Original Article

The incidence of hypoxemia due to malposition of double lumen endotracheal tube during one lung ventilation

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Fac Med Baghdad
2014; Vol.56, No.2
Received: Jan., 2014
Accepted March.2014

Summary:

Background: Oxygenation during one lung ventilation (OLV) can be affected by positioning of Double lumen endobronchial tube (DLT). Mal position can occurs following intubation and moving the patient to the lateral decubitus position.

Objectives: To study the relation of hypoxemia to mal position of double lumen endo bronchial tube after patient positioning in lateral decubitus position and during one lung ventilation. The use of fiber-optic scope in detecting the mal position and correcting it is illustrated.

Methods: A study of 80 patients with ASA physical status I-II patients about to have elective thoracic operations. The intubation of the trachea was done with a left sided DLT, then checked clinically by auscultation and with use of fiber-optic scope and this done after patient positioning and during OLV. Oxygen saturation was measured by non invasive pulse oxy meter. IF oxygen saturation below 92 % (10.6kpa) 80 mmHg is detected, the DLT position must be checked and positive end expiratory pressure (PEEP), oxygen insufflations or (continuous positive airway pressure). CPAP or total lung ventilation (TLV) was tried if needed.

Result: Misplacement of DLT was found in 28 patients (35%) after patient positioning and in 24 patients (30%) during OLV. Patients who had malpostion of DLT after placing the patients in lateral decubitus position had a greater incidence of malposition of DLT in OLV (64%). The application PEEP to the dependent lung, CPAP or oxygen insufflations to the upper lung or brief periods of TLV were applied in 28 patients.

Conclusion: Patients who have mal position of DLT in lateral position had more incidence of hypoxemia and DLT mal position in OLV and mostly require intervention with use of fiber-optic bronchoscopy which is mandatory for detecting and correcting the mal position.

Keyword: Mal position tube, hypoxemia, double lumen endobronchial tube, one lung ventilation.

Introduction:

Endobronchial double-lumen tubes (DLT) are usually used for lung separation and placement of it is usually easy .Malposition of DLT can occur easily after intubation and moving the patient into lateral position 1,2,3,4. Correction of DLT Mal position and suctioning of blood or secretion are frequently required during surgery 1,2,4,5. DLT displacement may indicate poor matching with the anatomy of patient airway's . Hypoxemia is the most significant problem during OLV.6 The use of fiber-optic bronchoscope is to make sure the position of DLT after intubation and when there is any problem when patient move to lateral position and during OLV 7. The mal position of DLT was indicated when the tube had to be moved 1.0 cm or more in or out to correct its position 7.

These DLT are specifically designed to fit the anatomy of trachea, bronchial carina, and main bronchus according to Robertshow ,s suggestion 8. Guideline are available to choose a properly sized DLT according to Brodesky method 's for selecting double-lumen tube9.

Patients and Methods:

Eighty patients with ASA physical status I-II undergoing elective thoracic operation in the lateral position in the thoracic department in Al-jirahat (Ghazi al Hariri hospital)- Medical city Teaching Hospital. Forced expiratory volume in 1second (FEV1) and forced vital capacity (FVC) not less than 70% predicted values and also less than 8.5kPa (90% O2 saturation) are not included while breathing air. In addition, patients were judged to need a right sided DLT not included we consider DLT malposition would be more likely.

All patients were premedicated with medazolam 5 mg IM and pethidine 50 mg IM preoperatively. General anesthesia was induced with propofol 1.5-2.5 mg/kg, fontanyl 1-2mcg/kg and atracurium 0.5 mg/kg. Anesthesia was maintained with oxygen 100% , isofluran 1.2% and remifentanyl infusion 0.1mcg/kg/hr. Monitoring routinely included an ECG, pulse oximetry , capnography , non-invasive blood pressure monitoring and central venous line for central venous pressure monitoring. Systolic arterial was maintained within 20% the preoperative value by controlling doses of anesthetics, and giving ephedrine or metoprolol as necessary to treat changes in arterial pressures. The trachea was intubated with left sided DLT (bronchocath mallinchrodit). The size of DLT was chosen according to Brodesky, but be changed to meet the following criteria: a small air leak detectable with endobronchial cuff deflated and no leaks when inflated with a maximum of 3 ml air. Immediately after insertion, the correct position was

