

Practice Patterns of Left-Sided Double-Lumen Tube: Does it Match Recommendation from Literature – A Single-Centre Observational Pilot Study

Abstract

Context: Choosing appropriate-size double-lumen tube (DLT) has always been a challenge as it depends on existing guidelines based on gender, height, tracheal diameter (TD), or personal experience. However, there are no Indian data to match these recommendations. **Aim:** To find out whether the size of DLT used correlates with height, weight, TD, or left main stem bronchus diameter (LMBD). We also documented clinical consequences of any of our current practice. **Setting and Design:** Single-center observational pilot study. **Subjects and Methods:** Prospective, observational study of 41 patients requiring one-lung ventilation with left-side DLT. The choice of DLT was entirely on the discretion of anesthesiologist in charge of the case. Data were collected for TD, LMBD, height, weight, age, sex, and amount of air used in the tracheal and bronchial cuff. Any intraoperative complications and difficulty in isolation were also noted. **Statistical Analysis:** The statistical analysis was done with the National Council of Statistical Software version 11. **Results:** Average TD and LMBD were 16.5 ± 0.9 and 10.7 ± 0.8 mm for males and 14.2 ± 1.1 and 9.4 ± 1.1 mm for females, respectively. There was a weak correlation between DLT size and height ($R^2 = 0.0694$), TD ($R^2 = 0.3396$), and LMBD ($R^2 = 0.2382$) in the case of males. For females, the correlation between DLT size and height ($R^2 = 0.2656$), TD ($R^2 = 0.5302$), and LMBD ($R^2 = 0.5003$) was slightly better. **Conclusion:** Although there was a weak correlation between DLT size and height, TD, and LMBD, the overall intraoperative outcome and lung isolation were good.

Keywords: Computed tomography, double-lumen tube, height, left main bronchus diameter, tracheal diameter

Introduction

Double-lumen tube (DLT) is the key to the success of thoracic surgeries requiring one-lung ventilation. The options for lung isolation are many, among which DLT and bronchial blockers are a few of them. DLT has gained popularity due to its ease of use, minimal spillage of contents to another lung, and ability to provide ventilation separately to both lungs if required. The anatomical advantage of the longer left main bronchus has directed anesthetists to preferentially use a left-sided tube whenever feasible.^[1,2] Many authors have suggested the use of height, tracheal diameter (TD), and left main stem bronchus diameter (LMBD)-based formulas for determining the appropriate size of DLT.^[3] Based on the above background, we conducted the present study to find out the practice patterns of DLT use at our institute,

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correlation of DLT with height, TD, and LMBD, and the clinical consequences of any of the present practice.

Subjects and Methods

This was an observational study conducted in our institute from June 2017 to November 2017. Following approval from the Institutional Ethics board and a written informed consent from patients, this prospective, observational pilot study was carried out in 41 adult patients of either gender with age between 18 and 60 years undergoing elective thoracic surgery and lung isolation with left-side DLT. Patients with anticipated difficult intubation, abnormalities of airway (burn contractures and cleft lip or palate, temporomandibular joint ankylosis, and faciomaxillary injury or anomalies), patients with distorted anatomy of tracheobronchial tree (tracheal web, rings, or stenosis), and those undergoing emergency surgery were

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Prachi Kar,
Archana Pathy,
Ayya Syama
Sundar,
Ramachandran
Gopinath,
Srilata Moningi

Department of Anaesthesiology
and Critical Care Nizams
Institute of Medical Sciences,
Hyderabad, Telangana, India

Address for correspondence:

Dr. Archana Pathy,
Department of Anaesthesiology
and Critical Care, Nizams
Institute of Medical
Sciences, Punjagutta,
Hyderabad, Telangana, India.
E-mail: docarchana.pathy@
gmail.com

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excluded from the study. Patients with unanticipated difficult intubation were excluded after inclusion.

