

Double lumen tube: Size and insertion depth

ABSTRACT

Double lumen tubes (DLTs) are most commonly used to achieve one lung ventilation (OLV) in most thoracic surgical procedures unless contraindicated. Left-sided DLT (LDLT) is most commonly used nowadays for most thoracic surgical procedures. Though, the use of LDLT dates long back in history, two clinical and technical issues are yet to be resolved. The first issue is the ideal size of DLT which is defined as that which provides near-complete seal of the bronchial lumen without cuff inflation. There are no guidelines in literature which help in selecting the size of DLT. However, general consensus among thoracic anesthesiologists recommends the use of smaller sizes to avoid airway trauma. In our practice and for the last few years, we are using smaller size LDLT 35 F for females and 37 F for males with minimal airway trauma and had encouraging results. The second issue is the insertion depth of the LDLT. We have introduced a height-based formula to predict the insertion depth of LDLT with encouraging results. However, even with the use of the formula, we still recommend the use of fiberoptic bronchoscopic confirmation method for final positioning of the LDLT.


Key words: Double lumen tube; surgery; thoracic anesthesia

Double lumen tubes (DLTs) are most commonly used to achieve one lung ventilation (OLV) in most thoracic surgical procedures unless contraindicated. Left-sided DLT (LDLT) is most commonly used nowadays for most thoracic surgical procedures. Though the use of LDLT goes way back in history, two clinical and technical issues are yet to be resolved. The first issue is the ideal size of DLT which is defined as that which provides near-complete seal of the bronchial lumen without cuff inflation. The second issue is the insertion depth of the left-sided DLT (LDLT). Currently, there is no supportive evidence of having a predetermined method to ascertain proper insertion depth of LDLT and whether knowing the appropriate depth to place the DLT would assist in proper placement and minimize airway trauma during positioning.

In this brief review, we are going to address the aforementioned two issues: size and insertion depth of LDLT.

Size of LDLT

In the literature, there is scarce evidence on how to select the proper size of LDLT for a particular subject undergoing thoracic surgical procedure with lung isolation. Most anesthesiologists select the LDLT based on patient height and gender. Brodsky *et al.*^[1] and Hannallah *et al.*^[2] have introduced a table on how to choose the LDLT size based on radiological imaging. Tracheal diameter is measured at the level of the clavicles on the posterior–anterior chest radiograph and the bronchial diameter is measured on the computed tomography (CT) scan 1-2 mm of carina since the

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left mainstem is not clearly visible on the chest radiograph in 50-70% of the cases. Since imaging is amplified, the final diameter values should be deducted by 10%. Although, measuring radiograph films has a theoretical scientific background, it may not be practical. Moreover, this approach may have individual variations. Slinger mentioned that there is no other topic in thoracic anesthesia in which there is so little consensus as to how to best select the size of LDLT. It will depend to a large degree on the patient population with which one is dealing. Very simple selection protocol for adults based on the patient's height and sex: women <1.6 m (63 in.), 35 F; women >1.6 m, 37 F; men <1.7 m (67 in.), 39 F; and men >1.7 m, 41 F. This deals appropriately with the large majority of patients with exceptions for women <1.5 m (59 in., 32 F) and for men <1.6 m (37 F), and always resort to a smaller tube and bronchoscopy if any undue resistance is met.^[3] An investigation showed that measurement of the outer tracheal width by ultrasound (US) can be an additional useful method for predicting left mainstem bronchial diameter, and hence, the correct LDLT size, especially in emergency settings. Unfortunately, that investigation showed that, even with US, bronchial injury from an LDLT in some cases occurs.^[4] There is increasing interest to revisit the radiological imaging to determine the appropriate size of LDLT. Nowadays, obtaining a 3D CT scan is not difficult and measurements of tracheobronchial diameters can be automated using dedicated software. It is possible that, if technological developments make it easier to measure these diameters, this preoperative assessment step may become more common. In a recent study to compare manual and automated measurements of the diameters of the trachea and both main bronchi, mixed results were obtained since the automated measurements were not feasible in 20% of the cases, therefore, manual measurements were considered the standard.^[5] Using a wrong size DLT may lead to airway trauma and rupture. There is a tendency among anesthesiologists to use small DLT 35 F for females and 37 F for males in order to avoid airway trauma as well as inadvertent placement into the wrong side which can happen during its insertion. In our practice, we prefer to use smaller DLT sizes on the aforementioned assumption. For the last 7 years, we are using smaller DLT sizes with no problem whatsoever. In the literature, there are four case reports of airway trauma with trachea and left main bronchus rupture secondary to DLT placement with serious consequences.^[6-9] Recently, there was a study on Asian population measuring the transverse diameter (TD) of the cricoid cartilage using CT scan and US. The size of the DLT was selected based on the TD-US. The accuracy of the DLT, tracheal segment and the bronchial segment was compared between the left and right intubation groups. There was good correlation between the transverse cricoid diameter measured by US and CT. The overall accuracy

of the DLTs was similar in both groups. The choice of the DLT size was based on TD-US. Considering that the deflated tracheal cuff adds about 0.5 mm to the external diameter of the DLT, the sizes of DLT were selected as follows: 37 F for TD-US > 14.0 mm, 35 F for 13 mm < TD-US < 14.0 mm, and 32 F for 11.8 mm < TD-US < 13.0 mm. The authors concluded that the TD of the cricoid cartilage in most Asian women can be accurately measured by US and correctly predicted the size of the DLT.^[10]

