



Double-lumen tube placement with the patient in the supine position without a headrest minimizes displacement during lateral positioning

La mise en place d'une sonde à double lumière chez un patient en decubitus dorsal sans appuie-tête minimise le risque de déplacement au cours du passage en decubitus latéral

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Abstract

Purpose The correct position of double-lumen tubes (DLTs) is customarily confirmed after tracheal intubation by bronchoscopy with the patient supine on a headrest. However, displacement of DLTs usually occurs during lateral positioning because of neck extension. This study was undertaken to determine whether displacement of DLTs could be minimized during lateral positioning if DLTs were positioned without a headrest.

Methods One hundred patients scheduled for thoracic surgery were randomized into two groups ($n = 50$ each). After tracheal intubation using a headrest, adjustment of DLT position was performed according to group

assignment, i.e., either with the headrest in place or without the headrest. Using a bronchoscope, distances from the tracheal opening to the main carina and from the bronchial opening to the left bronchial carina were measured in both the supine and lateral positions.

Results Displacement of DLTs [mean (standard deviation)] during lateral positioning was greater in the headrest group than in the no-headrest group [12.3 (6.5) mm vs 6.8 (5.5) mm, respectively, in the trachea; 11.6 (6.7) mm vs 6.0 (4.6) mm, respectively, in the bronchus; $P < 0.001$]. The incidence of significant displacement, defined as > 10 mm from initial correct position, was greater in the headrest group than in the no-headrest group (64% vs 28%, respectively, in the trachea; 58% vs 20%, respectively, in the bronchus; $P < 0.001$).

Conclusion Displacement of DLTs during lateral positioning appears to be caused primarily by extension of the neck. Correct adjustment of DLT position without a headrest in the supine position is an easy and effective method to minimize DLT displacement during lateral positioning (ClinicalTrials.gov number, NCT01413347).

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Résumé

Objectif La bonne position des sondes à doubles lumières (DLT) est d'ordinaire confirmée par bronchoscopie après intubation trachéale chez un patient en decubitus dorsal avec appuie-tête. Cependant, ces sondes se déplacent habituellement au cours d'un changement de position en decubitus latéral en raison d'une extension du cou. Cette étude a été entreprise pour déterminer si le déplacement des DLT pouvait être minimisé au cours d'un passage en

decubitus latéral si les DLT étaient installées sans appuie-tête.

Méthodes Cent patients devant subir une chirurgie thoracique ont été randomisés en deux groupes ($n = 50$ pour chaque groupe). Après intubation trachéale utilisant un appuie-tête, un ajustement de la position de la DLT a été réalisé en fonction du groupe auquel appartenait le patient, c'est-à-dire avec un appuie-tête en place ou sans appuie-tête. Les distances séparant l'origine de la trachée de la grande carène et de l'origine de la bronche souche jusqu'à la carène de la bronche gauche ont été mesurées à l'aide d'un bronchoscope chez les patients en decubitus dorsal puis en decubitus latéral.

Résultats Le déplacement des DLT (moyenne [écart-type]) au cours de la mise en decubitus latéral a été plus important dans le groupe avec appuie-tête que dans le groupe sans appuie-tête (respectivement 12,3 [5,6] mm contre 6,8 [5,5] mm dans la trachée et 11,6 [6,7] mm contre 6,0 [4,6] mm dans la bronche; $P < 0,001$). L'incidence d'un déplacement significatif, défini comme étant > 10 mm par rapport à la position initiale, a été supérieure dans le groupe avec appuie-tête par rapport au groupe sans appuie-tête (respectivement, 64 % contre 28 % pour la trachée et 58 % contre 20 % pour la bronche; $P < 0,001$).

Conclusion Le déplacement des DLT au cours du changement de position en decubitus latéral semble principalement dû à l'extension du cou. L'ajustement correct de la position de la DLT sans appuie-tête en decubitus dorsal constitue une méthode facile et efficace pour minimiser le déplacement de la DLT au cours du passage en decubitus latéral (numéro ClinicalTrials.gov: NCT01413347).

Double-lumen endobronchial tubes (DLTs) are used commonly for one-lung ventilation (OLV) during thoracic surgery. Inappropriate DLT positioning can produce adverse events during OLV.¹ Therefore, proper positioning of DLTs is critical for performing OLV successfully.

Surgical manipulation, coughing, neck flexion or extension, and turning of the patient from the supine to the lateral position may result in DLT displacements.²⁻⁵ When patients are turned to the lateral position, outward displacement of DLTs predominates.⁵⁻⁷ Therefore, extension of the head and neck was considered customary during lateral positioning. Tracheal intubation is most likely performed under direct laryngoscopy with the patient in a supine position on a headrest. Following intubation, the DLT position is usually adjusted by using a fiberoptic bronchoscope (FOB) without removing the headrest, thus maintaining some degree of neck flexion. After lateral positioning, however, neck flexion is reduced, and some

degree of head extension remains, approximating the patient in a supine position with a headrest.

