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Case Report

Clinical application of fiberoptic bronchoscope combined with visual laryngeal mask awake tracheal intubation technique: a case report

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Abstract: We presented a case of successful awake endotracheal intubation in a patient with a giant goiter and severe tracheal stenosis. The patient had difficulty in airway management during the perioperative anesthesia due to tracheal deviation and stenosis caused by tumor compression. We applied a visual laryngeal mask combined with fiberoptic bronchoscope to visualize the whole procedure of endotracheal intubation, from visually assessing the glottic, subglottic, and the tracheal conditions, to evaluating the pressure of the tumor on the trachea and the maximum tracheal tube diameter that could be passed. During the entire process, the patient remained awake, maintained spontaneous breathing, and actively cooperated with the clinical staff. Hence, we demonstrated that this method is safe, effective, operable, and could be generalized as a form of endotracheal intubation for patients with known difficult airways.

Keywords: Awake tracheal intubation, visual laryngeal mask, fiberoptic bronchoscope, case report

Introduction

Nodular goiter is a relatively common type of thyroid disease. Its occurrence and development are related to iodine nutritional status. Both high and low iodine status can induce nodular goiter [1, 2]. As the mass grows, it gradually compresses the surrounding tissues and affects the patient's breathing when it invades the trachea. The growth of the lesion can last for more than 10 years. Patients with giant goiter can present with local tracheal deviation, airway stenosis, and dyspnea due to the long-term compression of the lesion on the airway. Airway management during perioperative anesthesia is particularly difficult, and the risk of anesthesia-related complication is extremely high. Relevant guidelines recommend that patients should undergo an awake tracheal intubation that preserves spontaneous breathing. Furthermore, when patients are intubated, the appropriate method should be selected based on the evaluation from four aspects: patient condition, anesthesiologist, surgeon, and equipment. In this study, we used fiberoptic bronchoscope (FB) combined with visual laryngeal mask (VLM) awake tracheal intubation technique to visualize the whole process, making the catheter pass smoothly through the narrow and deviated airway. We found that the combination of FB and VLM could avoid airway damage from the subjective operation and reduce the impact of FB on visibility by blocking trachea secretion. Although FB has shown the advantages of good lighting and fewer adverse reactions, it is difficult to operate. Using VLM as the FB catheter can reduce the operation difficulty. Therefore, the combination of FB and VLM can reduce the difficulty of endotracheal intubation, improve safety, and achieve more reliable, safe, and comfortable airway management. To date, we have operated 13 cases of giant goiter patients with trachea compression using this technique and achieved successful airway management. Nevertheless, the method was improved gradually based

Figure 1. A-C. Images of the goiter and the patient with restricted neck movement; D-F. Intra operative images of the patient.

on the special need of each patient. In this case report, we described our successful management in a patient with more special and severe symptoms of nodular goiter.

Case description

A 64-year-old female patient (height, 150 cm; weight, 52 kg; BP, 130/80 mmHg) was admitted to the hospital with thyroid nodules for more than 20 years. The patient had a history of hypertension for more than 1 year, which was well controlled by oral medication. No medical history of diabetes, coronary heart disease, hepatitis, tuberculosis, infectious diseases, operation, allergy, blood transfusion, and tumor in her family was reported.

Physical examination on admission showed bilateral neck asymmetry and normal local skin without obvious swelling and rupture. The left thyroid gland palpable mass was about 9.0 × 6.0 cm in size with smooth surface, clear boundary, and poor mobility. However, the mass was firm and could move up and down with swallowing (**Figure 1**). A smaller lesion of about 3.0 × 2.0 cm in size with the same clinical features was palpable on the right lobe of the thyroid gland. The enlarged lymph nodes were not in touch with both sides of neck's anterior and posterior, nor with the supraclavicular fossa anterior and posterior, and the supraclavicular fossa of both sides of neck. Computed tomography (CT) imaging of the neck revealed nodules in bilateral thyroid lobes, particularly, a cystic solid mass about 7.2 × 7.1 cm in size in the left glandular lobe with internal septa and multiple calcifications at the edges (**Figure 2**). Diffuse nodules with calcification were seen on the right lobe. In addition, not only the trachea and esophagus were flattened under pressure and shifted to the right, but also the trachea was chronically compressed with approximately 5-7 mm at the narrowest point of the airway. The preoperative anesthesia evaluation showed the following parameters: ASA grade II, mouth opening 4 cm, thyromental distance 8 cm, Mallapati score II, normal neck mobility, obvious airway stenosis, postural dyspnea, normal ECG, normal blood test, biochemical test, and coagulation function, and no obvious abnormalities in the five main thyroid functions (**Figure 2**).

