

Original Article

Measuring incisor-carina distance by fiberoptic bronchoscopy to guide the placement of a left-sided double-lumen endobronchial tube

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Abstract: The aim of this randomized observational study was to evaluate the effect of measuring the incisor-carina distance by fiberoptic bronchoscopy in guiding the placement of a left-sided double-lumen endobronchial tube. Fifty patients (American Society of Anesthesiologists class I-II) undergoing elective thoracic procedures requiring single-lung ventilation using a left-sided double-lumen endobronchial tube were evaluated. Patients were randomly divided into either group M, in which a left-sided double-lumen endobronchial tube was placed by measuring the incisor-carina distance with fiberoptic bronchoscopy, or group B, in which the endobronchial tube was placed by blind insertion and then confirmed with fiberoptic bronchoscopy. After placement, tube position was assessed by fiberoptic bronchoscopy and cases requiring adjustment were recorded. The intubation time and postoperative adverse reactions related to intubation were also recorded. We conclude that compared with blind placement, this method can reduce total intubation time, increase the rate of accurate placement, and reduce the incidence of adverse reactions related to intubation. It is relatively simple and reliable, and is useful in clinical application.

Keywords: Intubation, endobronchial tube, bronchoscopy, ventilation, single-lung

Introduction

The use of a double-lumen endobronchial tube (DLT) for single-lung ventilation in thoracic surgery is a well-established technique [1]. Traditional "blind insertion" of the DLT is still widely used in clinical practice. Blind placement appears easy and quick, but has a high malposition rate [2-4]; furthermore, the left-sided DLT (L-DLT) is easily misplaced into the contralateral main bronchus [5, 6], with an incidence as high as 7-24% [7, 8]. Therefore, fiberoptic bronchoscopy had been strongly advocated to guide the initial placement of L-DLT, to avoid severe misplacement and limit potential bronchial damage [9, 10]. However, Boucek and colleagues [11] reported that the directed approach with fiberoptic bronchoscopy required more time than that for blind insertion followed by confirmation with fiberoptic bronchoscopy. In our randomized observational study, we guided placement of the L-DLT on the basis of the depth of insertion calculated from

the incisor-carina distance (ICD), which can be measured incidentally with fiberoptic bronchoscopy before guiding the tube into the bronchus. The objective was to determine whether this new method would save intubation time, improve the rate of accurate placement, and reduce adverse reactions related to intubation.

Subjects and methods

This study was approved by the ethics committee of of Huai'an First People's Hospital, each patients signed the written informed consent. Fifty patients (American Society of Anesthesiologists class [ASA] I-II) undergoing elective open thoracic procedures requiring single-lung ventilation were evaluated (**Figure 1**). The electrocardiogram, pulse oxygen saturation, end-tidal carbon dioxide, and invasive arterial pressure were monitored continuously. After preoxygenation, anesthesia was induced with intravenous fentanyl 4 µg/kg, midazolam 0.06 mg/kg, propofol 2 mg/kg, and rocuronium 0.6 mg/kg.

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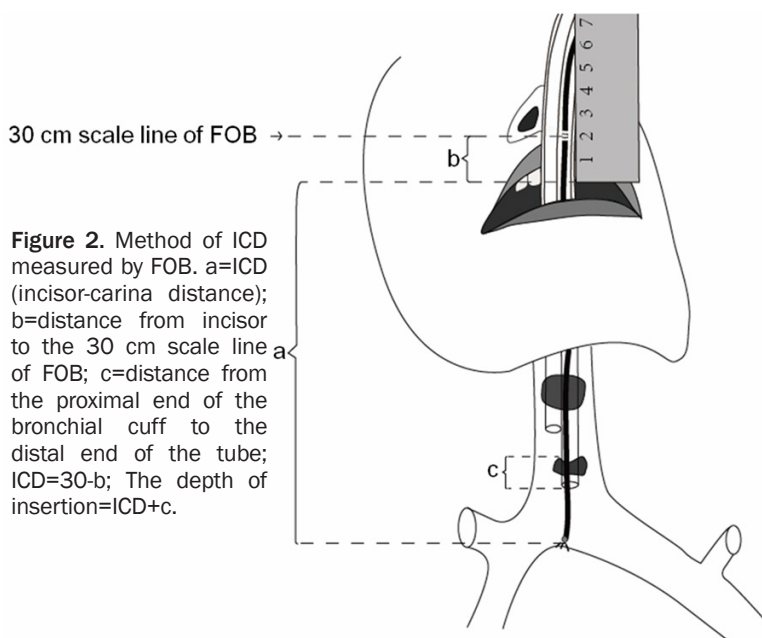
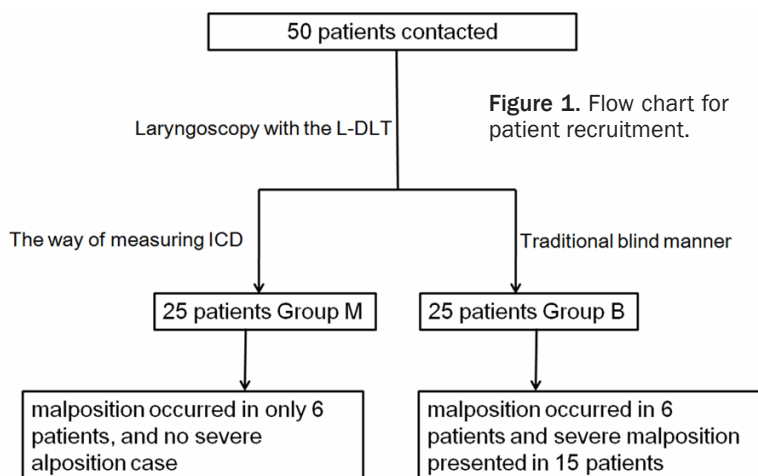