Insertion Depth of LDLT

Insertion depth is another issue related to LDLT. Two methods were described to accurately place the LDLT. The first and most common is the traditional method where the tip of the endobronchial tube is advanced through the larynx under direct vision, rotated 90 degrees to the left (counterclockwise), and then advanced blindly into the left mainstem bronchus followed by fiberoptic bronchoscope (FOB) confirmation. The second and less common is the direct method where the LDLT is placed under vision with FOB placed through the bronchial lumen. Both methods resulted in a successful left mainstem placement of the endobronchial tube with more time required for the direct method.^[11] Several studies showed positive correlation between body height (BH) and the optimal insertion depth of a LDLT. Several methods have been described to predict the correct insertion depth of LDLT. Chow *et al.*^[12] developed a formula based on the clavicular-to-carinal distance of the trachea and the BH in 78% of their patients. Brodsky *et al.*^[13] demonstrated that a height-and-gender-based formula could predict the insertion depth of LDLT. Liu *et al.*^[14] reported an accurate insertion depth of LDLT in 90% of their patients by measuring the distance between the vocal cords and the carina according to chest CT scan. In a pilot study, we recruited our patients whose tracheas were intubated correctly with LDLT using FOB confirmation and examined the published formulae aiming to achieve an accurate estimation of the optimal insertion depth LDLT. We prospectively recruited 41 adult patients who underwent thoracic surgery with OLV.

The study included patients whose procedure required placement of a LDLT. We have used LDLT 35 F for females and 37 F for males. The optimal position of the LDLT was confirmed using FOB and defined when the inflated endobronchial cuff was placed in the left main bronchus just below the carina. We compared the insertion depth achieved with the conventional method of LDLT insertion by the following five formulae: $0.11 \times BH + 10.53$ (cm) by Brodsky *et al.*^[13]; $0.15 \times BH + 3.96$ (cm) by Bahk *et al.*^[15]; $0.148 \times BH + 3.8$ (cm) by Chow *et al.*^[12]; $0.1 \times BH + 12.5$ (cm) by Takita *et al.*^[16]; and $0.1977 \times BH - 4.2423$ (cm) by Lin *et al.*^[17]

The insertion depth of LDLT in our series was positively correlated with all the studied formulae and best correlated to Brodsky *et al.* formula.^[13] We were able to find another height-based formula out of this pilot study suitable for our patients: the insertion depth of LDLT = $0.249 \times (BH)^{0.916}$.^[18] Chow *et al.*^[12] reported that their formula, based on the clavicular-carinal distance of the trachea and patient's height, provided an acceptable position of the LDLT without further adjustment in 78% of the patients. In another study, which was published recently, we hypothesized that our formula^[18] would predict the accurate insertion depth of LDLT at least as accurately as Chow *et al.*'s formula. In a prospective observational study on 66 patients who underwent thoracic surgery required OLV using LDLT. We used the formula $LDLT = 0.249 \times (BH)^{0.916}$ to determine the insertion depth of the LDLT. We used an application (app) saved on a smartphone to perform the calculation of the LDLT's depth of insertion. After the user installs the application, they are presented with the calculator where they enter the height of the patient. This is then fed as an input to the formula to produce the insertion depth of the tube in centimeters. In this study, we calculated the insertion depth of LDLT using a free Android app on the Play Store: [https://play.google.com/store/apps/details?id = com.ldlt.ldltcalculator](https://play.google.com/store/apps/details?id=com.ldlt.ldltcalculator). We found that our formula provided satisfactory positioning of LDLT in about 70% of the patients and that in the remaining patients, the adjustments required to achieve satisfactory positioning under FOB guidance were minimal.^[19]

In conclusion, there are no guidelines in literature which help in selecting the size of DLT. However, general consensus among thoracic anesthesiologists exists in using smaller sizes to avoid airway trauma. In our practice, and for the last few years, we are using smaller size LDLT 35 F for females and 37 F for males with minimal airway trauma and encouraging results. Regarding the insertion depth of LDLT, our height-based formula could be used as an initial default to guide the initial insertion depth of LDLT. We found that the formula provided satisfactory positioning in most of our patients, and that in the remaining patients, the adjustments required to achieve satisfactory positioning under FOB guidance were minimal. Even with the use of our formula to predict the insertion depth of LDLT, we still recommend the use of FOB confirmation method for the final positioning of the LDLT.

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Conflicts of interest

There are no conflicts of interest.

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