

Difficulty in inserting left double-lumen endobronchial tubes at the cricoid level in small-statured women: A retrospective study

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ABSTRACT

Background and Aims: Left double-lumen endobronchial tube (DLT) sizes are selected using tracheal diameters and left mainstem bronchial diameters (LMBDs) determined from chest radiographs or computed tomography (CT) scans. In Western women, 35-Fr or 37-Fr DLTs are often selected. However, difficulties can be encountered when inserting 32-Fr or 35-Fr DLTs in Japanese women. We investigated success rates for 32-Fr or 35-Fr DLT insertion in Japanese women and determined the causes of unsuccessful DLT insertion. **Methods:** We searched anaesthesia records of Japanese women aged ≥ 20 years who underwent thoracic surgery with 32-Fr or 35-Fr DLTs between April 2010 and March 2015 in our hospital. In the successful group (SG), patients were intubated using the initially selected DLTs. By contrast, in the unsuccessful group (UG), the DLT size had to be changed. The Mann–Whitney U-test and Fisher's exact test were used to compare groups. **Results:** The SG included 149 (96.1%) of 155 cases of 32-Fr DLT use and 119 (95.2%) of 125 cases of 35-Fr DLT use. Patient height was significantly lower in the UG than in the SG for the 35-Fr DLT ($P = 0.0036$). In seven of 12 UG patients (three for 32-Fr and four for 35-Fr), the transverse diameters of cricoid cartilages were smaller than the DLTs' tracheal diameters, thereby preventing passage through the cricoid cartilages. **Conclusion:** Along with LMBDs, transverse diameters of cricoid cartilages based on CT scans or ultrasonogram findings may help in selecting the appropriate left DLT size.

Key words: Cricoid cartilage, intubation, pulmonary ventilation, trachea

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INTRODUCTION

Double-lumen endobronchial tubes (DLTs) can be used in differential pulmonary ventilation for thoracic surgery. Appropriate left DLT sizes can be selected using tracheal diameters^[1] and left mainstem bronchial diameters (LMBDs) determined from chest radiographs^[2] or from chest computed tomography (CT) scans.^[3] In Western women, 35-Fr or 37-Fr DLTs are often selected.^[1,3] However, difficulties were encountered when inserting 32-Fr DLTs into Japanese women.^[4] Therefore, we retrospectively searched the success rates for 32-Fr or 35-Fr DLT insertion in Japanese women and determined the causes of unsuccessful DLT insertion.

METHODS

The study was approved by the Institutional Review Board (approval number 360). Anaesthesia records

of female patients ≥ 20 years old who underwent thoracic surgery with left DLTs (Portex Blue Line™ Endobronchial Tube; Smiths Medical Japan Ltd., Tokyo, Japan) in our hospital between April 2010 and March 2015 were retrospectively extracted. Patients who had undergone cardiac surgery with DLTs and those whose records did not indicate DLT sizes or patients' characteristics were excluded from the study. Only one anaesthesia record was adopted for patients who underwent multiple operations.

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The patients' characteristics were extracted from anaesthesia records. The LMBDs and transverse diameters of cricoid cartilages were measured from CT scans. In the successful group (SG), patients were intubated using the initially selected DLTs. In the unsuccessful group (UG), the DLT size had to be changed.

The patients' height and LMBDs in the two groups were compared using the Mann–Whitney U-test. Frequencies for patients' height ≥ 150 or <150 cm were compared between the SG and UG groups using Fisher's exact test. $P < 0.05$ was considered statistically significant. Data are presented as the mean \pm standard deviation.

RESULTS

In total, 301 records were extracted and 21 records were excluded, leaving 280 records for investigation. Combined resident anaesthesiologists with anaesthesia experience of 3–5 years and a supervising anaesthesiologist with 10–23 years of experience anaesthetised the patients. Among the 280 patients (mean age, 66.0 ± 13.5 years; mean height, 151.9 ± 6.2 cm; mean weight, 51.2 ± 8.9 kg), 149 (96.1%) of 155 cases with 32-Fr DLTs and 119 (95.2%) of 125 cases with 35-Fr DLTs were successful. No difference was observed in the patients' height frequencies between the SG and UG for 32-Fr DLTs, whereas the patients' height frequencies in the UG were significantly lower than those in the SG for 35-Fr DLTs [$P = 0.0036$, Table 1].

In the 32-Fr SG, 125 transverse diameters of cricoid cartilages (measured from CT) averaged 12.5 ± 1.1 mm, but the remaining 24 transverse diameters of cricoid cartilages were not obtained. In the 35-Fr SG, 97 transverse diameters of cricoid cartilages averaged 13.1 ± 1.3 mm, but the remaining 22 transverse diameters of cricoid cartilages were not obtained. Table 2 shows the details of 12 patients in the UG. Among six cases, each of 32-Fr and 35-Fr DLT use in the UG, the transverse diameters of cricoid cartilages were not obtained in two patients. In the remaining 32-Fr DLT cases, the transverse diameters of cricoid cartilages were smaller than the tracheal diameter (10.1 mm \times 11.2 mm) of the DLT in three patients (9.4, 9.4 and 10.0 mm) and smaller than the bronchial diameter (7.3 mm \times 8.9 mm) in one patient (10.6 mm; 8.8 mm LMBD). In the remaining 35-Fr DLT cases, the transverse diameters of cricoid cartilages were smaller than the tracheal diameter (11.0 mm \times 12.6 mm) of the DLT (10.6, 10.6, 10.7 and 10.7 mm).