Table 1. Comparison of patients characteristics between two groups (n=25, respectively)

| Index | Group M (n=25) | Group B (n=25) | P value |
|--|-------------------|-------------------|---------|
| Gender (cases, M/F) | 14/11 | 16/9 | 0.564 |
| Age (years, $\bar{x} \pm s$) | 50 \pm 11 | 48 \pm 13 | 0.5598 |
| BMI (kg/m ² , $\bar{x} \pm s$) | 23 \pm 5 | 25 \pm 4 | 0.1249 |
| ASA level (cases, level I/II) | 12/13 | 11/14 | 0.777 |

Intubation was performed under direct laryngoscopy with the L-DLT (Portex, Smiths Medical International Ltd.). The size of the tube was based on the width of the tracheal diameter on

the preoperative chest radiograph, as described by Chow and colleagues [12].

In measuring ICD group (group M), the L-DLT was placed by measuring the ICD. After the bronchial cuff passed the glottis and the tube stylet was removed, the operator introduced a fiberoptic bronchoscope (FOB) (Olympus LF-2, 3.4 mm diameter) into the bronchial lumen of the tube, and advanced it to the tracheal carina; meanwhile, the assistant measured the distance (b) from the incisor to the 30-cm scale line of the FOB with a ruler to obtain the ICD (ICD=30-b), and then calculated the depth of insertion (d), based on the ICD and the distance (c) from the proximal end of the bronchial cuff to the distal end of the bronchial tube ($d=ICD+c$). The L-DLT was then placed at this calculated depth of insertion after guiding it into the left main bronchus under the direct vision of FOB (**Figure 2**).

In blind manner group (group B), the L-DLT was inserted in the traditional blind manner. After the bronchial cuff passed the glottic opening, the tube was rotated 90° to the left and advanced until slight resistance was encountered (**Figure 2**).

After placement had been completed, FOB was used to assess and adjust the position of the tube. The ideal position of the L-DLT was that in which the proximal part of the bronchial cuff could be seen just below the tracheal carina when the FOB was inserted into the tracheal lumen. The orifice of the left upper lobe bronchus was situated distal to the tip of the bronchial tube when the FOB was introduced into the bronchial lumen. Malposition indicated that the tube was located beyond 5 mm away from the ideal position. Severe malposition indicated that the bronchial tube was inserted too deep

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Table 2. Comparison of placement time, confirmation time (sec), total intubation time (sec) between the two groups (n=25)

| Index | Group M | Group B | P value |
|---|---------|---------------------|---------|
| Placement time [s, $\bar{x} \pm s$] | 122±38 | 68±24 ^a | 0.0001 |
| Confirmation time [s, $\bar{x} \pm s$] | 32±13 | 158±24 ^a | 0.0001 |
| Total intubation time [s, $\bar{x} \pm s$] | 161±45 | 234±72 ^a | 0.0001 |

Note: compared with group M, ^a*P*<0.05.

