Ventilation through placing the endotracheal tube passed down beyond the obstruction during general anesthesia in patient with mediastinal mass

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Most common and featured complication in anesthetized patient with mediastinal mass is tracheobronchial compression distal to endotracheal tube. Because of reduced lung volume, relaxation of bronchial smooth muscle and eliminated diaphragm movement, general anesthesia exacerbate extrinsic intrathoracic airway compression. Once trachea or bronchus is collapsed, it is usually known to impossible to pass an endotracheal tube through compressed airway forcibly. However, if ventilation proves difficult, an attempt should be made to pass the endotracheal tube down the least obstructed portion and some cases reporting successful ventilation through placing endotracheal tube passed further down beyond the obstruction even after neuromuscular blockade. We describe the anesthesia experience that placing the endotracheal tube passed beyond the obstruction using fiberoptic bronchoscope in child with total tracheal obstruction after induction of general anesthesia.

Keywords: Mediastinal mass; General anesthesia; Airway; Obstruction

INTRODUCTION

Patient with mediastinal mass may require biopsy of the mass or resection via sternotomy or thoracotomy. Most common and featured complication in anesthetized patient with mediastinal mass is tracheobronchial compression distal to endotracheal tube. We describe the anesthesia experience that placing the endotracheal tube passed beyond the obstruction using fiberoptic bronchoscope in child with total tracheal obstruction after induction of general anesthesia.

CASE REPORT

An 8-year-old male child visited the emergency department with dyspnea and swelling in face and neck (Fig. 1) accompanied with a two weeks history of cough. He had no previously diagnosed comorbidities and no history of congenital diseases. His height was 129 cm and weight was 31 kg, as her parents informed. Diffuse neck swelling with distention of the neck veins and multiple submandibular mass was present on physical examination. A 3.5 cm mass in anterior mediastinum (Fig. 2), compressing the superior vena cava and respiratory tract including distal trachea, ca-

rina and both main bronchus, and multiple enlarged lymph nodes in both lateral necks, both supraclavicular area and both axillary area was revealed in chest-computed tomography (CT) image. The shortest diameter of compressed trachea in CT image was 16% of unaffected portion in cephalad to mediastinal mass. To determine the method of treatment, pediatrician and thoracic surgeon decided to emergency operation (axillary lymph node biopsy) under general anesthesia.

After arriving in the operating, standard monitoring was applied. The heart rate was 112 bpm, blood pressure 112/69 mmHg and O₂ saturation 99% on room air. After patient was preoxygenated with 100% O₂ by face mask, thiopental sodium (Pentotal Sodium® 0.5 g; JW Pharmaceutical, Seoul, Korea) 150 mg was injected intravenously for general an-

esthesia. Mask ventilation was done properly without particular difficulties. Rocuronium (Esmeron® 10 mg/mL; NV Organon, Oss, The Netherlands) 20 mg was injected. Mask ventilation was accomplished well until then. During the endotracheal intubation, the patient was graded at Cormack & Lehane grade I. There were no specific peculiarities in the oral cavity and oropharynx and endotracheal intubation (Internal diameter 6.0 mm) was performed easily.

After endotracheal cuff was inflated, hard resistance made manual positive ventilation unavailable. No breathing sound was auscultated on both lung fields and airway pressure was raised over 30 cmH₂O. Instantly extubation was performed and manual bag mask ventilation was attempted with facial mask. Under bag mask ventilation, the airway pressure displayed on monitor rose and tidal volume was 10–20 mL. Subsequently pulse oximetry reading began to decrease. Endotracheal intubation was attempted again and performed easily (Internal diameter 6.0 mm). Scanty amount of secretion was seen in the oropharynx without specific peculiarities. Airway pressure rose to over 30 cmH₂O again as soon as endotracheal cuff inflated and breath sound was not auscultated on both lung fields. A few seconds later, Blue tinge was spotted on lips and the pulse oximetry reading was decreased to 30%. Heart rate dropped to 80 bpm. At this point, atropine 0.5 mg and sugammadex (Bridion®; Merck & Co. Inc., Kenilworth, NJ, USA) 200 mg were injected for prompt reversal of the neuromuscular blocking agent. Despite no specific abnormalities were seen through laryngoscope, ex-

Fig. 1. Swelling in face and distension of neck veins.