Before the operation, the anesthesiologist and the patient discussed the anesthesia procedure and were fully prepared for the surgery to relieve the patient's anxiety and build trust and cooperation between the doctor and the patient. The anesthesiologist, anesthesiologist assistant, nurse, and surgeon were also in full communication. The patient was fasted for 8 hours and abstained from drinking 4 hours before surgery. Half an hour before surgery,

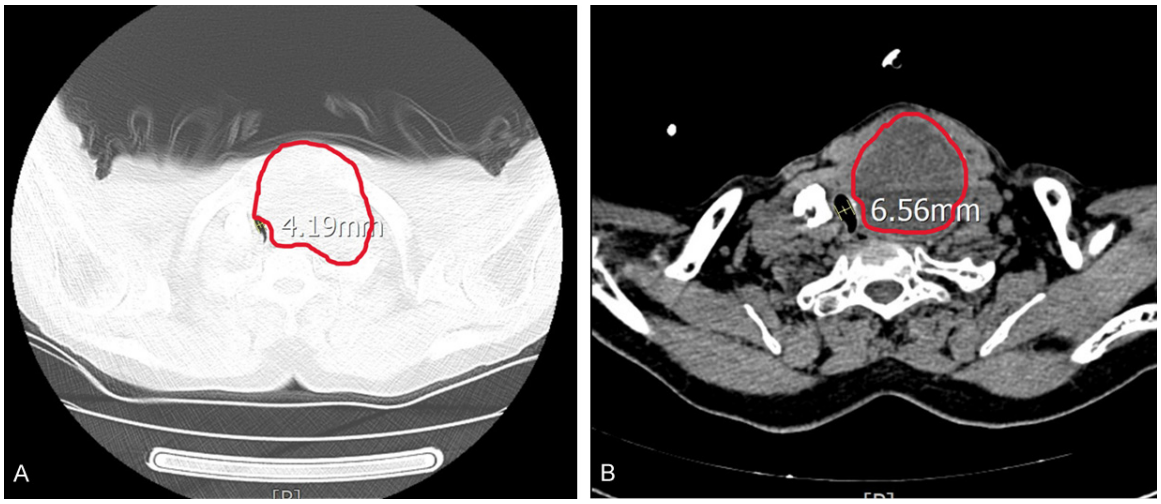

Figure 2. A, B. Computed tomography face images of the patient. The patient's trachea was markedly compressed, and the narrowest part of the trachea had an inner diameter of approximately 5-7 mm.

phencyclidine hydrochloride injection (1 mg) was intramuscularly injected to inhibit glandular secretion. After admission to the operating room, the patient was provided with open intravenous fluid access. Heart rate, respiration, pulse oxygen saturation, and transnasal end-expiratory CO_2 wave were monitored by PHILIP MP-50 multifunctional monitor. In addition, invasive ambulates blood pressure was monitored by right radial artery puncture, and the Bispectral EEG index (BIS) was also monitored.

The patient was awake and in supine position. Oxygen was given through a nasal catheter throughout the procedure, and 2% lidocaine gel was gargled for 3-5 minutes for adequate oral and pharyngeal surface anesthesia. The patient received an intravenous injection of midazolam (0.5 mg), dexmedetomidine (0.5 $ug{\cdot}kg^{-1}{\cdot}h^{-1}$), and a fractional administration of sufentanil (7.5 μg) to alleviate anxiety, reduce the body response to stress, and maintain the spontaneous breathing with light sleep and oral interaction ability and BIS at 85-90. We chose No. 3 disposable VLM for this procedure, let the patient breathe naturally before starting, and then gently inserted the VLM into the patient's mouth. VLM was stopped after we observed the epiglottis cartilage and glottis on the screen to avoid being placed too deep into the patient; hence, it only caused slight discomfort to the patient during this process. The opening and closing of the glottis could be viewed on the monitor to evaluate the glottis and its surrounding tissues. We used a local anesthetic extension catheter and placed it 1 cm in front of the acoustic door through a laryngeal mask catheter, sprayed 2% lidocaine for glottic surface anesthesia and inserted the catheter below the glottic surface for tracheal mucosal surface anesthesia. After the patient breathed spontaneously through the VLM for 2-3 minutes, the surface anesthesia was fully effective, and a FB with a diameter of 3.8 mm was inserted through the VLM to evaluate the subglottic and tracheal stenosis. We observed that the airway wall bulged inward 4 cm below the glottis, and the lumen was narrow of about 2 cm long, with the narrowest left to right diameter of about 5-7 mm. The trachea structure was complete without trachea congestion or rupture. After evaluation, we chose an ID 6.0 enhanced endotracheal tube (ETT) for the procedure. Both inside and outside of the catheter were lubricated with lidocaine gel, and the catheter was placed through the laryngeal mask catheter, which was successfully guided through the glottis and airway stenosis by FB. The catheter tip was about 3 cm from the tracheal carina, and the intubation depth was 26 cm. Then, the VLM was withdrawn, and the tracheal tube was fixed. During the procedure, the patient was awake and breathed on her own, while the BIS fluctuated between 75 and 90. In addition, the end-expiratory CO_2 waveform was monitored to ensure effective ventilation. The patient exhibited good swallowing reflex, only coughed slightly, and breathed smoothly th-