Table 3. Comparison of tube position, adverse reactions related to intubation between the 2 groups (n=25, respectively)

| Group | Tube position assessed by FOB [n (100%)] | | Adverse reactions related to intubation [n (100%)] | |
|---------|--|--------------------------|--|----------------------|
| | Ideal position | requiring FOB adjustment | Oropharyngeal bleeding | Swallowing pain |
| Group M | 22 (88%) | 3 (12%) | 10 (40) | 15 (60) |
| Group B | 4 (16%) ^a | 21 (84%) ^a | 21 (84) ^a | 24 (96) ^a |
| P value | 0.000 | | 0.001 | 0.002 |

Note: compared with group M, ^a*P*<0.05.

in the left lower lobe bronchus, too shallow and still in the trachea, or in the contralateral main bronchus [13].

After placement, the tube position (ideal position, malposition and severe malposition) was assessed with an FOB and cases requiring adjustment were recorded. The sum of the placement and FOB confirmation times was the total intubation time, and all were recorded. Postoperative adverse reactions related to intubation, including oropharyngeal bleeding and swallowing pain, were also recorded.

SPSS 16.0 statistical software was used for the analysis. Measurement data that met the normal distribution were expressed as mean \pm standard deviation ($\bar{x} \pm s$), and comparisons between two groups were performed by using the t test. The counting data were compared with the chi square test, with *P*<0.05 considered as statistically significant.

Results

Tracheal intubation with the L-DLT was successful in all patients in both groups, and no patient withdrew from the study. There was no significant difference in age, gender, body mass index, or ASA class (*P*>0.05, **Table 1**).

Tube positions were assessed by FOB after placement. Of 25 patients in group B, malposition occurred in 6 and severe malposition in 15 (misplacement into the right main bronchus in 6 cases); of 25 patients in group M, malposition occurred in only 3, with no severe malposition cases. There were significantly fewer cases requiring FOB adjustment in group M than in group B (*P*<0.05, **Table 3**).

The placement time in group M was significantly longer than that in group B, and the FOB confirmation time and total intubation time in group M were significantly shorter than those in group B (*P*<0.05, **Table 2**). The incidence of oropharyngeal bleeding and swallowing pain after extubation in group B was significantly higher than that in group M (**Table 3**).

Discussion

Studies have shown that there is a statistically significant positive linear correlation between the optimal depth of insertion of L-DLT and body height [14, 15] or other body parameters such as the distance from clavical to tracheal carina [16]. However, the depth of insertion obtained from regression line analysis is not suitable for all patients, and its accuracy rate assessed by fiberoptic bronchoscopy is less than 80%, especially in patients with short stature, in whom clinical application is unsafe and cannot be recommended [17]. Therefore, fiberoptic bronchoscopy was advocated for initial use to guide the placement of the L-DLT in order to avoid complications caused by malposition. In addition, the right main bronchus is more stubby than the left main bronchus, and its angle with the trachea is smaller than that of the left main bronchus; thus, the L-DLT is easily misplaced into the right main bronchus [18, 19]. Placement under the guidance of an FOB could avoid this misplacement and reduce injury to the vocal cords, trachea, and bronchial mucosa resulting from repeated intubation attempts.

The ideal position of the L-DLT is that with the proximal end of the inflated bronchial cuff just below the carina. Therefore, the actual depth of insertion of the L-DLT was simply the total of

the ICD and the distance from the proximal end of the bronchial cuff to the distal end of the bronchial tube. In our study, we incidentally measured the ICD using fiberoptic bronchoscopy before guiding the L-DLT into the bronchus, and obtained the individualized depth of insertion for each patient; this is more accurate than the depth calculated from an equation (88% vs. 78%) [16], and is also suitable for patients with short stature.

Compared with blind insertion followed by confirmation with an FOB, this new method not only avoids misplacement of the L-DLT into the right main bronchus but also improves the rate of accurate placement; fewer cases required FOB adjustment because of intubation based on the individualized depth of insertion. The total time of intubation is decreased, as the time of positioning and adjustment using FOB decreased significantly, thus reducing the incidence of adverse reactions related to multiple intubation attempts [20, 21]. A limitation of this new method is that measurement of the ICD by using an FOB requires combined effort of an operator and assistant, while blind DLT placement or placement with FOB guidance can be performed by one person.

We conclude that this new method is more advantageous than the approach involving blind insertion followed by confirmation with fiberoptic bronchoscopy. This method can reduce the intubation time, improve the rate of accurate placement, and reduce the incidence of adverse reactions related to insertion. It is relatively simple and reliable, and is useful in clinical application.

Disclosure of conflict of interest

None.

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