The Application of video laryngeal mask in Non-intubated Thoracic Surgery

Abstract: With the application of enhanced recovery after surgery (ERAS) concepts in thoracic surgery and the improvement of anesthesia techniques and the optimization of patient management, Non-intubated Thoracic Surgery is gradually replacing general anesthesia with tracheal intubation. Non-intubated Thoracic Surgery has clinical advantages such as reducing the damage to patients caused by general anesthesia and mechanical ventilation, accelerating rapid recovery of patients, and shortening hospital stays. The video laryngeal mask, as a highly comfortable and low-stress important airway management tool for non-intubated thoracic surgery, meets the clinical needs of non-intubated thoracic surgery. Therefore, this article reviews the clinical advantages of the video laryngeal mask in non-intubated thoracic surgery, aiming to provide a theoretical basis for its clinical application in non-intubated thoracic surgery.

Keywords: Visualization, Laryngeal mask, Non-intubated Thoracic Surgery

Introduction

In recent decades, Video-assisted thoracic surgery (VATS) has gradually replaced traditional thoracotomy and has been widely used in thoracic surgeries due to its advantages such as less trauma and faster postoperative recovery. The success of VATS is highly dependent on the exposure of the surgical field provided by One-Lung Ventilation (OLV), and traditionally lung isolation is achieved through Double-Lumen Endotracheal Tube (DLT). However, the use of DLT for lung isolation can increase the risk of airway trauma, large hemodynamic fluctuations, a higher incidence of postoperative hoarseness and sore throat due to adverse intubation events[1]. With the development of VATS techniques

and anesthesia techniques, Non-intubated Thoracic Surgery has been widely used in VATS. Non-intubated Thoracic Surgery is an anesthesia technique that preserves spontaneous breathing without intubation, using laryngeal mask instead of tracheal tubes, ultrasound-guided regional block instead of general anesthesia, and preserves spontaneous breathing. It avoids airway injury associated with mechanical ventilation and intubation. Non-intubated Thoracic Surgery avoids the use of muscle relaxants to shorten anesthesia time, and has a faster recovery after operation[2]. A study on the economic benefit analysis of non-intubated thoracic surgery published in the Journal of Thoracic Disease in 2024 found that compared with mechanical ventilation, tubeless anesthesia can reduce the cost of anesthesia consumables by approximately $90 (tubeless group vs. MV group: $233.51 VS $324.02, $P < 0.001$), and the overall perioperative drug cost of the patients was saved by approximately $74 (tubeless group VS MV group: $290.63 VS $364.14, $P < 0.001$), reducing the overall medical cost of patients undergoing thoracic Surgery, which is in line with the concept of Enhanced Recovery After Surgery (ERAS) [3].

As an important airway management tool for tubeless thoracic anesthesia, the Laryngeal Mask (LM) has the advantages of simple operation, low hemodynamic irritation to patients, and few postoperative complications. Compared with DLT, laryngeal mask reduces the occurrence of postoperative complications such as sore throat to improve the postoperative comfort of patients [4, 5]. In addition, when LM is used for airway management, it does not directly stimulate the submucosal sympathetic nerve of the airway [6], ensuring the hemodynamic stability of the patient during the operation. However, traditional LM still has potential airway management safety issues such as incorrect blind probing insertion position, displacement leakage and laryngeal injury,

which are related to poor blind insertion and laryngeal mask positioning [7, 8]. Moreover, considering the limitations of the body position in thoracic surgery, the traditional LM used in the lateral position during thoracic surgery may pose anesthesia risks such as displacement, air leakage and aspiration due to improper placement of the laryngeal mask during the operation, which poses a considerable clinical challenge for the combined use of LM and tubeless anesthesia in airway management.

With the progress and transformation of anesthesia technology, the laryngeal mask has added video functions on the basis of the original ventilation, achieving visualization of the laryngeal mask. Compared with the traditional LM, the video laryngeal mask has the advantages of visual insertion, accurate positioning, less soft tissue injury of the throat, high oropharyngeal leak pressure (OLP), and good sealing performance [9]. During the process of placing the laryngeal mask, the indwelling condition of the laryngeal mask placement can be observed under the full guidance of the video endoscope to ensure the correct placement position of the laryngeal mask. It improve the success rate of laryngeal mask placement and reducing the risk of displacement and air leakage. At the same time, it is necessary to avoid complications such as laryngeal injury caused by the improper placement of the laryngeal mask, as well as laryngeal spasm and hemodynamic instability in patients caused by multiple blind insertion attempts, reduce perioperative stress response and decrease the use of postoperative analgesic drugs [9, 10]. In addition, or when there is reflux and aspiration, the position of the video laryngeal mask can be adjusted under the video endoscope and negative pressure aspiration can be performed, which avoid the occurrence of aspiration pneumonia. Moreover, the video laryngeal mask has a high OLP and good sealing performance. It can be used in a lateral position to ensure that the laryngeal mask does not shift or leak air. Therefore, the use of

