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RESEARCH ARTICLE

COMPARING COMPUTED TOMOGRAPHY GUIDED BRONCHIAL WIDTH MEASUREMENT VERSUS CONVENTIONAL METHOD OF SELECTING DOUBLE LUMEN TUBE IN PATIENTS REQUIRING ONE LUNG VENTILATION-A PROSPECTIVE OBSERVATIONAL STUDY

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Key words:-

Double Lumen Tube, One Lungventilation, Leftmainbronchus Width Ctsan,

Abstract

Aim: The study was conducted to compare CT guided bronchial width measurement against conventional method of DLT insertion for one lung ventilation.

Materials and Methods: A prospective randomised observational study conducted in 52 adult patients who underwent elective thoracic surgery.

GroupA-based on demographic characters..

GroupB-based CT scan measurement of LMB width.

Data analysis : In this study, statistical analysis was done using SAS (statistical analysis system) software. All the categorical variables were described using mean and standard deviation, while the continuous variables were described in frequency and percentages.

Results: Group A(male), revealed a correlation of 68.75% . Group B(male), revealed a correlation of (88.23%). Group A(female) revealed a correlation in 70% .Group B(female) revealed a correlation of 77.7%.

Conclusion: We conclude that selection of DLT by Conventional method is reliable and in patients with height of less than 160 cm, selection of DLT by CT scan measured Left Main Bronchial Diameter improves the success rate and reduces the complications.

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Introduction:-

To perform one-lung ventilation, there are three options for lung isolation, the double-lumen tube (DLT), bronchial blocker (BB), and single-lumen endobronchial tube. Among these, the Double lumen tube is commonly used for one lung ventilation.

The selection of an appropriate size tube for lung isolation has been referred to as one of the "dark arts" in the practice of anesthesia, which poses several difficulties. One of such difficulties in double lumen tube insertion is the correct placement of the bronchial end of the tube in the left or right main bronchus. Choosing the correct size tube certainly facilitates successful insertion.

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Selecting the correct size double lumen tube is especially difficult because sometimes the internal diameter of the left main bronchus does not correlate closely with the demographic characteristics like the height, weight, age, or sex. An objective method for predicting the appropriately sized double lumen tube is likely to reduce the incidence of airway trauma during intubation, reduce the incidence of failed attempts, the need for repeated intubation attempts, and reduce associated costs. In studies conducted in Caucasian and Asian populations, CT scans have been used to calculate the appropriate diameter of the left main bronchus in the patients, and it has been found that prediction of double lumen size based on the diameter of the left main bronchus is fairly accurate. However, there are not many studies in the published literature to determine DLT size in the Indian population.

Hence, we have designed this study to compare the appropriate size of the left-sided double lumen tube which can be used in the adult patients requiring lung isolation with the size of the double lumen tube based on the diameter of the left main bronchus from the CT (computerized tomography) scan of the thorax.

Aim of the study:-

The aim of the study is to determine the appropriate size double lumen tube for lung isolation.

Primary Objectives:

To compare the CT guided left main bronchus diameter versus the conventional method of using demographic characteristics (height, sex) in selecting the correct size DLT.

Secondary Objectives:

1. To compare the time taken for DLT insertion between both the groups.
2. To compare the number of attempts taken for DLT insertion.

Materials and Methods:-

52 adult patients presenting for various elective thoracic surgeries requiring one lung ventilation under general anaesthesia were randomly assigned into two groups using computer generated randomized numbers.

Group A-Conventional method for selecting DLT size (based on height and sex)

Group B-CT-guided selection of the DLT

Study Design:

Prospective randomised Observational Comparative Study

Study Centre:

Cardiothoracic Surgery Operation Theatre, Rajiv Gandhi Government General Hospital, Park Town Chennai-3

Study Population:

Based on the previous study by Chow et al¹⁶, that had a positive predictive value of 84% acceptance error of +/- 10% and level of significance (alpha) 0.05, type 2 error (beta) 20% and power of study (1 - beta) 80% CI of 95% and sample size is calculated using the formula

$$N = Z^2pq / d^2$$

and it is found to be 52

Duration Of Study: January 2022 to December 2022

Inclusion Criteria:

1. Age: 18 years to 70 years
2. ASA: I to IV
3. Surgery: Elective
4. Who have given valid informed consent.
5. Normal tracheal lumen

Exclusion Criteria:

1. Allergic to drugs used
2. Patient refusal

3. Patients with anticipated difficult airway
4. Patients requiring emergency surgeries
5. ASA PS V
6. Patients requiring Right sided DLT

Materials:-

1. Mallickendrot Bronchocath leftDLTs 28,32,35,37,39,41Fr
2. Flexible Fiberoptic bronchoscope
3. Syringes
4. Lubricant jelly
5. Leak free circle system with CO₂ absorbant
6. Drugs for General Anaesthesia and emergency drugs
7. Monitors: ECG, IBP, Pulse oximetry, Temperature probe, respiratory gas monitor, Capnometry.

