Always Use the Biggest Double-Lumen Endotracheal Tube if Possible (Pro)

Javier H. Campos, M.D.
Professor of Anesthesia
Executive Medical Director of Operating Rooms
Vice Chair for Clinical Affairs
Director of Cardiothoracic Anesthesia
Department of Anesthesia
University of Iowa Health Care
Iowa City, IA 52241
email: javier-campos@uiowa.edu
Introduction

The disposable double-lumen endotracheal tube (DLT) made of polyvinyl chloride material is the most commonly used device for lung separation in North America. (1-2) The left-sided DLT is used more commonly (3) than the right-sided DLT. (4) Many investigations have focused on efficiency, performance, and outcomes among thoracic or non-thoracic anesthesiologists with the use of a left-sided or right-sided DLT. (5-6-7-8-9) In addition, other research has focused on radiological studies to predict the proper size of DLT in any given patient. (10-11-12-13)

The purpose of this review is to make recommendations based upon scientific evidence, case reports or personal experience to why the biggest DLT should be used whenever possible when lung separation is required. The areas of discussion include 1) size selection of DLTs, 2) radiological studies and DLT size, 3) airflow resistance and DLTs, 4) airway injuries and DLTs, 5) specific advantages of the use of a larger DLT, and 6) clinical recommendations.

Double-Lumen Endotracheal Tube Size Selection

Regarding the selection of the proper size for a DLT, all studies have focused on the left-sided DLT, in part because the infrequent use of the right-sided DLT. A common problem with the left-sided DLT is the lack of objective guidelines to properly choose the correct or approximate size of the DLT. Therefore anesthesiologists have considered the patient’s gender, height and weight or their personal experience to choose what they consider the appropriate size of the DLT. For this discussion, a small DLT is termed if the DLT size is 35 or 37F and a large DLT is considered a 39 or 41F, in adult patients.

A left-sided DLT that is too small requires a large endobronchial cuff volume, which might increase the incidence of malposition. In addition, a small DLT does not readily allow fiberoptic bronchoscope placement and can make suction difficult. A properly sized DLT is one in which the main body of the tube passes without resistance through the glottis and advances easily within the trachea and in which the bronchial component passes into the intended bronchus without difficulty.

The use of an incorrect size of DLT may lead to iatrogenic injury of the airway or failure to provide proper lung isolation. (14) In a study performed in adult cadavers, it was shown that the cricoid ring diameter never exceeds the diameter of the glottis. If a DLT encounters resistance when passing the glottis, it is likely that the DLT would encounter resistance when passing the cricoid ring. (15)

Radiological Studies and Double Lumen Endotracheal Tube Sizes

In the 1990s a number of methods were proposed for determining proper left-sided DLT size. Brodsky et al. (10) reported that measurement of tracheal diameter at the level of the clavicles on the preoperative posteroanterior chest radiograph can be used to determine proper left-sided DLT size. This method led to a 90% increase in the use of larger left-sided DLTs (i.e., 41F DLT in men and 39F and 41F in women). Chow et al. (11) using the methodology of Brodsky et al. (10) found this approach less reliable in Asian patients. In their study, (11) the overall positive predictive value for proper size of left-sided DLT was 77% for men and 45% for women. This method seems to have limited use in patients of small stature, such as
Asians and women, and for such patients alternative method should be sought. Another method for selecting a left-sided DLT uses measurements of the left mainstem bronchial diameter from a computed tomography (CT) scan. Seymour showed that the mean diameter of the cricoid ring is the same as that of the left mainstem bronchus. In this cadaver study the left mainstem bronchus-to-cricoid ratio almost invariably exceeded 83% in both sexes. A CT scan can identify the bronchial wall or cricoid rings, facilitating measurement of bronchial diameters. For this method to be reliable, the distal outside diameter of the bronchial portion of the DLT must be known. Currently this information is not included in the manufacturer’s package insert. A properly sized left-sided DLT should have a bronchial tip 1 to 2 mm smaller than the patient’s left bronchus diameter to allow for the place occupied by the deflated bronchial cuff.

In one study, Eberly, et al used a 3-dimensional image reconstruction of tracheobronchial anatomy from the spiral CT scans combined with superimposed transparencies of DLTs to predict proper size for a right-sided or left-sided DLT. Taken together, the studies discussed above suggest that chest radiographs and CT scans can be valuable tools for selection of proper DLT size, in addition to their proven value in assessment of any abnormal tracheobronchial anatomy and they should be reviewed before the placement of DLT. With the advancement in radiological studies, a multidetector 3-dimensional CT scan of the chest along with 3-dimensional reconstruction of the tracheobronchial tree, would allow detection of any abnormal anatomy that might affect the proper selection and placement of a DLT. In practice, radiological studies are not commonly used to select the proper size; however, radiological studies are important to review during preoperative assessment because they allow us to determine whether or not there is any distorted anatomy that can make a small or large DLT difficult to advance.