video laryngeal masks for non-intubated thoracic surgery can avoid potential airway management problems such as incorrect insertion position due to blind exploration and displacement , increase the success rate of the first insertion for patients, and it also reduce the occurrence of postoperative laryngeal injury and bleeding to improve the quality of patient recovery, and conform to the concept of enhanced recovery after surgery. Therefore, this article reviews the clinical advantages of the video laryngeal masks in the application of non-intubated thoracic surgery.

I. The video laryngeal mask increases the success rate of the first insertion and reduces the risks of air leakage and aspiration during lateral displacement.

Study have shown that 50-80% of patients still have inaccurate laryngeal mask placement positions in clinical practice [7]. When LM is applied to airway management in thoracic surgery, anesthesiologists cannot observe the laryngeal mask, glottis and surrounding anatomical structures under bright vision to determine whether the laryngeal mask placement position is appropriate and whether the selected laryngeal mask model is consistent with the patient's laryngeal anatomical structure. The judgment can only be made through indirect assessment indicators such as visual examination to observe the rise and fall of the chest and abdomen or auscultation. In addition, the success rate of traditional laryngeal mask placement is related to the clinical experience of anesthesiologists. For junior anesthesiologists, the success rate of the first laryngeal mask placement is not high, and the position of the laryngeal mask needs to be repeatedly adjusted to ensure the accuracy of the placement. The video laryngeal mask can clearly observe the position of the laryngeal mask and the anatomical structures around the glottis under

full visibility, and can provide real-time image feedback, allowing the operator to intuitively determine the position of the laryngeal mask and make immediate adjustments. It improve the success rate of the first insertion and ensuring that the laryngeal mask is placed in the ideal anatomical position, thereby enhancing the OLP.

In addition, before beginning thoracic surgery, the intraoperative position is often changed from supine to lateral, which may cause the laryngeal mask to shift and leak air. It is necessary to adjust the position of the laryngeal mask in a timely manner to ensure good ventilation for the patient. The Safe LM can provide real-time feedback of glottic and peripheral anatomical images. Anesthesiologists can visually determine the position of the laryngeal mask and make immediate adjustments after changes in body position, reducing the difficulty of adjusting the position of the laryngeal mask in the lateral position. At the same time, there is no need to use bronchoscopy for exploration, saving the cost of bronchoscopy usage and disinfection. Sun et al. conducted a study on the use of video laryngeal masks and LMA Supreme in lateral position surgery and found that the OLP of the video laryngeal masks was significantly higher than that of LMA Supreme in the supine position (video laryngeal mask group VS LMA Supreme group: 30 (26 to 37) cm H2O VS 25 (22 to 29) cm H2O, $P < 0.001$). When the patient changed from supine position to lateral position, the OLP of the video laryngeal mask was higher than 7 cm H2O (video laryngeal mask group VS LMA Supreme group: 29 (23 to 37) VS 24 (20 to 26) cmH2O, $P < 0.001$), and no displacement or air leakage was observed during the operation. This verified that compared with the traditional laryngeal mask, the video laryngeal mask used in the lateral position could ensure a tight fit between the laryngeal mask and the larynx, increase the OLP of the laryngeal mask in the lateral position, and reduce the detachment and

displacement of the laryngeal mask during the lateral position. It can be applied to thoracic surgeries in a long-term lateral position [11].At the same time, compared with other supine position surgeries, thoracic surgery in a lateral position is more prone to an increase in airway secretions and the reflux and aspiration of gastric contents into the airway, which can lead to aspiration pneumonia and cause major medical accidents. Moreover, excessive airway secretions may cause laryngeal airway spasm. If the oral secretions are not adequately aspirated, the patient may experience breathing difficulties due to laryngeal spasm after the laryngeal mask is removed. To address the risks of increased airway secretions and reflux and aspiration of gastric contents in the lateral position during thoracic surgery, Safe LM adopts a split design to monitor the conditions around the glottis in real time under a visual screen. If reflux and aspiration occur, the suction tube can be promptly lowered and the secretions and gastric contents in the inhalation tract can be aspirated through a negative pressure suction device, thereby preventing laryngeal spasm and aspiration pneumonia. In addition, if a bronchial blocker is placed during the operation to perform lung isolation[12], real-time monitoring of glottic function can assist the bronchial blocker in smoothly entering the glottis under visual guidance, eliminating the need for bronchoscopy exploration and avoiding difficulties in the position of bronchoscopy exploration[13]. Therefore, the use of the video laryngeal masks in tubeless thoracic surgery can increase the success rate of the first insertion of the laryngeal mask to ensure a tight fit between the laryngeal mask and the larynx, and at the same time reduce the risk of laryngeal mask displacement and air leakage in the lateral position.

