One lung ventilation using double-lumen tubes: Initial experience from Lagos, Nigeria

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Abstract

Background: One lung ventilation (OLV) is a technique routinely used in thoracic anesthesia to facilitate thoracic surgery. Double-lumen tubes (DLT) remain the most popular and reliable choice for one lung ventilation especially in adult patients though use in Nigeria is limited. This study aimed to describe the experience in our institution with the use of double-lumen tubes for one lung ventilation.

Materials and Methods: This was a retrospective cross-sectional study conducted on all patients who had double-lumen tube intubations for one lung ventilation between March 2008 and Feb 2013.

Results: A total of 55 patients (27 males and 28 females, with a mean age of 39.6 ± 15.7 years) had left double-lumen tube intubations during the period. There were 30 left-sided (54.5%) and 25 right-sided (45.5%) surgical procedures performed. Tube position was verified by flexible bronchoscopy in 50 patients (91.9%) and by chest auscultation in 5 patients (9.1%) with satisfactory collapse in all but one of the procedures. The major surgical indications for one lung ventilation were Video-assisted Thoracic Surgery (VATS) in 22 patients (40%) and Heller's cardiomyotomy in 17 (30.9%). There were no mortalities and all patients had a complete recovery with no sequelae attributable to double-lumen tube use or one lung ventilation.

Conclusions: One lung ventilation is an integral component of modern anesthetic practice. It can be safely practiced in Nigeria with appropriate equipment and expertise. The use of DLT for OLV to enhance thoracic anesthetic practice should be encouraged in other Nigerian institutions.

Key words: Anesthesia, double-lumen tubes, Nigeria, one lung ventilation, thoracic

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Introduction

One lung ventilation (OLV) is a technique routinely used in thoracic anesthesia to facilitate thoracic surgery. It is used to create a silent operative lung field and to improve exposure during surgery. OLV can be achieved using different methods. However, double-lumen tubes (DLT) remains the most popular and reliable choice for OLV in adult patients.[1-5] Use of DLT is limited in Nigeria with most institutions performing thoracic procedures using low tidal volumes to create a silent lung field.

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The aim of this study was to describe the experience in our institution with the use of DLT for OLV.

Materials and Methods

Institutional settings

Preoperative assessment including Pulmonary Function Tests (PFTs) and Arterial Blood Gas (ABG) analysis on room air was done for each patient and a premedication dose of glycopyrrolate 0.2 mg was given prior to induction

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of anesthesia. Standard monitoring during anesthesia included electrocardiography for heart rate and rhythm, non-invasive blood pressure, pulse oximetry, and end-tidal capnometry. Invasive monitoring with arterial blood pressure, central venous pressure monitoring, and intraoperative ABG analysis was used at the discretion of the consultant anesthetist. After initiation of general anesthesia with propofol 1.5-2.5 mg kg^{-1}, fentanyl 2 mcg kg^{-1} or pentazocine 30 mg and suxamethonium 1.5-2.0 mg kg^{-1}, an appropriately sized left sided portex DLT was inserted. Sizing of DLT and depth of insertion was conventionally determined by the patient's height and gender[6,7] (Females <160 cm, 35 Fr and >160 cm, 37 Fr; Males <170 cm, 39 Fr and >170 cm 41 Fr). The average depth of insertion for the DLT was 29 cm for a height of 170 cm with a one cm change in depth insertion/10 cm change in height. Anesthesia was maintained with vecuronium 0.08-0.1 mg kg^{-1} or a tracurium 0.5 mg kg^{-1}, isoflurane 1.2-1.5% and fentanyl as needed. Correct tube placement was verified by flexible bronchoscopy in 91.9% of patients and by chest auscultation in 9.1% in the supine position and after turning the patient to the lateral decubitus position. A 3.6 mm pediatric fiberoptic bronchoscope (FOB) provided by Karl Storz, Tuttlingen Germany, was used in our study.

Ventilator settings after intubation were FiO_2 of 100%, tidal volume of 6-8 ml/kg, respiratory rate set to maintain an end tidal CO2 between 30 and 35 mmHg, peak inspiratory pressure limit of 35 cm H2O and this was maintained after OLV initiation. Positive End-expiratory Pressure/Continuous Positive Airway Pressure (PEEP/CPAP) were added at the discretion of the consultant depending on the patient's clinical status. Airway management including DLT placement was performed by either the consultant anesthetist or an anesthesia resident.

