Tracheal laceration detected by high end-tidal CO₂ during endoscopic thyroidectomy

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Endoscopic thyroidectomy is frequently used for cosmetic reasons, such as reducing cervical scarring. Subcutaneous gas insufflation with CO₂ is needed to maintain the surgical space, and optimal surgical techniques and careful attention are required when conducting this procedure due to the limited space available for the endoscopic instruments. We report here a case of a tracheal laceration with a tear in the cuff of a reinforced tube, which was detected by an abrupt increase in end-tidal CO₂ to 90 mmHg. Reintubation was achieved using a tube exchanger and the patient was effectively ventilated without complications.

CASE REPORT

A 37-yr-old, 69-kg, ASA I woman with right-side, 1.2 cm thyroid cancer underwent elective endoscopic thyroidectomy. The patient had no history of cardiovascular, pulmonary, or renal disease, and a preoperative physical examination and laboratory tests, including a thyroid function test, revealed no significant abnormalities. Intraoperative monitoring included electrocardiography, noninvasive blood pressure monitoring, capnography, and pulse oximetry. The patient had a pre-induction blood pressure (BP) of 138/68 mmHg, a heart rate (HR) of 80 beats/min, and a SpO₂ of 100%.

Anesthesia was induced with propofol 110 mg i.v. and rocuronium 45 mg i.v. The trachea was intubated with a 7.0-mm reinforced tube with a stylet. Tube cuff pressure was maintained at around 20 cmH₂O. There were no specific problems during intubation, and both lung sounds were equal. Anesthesia was maintained with sevoflurane 1.5−3.0 vol%, nitrous oxide 50% and oxygen. Mechanical ventilation was provided at a tidal volume of 600 ml and a respiratory rate of 10/min, which produced a peak inspiratory pressure of 15−16 cm H₂O and an end-tidal CO₂ of 30−32 mmHg.

The patient was placed supine with the neck extended using a shoulder pillow. After making two incisions on both upper circumareolar areas, two 12-mm ports were placed for the flexible endoscope, and the operational instruments were inserted. The working space was established with subcutaneous CO₂ insufflation at a pressure of up to 5−6 mmHg. In addition, two 5-mm ports were placed through both axilla for graspers and dissectors (Fig. 1). Endoscopic thyroidectomy was started with full visualization of the superior and inferior thyroidal arteries, parathyroid glands, and recurrent laryngeal nerve.
After starting CO₂ insufflation, the respiration rate was increased to 12−15/min to maintain an end-tidal CO₂ of around 35 mmHg. HR increased to 100−110 beats/min without changes in BP or SpO₂. At 50 min after CO₂ insufflation, the peak inspiratory pressure suddenly dropped to 8−9 mmHg and the end-tidal CO₂ pressure increased to 50−60 mmHg with an irregular capnographic pattern. At that time, the patient’s BP was 115/65 mmHg, HR was 100 beats/min, and SpO₂ was 100%. We suspected that there might be inadequate ventilation or a gas leak, and we immediately changed mechanical ventilation to manual ventilation at 6 L/min of oxygen flow.

After detecting noise in the oral cavity, we found that the pilot balloon had deflated, but were unable to reinflate the cuff after repeated air injection. Five minutes after the sudden decrease of airway pressure, the end-tidal CO₂ abruptly increased to 90 mmHg with an irregular capnographic pattern, and we requested that the surgeon endoscopically examine the tracheal region for injury. To maintain effective mechanical ventilation, we reinserted a 7.0-mm reinforced tube using a tube exchanger (Cook Critical Care, Bloomington, India), because a surgical drape totally covered the patient’s head and neck area. During repair of the tracheal lesion, a new endotracheal tube was passed beyond the laceration site (25 cm from the teeth). In addition, we observed blood clots and a 0.5 cm longitudinal tear at the cuff of the extubated tube. The operation was changed to an open thyroidectomy for primary repair of the tracheal laceration, and a 1 cm-long laceration was found on the left side of the anterolateral tracheal wall below the thyroid cartilage. This was repaired by the surgeon by primary closure and the postoperative course was uneventful.