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confirmed by auscultation and fiber-optic bronchoscopy. The criteria for correct DLT position were adopted as unobstructed view into left upper and lower lobe bronchus through the endobronchial lumen with the bronchial cuff immediately below the carina and just visible in the main left bronchus through the tracheal lumen. The position was checked and corrected by fiber-optic after intubation and again after the lateral position. A pressure controlled ventilation mode was used. The inspiratory pressure was set at 15 cm H2O for two lung ventilation and the ventilator frequency was adjusted to maintain PCO2 around (30-35 mmHg), that's controlled by capnography.

Once the OLV started the inspiratory pressure was adjusted to 20-25 cm H2O. The assessment was done by adequacy of lung isolation and this done by the ITV (inspired tidal volume), ETV (expired tidal volume), the surgeon view, and airway pressure and blood oxygen saturation

Hypoxemia during OLV was defined when PO2 less than (80mmHg) 10.6 kpa (oxygen saturation less than 92%)2. Hypoxemia was treated by after checking the source of oxygen and suctioning the tube to exclude the obstruction then 5 cm H2O of PEEP was applied to the dependent lung at first then continuous positive airway pressure (CPAP) 5 cmH2O or 5 liters of apnea oxygen insufflations to the upper lung. Finally a brief period of total lung ventilation (TLV) were used if there is persistent hypoxemia. For each intervention a fiber-optic bronchoscope was done to allow correction of the tube position.

Statistical analysis: Analysis was done using descriptive statics. Data for continuous variable are expressed as mean (SD) with range maximum –minimum values. Hypothesis testing was done using the x2 test or fishers, exact test accompanied with the relative risk (RR) and its 95% confidence interval (CI). Result were considered significant at $p<0.05$.

Table 1 patients characteristic and features

	Mean(SD)	Range
Number	**80**	
Age(yr)	**53(13)**	**28-63**
Weight	**68(8)**	
Gender(M/F)	**48/32**	
Operative site(R/L)	**36/44**	
Surgical proce ocedure		
Lobectomy	**45**	
Biopsy	**19**	
Segmentectomy	**11**	
Achalasia	**5**	

Results:

The tube sizes were used 35F (9 patients), 37F (18 patients), 39F (34 patients) and 41F (19 patients). Malposition of DLT was detected bronchoscopically after patient positioning in 28 patients (35%) and 24 patients (30%) in OLV as shown in table 2. Treatment of hypoxemia was needed in 28 patients (35%). Twenty eight (28) patients (35%) had DLT malposition and eighteen (18) patients (22.8%) develop malposition during OLV and with hypoxemia in seventeen (17) patients (21%). Thus (64%) of patients with DLT malposition after lateral positioning developed again during OLV and (95%) of these patients experienced hypoxemia during OLV table 3.

Table 2 Intervention groups of patients . DLT malposition after patients positioning and in OLV. 28 patients with malposition after lateral positioning and use fiber-optic bronchoscopy. DLT malposioning was detected 24 patients in OLV even after confirmed with fiber-optic bronchoscopy after positioning.

	Number of patient n=80(100%)	DLT malposition detected Afterposi tioning n=28(35%)	DLTmalposition during OLV n=24 (30%)
No intervention	(65%)52/80	13/52(25%)	8/52(15.4%)
First intervention (PEEP)	(35%) 28	20/28(71%)	19/28(67.8%)
Second intervention Insufflations or (CPAP)	(20٪) ١٦	8/16(50%)	7/16(43.7%)
Third intervention (TLV)	(15%) 12	8/12(66.6%)	9/12(75%)

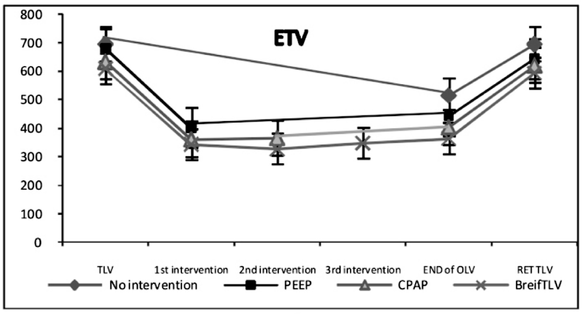
Table 3: Assessment of DLT positioning after patient positioning. DLT malposioning could occur after initial placement with fiber-optic bronchoscopy. DLT malposioning could occur during OLV even after initial conformation and correction of placement in lateral position with fiber-optic bronchoscopy.

