Journal of Cardiothoracic and Vascular Anesthesia ▮ (▮▮▮▮) ▮▮▮–▮▮▮

Contents lists available at ScienceDirect

ScienceDirect

journal homepage: www.jcvaonline.com

Original Article

Chest Computed Tomography Image for Accurately Predicting the Optimal Insertion Depth of Left-Sided Double-Lumen Tube

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Objective: The main objective of this study was to assess the feasibility and accuracy of measuring the distance between the vocal cord and carina using chest computer tomography (CT) as a guide for the intubation of a left-sided double-lumen tube (LDLT).
Design: Single-center, prospective, randomized study.
Setting: Local hospital in China.
Participants: Sixty adult patients undergoing elective thoracic surgery requiring an LDLT for one lung ventilation were enrolled in this study.
Interventions: Patients were randomly allocated to the following 2 groups: blind intubation group (B group, n = 30) or chest computed tomography–guided group (C group, n = 30). The placement of the LDLT was accomplished using 1 of the 2 intubation methods. After intubation, an independent anesthesiologist evaluated the position of the LDLT and carina and bronchial injuries using fiber optic bronchoscopy. The number of optimal positions, the time for LDLT intubation, the time for fiber optic bronchoscope confirmation, and carina and bronchial injuries were recorded.
Results: Sixteen of 30 intubations in the B group were in optimal position, whereas 27 of 30 intubations in the C group were in optimal position; the difference was statistically significant ($p < 0.01$). The time for intubation of the LDLT took 118.0 ± 26.2 seconds in the B group and 71.5 ± 8.7 seconds in the C group ($p < 0.01$). The time for position confirmation using fiber optic bronchoscope took 40.8 ± 15.8 seconds in the B group and 18.7 ± 7.9 seconds in the C group ($p < 0.05$). The incidences of carina and bronchial injuries were obviously lower in the C group (occurred in 3 of 30 cases) than in the B group (11 of 30 cases) $p < 0.05$. The incidences of postoperative sore throat and hoarseness showed no significant differences between the 2 groups ($p > 0.05$).
Conclusion: This study demonstrated that the method of measuring the distance between the vocal cord and carina according to the chest CT as a guide for the intubation of LDLT is more effective and more accurate than the blind intubation method.

Key Words: chest computed tomography image; double-lumen tube; insertion depth; one-lung ventilation; thoracic surgery

ONE-LUNG VENTILATION (OLV) is required for most thoracic surgeries. The double-lumen tube (DLT), especially the left-sided double-lumen tube (LDLT), is widely used for OLV. Inappropriate positioning of a DLT can lead to adverse events during OLV. Therefore, optimal positioning of a DLT is essential for OLV. Even though determining the final correct position of a DLT during intubation using a fiberoptic bronchoscope (FOB) should be a standard procedure,[1,2] an efficient, accurate, and easy-to-use method still is necessary when performing nonvisualized intubation of a DLT because the FOB is relatively expensive and many anesthesiologists lack experience with the FOB.[3] Therefore, the authors attempted to seek an accurate and simple method to perform nonvisualized intubation of DLT.

The objective of this study was to investigate the feasibility and accuracy of measuring the distance between the vocal cord

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http://dx.doi.org/10.1053/j.jvca.2017.09.025
1053-0770/

and carina using chest computed tomography (CT) as a guide for intubation of an LDLT.

Patients and Methods

Study Population

This study was approved by the local medical ethics committee, and written informed consent was obtained from all participants. Sixty adult patients undergoing elective thoracic surgery requiring an LDLT for OLV were enrolled (Fig. 1). Exclusion criteria were as follows: age < 18 or > 70 years, American Society of Anesthesiologists classification $>$ III, body mass index > 35 kg/m^2, modified Mallampati classification $\geq$ III, thoracic surgery within the last month, suspected tuberculosis or systemic infection, and severe cardiopulmonary disease.

