Original Article

Insertion depth of left-sided double-lumen endobroncheal tube: A new predictive formula

ABSTRACT

Background: In the field of thoracic anesthesia, it is well-established practice that the insertion depth of left-sided double-lumen tube (LDLT) is achieved after checking its position via fiberoptic bronchoscopy (FOB). Several studies have shown positive correlation between body height (BH) and the optimal insertion depth of a LDLT. Each of these studies has developed a formula for proper insertion depth of the LDLT. In this study, we prospectively studied our patients whose tracheas were intubated correctly with LDLT using FOB confirmation and examined the optimal insertion depth of LDLT aiming at finding a formula suitable for our patients.

Methods: After obtaining the institutional review board approval of College of Medicine Research Centre, King Saud University, we recruited 41 adult patients who underwent thoracic surgery with one-lung ventilation (OLV). The study included patients whose procedure required placement of a LDLT. The optimal insertion depth of the LDLT was confirmed using FOB. The following variables were recorded, the patient's sex, age, BH, and the final correct insertion depth of the LDLT (cm) measured from the corner of the mouth. The results of LDLT insertion depth in our study were compared to another published five studies. Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) version 22 software (SPSS Inc., Chicago, IL, USA).

Results: Positive correlation was found between BH (cm) and insertion depth of LDLT (cm) since r = 0.744 ($P < 0.05$). Also, positive correlation was found between the LDLT size (Fr) and insertion depth of LDLT (cm) since r = 0.792 ($P < 0.05$) where r is Pearson's correlation coefficient. By fit curve (Curve Estimation), we were able to get the predicted equation for our cases as follow: the insertion depth of LDLT (cm) $=0.249 \times (BH)^{0.916}$ with significant correlation to the other five formulae ($P < 0.05$).

Conclusion: In the present study we have obtained a novel formula to predict the insertion depth of LDLT. Currently we are conducting a verification study on a larger sample size to attest its validity. However at this stage and till the results are released we cannot judge on it. We believe time will tell about the validity of our formula for our patients.

Key words: Double-lumen tube; insertion depth; thoracic anesthesia

Introduction

In the field of thoracic anesthesia the insertion depth of left-sided double-lumen tube (LDLT) is usually achieved and confirmed with FOB. Commonly used LDLTs sizes in adults are 35-37 Fr for females and 39-41 Fr for males, with external bronchial diameters of 11.7-12.3 mm and 13.0-13.7 mm, respectively.[1] Two methods were described to accurately place the LDLT. The first and most common is the traditional method where the tip of the endobronchial tube advanced through the larynx under direct vision, rotate the tube 90

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degrees to the left (counterclockwise), and then advance the tube blindly into the left mainstem bronchus followed by FOB confirmation. The second and less common is the direct method where the LDLT placed under vision with FOB placed through the bronchial lumen.[2-4] Both methods resulted in a successful left mainstem placement of the endobronchial tube with more time required for the direct method.[5] Several studies showed positive correlation between BH and the optimal insertion depth of a LDLT. Each of these studies developed a formula for proper insertion depth of the LDLT.[6-10]

In this pilot study we recruited our patients whose tracheas were intubated correctly with LDLT using FOB confirmation and examined the published formulae aiming to achieve an accurate estimation of the optimal insertion depth LDLT. Also we aim to establish a predictive formula of optimal insertion depth of LDLT suitable for our patients.

Methods

After obtaining the institutional review board approval of College of Medicine Research Centre, King Saud University (E-18-3064/IRB 06.05.2018) and written informed consents from patients, we prospectively recruited 41 adult patients who underwent thoracic surgery with one lung ventilation (OLV). The study included patients whose procedure required placement of a LDLT (double-lumen bronchial tube-left sided, Sulejowek, Poland). Exclusion criteria were patients with intraluminal bronchial lesions and patients with difficult airway. We have used LDLT 35 Fr for females and 37-39 Fr for males. The optimal position of the LDLT was confirmed using FOB and defined when the inflated endobronchial cuff is placed in the left main bronchus just below the carina. The same anesthesiologist inserted and confirmed the LDLT position using bronchoscope. The following variables were recorded, the patient's sex, age, body weight, body height (BH), and the insertion depth of the LDLT (cm) measured from at the corner of the mouth following FOB. We compared the insertion depth achieved with the conventional method of LDLT insertion with the following five formulae: 0.11XBH + 10.53 (cm) by Brodsky *et al*.[6]; 0.15XBH + 3.96 (cm) by Bahk and Oh[7]; 0.148XBH + 3.8 (cm) by Chow *et al*.[8]; 0.1XBH + 12.5 (cm) by Takita *et al*.[9]; and 0.1977XBH – 4.2423 (cm) by Lin.[10] Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) version 22 software (SPSS Inc., Chicago, IL, USA). Variables were presented as mean and SD. Also we used the Pearson's correlation coefficient to compare between the insertion depth of LDLT and the other five published formulae. We used curve estimation to find the best predicted equation between BH and insertion depth of LDLT (cm). Sample size calculation was done, assuming confidence level 80%, interval 5% and SD 0.5, a sample size of 41 patients was calculated.

