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RESEARCH

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Videolaryngoscopy is associated with a lower rate of double-lumen endotracheal tube malposition in thoracic surgery procedures, retrospective single-center study

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Abstarct

Background The optimal positioned double-lumen endotracheal tubes (DLT) is crucial in thoracic surgery requiring lung isolation. This study aims to compare the accuracy and complication rates of DLT placement using videolaryngoscopy (VL) versus conventional direct laryngoscopy (DL).

Methods This retrospective single-center study included 89 patients who underwent thoracic surgery with DLT placement between July 2023 and May 2024. Patients were divided into two groups: VL ($n=45$) and DL ($n=44$). Patient characteristics, intubation times, malposition rates, and complications were recorded. DLT position was confirmed using fiberoptic bronchoscopy.

Results The incidence of DLT malposition was significantly lower in the VL group (13.3%) compared to the DL group (31.8%) ($p=0.037$). The overall complication rate was also lower in the VL group (4.4%) compared to the DL group (11.4%) ($p=0.024$). The mean time from anesthesia induction to the first incision was shorter in the VL group (25.2 ± 6.1 min) than in the DL group (28.3 ± 6.5 min) ($p=0.02$).

Conclusions VL significantly reduces the incidence of DLT malposition and associated complications in thoracic surgery compared to DL. The improved visualization and multiple blade options of the C-MAC videolaryngoscopy set likely contribute to these findings. Further research is warranted to confirm these results in larger, multicenter studies.

Trial registration Institutional Review Board (Registration number: 80576354-050-99/437, 27.06.2024).

Keywords Direct laryngoscopy, Double-lumen endotracheal tube, Malposition, Videolaryngoscopy

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Introduction

The successful placement of double-lumen endotracheal tubes (DLT) is crucial in thoracic surgery procedures where lung isolation is required, and malposition of these tubes can lead to complications such as inadequate ventilation, hypoxia, and potential damage to the airway structures [1–4]. Traditional direct laryngoscopy (DL) has been the standard method for endotracheal intubation, but advancements in video laryngoscopy have prompted a reevaluation of intubation techniques [5, 6]. Video laryngoscopy (VL) provides a superior view of the glottis and facilitates a more controlled and precise intubation process.

In this study, we aim to test the hypothesis that the utilization of VL for the placement of double-lumen endotracheal tubes will result in a decreased incidence of malposition compared to the conventional DL approach.

Methods

Ethical statement

This observational study was approved by the Institutional Review Board of our center. Informed consent was obtained from the patients included in the study (No: 80576354-050-99/437, 27.06.2024).

Patient selection

The data of the patients who underwent thoracic surgery procedures between July 2023 to May 2024 were recorded. Among these cases, patients who used double lumen intubation for lung isolation were selected. Patients with endobronchial or endotracheal lesions, tracheal stenosis, tracheomalacia, and anatomical variations in the tracheobronchial system were excluded from the study. Difficult airway was defined as failure to achieve tracheal intubation after two or more attempts by a single practitioner, resulting in extended intubation time and an increased risk of oxygen desaturation and this patient group was excluded from the study. The patients included in the study were divided into two groups according to the use of VL or DL.

The patients in these two groups were compared in terms of their characteristic features, mean time from anesthesia induction to the first incision, DLT malposition and tube-related complication rates.

Airway management

All procedures were conducted by board-certified anesthetists with five years of experience in thoracic surgery and specialized training in airway management, ensuring a standardized approach to both intubation and tube placement verification via fiberoptic bronchoscopy. Patients were prepared and assessed preoperatively for their medical history, allergies, and previous anesthesia experiences, along with an evaluation of mouth opening, neck mobility, and airway anatomy. Following standard anesthesia induction, the VL group had the DLT placed using a VL (KARL STORZ C-MAC videolaryngoscope), with the tube's advancement into the trachea monitored on the video display (Fig. 1). The VL set had four different blades with varying sizes and/or angulations (Fig. 2).

