International Journal of Anesthesia and Clinical Medicine
2023; 11(1): 44-48
http://www.sciencepublishinggroup.com/j/ijacm
doi: 10.11648/j.ijacm.20231101.20

Case Report

Anesthesia Management of Trachea Reconstruction in a Patient with Traumatic Neck Closed Tracheal Complete Rupture

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To cite this article:
Jiaqi Yang, Yang Chen, Yu Li. Anesthesia Management of Trachea Reconstruction in a Patient with Traumatic Neck Closed Tracheal Complete Rupture. *International Journal of Anesthesia and Clinical Medicine.* Vol. 11, No. 1, 2023, pp. 44-48.
doi: 10.11648/j.ijacm.20231101.20

Received: May 13, 2023; **Accepted**: June 1, 2023; **Published**: June 10, 2023

Abstract: Closed cervical tracheal rupture caused by trauma is a rare clinical emergency severe disease. We report the anesthesia experience of a 37-year-old male patient undergoing emergency tracheal reconstruction surgery due to a traumatic neck closed tracheal complete rupture. The patient was conscious and hoarse when entering the operation room, complained of dyspnea during inspirations, maxillofacial neck swelling, obvious subcutaneous crepitus of neck by palpation, and limited mouth opening. Mallampati grade III, neck movement was limited due to pain, and difficulty in intubation was considered in combination with the patient's neck, chest computed tomography (CT) and airway evaluation. Failure of intubation after the administration of muscle relaxants may result in rapid difficulty in establishing a surgical airway. Intubation under the guidance of awake bronchoscopy may fail to reach the distal tracheal end, and may lead to increased airway injury and inability to maintain ventilation. In order to ensure the safety of patient, it was decided to explore the neck incision under local anesthesia, find the broken end of the trachea, insert the endotracheal tube at the distal end, and then perform general anesthesia to control the airway. Intraoperative vital signs were stable of the patient. After the operation, the tracheostomy tube was changed and transferred the patient to ICU for further treatment. Patients with cervical tracheal rupture, establishing airway under local anesthesia with preserve the patient's spontaneous breathing combined sedation is a selection of security technology.

Keywords: Tracheal Rupture, Neck Closed Injury, Tracheal Reconstruction, Anesthesia Management

1. Introduction

Closed cervical tracheal rupture caused by trauma is a rare clinical emergency severe disease with a high mortality rate. Due to the absence of skin wounds, it is often misdiagnosed, missed diagnosis and not timely and correctly treated, thus endangering the lives of patients. Studies have shown [1, 2] that closed injury and the need for emergency airway intervention are independent predictors of mortality in patients with neck trauma. If the possibility of closed laryngeal trauma is ignored or the degree of injury of laryngotracheal mucosa and cartilage is underestimated in the acute stage of injury, patients are likely to develop dyspnea, asphyxia, shock and other life-threatening complications. Delayed identification and intervention may also leave behind long-term complications such as laryngotracheal stenosis, voice disorders and swallowing disorders, which seriously affect patients' quality of life. This article summarizes the anesthesia management experience of a patient in our hospital who underwent emergency tracheal reconstruction due to cervical closed tracheal complete rupture. Combined with relevant literature reports at home and abroad, it is described as follows.

2. Case Presentation

A 37-year-old male, was admitted to hospital due to "head, neck and chest pain caused by trauma for 1 day". One day ago, the patient was crushed by the lifting arm of the lifting engineering truck while working in the construction site,

presenting pain in the head, neck and chest, accompanied by shortness of breath, cough and sputum, bloodshot sputum, hoarseness, limb weakness, and numbness in the left upper limb. CT examination conducted in the outside hospital suggested: tracheal fracture, cervical spine fracture, and lung contusion. Specialized physical examination: the patient was conscious, hoarseness, acute illness, limited head movement, neck support, several skin abrasions in front of the neck, red and swollen skin on the abrasions, and a few dry scabs. The carotid artery, jugular vein and thyroid gland were not touched due to the occlusion of the neck support. The palpable skin in the front of the neck had tenderness, and the skin in the neck and maxillofacial region had twisting sensation. Auxiliary examination: CT of head, neck and chest enhanced scan + 3D imaging of cervical body bone suggested multiple accumulation of gas in bilateral neck, left maxillofacial, mediastinum and posterior sternum, discontinuous tracheal flow, irregular horizontal lumen of about thoracic 1 vertebrae - thoracic 3 vertebrae, local narrowing of lumen, and fracture of the above multiple tracheal systems. The cervical spine sequence was continuous, and the left transverse process of the 5th and 6th vertebrae of the neck was fractured, involving the transverse foramen. Both lungs scattered spot, strip shadow. Admission diagnosis: 1. Trachea rupture; 2. Cervical spine fracture (5.6 vertebral body fracture of cervical spine); 3. Pulmonary contusion; 4. Pneumonia. After completing relevant preoperative preparation, the patient was sent to the operating room for emergency neck exploration + tracheal reconstruction.

