One-Lung Ventilation with a Single Lumen Endotracheal Tube Following Complete Laryngectomy: A Case Report

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ABSTRACT

One-lung ventilation (OLV) is increasingly being employed in a wide variety of surgical operations. Even though, double lumen tube has been the mainstay of management in such cases; other lung isolation techniques have been developed over the years according to specific conditions of the patient. One such special circumstance involves the presence of a permanent tracheostomy stoma. We present a case of a 58-year gentleman, with a history of total laryngectomy and a permanent tracheostomy, who had to undergo a left open thoracotomy and lower lobe excision requiring OLV. Anaesthesiologists should be well-versed about the substitutes to provide OLV, especially in low-resource settings, in order to deliver optimum surgical conditions while maintaining standardised patient care.

Key Words: *Endotracheal tube, Lung isolation, One-lung ventilation, Tracheostomy, Total laryngectomy*.

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INTRODUCTION

The inevitable need for one-lung ventilation (OLV) is expanding in a number of surgical procedures, and anaesthesiologists are routinely asked to selectively ventilate a single lung.[1] The ideal technique for lung isolation depends on numerous factors that may include (a) the indication for OLV, (b) upper and lower airway anatomy, (c) accessibility of airway equipment, and (d) the anaesthesiologist's expertise and choice.[2] Although double-lumen endobronchial tubes (DLT) are universally employed to isolate the lung, the use of endobronchial blocker tubes, and uncommonly endobronchial placement of a single lumen endotracheal tube (ETT) may negotiate some benefit in patients with an unfavourable airway anatomy.[1]

In the majority of cases, lung isolation is safely administered and swiftly accomplished. However, some specialised cases like patients with a permanent tracheostoma pose unparalleled challenges in terms of lung seclusion, and the methods employed in such cases for lung separation are quite limited.[2] As the tracheostomy site gets closer to the carina and the tracheal stoma gets smaller or restrictive, this may potentially lead to malposition of the tube.[2] Anaesthesiologists should be conversant with the available substitute techniques to DLT in tracheostomised patients. Here, we report a scenario in which OLV with the conventional ETT was achieved following complete laryngectomy. The patient consented to publishing this case, including all relevant images.

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CASE REPORT

A 58-year gentleman had a history of papillary carcinoma of thyroid and carcinoma larynx in 2016 for which he underwent radical neck dissection, total laryngectomy, and total thyroidectomy with a permanent tracheostoma. Now, he presented with a lung mass causing empyema of the lingula, left lower lobe and part of the left upper lobe, and was going to undergo a left open thoracotomy and lower lobe excision requiring OLV. On preoperative examination, he was 165 cm tall and 70 kg in weight, with a body mass index of 24 kg/m^2. His heart rate was 101 beats per minute (bpm), blood pressure of 129/84 mm Hg, respiratory rate of 16 breaths per minute and a room air oxygen saturation of 97%. Relevant laboratory investigations were within the normal limits. The stoma appeared clean and unobstructed, but small in size.

As total laryngectomy omitted the option of tracheal intubation orally, the condition demanded intubation *via* the tracheostoma. At that time, 35 Fr (Portex 10.8 mm external diameter) was the smallest size of DLT available at the hospital. So, it was decided to use the conventional polyvinyl chloride ETT with a single lumen, which is less traumatic than a DLT. The potential of airway injury in such a case led to a contingency plan involving a fiber optically-directed appropriately-sized ETT to achieve OLV.

On arrival in the operating room, standard ASA monitoring was practised. The patient was given 100% supplemental oxygen *via* a disposable face mask of size 4, making a seal around the patient's stoma. After preoxygenation, IV Midazolam 4 mg was given, followed by IV Ketamine 100 mg. Confirming the patient's loss of consciousness and continued spontaneous breathing, a Nelaton catheter (Wellead, 10 French Gauge) was inserted 3 cm into the stoma and left in place (Figure 1 A,B).