Relative risk (RR), 95% confidence interval (95&)CI),and P values (x2test)between DLT malposition and each intervention.

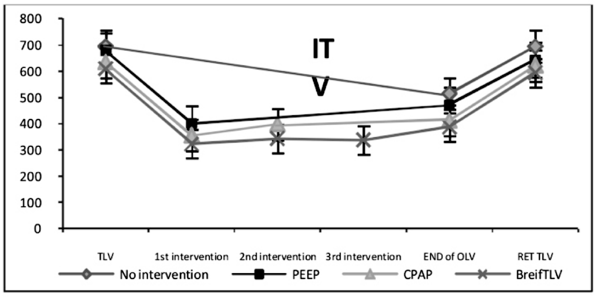
	DLT malposition after Patient positioning n=28	DLT acceptable positioning after patient positioning n=52	RR	95%CI	P
PEEP n=28	17	11	3.04	1.95-4.76	<0.05
Insufflation or CPAP =16	10	6	2.22	1.45-3.42	<0.01
TLV=12	8	4	2.21	1.27-3.54	<0.01
DLT malposition during OLV=24	18	6	4.31	2.79-6.66	<0.05

	DLT malposition during OLV n=24	DLT acceptable position during OLV n=56	RR	95% CI	P
PEEP n=28	20	8	12.2	5.41-27.1	<0.01
Insufflation or CPAP =16	12	3	5.05	3.15-8.06	<0.01
TLV=12	8	4	3.39	2.10-5.49	<0.01

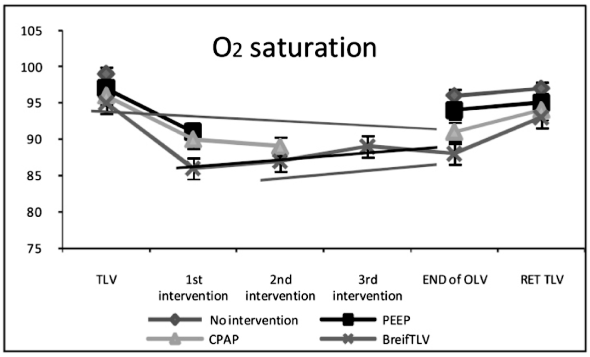
The values of the ITV, ETV and O2 saturation are measured. As the mode of ventilation is pressure controlled with peak airway pressure 20-25 cmH2O and PEEP 5 cm H2O and the tidal volume 6-8 ml/kg. We try to avoid a large tidal volume that lead to increase intrapulmonary shunting , and avoid small tidal volume that increase the incidence of the atelectasis. The measuring the airway pressure is mandatory in the OLV to provide measurement of tidal volume with measuring oxygen saturation. The respiratory rate is measured according the End-tidal CO2 that range between 30-35 cmH2O.



A



B



C

Fig changes in ITV and ETV .it shows the no intervention during OLV, 1st intervention just before application of PEEP in the dependent lung, 2 nd intervention just before insufflations of oxygen in the upper lung or CPAP and brief TLV during OLV and 3rd intervention just before application of brief TLV. Then the end of OLV just before the end of OLV fallowed by return (ReTLV) that ventilation with TLV. B show the inspired tidal volume(ITV) , A show the expired tidal volume(ETV) and C show oxygen saturation in the blood.

