Tracheal Diameter Predicts Double-Lumen Tube Size: A Method for Selecting Left Double-Lumen Tubes

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There are no objective criteria for selecting the size of a double-lumen endobronchial tube (DLT) (1). An inappropriately sized DLT can cause airway trauma and interfere with oxygenation and lung separation during one-lung ventilation. The goal of this study was to determine if measurement of tracheal diameter from the preoperative chest radiograph can be used to predict which size DLT to choose for each patient.

Methods

With approval by our institution's Human Subjects Committee, 70 patients (13–82 yr) undergoing a variety of thoracic surgical procedures were enrolled prospectively over a 5-mo period.

The width of the patient's trachea at the level of the clavicles was measured from a recent posterio-anterior (PA) chest radiograph. A nonbeveled left BronchoCath DLT (Mallinckrodt, St. Louis, MO) (2) was chosen based on this measurement and the DLT dimensions provided by the manufacturer (Table 1). If the trachea measured ≥18 mm, a 41 Fr DLT was placed. For a patient with a tracheal diameter ≥16 mm, a 39 Fr DLT was used; for a tracheal diameter ≥15 mm, a 37 Fr DLT was used; and for a tracheal diameter <15 mm, a 35 Fr DLT was used.

After induction of general anesthesia and neuromuscular blockade, the DLT was inserted using a sequence of steps previously described (3). As is the practice in our institution, fiberoptic bronchoscopy was not performed in any patient. Both the tracheal and bronchial cuffs were inflated with a sufficient amount of air to seal any air leak present during positive pressure ventilation.

The number of attempts needed to intubate the left bronchus and any difficulties passing the tube through the glottis or advancing it down the trachea into the bronchus were recorded.

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Linear regression analysis (method of least squares) was used to evaluate tracheal width as related to patient height, weight, and age. The relationship between gender and tracheal width was assessed with analysis of variance. $P < 0.05$ was considered statistically significant.

Results

Patient demographics are summarized in Table 2. There were 38 men and 32 women enrolled in the study. The average tracheal width for men was 20.9 ± 0.32 (SD) mm and 16.9 mm ± 0.25 (SD) mm for women (Fig. 1). The DLTs chosen are shown in Figure 2.

All DLTs selected using the measured tracheal width as a guideline were successfully placed in the trachea and bronchus. Three patients received larger tubes than indicated by the guidelines. These patients are included in the analysis, since a smaller tube would also have fit their airway.

There was no statistically significant relationship between tracheal size and age, weight, and height. The tracheal width for women was significantly narrower than for men ($P < 0.005$) (Fig. 1).

We encountered minor difficulty in advancing the tube through the glottis in 10 (14.3%) patients and mild resistance while advancing the tube down the trachea into the bronchus in 19 (27.1%) patients. In 18 (25.7%) patients, the right main bronchus was initially entered. In these patients, both cuffs were deflated, and the tip of the DLT was withdrawn above the carina. The left bronchus was then easily intubated by raising the patient's head and neck and simultaneously abducting both to the right while readvancing the tube.

All tubes functioned properly, because there were no episodes of hypoxemia, and the appropriate lung was successfully deflated during one-lung ventilation.

There was one postoperative complication that may have been associated with a DLT. A 22-yr-old woman with leukemia developed a nonpyogenic granuloma at the base of her glottis (by the esophageal opening) 14 days after undergoing a right upper lobectomy for

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Table 1. Guidelines for Choice of Left Double-Lumen Endobronchial Tube (DLT)

Measured tracheal width (mm)	Predicted left bronchus width (mm)	DLT size	Outside diameter (mm)	
			Main body	Left lumen
≥18	≥12.2	41Fr	14–15	10.6
≥16	≥10.9	39Fr	13–14	10.1
≥15	≥10.2	37Fr	13–14	10.0
≤14	≤9.5	35Fr	12–13	9.5

Tracheal width (in mm) measured from chest radiograph.
Predicted left bronchus = tracheal width (mm) × 0.68.
DLT = nonbeveled, left BronchoCath (Mallinckrodt Medical, Inc., St. Louis, MO).
Outside diameter (in mm) for the main body of the tube (DLT) and for the left lumen of the DLT. Size specifications are provided by manufacturer.

Table 2. Patient Demographics

Gender (*n*)	Male (38)	Female (32)
Age (yr) ± SD	60 (±14)	55 (±17)
Range	23–82	13–77
Height (in.) ± SD	70 (±3)	65 (±2)
Range	62–78	62–70
Weight (lb) ± SD	174 (±33)	144 (±35)
Range	120–250	94–230

an aspergilloma. Her trachea was 16 mm wide, and she had been intubated with a 39 Fr DLT without difficulty noted at the time of placement.

