Microlaryngeal endotracheal tube for lung isolation in pediatric patient with significant tracheal narrowing

ABSTRACT
A 15-year-old boy, weighing 45 kg, 160 cm in height with large anterior mediastinal mass and significant tracheal narrowing was scheduled for thoracotomy and excision of the mass. He had a history of progressive dyspnea, inability to lie supine, and a right upper hemithorax mass 13 cm × 13 cm × 11 cm as evident on a computerized tomography with significant compression of the trachea and right main stem bronchus. Inhalational induction was carried out using sevoflurane with 100% oxygen. After achieving adequate depth of anesthesia with the maintenance of spontaneous respiration with oxygen and sevoflurane (minimum alveolar concentration 1.7), left principal bronchus was intubated under fiber-optic bronchoscopy, with 5 mm cuffed microlaryngeal surgery tube. Excellent lung isolation was achieved. Selection of endotracheal tube for lung isolation and endobronchial intubation in the presence of significant tracheal narrowing are discussed.

Key words: Anterior mediastinal mass; cystic hygroma; endobronchial intubation; extrinsic tracheal compression; lung isolation; MLS tube; stridor

Introduction
Depending on the location of the mass to mediastinal structures, children present with most common symptoms of an anterior mediastinal mass such as cough, dyspnea, hoarseness of voice, fever, and stridor. The mediastinal mass may lead to tracheal compression and narrowing. Airway obstruction and difficult positive pressure ventilation have been reported with intravenous induction of general anesthesia.[1] Surgical excision of the cystic mediastinal mass may require lung isolation due to chances of contamination of opposite lung. For lung isolation, though Double Lumen Tubes (DLT) and Univent tubes are available, endobronchial intubation with smaller size endotracheal tubes is another option. We describe the successful intraoperative lung isolation using microlaryngeal surgery (MLS) tube in a case of anterior mediastinal mass for thoracotomy with excision of mass. Consent for publishing details of case history and radiological photographs have been taken from the patient’s parents.

Case Report
A 15-year-old boy, weighing 45 kg, 160 cm in height with an anterior mediastinal mass was scheduled for right posterolateral thoracotomy and excision of mass with one lung ventilation (OLV). He had complaints of shortness of breath, dry cough, night stridor, and inability to lie supine for the past 2 months. Dyspnea was gradually progressive and was relieved in left lateral and knee-chest position. On examination, the patient was dyspneic at rest without pallor, cyanosis, or clubbing. His pulse rate was 90/min, noninvasive

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blood pressure 110/76 mmHg, respiratory rate (RR) 19/min, and SpO₂ 98%. Respiratory system examination revealed a left deviation of the trachea with markedly decreased air entry on the right side. Airway examination and other systemic examination were within normal limits.

His hemoglobin, other biochemical investigations, and arterial blood gas were within normal limit. Chest X-ray showed a homogenous opacity occupying the right hemithorax with marked mediastinal shift [Figure 1]. Pulmonary function tests showed forced vital capacity (FVC) 52%, forced expiratory volume 1 s (FEV₁) 18%, and FEV₁/FVC 35%. Contrast-enhanced computerized tomography (CECT) chest showed a cystic mass in the right hemithorax compressing the trachea and right bronchus with rib erosion [Figure 2]. Magnetic resonance imaging revealed large septated right upper hemithorax solid cystic mass with a size of 13 cm × 13 cm × 11 cm, causing mass effect on the mediastinum and compression of superior vena cava, trachea, right main stem bronchus, collapse of right upper lobe. Three-dimensional (3D) reconstruction of the tracheobronchial tree revealed marked extrinsic compression from mid trachea to just above the carina with complete nonvisualization of the right principal bronchus [Figure 3].

Inhalational induction with the maintenance of spontaneous ventilation and fiber-optic bronchoscope (FOB)-guided endobronchial intubation was planned. The rigid bronchoscope was kept standby for rescue ventilation. In the preoperative room, nebulization with 4% lignocaine was done. In the operating room, inhalational induction with increasing concentrations of sevoflurane in 100% was initiated through closed circuit. After the loss of consciousness, a 5 mm nasopharyngeal airway was inserted into left nostril and was connected to the closed circuit. Spontaneous ventilation and anesthetic depth were maintained. FOB was done and further topical anesthesia was done with 4% lignocaine, total dose of lignocaine was 5 mg/kg. Bronchoscopy confirmed significant extrinsic tracheal compression beginning at mid trachea, increasing in severity till it became a transverse slit with nonvisualization of the right principal bronchus.

The left principal bronchus was orally intubated under FOB guidance, with softened 5 mm cuffed single lumen Mallinckrodt MLS tube [Figure 4]. Tip of the MLS tube was positioned in the left principal bronchus a few millimeters before its bifurcation into upper and lower lobar bronchi. Balanced general anesthesia was maintained with fentanyl 100 mcg and atracurium 4 mg. Left lateral position was made, repeat FOB was performed to confirm MLS tube tip position and ventilation to left upper lobe before the start of surgery.