When the patient entered the operating room, he was conscious and hoarse, complained of breathing difficulties during inspiration, maxillofacial and neck swelling, obvious subcutaneous crepitus of neck by palpation, and mouth opening was limited. Mallampati grade III, neck movement was limited due to pain, ECG monitoring showed HR: 70 times/min, BP: 135/72mmHg, air suction SPO2: 97%. Combined with the patient's imaging and airway evaluation, the patient was considered to have difficulty in intubating. For example, failure of intubation after the administration of muscle relaxants may result in difficulty in rapidly establishing surgical airway; intubation under the guidance of awake bronchoscopy may fail to reach the distal tracheal end, and may lead to increased airway injury and inability to maintain ventilation. In order to ensure the safety of patients, after communicating with surgeons, it was decided to conduct neck incision exploration under local anesthesia. After finding the broken end of the trachea, the endotracheal tube was inserted into the distal end, and then general anesthesia was performed to control the airway. Airway management plan was formulated, oxygen inhalation was given by mask, and intubation equipment such as anesthesia, rescue drugs, endotracheal tube, visual laryngoscope and fiberoptic bronchoscope were prepared. Two 16G venous access channels were established peripherally, 0.6 mg Penehyclidine hydrochloride injection was given intravenously to inhibit gland secretion, and 2.5 ug sufentanil was injected intravenously, combined with local anesthesia, and left radial artery puncture catheterization was performed to monitor the invasive arterial blood pressure. The initial blood gas analysis showed that: PH:7.417, PCO2: 40.1 mmHg, PaO_2: 281.1 mmHg, glucose 6.1 mmol/L, total hemoglobin concentration 125.7g/L, whole blood lactic acid: 1.4 mmol/L, sodium 136.9 mmol/L, potassium 3.77 mmol/L, calcium ion 1.058 mmol/L, Chlorine 106 mmol/L, standard bicarbonate concentration 25.3 mmol/L, whole blood alkalinity remaining 0.73 mmol/L.

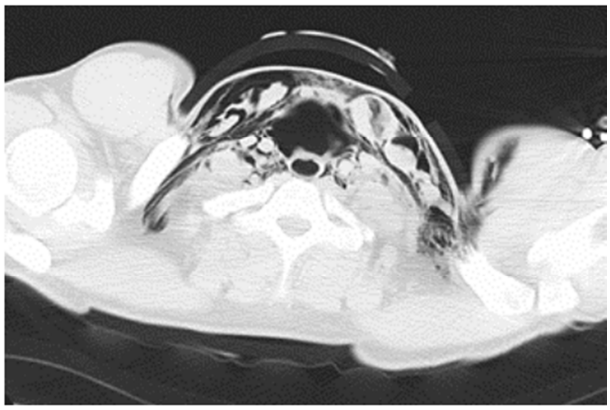

Figure 1. *Preoperative CT of the neck showed gas accumulation in the neck, discontinuous tracheal flow, and irregular lumen.*

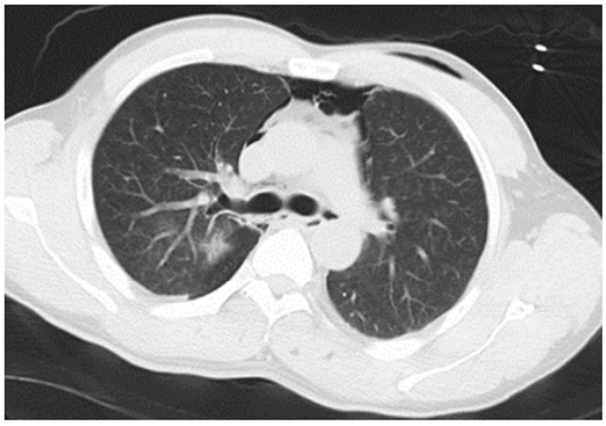

Figure 2. *Preoperative chest CT showed multiple gas accumulation in mediastinum and posterior sternum with local lumen stenosis.*

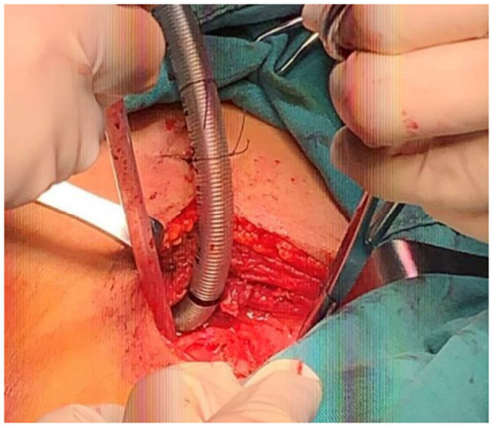

Figure 3. *Intraoperative exploration of the neck to locate the broken tracheal end and insert a tracheal intubation.*

