

Comparison of different size left-sided double-lumen tubes for thoracic surgery

Raisa D Nguyen, Lakshmi N Kurnutala, Michelle A Tucci, Bryan J Hierlmeier

Department of Anesthesiology, University of Mississippi Medical Center, Jackson, MS 39216, USA

ABSTRACT

Study Objective: The aim of this study is to see if there are any clinical differences between using 35 F DLT for all patients versus using patient height regardless of gender to estimate appropriate DLT size.

Design: Prospective randomized study.

Setting: University Hospital.

Patients: 50 patients age 18 years, undergoing lung or esophageal surgery requiring OLV.

Interventions: Patients randomized to two groups (group-35F, group –DLT based on height).

Measurements and Main Results: Data collected include demographics, ASA status, airway assessment, number of intubation attempts, Cormack-Lehane grade, number of times DLT repositioned, incidence of sore throat, oxygen saturation at induction and oxygen saturation at 5 minutes and 10 minutes after OLV. There was no statistically significant difference in demographics, ASA classification, Mallampati score, number of intubation attempts, Cormack-Lehane grade, number of times DLT was repositioned, and incidence of sore throat. In height based DLT group the odds were higher for the incidence of sore throat in 37-41 F group. Oxygen saturation at induction, 5 minutes and 10 minutes after OLV are not statistically significant between the two groups. Conclusion: Our findings suggest that the majority of patients receive unnecessarily large DLTs for thoracic surgery, which not only makes intubation inherently more difficult but also increases their risk of postoperative sore throat.

Keywords: Double lumen tube, fiber optic bronchoscope, one lung ventilation, thoracic surgery

Address for correspondence: Dr. Bryan J Hierlmeier, University of Mississippi Medical Center, 2500, N State St, Jackson, MS - 39216, USA.

E-mail: bhierlmeier@umc.edu

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INTRODUCTION

Since the introduction of the double-lumen endotracheal tube (DLT) in the mid-20th century, DLTs have become the standard of care for one-lung ventilation in anesthesia and has revolutionized thoracic surgery. Despite its relatively long history, there is still no consensus on how to choose the most appropriate size of DLT for each patient. Most practitioners base their decision on personal experience, usually depending on the patient's gender and height, with the most common sizes ranging from 35 to 41-French in adult patients.^[1-3] Others prefer to use the largest DLT

possible that will fit through the patient's vocal cords with the thought that using a larger tube allows for better surgical exposure, less chance of the DLT dislodging in the airway, and less chance of causing ischemia by avoiding over inflation of the bronchial cuff.^[1-6] Conversely, using a larger tube has the inherent risk of causing greater trauma and possibly rupture to the airway.^[7] Previous studies have attempted to determine a suitable size of DLT by measuring the diameter of the left main stem bronchus^[4] or trachea.^[8,9] with radiographic imaging, or even by calculating left main stem bronchus width using tracheal width.^[10,11]

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Nevertheless, even the more objective methods do not appear to be applicable to all patients, especially Asians who tend to be smaller than other ethnicities.^[12] Our study aims to determine whether there is any difference in ease of intubation and oxygenation between using a standard smaller size of left-sided DLT (35F) for all patients versus using the patient's height regardless of gender to estimate an appropriate tube size. Our primary objective was to see if using a 35F DLT for all patients would lead to an easier intubation regardless of patient height without affecting oxygenation, while using a larger DLT would lead to a more of challenging intubation. As the incidence of postoperative sore throat has been seen with intubation and size of endotracheal tube^[13-17] our secondary objective was to see if there was a difference between different DLT sizes and the incidence of sore throat.

METHODS

After institutional review board (IRB, University of Mississippi Medical Center, Jackson, MS) approval, we enrolled and consented 50 patients prior to surgery aged 18 years or older undergoing lung or esophageal surgery which required one-lung ventilation (OLV) and placement of a left-sided DLT. Surgeries included in the study were pulmonary wedge resections, pulmonary lobectomies, pleurodesis all done via video assisted thoracic surgery with the patient in the lateral position. The study was conducted at the University of Mississippi Medical Center (Jackson, MS) from September 2017 to March 2018.

