New landmarks improve the positioning of the left Broncho-Cath™ double-lumen tube-comparison with the classic technique

[De nouveaux repères facilitent la mise en place du tube double-lumière Broncho-Cath™ gauche - comparaison avec la technique classique]

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Purpose: To compare a new technique (NT) for positioning the left modified Broncho-Cath™ double-lumen tube (LM- DLT) by fibreoptic bronchoscopy (FOB) to the classic technique (CT).

Methods: Sixty-one adult patients undergoing elective thoracic surgery with LM-DLT were randomly assigned to the NT or to the CT group. For the NT, the endoscopist confirms the left mainstem endobronchial intubation. The proximal edge of the blue bronchial cuff should not be visualized at the carina. Then, through the left bronchial lumen, by transparency across the wall of the tube, the position of the tube is adjusted so that the carina lies midway between the black radiopaque line and the top of the bronchial cuff. After this, the orifice of the left upper lobe (LUL) bronchus should be clearly seen. For the CT, the endoscopist uses the technique described by Benumof and Slinger. After lateral positioning of the patient, the LM-DLT was repositioned if the top of the endobronchial cuff was above the carina or when the LUL bronchus was obstructed.

Results: The incidence of proximal repositioning was significantly less in the NT compared to the CT (16% *vs* 43%, $P=0.007$).

Conclusion: Using this new technique, the LM-DLT is inserted deeper in the left mainstem bronchus. This new landmark augments the range of movement that can be tolerated without requiring repositioning of the LM-DLT. This NT to position and to assess LM-DLT, by transparency across the wall of the tube with FOB, is better adapted to the LM-DLT and its recent modifications.

Objectif: *Comparer une nouvelle technique (NT) de positionnement du tube double-lumière Broncho-Cath™ gauche modifié (TDL-GM), à l'aide de la fibroscopie, à la technique classique (TC).*

Méthodes: *Soixante et un patients adultes devant subir une chirurgie thoracique programmée avec un TDL-GM ont été randomisés aux groupes NT ou TC. Suivant la NT, l'endoscopiste confirme l'intubation de la bronche souche gauche et le sommet du ballonnet ne doit pas être visualisé juste sous la carène. Par la lumière bronchique, par transparence au travers de la paroi du tube, on ajuste celui-ci pour que la carène se situe à mi-chemin entre la ligne noire radio-opaque et le sommet du ballonnet bronchique. On s'assure également que la bronche lobaire supérieure gauche (LSG) est libre. Suivant la TC, l'endoscopiste utilise la technique décrite par Benumof et Slinger. Après le positionnement en décubitus latéral, le TDL-GM est repositionné lorsque le sommet du ballonnet fait hernie au dessus de la carène ou si la bronche LSG est obstruée.*

Résultats: *Les repositionnements proximaux sont significativement moins fréquents en utilisant la NT comparativement à la TC (16 % vs 43 %, P=0,007).*

Conclusion: *Lorsqu'on utilise la NT, la partie endobronchique du TDL-GM est insérée plus profondément dans la bronche souche gauche avec de nouveaux points de repère et augmente par conséquent la marge de mouvement qui peut être tolérée sans nécessiter un repositionnement du TDL-GM. Cette NT de positionnement et de vérification, par transparence au travers de la paroi du tube, est mieux adaptée aux modifications récentes du TDL-GM.*

THE left Broncho-Cath™ (Mallinckrodt Anesthesiology, St-Louis MO, USA) double lumen tube (DLT) was redesigned in 1994. It was the first major modification in 15 yr. The left modified-DLT (LM-DLT) incorporates several new design changes that facilitate its use (Figure 1). First, the endobronchial portion was shortened from 58 to 45 mm. Second, the endobronchial cuff length was reduced from 19, including