Methodology:-

Patients posted for elective surgeries requiring one lung ventilation under general anaesthesia and those who satisfied inclusion criteria and had given written informed consent were divided into two groups by computer generated randomised numbers, Group A and B.

Premedication was given, multipara monitoring devices were attached and baseline vital parameters were documented. After securing an intravenous line, induction of general anaesthesia was performed. Both the groups of patients received the same drugs calculated to their weight for anaesthesia and maintenance.

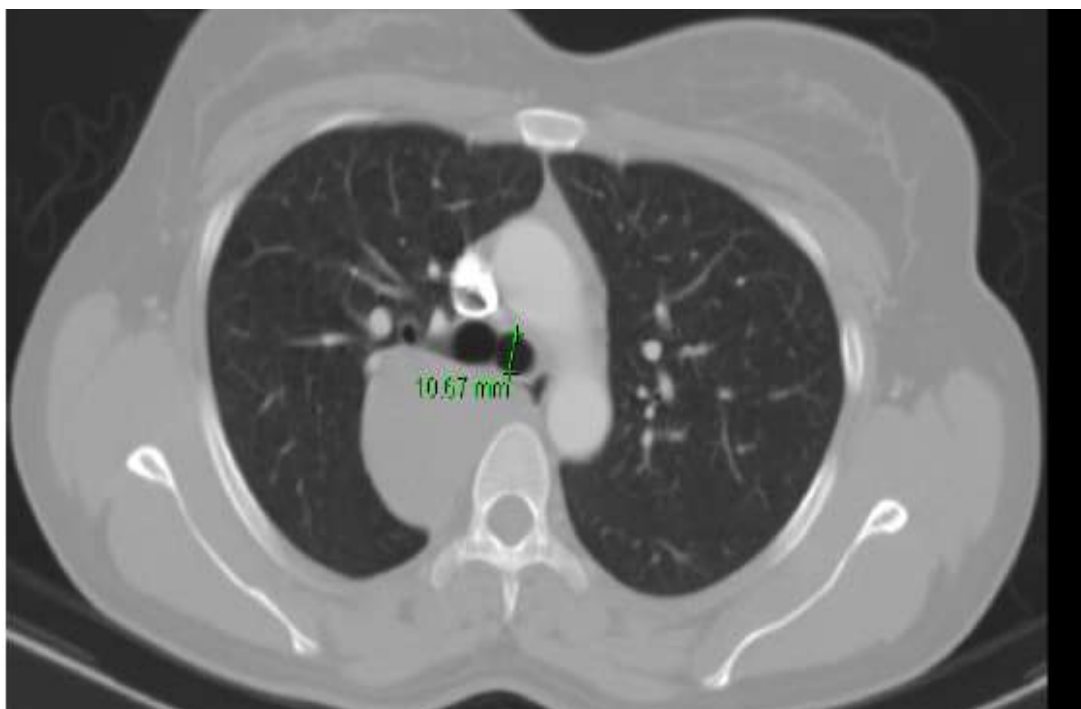
Patients in Group-A were intubated with a DLT whose size was based on the demographic characters like height and sex.

The size of the double lumen tube based on the height and sex of the patient was determined using the following criteria according to the 9th edition of Miller's Anaesthesia².

Males		Females	
Height(cm)	DLT Size	Height(cm)	DLT Size
>170	41Fr	>160	37Fr
160-170	39Fr	152-160	35Fr
<160	37Fr	<152	32Fr

Patients in Group-B were intubated with a DLT whose size was derived from the CT scan guided diameter of left main bronchus.

On the CTscan of thorax, diameter of the bronchus was measured at the level of the carina, where the right, left bronchi were seen as a singular structures. The measurements were done in antero-posterior dimension, and perpendicular to the long axis of the bronchus.⁷



Measurement of the left mainstem bronchus from CT-Thorax, Green line denotes the left main bronchus diameter.