Patients were excluded from the study if they met one or more of the following criteria:

- Patient declined participation
- Need for rapid sequence intubation (RSI) due to increased aspiration risk
- Anticipated difficult intubation possibly requiring awake fiberoptic intubation
- Emergency surgery
- Patient was already intubated with a single-lumen endotracheal tube (SLT)
- Surgeon requested to start the procedure with SLT and later switch to DLT.

After the patient consented to the study, he or she was randomized to one of two groups, (1) 35F DLT or (2) DLT based on height. Computer-generated randomization was used to place patients into two groups. All DLTs used for this study were Covidien Mallinckrodt™ Left Endobronchial Tubes ranging from 32 to 41F. DLT size based on height was determined by the following approach regardless of the patient's gender, which we considered to

be more conservative than most other recommendations for tube sizing [Table 1].

Induction of general anesthesia consisted of propofol 1–2 mg/kg or etomidate 0.2 mg/kg, lidocaine 0.5–1 mg/kg, fentanyl 1–2 µg/kg, and 100% fraction of inspired oxygen (FiO₂). Adequate neuromuscular blockade was achieved with either rocuronium 0.6–1.2 mg/kg or cisatracurium 0.15–0.2 mg/kg prior to intubation.

Intubation by direct laryngoscopy was performed by either an anesthesiology resident physician or certified registered nurse anesthetist (CRNA). The anesthesia provider was allowed to use his or her preferred laryngoscope blade (Macintosh 3 or 4, or Miller 2 or 3). DLT placement was confirmed with a flexible 3 mm diameter fiberoptic bronchoscope using the tower video screen. If the DLT was determined to be too large to pass through the patient's vocal cords, it was switched out for the next smaller size until an appropriate size was achieved.

General anesthesia was maintained with sevoflurane or desflurane in 100% FiO₂ for at least the first 10 minutes after intubation. Ventilator settings consisted of volume-controlled ventilation 5–8 mL/kg, positive end-expiratory pressure (PEEP) 5 cmH₂O, and respiratory rate adjusted to end-tidal carbon dioxide (ETCO₂) less than 45 mmHg.

After successful intubation, a survey sheet was completed by the anesthesia provider who performed the intubation. The provider recorded the patient's American Society of Anesthesiologists (ASA) physical status classification (1–6), procedure, medical history, preoperative Mallampati score, Cormack-Lehane view (1–4), number of intubation attempts, and size of DLT placed. If the DLT size needed to be changed, the provider explained the events that led to the change. If the DLT required repositioning after initial placement and turning the patient to lateral decubitus position, this was also explained on the survey sheet.

Three oxygen saturations were recorded at the time of induction and after initiating OLV (after 5 and 10 minutes). Hypoxia was defined as an oxygen saturation of less than 90%. If hypoxia occurred during OLV, the anesthesia team performed the following steps at its discretion:

Table 1: DLT size based on patient's height^[1,5]

Height	DLT Size
<5'3" (<160 cm)	35F
5'3" to 5'8" (160-174 cm)	37F
5'9" to 6'0" (175-182 cm)	39F
Greater than 6'0" (>182 cm)	41F

- Check DLT position with fiberoptic bronchoscope
- Increase PEEP to the dependent lung
- Continuous positive airway pressure (CPAP) to the non-dependent lung
- Two-lung ventilation.

On postoperative day 0 or 1, patients were asked a yes or no question to whether they experienced any sore throat after the procedure.

Statistical analysis

All data are recorded for each group as mean ± standard deviation, and $P \leq 0.05$ was considered statistically significant. Initial power analysis was completed and showed that 22 patients were needed in each group so we rounded to 25 patients in each group. The data for age, height, weight, body mass index (BMI), ASA classification, Mallampati score, Cormack-Lehane grade, and oxygen saturation were compared using *t*-test for independent samples. The significance of the difference between two independent proportions was used to determine difference in the number of males and females in the two groups. A 2 × 2 contingency table was used to determine rates, risk ratio, odds ratio, and confidence intervals for the outcome of sore throat between the participants receiving a 32 or 35F DLT to those receiving a DLT of 37F or larger.