Before the operation, dexmedetomidine was injected and sedated, and the patient's respiration and oxygenation were paid close attention to. The surgeon first made a longitudinal incision under the local anesthesia under the annular cartilage of about 3cm, cut the skin and separated the subcutaneous tissue. It was found that the neck tissue was swollen with gas, part of the banded muscle was transverse fracture, the fifth cartilage ring of the trachea was completely broken, the posterior wall of the trachea was longitudinally broken, and the broken end was compressed downward to the mediastinum. The right recurrent laryngeal nerve was torn and severed into the throat, and the right parathyroid gland was separated from the surrounding tissues. The broken end of the trachea was found, hemostatic was fully stopped, and the surrounding blood and secretions were absorbed. Then a 7.0 enhanced tracheal catheter was inserted into the distal end of the trachea and threaded tube was connected, with a depth of 10cm. Propofol 60mg, Sufentanil 10ug and rocuronium 40mg were added intravenously and mechanically controlled ventilation was performed under general anesthesia. At the same time, the anesthesia machine gave an alarm indicating high airway resistance and low tidal volume. Considering that the depth of the endotracheal tube was too deep, single lung ventilation was caused. At this time, the airway pressure and tidal volume are in the normal range. The tracheal intubation was fixed in the surrounding skin through sutures, the isthmus of the thyroid was severed intraoperatively, the broken end was ligation, the 5th tracheal ring was trimmed, the broken end of the tracheal was sutured to the tracheal intubation, the 2-3 rings of tracheal cartilage were incised longitudinal, and the tracheal intubation at the broken end was replaced to the 2-3 tracheal cartilage ring, the broken end is sutured contrastively, microinstrumentation of right recurrent laryngeal nerve, will lower parathyroid graft on the right in the middle of sternocleidomastoid, two drainage tubes were placed in the operative cavity to stop bleeding thoroughly, subcutaneous and skin sutured layer by layer, and endotracheal intubation was replaced with percutaneous tracheostomy tube which ID=7.5 mm with internal diameter.

3. Discussion

The trachea is a cavity composed of 18-22 cartilage rings, whose functions include ventilation, heating and humidification, removal of trachea and bronchial secretions and defense reflex. The starting point of the trachea is generally slightly higher in females than in males, but higher in newborns, and can reach the level of C3-C4 cervical intervertebral disc, which decreases with the decrease of the larynx. The distance from the starting point to the carina of the trachea in adults is 10-13cm. The left and right diameter is 2.0-2.5 cm, and the anterior and posterior diameter is 1.8-2.2 cm. The front and both sides are composed of "C" shaped cartilage rings, accounting for about 2/3 of the circumference of the trachea. The rear is a stretchable membrane, among which the only complete cartilage ring is the cricoid cartilage, which is connected by connective tissue and smooth muscle to provide support for the trachea. Thus maintaining the opening state of the trachea [3, 4]. The trachea is divided into cervical segment and thoracic segment according to its stroke and position. The cervical segment of the trachea is connected with the surrounding structures through loose connective tissue, so it is highly active. The important structures in front of the trachea include the isthmus of the thyroid and the blood vessels of the thyroid, the left and right lobes of the thyroid and the great blood vessels of the neck, the esophagus and the spine, and the recurrent laryngeal nerves pass through the tracheoesophageal groove on both sides [5].

Tracheal diseases include congenital and acquired trachea diseases in children (such as tracheal dysplasia, tracheal atresia), tracheal stenosis, primary and secondary tracheal tumors, tracheal trauma, tracheal softening and compression, and other infectious, inflammatory, invasive, idiopathic and various kinds of tracheal diseases. Most of these patients present preoperative symptoms such as hemoptysis, infection, intractable cough, dyspnea, respiratory obstruction, hoarseness, etc. In severe cases, respiratory failure may occur, thus endangering life [6].