All the patients received routine premedication in the form of ranitidine 150 mg and alprazolam 0.5 mg on the night before surgery. Monitoring was done with standard electrocardiogram, pulse oximetry, end-tidal carbon dioxide, temperature, invasive blood pressure, and central venous pressure. Thoracic epidural catheter was placed at incision congruent level if there was no contraindication. All the patients received a standardized institutional anesthetic protocol. After adequate muscle relaxation, patient's trachea was intubated with left-sided DLT. The choice of the size of DLT was totally at the discretion of the concerned anesthesiologist in charge of the patient. As a part of the institutional protocol, if air leak persisted on isolation even after inflation of bronchial cuff with 4 ml of air, the tube was considered undersized, and it was changed with the immediate larger sized tube available. Similarly, inability to pass DLT beyond glottis or resistance in passing was considered oversized tube and was replaced with the immediate smaller sized tube available. The proper placement of DLT was also checked with fiberoptic bronchoscope.

Various intraoperative maneuvers used in the event of intraoperative isolation problem such as pushing the tube inside, pulling the tube outside, and changing of ventilation mode (e.g., switch to pressure-controlled volume guaranteed [PCV-VG]) inflation of bronchial cuff further with extra amount of air were also noted down. Intraoperative airway pressure, air leak, and hypoxemia were also noted. Intraoperative hypoxemia was defined as SpO₂ less than $\leq 92\%$ at any point of time during surgery. The number of attempts required for DLT placement was also noted. The amount of air required for inflation of tracheal and bronchial cuff was also noted.

Demographic data such as age, sex, height, and weight were collected. The tracheal and left main bronchial diameters were also noted. The TD was measured at the level of clavicular heads. The left main bronchial diameter was measured at a plane 1 cm below the slice that showed carina where the left main bronchus was seen. The measurements were done by the same radiologist, preoperatively, each time to reduce inter-observer bias and confusion. Medweb software (Bloomberg @ inc.) and digital ruler were used in all cases. With digital ruler, the measurements were done to the nearest millimeter. Pixel-by-pixel and zooming-in images resulted in better accuracy and precision during measurement. Patients were followed up in the postoperative period for occurrence of sore throat and pneumothorax which might have occurred due to mismatched tube size or airway trauma.

Statistics

Data were collected, and statistical analysis was done using National Council for Statistical Software (NCSS) version 11 (NCSS Statistical Software, Kaysville, Utah, USA).

Descriptive data were presented as mean and standard deviation. Correlation was done with Spearman's correlation analysis.

Results

A total of 43 patients were recruited for the study, out of which two patients were excluded from the study due to unanticipated difficult intubation. Data of 41 patients were collected. Out of which, 18 (44%) underwent lobectomy, 6 (14.6%) pneumonectomies, 10 (24.4%) decortications, and 7 (17.5%) were other procedures (mediastinal masses, chest wall tumor, or bullectomy). There were 28 (68.3%) males and 13 (31.7%) females. Demographic data and airway diameters are described in Table 1.

Surgeons complained of inadequate surgical exposure due to inadequate isolation only in one case out of 41. In three cases (7.31%), high airway pressure (>35) was observed and was managed with alternate ventilation strategy such as PCV-VG. The amount of air inflated in tracheal cuff was on average 7.3 ± 1.1 ml and 6.6 ± 0.7 ml for males and females, respectively. The amount of air inflated in bronchial cuff was 3.5 ± 0.6 and 3.0 ± 0.8 ml for males and females, respectively. In two cases, extra air was required to inflate bronchial cuff after positioning to achieve good isolation. In the study cases, we had not used nitrous oxide which is routine practice in our institute. Prolonged hypoxemia was not documented in any of our study patients. There was no incidence of postoperative sore throat or pneumothorax.

The majority of males (75%) were intubated with 37 Fr DLT followed by 35 Fr (21.4%) and 32 Fr in 3.6%. In majority of females, 32 Fr (69.2%) DLT was used followed by 35 Fr (23.1%) and 28 Fr in 7.7% cases. Spearman's correlation analysis revealed a weak correlation of height with DLT size selected in both males and females. However, correlation of TD and LMBD with DLT was better in females as opposed to males. The details of correlation are described in Table 2 and Figures 1-3.