II. The video laryngeal mask reduces perioperative stress responses, which is in line with the ERAS concept

The ERAS concept was first proposed by Professor Kehlet, a Danish

surgeon, in 1997. Based on evidence-based medical evidence, it aims to reduce surgical stress and postoperative complications through a series of perioperative optimization measures, accelerate patient recovery, improve postoperative recovery quality, shorten hospital stays, lower medical costs, and alleviate the economic burden on patients [14]. Compared with DLT, the video laryngeal mask causes less airway damage to ensures stable hemodynamics during the operation, provides higher patient comfort, and when combined with tubeless thoracic anesthesia, it can shorten the hospital stay, which is more in line with the ERAS concept. According to research reports, laryngeal mask combined with tubeless thoracic anesthesia for patients undergoing thoracoscopic mediastinal tumor resection can shorten the anesthesia time (tubeless group VS DLT group: 177.63min VS 202.53min, P=0.004), and the hospital stay of patients in the tubeless group was shortened by approximately 3 days (tubeless group VS DLT group: 2.58 days VS 5.47 days, P=0.002) [2], which can convert some elective surgeries that may require a few days of hospital observation into day surgeries that can be discharged within 24 hours [15], improving the operational efficiency of the hospital. Furthermore, the results of a meta-analysis published in the journal Public Library of Science in 2019 showed that: Compared with tracheal intubation, the levels of Interleukin-6 (IL-6), Interleukin-8 (IL-8), and CRP in patients under tubeless thoracic anesthesia were lower after surgery, and the levels of epinephrine and procalcitonin were also decreased. This verified that tubeless thoracic anesthesia can alleviate the perioperative stress response of patients, to accelerate patient recovery [15].

In addition, the video laryngeal mask can not only alleviate the stress response of DLT to the respiratory and circulatory systems, but also further reduce the perioperative stress response of patients. Although DLT is the most common airway management method in thoracic surgery, it

has a relatively high airway safety. However, during the intubation period of DLT, adverse cardiovascular events such as tachycardia, hypertension and arrhythmia may occur. Compared with DLT, the hemodynamic stability of LM during implantation may be related to the fact that LM is a supraglottic ventilation device. It does not directly stimulate the submucosal sympathetic nerve endings of the airway [6]. A study published in Ann Med in 2025 on Safe LM and ETT in arthroscopic airway management found that compared with ETT, the mean arterial pressure and heart rate of Safe LM during the implantation and removal of LM were lower than ETT group. It verify that LM can reduce the stress response during anesthesia. This ensures the patient's stability during the operation [16]. Moreover, inaccurate placement of the laryngeal mask may cause tissue damage such as compression, congestion, redness and swelling of the soft tissues in the patient's throat, induce inflammatory stress in the body, and it promote the release of inflammatory factors such as IL-6 and tumor necrosis factor -α (TNF- α) by macrophages to act on the cardiovascular system. It causes adverse events such as intraoperative hypotension and arrhythmia in patients. Therefore, the visualization of the laryngeal mask enables the operator to intuitively determine the position of the laryngeal mask. It make immediate adjustment to avoid laryngeal spasm and laryngeal inflammatory reactions caused by improper placement of the laryngeal mask and repeated adjustments of the laryngeal mask which reduces the occurrence of perioperative adverse cardiovascular events in patients, and promoting the concept of ERAS.

Ⅲ. The video laryngeal mask reduces postoperative complications and improves the quality of postoperative recovery for patients

As a common airway tool in thoracic surgery, DLT can provide good lung isolation conditions. However, the material of DLT is relatively hard,

and its outer diameter is relatively thick can easily cause severe airway injury. The incidence of postoperative throat pain and hoarseness is relatively high, approximately 44% to 60%[17, 18]. The laryngeal mask applied in airway management during thoracic surgery causes less airway damage and has a lower incidence of complications such as Postoperative Nausea and Vomiting (PONV), sore throat and hoarseness [19, 20]. Meanwhile, compared with traditional laryngeal masks, the video laryngeal masks can be placed under visual conditions, avoiding damage to tissues such as the epiglottis and arytenoid cartilage, reducing the occurrence of adverse events related to glottic devices such as postoperative laryngeal pain, which improve the postoperative recovery quality of patients.

