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Comparison of the use of single lung ventilation Vs both lung ventilation in Video Assisted thoracoscopy

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Abstract- Lack of availability of medical instruments are frequent limitations in new-fangled surgeries in developing countries. Video-assisted thoracic surgery usually performed with Single lung ventilation (SLV) using a double lumen tube, at times lack of double lumen tubes necessitated the use of single lumen tubes with 'double lung ventilation' (DLV). The lack of evidence for the surgical and anaesthetic feasibility of the use of DLV dictated a review enabling a comparison with DLV for similar surgical procedures.

Both SLV and DLV provided adequate space for surgery .The changes in the cardio-respiratory parameters were similar during both as was blood loss. The insufflations pressures and the volumes of CO_2 required were similar.

The positive observation of easier re-expansion of the lung was noted in DLV. There were no unexpected post-operative complications following either mode of ventilation.

A single lumen endotracheal tube is a safe and effective alternative for VATs.

Index Terms- thoracoscopy, single lung ventilation, double lung ventilation

I. Introduction

Many medical institutions in developing and lower middle income countries constrains associated with equipment. As the Single lung ventilation (SLV) is the preferred mode of ventilation for patients undergoing thoracic endoscopic surgeries, lack of double lumen endotracheal tubes necessitates double lung ventilation (DLV).Data on the adequacy of surgical access and adverse effects on ventilation and cardiac output and effects of both lung ventilation in these surgeries are very scarce. We presents our observations on the surgical access , cardiorespiratory effects , the time , the risk of converting to open surgery, CO_2 usage with regards to its effects and excretion,the insufflation pressures used when DLV was a necessity. The procedures are compared when surgery was carried out using SLV.

In open surgery , Once the intrinisic negative pleural pressure dynamic is breached , the lung collapses and retracts toward the hilum due to intrinsic elasticity. [1] ,creating an Open pneumothorax . compaired to this In VATs the creation of Carbon dioxide tension simulate the effects of tension pnemothorax. This theoretically can lead to rise in intrathoracic pressure and reduces venous return, pulmonary blood flow and increases right heart workload[2]

In DLV carbon dioxide needs to be insufflated initially and intermittently into the chest cavity in contrast to Initial insufflation in SLV. Thus the total volume of CO_2 and the required insufflation pressures may be different. This effect can compress the ventilating lung in DLV instead of non ventilated lung as in SLV which may have adverse respiratory and cardiovascular effects.

The degree of lung collapse obtained in DLV should be adequate to provide space for instrumentation and dissection. In addition another issue to consider is the ongoing suction during surgery which has a tendency to get the lung to re expanded hindering dissection which is not a problem in SLV.

II. Method

A prospective study with data collected from patients who underwent VATS with DLV and SLV at the surgical unit, Teaching Hospital ,Peradeniya are reported .

At the site of camera port an incision was made and dissected until pleural cavity is entered using a scissor. This induces a small pneumothorax preventing any lung damage when the camera port is pushed in. CO2 insufflation was started initially to build a pressure of 6mmHg. The camera is introduced and the degree of lung collapse and mediastinal anatomy was inspected. Then two working ports were introduced. Gentle compression with instruments also facilitate lung collapse. Respiratory and cardiovascular parameters were monitored throughout the procedure. The gas insufflation pressure was increased until adequate lung collapse is achieved, while monitoring vital parameters. The insufflation pressure and the volume of CO_2 required to obtain the lung collapse were noted. The total volume of CO_2 required for the entire procedure was also recorded. The adequacy of space obtained for instrumentation and dissection was noted. The need for retractors was assessed. The space provided is reflected by safe completion of the procedure. As indices of this time for surgery, blood loss and conversion to open surgery were recorded.

III. Results

Table 1- procedures with the position and the mode of ventilation, the mean time blood loss, use of additional ports for retractors and conversion to open Surgery

Procedure	SLV	DLV	Position	Average time taken	Additional ports	Mean Blood loss	Conversion
Lymph node dissection	2	-	Supine	4 hr	Nil	150ml	Nil
Thymectomy	2	6	Supine	OLV- 3.5 hr DLV- 3.8 hr	One (OLV)	150ml	Nil
Thoracoscopy assisted excision of retrosternal goiter	-	2	Supine	4.5 hr	One(OLV)	150ml	Nil
Mobilization of thoracic esophagus in three stage esophagectomy	10	5	Prone	OLV- 2.5 hr DLV- 2 hr	Nil	100-150	Nil

Table 2- The required insufflations pressure, Initial CO_2 volume required to obtain lung collapse and total volume of CO_2used

Procedure	SLV	Insufflations pressure mmHg	Initial CO_2 volume	total volume	DLV	Insufflations pressure	Initial CO_2 volume	total volume
LND	2	6-8			-	-		
THY	2	6-8			6	6-8		
RTHY	-	6-8			2	6-8		
OES	10	6-8			5	6-8		