We hypothesized that placing the patient in the supine position without a headrest would prevent the slight extension of the neck from being further extended during lateral positioning and result in less DLT displacement in the lateral position. The purpose of this study was to determine whether displacement of DLTs could be minimized during lateral positioning when DLTs were correctly positioned with the patient placed in the supine position without a headrest.

Methods

The study protocol was approved by Seoul National University Hospital Institutional Review Board in March, 2011. After obtaining informed written consent, 100 patients were enrolled in this study. The patients were aged 19 to 71 yr and scheduled for elective thoracic surgery in the lateral position requiring the placement of a left-sided DLT. Patients were excluded from the study if they absolutely required a right-sided DLT, presented an intraluminal lesion in the left mainstem bronchus, had distorted anatomy of the tracheo-bronchial tree on chest radiograph, or had limited cervical movement.

The DLT size was selected according to the sex and height of the patient⁸ as follows: 39 Fr DLT for male patients > 178 cm; 37 Fr DLT for male patients 160-178 cm and for female patients > 165 cm; 35 Fr DLT for male patients < 160 cm and for female patients 153-165 cm; and 32 Fr DLT for female patients < 153 cm.

After placing a 9 cm high headrest under the patient's head, general anesthesia was induced with fentanyl $1.5 \mu\text{g}\cdot\text{kg}^{-1}$, propofol $2.0 \text{mg}\cdot\text{kg}^{-1}$ and rocuronium $0.8 \text{mg}\cdot\text{kg}^{-1}$. In all patients, the trachea was intubated with the headrest in place using a disposable polyvinyl chloride left-sided DLT (Broncho-Cath®, Mallinckrodt Medical Ltd., Athlone, Ireland). After the bronchial tip of the DLT passed beyond the vocal cords, the stylet was removed, the DLT was rotated 90° counterclockwise and then advanced until slight resistance was met. The DLT position was adjusted temporarily by palpation of the bronchial cuff pressure.⁸

Afterwards, the patients were divided randomly into two groups, i.e., with or without a headrest, using an internet-based computer program (<http://www.randomizer.org>). In the headrest group, the headrest was left in place, and the DLT position was correctly adjusted under direct vision of a FOB (Olympus LF-DP or LF-GP, Olympus Optical Co., Tokyo, Japan) with the patient in the supine position. In the no-headrest group, the headrest was removed after tracheal intubation, and the DLT position was correctly adjusted

with the patient in the supine position. Both tracheal and bronchial cuffs were inflated, and then the bronchial cuff was placed just below the carina without herniation by the anesthesiologist who had performed tracheal intubation but was not involved in the study.

After adjusting the position of the DLT with the patient in the supine position and fixing the DLT firmly with tape at the corner of the patient's mouth, the distance from the distal opening of the tracheal lumen to the main carina (tracheal distance) was measured with a FOB passing through the tracheal lumen. The distance from the distal tip of the bronchial lumen to the left bronchial carina (bronchial distance) was also measured with the FOB passing through the bronchial lumen (Figure). Both tracheal and bronchial distances were measured as described previously.⁵ To measure the tracheal distance, the tracheal carina was visualized at the tip of the FOB, and a piece of tape was placed on the FOB at the point where it entered the self-sealing diaphragm of the elbow connector. Subsequently, the FOB was withdrawn until its tip was located at the distal opening of the tracheal lumen indicated by the vertical black mark on the DLT, and another piece of tape was placed on the FOB at the point of entry into the self-sealing diaphragm. The distance between the two pieces of tape was measured to the nearest 1 mm interval. To measure the bronchial distance, the FOB was passed through the bronchial lumen and the same measuring procedure was repeated.

