

# Placement of left double-lumen endobronchial tubes with or without a stylet

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**Purpose:** This study was designed to determine if leaving a stylet in the left Bronch-Cath® endobronchial tube (DLT) for the entire intubating procedure improves the accuracy of placement on the initial attempt, without introducing complications.

**Methods:** Sixty ASA 1–3 patients were randomized to one of two groups. In Group 1 (n = 30), the stylet was retained for the entire intubation procedure and in Group 2 (n = 30), the stylet was removed once the bronchial cuff had passed the vocal cords. In both groups, the DLT was turned 110° counterclockwise and advanced until resistance was encountered. Placement was assessed by auscultation and fiberoptic bronchoscopy (FOB). After surgery, the DLT was replaced by a single-lumen endotracheal tube. The thoracic surgeon (blinded to the method of intubation, and using a FOB) assessed the appearance of the tracheobronchial mucosa.

**Results:** The two groups were similar with respect to sex, height, weight, DLT size, surgeon and expertise of the laryngoscopist. When the stylet was retained, the DLT was correctly placed 60% of the time compared with 17%, if the stylet was removed, (P = 0.001). Seven out of 30 DLTs in Group 2 were initially placed into the right mainstem bronchus, (P = 0.005). The average time to confirmation of correct tube placement by FOB was increased in Group 2, (P = 0.01). Although the observed incidence of left bronchial, mucosal petechiae and erythema was greater in Group 2, this was not statistically significant, (P = 0.063).

## Key words

ANAESTHESIA: thoracic;  
ANAESTHETIC TECHNIQUES: bronchoscopy,  
endobronchial, one-lung anaesthesia;  
EQUIPMENT: double-lumen endobronchial tubes;  
INTUBATION: technique.

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**Conclusion:** Retaining the stylet for the entire intubation procedure allows for a more rapid, accurate placement of the DLT without increasing the incidence of tracheobronchial mucosa injury.

**Objectif:** Cette étude visait à déterminer si le fait de laisser un guide dans un Bronch-Cath® endobronchique gauche (TEG) pendant toute la manoeuvre d'intubation assurait l'exactitude de la position dès la première tentative et ne provoquait pas de complications.

**Méthode:** Soixante patients ASA 1–3 ont été répartis aléatoirement en deux groupes. Dans le groupe 1 (n = 30), le guide est demeuré en place pendant la manoeuvre d'intubation, et dans le groupe 2, le guide a été enlevé dès que le tube eût passé les cordes vocales. Dans les deux groupes, le TEG a été pivoté à 110° dans le sens contraire aux aiguilles d'une montre et avancé jusqu'à la rencontre d'une résistance. La position du tube a été vérifiée par auscultation et bronchofibroscopie. Après la chirurgie, le TEG a été remplacé par une tube ordinaire. Le chirurgien thoracique (qui ignorait la méthode d'intubation et utilisait un bronchofibroscope) a évalué la muqueuse trachéobronchique selon son apparence.

**Résultats:** Les deux groupes étaient identiques quant au sexe, la taille, le poids, le diamètre du tube, le chirurgien et la compétence du laryngoscopiste. Avec un guide en place, le TEG a été correctement installé 60% du temps comparativement à 17% avec retrait du guide (P = 0,001). Dans le groupe 2, dans sept cas sur 30, le TEG a été placé initialement dans la bronche souche gauche (P = 0,005). Le délai de confirmation de l'exactitude de la position vérifiée par bronchofibroscope a été prolongé dans le groupe 2 (P = 0,01). L'incidence d'érythème et de pétéchie de la muqueuse bronchique, bien que plus élevée dans le groupe 2, n'était pas significative (P = 0,063).

**Conclusion:** Le maintien du guide pendant la manoeuvre d'intubation du TEG permet une mise en position rapide et précise sans augmentation de l'incidence de lésions muqueuses trachéobronchiques.

Accurate placement of double-lumen tubes (DLTs) is essential for one-lung ventilation. In the past, chest auscultation has been used to confirm placement of the

DLT. However, recent studies show that auscultation alone is unreliable.<sup>1-4</sup> Fibreoptic bronchoscopy (FOB) is now considered the method of choice for confirming tube placement.<sup>1-3,5-7</sup> Post-placement FOB has revealed that disposable, polyvinyl chloride DLTs are malpositioned in 48%–78% of patients.<sup>1,3,5</sup>

The left-sided DLT can be malpositioned in three ways; into the right mainstem bronchus, inserted too far, or not far enough into the left mainstem bronchus.<sup>8</sup> Problems resulting from improper positioning of a DLT include hypoxaemia, airway trauma and unsuitable surgical conditions.<sup>8</sup>

Double-lumen tubes are supplied with a stylet in place to help retain their shape. It is recommended that this stylet be removed just after the tip of the tube passes through the vocal cords, because of the theoretical risk of damage to the tracheobronchial mucosa.<sup>6</sup> However, the literature does not support this concern. We hypothesized that removing the stylet early in the intubation sequence may increase the flexibility of the DLT, altering the degree of rotation as the tube is turned and advanced, thus contributing to malpositioning.