Studies have reported that 6% to 34% of patients who used laryngeal masks for airway management experienced sore throat after surgery [7, 21, 22]. The occurrence of adverse events related to supraglottic ventilation devices such as laryngeal bleeding and sore throat is associated with the blind insertion technique of laryngeal masks and the inability to observe the anatomical structure of the supraglottic larynx and the fit of the laryngeal mask [23]. After the insertion is completed, the anesthesiologist needs to repeatedly adjust the position of the laryngeal mask to ensure that there is no air leakage during the operation. However, during this process, it may cause damage to the epiglottis and oral soft tissues, resulting in pain and bleeding in the throat after the operation. Moreover, inaccurate placement of the laryngeal mask may lead to tissue damage such as congestion and swelling of the soft tissues in the patient's throat due to compression. Compared with traditional laryngeal masks, video laryngeal masks can be placed and adjusted under visual conditions, which eliminates the differences brought by laryngeal mask placement techniques and avoids bleeding in the throat caused by poor laryngeal

mask positioning or repeated adjustment of the laryngeal mask position during the operation. Wei et al. also found that postoperative pain was reduced in patients undergoing thoracic surgery with laryngeal mask combined with tubeless anesthesia (NRS score of Tubeless group vs. DLT group: 1.78±0.48 VS 3.41±0.87, P=0.016), the number of cases requiring opioid drugs for postoperative analgesia decreased to approximately 25% (tubeless group VS DLT group: 22.88% VS 48.38%, P=0.016), accelerating the postoperative recovery of patients [2]. Furthermore, research has found that compared with double-lumen tracheal intubation, the incidence of postoperative sore throat in the SafeLM combined with occluder group was significantly lower than that in the DLT group (SafeLM group VS DLT group 10% VS 45%, P < 0.01)[13]. Therefore, the use of the video laryngeal masks in airway management during thoracic surgery can better reduce the occurrence of postoperative complications such as laryngeal bleeding and pain to improve the quality of postoperative recovery for patients.

Conclusion

The emergence of minimally invasive surgery assisted by thoracoscopy has brought new treatment options to lung cancer patients and further improved their quality of life. Traditional thoracic surgery relies on double-lumen bronchial intubation to achieve lung isolation. With the innovation of minimally invasive endoscopic techniques and the deep integration of the concept of ERAS, thoracic anesthesia has undergone a transformation towards "Tubeless". By using laryngeal masks instead of tracheal tubes, ultrasound-guided regional block instead of general anesthesia, and retaining spontaneous breathing to avoid mechanical ventilation to construct a new paradigm of "precise analgesia - physiological ventilation - minimal trauma" which eliminate intraoperative tracheal intubation, urinary catheters and postoperative

thoracic tubes. The aim is to simplify the steps, reduce postoperative discomfort of patients, facilitate rapid recovery and improve prognosis. It has also been proven to be safe for application during the perioperative period. However, the laryngeal masks widely used in thoracic surgeries at present are all second-generation laryngeal masks. It is impossible to observe the relative anatomical position between the laryngeal mask and the larynx under visual conditions, which poses anesthesia risks such as laryngeal mask displacement and air leakage, as well as reflux and aspiration. With the development of medical technology and the innovation of laryngeal mask technology, laryngeal masks have added video functions on the basis of their original ventilation functions, achieving visualization. Anesthesiologists can precisely place the laryngeal mask in the ideal anatomical position under visual observation, improving the success rate of the first insertion. Meanwhile, the video laryngeal mask can monitor its position in the lateral position in real time. If there is displacement, air leakage or reflux aspiration, it can be aspirated promptly, enhancing the airway safety of the laryngeal mask when used in the lateral position during thoracic surgery. In addition, the video laryngeal mask can also avoid the stimulation to the cardiovascular system caused by repeated adjustment of the laryngeal mask position and tracheal intubation to reduce perioperative stress responses, and maintain the hemodynamic stability of patients. Placing laryngeal masks under visual conditions can also prevent laryngeal injuries caused by blind insertion of laryngeal masks to reduce the occurrence of postoperative complications, improve the postoperative recovery quality of patients, shorten the hospital stay of patients, which conform to ERAS. It can convert some elective surgeries into day surgeries to optimize hospital operation and management, which show good economic value.

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