Closed cervical tracheal injury refers to the violent impact on the neck and the trachea being squeezed against the hard cervical spine, resulting in the contusion and tear of tracheal cartilage and soft tissue, while the skin is intact [7, 8]. The main reason for tracheal injury is that severe violence at the moment of injury compreses the tracheal on the rear spine; rapid movement produces shear effect on the tracheal; at the same time, the glottis closes, and the compression of the chest causes a rapid increase in tracheal pressure. Symptoms and signs of tracheal injury often need to reach a certain degree before showing, resulting in a high rate of early misdiagnosis and missed diagnosis [9]. The symptoms of tracheal injury can be manifested as chest tightness, chest pain, dyspnea, cough, hemoptysis, hoarseness, subcutaneous emphysema, dysphagia, etc. The fracture above the level of tracheal carina can form obvious mediastinal emphysema due to gas entering the mediastinum, resulting in blocked venous return and reduced cardiac output, leading to different degrees of cardiopulmonary dysfunction, such as delayed diagnosis and rescue. It will endanger patients' lives [10]. Once cervical tracheal rupture is diagnosed, airway reconstruction should be performed actively to ensure airway integrity and continuity. Moreover, if there is no asphyxia caused by active bleeding within 48 hours of cervical tracheal rupture, there is no severe pulmonary inflammation in the lung, which has a good surgical effect and can reduce complications such as late tracheal stenosis, atresia and disability caused by delayed diagnosis and treatment [11].

Anesthesia management of tracheal rupture surgery is tricky, and its complexity comes from the need to control the airway, maintain satisfactory oxygenation and ventilation on the one hand, and ensure good exposure to tracheal surgery on the other hand [12]. As the trachea itself is the object of surgery and the only way to supply oxygen to the body, surgical operation and airway management of anesthesia

interact with each other, so anesthesia cannot be carried out in isolation, and endotracheal intubation and anesthesia management are more difficult and risky [13]. When tracheal injury occurs, the functions of the trachea mentioned above, including ventilation, cleaning, heating and humidification, and defense reflex, will be affected to varying degrees, and the biggest impact on anesthesia is the change of ventilation function. For patients with tracheal laceration, anesthesia is considered according to their critical degree, and anesthesia techniques that do not damage the fragile airway are selected [14]. The partially broken trachea may be completely broken due to the insertion of the tracheal catheter, and the compression of the cricoid cartilage may cause dislocation of the fractured cricoid or thyroid cartilage. Until the airway is not secured, the safest approach is to retain the patient's spontaneous ventilation. It has been reported in the literature that patients with tracheal rupture should not be subjected to tracheal intubation, so as to avoid further aggravating the original injury. In principle, the tracheal tube should be exposed first, and a tracheal catheter should be inserted at the broken point. After proper depth of insertion, the tracheal capsule should be inflated and checked manually for the existence of air leakage. When conditions permit, fiberoptic bronchoscope-guided intubation can be performed awake under superficial anesthesia to avoid tracheal reinjury caused by blind intubation and intubation difficulties caused by extensive subcutaneous emphysema of neck and chest [15-19]. After surgery, the head bending position should be maintained to reduce the anastomotic tension, provide perfect analgesia, reduce the anxiety of patients, and improve the prognosis [1].

4. Conclusion

According to the anesthesia management of this patient, our experience is as follows: 1. Perfect preoperative evaluation and monitoring means: Such acute and critical patients should be thoroughly evaluated and monitored before surgery. The emphasis of preoperative evaluation is on the method and difficulty of airway establishment and whether there are other concomitators. Intraoperative monitoring includes ECG, heart rate, SPO_2, $PETCO_2$, ABP, body temperature, urine volume, arterial blood gas, and CVP, BIS and other indicators if necessary. Perfect monitoring can detect problems early, timely treatment, to avoid further deterioration of intraoperative conditions. 2. Fine airway management: during tracheal trauma, there is bleeding or stenosis in the injured area, and the insertion of the endotracheal tube may cause coughing, aggravated bleeding, increased oxygen consumption, and partial tracheal rupture into complete rupture. Compression of cricoid cartilage may promote dislocation of fractured cricoid or thyroid cartilage. The safest method is to preserve the patient's spontaneous breathing, avoid the use of muscle relaxants before the safe establishment of the patient's airway, and adopt individualized airway establishment methods according to the patient's specific conditions. In this case, preoperative imaging examination of the patient indicated irregular horizontal lumen between thoracic vertebrae 1 and thoracic vertebrae 3, and intubation may fail under fiberoptic guidance. Moreover, the patient was a patient with neck trauma, and it was difficult to establish an emergency surgical airway to a certain extent. In order to ensure the safety of the patient, the basic sedation combined with local anesthesia was used to perform tracheotomy ventilation below the broken end of the trachea, and then general anesthesia was added. Although the depth of the endotracheal tube was too deep at the beginning, it was soon adjusted to the appropriate depth. Another advantage of this airway establishment method is that it can provide good conditions for trachea anastomosis, and facilitate the intraoperative replacement of air catheter, so as to reduce the tension of respiratory airflow on the anastomosis. 3. Teamwork: The rescue of critically ill patients is a multi-department collaboration. Our goal is to ensure patient safety, optimize the prognosis, give full play to the role of each team member, avoid or timely deal with the clinical situation of critical patients' lives, and carry out individualized management of patients to ensure perioperative patient safety.

Conflict of Interests

All the authors do not have any possible conflicts of interest.

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