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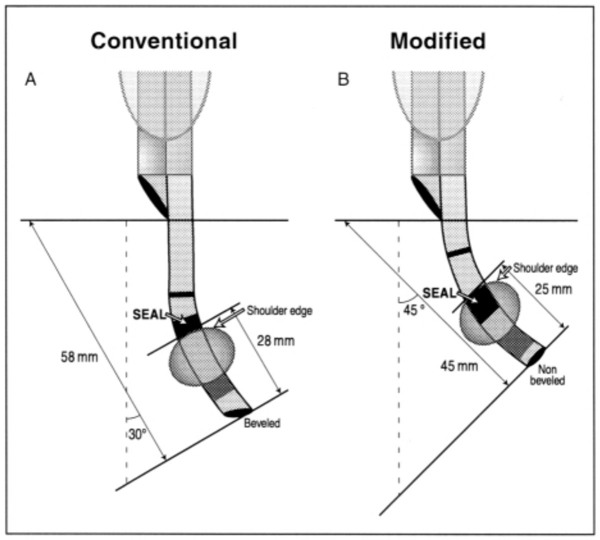

FIGURE 1 Left broncho-cath DLT modifications.

the outside proximal seal of the cuff (Figure 1A), to 15 mm as the proximal seal of the cuff had been repositioned inside the cuff (Figure 1B), and the cuff was moved 3 mm caudally. Third, the angle between the tracheal tube axis and the bronchial tube axis was increased from 30 to 45, and finally, the bevelled bronchial tip was eliminated. These modifications increase its margin of safety[1,2] and diminish the risk of obstruction in the expiratory phase.[3]

However, in our experience, the modification of the tip and the cuff of the LM-DLT caused problems when it was positioned using the classic approach[4,5] for insertion by fibreoptic bronchoscopy (FOB). It was observed frequently that, after moving the patient from the supine to the lateral position, the cuff moved to bulge in the trachea and the bronchial tip tended to herniate or dislodge from the left mainstem bronchus. Proper placement of a DLT is imperative for its proper functioning.[6] Malpositioning can impair gas exchange and the capacity to isolate and deflate the operated lung.[7]

It is well demonstrated that the position of the DLT during anesthesia may be altered by surgical manipulation, patient coughing, or by moving the head, the neck or the entire patient.[8] Desiderio *et al.* demonstrated that the Sher-I-Bronch™ (Sheridan, Argyle NY, USA) DLT moved in 72% of cases during lateral positioning and this regardless of endobronchial cuff inflation.[9] This movement is predominantly in the upward direction. Recently, Klein confirmed this result with the use of LM Broncho-Cath™ DLT. After using classic recommendations, proximal malpositioning was seen in 43% of patients, following lateral positioning of the patient.[10]

We describe a new technique for placing the LM-DLT and propose an innovative method to assess positioning. The aim of this study was to investigate the potential usefulness of this new technique for better positioning and verifying of the LM-DLT. The new technique was compared with the actual standard recommendations for positioning the LM-DLT using FOB.[4,5]

Materials and methods

With the approval of the Research Ethics Committee of our institution, we obtained informed consent from 61 adult patients. These patients underwent elective thoracic surgery requiring endotracheal intubation with a LM-DLT and were randomly assigned to the CT (30 patients) or the NT (31 patients). Exclusion criteria included any anatomical abnormality in a major airway such as a proximal tumour, significant tracheal deviation, previous pulmonary resection or thoracic radiotherapy.[11] We used the LM Broncho-Cath™ DLT. The study started when the LM-DLT was inserted after induction of anesthesia and ended when the lateral positioning was completed and after verification and repositioning of the LM-DLT when necessary.

Monitoring consisted of electrocardiography, invasive arterial blood pressure, pulse oximetry, end-tidal CO_2 and pressure-volume loop displayed by side stream spirometry (Capnomac Ultima, Datex-Engstrom, Helsinki, Finland). Glycopyrrolate, 0.2 mg *iv* was injected just after the installation of the *iv* line as an antisialogue to permit optimal visualization with the FOB.