The size of the double lumen tube based on the bronchial diameters from CT scan was chosen using the following criteria¹⁷.

LMBD(mm)	<10	10-11	11-12	12-13	>13
DLT (Fr)	32	35	37	39	41

The time taken for insertion of the DLT²³, the number of attempts required to insert the DLT, and complications, if any, that occurred during intubation were documented and analysed.

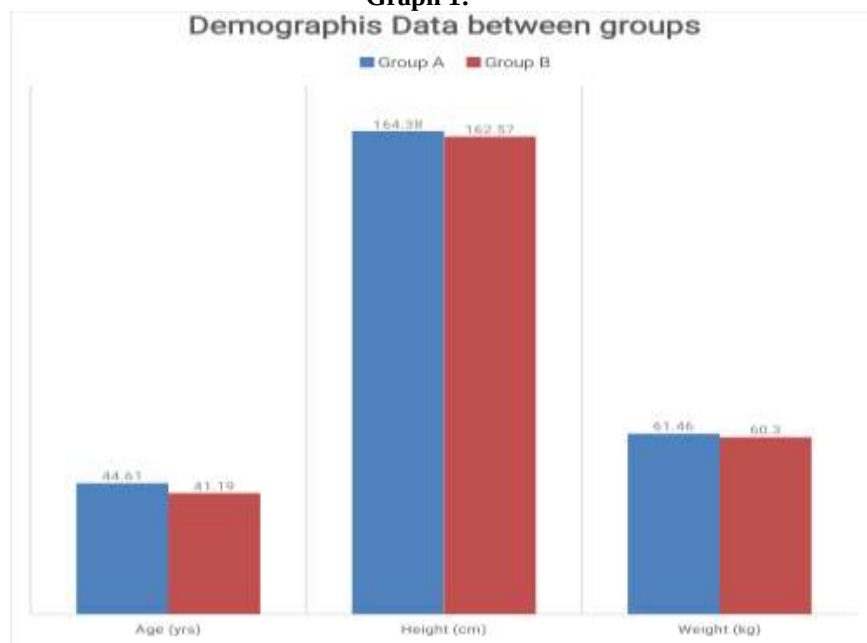
Observation and Results:-

Demographic data

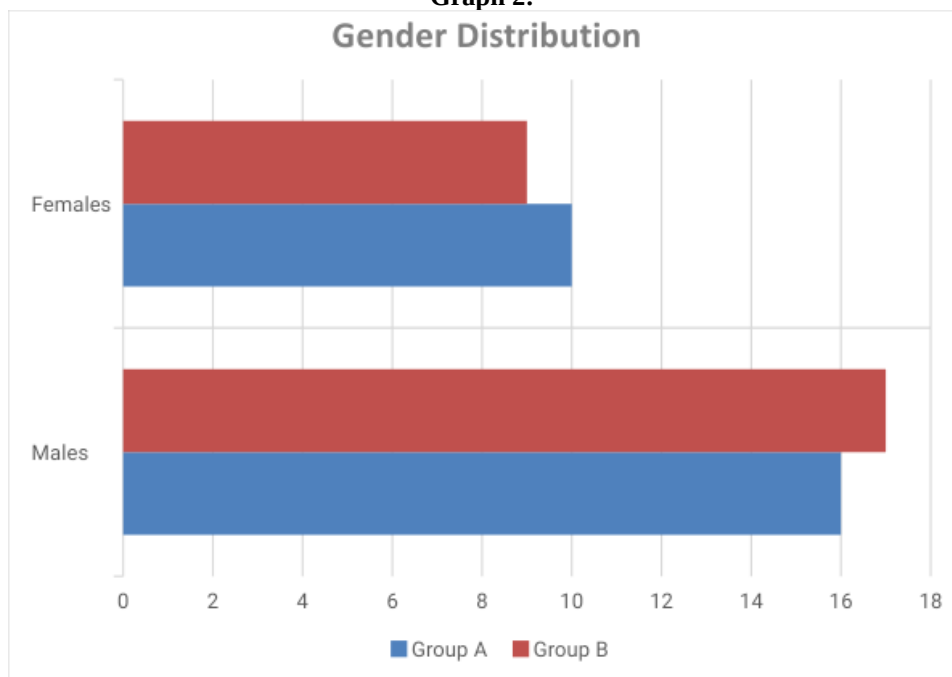
Table 1:-

	Group A N=26		Group B N=26		P value
	Mean	SD	Mean	SD	
Age (years)	44.61	8.70	41.19	11.04	0.22
Height (cms)	164.38	7.53	162.57	8.23	0.41
Weight (kg)	61.46	10.50	60.30	8.15	0.65

Both the groups were comparable in terms of their Age, height and weight with $P > 0.05$.