Others have relied on the use of clinical experience and observations to select smaller sized DLTs (e.g. 35F) for all adult patients regardless of gender, height and weight. A recent study involving thoracic anesthesiologists by Amar, et al showed that the use of a smaller DLT (i.e. 35F or 37F left-sided DLT) rather than a conventionally larger sized DLT (i.e. 39 or 41F) was not associated with any difference in clinical intraoperative outcomes, regardless of patients size or gender in 300 patients undergoing thoracic surgery requiring lung isolation. However, in this study only 51 (35%) of the patients who received a 35F DLT were male and 92 (65%) were female. In practice, women usually receive a 35F DLT - therefore, the question of whether or not a 35F for all patients is favorable remains unclear.

**Airflow Resistance and Double-Lumen Endotracheal Tubes**

The study by Hannallah, et al comparing the effective diameter and airflow resistance of the left-sided DLT made of polyvinyl material showed that the effective diameter and airflow resistance of each individual lumen of size 35F through 41F DLT are very comparable to those of size 6.0 mm internal diameter (ID) through 7.0 mm ID single-lumen endotracheal tube. It is well known that small breathing tubes lead to higher peak inflation pressures, predisposes patients to inadvertent positive end-expiratory pressure (auto PEEP) and interfere with passage of larger fiberoptic bronchoscopes (i.e. 4.5 mm outer diameter [OD]) and pulmonary toilet.

The risk of developing auto-peep when a DLT is in use can be significant during fiberoptic bronchoscopy if the bronchoscopy is performed during one-lung ventilation through the ventilated side, as the lumen of
the DLT will be securely compromised by the size of the bronchoscope. Table 1 displays a comparison between the ID and OD diameter of a single-lumen endotracheal tube and the DLTs and bronchoscope size to be used.\(^{[21]}\)

**Table 1**

<table>
<thead>
<tr>
<th>Single-lumen Endotracheal Tube (mm)</th>
<th>Double-lumen Endotracheal Tube</th>
<th>FOB Size OD (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID</td>
<td>OD</td>
<td>French OD</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>--------</td>
</tr>
<tr>
<td>7.5</td>
<td>10.2</td>
<td>35</td>
</tr>
<tr>
<td>8.0</td>
<td>10.9</td>
<td>37</td>
</tr>
<tr>
<td>8.5</td>
<td>11.5</td>
<td>39</td>
</tr>
<tr>
<td>9.0</td>
<td>12.1</td>
<td>41</td>
</tr>
</tbody>
</table>

**Airway Injuries and Double-Lumen Endotracheal Tubes**

Airway injuries such as hoarseness, sore throat, vocal cord lesions and bronchial injuries have been reported with the use of the DLTs. A study by Knoll et al\(^{[22]}\) showed that postoperative hoarseness occurred significantly more frequently in the DLT group (44% ) compared to the group that received a single-lumen endotracheal tube followed by a bronchial blocker (17%). Also, similar findings were observed for vocal cord lesions, 44% versus 17% respectively, in the 60 patients studied. However, the incidence of bronchial injuries was similar in both groups. In Knoll’s study, the estimation of the proper size of a DLT was based upon radiological measurements with the chest radiograph (tracheal width). Unfortunately the DLT size used is not reported; therefore, there is no definitive answer to whether the biggest versus smallest tube has direct implications on the outcome.

In contrast, a recent study by Ruetzler, et al\(^{[23]}\) comparing a DLT versus the EZ-blocker, a bronchial blocker that relies on the passage of a single-lumen endotracheal tube, in patients undergoing one-lung ventilation showed similar incidence of hoarseness and sore throat in the 40 patients studied (7/20 in the DLT group versus 8/19 in the EZ-blocker group). There were no serious complications such as a bronchial rupture with the use of these lung isolation devices. The size of the DLT used were 37 F for women and 39F for men. There is one study\(^{[24]}\) where the use of prophylactic dexamethasone 0.2 mg/kg decreased the incidence of sore throat and hoarseness after tracheal extubation with the use of DLT. In this study, female patients received 35F DLT and male patients received 37F DLT. This clearly indicates that airway injuries can be seen and treated with smaller DLTs (i.e. 35 or 37F).

Airway trauma and rupture of the membranous part of the trachea or the bronchus continues to be an isolated problem with the use of DLT.\(^{[25-26-27]}\) This problem has been reported during insertion and placement while the case is in progress or during extubation.\(^{[28]}\) Another reported problem has been with the development of bilateral pneumothoraces or a tension pneumothorax in the dependent and ventilated lung during one-lung ventilation.\(^{[29-30]}\) A 25 year review of the literature by Fitzmaurice and Brodsky\(^{[31]}\) found that most airway injuries were associated with undersized DLTs particularly in women who received a 35F disposable DLT. It is likely that airway damage occurs when an undersized DLT migrated distally into the bronchus, and the main (i.e. tracheal) body of the DLT comes into contact with the bronchus producing lacerations or ruptures of the airway.
Recent reports have shown that airway ruptures with the use of DLT remain a rare event; however, they might result in catastrophic consequences. Although we realize that there are multiple potential causes of rupture of the trachea or bronchus\(^{25-32-33}\) without any question, all cases of airway rupture have been reported with the use of smaller DLTs including 35 and 37F. Table 2 displays case reports of ruptured airways and use of DLTs. Whether or not smaller size is related to airway rupture, I have not seen a recent report of tracheobronchial rupture with the use of a 39 or 41F DLT.