Subsequently, the patient's airway was examined using a flexible fiberoptic bronchoscope (FOB) while visualising the carina. The right upper lobe was identified and ETT of size 6.0 mm (Portex) was rail-roaded on the bronchoscope and positioned proximal to the right upper lobe. The bronchoscope was removed, and the tube was connected to the ventilator (Figure 1 C,D). The Nelaton catheter, which was inserted into the stoma, was used to provide continuous positive airway pressure (CPAP) to the non-ventilated left lung during the surgery. The patient was making adequate tidal volume for his ideal body weight and saturation was maintained between 90-95%. After verifying the final location of the tube, the ETT was secured in place at 10 cm, with the help of 2-0 Prolene sutures (Figure 1). IV Rocuronium 50 mg was given for muscle relaxation. The patient was ventilated in pressure control mode and inhalational anaesthetic Sevoflurane 0.5-2 vol% with 50% oxygen and 50% air at 1-2 L/min was administered to maintain minimum alveolar concentration between 0.7 and 1.0. An arterial line was placed in the left radial artery for continuous blood pressure monitoring and a 16-gauge IV cannula was inserted. IV Morphine 2 mg was given along with IV Dexmedtomidine 48 µg for analgaesia.

The patient was then turned to the right lateral decubitus position, all pressure points were covered, eyes taped shut, and head supported on a gel head ring. Positive end expiratory pressure of 5 cm H_2O was given to the right lung, and a Nelaton catheter was connected to CPAP device with 100% oxygen, giving a continuous pressure of 5 cm H_2O to the non-dependent lung (Figure 1D). The patient's saturation was now 95-98%. After standard preparation and draping, the surgery was started. Left thoracotomy and lobectomy was done which lasted for 2 hours and 40 minutes. Intraoperatively, muscle paralysis was provided by intravenous cis-atracurium intermittently. There was approximately 500 ml blood loss, for which 500 ml crystalloid, 250 ml colloid, and 2 packed cells were administered through a blood warmer. Hourly urine output remained adequate and was approximately 30 ml/hr. His blood pressures were kept within 20% of baseline with continuous phenylephrine infusion at 0.3-0.5 µg/kg/min. His systolic blood pressure was in the ranges of 150-80 mm Hg and diastolic was between 90-45 mmHg. Heart rate stayed between 60-100 bpm. After completion of the procedure, the surgeon inserted an extra pleural catheter under direct vision, through which we administered at 15 ml of 0.5% Ropivacaine in three divided doses.

After the dressing, the patient was turned to supine position and Sevoflurane was turned off. Once muscle paralysis faded, it was reversed with IV Neostigmine 2.5 mg and IV Glycopyrrolate 0.5 mg, after spontaneous respiration was restored. When the patient was fully awake and responsive, ETT was removed from the stoma, and 100% oxygen was given *via* a trach mask. On arrival at CICU, the patient remained vitally stable and oxygen saturation was 98% with 10 litres of 100% oxygen on tracheostomy mask. To control surgical pain postoperatively, 0.125% Bupivacaine infusion was started at 5 ml/hr *via* the extrapleural catheter. On the second postoperative day, he was shifted to the general ward. The histopathology report of the excised lung mass later showed evidence of well-differentiated keratinising squamous cell carcinoma (SCC).

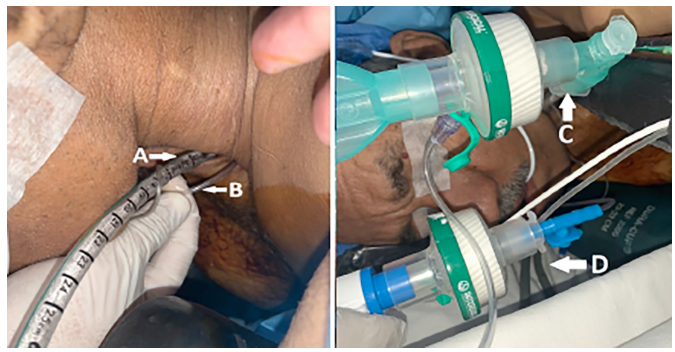

Figure 1: (A) Endotracheal tube size 6.0; (B) Nelaton Catheter 10 Fr; (C) ETT connected to the circuit; (D) Nelaton Catheter connecter to CPAP device.