rough the tracheal tube without special discomfort. After the successful endotracheal intubation, the patient was induced by general anesthesia followed by an intravenous injection of midazolam (1 mg), sufentanil (5 μg), etomidate (12 mg), and rocuronium (40 mg). After spontaneous respiratory arrest, the patient was given volumetric controlled mechanical ventilation (VCV), with tidal volume (VT) 350 ml, respiratory rate 12 bpm, oxygen concentration (FiO_2) 50%, and positive end-expiratory pressure (PEEP) 4 cm H_2O. The airway pressure was monitored at 16 cm H_2O. Propofol injection (4-6 mg/kg/h), remifentanil diluted solution (0.2-1.0 μg/kg/min), and dexmedetomidine (0.5 μg/kg/h) were continuously injected into the patient intraoperatively, while rocuronium was added as needed. Words are difficult to describe the operation method, in order to understand the operation steps more vividly, we recorded the main operation steps in Supplementary Video 1.

Surgical exploration showed an obvious swelling of the thyroid gland on the left side, with a soft, cystic, and solid mass about 12 × 10 cm in size with a clear boundary. Multiple cystic and solid nodules were observed in the right lobe of the gland, and the largest nodule was about 5 × 4 cm in size which was soft, cystic, and solid with clear boundaries. The trachea was displaced to the right under pressure; however, the trachea ring was intact, and the outer membrane of the trachea wall was intact without trachea collapse. The pathology examination of the samples resected during the operation showed the following: 1. Nodular goiter with hemorrhage on the left thyroid plus isthmus, necrosis, and cystic changes; 2. Nodular goiter on the right thyroid. The surgical methods were determined as follows: left thyroid gland + isthmic excision + right gland partial excision cryosurgery + parathyroid sternocleidomastoid muscle auto implantation. The patient underwent surgery without incident, the vital signs were stable, the position of the trachea was restored to the center after tumor resection, and the airway pressure was reduced to 12 cm H_2O. After the surgery, the patient's consciousness and spontaneous breathing were gradually recovered through intravenous injection of neostigmine (1 mg), atropine (0.5 mg), and flumazenil (0.5 mg). The tracheal tube was successfully removed 5 min later, and the patient showed good consciousness, breathing, swallowing reflex, and stable vital signs. After being transferred to the post-anesthesia care unit (PACU) for monitoring for 30 minutes, the patient did not complain of any special discomfort and was returned to the ward for a total anesthesia time of 120 minutes. After surgery, the patient was also subjected to ECG monitoring, oxygen inhalation, and fluid rehydration. In addition, the neck drainage tube was closely examined for any complications such as infection, cough expectoration, choking, or dysphagia. Anesthesia follow-up was conducted on the third day after surgery, and the patient didn't report special discomfort; therefore, the drainage tube was removed, and the patient was discharged from the hospital.

Discussion

Thyroid disease, nodular goiter in particular, has become one of the most common diseases in recent years. As the goiter continues to grow, and invade and displace the trachea, patients with severe nodular goiter can develop tracheal stenosis, and the narrow trachea will gradually affect the patient's breathing, causing chest tightness, asthma, and etcetera. Currently, surgery is the primary treatment option for thyroid tumors. However, the perioperative airway management of patients with long and giant goiters is extremely difficult, exhibiting a higher risk of anesthesia induction. Therefore, it is imperative to develop reliable airway management strategies. In this case report, we described our procedure on a patient with a thyroid mass of 7.2 × 7.1 cm and the trachea chronically compressed approximately 5-7 mm at the narrowest point of the airway. Endotracheal intubation in such situation is normally extremely difficult, and inappropriate anesthetization will cause serious consequences. Thus, preoperative evaluation is important. It is generally accepted that patients with Mallampati grade ≥ III, mouth opening distance (MO) ≤ 4 cm, parathyroid distance (TMD) ≤ 6 cm, and reduced neck mobility (nm) on routine examination have a high risk of developing endotracheal intubation-related complications [3], and ATI with preserved spontaneous breathing is recommended with deformation of tracheal compression and the development of airway stenosis. Normally, tracheal stenosis is evaluated by the standard neck and chest imaging combined with FB.