Demographic data**Graph 1:-****Gender distribution****Table 2:-**

	Group A N=26		Group B N=26		Total
	n	%	n	%	
Males	16	61.25	17	65.38	33
Females	10	38.46	9	34.61	19

Gender distribution**Graph 2:-**

The distribution of males and females in Group A was 61.25% and 38.46% while the same was 65.38% and 34.61% in Group-B

Comparison between Gender and Demographic data

Table 3:-

	Males		Females	
	Mean	SD	Mean	SD
Age (yrs.)	43.27	9.67	42.26	10.79
Height (cm)	168.39	3.99	154.94	5.09
Weight (kg)	64.79	7.82	54.10	7.38

Both the sex were comparable in terms of their Age, height and weight with $P > 0.05$

Size of DLT in males and Females

Table 4:-

Size of DLT	Males	Females
28 Fr	-	1
32 Fr	-	7
35 Fr	-	8
37 Fr	8	3
39 Fr	15	-
41 Fr	10	-

DLT size chosen by Bronchial diameter of the patient vs DLT size used for OLV in males in Group B

Table 5:-

DLT size based on Bronchial diameter	DLT size used in Males			Total
	37 Fr	39 Fr	41 Fr	
37	2			2
39	1	9		10
41		1	4	5
Total	3	10	4	17

Among Group B, comparison of the double lumen tube size used to achieve lung isolation and the ventilation in the 17 males with the double lumen tube size predicted from the bronchial diameter as measured from the CT-thorax revealed a correlation in 15 out of 17 males in group B (88.23%). 2 males (11.7%) were intubated with a DLT smaller than the predicted size from bronchial diameter.

Table 6:- DLT size chosen by Bronchial diameter of the patient vs DLT used for OLV in females in Group B.

DLT size based on Bronchial diameter	DLT size used in Females				Total
	28Fr	32Fr	35 Fr	37 Fr	
32	1	3			4
35		1	3		4
37				1	1
Total	1	4	3	1	9

Among Group B, comparison of the double lumen tube size used to achieve lung isolation and the ventilation in the nine females with the double lumen tube size predicted from the bronchial diameter as measured from the CT-thorax revealed a correlation of 77.7% (7 out of 9 females). 22.3% (two females) were intubated with a double lumen tube smaller than the predicted size from bronchial diameter.

Table 7:- DLT size chosen by Height and Sex of the patient(Group A)vs DLT used for OLV in males.

DLT Height	DLT Used in Males			Total
	37Fr	39 Fr	41 Fr	
39	5	5		10

41			6	6
Total	5	5	6	16

Among Group A, comparison of the DLT size used to achieve lung isolation and the ventilation in the sixteen males with the DLT size predicted from the height and Sex revealed a correlation of 68.75% i.e, 11 out of 16 males in group A.

Five males (31.25%) were intubated with a DLT smaller than the predicted size from demographic data.

Table 8:- DLT size chosen by Height and Sex of the patient vs DLT used for OLV in females.

DLT size based on Height and sex	DLT Used in Females				Total
	28Fr	32Fr	35 Fr	37 Fr	
32		2			2
35		1	3		4
37			2	2	4
Total	0	3	5	2	10

Among Group A, comparison of the DLT size used in the ten females with the DLT size predicted from the height and Sex revealed a correlation in 70% i.e, 7 out of 10 females in group A.

The rest of the three females (30%) were intubated with a tube smaller than the predicted size from demographic data.

Table 9:- DLT size chosen by Height and Sex of the patient vs DLT chosen by Bronchial Diameter for OLV in males.

DLT size based on Height and Sex	DLT predicted by Bronchial diameter in males			Total
	37 Fr	39 Fr	41 Fr	
39	5	5		10
41			6	6
Total	5	5	6	16

Table 10:- DLT size chosen by Height and Sex of the patient vs DLT chosen by Bronchial Diameter for OLV in females.