### Table 2

<table>
<thead>
<tr>
<th>Author</th>
<th>Age, Gender</th>
<th>Weight, Height</th>
<th>Size DLT</th>
<th>Complication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yüceyar L</td>
<td>78 yo, Female</td>
<td>55kg; 150 cm</td>
<td>37 F</td>
<td>Left mainstem bronchial rupture</td>
</tr>
<tr>
<td>Acta Anaesthesiol Scand</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2003; 47:622-625</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kim HK</td>
<td>70 yo, Male</td>
<td>66kg; 170 cm</td>
<td>37 F</td>
<td>Left mainstem bronchial rupture</td>
</tr>
<tr>
<td>Korean J Anesthesiol</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010; 59:21-25</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Venkataramanappa V</td>
<td>78 yo, Female</td>
<td>61 kg; 152 cm</td>
<td>35 F</td>
<td>Laceration membranous part of the trachea (subglottic area to entrance of right bronchus)</td>
</tr>
<tr>
<td>J Clin Anesth</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011; 23:66-70</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kim J</td>
<td>76 yo, Female</td>
<td>55kg; 148 cm</td>
<td>32 F</td>
<td>Laceration and rupture membranous part of trachea (8 cm long)</td>
</tr>
<tr>
<td>Korean J Anesthesiol</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011; 60: 285-289</td>
<td></td>
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</tbody>
</table>

### Specific Advantages of the Use of the Biggest Double-Lumen Endotracheal Tube

There are specific clinical situations where the biggest DLT that can fit into the patient’s mainstem bronchus should be used. Patients who undergo bilateral lung transplantation and have severe emphysema, it is easy to release the air trapping of larger lumen of the DLT. In addition, in order to effectively inspect the airway and remove secretions through the suction channel of the fiberoptic bronchoscope, a bigger size DLT and fiberoptic bronchoscope will facilitate this task.

In addition, patients who have a descending thoracic aortic aneurysm and have a great amount of bleeding and secretions through the lumens of the DLT\(^{34}\). The biggest DLT allows the passage of a large suction catheter; therefore it will facilitate clearance of the airway.

Patients undergoing bronchopulmonary lavage, I prefer to use the biggest DLT possible in order to facilitate and aspirate large amounts of saline solutions from one of the lumens of the DLT while proper ventilation is achieved with the ventilated lung. Patients whom height is greater than 180 cm tall, I recommend the use of the biggest DLT (i.e. 39 or 41F) because the length of the DLT in relationship to the depth of insertion can only be achieved if the marking of the DLT in relationship to the teeth is
approximately 31 cm at the marking of the DLT. Also, less air is needed to inflate the endobronchial cuff balloons; therefore less chance of malposition.

**Table 3 Describes patients that I recommend the use of the biggest DLT possible (i.e. 39 or 41F)**

<table>
<thead>
<tr>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Bilateral lung transplantation and severe emphysema (patient height &gt;170 cm)</td>
</tr>
<tr>
<td>- Bronchopulmonary lavage (patient weight &gt;85kg, patient height &gt;170 cm)</td>
</tr>
<tr>
<td>- Descending thoracic aortic aneurysm</td>
</tr>
<tr>
<td>- Any patient whom height is &gt;180 cm tall</td>
</tr>
<tr>
<td>- Any patient that requires lung separation where I can use a 39 or 41F</td>
</tr>
<tr>
<td>- Right-sided DLTs I prefer to use 39 or 41F (whenever possible)</td>
</tr>
</tbody>
</table>

**Clinical Recommendations**

Based on personal experience or scientific evidence, although I am not opposed to the use of small sized DLTs, whenever possible, I prefer and recommend the use of the biggest DLT in adult patients requiring lung isolation techniques. The reasoning for recommending the biggest sized DLT include: 1) less airflow resistance, 2) easy access to the use of large fiberoptic bronchoscope, 3) easy to remove secretions, 4) less reported airway injuries than smaller sized DLTs, 5) less chances of developing auto PEEP and 6) in tall patients it is easier to keep the DLT in place with less chance of malpositions.

I do not routinely use radiological studies to select the proper size of the DLT; however, factors that I do consider include the patient’s height and general build. In general, for males who are 170 cm tall and 80 kg weight, I use 39 or 41F, right or left-sided DLT; for females 35, 37 or 39F whenever there is no resistance while passing and positioning the device. I recommend reviewing radiological studies (chest x-ray and CT scan) to recognize tracheobronchial anatomy. I recommend the use of fiberoptic bronchoscope to guide and place DLTs. I rarely have to substitute for a smaller sized DLT in my practice in thoracic anesthesia.
References