Discussion

The present observational pilot study revealed that smaller DLT (than recommended) is used for lung isolation in

Table 1: Demographic data

	Mean±SD	
	Male (n=28)	Female (n=13)
Age	39.11±9.382	40.00±14.177
Height (cm)	165.54±4.509	151.69±4.328
Weight (kg)	51.21±9.500	49.46±8.353
Tracheal diameter (mm)	16.54±0.962	14.23±1.166
Left main bronchus diameter (mm)	10.71±0.897	9.46±1.127
Bronchial cuff (ml)	3.50±0.694	3.00±0.816
Tracheal cuff (ml)	7.36±1.162	6.62±0.768

SD: Standard deviation

Indian anesthetic practice, and there is a weak correlation of height, TD, and LMBD with DLT size; however, this

did not lead to any clinically appreciable problems in lung isolation, surgeon complaints, or complications associated with spillage.

Table 2: Correlation between double-lumen tube, left main bronchus diameter, tracheal diameter, and height

	Female			Male		
	LMBD	TD	Height	LMBD	TD	Height
Correlation	0.7073	0.7282	0.5156	0.4880	0.5827	0.0048
R ²	0.5003	0.5302	0.2658	0.2382	0.3396	0.0694

LMBD: Left main bronchus diameter, TD: Tracheal diameter

It is important to choose an appropriate-size DLT to avoid the complications and expenses associated with a tube, that is, either too large or too small. The best-fit tube would be the tube whose bronchial lumen just fits the bronchial lumen, and with minimal cuff, it seals the bronchial lumen. However, a DLT that is too large can injure the airway and can lead to rupture of airway.^[4]