Under general anesthesia, the LM-DLT was inserted into the trachea. The size was selected according to Brodsky's chart.[12,13] The patient's head was placed on a pillow in a neutral position. With the LM-DLT in place, the cuffs were inflated with the minimum amount of air necessary to ensure absence of air leaks, confirmed by the pressure-volume loop displayed by side stream spirometry.[14]

One investigator (G.F.) performed all the fibreoptic examinations using a 4-mm FOB (Olympus LF-1, Olympus Optical Co Ltd, Tokyo, Japan) and assessed adequacy of tube placement according to the following criteria : *1- CT:* In the supine position, via the right tracheal lumen, the endoscopist should see a clear, straight-ahead view of the tracheal carina. It is important to see the upper surface of the left endobronchial

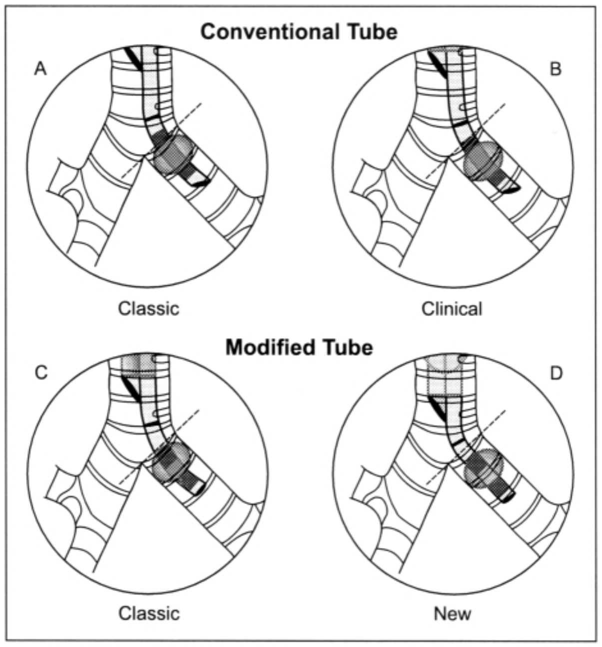

FIGURE 2 Left double lumen tube positions.

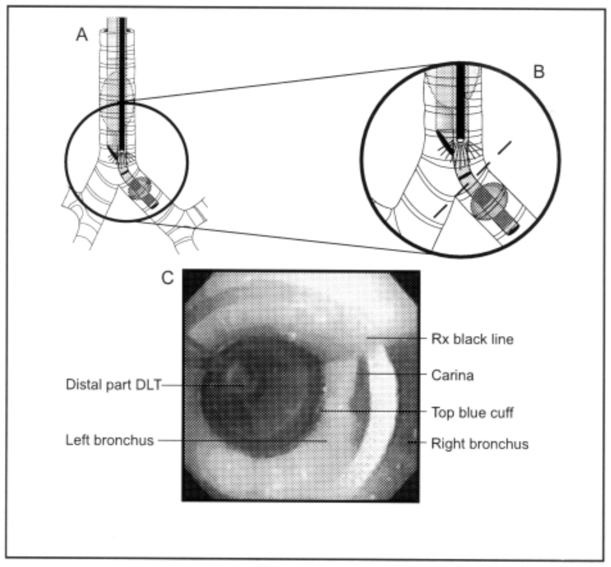

FIGURE 3 Visualization of the carina by transparency.

blue cuff just below the carina (Figure 2C). Then, looking down the left endobronchial lumen, the orifice of the LUL bronchus and the bronchial carina should be seen clearly to assure a properly positioned LM-DLT. *2- NT:* The endoscopist confirms the left mainstem endobronchial intubation and the position of tracheal carina. The proximal shoulder edge (Figure 1) of the blue bronchial cuff should not be visualized at the carina. However, through the left bronchial lumen, and by transparency across the wall of the tube, the position of the tube is adjusted so that the carina is midway between the black radiopaque line and the top of the bronchial cuff (Figures 2D and 3). Finally, the orifice of the LUL bronchus and the bronchial carina should be clearly seen.

The LM-DLT was fixed firmly in position with a tie at the level of the lips and a bow tie at the bifurcation of the lumens of the DLT.[15,16] After lateral positioning of the patient, FOB was used to evaluate the position of the LM-DLT. The most proximal acceptable position was when the top of the blue endobronchial cuff was just below the carina.[4] The most distal acceptable position was when the LUL was clearly seen. If displacement exceeded the described limits, the LM-DLT was repositioned.

Means and standard error of the mean (SEM) were determined for continuous variables and percent for categorical variables. Mean values of quantitative variables were compared using a Student's t test. Categorical variables were analyzed using the Fisher's exact test. The results were considered significant if P values were 0.05. The data were analyzed using the statistical package program SAS (SAS Institute Inc., Cary NC, USA).