Discussion:

Using a DLT is the method of choice for lung separation and OLV for thoracic procedures. Which may be crucial if bleeding or secretion is a problem. Primary placement of the DLT as well as the danger of dislodgment due to patient position or surgical manipulation necessitate fiber optic monitoring during thoracic surgery10 .The malposition of DLT after placing in the lateral position had more hypoxemia during OLV, and persistent DLT malposition during OLV , even after correction of the DLT position with fiber optic bronchoscope. Malposition of DLT is movement of the tube of more than 1 cm in or out of the optimal positioning has been suggested as being clinically relevant and need for correction18. Subsequent manipulation by the surgeon by may lead to misplacement and increase the rate of hypoxemia 11. Some factors may predispose to malposition and hypoxemia during OLV. Factors such as the surgical procedure, move-ment of the mediastinum by the gravity, and compression by abdominal content might change the relationship between the DLT and the patient,s tracheobronchial anatomy 12 . The position of DLT is usually checked when hypoxemia is detected during OLV. We found that DLT malposition can happen repeatedly13. Patient with hypoxemia (11-35% of all patients) may involve patients with persistent DLT malposition. Campose and co-worker detected malposition despite initial adjustment using fiberoptic bronchoscopy in 12.5-25% of patients during OLV 5,6. S.Inoue and Nishimine detect (9-28%) may involve patients hypoxemia with persistent DLT malposition11. Hurford detect 44% need to readjust after initial intubation and 30% during operation with 18% complication that include hypoxemia, increase airway pressure and trauma1. The extension and the type of the disease affect the position of DLT and also ventilation. As many patients in our study with extensive malignancy, hydatid cyst, tuberculosis and emphysema. That can causes distortion of trachea and bronchi in addition to the compression effect. These are additional factors for malposion of DLT and hypoxia. We found that patients whose oxygenation improved had better lung isolation than those patients in whom oxygenation did not improve although each intervention made. The hypoxemia was treated by application of first PEEP to the dependent lung, then O2 insufflation or CPAP, then TLV if hypoxemia continue (Pao2 decrease) according to Lewis 1,14. We ventilate the lung with pressure controlled ventilation with peak pressure range 20-25 cm H2O and PEEP 5 cmH2O can be applied during OLV, that is very well tolerated with no deterioration in blood pressure, heart rate or stroke volume 15, and CPAP 5-10 cmH2O according to Tugrul 16. Tidal volume will be vary between 450-650 ml (6-8 ml/kg) depend on lung compliance and lung size. Any airways narrowing from DLT malposition will increase resistance and reduce tidal volume further 11. The small tidal volume allow atelectasis in the dependent lung and and a large tidal volume increase the shunt during OLV 17. Ventilation rate and inspiratory : expiratory ratio are altered according to end-tidal carbon dioxide of 30-35 mmHg and oxygen saturation did not decrease below 92% in any patients 11,17. Although the CPAP as a preventive measure in treatment of hypoxia , it's necessary to reinflate the collapsed lung by applying a high airway pressure and then using the CPAP to keep the lung at a constant level of inflation19. Support for this come from ITVs and ETVs during OLV. The patients who require more intervention and correction of DLT placement had a smaller ITV and ETV. This means patients develop ventilation failure during OLV caused by persistent DLT malposion11. Monitoring of airway pressure with ITV and ETV is important in deliver ideal tidal volume and prevention of hypoxemia. Alternative to DLT are univent tube, which is a single –lumen with enclosed bronchial blockers, can be easier to insert with use of fiber-optic 11, 19. However, the frequency of malposition can be greater than DLT 4, 20. Therefore frequent fiber-optic assessment seems necessary although further study needed.

Conclusion:

Patient with malpostion of DLT after lateral position were more likely to have malpostion of DLT in OLV and more likely to develop hypoxemia even sometimes with use of fiber-optic bronchoscopy for detecting the malposition. The measuring of ITV, ETV, oxygen saturation and ETCO2 is very helpful in detecting hypoxemia. The treatment the hypoxemia during OLV with a PEEP, oxygen isufflation or CPAP and lastly TLV. The fiber-optic bronchoscopy is very helpful in detecting the malposition of DLT after lateral position and in OLV.

Acknowledgement: I would like to thank professor waleed M. Hussen for his advices and revision.

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