Results

There was nonsignificant difference between males and females patients regarding the insertion depth of LDLT, BH (cm), and BMI ($P < 0.05$) [Table 1]. There was negative correlation between BMI and LDLT size and insertion depth ($P > 0.05$). Positive correlation was found between LDLT size (Fr) and insertion depth of LDLT (cm) since $r = 0.79$ ($P < 0.05$) where r is Pearson's correlation coefficient. There was positive correlation between the BH and insertion depth of LDLT. Using the fit curve, we found the best predicted equation between BH (cm) and insertion depth of LDLT (cm) since $R^2 = 0.6$ and $r = 0.8$ (R^2 is the Residual and r is the Pearson's correlation coefficient). Our predicted equation for insertion depth of LDLT (cm) was $0.249 \times (BH)^{0.916}$ [Figure 1]. We found significant correlation between our formula compared to the other five formulae ($P < 0.05$) [Table 2]. However formula 1[6] represents the best correlation to our findings ($r = 0.75$) ($P < 0.0001$). In our series we encountered no malposition after LDLT insertion when the patients were turned to the lateral decubitus positions.

Discussion

The insertion depth of LDLT in our series was positively correlated with all the studied formulae and best correlated to formula 1 of Brodsky *et al*.[6] However another dimension in our study was the new predictive formula with positive correlation between the BH of the patients and the insertion

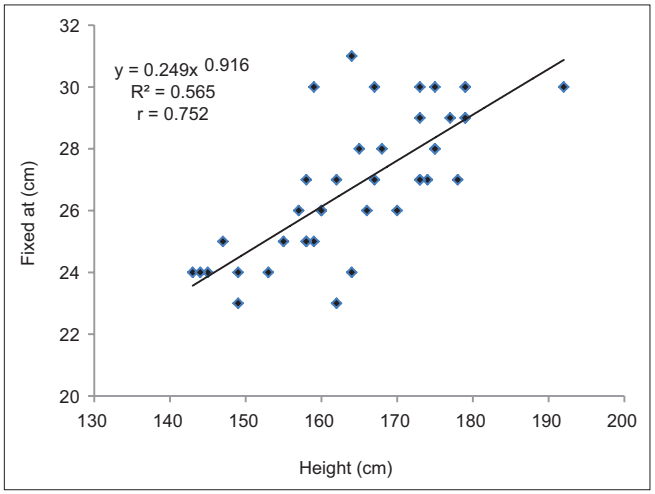

Figure 1: Correlation between insertion depth of LDLT (fixed at) (cm) and height (cm)

Table 1: Comparison between males and females variables

	Gender	
	Males (*n*=25)	Females (*n*=16)
Insertion depth (cm)	28.3±1.6	24.7±1.1
LDLT size (Fr)	37.3±0.7	35.1±0.5
Age (years)	45.4±19.8	44.2±14.7
Weight (kg)	74.7±19.4	73.8±14.6
BMI	25.2±6.9	30.0±5.3
Height (cm)	171.3±8.9	155.0±7.1

Table 2: Pearson's correlation coefficient between insertion depth of LDLT (cm) (our formula) with other formulae

Formulae	Insertion depth of LDLT (cm) (our formula)
Brodsky *et al*.[6]	*r*=0.75
	P<0.0001
Bahk and Oh[7]	*r*=0.74
	P<0.0001
Chow *et al*.[8]	*r*=0.71
	P<0.0001
Takita *et al*.[9]	*r*=0.65
	P<0.0001
Lin[10]	*r*=0.72
	P<0.0001

depth of the LDLT. Lin in his study introduced a new useful simple method to predict the optimal insertion depth of LDLT: 170-29.5-5-1 (the insertion depth is 29.5 cm for patients who are 170 cm tall, and the insertion length is increased or decreased by 1 cm for every 5 cm increase or decrease in BH.[10] Many previous studies have reported a significant correlation between BH and the optimal insertion depth of LDLT among adults. However, in one study it has been suggested that the appropriate insertion depth of LDLT can be estimated by external measurement. That study examined the accuracy of external measurement in estimating the actual length of insertion required. Although there was a fair correlation between the measured external length and the final inserted length, the 95% confidence intervals of slope and intercept allowed a large variation and the prediction was too wide to be clinically useful. Height was reasonably well correlated with the final length but an equally wide 95% confidence interval rendered it of little clinical value. There was no correlation between weight and final tube length. It was concluded from that study that external measurement alone is not adequate to predict a clinically acceptable position of the LDLT.[11]