This study was designed to determine if retaining the stylet in the DLT for the entire intubating procedure improved the accuracy of placement on the initial attempt, without introducing complications. This would benefit the patient if it decreased the incidence of hypoxaemic events, reduced the induction to surgical preparation time or decreased the potential for airway trauma.

## Methods

Following ethics approval and with written, informed consent, 60 consecutive ASA physical status 1–3 patients, undergoing thoracotomy or thoracoscopy requiring left-sided DLTs, were studied. Patients were excluded from the study if a left-sided DLT was contraindicated. These contraindications included a lesion along the path of the DLT, tracheal or left bronchial stenosis and distorted carinal architecture.<sup>6</sup> Upon entry, patients were randomized to one of two groups. In Group 1 ( $n = 30$ ), the stylet was retained for the entire intubation procedure, until the intubator felt the DLT was correctly positioned. In Group 2 ( $n = 30$ ), the stylet was removed once the bronchial cuff passed the vocal cords. Left Broncho-Cath<sup>®</sup> Endobronchial tubes (Mallinckrodt, catalogue #95892-95895) were used. The selection of the appropriate DLT size was based on the recommendations of Hannallah, (Table I).<sup>9</sup>

Patients were preoxygenated. The induction agents were chosen at the discretion of the attending anaesthetist. After induction of anaesthesia and direct laryngoscopy, tracheobronchial intubation was performed.

TABLE I Selection of DLT sizes

Height	Female	Male
<165 cm	35 Fr.	37 Fr.
165–179 cm	37 Fr.	39 Fr.
>179 cm	39 Fr.	41 Fr.

All intubations were performed by senior residents or staff anaesthetists.

In both groups, the DLT was turned 110° counter-clockwise after the blue bronchial cuff had passed the vocal cords and was advanced until resistance was encountered. The bronchial and tracheal balloons were inflated with no more than 3 ml and 10 ml of air, respectively.<sup>10</sup> Placement was assessed initially by auscultation using the method described by Wilson.<sup>11</sup> The accuracy of placement was confirmed using an Olympus LF1 fibreoptic bronchoscope by a single bronchoscopist (DL).<sup>5</sup> The FOB was initially passed into the tracheal lumen looking for a clear view of the tracheal carina, the left lumen going off to the left and the proximal edge of the blue bronchial cuff located just below the tracheal carina. The FOB was then passed into the bronchial lumen looking for an unobstructed view of the left bronchial carina and the left upper lobe (LUL) bronchial orifice. Following this assessment, the DLT was repositioned if incorrect placement was identified.

A stopwatch was employed to measure the time from the start of laryngoscopy to initial blind DLT placement, from the start of FOB to confirmation of correct tube position (including the time for DLT repositioning, if necessary) and from the start of laryngoscopy until the patient was turned.

After surgery, the anaesthetized patient was turned supine. The DLT was removed and replaced by a single-lumen endotracheal tube. The thoracic surgeon, blinded to the method of intubation and using a fibreoptic bronchoscope assessed the appearance of the tracheobronchial mucosa. Their observations regarding the presence or absence of mucosal petechiae, erythema, bleeding or mucosal tears were recorded. Positive findings were further classified according to location and severity.

A prestudy power calculation was carried out based on the reported incidence of incorrect DLT placement.<sup>1,3,4</sup> This analysis indicated that a total of 60 patients were required in order to have an 80% chance of detecting at least a 25% improvement in DLT placement, if a stylet was retained in the tube for the duration of intubation, ( $\alpha = 0.05$ ). Using a computer generated code prepared by the statistician, patients were randomized into one of two groups, in blocks of ten, to mini-

mize the potential confounding influence of laryngoscopists' experience with DLT placement. Results were analysed using the Chi-square and Fisher exact test to compare proportions and complication rates. The Wilcoxon rank-sum test was used to compare time measurements. In addition, the Breslow Day test for homogeneity of odds ratios and analysis of variance were used to determine if the level of expertise of the laryngoscopist (Resident level PGY 3, 4, 5 or Staff) affected the success of DLT placement.