RESULTS

Demographics

Fifty patients were enrolled in this study with 25 randomized to the 35F group and 25 randomized to the DLT based on height group as seen in Figure 1. Mean age, height, weight, BMI, ASA classification, and Mallampati score are shown in Table 2. No differences were seen in terms of age, weight, height, BMI, ASA classification, and Mallampati score when the two groups were compared using two sample *t*-test for independent samples. In the 35F group, there were 13 males and 12 females, while in the DLT based on height group, there were 9 males and 16 females but

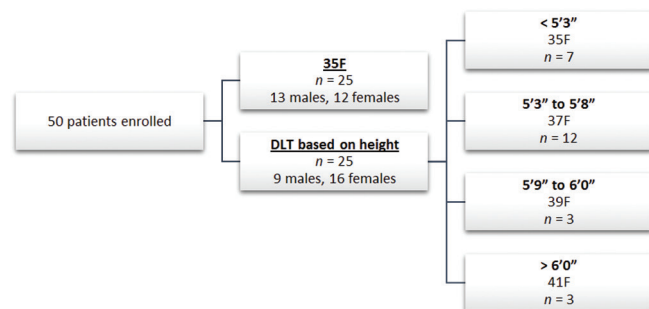


Figure 1: Enrollment diagram

there was no statistically significant difference between the groups as seen in Table 2.

Difficulty of intubation, adequacy of lung isolation, and incidence of sore throat

Table 3 shows that no differences were detected between the groups for the number of intubation attempts, Cormack-Lehane grade, number of times the DLT was repositioned, or the incidence of sore throat. Also, no correlation existed between the number of intubation attempts and repositioning of the DLT with the incidence of sore throat.

Due to miscommunication about the study protocol with some anesthesia providers, six patients were mistakenly intubated using a GlideScope® (5 patients) or C-MAC® video laryngoscope (1 patient). These patients were excluded from the analysis of intubation attempts, Cormack-Lehane grade, and sore throat. In addition, two patients who underwent video-assisted thoracoscopic surgery (VATS) washout for hemothorax required reintubation with SLT at the end of the procedure due to residual hemothorax. These patients remained intubated on postoperative day 1 and could not be assessed for sore throat. Patients excluded from the sore throat calculation are shown in Figure 2.

The outcome of sore throat was compared between individuals who received 32-35F DLT with those receiving 37-41F, as shown in Table 4. The data shows that the rate of sore throat was 40% when 32-35F DLT was used, and the rate increased to 53% when the DLT was 37-41F. The odds were higher for the incidence of sore throat in the

Table 2: Comparison of patient demographics between two populations

Group	35F	DLT based on height	P
Male	13	9	0.25
Female	12	16	0.39
Age	62.0±14.6	56.0±15.4	0.086
Height (m)	1.71±0.03	1.66±0.05	0.052
Weight (kg)	82.24±9.04	77.88±8.65	0.238
BMI (kg/m ²)	27.7±6.2	27.9±6.3	0.939
ASA class	2.76±0.298	2.84±0.154	0.313
Mallampati score	1.96±0.1873	2.00±0.2913	0.405

P<0.05 Significant

Table 3: Comparison of number of intubation attempts, Cormack-Lehane grade, number of times DLT was repositioned, and incidence of sore throat

Group	35F	DLT based on height	P
# of intubation attempts	1.32±0.780	1.14±0.351	0.618
Cormack-Lehane grade	1.41±0.590	1.22±0.190	0.248
# of times DLT was repositioned	0.48±0.41	0.52±0.35	0.24
Sore throat	0.450±0.22	0.454±0.38	0.502

P<0.05 Significant

37-41F group, but the difference between the groups was not statistically significant ($P = 0.307$).

Oxygen saturation

Table 5 shows no differences in oxygen saturation between the two groups just prior to induction of anesthesia and at 5 and 10 minutes after initiating OLV. There was no statistically significant difference between the two groups.

DISCUSSION

Outcomes

There were no significant differences in patient demographics, intubation attempts, Cormack-Lehane grade, number of times DLT was repositioned, sore throat, or oxygen saturation.

