy, non-intubated anesthesia is now being used in more complex procedures. Intraoperative cough reflex caused by vagal nerve stimulation may lead to mediastinal swing. However, lidocaine application on the visceral pleura or intraoperative vagus nerve block effectively suppresses the cough reflex.

Airway management is critical in Tubeless anesthesia. Muscle relaxants are avoided or minimized, and oxygen is delivered via laryngeal mask airway (LMA), face mask, or nasal cannula. Studies have shown that high-flow mask oxygenation is adequate for minor surgeries. LMA is most commonly used, requiring close monitoring to ensure seal integrity and avoid airway obstruction.

Spontaneous respiration and diaphragmatic movement may interfere with surgery. Artificial pneumothorax eliminates negative intrathoracic pressure, aiding lung collapse and surgical exposure. Permissive hypercapnia ($PaCO2 \leq 55$ mmHg) is generally considered safe and beneficial during non-intubated anesthesia. While mild hypercapnia does not affect hemodynamics, persistent $CO2$ elevation can cause cardiopulmonary impairment, requiring conversion to intubation.

2.2 Avoidance of Urinary Catheterization

Urinary catheters are routinely placed in prolonged surgeries due to anesthetic-induced urinary retention. However, in short, uncomplicated procedures, catheterization can be omitted. Most thoracoscopic surgeries (e.g., bullectomy, pulmonary nodules, mediastinal tumors) can be completed in under two hours without affecting urinary function. Omission reduces infection risk and nursing burden.

2.3 Avoidance of Chest Drainage Tubes

Chest drains, traditionally used for monitoring and facilitating lung re-expansion, can be avoided with advanced VATS techniques. Minimal bleeding, absence of air leaks, and pleural integrity are

prerequisites. Postoperative evaluation with imaging ensures safety.

2.4 Contraindications

Patients with pleural adhesions, prior thoracic surgeries, radiation history, morbid obesity, obstructive sleep apnea, or difficult airway are not suitable for Tubeless procedures. ASA ≥ III, spinal deformities, and poor lung function also contraindicate its use [4].

3. Applications in Common Thoracic Diseases

3.1 Spontaneous Pneumothorax

Bullectomy is a typical application of Tubeless anesthesia. Studies show comparable safety and efficacy to intubated approaches [5]. Tubeless procedures reduce operative time, postoperative pain, hospital stay, and cost, supporting ERAS principles.

3.2 Non-small Cell Lung Cancer (NSCLC)

Lobectomy with lymph node dissection remains the standard for NSCLC. Tubeless lobectomy is viable for stage I–II tumors without bronchial or nodal involvement [6]. Chen et al. [7] demonstrated feasibility using epidural anesthesia with vagus nerve block. Studies confirm equivalent outcomes and reduced complications compared to intubated approaches. Tubeless anesthesia may also enhance adjuvant chemotherapy compliance [8].

4. Advantages and Limitations of Tubeless Anesthesia

Tubeless techniques reduce risks associated with neuromuscular blockers, mechanical ventilation, and invasive tubes. Enhanced respiratory, gastrointestinal, and immune recovery have been reported [9]. LMA use mitigates trauma compared to double-lumen tubes. Avoiding urinary and chest drains enhances comfort, reduces complications, and supports early mobilization. However, challenges include airway seal maintenance, hypercapnia, anesthetic depth management, and patient selection. Surgical teams must be well-prepared for conversions and vigilant for postoperative complications.

5. Conclusion and Future Perspectives

Tubeless anesthesia aligns with modern thoracic surgery goals—minimizing trauma and enhancing recovery. From basic to complex procedures, its scope is expanding. Despite growing domestic adoption, global application remains limited. Rigorous clinical trials and standardized protocols are needed to validate and refine Tubeless techniques for broader clinical use.

References

[1] Buckingham W W, Beatty A J, Brasher C A, et al. The technique of administering epidural anesthesia in thoracic surgery[J]. Diseases of the Chest, 1950, 17(5): 561-568.
[2] Pompeo E, Mineo D, Rogliani P, et al. Feasibility and results of awake thoracoscopic resection of solitary pulmonary nodules[J]. The Annals of thoracic surgery, 2004, 78(5): 1761-1768.
[3] Piccioni F, Langer M, Fumagalli L, et al. Thoracic paravertebral anaesthesia for awake video-assisted thoracoscopic surgery daily[J]. Anaesthesia, 2010, 65(12): 1221-1224.
[4] Gálvez C, Bolufer S, Gálvez E, et al. Anatomic segmentectomy in nonintubated video-assisted thoracoscopic surgery[J]. Thoracic Surgery Clinics, 2020, 30(1): 61-72.
[5] Liu J, Liang H, Cui F, et al. Spontaneous versus mechanical ventilation during video-assisted thoracoscopic surgery for spontaneous pneumothorax: A randomized trial[J]. The Journal of Thoracic and Cardiovascular Surgery, 2022,

163(5): 1702-1714. e7.
[6] Ahn S, Moon Y, AlGhamdi Z M, et al. Nonintubated uniportal video-assisted thoracoscopic surgery: a single-center experience[J]. The Korean Journal of Thoracic and Cardiovascular Surgery, 2018, 51(5): 344.
[7] Chen J S, Cheng Y J, Hung M H, et al. Nonintubated thoracoscopic lobectomy for lung cancer[J]. Annals of surgery, 2011, 254(6): 1038-1043.
[8] Furák J, Paróczai D, Burián K, et al. Oncological advantage of nonintubated thoracic surgery: better compliance of adjuvant treatment after lung lobectomy[J]. Thoracic cancer, 2020, 11(11): 3309-3316.
[9] Li S, Jiang L, Ang K L, et al. New tubeless video-assisted thoracoscopic surgery for small pulmonary nodules[J]. European Journal of Cardio-Thoracic Surgery, 2017, 51(4): 689-693.