### Results

The study groups were similar with respect to sex, height, weight, and DLT size (Table II). The level of expertise of the laryngoscopist was similar in the two groups and did not affect the ability to correctly position the tube. Oxygen saturation was maintained at greater than 94% throughout the intubating procedure in 59/60 patients. In Group 2 (stylet removed), one patient's oxygen saturation decreased to 91% during a difficult intubation but recovered quickly with the administration of 100% oxygen.

The average time to confirmation of correct tube placement by fiberoptic bronchoscopy was  $179 \pm 121$  sec in Group 1 (stylet retained) compared with  $301 \pm 230$  sec in Group 2 (stylet removed), ( $P = 0.01$ ). The mean time from the start of laryngoscopy to completion of positioning the patient for surgery was  $8.5 \pm 6.6$  min in the stylet retained group versus  $12.3 \pm 6.2$  min in the stylet removed group, ( $P = 0.03$ ). Both the confirmation of correct tube placement by FOB and the onset of surgical preparation was faster in the group that had the stylet retained for the duration of intubation. Time from the start of laryngoscopy to initial blind DLT placement was similar for both groups.

Seven out of 30 DLTs in Group 2 (stylet removed) were initially placed into the right mainstem bronchus, ( $P = 0.005$ ). When the stylet was retained, the DLT was correctly placed 60% of the time compared with 17%, if the stylet was removed, ( $P = 0.001$ ) (Table III).

The two thoracic surgeons each examined 26 and 34 patients, ( $P = \text{NS}$ ). There was no evidence of tracheobronchial tears in either group. No patients had evidence of tracheal mucosal damage. Although the observed incidence of left bronchial, mucosal petechiae and erythema was higher when the stylet was removed early in the intubation sequence, this was not statistically significant ( $P = 0.063$ ). The incidence of left bronchial mucosal injury was not influenced by the experience of the intubator or DLT size.

### Discussion

Currently, DLTs are used to control ventilation, to pre-

TABLE II Demographic data

Group	Sex M/F	Height* (cm)	Weight* (kg)	DLT size 35/37/39/41 Fr.
Stylet	21/9	$173 \pm 9$	$77 \pm 16$	4/7/12/7
No Stylet	16/14	$168 \pm 9$	$71 \pm 18$	7/10/11/2

\*Values are represented as mean  $\pm$  SD.

TABLE III Left-sided DLT position

DLT Placement	Stylet (n = 30)	No Stylet (n = 30)
*RMS (incorrect bronchus)	0	7
LMS (in too far)	8	15
LMS (out too far)	4	3
†LMS (correct position)	18	5

LMS = left mainstem; RMS = right mainstem.

\*RMS vs. all other positions: Fisher exact test,  $P = 0.005$ .

†Correct vs. all other positions: Chi-Square = 11.915,  $df = 1$ ,  $P = 0.001$

vent cross contamination between lungs and to enhance visualization during surgery.<sup>6</sup> Placement of DLTs presents several potential problems. These include unsuccessful or difficult intubation, tube dislodgement, unsatisfactory lung deflation, tube malposition and hypoxaemia.<sup>12</sup> To increase the accuracy of placement and decrease potential complications, use of the fiberoptic bronchoscope in addition to auscultation has been recommended to confirm DLT placement.<sup>1-3,5-7</sup> Any changes in technique which enable a more rapid and accurate placement of the DLT should benefit the patient.

When the stylet was retained, the DLT was found to be in the correct bronchus and in the correct position more often than when the tracheobronchial intubation was done without a stylet. Accuracy of placement did not depend on the experience of the laryngoscopist, size of the DLT and sex or size of the patient. One of the most commonly reported causes for malposition of DLTs is the selection of a tube that is inappropriately too small for the patient.<sup>13</sup> In our study, we controlled for DLT size by the patient's height. We found that there was no increase in DLT malplacement in the patients who had smaller DLTs positioned with or without a stylet. When the stylet is removed early in the intubation sequence, it is possible that the DLT becomes soft, flexible and subject to increased torque. In this situation the endobronchial portion of the tube may be more likely to enter the right mainstem bronchus.

Sources suggest that the endobronchial tube should be

advanced until resistance is encountered.<sup>6</sup> However, resistance is a very subjective sensation and can be interpreted differently. When the stylet was removed early, the endobronchial tube tended to be placed too deeply into the correct bronchus. This occurred less often if the stylet was retained. The stylet helps to retain the shape and stiffness of the bronchial curvature, thus it can abut against the tracheal carina and prevent slippage of the tube further down into the left mainstem bronchus. None the less, in both groups the most common malplacement was inserting the DLT too deeply into the left mainstem bronchus.

Time to confirmation of correct tube placement by fiberoptic bronchoscopy and onset of surgery preparation was decreased if the stylet was retained for the duration of intubation. This is of benefit in a busy operating room setting. Reduced delays before the onset of surgery may enhance operating room efficiency.