In contrast, the conventional direct laryngoscopy group underwent tube placement using a traditional DL, with direct visualization facilitating the procedure. After the tube placement, the position of the tube was verified in both groups using fiberoptic bronchoscopy (STORZ Fiberscope 2.8) to ensure accurate positioning and identify any malposition. DLT malposition was examined under three categories: deeply migration into the bronchus, proximally located tube, and migration to the contralateral bronchus. When DLT malposition was detected, one of two actions was taken: either the tube was repositioned without removal, or it was replaced with a new tube of a different size.

The steps for DLT placement were as follows:

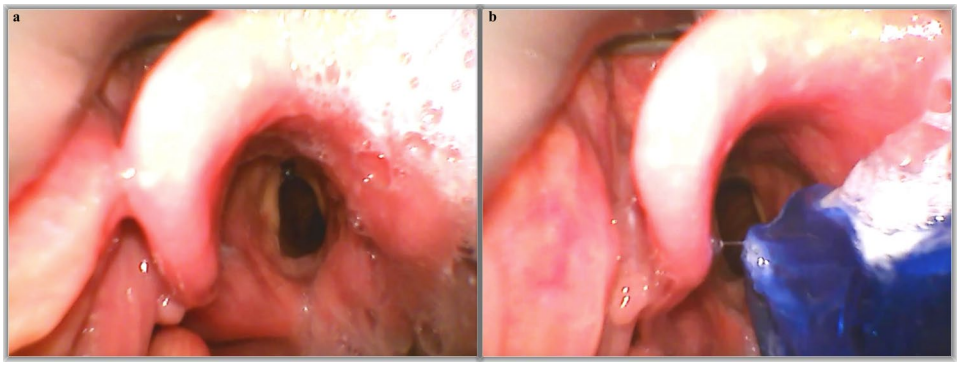

Fig. 1 In this image, a double-lumen endotracheal tube is being placed under videolaryngoscopy. VL provides a clear and detailed view of the epiglottis (**a** and **b**)

Fig. 2 In (**a**), the blades of the KARL STORZ C-MAC videolaryngoscope are shown. Blades of different sizes and angulations facilitate intubation in patients with varying anatomies. In (**b**), the monitor of the videolaryngoscope is shown

1. *Patient Positioning.*

   The patient was placed in the supine position, with the head and neck slightly elevated to ensure a comfortable extension position.

2. *Premedication and Sedation.*

   General anesthesia was induced, and muscle relaxants were administered.

3. *Equipment Preparation.*

   An appropriately sized double-lumen tube (typically 35–37 French for women and 39–41 French for men) was prepared, along with necessary intubation tools (laryngoscope or videolaryngoscope and bronchoscope).

4. *Laryngoscopy (VL or DL).*
5. *Tube Advancement.*

   The double-lumen tube was carefully advanced orally. The tube was positioned in the trachea with its beveled tip facing forward. Once the bronchial cuff was visualized passing through the vocal cords, the stylet was withdrawn.

6. *Tube Rotation.*
7. *Left Double-Lumen Tube.*

   To direct the tube into the left bronchus, the tube was rotated 90 degrees counterclockwise after entering the trachea and advanced into the left main bronchus.

8. *Right Double-Lumen Tube.*

   To direct the tube into the right bronchus, the tube was rotated 90 degrees clockwise after entering the trachea and advanced into the right main bronchus.