Although FB is the benchmark for the diagnosis and evaluation of tracheal stenosis, its invasive nature makes it risky to operate [4]. Endotracheal intubation is more likely successful and safer with patients awake. Sedation, airway surface anesthesia, oxygen supply, and operation skills are vital to the success of ATI. In addition, posture, drugs, and communications between anesthesiologists and patients are also important [5], which was thoroughly considered in this case study. During ATI process, comfort and safety can be improved by appropriate doses of dexmedetomidine, midazolam, and lidocaine before endotracheal intubation [6]. It is worth noting that dexmedetomidine conscious sedation improves patients' comfort and coordination, barely affecting respiratory function during operations. Compared with remifentanil, dexmedetomidine can significantly reduce the incidence of hypoxemia during awake intubation with a FB [7].

As an upper glottic airway device, VLM is easier to operate and has higher success rate of the first intubation compared to the traditional devices. Based on the guidelines, for patients with good airway surface anesthesia, a laryngeal mask is recommended to assist awake endotracheal intubation, maintain airway patency, and reduce friction [5]. VLM can avoid airway injury from operating the device and has better control of respiratory speed. In addition, its cuff can block tracheal secretion, thereby maintaining a clear view of the FB, reducing the difficulty of endotracheal intubation, and ensuring patients' ventilation during the recovery [8]. Furthermore, VLM can detect and extract foreign objects or secretions in real time, preventing patients from accidentally ingesting them before endotracheal intubation, avoiding airway obstruction, and securing airway management.

When assessing the clinical application of SaCoVLMTM and TotaltrackTM video laryngeal masks, studies have shown that the sealing pressure of SaCoVLMTM is 34.1±6.2 cm H_2O, and the esophageal and gastric drainage is smooth. Importantly, the success rate of the first intubation is 95%, which is higher than that of the current blind insertion technology (77-88%). In addition, the average time of VLM is 5, 13 and 24 seconds for vocal cord visual positioning, confirmation ventilation, and endotracheal intubation, respectively [8, 9].

In this case study, a SaCoVLMTM disposable VLM was used for ventilation and glottic evaluation. The glottis and its surrounding tissues were observed to ensure the patient's ventilation. The VLM enabled the spray of local anesthetic more accurately, providing a better effect on the surface of the glottis and trachea. The placement of a laryngeal mask under the visual state reduced pharyngeal irritation. In addition, the laryngeal mask showed better tolerance and coordination when using 2% lidocaine gel for oral mucosal anesthesia. Furthermore, as an upper glottic airway device, the laryngeal mask is suitable for "awake test ventilation" [10]. Combined with end-expiratory carbon dioxide monitoring, it improves the monitoring of the ventilation effect on patients.

Herein, after the successful placement of a visualized laryngeal mask, we found that FB was smaller with less pressure on tissue and cardiovascular response, compared with traditional visual laryngoscopy [11]. Given the difficulty of endotracheal intubation, the FB lens can be effectively used to observe the airway with less injury on the trachea, to predict tracheomalacia, and to assist tracheal surgery after operation [12]. Placing along the midline of the mouth, FB can slide along the surface of the velopharyngeal to expose the glottis during intubation. However, in actual operation, the direction of the soft mirror body is difficult to control that it can only be moved in, out, left-handed, and right-handed. The difficulty of placement and the lens covered by secretions compromise the view during observation. Some studies have shown that awake endotracheal intubation with a FB takes more time than VLM [13]. Other studies have also indicated that the number of awake fiber intubation is related to the incidence of complications, and that the operation skills affect its safety [14]. Moreover, during tracheoscopy, the glottis was fully exposed when a FB passed through the airway [8]. Thus, the combination of FB and VLM provides a more effective solution for managing patients with complex and difficult airways. As a catheter of the FB, VLM is particularly suitable for beginners to operate since it reduces the operation difficulty, identifies the anatomy of the upper airway, makes the glottis exposure easier, and provides a clearer vision [10]. Using a long local catheter through the laryngeal mask catheter, we achieved expected results by spraying local anesthetics and per-

forming surface anesthesia on the glottis and trachea in the visual picture. The fiberoptic bronchoscope entered the trachea smoothly with ideal glottis exposure and airway surface anesthesia. Clear tracheal stenosis could be observed without tracheal softening and tracheal mucosal defect. As a result, we could evaluate the compression of the trachea by the tumor, select the largest and passable tracheal model to avoid injury, maximize the area of the tracheal lumen, and reduce airway pressure.

Therefore, for patients with known difficult airways, it is critical to choose personalized respiratory management methods, suitable tools, and reasonable anesthesia planning in advance to ensure a safe and successful operation.

Conclusion

The patient with giant goiter in this case study was known to have a difficult airway. After full evaluation before the operation, we chose to use VLM-assisted FB for glottic and tracheal evaluation and surface anesthesia. Under the condition of keeping patients awake and breathing autonomously, the whole process of endotracheal intubation could be clearly visualized, and airway management was more reliable, safe, and comfortable. Hence, for patients with difficult airway, thorough planning and airway evaluation before the operation are essential to prevent the development of emergency situation.

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Disclosure of conflict of interest

None.

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