Results

The demographic data including age, sex, weight and ASA status were similar in each group (Table I). There was a difference in the two groups concerning height.

Among the 61 patients, 72% were operated for lung cancer surgery, 7% for emphysema reduction surgery and the residual 21% for other conditions or procedures (e.g., tuberculosis, lung biopsy, etc.). The distribution of the type of surgery was similar in the two techniques.

The displacement of the LM-DLT after lateral positioning was similar in each group and in each direction (cephalad, caudal or none) as described in Table II. The incidence of proximal repositioning was significantly less for the NT compared to the CT (16% *vs* 43%, P=0.007). The incidence of distal repositioning for a clear view of the LUL bronchus was similar in each group.

In both groups, the following variables were examined and did not significantly influence repositioning:

TABLE I Demographic data

Variables	*Classic group*	*SEM#*	*New group*	*SEM#*
Age (yr)	63.67	2.06	58.00	2.72
Gender				
F	13 (43%)		09 (29%)	
M	17 (57%)		22 (71%)	
Height (cm)	163.47*	1.54	170.27*	1.76
Weight (kg)	67.46	2.09	68.75	2.53
ASA				
II	19 (63%)		21 (67%)	
III	11 (37%)		10 (32%)	

* $P < 0.005$
#Standard error of the mean.

TABLE II Results

Technique	*Classical*	*New*	*P*
# patients	#30	#31	
Displacement			
Proximal	13 (43%)	10 (32%)	0.434
Distal	12 (40%)	14 (45%)	0.797
Combined	25 (83%)	24 (77%)	0.749
Repositioning			
Proximal	13 (43%)	5 (16%)	0.007*
Distal	03 (10%)	2 (07%)	0.635
Combined	16 (53%)	7 (23%)	0.018*

* significant

performance of the epidural before or after induction, the presence or absence of superior or inferior dentition, the side of surgery and the size of the LM-DLT. Height did not influence displacement or repositioning.

Endotracheal visualization of the landmarks with FOB, across the wall of the LM-DLT, was evaluated and was easy in all of the patients in this study.

Discussion

The LM-DLT was redesigned to achieve the primary objectives described previously: ease of use, elimination of potential for obstruction during the expiratory phase and an acceptable margin of safety.[2,15,17] However, the LM- DLT has the seal of the cuff inside the endobronchial cuff. This finding can explain partially why the LM-DLT tends to be malpositioned proximally.[18] Furthermore, the endobronchial part of the LM-DLT is shorter (45 mm *vs* 58 mm) than the left conventional-DLT. This diminishes the relative stability of the LM-DLT while in the left mainstem bronchus. The increase in the angulation between the tracheal and endobronchial sections, while adapting to the anatomy, facilitates endobronchial intubation but equally augments the facility of dislodgement from the left mainstem bronchus. For these reasons, a new technique is proposed to position and to assess the LM-DLT. This new technique (Figure 2D) probably represents the equivalent of the "clinical position" (Figure 2B) used for the left conventional-DLT. The endobronchial part of LM-DLT is inserted deeply. This position necessitates less repositioning than the classic position (Figure 2C) because the proximal margin of movement is increased to about 5 mm. In this study, when the NT is compared to the CT, the incidence of proximal repositioning was significantly reduced (16% *vs* 43%). Since distal repositioning was similar in each group, the NT represent an improvement over the CT.

However, after positioning of the patient, the LM-DLT still tends to herniate and dislodge from the left mainstem bronchus.[10] The LM-DLT is vulnerable to malpositioning when changing the patient from the supine to the lateral decubitus position.[19] Desiderio *et al.* stated that it is actually advantageous to have the endobronchial cuff at least 1 cm inside the left mainstem bronchus, considering the tendency for carinal shift downward and perhaps LM-DLT movement upward with positioning. However, they did not determine the precise positioning and the modalities used to assess it, nor did they discuss the margin of safety.[9] The merit of our study is to specify the landmarks of a NT. To our knowledge, this study represents one of the very few prospective studies comparing and challenging standard FOB recommendations for positioning DLT.[4,5]

Our FOB definition of tube displacement may be responsible for the high rate of displacement observed (53%), compared to the rate reported (43%) by Klein[10] for whom the definition of acceptable proximal displacement was when the cuff herniated by about 0.5 cm. Such borderline tube placement carries the potential risk of subsequent displacement, obstruction or insufficient lung separation.