There were no other complications attributed to any DLT.

Discussion

In the past, we based our choice of DLT size on patient height and gender (4). This study found that, for most men in our patient population, no matter what their height or weight, a 41 Fr DLT could be used. For women, gender, height, and weight were not reliable guides in predicting airway dimensions.

There are two considerations related to size in selecting a DLT. The main body of the tube must pass atraumatically through the glottis and advance down the trachea, and the bronchial component must be able to enter the intended bronchus.

Hannallah et al. (5) tried to select a DLT by measuring the width of the left main bronchus from the chest radiograph. Since the left bronchus could be measured only in half of the patients in their study, this method may have limited clinical application. In contrast, tracheal width was easily measured from the chest radiograph in all of our study patients.

Measurements of the trachea from a radiograph in our study yielded similar results to a postmortem study of adult airways (6). That study found that the average tracheal diameter for males was 22 mm (range = 15–27 mm) and 17 mm (range = 13–25 mm) for females. The average diameter of the left bronchus was 15 mm (range = 10–18 mm) for males and 12 mm (range = 9–15 mm) for females in that study. Although there was variation in tracheal and bronchial width among individuals, these authors found a significant correlation between tracheal and bronchial measurements for any individual patient. They stated that bronchial diameter could be determined accurately using a ratio of left bronchial diameter to tracheal diameter of 0.68 (6). Therefore, to select a DLT, one need not measure bronchial width; measurement of tracheal width is sufficient for predicting bronchial size.

Our clinical practice is to use large DLTs. In the past, we chose 41 Fr tubes for men and 37 Fr and 39 Fr DLTs for women (4). Using tracheal width as a guideline, we placed 41 Fr tubes in 10 of the 32 women in this study.

Many anesthesiologists intentionally select a small DLT because they fear that too large a tube might injure the airway (1). We believe that most intraoperative positioning problems occur from small DLTs, which can easily advance too deep into the bronchus and obstruct the upper lobe orifice (7). The bronchial cuff of small DLTs must be inflated with large volumes of air that can cause airway rupture or cuff herniation into the carina. If the cuff is underinflated, the lung will fail to collapse and/or the opposite lung will not be isolated or protected from contamination. The lumen of a smaller DLT offers more resistance to airflow during one-lung ventilation and makes it more difficult to advance a fiberoptic bronchoscope or suction catheter.

We previously reported minor problems with the new BronchoCath DLT (2). We believe the difficulty introducing the tip of the tube through the glottis and the resistance advancing the tube down the trachea are caused by the absence of a leading bronchial edge on these tubes and are not related to tube size. Although absence of a beveled tip on the bronchial lumen makes initial placement slightly more difficult, we prefer these modified BronchoCath tubes because of other design changes that include a tighter curve on the bronchial lumen, a shortened bronchial cuff, and an inverted proximal bronchial cuff shoulder. These modifications increase the "margin of safety" of these tubes (8).

The optimal size DLT is the largest tube whose bronchial lumen fits the desired bronchus with only a small air leak when its cuff is deflated (5). The decision as to what size DLT to use is often based on personal experience and preference. We found that direct measurement of tracheal width can be used as a guide to help predict which left DLT to select for each patient.