DLT size based on Height and sex	DLT predicted by Bronchial diameter in Females				Total
	28Fr	32Fr	35 Fr	37 Fr	
32		2			2
35		1	3		4
37			2	2	4
Total	0	3	5	2	10

Table 11:- Complications with DLT insertion:

		Male			Female			X ²
		Group A	Group B	Total	Group A	Group B	Total	
		16	17		10	9		
Failure to advance	No	13	14	27	7	9	16	1.0
	Yes	3	3	6	3	0	3	
Inadequate isolation	No	15	14	9	10	7	17	0.19
	Yes	1	3	4	0	2	2	
Trauma during insertion	No	16	17	33	10	9	19	-
	Yes	0	0		0	0	0	
DLT into wrong side	No	16	17	33	10	9	19	-
	Yes	0	0		0	0	0	

Table 12:- Demographic data and size of DLT used.

	28Fr	32Fr	35Fr	37Fr	39Fr	41Fr
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Height (cm)	148	151.14 $\pm$ 2.47	156.87 $\pm$ 4.25	164.09 $\pm$ 2.62	166.6 $\pm$ 2.13	173.6 $\pm$ 1.89
Weight (kg)	50	49.71 $\pm$ 9.9	56.65 $\pm$ 5.09	62 $\pm$ 5.27	63.4 $\pm$ 8.83	68.2 $\pm$ 7.53
Age (yrs.)	58	38 $\pm$ 13.8	43.25 $\pm$ 8.64	45.90 $\pm$ 8.08	42.53 $\pm$ 10.02	41.8 $\pm$ 9.78
Sex	1F	7F	8F	3M + 8F	15M	10M
LMBD (mm)	9.7	9.85 $\pm$ 0.31	10.5 $\pm$ 0.10	11.8 $\pm$ 0.41	12.63 $\pm$ 0.22	13.3 $\pm$ 0.18

Table 13:- Height in relation to DLT size used and LMBD in males.

Height (cm)	<160	160-170	>170
LMBD (mm)		12.4 $\pm$ 0.372	13.3 $\pm$ 0.164
No.of DLTs used		37Fr= 8 39Fr= 15 41Fr= 1	41Fr= 4

According to the Sex and height criteria for selection of DLT size, if a male is less than 160cm tall, a 37Fr DLT may be considered. None of the male study population in our study were less than 160cm.

A DLT of size 39Fr is considered for males between 160-170cm. The mean LMBD of this height group observed was 12.4 $\pm$ 0.37mm. 15 out of 24 males(62.5%) were intubated with 39Fr DLT.

A DLT of size 41Fr is considered for males above a height of 170cm. The mean LMBD of this height group observed was 13.3 $\pm$ 0.16mm. 4 out of 4 males(100%) were intubated with 41Fr DLT.

Table 14:- Height in relation to DLT size used and LMBD in females.

Height (cm)	<152	152-160	>160
LMBD (mm)	9.9 $\pm$ 0.469	10.46 $\pm$ 0.541	
No.of DLTs used	28Fr= 1 32Fr= 4 35Fr= 1	32Fr= 3 35Fr= 5 37Fr= 1	

According to the Sex and height criteria for selection of DLT size, if a female is less than 152cm tall, a 32Fr DLT may be considered. 4 out of 6(66.7%) female study population in my study were intubated with 32Fr DLT, while one each were intubated with a DLT size smaller(16.7%) than the predicted and larger(16.7%) than the predicted DLT size.

A DLT of size 35Fr is considered for females between 152-160cm. The mean LMBD of this height group observed was 10.46 $\pm$ 0.54mm. 5 out of 9 females(55.5%) were intubated with 35Fr DLT.

A DLT of size 37Fr is considered for females above a height of 160cm. None of our female study population were taller than 160cm

Table 15:- Comparison of time taken to Insertion of DLT. Time(sec)

Group A		Group B		P value
Mean	SD	Mean	SD	0.388
84.34	20.55	90.96	32.93	

Table 16:- Comparison of number of attempts taken to insert DLT.

Group A		Group B		P value
Mean	SD	Mean	SD	0.23
1.34	0.48	1.53	0.64	

Discussion:-

Decades after the introduction of one-lung ventilation and isolation¹, the choice of size of the double lumen tube for an individual is primarily based on the anaesthesiologist's personal experience and preference or on formulas based on the patient's height and Sex.

The use of double-lumen tube would be associated with greater safety and success if more objective criteria were used to select the size of double-lumen tube.

In our institution, selection of double-lumen tube size is often based on the experience of the anaesthesiologist or on the criteria of height and sex.

