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Double-lumen Tube Position Confirmation with Fiberoptic Bronchoscope after Turning Patients into Lateral Position: Is It Necessary?

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Abstract

Background: Our goal was to compare two common methods including auscultation and Fiber-Optic Bronchoscopy (FOB) in confirming the correct placement of Double-Lumen Tube (DLT).

Methods: Seventy six patients were enrolled. After DLT insertion, clinical verification was made by auscultation, then FOB was applied. At lateral decubitus, the position of DLT was rechecked by auscultation, and then by FOB. The incorrect position including malposition and misplacement were compared between two routine methods of auscultation and FOB.

Results: After blind intubation, 21.1% of DLTs were considered to be in an incorrect position. Meanwhile, FOB showed that 46.1% of DLTs were not placed correctly. Among all the patients, 53.9% of DLTs were in the optimal position. Misplacement was diagnosed in 35.5% and malposition in 10.5% of the patients. After positioning to the lateral decubitus, using auscultation, we found that 5.3% of tubes were dislocated, but according to FOB, it was 10.5%. The agreement coefficient between auscultation and FOB was 0.42 in the supine position and 0.64 in lateral position.

Conclusion: Our results showed that although FOB needs more time to check the position of DLT, it should be used to confirm the exact position of DLT.

Keywords: Auscultation, Double-lumen tube, Fiberoptic bronchoscopy, Lateral decubitus, Thoracic surgery

Introduction

Lung isolation and one-lung ventilation using double-lumen tube are almost always required for thoracic surgery (1). The lung should be collapsed to let the surgeon proper visualization of the operation field and prevent contamination of the dependent lung and postoperative lower respiratory tract infection (2).

Inappropriate Double-Lumen Tube (DLT) positioning can produce adverse events during One-Lung Ventilation (OLV). A malpositioned DLT will fail to allow the lung collapse, causing gas trapping during positive-pressure ventilation, or it may partially collapse the ventilated or dependent lung, producing hypoxemia. Therefore, proper positioning of Double-Lumen Tube (DLT) is critical (3,4).

DLT movement, no matter how small, can cause difficulty in differential lung ventilation, produce hypoxemia and interfere with the surgical procedure (5,6). Change in body position from supine to lateral may lead to malposition of the DLT (7).

Although majority of the anesthesiologists know that positioning can cause malposition of DLT, there are few studies evaluating the position of DLT before and after positioning.

To avoid malposition of the DLT either during the insertion or after patient positioning, fiberoptic bronchoscopy has been recommended as a reliable method to evaluate DLT placement and lung separation (8). Despite these recommendations, some authors argue that bronchoscopy is costly, time-consuming, and not universally available, thus it should not be considered “routine” (9).

Therefore, we designed this study to evaluate the malposition of DLT after positioning from supine to lateral using and comparing two methods of auscultation and fiberoptic bronchoscopy.

Materials and Methods

Following approval by the Tehran University of Medical Sciences School of Medicine ethics committee, 76 consecutive patients (ASA physical status II, III, and above 18 year-old) scheduled for thoracic surgery were enrolled in this cross-sectional study over an 8-month period. After explaining completely about the procedure, we obtained written informed consent. Patients with a difficult airway (Mallampati 3-4, or mouth opening<3 *cm*), airway anomaly, and anticipated use of right-sided DLT (like the patients with anomalies of left main bronchus and those with surgery in their left main bronchus) were excluded from the study.