DISCUSSION

Head and neck SCC (HNSCC) is the sixth most prevalent malignancy globally.[3] There were 450,000 fatalities in 2018 directly linked to HNSCC.[3] By 2030, the incidence is expected to increase by 30%, with 1.08 million new cases per year.[3] Due to increased consumption of goods containing carcinogens, the prevalence of HNSCC is highest in places like Southeast Asia and Australia.[3] Typically, men are 2-4 times more likely to get HNSCC than women.[3]

It is evident that many attributes of an airway have to be taken into account before considering OLV; this becomes even more crucial in patients with tracheostoma. Although ideally, a DLT is favoured in removing bleeding and respiratory secretions from the diseased lung, the single lumen tube (SLT) that we employed was made of a softer and more flexible material and had a straighter orientation, which permits smooth and unobstructed navigations of the FOB, within the trachea.[4] Moreover, it had a smaller external diameter which eradicates the possibility of injury to the surrounding tissue. In 2006, Knoll *et al*.[5] conducted a randomised, controlled, prospective study where OLV was applied with either a DLT or an SLT with a bronchial blocker (BB).[5] Among 56 patients, the incidences of sore throat and vocal cord lesions postoperatively were 17% with SLT, and 44% with DLT.

In addition, an unconventional technique that we experimented with was the use of a Wellead 10 Fr Nelaton catheter to provide CPAP during OLV. As mentioned, we inserted the catheter of about 3 cm into the stoma and attached it to a CPAP device to provide 5 cm H_2O of continuous pressure to the non-ventilated lung. This novel technique proved useful during OLV, as well as during tracheal intubation and fiberoptic manipulation. This simple technique of endobronchial insertion of a SLT avoided spillage of the non-diseased lung. BBS and Fogarty catheters have a chance of displacement from their original position during surgery, which can often defeat the purpose of OLV and lead to contamination. Moreover, with this technique, we could successfully provide OLV to the surgeon, which could have been beneficial if a pneumonectomy was deemed necessary. Furthermore, the CPAP that we applied to the operated lung was ideal; it did not

interfere with the surgeon's operative field, and at the same time, helped with ventilation and oxygenation.

In the past, similar cases had been reported where different techniques were implemented to provide OLV. Chen *et al*. reported the use of a Foley catheter as a BB for OLV.[6] Later in 2003, Uzuki *et al*. wrote about the use of spiral ETT and ETT in lung isolation.[7] In a retrospective study in 2012, Ueda *et al*. reviewed that BBs were successful in both right- and left-sided lung isolation.[8] In 2019, Campos *et al*. did a retrospective data analysis of 70 cases with tracheostomies explaining various methods for OLV, showing that patients undergoing lobectomy benefited more with selective lobar blockade as compared to complete lung collapse, by providing improved oxygenation.[9] Furthermore, when compared to DLTs, BBs warrant less chances of minor airway trauma.[2] Seo *et al*. in 2007 presented the application of a univent tube in a similar case.[10] It is a standard tracheal tube with a supplementary passage for a BB. Frequently used BBs which can be easily moved across the conventional one lumen tube include the Arndt blocker, the EZ-blocker, the Fuji Uni-blocker and the Cohen tip-deflecting blocker.[2] Patients with a tracheostoma may be best handled with a BB and FOB guidance enabling correct positioning with simultaneous ventilation through a multiport adaptor.[2] Interestingly in 2014, Howell *et al*. employed a left endobronchial Mallinckrodt microlaryngeal tube for a tracheostomised patient for lung isolation.[11] More recently, Kostroglou *et al*. shared a clinical experience of using a Fastrach ETT in an identical case scenario.[4]

In conclusion, we bring to light a novel attempt at lung isolated ventilation in a gentleman with a permanent tracheostoma, in view of pertinent literature. Lung isolation in such patients can be challenging. Though DLTs are the cornerstones for achieving lung isolation, they come with added dangers of airway trauma. The perils could be even more significant in patients with inherently challenging airways. In limited resource settings and special circumstances, the thoracic anaesthesiologist may come up with solutions like placement of a single lumen ETT into a bronchus to isolate the lung. Hence, anaesthesiologists should be well-acquainted with such substitutes and develop expertise in their use, in order to provide optimal surgical conditions, while maintaining standardised patient care.

COMPETING INTEREST:
The authors declared no conflict of interest.

PATIENT'S CONSENT:
The patient consented to publish this case, including all relevant images.

AUTHORS' CONTRIBUTION:
MSY, KM, HIN: Substantial contributions to the conception or design of the work.
MSY, HIN, SSA, KS: Acquisition, analysis, or interpretation of data for the work.
MSY, KM: Drafting the work or revising it critically for important intellectual content.
MSY, KM, HIN, SSA, KS: Final approval of the version to be published.
All authors agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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