Irrespective of the clinical expertise of the anaesthetist, if the DLT is initially placed in the right mainstem bronchus it can be difficult to diagnose whether the tube is, in fact, in the incorrect bronchus or has been advanced too far into the correct bronchus using FOB alone. Usual landmarks such as the carina are lost. Initial auscultation helps to distinguish this difference. Fiberoptic bronchoscopy does not replace auscultation in assessing placement of DLT. Instead, these techniques complement each other.

It has been suggested that leaving a stylet in the DLT for the entire intubating procedure increases the incidence of tracheobronchial injury.<sup>6,14</sup> Removing the stylet once the tip of the DLT passes the vocal cords is recommended by both product manufacturers\* and experienced anaesthetists.<sup>6,14</sup> However, there are no published case reports which implicate a stylet as the sole cause of tracheobronchial damage. In fact, retaining the stylet might reduce the incidence of tracheobronchial injury. Bronchial mucosal erythema and petechiae occurred to a greater extent in the group who had the stylet removed. Increased manipulation of the DLT to assure adequate placement may have led to excessive trauma. In both groups, erythema and petechiae were seen in the area of the bronchial cuff despite inflating the cuff with less than 3 ml of air. This would concur with previous reports of mucosal injury from over distension of the bronchial cuff.<sup>6,10,14,15</sup> We did not measure bronchial cuff pressure intraoperatively. After extubation, the cuff was examined and found to be intact in all cases. No patient developed tracheal mucos-

\*Mallinckrodt Medical. Package insert for Left Broncho-Cath Endobronchial Tubes, Catalogue #95892-95895. Mallinckrodt Medical, Inc. 1993.

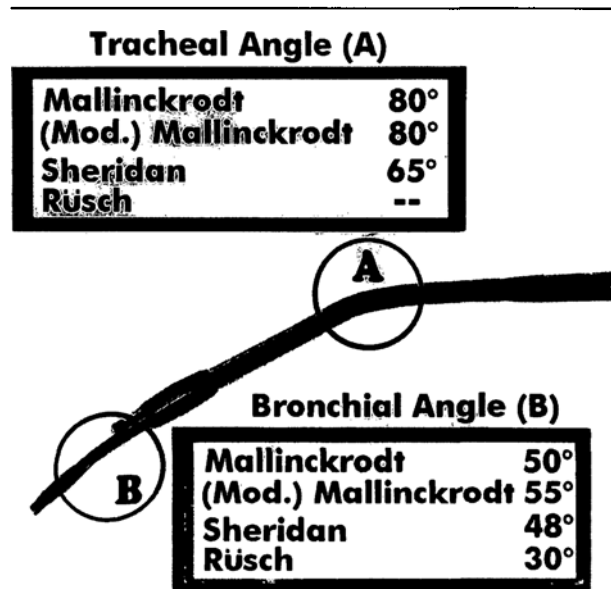


FIGURE Double lumen tube angles.

al damage and no bronchial lacerations were encountered.

Recently, modifications have been made to the Mallinckrodt Left Broncho-Cath<sup>®</sup> Endobronchial Tube.\* This was done in an attempt to prevent occlusion of the bronchial tip when the patient's position changes, to facilitate fiberoptic visualization of the LUL bronchus and to increase the margin of safety for obstruction of the LUL bronchus.<sup>16</sup> The manufacturer postulates that the insertion of this modified DLT could be more difficult or cause bronchial mucosal trauma.<sup>16</sup> As the Figure indicates, the tracheal (proximal) angle is 80° and 65° on the Mallinckrodt and Sheridan tubes, respectively. The bronchial (distal) angle is 55° (Mallinckrodt modified DLT), 50° (Mallinckrodt unmodified DLT), 48° (Sheridan) and 30° (Rüsch). The Portex company declined to supply any information pertaining to their DLT angles and the Rüsch company was not able to provide us with the tracheal angle of their DLT. Since, in this study, retaining the stylet in the unmodified tubes for the duration of intubation increased accuracy of placement, we believe that this method would only enhance the correct placement of the modified left-sided DLT.

In summary, we recommend that the stylet be retained in the Left Broncho-Cath<sup>®</sup> DLT for the entire intubation procedure. This change to the current me-

\*Mallinckrodt Medical. Package insert in modified Left Broncho-Cath<sup>®</sup> Endobronchial Tubes, Catalogue #95892-95895, Mallinckrodt Medical, Inc. 1994.

thodology allows for a more rapid, accurate placement of the DLT without increasing the incidence of tracheo-bronchial mucosal damage.

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