Conclusion

When the NT is compared to the recommended CT, the incidence of proximal repositioning is lessened by 63% (16% *vs* 43%). This NT inserts the endobronchial part of the LM-DLT more deeply in the left mainstem bronchus with the use of new landmarks visualized by transparency across the wall of the DLT. The new position increases the margin of movement and is better adapted to the LM-DLT and its recent modifications.

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References

1 *Benumof JL*. Improving the design and function of double-lumen tubes. J Cardiothorac Anesth 1988; 2: 729–33.
2 *Yahagi N, Furuya H, Matsui J, et al*. Improvement of the left Broncho-Cath double-lumen tube. Anesthesiology 1994; 81: 781–2.
3 *Desai FM, Rocke DA*. Double-lumen tube design fault (Letter). Anesthesiology 1990; 73: 575–6.
4 *Slinger PD*. Fiberoptic bronchoscopic positioning of double-lumen tubes. J Cardiothorac Anesth 1989; 3: 486–96.
5 *Benumof JL*. Anesthesia for Thoracic Surgery, 2nd ed., San Diego, CA: W.B. Saunders Company, 1995: 354–60.
6 *Boucek CD, Landreneau R, Freeman JA, Strollo D, Bircher NG*. A comparaison of techniques for placement of double-lumen endobronchial tubes. J Clin Anesth 1998; 10: 557–60.
7 *Brodsky JB, Shulman MS, Mark JBD*. Malposition of left-sided double-lumen endobronchial tubes. Anesthesiology 1985; 62: 667–9.
8 *Riley RH, Marples IL*. Relocation of a double-lumen tube during patient positioning (Letter). Anesth Analg 1992; 75: 1071–5.
9 *Desiderio DP, Burt M, Kolker AC, Fischer ME, Reinsel R, Wilson RS*. The effects of endobronchial cuff inflation on double-lumen endobronchial tube movement after lateral decubitus positioning. J Cardiothorac Vasc Anesth 1997; 11: 595–8.
10 *Klein U, Karzai W, Bloos F, et al*. Role of fiberoptic bronchoscopy in conjonction with the use of double-lumen tubes for thoracic anesthesia. Anesthesiology 1998; 88: 346–50.
11 *Slinger PD, Chripko D*. A clinical comparaison of bronchial cuff pressures in three different designs of left double-lumen tubes. Anesth Analg 1993; 77: 305–8.
12 *Brodsky JB, Macario A, Mark JBD*. Tracheal diameter predicts double-lumen tube size: a method for selecting left double-lumen tubes. Anesth Analg 1996; 82: 861–4.
13 *Brodsky JB, Mackey S, Cannon WB*. Selecting the correct size left double-lumen tube (Letter). J Cardiothorac Vasc Anesth 1997; 12: 924–5.
14 *Bardoczky GI, Engelman E, D'Hollander A*. Continuous spirometry: an aid to monitoring ventilation during operation. Br J Anaesth 1993; 71: 747–51.
15 *Benumof JL*. Anesthesia for Thoracic Surgery, 2nd ed., San Diego, CA: W.B. Saunders Company, 1995: 366.
16 *Cohen E, Koorn R*. An easy way to safely tie a double-lumen tube (Letter). J Cardiothorac Vasc Anesth 1991; 5: 194–5.
17 *Brodsky JB*. Modified bronchocath double-lumen tube (Letter). J Cardiothorac Vasc Anesth 1995; 9: 784–5.
18 *Campos JH, Reasoner DK, Moyers JR*. Comparaison of a modified double-lumen endotracheal tube with a single-lumen tube with enclosed bronchial blocker. Anesth Analg 1996; 83: 1268–72.
19 *Cheng KS, Wu RSC, Tan PP*. Displacement of double-lumen tubes after patient positioning (Letter). Anesthesiology 1998; 89: 1282–3.