An independent anesthesiologist who had undergone specific training by a senior radiologist screened all patients preoperatively and performed the CT measurements using the Picture Archiving and Communication System on a computer. The diameter of the trachea was measured on the CT slice where the trachea was narrowest among all the tracheal CT slices. The diameter of left mainstem bronchus was measured on the first CT slice where the left and right bronchi could be seen distinctly as singular structures. The diameters of the trachea and left mainstem bronchus were measured perpendicular to CT slice of trachea or left mainstem bronchus long axis. An LDLT with a bronchial tip 1 to 2 mm smaller than the diameter of patient's left mainstem bronchus was chosen to allow for the additional space occupied by the deflated endobronchial cuff. The distance between the vocal cord and carina was calculated according to the number of CT slices (slice thickness 5 mm) from the vocal cord slice to the carina slice (Fig 2, A and B).

All patients were allocated randomly to the B group (blind intubation group) or the C group (chest CT–guided group). Randomization (1:1) was based on codes generated using SAS 9.2 software (SAS Institute, Cary, NC) by a statistician who did not participate in this study. These codes were kept in sequentially numbered opaque envelopes and stored at the site of investigation until the end of the study.

Intubation of LDLT

All patients in the 2 groups were placed in the supine position and monitored using invasive arterial blood pressure, heart rate, electrocardiography, and peripheral oxygen saturation in the operating room. Anesthesia was induced with midazolam 0.05 mg/kg, propofol 1.5 to 2 mg/kg, fentanyl 3 μg/kg, and vecuronium 0.15 mg/kg. All patients were intubated with an LDLT (Tuoren Medical Technology Company, Xinxiang, China) exactly 3 minutes after receiving vecuronium by the same thoracic anesthesiologist using 1 of the 2 intubation methods via laryngoscope.

In the B group, the steps of intubation were as follows. First, after the endobronchial cuff had passed the vocal cords, the stylet was removed. Second, the LDLT was rotated 90 degrees toward the left mainstem bronchus and advanced smoothly until a slight resistance was encountered, then the endotracheal and endobronchial cuffs were inflated, and the correct position of the LDLT was verified by auscultating both lungs. If the position of the LDLT was inappropriate, the endotracheal and endobronchial cuffs were deflated and the LDLT was retracted

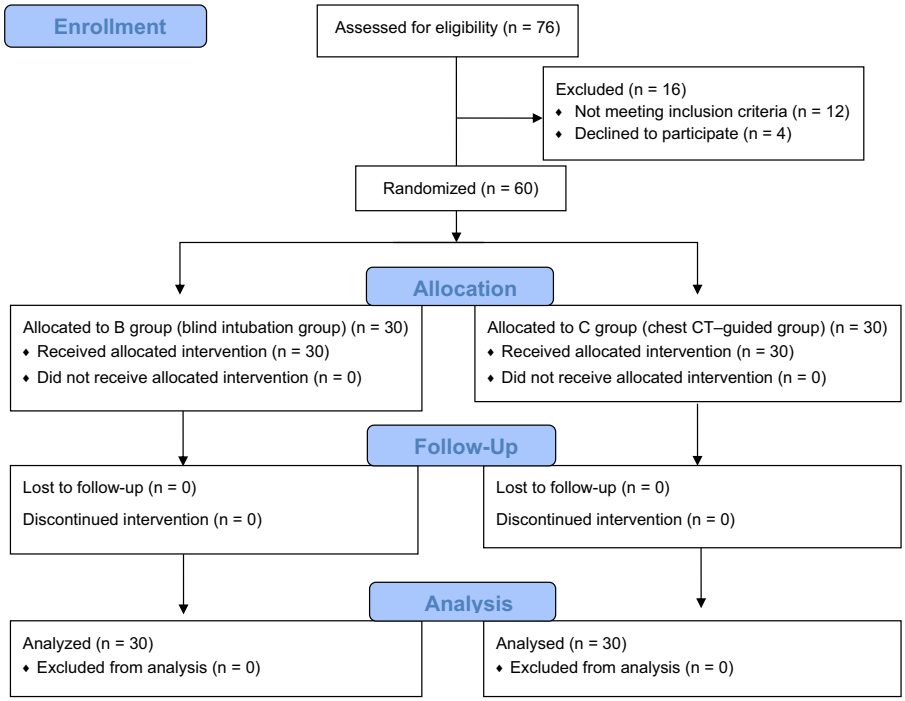

Fig 1. Flow diagram.

Please cite this article as: Liu Z, et al. (2017), http://dx.doi.org/10.1053/j.jvca.2017.09.025