Postoperative pain management options were intercostal block/paravertebral block performed by the surgeon intraoperatively, with subcutaneous local infiltration, thoracic epidural, and intravenous opioids either on demand or by patient-controlled analgesia.

This was a retrospective cross-sectional study conducted on all patients who had DLT intubations for OLV between March 2008 and February 2013. Permission was obtained from our Institutional Ethics Committee for use of the existing patient data from the medical records and the thoracic surgery database. The data extracted were patient demographics, surgical procedure, DLT size, operative side, mode of verification of DLT, intraoperative and postoperative complications, adequacy of ventilation and need for postoperative ventilation.

The statistical analysis performed was mostly descriptive. Summary data is presented as numbers, mean, standard deviations, and percentages as appropriate.

Results

Over the study period 55 patients had DLT intubation. The mean age was 39.6 ± 15.7 years and the male to female ratio was approximately 1:1 (27 males to 28 females). American Society of Anesthesiologists (ASA) classification was ASA II in 32 patients (58.2%) and ASA III in 23 patients (41.8%). Invasive monitoring was used for 14 patients (25.5%). The size of DLT used was 39 Fr in all the male patients and 37 Fr in all but one of the female patient, who had a 32 Fr DLT inserted. The DLT position was verified by flexible bronchoscopy in 50 patients (91.9%) and by clinical auscultation in five patients (9.1%).

Satisfactory lung collapse was achieved in all but one instance where OLV had to be abandoned due to severe desaturation (oxygen saturation <90%) on initiation of lung collapse. The procedure was later converted from a VATS bullectomy to an open thoracotomy.

Table 1 shows the distribution of procedures, the side of the hemithorax involved (right or left side) and which procedures required invasive monitoring. VATS procedures (40%) were the commonest surgical indication for OLV followed by Heller's cardiomyotomy for achalasia (30.9%).

Postoperatively, 51 patients (93%) were sent to the Thoracic Surgery Ward after a minimum of one hour in the Anesthesia Recovery Room, while four patients (7%) required ventilatory support in the Intensive Care Unit (ICU) and were extubated the following day. There were no mortalities and all patients had complete recovery, with no sequelae attributable to DLT use or OLV.

Table 1: Surgical procedure, site of surgery, and monitoring

Surgical procedures	*N* (%)	Left sided	Right sided	Invasive monitoring
VATS procedures	22 (40)	9	13-6	-
Heller's cardiomyotomy	17 (30.9)	17-3	-	-
Lobectomy	6 (10.9)	1	1	Yes
Pneumonectomy	3 (5.5)	-	1	Yes
Bullectomy	2 (3.6)	-	2	Yes
Ivor-Lewis Esophagectomy	1 (1.8)	-	1	Yes
Excision of posterior mediastinal mass	2 (3.6)	-	1	Yes
Diaphragmatic plication	1 (1.8)			-
Ligation of thoracic duct	1 (1.8)			-
Total	55	30	25	14

Discussion

Indications for one lung ventilation differ depending on the thoracic procedure envisaged.[8] The risks of severe hypoxemia and unsatisfactory lung collapse increase if patients are not selected properly, so a thorough preoperative assessment with emphasis on the patient's ability to cope with OLV is necessary. Routine spirometry and ABG while at rest help in risk stratification in these cases as OLV causes physiological changes that can be injurious to the already compromised patient. Coupled with the effect of lateral decubitus positioning and increase in the shunt fraction, patients need to be carefully evaluated prior to OLV. The preoperative state of the patient should always be taken into consideration and optimized fully with interventions undertaken only if the risk of decline in ventilatory function postoperatively is low.

Our study used left DLT for all procedures irrespective of the operative side, which concurs with other studies in which right DLT were not routinely inserted due to problems with sub-optimal placement and greater risk of upper lobe obstruction.[1,3,4] Right DLT use is usually reserved for surgeries involving the left main stem bronchus or left pneumonectomy[9,10] as inadvertent stapling of the stump of the bronchus with the endobronchial portion of a left DLT is possible. We performed three left pneumonectomies with left DLT and ensured that at the time of bronchial resection, the endobronchial part had been withdrawn well into the trachea.