The patients were placed in the lateral decubitus position, an axillary roll was placed just caudal to the dependent axilla, and the operating table was flexed under the patient's iliac crest. The anesthesiologist who had performed the tracheal intubation was instructed to make every effort to minimize the head and neck movement

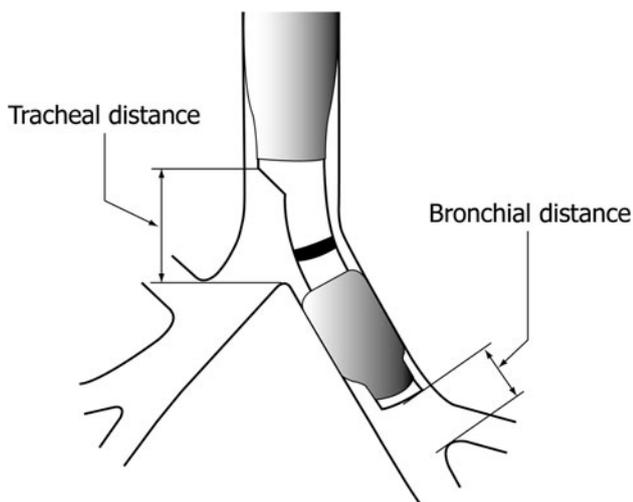


Figure A schematic diagram explaining the tracheal and bronchial distances.

during lateral positioning. To prevent movement of the DLT during positional change, the DLT was held at the level of the incisors with one hand while keeping the head and neck immobile with the other hand. According to our departmental protocol, the head and neck were aligned with the thoracic vertebral column to prevent the neck from flexing laterally. An experienced anesthesiologist (J.H.B.) supervised all positioning procedures.

All the distance measurements in the supine and lateral positions were performed by another experienced anesthesiologist (J.H.S.). The displacements during positional change were defined as the differences in the tracheal and bronchial distances obtained by subtracting the measurements between the supine and lateral positions. A significant DLT displacement was defined as an inward or outward movement of > 10 mm from the initial correct position.⁹

In the Yoon *et al.* study,⁵ the DLT tracheal displacement was 6.3 (5.5) mm in the group without a neck brace. We considered a 50% decrease in the distance of tracheal displacement to be clinically significant. Assuming a type I error protection of 0.05 and a power of 0.80, 49 patients were needed in each group. We enrolled 100 patients.

Data were expressed as mean (standard deviation), and range, or number of patients. Positive values for displacement refer to outward movement and negative values refer to inward movement. Statistical differences in DLT displacement were compared with paired Student's *t* test. The differences in the incidence of significant displacements of DLTs were analyzed by a Chi square test. We used SPSS® software version 18.0 (SPSS Inc, Chicago, IL, USA) for statistical analyses. A *P* value < 0.05 was considered statistically significant.

Results

After screening 117 prospective patients, seven patients did not meet the inclusion criteria and ten patients refused to participate. One hundred patients were finally enrolled; 50 patients were allocated to the headrest group and 50 were allocated to the no-headrest group. Both groups were comparable with respect to age, weight, height, body mass index, sex, surgical position, and selected DLT size (Table 1). Ten patients underwent a thoracotomy and 90 patients underwent video-assisted thoracoscopic surgery.

During lateral positioning, most of the DLTs showed outward displacement, for which a plus sign is used. During lateral positioning, DLT displacement was greater in the headrest group than in the no-headrest group [in the trachea: 12.3 (6.5) mm; range 1–22 mm vs 6.8 (5.5) mm; range –6 to 15 mm, respectively; in the bronchus: 11.6 (6.7) mm; range –5 to 21 mm vs 6.0 (4.6) mm; range –5

Table 1 Patient characteristics

	Headrest (<i>n</i> = 50)	No-headrest (<i>n</i> = 50)
Age, yr	54.5 (12.8) (19-70)	55.6 (12.1) (19-71)
Weight, kg	63.7 (10.4) (41-87)	62.0 (9.6) (45-86)
Height, cm	164.3 (6.2) (152-176)	163.1 (7.7) (147-182)
Body mass index, kg·m ⁻²	23.5 (3.3) (17-31)	23.4 (3.5) (16-30)
Sex, male: female	28: 22	23: 27
Position, RLD: LLD	20: 30	20: 30
Double-lumen tube size (Fr)		
32	3	4
35	23	26
37	21	18
39	3	2

Values are expressed as mean (standard deviation), (range), or number of patients. There were no differences in all the parameters between the two groups. RLD = right lateral decubitus position; LLD = left lateral decubitus position

to 12 mm, respectively] ($P < 0.001$, for both comparisons). There was no significant difference between the tracheal and bronchial displacements. There were no significant differences in displacements between right and left dependent side after lateral positioning (Table 2). Significant displacements occurred more frequently in the headrest group than in the no-headrest group (in the trachea: 32/50 [64%] vs 14/50 [28%], respectively; in the bronchus: 29/50 [58%] vs 10/50 [20%], respectively) ($P < 0.001$, for both comparisons). All significant displacements were caused by outward displacement.