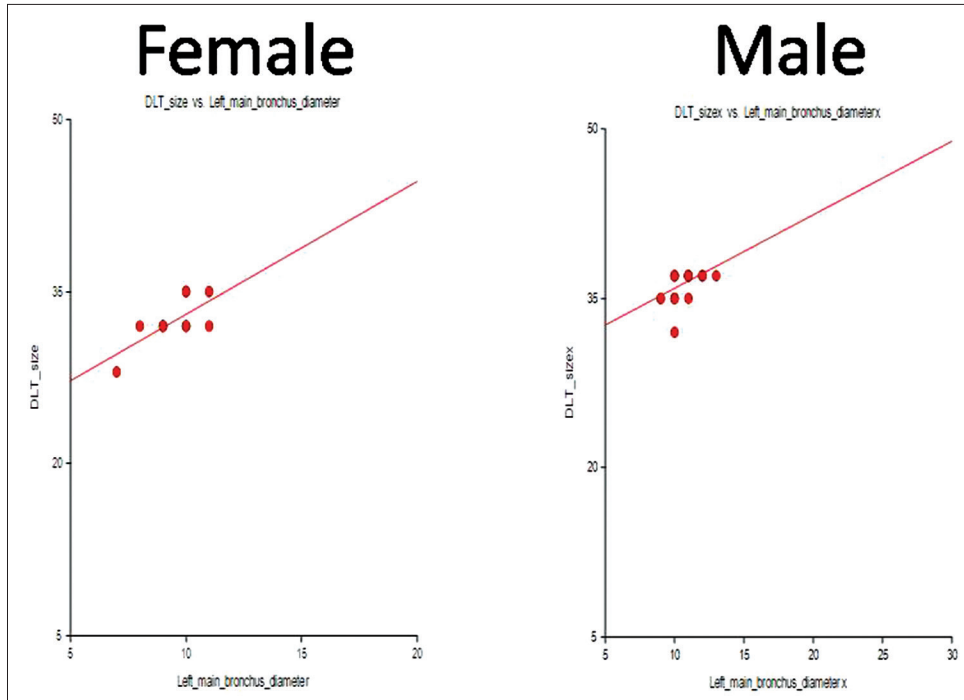


Figure 1: Correlation between double-lumen tube and left main bronchus diameter

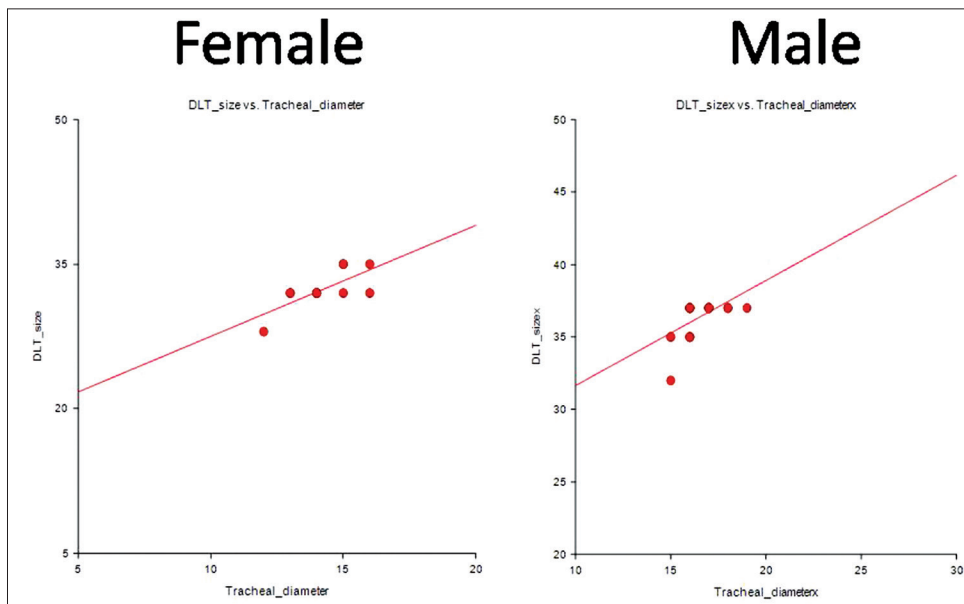


Figure 2: Correlation between double-lumen tube and tracheal diameter

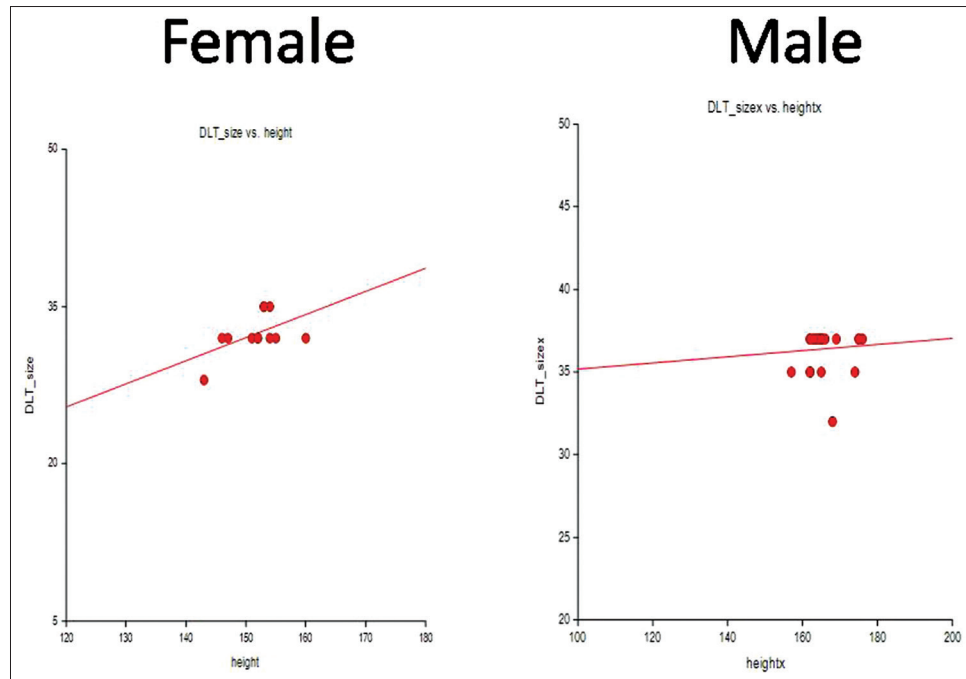


Figure 3: Correlation between double-lumen tube and height

Many height, TD, and bronchial diameter-based formulas have come up for determining the correct size of the DLT.^[5-7] However, these studies are based on the data from Western literature, and suitability of its application to Indian population is doubtful. Since the average stature of Indian patients is smaller than Western population, they are likely to require a smaller size DLT. Thus, it is probable that anesthesiologists in Indian subcontinent have a tendency to use a downsize tube.

The subglottic TD is smallest as compared to the other level TDs.^[8] In our study, the mean TD for male was 16.5 ± 9.6 mm, and for females, it was 14.2 ± 1.1 mm which is much smaller compared to study by Brodsky and Lemmens where tracheal width at interclavicular line from chest X-ray posteroanterior view was 20.90 ± 0.32 mm for men and 16.90 ± 0.25 mm for women, and correspondingly, they had used 41 FZ and 37 FZ DLT in males and females, respectively.^[3] In a study by Prasanna Kumar and Ravikumar, TD of Indian patients was lower than Western population. Even the sagittal and coronal diameter of trachea did not correlate with height. This may explain the poor correlation of height and DLT choice in our study group.^[8]

Most of these studies have used midclavicular or end clavicular diameter of the trachea as reference point.^[6,9] Some of these studies that used anteroposterior view of chest X-ray to calculate the TD have an additional correction factor for calculation. This can sometimes lead to false increase in value of TD.^[3] The subglottic and mid-TD are smaller compared to the midclavicular diameter.^[10] Use of these formulas can sometimes bias us to use of bigger size DLT.