Fig. 2. Preoperative chest-computed tomography. (A) Mass in anterior mediastinum, compressing superior vena cava in sagittal view. (B) Mass compressed distal trachea in coronal view.

Fig. 3. Chest X-ray (A-P view). Endotracheal tube inserted into right main bronchus.

tubation was performed immediately because of difficulties in positive pressure ventilation. As soon as extubation was done, positive ventilation with facial mask was attempted. Resistance felt through bag was still firm, but ventilation through mask became available soon. Subsequently, enough tidal volume was achieved and pulse oximetry reading increased to 99% followed by recovery of heart rate to 150–160 bpm.

Dexamethasone 5 mg was injected and endotracheal intubation was performed again. Sodium thiopental 25 mg was injected but neuromuscular blocking agent was not injected. Deciding explore trachea and both bronchus, fiberoptic bronchoscope (OLYMPUS LF-DP; Olympus Medical Systems Corporation, Tokyo, Japan) was inserted through endotracheal tube. Seen through fiberoptic bronchoscope, trachea was compressed distal to the tip of endotracheal tube as patient's chest expanded and opened following its contraction. Endotracheal tube tip was advanced into 2 cm further to secure ventilation. Soon resistance through bag was relieved and tidal volume increased. Chest X-ray was checked. In chest AP view, endotracheal tube inserted into right bronchus was seen (Fig. 3).

As positive pressure ventilation was secured and vital sign was remained stable. Scheduled axillary lymph node biopsy was performed. Emergency operation was performed for 25 min without any event. The patient was transferred to the intensive care unit (ICU) with endotracheal tube inserted in

right bronchus remained. In the ICU, controlled ventilation with sedation with dexmedetomidine was performed in reverse Trendelenburg position. To relieve symptoms resulted from the mediastinal mass including superior vena cava syndrome, emergency radiotherapy was performed.

DISCUSSION

Mediastinal mass can lead to hemodynamic instability and airway collapse, especially in patients undergoing general anesthesia [1–3]. Etiologies of mediastinal mass arise from the lymphomas, neurogenic tumors, lymphangiomas, germ cell tumors, enteric cysts, and other histological types of tumors. Lymphoma takes largest proportion of reported cases.

Patient with mediastinal mass may require biopsy of the mass or resection via sternotomy or thoracotomy. Most common and featured complication in anesthetized patient with mediastinal mass is tracheobronchial compression distal to endotracheal tube. Because of reduced lung volume, relaxation of bronchial smooth muscle and eliminated diaphragm movement, general anesthesia exacerbate extrinsic intrathoracic airway compression [4]. Narrowing of airways is further exacerbated by administration of neuromuscular blocking agent and establishing positive pressure ventilation [5]. It is reported that 8 cases received neuromuscular blocking agent and positive pressure ventilation among 26 cases of child having mediastinal tumor with radiologic evidence of cardiovascular or respiratory compression. One of these eight patients had an episode of hypoxemia [6].

Compression of the trachea or bronchi may be expressed as cough or dyspnea and impingement of the recurrent laryngeal nerve causes hoarseness. To identify risk of airway compromise, it is important to elicit a symptom of dyspnea, particularly postural dyspnea or postural orthopnea/stridor. Once postural symptoms are identified, an effort to minimize postural symptoms should be defined. Involvement of the superior vena cava may lead to Superior vena cava syndrome and direct compression of the heart can results in syncope, postural symptoms and even severe cardiac tamponade symptoms [6–8]. In the present case, the patient complained cough lasting 2 weeks and dyspnea. And plethora on neck veins was appeared. These symptoms and signs imply that obstruction of airway and superior vena cava.

Radiologic evidence of respiratory or cardiovascular com-

pression was appeared in 76% of the patients with signs or symptoms suggesting cardiopulmonary compromise [6]. The most important diagnostic tool for these patients is chest-CT image. Chest-CT is required to define the location and size of the mediastinal mass. Asymptomatic adult patient with tracheal/bronchial diameter >50% of normal diameter on CT image considered to be able to safely given general anesthesia. Adult or child patients with severe symptom who cannot tolerate supine position should be considered high risk patient. Fatal anesthetic complications including death usually have been reported in children. These fatal complications may be the result from the more compressible cartilaginous structure of the upper airway in children compared to adults or because of the difficulty in obtaining a history of postural symptoms. Child with tracheal/bronchial diameter <50% of normal diameter on CT image regardless of symptoms also should be considered high risk patient [9].