Discussion

Displacement of DLTs during lateral positioning was minimized when the DLT position was adjusted with the patient in the supine position without a headrest. When patients are turned from the supine to the lateral decubitus position, outward displacement of DLTs usually occurs and may be closely related to neck movement.^{2,5} Generally,

flexion or extension of the head and neck produces inward or outward displacement of single-lumen tubes or DLTs, respectively.^{2,5,10} By restricting head and neck movements with a neck brace, the DLT displacement was minimized during lateral positioning.⁵ Although efforts were made to restrict the patients' head and neck movements during lateral positioning, some displacement of DLTs is inevitable due to differences in the position of the head and neck in the supine and lateral positions. In the supine position with a headrest, the patient's neck is flexed on the chest by elevating the head on the headrest. In the lateral position, neck flexion is minimized, resulting in extension of the head and neck relative to the supine position with a headrest. Therefore, outward displacement of DLTs persists during lateral positioning.

The margin of safety in positioning left-sided DLTs is the length of the left mainstem bronchus minus the distance between the proximal margin of the bronchial cuff and the tip of the bronchial lumen.¹¹ In this study, significant displacement of DLTs was defined as a migration of > 10 mm from initial correct position regardless of its direction. In both groups, there was no case of significant inward displacement of DLTs after lateral positioning. However, the incidence of significant outward displacement of DLTs was higher in the headrest group than in the no-headrest group. Therefore, it would be clinically helpful to adjust the DLT position correctly without a headrest. However, even though such efforts were carried out, some degree of proximal displacement seemed to be unavoidable. Therefore, removal of a headrest before FOB confirmation in the supine position cannot obviate the need to recheck the DLT position after lateral positioning. Furthermore, in order to make DLT displacement less risky, we recommend positioning the proximal margin of the DLT bronchial cuff 5-10 mm deeper than the carinal level before lateral positioning.⁵⁻⁷

During direct laryngoscopy in the sniffing position, the patient's head is usually elevated by supporting the occiput on a headrest about 10 cm high.¹² In our study, the 9 cm high headrest was used because it provided better laryngoscopic views than 3 cm or 6 cm high headrests.¹³ Desiderio *et al.*⁶ reported that the Sher-I-Broth™ DLT (Sheridan, Argyle, NY, USA) was displaced proximally about 9.2 mm in both

Table 2 Tracheal and bronchial displacements of the double-lumen tubes depending on the side of the lateral decubitus position

Displacement	Headrest group*		No-headrest group	
	RLD (<i>n</i> = 20)	LLD (<i>n</i> = 30)	RLD (<i>n</i> = 20)	LLD (<i>n</i> = 30)
Δ Tracheal, mm	12.1 (5.9) (3-21)	13.7 (6.9) (1-22)	5.8 (4.7) (-3 to 15)	6.9 (5.4) (-6 to 14)
Δ Bronchial, mm	10.7 (6.4) (0-19)	12.1 (6.9) (-5 to 21)	6.8 (4.1) (0-12)	5.6 (4.8) (-5 to 12)

Values are expressed as mean (standard deviation), (range). Positive values refer to inward displacement and negative values to outward displacement. $P < 0.001$ compared with the no-headrest group. There were no significant differences in displacements of double-lumen tubes relative to the side of the lateral decubitus position and between tracheal and bronchial displacements. RLD = right lateral decubitus position; LLD = left lateral decubitus position

the trachea and the bronchus during lateral positioning regardless of bronchial cuff inflation. In that study, the proper DLT position was confirmed by a FOB with the patient on the donut-shaped headrest. Therefore, the degree of displacement may be smaller than that of the headrest group in our study and larger than that in the no-headrest group. Yoon *et al.*⁵ reported that the Broncho-Cath® DLT was withdrawn about 2.2 mm in the trachea during lateral positioning with the neck brace and 6.3 mm without the neck brace. In the group without the neck brace, the DLT position was adjusted with the patient's head on a small blanket, so the degree of displacement was comparable with that of the no-headrest group in our study.

There was no difference in DLT displacement between right and left lateral positions, which is comparable with the results of Yoon *et al.*'s previous study.⁵ Thus, gravity does not appear to have a significant effect on DLT displacement.⁵ The difference between tracheal and bronchial displacements during lateral positioning was inconsistent in the previous studies.^{5,6} In Yoon *et al.*'s study,⁵ the tracheal displacement was more prominent than the bronchial displacement, whereas there was no difference in the two types of displacements in the other study.⁶ Further investigation may be needed with regard to this matter.

The DLT displacement during lateral positioning seems to be caused primarily by neck extension. Therefore, every effort should be made to prevent this occurrence during lateral positioning. After tracheal intubation of DLTs, removing a patient's headrest before a FOB-guided adjustment of the DLT position is an easy and effective method to minimize DLT displacement during lateral positioning.

Conflicts of interest None declared.

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