Chow *et al.* accurately predicted the left-side DLT size based on the LMBD from computed tomography (CT) scan, especially for the smaller size DLTs, which is similar in our study. Cui *et al.* had found a good correlation between LMBD and DLT size with a correlation coefficient of 0.7346. Our study is in agreement with the above results (correlation coefficient of 0.7073).^[9,11,12] Hannallah and Gomes have used a fine caliper to measure the TD and LMBD which required fine expertise and was not very accurate; Chow *et al.* preferred to use electronic caliper with double magnification, and thus more accurate measurements were possible. In our study population, we used Medweb software which is basically pixel-by-pixel, zooming-in image during measurement, so error was minimized. Three-dimensional reconstruction of trachea gives the best estimate of TD. Eberle *et al.* have proven that individualized selection of DLTs based on three-dimensional reconstruction of the tracheobronchial image from routine preoperative CT scans leads to clinically appropriate choice of DLTs with high accuracy.^[13]

In the present study, there was a moderate-to-poor correlation between height, LMBD, and TD with DLT in male patients but moderate-to-good correlation in female patients. This discrepancy can be explained by the inclination to use a smaller sized tube in our anesthesiologists.

A study by Amar *et al.* found that downsizing DLT did not have any effect on the incidence of hypoxemia, adequacy of lung isolation, or need for repositioning.^[14] Similarly, no case of hypoxemia was reported in our study. Only 2 out of 41 patients required 2 ml extra air in bronchial cuff for achieving good isolation.

Limitations of our study

It was a single-center, observational, pilot study with low sample size. Cuff pressure was not monitored. TD was measured at the midclavicular level.

Conclusion

Use of undersized tube was common in our setting. However, it did not lead to any clinically detectable significant problems in lung isolation. Larger studies are required for further information.

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Conflicts of interest

There are no conflicts of interest.

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