Because there was no difference in number of intubation attempts or Cormack-Lehane grade, it can be inferred that the difficulty of intubation was the same between the two groups. However, there were instances in which the anesthesia provider achieved a satisfactory view of the vocal cords (Cormack-Lehane grade 1 or 2) but had difficulty inserting the DLT due to it being too large and had to make multiple attempts or rotate the DLT while passing through the cords. This occurred for all sizes from 35-41F. One female patient who was assigned to the 35F group required 3 intubation attempts because the DLT was too large, and she ultimately received a 32F tube.

Table 4: Rates, odds, and risk and odds ratios of sore throat with confidence intervals (CI)

Group	32-35F	37-41F
Rate	0.4063	0.5333
Odds	0.6842	1.1429
95% CI risk ratio	0.761 (0.40, 1.43)	
95% CI odds ratio	0.599 (0.17, 2.05)	

Table 5: Oxygen saturation levels at induction and after initiating one-lung ventilation (OLV)

Group	Induction	5 min after OLV	10 min after OLV
35F	99.64±0.503	98.44±1.290	98.16±1.175
DLT based on height	99.40±0.762 $P=0.296$	98.80±1.044 $P=0.292$	97.68±1.652 $P=0.313$

The main complaint from anesthesia providers regarding the 35F DLT was that the tube dislodged after initial placement (backed out of the left mainstem bronchus), resulting in inadequate lung isolation. This required that the tube be repositioned, sometimes multiple times, and several providers reported having to heavily tape the tube to keep it in place. Despite this observation, there was no statistical difference between the study groups for number of times the DLT was repositioned.

There is also some concern of a smaller DLT dislodging and migrating distally into the airway. This occurred with 2 patients (173 cm male and 160 cm female) in which the tube had to be pulled back 1 centimeter after the patient was turned to lateral decubitus position. However, both received a 37F tube, which we would not deem considerably small for either patient. Furthermore, the fact that there was no difference in the number of times the DLT was repositioned as well as no difference in oxygen saturation at three different time points indicates that adequate lung isolation was achieved for both groups.

While there was no statistical difference in sore throat between the study groups, we noted a lower rate of sore throat (40%) when a 32–35F DLT was used versus a larger size (53% for 37–41F). This suggests that patients who receive smaller DLTs may have a lower incidence of sore throat postoperatively.

Limitations

Our study had a small sample size of 50 patients and was conducted at one academic institution. Therefore, our results may not be applicable to all situations.

Another limitation was the inability to standardize the anesthesia providers who performed the intubations. We had initially planned to enlist only upper-level anesthesiology residents, but we found this to be impossible due to daily staffing changes, which meant that CRNAs were often being assigned to thoracic cases.

Although we looked at incidence of sore throat as one of our secondary outcomes, we did not delineate the

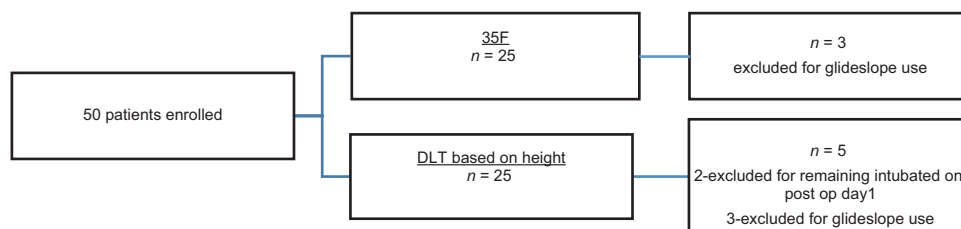


Figure 2: Exclusion diagram

possible causes of sore throat. Consequently, we do not know whether experiencing a sore throat was more related to the number of intubation attempts, DLT size, or whether there was any correlation with other factors such as the laryngoscope blade used. There was also some interpretation needed on our part to determine whether the patient actually experienced sore throat as some patients could not give a straightforward answer.

As mentioned earlier, there was some miscommunication of the study protocol with anesthesia providers. This led to a few providers using a video laryngoscope for intubation instead of performing direct laryngoscopy, and some of this data had to be excluded from analysis.

CONCLUSION

Totally, 24 of the 25 patients who were randomized to the 35F group would have received a larger DLT if they had been randomized to the group based on height. Our findings suggest that the majority of patients receive unnecessarily large DLTs for thoracic surgery, which not only makes intubation inherently more difficult but also increases their risk of postoperative sore throat.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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