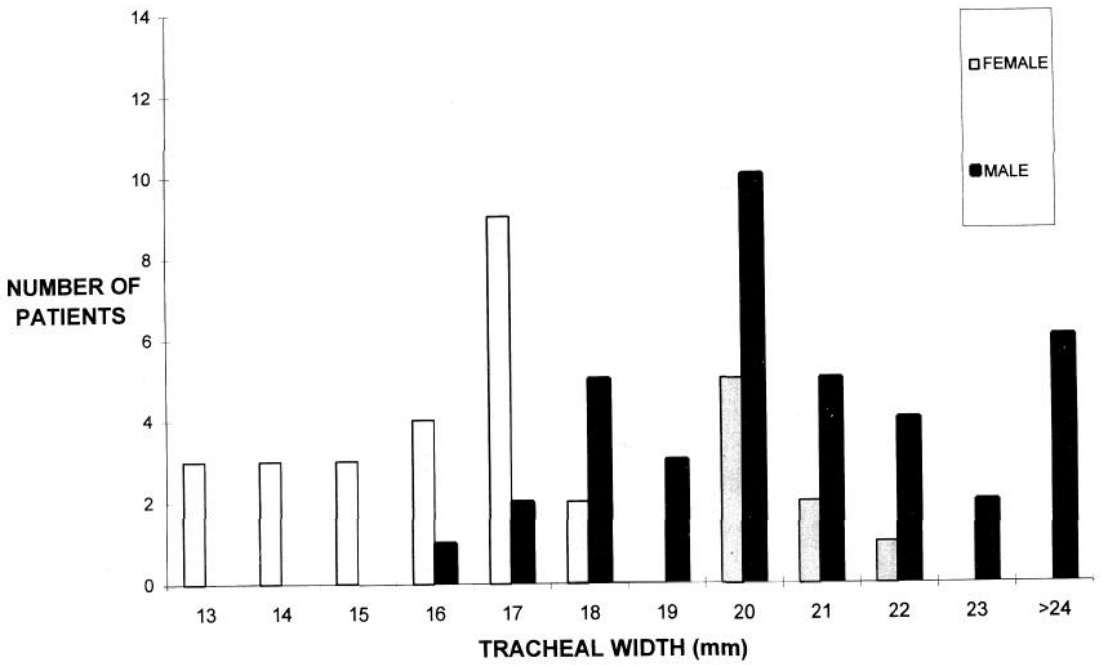

Figure 1. Distribution of tracheal diameters by gender. Average tracheal width for the 38 men in this study was 20.9 mm (range = 16–35 mm) and for 32 women was 16.9 mm (range = 13–22 mm). These results were similar to a postmortem study of adult airways that reported that the average tracheal size for men was 22.0 mm (range = 15–27 mm) and 17 mm (range = 13–25 mm) for women (7).

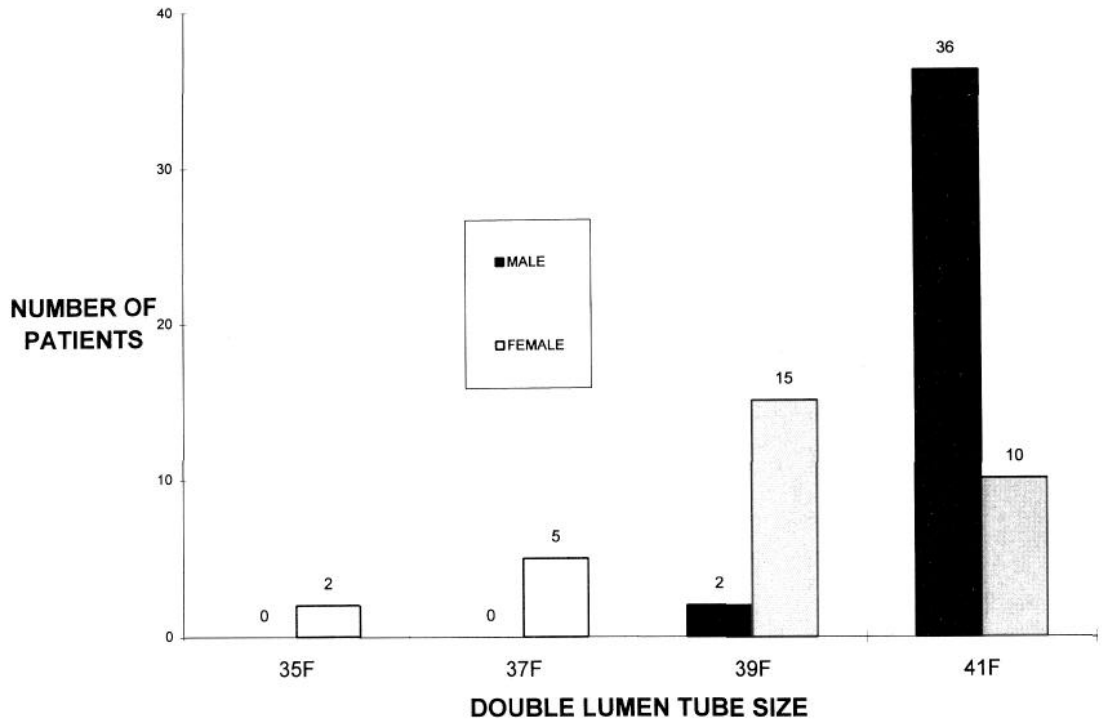

Figure 2. Distribution of double-lumen endobronchial tube (DLT) choices by patient gender. Most men (36 of 38) were intubated with a 41 Fr DLT. Ten of 32 women were intubated with a 41 Fr DLT.

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