Over the years, studies have been conducted to evaluate the usefulness of more objective criteria for selection of double-lumen tube size, such as tracheal diameter based on chest radiography or bronchial diameter based on computed tomography of the chest⁵.

In the present study, we considered the height and Sex of the patients for selecting the size of DLT in one group versus the diameter for the left main bronchus measured from the computer tomographic scan of the chest.

The computed tomography (CT) imaging of the thorax was routinely performed in patients undergoing elective surgery requiring lung isolation with a DLT and we can readily visualise the left main bronchus and measure its diameter. In studies performed on Caucasian and Asian patients, imaging scans were used to measure the LMBD (diameter of the left mainstem bronchus), and it was noticed that prediction of the size of the tube based on the diameter of the left mainstem bronchus was fairly accurate⁷.

In our study, Thirty three male and nineteen female patients of Indian origin were included. Successful isolation of the lung after the first intubation attempt with a double-lumen tube was 59.61% (31/52). The success rate was 57.8% (11/19) in females and 60.6% (20/33) in males. Most female study patients were intubated with a 35-F DLT (8/19, 42.1%) and 32Fr DLT (7/19, 36.8%) and most male patients were intubated with a 39-F DLT (15/33, 45.45%) and 41Fr DLT (10/33, 30.30%). Our study results were comparable to those done by Praneeth Suvvari²¹ et al and Chow¹⁷ et al.

We agree with Hannallah⁷ et al that measurements on CT scans require training and may not be accurate when performed by amateurs. Measurements of the diameter of the left main stem bronchi from computed tomography of the chest were performed by a single consulting radiologist, similar to previous studies by Hannallah⁷ et al. and Chow¹⁷ et al. The left main bronchial diameter was measured in the first slice of the CT scan just posterior to the carinal plane, where the two bronchi became visible as individual structures. The diameter of the bronchus was measured using a fine caliper placed perpendicular to the bronchus (long axis).

The correlation between DLT sizes used to achieve one-lung isolation and ventilation in study patients by Conventional method and DLT sizes based on the left main bronchial diameter were analysed. Although no statistically significant correlation was found between both the groups, the highest correlation for correct DLT size inserted was with DLT size based on CT-guided LMB diameters (88.23% in males, 77.77% in females) rather than the conventional method derived from the Sex and height of the individual (68.75% in males and 70% in females).²¹

Comparison of our study with the study conducted by Chow¹⁷ et al. shows that the height of the Indian woman is similar to that of the Southeast Asian woman.

Analysis of complications related to DLT insertion (i.e., failure to advance the DLT, inadequate isolation, trauma, and wrong side) in relation to Sex were statistically insignificant. The inter-group differences in the occurrence of the complications were also statistically insignificant.

It was seen that four patients (15.38%) (2 male and 2 female) received an oversized DLT from Group B, where as eight patients (30.76%) (5 male, 3 female) received an oversized DLT predicted from Group A. Complications resulting from the introduction of an oversized DLT resulted in the form of failure to advance the DLT were seen in six (23.07%) in Group A, while it was seen in three (11.5%) in Group B.

One female in group B was 148cm tall and the predicted DLT size was 32Fr. However we failed to insert the 32Fr DLT. The CT guided LMBD was not measured and if calculated, the necessity for reinsertion of a different sized DLT would have been avoided.

In our study population 5/16 males (31.25%) and 3/10 females (30%) in Group A had to be intubated with smaller than the DLT size as predicted by the demographic variables. The additional use of CT-guided LMBD would have been useful for predicting the appropriate size of DLT in group A. Failure to advance the double-lumen tube and multiple intubation attempts could have been avoided if the bronchial diameter had been measured before placement of the double-lumen tube²¹.

Since our numbers are small, we cannot derive statistically significant results from these observations. In view of the above observations, it may be recommended that in short statured women, bronchial diameter should be used in addition to the height of the individual to select the appropriate size of the double lumen tube in order to improve the success rate and minimize complications as per the study by Sato Mika²⁵ et al.

Conclusion:-

In this Prospective randomised Observational Study comparing Computed Tomography guided Bronchial Width Measurement versus Conventional Method of selecting Double Lumen tube, we conclude that selection of DLT by Conventional method is reliable and in patients with height of less than 160 cm, selection of DLT by CT scan measured Left Main Bronchial Diameter improves the success rate and reduces the complications.

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