DISCUSSION

In our study, the success rate of DLT insertion in Japanese women was satisfactory (around 95%) and the main cause of unsuccessful DLT insertion seemed to be difficult passage through the cricoid cartilage. In a previous study involving 32 American women, all left DLTs were successfully inserted after size selection based on chest radiographs.^[1] However, literature regarding the appropriate DLT sizes for short-statured

Table 1: Left double-lumen tube selection according to patient height and left main bronchial diameter

DLT size	SG*	UG†			P value (OR [95% CI])
		32-Fr‡	28-Fr‡	Blocker	
32-Fr DLT	149	-	4	2	
Patient height (n) [§]	150.6 \pm 6.1		150 \pm 6.5		0.834
≥ 150 cm	66		3		1.0 (0.80 [0.60-4.1])
<150 cm	83		3		
LMBD (n) [§]	11.2 \pm 1.4		10.4 \pm 1.2		0.156
≥ 10.5 mm	108		2	-	
10- <10.5 mm	16		-	1	
<10 mm	25		2	1	
35-Fr DLT	119	5	-	1	
Patient height (n) [§]	153.9 \pm 5.8		147.3 \pm 3.4		0.006 [¶]
≥ 150 cm	93		1		0.0036 (17.9 [2.0-160]) ^{¶¶}
<150 cm	26		5		
LMBD (n) [§]	11.3 \pm 1.3		10.9 \pm 1.2		0.701
≥ 10.5 mm	88	4		1	
10- <10.5 mm	23	-		-	
<10 mm	8	1		-	

*SG – The patients were intubated initially with the selected DLTs, †UG – The patients required a DLT size change, ‡Selected DLT sizes, §The data are presented as mean \pm SD, ||The data are presented as the number, ¶ $P < 0.05$. CI – Confidence interval; DLT – Double-lumen tube; LMBD – Left main bronchial diameter; OR – Odds ratio; SG – Successful group; UG – Unsuccessful group; SD – Standard deviation

Table 2: Details of unsuccessful 32-Fr and 35-Fr left double-lumen tube insertions (six cases each)

DLT size	Age (years)	Height (cm)	Weight (kg)	LMBD* (mm)	TDCC* (mm)
32-Fr DLT	76	145	47.4	12.2	9.4 [‡]
	35	154	41.8	10.2	9.4 [‡]
	59	160	50.1	9.9	10.0 [‡]
	72	147	54.8	8.8 [†]	10.6 [‡]
	71	140	43.1	9.3	NA
	63	153	52.8	11.9	NA
35-Fr DLT	71	154	50.6	10.5	10.6
	76	145	47.4	12.5	10.6
	71	149	72.5	11.0	10.7
	69	145	57.3	10.8	10.7
	70	147	46.9	8.8 [§]	NA
	74	144	54.2	11.9	NA

*The lengths are obtained by computed tomography, [†]7.3 mm × 8.9 mm bronchial portion of the 32-Fr DLT may not pass, [‡]10.1 mm × 11.2 mm tracheal portion of the 32-Fr DLT may not or cannot pass, [§]8.7 mm × 10.1 mm bronchial portion of the 35-Fr DLT may not pass, ^{||}11.0 mm × 12.6 mm tracheal portion of the 35-Fr DLT cannot pass. DLT – Double-lumen endobronchial tube; LMBD – Left main bronchial diameter; NA – Not available, TDCC – Transverse diameter of the cricoid cartilage

women, such as Japanese women, is not readily available. Moreover, anaesthesiologists in South Asian countries^[5] who treat short-statured women may face difficulties in selecting appropriate DLTs. Another report showed that tracheas were successfully intubated in 18 Asian women after selecting left DLT sizes based on CT scans.^[6] Smaller sizes were required in 2% (6/300) of American adult patients because of the greater difficulty of insertion into the left mainstem bronchus than in the glottis.^[7] In the current study, difficulty in passage through smaller cricoid cartilages occurred in seven patients (2.5%, 7/280).