The critical need for a precise technique to confirm LDLT depth of insertion is addressed in a study by Liu *et al*.[12] Considering that the majority of patients presenting for thoracic surgery undergo chest CT scan for surgical guidance, anesthesiologists should extract useful data, such as left mainstem bronchial diameter and the distance from the carina to the vocal cords, to guide LDLT size and its insertion depth respectively. In one study, it was found that preintubation measurement of the distance between the incisors teeth and the secondary carina using adult FOB was an effective, less resource-intensive method to know the insertion depth of LDLT.[13] Although the data presented by Liu *et al*. were significant, the small sample size of the study prevents extrapolation of the findings to all patients, with special reference to patients in ASA III or higher.[12] Even though FOB is costly, the efficacy of LDLT placement guided with it is obvious, and FOB to be considered standard of care in both LDLT placement and management of OLV should problems be encountered.[14]

In one study, though there was significant correlation between BH and insertion depth of LDLT among adult patients of short stature (less or equal 155 cm), clinical application of the equation was not warranted and these tubes should be inserted under direct vision under FOB guidance.[15] In a previous study, the authors examined the accuracy of five formulae for predicting the optimal depth of LDLT insertion based on BH, and they found the formula of 0.1977 BH – 4.2423 provided the best predictability among other formulae. However, the author added that this formula to be applied only as a guide and should not be used to determine the final insertion depth of LDLT.[6-10] The limitations of our study include small sample size and noninclusion of right-sided DLTs or DLTs of smaller sizes 26, 28, 32 F. In the present study we have obtained a novel formula to predict the insertion depth of LDLT ($0.249 \times (BH)^{0.916}$). Currently we are conducting a larger sample size study to attest the validity of our formula. However at this stage and till the results are released we cannot judge on it. We believe time will tell about the validity of our formula for our patients.

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Conflicts of interest

There are no conflicts of interest.

References

1. Levy-Faber D, Malyanker Y, Nir RR, Best LA, Barak M. Comparison of VivaSight double-lumen tube with a conventional double-lumen tube in adult patients undergoing video-assisted thoracoscopic surgery.

Anaesthesia 2015;70:1259-63.
2. Cohen JA, Denisco RA, Richards TS, Staples ED, Roberts AJ. Hazardous placement of a Robertshow-type endobronchial tube. Anesth Analg 1986;65:100-1.
3. Ovassapian A. Fiberoptic Airway Endoscopy in Anesthesia and Critical Care. New York: Raven Press; 1990. p. 86-9.
4. Klein U, Karzai W, Bloos F, Wohlfarth M, Gottschall R, Fritz H, *et al*. Role of fiberoptic bronchoscopy in conjunction with the use of double-lumen tubes for thoracic anesthesia. Anesthesiol 1998;88:346-50.
5. Boucek CD, Landreneau R, Freeman JA, Strollo D, Bricher NG. A comparison of techniques for placement of double-lumen endobronchial tubes. J Clin Anesth 1998;10:557-60.
6. Brodsky JB, Benumof JL, Ehrenwerth J, Ozaki GT. Depth of placement of left-sided double-lumen endobronchial tubes. Anesth Analg 1991;73:570-2.
7. Bahk JH, Oh YS. Prediction of double-lumen tracheal tube depth. J Cardiothorac Vasc Anesth 1999;13:370-1.
8. Chow MYH, Goh MH, Ti LK. Predicting the depth of insertion of left-sided double-lumen endobronchial tubes. J Cardiothorac Vasc Anesth 2002;16:456-8.
9. Takita K, Morimoto Y, Kemmotsu O. The height-based formula for prediction of left-sided double-lumen tracheal tube depth. J Cardiothorac Vasc Anesth 2003;17:412-5.
10. Lin WL, Chen-Hwan C. Predicting optimal insertion depth of a left-sided double-lumen endobronchial tube. J Cardiothorac Vasc Anesth 2016;30:942-6.
11. Dyer RA, Heijke SA, Russell WJ, Bloch MB, James MF. Can insertion length for a double-lumen endobronchial tube be predicted? Anaesth Intens Care 2000;28:666-8.
12. Liu Z, Zhao L, Jia Q, Yang X, Liang SJ, He W. Chest computed tomography image for accurately predicting the optimal insertion depth of left-sided doublelumen tube. J Cardiothorac Vasc Anesth 2018;32:855-9.
13. Amin N, Tarwade P, Shetmahajan M, Pramesh CS, Jiwnani S, Mahajan A, *et al*. A randomized trial to assess the utility of preintubation adult fiberoptic bronchoscope assessment in patients for thoracic surgery requiring one-lung ventilation. Ann Card Anaeth 2016;19:251-5.
14. Heir JS, Guo SL, Purugganan R, Jackson TA, Sekhon AK, Mirza K, *et al*. A randomized controlled study of the use of video double-lumen endobronchial tubes versus double-lumen endobronchial tubes in thoracic surgery. J Cardiothorac Vasc Anesth 2018;32:267-74.
15. Yasumoto M, Higa K, Nitahara K, Shono S, Hamada T. Optimal depth of insertion of left-sided double-lumen endobronchial tubes cannot be predicted from body height in below averaged-sized adult patients. Eur J Anaesthesiol 2006;23:42-4.