**DISCUSSION**

The use of endoscopic thyroidectomy is increasing as it leads to less cervical scarring, reduced invasiveness, less pain, short anesthesia and operation duration, and shorter hospital stays [1,2]. Several techniques for endoscopic thyroidectomy have been used [6], and the bilateral axillo-breast approach with subcutaneous CO₂ insufflation was adopted at our hospital.

Surgeons should be familiar with handling endoscopic instruments and with normal and abnormal anatomical structures [7]. Endoscopic thyroidectomy may cause complications from the CO₂ insufflation, which is used to establish a surgical space during endoscopy [3]. CO₂ insufflation pressure below 10 mmHg can be used without risk of hypercarbia [8,9].

The clinical features of tracheal lacerations are variable, from asymptomatic to life-threatening cardiovascular complications such as sudden development of subcutaneous emphysema during the operation, delayed hemoptysis, chest pain, and respiratory difficulty during the early postoperative period [10-13]. In particular, tracheal laceration often recognized during operation and immediately repaired with low morbidity, but an unrecognized injury or delayed rupture secondary to trachea necrosis, can present up to 2 weeks postoperatively. The risk factors for tracheal injury include female gender, a thyrotoxic goiter, prolonged intubation at a high cuff pressure, use of diathermy for bleeding control, and a persistent cough during the postoperative period [14,15].

In our case, although the patient was positive pressure ventilated, no subcutaneous or mediastinal emphysema was evident. Because the trachea and endotracheal cuff were injured simultaneously by an endoscopic surgical maneuver, airway pressure was reduced and the subcutaneous CO₂ insufflation pressure (usually 5−6 mmHg) for endoscopy then exceeded the airway pressure. This means that the insufflated CO₂ could move to the trachea, oral cavity and endotracheal tube through the leakage hole in the trachea and the cuff tear site. Consequently, the end-tidal CO₂ pressure increased to 90 mmHg abruptly, which was recognizing the tracheal injury easily and quickly. However, had tracheal injury not been accompanied by a tear in the endotracheal cuff, any attempt at positive-pressure ventilation could have lead to subcutaneous emphysema and a
slow increase in end-tidal CO$_2$.

During endoscopic thyroidectomy with subcutaneous CO$_2$ insufflation, tracheal laceration may produce variable clinical features depending on the laceration site. Tracheal laceration below the endotracheal cuff might induce subcutaneous emphysema by positive ventilation [10], whereas lacerations at the endotracheal cuff (with cuff injury) may cause mechanical ventilation failure, as occurred in our case. On the other hand, tracheal laceration above the endotracheal cuff may not manifest any clinical signs or symptoms (insufflated CO$_2$ may move to the oral cavity) [4,14].

Tracheal injury during the operation was a true emergent condition. Furthermore, the reestablishment of ventilation proved difficult due to the surgical drape over the head and neck area. In this case, we chose to reintubate using a tube exchanger and positioned the tube deeply, distal to the lesion site, which enabled ventilation and repair.

For the simple repair of tracheal injuries, tracheal intubation can be maintained with the cuff distal to the lesion, but with complete tracheal laceration or multiple tears, bronchial intubation with a double-lumen tube, high-frequency jet ventilation, and cardiopulmonary bypass may be needed [12]. When normal landmarks of the larynx or trachea are lost due to subcutaneous emphysema, intubation over a flexible fiberoptic bronchoscope, tracheostomy, or intubation through the tracheal defect are other useful options [12]. Surgical repairs of tracheal injuries may involve anything from simple suturing at the laceration site to end-to-end anastomosis for disruptions. In general, visual inspection may fail to detect a small tracheal laceration. The surgeon should instill saline into suspected laceration site, and anesthesiologists should adopt positive-pressure ventilation with a deflated cuff to detect an extrapulmonary air leak for all types of thyroid surgery. During tracheal repair, positive-pressure ventilation should be avoided, and extubation should be performed at the earliest suitable opportunity [13].

In conclusion, this report shows that end-tidal CO$_2$ monitoring is valuable for detecting tracheal injury with cuff tears during endoscopic thyroidectomy with CO$_2$ insufflation. Furthermore, anesthesiologist must know that the different clinical features that might be encountered according to tracheal laceration sites during endoscopic thyroidectomy.

**REFERENCES**