LND- Lymph node dissection THY- Thymectomy RTHY - Retrosternal goiter OES- esophagectomy

Table 3- The respiratory and cardiovascular parameters

a. Respiratory parameters compairing two ventilatory stratergies

		Peak air way pressures			Saturation change			End Tidal CO2			
	Changes from the base line	1-5	5-10	>10	1-3	3-5	5-10 drop	Red 1-5	Red 5-10	Inc 1-5	Inc 5-10above
THY	(OLV) 2	2			1	1				2	
	(BLV)6	6			6					6	
OES	(OLV)10	10			7	3				8	2
	(BLV)5	5			5					4	1

THY- Thymectomy OES- esophagectomy

b. cardiovascular parameters compairing two ventilator stratergies-

	Procedure	Heart Rate change			Blood Pressure change (Sys)			Blood Pressure change (Diast)		
	Changes from the base line	10-20	20-30	30-40	10-20	20-30	30-40 above	10-20	20-25	25-30 above
THY	(OLV)2	2				1	1	2		
	(BLV)6	5	1			6		6		
OES	(OLV)10	6	4		1	4	1	9	1	

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	(BLV)5	2	2			5		5		

THY- Thymectomy OES- esophagectomy

All the patients' respiratory and cardiovascular parameters were stable and not significantly different in both ventilator statergies during the equivalent procedures

Surgical team special notes

In both ventilatory situations the space obtained provided a clear display of the lesion and the related anatomy for a safe dissection. There was adequate room for instrumentation. Only one thymectomy and retrosternal thyroidectomy required a retractor. This was to retract the pathology and not the lung.

A re expansion of the lung during the surgery was experienced with DLV , which could hinder the dissection . But Once this was experienced the cause was identified as suction. The suction of blood /fluid only and not applying the suction too long to the space obviate this setback, and practiced in later cases. However quick re collapse was not identified as a problem .

Another comment was that with DLV the re-expansion of the lung was found to be easier simply by shutting down CO_2.

Post Operative period

One patient with retrosternal goiter who had both lung ventilation was electively ventilated for 24 hrs due to the extent of the resection. All Oesophagectomy patients were ventilated with a range of 2-5 days having both groups mixed up. One patient with OLV and one with BLV had respiratory tract infection and BLV patient had a leak on to the necks and both patients died After two weeks and three weeks respectively. Thymectomy patients were observed in the intensive care unit for 16- 24 hrs no complications detected. Other post esophagectomy patients were discharged from ICU by fourth day. The thymectomy and retrosternal goiter patients were sent to the ward on day one. All other patients were managed in the ward.

IV. Discussion

There is a possibility the capnothorax can act like a tension pneumothorax. This is likely as reported by Peden CJ, Prys-Roberts C[7] either the lung deflated too fast or the CO2 was insufflated too rapidly . Both situations were explained when doing the SLV. In the observations in this study , SLV and DLV both did not caused any adverse changes of cardio – respiratory parameters. In DLV this may be less as the lung is partially collapse by the tcapnothorax. The possible hypoxia explained in the SLV also will be less likely in DLV hence both lungs are ventilated with minimal shunt.

Intraoperative access of DLV was similar with same adjustments with SLV and did not show much deference of the time (Table1). The insufflation pressures showed a slight increase in the pressure used with DLV compared to its equivalent surgery with SLV (Table 2)

In both situations the procedures were performed with minimal blood loss . The important fact to note was there was no requirement of the additional ports for Retractors and no conversion to open Surgery when using DLV. This indirectly indicates that the space obtained must have provided a clear display of the lesion and the related anatomy for a safe dissection. It was evident that there was adequate room for instrumentation. Only one thymectomy and retrosternal thyroidectomy required a retractor. This was said to be to retract the pathology and not the lung.

In DLV theoretically a high insufflation pressures and volumes are required to partially collapse the lung to provide surgical access. This is not a necessity during SLV . In all cases the maximum insufflation pressure used was 6-8mmHg. But it was pointed out that in long major procedures The CO_2 volume required for initial collapse and the total volume for the procedure was more with double lung ventilation. Though large volumes of CO^2 was used during DLV there was no complications detected (Airway pressures, Hypercapnoea) during Surgery.

With double lung ventilation it was reported to be possible to simply re-expand the lung by shutting down CO_2 , This may be an advantage in long procedures.

Eventhough there were some complications noted in the post operative period in major procedures like Oesophagectomy it is seems there is no difference between the two ventilatory statergies.

V. Conclusions

The space provided for surgery is not different whether single lung or double lung ventilation was used. The gas insufflations pressure has no significant difference. The total volume of CO_2 used is higher in double lung ventilation but had no adverse out come. Therefore double lung ventilation with a lung collapse induced with a capnothorax of 6-8mmHg can be safely and effectively be used in thoracoscopic surgeries. It will certainly avoid the difficulties encountered with intubation with a double lumen tube and complications of One lung ventilation. It also allows a simple and quick re-expansion of the lung when required.

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