Anesthesia was continued with 60% oxygen in air and isoflurane (minimum alveolar concentration 1.0–1.3) and morphine. Volume-controlled ventilation with 300 ml tidal volume and 20/min RR was initiated. Initial peak airway pressures were 38 cm of H₂O, which decreased to 20 cm of H₂O after excision of the mass. Surgical findings were suggestive of cystic hygroma. After excision of mass, repeat FOB showed an opened up right principal bronchus. Then, MLS tube was withdrawn till the tip was positioned in the trachea and suction of right bronchus was done and the right lung ventilation was started for identification and suturing of leaks in the right lung parenchyma. Rest of the surgery was uneventful. Duration of surgery was 285 min. Total blood loss was 1.2 l, which was adequately replaced.
Postoperatively, trachea was not extubated, and the patient was shifted to the intensive care unit. The patient was ventilated overnight in view of long-standing tracheal compression. Analgesia was maintained with morphine infusion. Trachea was extubated on the 1st postoperative day after performing a standard leak test. The patient was shifted to the ward on the 2nd postoperative day with normal ventilatory and hemodynamic status. Rest of the hospital course was uneventful. He was discharged from the hospital after 1 week. Later, histological diagnosis of the mass confirmed it as seminoma.

Discussion

Patients with anterior mediastinal mass have a higher risk for respiratory and cardiovascular collapse after induction of general anesthesia. Patients with symptoms of airway compromise such as dyspnea at rest, postural dyspnea, orthopnea, and stridor are at a high risk of intraoperative airway problems.[2]

Our patient was prone to intraoperative airway problems as he had significant airway narrowing, i.e., tracheal compression >50%, bronchial obstruction due to pressure effect of the large mediastinal mass, and anterior location of the tumor.[5] Hence, 3D reconstruction of the tracheobronchial tree was planned to evaluate location and extent of airway compression for the planning of airway management.

Although awake FOB-guided intubation after nebulization of local anesthetic is the technique of choice, it was not possible in this patient due to age. Inhalational induction with spontaneous ventilation was chosen as it is the most common technique used for children.[4] These patients are more prone to hypoxia during anesthesia due to reduced lung volumes and increased compressibility of large airways. Partial obstructed respiration generates large negative pressures, which further reduces tracheal diameter.[5] In the present scenario, spontaneous ventilation was maintained till left main bronchus was intubated bypassing tracheal obstruction.

In the present patient, OLV was needed to prevent contamination of opposite lung during cystic mass surgery. Selection of ETT was also difficult. DLT or univent was not used due to a larger outer diameter which may lead to airway trauma with significant tracheal narrowing.[6] Right principal bronchus was not visualized due to compression by the large mass, so bronchial blockers or Fogarty catheter could not be used.

Endobronchial intubation with single lumen cuffed ETT was the only option left as tracheal cuff functions such as bronchial cuff. However, few problems are associated with their use for endobronchial intubation. As measured, the distance of the tracheal cuff from the tip of the single lumen ETT is 20 mm in contrast to 5 mm distance of the bronchial cuff from the tip of the DLT. The volume and length of the tracheal cuff are significantly greater in single lumen ETTs in comparison to the bronchial cuff of DLT. Structural and positional differences of the tracheal cuff of single lumen ETT may lead to bronchial injury during its negotiation into the main stem bronchus. Because of the longer length, cuff of ETT may lie at the carina with failed isolation of the healthy lung. There may be the possibility of blockade of ventilation to the upper lobe with further negotiation of cuff into the bronchus.

In our patient, for left endobronchial intubation, approximate depth of insertion of ETT at incisors would be approximately 240 mm.[7] However, conventional ETTs have a shorter length (245 mm [5.0 mm ID Unomedical, Bakar Arang Industrial Estate, Kedah, Malaysia]) which was inadequate for endobronchial intubation in comparison to DLT (370 mm [28 Fr Portex Blue Line endobronchial tube, 8 Fr]. Figure 3: Three-dimensional reconstruction of tracheobronchial tree showing severe tracheal narrowing (left) and completely occluded right principal bronchus (right)

Figure 4: Microlaryngeal surgery tube (Mallinckrodt Medical, Athlone, Ireland)
Among available single lumen ETTs, MLS tube has longer length (368 mm in length with connector) (5.0 mm Mallinckrodt Medical, Athlone, Ireland), so endobronchial intubation with MLS ETT (5 mm ID) was done.

MLS tube is a small diameter single lumen ETT, which is used for microlaryngeal surgeries as it offers more working space to the surgeon. Its length is comparable to a standard ETT of 8 mm ID. These tubes have special low pressure, large volume, and large diameter cuff to protect the airway. In addition, it has a murphy eye. It can be used for both oral and nasal endotracheal intubation. The internal diameter, outer diameter, cuff diameter, and length are shown in Table 1.

After excision of mass, MLS tube was withdrawn into the trachea to ventilate both the lung and to identify breach in the right lung to prevent postoperative air leaks.

In conclusion, for children with severe extrinsic tracheal compression, limited options are available for lung isolation. Knowledge about various options available and timely decision making will make anesthesia safer in such cases.

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Conflicts of interest
There are no conflicts of interest.

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| Internal diameter (mm) | Outer diameter (mm) | Resting cuff diameter (mm) | Length of MLS tube with connector (mm) |
|------------------------|---------------------|-----------------------------|----------------------------------------|
| 4.0                    | 5.6                 | 25                          | 368                                    |
| 5.0                    | 6.9                 | 27                          | 368                                    |
| 6.0                    | 8.2                 | 27                          | 368                                    |

MLS: Microlaryngeal surgery