It is also suggested that pulmonary function testing might contribute to risk prediction or perioperative management of patient with a mediastinal mass. Mixed obstructive and restrictive pattern on pulmonary function testing predicted a greater rate of postoperative respiratory complications [10].

Lam et al. suggested predictors of airway compromise in children having a mediastinal mass. Factors associated with the development of acute airway compromise were anterior location of the mediastinal mass, histological diagnosis of lymphoma, symptoms and signs of superior vena cava syndrome, radiological evidence of vessel compression or displacement, pericardial effusion, and pleural effusion [7]. Patients with low risk characteristics can be given general anesthesia safely with positive pressure ventilation and standard monitoring. Patients with high risk characteristics need specific management based on their symptoms and radiologic studies including airway management, maintain spontaneous ventilation, rescue position and cardiopulmonary bypass [8,11,12]. In the present case, the patient had supine dyspnea and tracheal compression near carina >50% of diameter compared with proximal portion of trachea was identified on CT scan. He had 3 of the risk factors: Anterior location of the mass, superior vena cava syndrome, radiologic evidence of vessel compression. Therefore, specific preparation and management for perioperative airway collapse should have made.

Airway can be secured with awake fiberoptic broncho-

scopy with an armored tube using local anesthesia supplemented either by judicious intravenous sedation or after an inhalational induction and conventional laryngoscopy. Fiberoptic visualization helps the defining the site and degree of obstruction and tracheal narrowing. The cause of airway obstruction after the administration of muscle relaxant can be easily identified, and the final positioning for surgery can be done under its guidance [5]. Adequate position of endotracheal tube need to be determined preoperatively and airway should be secured beyond stenosis when patient is awake.

Maintenance of the spontaneous ventilation via an endotracheal tube should be continued until airway is definitively secured or procedure is completed. Procedure under spontaneous ventilation should have tried to evade tracheal obstruction. If rescue position was established before the patient came into operation room, changing position in advance of trying manual positive pressure ventilation could be helpful. In addition, biopsy under local anesthesia or preoperative corticosteroid therapy or radiotherapy with biopsy through nonradiated window could be considered [6].

Once trachea or bronchus is collapsed, it is usually known to impossible to pass an endotracheal tube through compressed airway forcibly. However, if ventilation proves difficult, an attempt should be made to pass the endotracheal tube down the least obstructed portion and some cases reporting successful ventilation through placing endotracheal tube passed further down under beyond the obstruction even after neuromuscular blockade [1,3,5]. The anesthesiologist must be prepared for emergency airway maneuvers and should keep in mind ventilation become difficult. Other options include rapidly awakening the patient, shifting the patient to a preplanned "rescue" position, or utilizing rigid bronchoscopy for ventilation. Rigid bronchoscopy has been advocated as a method to secure the airway when an endotracheal tube cannot be advanced past the site of airway obstruction. As well as rigid bronchoscopy can be used to deliver the endotracheal tube distal to the obstruction, it can be used in oxygenation during resuscitation.

The final option in adult patients in the management algorithm for a critical mediastinal mass is cardiopulmonary bypass. Femoro-femoral cardiopulmonary bypass has been suggested in rescue from hemodynamic or respiratory collapse. It is suggested that the high risk patient should have

the femoral vessels cannulated under local anesthesia in readiness for cardiopulmonary bypass prior to induction of anesthesia [1]. Even though preoperative preparation for cardiopulmonary bypass should be considered in the high risk patients, the ischemic interval during emergent cannulation and institution of cardiopulmonary bypass is likely to result in significant neurologic injury even with a primed circuit and a cardiac surgeon and perfusionist standing by in the operating room.

In summary, the present case showed a significant airway obstruction occurred in patient with mediastinal mass. Despite urgent condition of ventilation failure, an approach with fiberoptic airway evaluation and prompt attempt to secure airway placing endotracheal tube beyond the obstruction achieved successful ventilation. However, the placement of endotracheal tube through airway forcibly after collapse of trachea or bronchus following administration of muscle relaxant is considered as impossible and clinician must prepare alternative anesthetic methods including perform surgery under local anesthesia or maintain spontaneous ventilation instead of positive pressure ventilation and muscle relaxants.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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