After premedication with 0.03 *mg/kg* midazolam, 1-2 *μg/kg* fentanyl and induction of general anesthesia using propofol 1.5 *mg/kg* and cisatracurium 0.2 *mg/kg*, a left Robertshaw DLT was inserted. The size of double-lumen tube was selected 0 *cm* 35F, women > 160 *cm* 37F; men ≤ 170 *cm* 39F, > 170 *cm* 41F. The amount of insertion of double-lumen tube was based on this formula: DLT depth [*cm*] = 12.5+0.1 × height [*cm*]). All cases were intubated by three experienced anesthesiologists in the field of thoracic anesthesia using conventional maneuvers and the patients’ height was used to guide the depth of DLT insertion and thereafter the depth of DLT insertion and the position of DLT were checked by auscultation (9). Then flexible bronchoscopy was performed using a 2.8 *mm* Diameter Olympus video bronchoscope to recheck and confirm the position of DLT or reposition the tube according to the following criteria proposed (10). After positioning the patient to the lateral decubitus, the DLT position was again checked primarily by auscultation and then by Fiber-Optic Bronchoscopy (FOB).

Bronchoscopic criteria for evaluating DLT position are as follows:

1- Optimal: The bronchial cuff of DLT is immediately below the tracheal carina, and there is a clear view of the left subcarinal with unobstructed left upper and lower bronchi.

2- Misplacement: Partial dislocation of DLT either proximally or distally. DLT has to be moved (in or out) for more than 0.5 *cm* to be in the correct position.

3- Critical malposition: DLT dislocated in the trachea or in the right bronchi.

Clinical evaluation of the patients and auscultation assessment of DLT position was conducted by three expert anesthesiologists and the endoscopist was not informed of the previous result. Before and after changing the position to the lateral decubitus, auscultation and fiberoptic evaluation were performed by a different anesthesiologist in every case, thus we kept the evaluators blinded.

After the bronchoscopic assessment, the DLT was either secured in its position or repositioned according to the bronchoscopic findings.

Following a pilot study with 10 cases, we applied nQuery advisor software to calculate the sample size in this agreement study with cross-sectional method. The result showed that 66 cases should be enrolled considering $\alpha = 0.05$ and $\beta = 0.2$. Patients were enrolled in the study with simple sampling method.

Statistical analysis using the statistical software package SPSS 16.0 for windows, was performed by application of chi-square test, student's T-test as well as kappa agreement test. A probability value of less than 0.05 was considered significant.

Results

Seventy-six adult patients scheduled for elective thoracic surgery, included 33 (43.4%) females, requiring the placement of a left DLT and lateral positioning were enrolled in the study. The demographic data including age (44.8 ± 15.6 years), height (169.5 ± 9.5 *cm*), weight (72.3 ± 11.9 *kg*), and body mass index (25.3 ± 3.8 kg/m^2) were measured. The DLT sizes used and distribution of right and left thoracotomies were depicted (Table 1).

Auscultation and FOB for the first time (supine position) took 34 ± 17 and 86 ± 47 seconds, respectively. Average time for auscultation and FOB at the second time was 30 ± 15 and 74 ± 34 seconds, respectively.

After blind intubation, 21.1% of DLTs were considered not to be in the correct position using clinical evaluation. However, bronchoscopy showed that 46.1% of all DLTs were placed incorrectly, 35.5% of them were misplaced, and critical malposition occurred in 10.5% of the patients (Table 2). All the misplaced and malpositioned DLTs were then relocated into the correct position.

Following the change in the patients' position to lateral decubitus, auscultation showed new misplacement in 5.3% of all patients; nevertheless, the fiberoptic assessment revealed DLT misplacement in 10.5% of the patients (Table 2).

According to the results of second time FOB, correct positioning of DLT was performed in 68 cases; all had already been diagnosed correctly with auscultation. Despite findings from FOB which showed malposition in 8 patients, auscultation could recognize only 4 cases (50%). Agreement between auscultation and FOB results for the first time was significant (kappa = 0.42) which increased considerably in the second time (kappa = 0.64) (Table 3).

Evaluating different variables such as age, sex, height, weight, BMI, and size of DLT, none of them affected incorrect positioning of DLT for the first time. The variables mentioned above and the direction of left or right lateral rotation had no effect on the malposition of DLT (Tables 4-6).

In the current study, the kappa coefficient increases with increasing DLT size that means in patients who needed larger DLT size, the greater agreement between auscultation and FOB was recorded after blind intubation (Table 7).