In a previous study in the United States, a 28-Fr DLT was restrictively used in young patients or small adults.^[7] In 8 of 32 short Asian women (height, <152 cm), a left DLT <32-Fr in size (8.7 mm outer diameter of the bronchial lumen, Broncho-Cath™; Mallinckrodt, St. Louis, MO, USA) was needed.^[6] Moreover, left DLTs <35-Fr (9.6 mm, Broncho-Cath™) in size were needed in 27 of 48 women with heights of 152–160 cm.^[6] According to Miller's Anaesthesia, a reputed textbook, the bronchial diameter should be examined and a 32-Fr DLT should be considered for short-statured female patients (<152 cm); the DLT should be able to pass the glottis without resistance.^[9] Difficulties were reported in placing 35-Fr DLTs in three American female patients with LMBDs ≤10 mm,^[3] in inserting 32-Fr DLTs in one of seven Asian female patients with LMBDs <10 mm and in inserting 35-Fr DLTs in five of nine Asian female patients with LMBDs ≥10 mm but <11 mm.^[6]

In our study, the patients' height (average, 152 cm) were relatively low, and the heights in the UG were significantly lower than those in the SG for 35-Fr DLT

cases ($P = 0.0036$). Thus, Japanese women's heights may influence the success rates of DLT insertion. In South Asian countries, the average height of women was 151 cm in the Philippines, Bangladesh and Nepal^[5] and 152 cm in India.^[10] Anaesthesiologists in those countries may face same difficulties in selecting DLTs as Japan; however, further investigation is required.

In seven of the 12 UG cases in the present study, the DLTs may not have passed through the cricoid cartilage [Table 2]. In 27 Swedish women, the average transverse diameter of cricoid cartilage was 11.6 mm; the cricoid ring did not permit passage of a standard-sized tracheal tube (internal diameter, 7 mm; outer diameter, 9.6 mm; equivalent to 28-Fr) without mucosal damage.^[11] Moreover, transverse diameters of cricoid cartilage measurement were useful for selecting a single lumen tube size.^[12]

Mean inner transverse diameters of the female cricoid cartilage at the cranial edge ranged from 9.1 mm in North Indians to 12.8 mm in Japanese,^[11,13-16] except 25.8 mm in Nigerians,^[17] whereas mean inner transverse diameters of the cricoid cartilage at the caudal edge ranged from 14.5 to 16.8 mm.^[14-16,18] Japanese women may have a relatively larger cricoid cartilage than women in other countries [Table 3]. The mean inner transverse diameter of the cricoid cartilage at the caudal edge 2–4 mm surpasses the diameter at the cranial edge.^[14-16] We may bear in mind that inner transverse diameters of the cricoid cartilage at the cranial edge narrower than the caudal edge would limit DLT passage through the cricoid. All human resources of the larynx^[11,13-18] were cadavers (or autopsy specimens). The inner transverse diameter of the cricoid cartilage was directly measured and

Table 3: Mean inner diameters of the female cricoid cartilage

Country	Authors [reference number]	n	Cranial edge	Caudal edge
North Indians	Singla <i>et al.</i> ^[13]	5	9.1	-
Swedish	Randestad <i>et al.</i> ^[11]	27	11.6	-
German	Eckel <i>et al.</i> ^[14]	25	12.4	14.5
Indian	Jain and Dhall ^[18]	20	-	15.7
Indian	Yadav <i>et al.</i> ^[15]	14	12.4	16.6
Japanese	Tayama <i>et al.</i> ^[16]	3	12.8	16.8
Nigerian	Ajmani ^[17]	12	25.8	

Sizes are presented as mm

deemed accurate. However, the small number of specimens may have an influence on the study results, such as $n = 3$ ^[16] and 5 ^[13] compared to $n = 20$,^[18] 25 ^[14] and 27 .^[11] In our study, it was difficult to differentiate whether the measurement portion was the cranial or caudal edge using the 5-mm sliced CT because the height of the anterior portion of the cricoid cartilage is usually <5 mm.

We also encountered difficulty in inserting a 32-Fr left DLT in another small 75-year-old Japanese woman (height, 144 cm). The DLT could not pass through the cricoid cartilage, which had a 9.2- or 8.8-mm transverse diameters of cricoid cartilage, based on the ultrasonogram and CT scan, respectively.^[4] Unfortunately, the transverse diameter of cricoid cartilage cannot always be calculated from CT scans for diagnosing pulmonary cancer as in this study [4 of 12 cases in UG, Table 2]. Nevertheless, ultrasonographic measurement of transverse diameters of cricoid cartilages before anaesthesia can help in choosing the appropriate left DLT size, especially in small-statured women.

This study has several limitations. First, the anaesthesiologists in our department almost always referred to Western recommendations for selecting DLT size. Moreover, we did not apply any strict common protocol for selecting DLT sizes. Second, we cannot evaluate whether intubated DLT sizes were appropriate, based only on anaesthesia records. Third, this was a retrospective study, which has inherent limitations. Improper DLT sizes were sometimes selected in this retrospective study although the success rate was very high in both groups. For 32-Fr DLT, the average height was <150 cm in 83 patients and the LMBD was <10 mm in 25 patients, whereas for 35-Fr DLT, the average height was <150 cm in 26 patients and the LMBD was <10 mm in eight patients. A future prospective study would lead

to proper DLT size selection when an appropriate protocol was used.

CONCLUSION

The 32-Fr and 35-Fr DLTs may not have passed through the cricoid cartilages in seven of the 280 Japanese women studied because of the small size of the cricoid cartilage. Therefore, referring to transverse diameters of cricoid cartilages calculated from CT scans or ultrasonograms in addition to tracheal and LMBDs may be a better strategy for selecting appropriate left DLT sizes.

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Conflicts of interest

There are no conflicts of interest.

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