The appropriate sizing of the DLT used is an important determinant for the success of lung isolation. Different methods are used to determine the size of DLT. Options include measuring the tracheal or bronchial width or using the height and gender of the patients[11-13] as a guide with no accepted consensus among practitioners. We chose our size depending on the height of the patient and tended towards using a smaller tube in most patients. Although smaller tubes increase the risk of distal migration, they also reduce the risk of trauma during placement and with fiberoptic bronchoscopy (FOB), possible migration is easily detected.[14,15] Monitoring the trend of peak inspiratory pressure (PIP) served to alert us early on about possible distal migration of the tube, but care was taken as changes in PIP can also be caused by surgical manipulations. Recommendations that larger sized tubes would be less prone to malpositioning have not been substantiated in literature.[12,16]

The gold standard for DLT verification still remains fiberoptic bronchoscopy with studies showing that clinical assessment and auscultation alone are unreliable methods of ascertaining correct positioning.[14,16-18] Alliaume and Smith both found incidences of malpositions as high as 78% in left DLT placement and 89% in right DLT placement when auscultation alone was used after blind placement.[16,17] Prior to our purchase of a pediatric flexible bronchoscope, verification of DLT position was done only by clinical auscultation. The one patient who had an unsatisfactory lung collapse with OLV was done during this period so it is very likely that unverifiable placement of the DLT was a contributory factor.

Skill with fiberoptic bronchoscopy is essential when placing DLT as lack of familiarity with the tracheobronchial anatomy is a major cause of tube malposition.[19] Anesthetists involved in thoracic surgery need to be familiar with bronchial anatomy to reduce the risk of errors due to ignorance regarding variations in anatomy and distortions caused by disease.[20] It has been found that there is a high incidence of malpositioning and total failure of placement of lung isolation devices with anesthetists who have limited thoracic experience.[19] Of further concern in Nigeria is the relatively high cost of purchasing flexible bronchoscopic equipment, the absence of competent maintenance, and nonexistent formal training for budding thoracic endoscopists.

The major indication for OLV in our study was for surgical access in VATS and Heller's cardiomyotomy. Though previously considered as relative indications for OLV, these have become the most common and foremost indications for lung isolation as more thoracic surgeons tend towards less invasive and cosmetically pleasing VATS procedures.[21]

Postoperative pain control is known to be quite challenging in thoracic cases[22] and until recently, thoracic epidural blocks were thought to be the method of choice for these patients.[23,24] We infrequently performed epidural blocks in our study due to the relative scarcity of epidural opioids at our institution. The short duration of action of local anesthetic agents solely coupled with the resultant sympathectomy and monitoring required with frequent re-dosing has deterred us from this option for pain control. We have recently resorted to paravertebral blocks performed by the surgeon under direct vision to supplement other intravenous modalities of treatment with an appreciable improvement in pain control. Baidya *et al.* recently published a meta-analysis showing that thoracic paravertebral blocks may be as effective as thoracic epidural blocks and safer than thoracic epidural blocks for the treatment of post-thoracotomy pain.[25]

We favour early extubation and mobilization to aid rehabilitation and reduce the incidence of pneumonias and thromboembolic events. Other risks of prolonged mechanical ventilation include stump disruption, acute lung injury, broncho-pleural fistula and persistent air leakage,[26] which can be avoided with a tailored approach to peri-operative anesthesia. The four patients (three pneumonectomies and one esophagectomy) that required postoperative ventilator support all had prolonged surgery with large fluid shifts and were extubated the day following surgery after fulfilling the extubation criteria. Early extubation, good post-operative care, and pain management with early mobilization all serve as vital components in enhancing postoperative recovery.[27]

Conclusion

One lung ventilation is an integral component of modern anesthetic practice. It can be safely practiced in Nigeria with appropriate equipment and expertise. The use of DLT for OLV to enhance thoracic anesthetic practice should be encouraged in other Nigerian institutions.

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