Table 1. The size of DLT, lateral decubitus distributions, and Cormack-Lehane grade.

Variables	Values	Frequency	Percent
Size of DLT	35	17	22.4
	37	20	26.3
	39	39	51.3
Lateral decubitus	Left	41	53.9
	Right	35	46.1
Cormack-lehane	1	51	67.1
	2	24	31.6
	3	1	1.3

Table 2. Comparison between auscultation and fiberoptic bronchoscopy (FOB) for correct placement of DLT.

Variables	Position	Frequency	Percent
Auscultation (1st time)	Correct	60	78.9
	Incorrect	16	21.1
FOB (1st time)	Correct	41	53.9
	Incorrect	35	46.1
FOB (1st time)	Optimal	41	53.9
	Misplacement	27	35.5
	Malposition	8	10.5
Auscultation (2nd time)	Correct	72	94.7
	Incorrect	4	5.3
FOB (2nd time)	Correct	68	89.5
	Incorrect	8	10.5
FOB (2nd time)	Optimal	68	89.5
	Misplacement	8	10.5

Table 3. Correct and incorrect placement of DLT for the 1st & 2nd time

Tube size		FOB 1		FOB 2		Kappa	p-value
		Correct	Incorrect	Correct	Incorrect		
Auscultation 1	Correct	40(66.7%)	20(33.3%)	-	-		0.001
	Incorrect	1(6.7%)	15(93.3%)	-	-	0.421	
Auscultation 2	Correct	-	-	68(94.4%)	4(5.6%)		0.001
	Incorrect	-	-	0	4(100%)	0.642	

Table 4. Correct and incorrect placement of DLT for the 1st & 2nd time considering gender.

Position of DLT		Male n = 43	Female n = 33	p-value
FOB (1st time)	Correct	23(53.5%)	18(54.5%)	0.9
	Incorrect	20(46.5%)	15(46.5%)	
FOB (2nd time)	Correct	38(88.4%)	30(90.9%)	0.7
	Incorrect	5(11.6%)	3(9.1%)	

Frequency (percent) is reported.

Table5. Correct and incorrect placement of DLT for the 1st & 2nd time considering the size of DLT.

Position of DLT		Size of DLT			p-value
		35 Fr n = 17	37Fr n = 20	39Fr n = 39	
FOB (1st time)	Correct	10(58.8%)	11(55%)	20(51.3%)	p = 0.8
	Incorrect	7(41.2%)	9(45%)	19(48.7%)	
FOB (2nd time)	Correct	16(94.1%)	18(90%)	34(87.2%)	p= 0.7
	Incorrect	1(5.9%)	2(10%)	5(12.8%)	

Frequency (percent) is reported.

Table 6. The effect of age, height, weight, and BMI on FOB result for the1st time and 2nd time.

	FOB (1st time) Position of DLT			FOB (2nd time) Position of DLT		
Variables	Correct	Incorrect	p-value	Correct	Incorrect	p-value
Age (year)	45.6±15.9	43.8±15.4	0.8	43.8±15.4	49.9±16.4	0.9
Height (*cm*)	167.9±9.1	170.7±9.9	0.9	170.7±9.9	171.9±10.7	0.6
Weight (*kg*)	72.5±11.1	71.9±12.9	0.6	71.9±12.9	70.0±11.9	0.6
BMI (*kg/m²*)	25.8±3.9	24.7±3.6	0.6	24.7±3.6	23.9±4.8	0.3

Mean ± SD is reported.

Table 7. Agreement between Auscultation and FOB after blind DLT insertion considering the size of the tube

Tube size	Auscultation	FOB Correct	FOB Incorrect	Kappa
35 Fr	Correct	10 (62.5%)	6 (37.5%)	0.161
	Incorrect	-	1 (100%)	
37 Fr	Correct	11 (61.1%)	7 (38.9%)	0.239
	Incorrect	-	2 (100%)	
39 Fr	Correct	19 (73.1%)	7 (26.9%)	0.586
	Incorrect	1 (7.7%)	12 (92.3%)	

Frequency (percent) is reported.

Discussion

In our study, FOB identified DLT malpositioning in 46.1% of the patients; however, auscultation revealed DLT malpositioning in only 21.1%. Our results are in agreement with previous studies which show that 15.5-44% of left-sided DLTs could not be positioned correctly using clinical signs alone, necessitating fibreoptic bronchoscopy (10,11). Likewise, satisfactory DLT positioning was shown in all cases using clinical criteria; however, subsequent fiberoptic bronchoscopy revealed malposition in 48 % (12). Even some other authors reported a higher misplacement rate of DLT inserted blindly detected by fiberoptic bronchoscopy (13,14). Several other studies showed similar results as far as it was concluded that continuous and routine use of FOB is a must in modern practice (4).

A limited number of studies claimed another result. For instance, it was concluded that although 12% of tubes were not in an optimal position, all were in a satisfactory position and non-required repositioning (15). There can be no doubt that the FOB is a useful tool, however, for an experienced anesthetist, this audit has not shown it to be essential.

It reported that although bronchoscopy is useful, no double-lumen tube positioning method is fail-safe (6). Operator experience with any method increases the likelihood of success, and a FOB is not always needed for left DLT placement (9).

In this study, after turning the patients to lateral decubitus, 10.5% of them required tube repositioning using FOB, but auscultation diagnosed only 5.3% of the malpositions. Possible reasons for this inaccuracy could be that the audibility of breath sounds is often affected by tidal volume, consistency of underlying lung tissue, thickness of the chest wall, noise intensity in the OT, sensitivity of the stethoscope, and hearing acuity of the individual (16). Therefore, according to our findings, final position of DLT should always be verified in the lateral positioning by FOB.

Using FOB, tube dislocation secondary to lateral positioning was demonstrated in 27% of their patients (17). Tube misplacement was found in 32% of the patients after lateral positioning (18). Moreover, the study conducted by Desidero *et al*, showed that there was a significant tracheal movement in 40 of 50 the patients and bronchial movement in 37 of 50 of them (19). The mentioned studies clearly represented that in a significant number of cases, DLT dislocation can occur following the change in the position of patients from supine to lateral decubitus.

In our study, evaluating the agreement between FOB and auscultation, we reached kappa = 0.64 for the second time and kappa = 0.42 for the first time. The higher value of kappa in second time may be justified by this fact that DLT placement was corrected prior to lateral positioning. Considering the kappa value, we concluded that in case FOB is not available, auscultation can be helpful as a simple and easy method.

In a study carried out by de Bellis *et al*, there was a complete agreement between the anesthesiologist (auscultation) and the endoscopist in 63% of the patients whose DLT had been correctly placed, as confirmed by flexible bronchoscopy (20).

Another conclusion from our study is that the DLT size can influence the agreement between auscultation and FOB; in patients who required larger DLT, the greater agreement between auscultation and FOB was detected. Similar to what was achieved in our study, the blind approach (auscultation) was twice as fast as the directed approach (FOB) (21).

According to the study by Boucek *et al*, although the blind and directed approaches resulted in the successful placement of DLT, more time was required using the directed approach (21). In other studies, such as Cheong *et al*, the bronchoscope allowed more rapid intubation compared to conventional technique (105 *vs.* 347 sec) (22).

The strong point of the present study was an evaluation of the patients before and after the positioning. None of the patients was deprived of FOB for DLT placement.

Conclusion

Although we found a high agreement - but not 100% - between fiberoptic bronchoscopy and auscultation for determining the proper placement of DLT, the poorly poisoned DLT can interfere with ideal intraoperative surgical and ventilatory conditions. Thus, DLT position should be checked by fiberoptic bronchoscope after turning the patients to the lateral position ensure that one-lung ventilation and lung isolation would be possible for all the patients.

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