9. *Cuff Inflation.*

Table 1 Patient characteristics

Variables	VL (*n* = 45)	DL (*n* = 44)	*P* value
Age (years) (mean ± SD)	54.3 ± 15.7	56.1 ± 15.9	0.59
Sex (male), n (%)	32 (71.1)	36 (81.8)	0.23
Weight (kg) (mean ± SD)	78.3 ± 10.2	77.4 ± 12.7	0.12
Height (cm) (mean ± SD)	171.6 ± 18.2	173.5 ± 16.3	0.21
BMI (mean ± SD)	28.1 ± 6.3	25.9 ± 5.8	0.09
ASA score			0.53
II	30 (66.7)	32 (72.7)	
III	15 (33.3)	12 (27.3)	
Mallampati score, n (%)			0.92
I	20 (44.4)	19 (43.2)	
II	18 (40.0)	16 (36.4)	
III	7 (15.6)	8 (18.2)	
DLT size used, n (%):			0.016
33	1 (2.2)	0 (0)	
35	7 (15.6)	10 (22.7)	
37	24 (53.3)	9 (20.5)	
39	11 (24.4)	20 (45.5)	
41	2 (4.4)	5 (11.4)	
DLT design used (left), n (%):	44 (97.8)	40 (90.9)	0.20
Operation, n (%)			0.39
Anatomical lung resection*	20 (44.4)	22 (50.0)	
Wedge resection	9 (20.0)	12 (27.3)	
Others**	16 (35.5)	10 (22.7)	

*Lobectomy, bilobectomy, segmentectomy, pneumonectomy

**Enucleation, mediastinal mass resection, esophagectomy, pleural biopsy, decortication

DL: Direct laryngoscopy, DLT: Double-lumen tube, VL: Videolaryngoscopy

10. *Confirmation of Tube Position.*

Placement was verified with a fiberoptic bronchoscope.

After the patients were placed in the lateral decubitus position, a second control was performed with fiberoptic bronchoscopy. The primary endpoint of the study was the incidence of double-lumen endotracheal tube malposition, defined as the misplacement of the tube detected by fiberoptic bronchoscopy and the secondary endpoint was the incidence of complication related to intubation.

Statistical analyses

SPSS 25.0 (SPSS Inc., Chicago, IL, USA) was used to perform statistical analysis. The normality of distribution was tested with the Shapiro-Wilk test for all numerical variables. Chi-squared or Fischer's exact tests were used to compare frequencies in categorical variables. Continuous variables are expressed as mean value ± standard deviation (SD) and discrete variables are expressed as numbers and percentages.

Table 2 Intraoperative variables

Variables	VL	DL	*P* value
Malposition, n (%)	6 (13.3)	14 (31.8)	0.037
Deeply migration into the bronchus	3 (6.7)	8 (18.2)	
Proximally located tube	3 (6.7)	5 (11.4)	
Migration to the contralateral bronchus	0 (0.0)	1 (2.3)	
Complication*, n (%)	2 (4.4)	5 (11.4)	0.024
Tube change**, n (%)	0 (0.0)	4 (9.1)	0.056
Time*** (min) (mean ± SD)	25.2 ± 6.1	28.3 ± 6.5	0.02

DL: Direct laryngoscopy, VL: Videolaryngoscopy

*This encompasses intubation-related complications that are detected and recorded intraoperatively. These can include examples such as mucosal bleeding, tracheobronchial laceration, airway obstruction, hypoxia, and bronchospasm

** The term "tube change" encompasses the removal and reinsertion of the endotracheal tube with the assistance of videolaryngoscopy or direct laryngoscopy. Cases where the tube's position is merely adjusted without removal are not included in this definition

*** Mean time from anesthesia induction to the first incision

Table 3 Comparison of postoperative clinical findings related with intubation

Variables	VL (*n* = 45)	DL (*n* = 44)	*P* value
Postoperative findings, n (%)			0.33
Sore throat	8 (17.8)	10 (22.7)	
Dysphagia	2 (4.4)	3 (6.8)	
Tooth pain	1 (2.2)	2 (4.5)	
Voice change	1 (2.2)	2 (4.5)	

DL: Direct laryngoscopy, VL: Videolaryngoscopy

Results

From July 2023 to May 2024, a total of 89 patients were included in the study. The mean age of the patients was 55.9 ± 14.9 years. There were 68 (76.4%) male and 21 (23.6%) female patients. Anatomical lung resection was performed on 42 (47.2%) patients. The patients were divided into two groups: 45 (50.6%) underwent intubation using VL, and 44 (49.4%) underwent intubation using DL. The characteristics of the patients are summarized in Table 1.

Correct placement of the DLT was achieved in 69 (77.5%) patients. Significant differences were observed between the VL and DL groups in terms of malposition rates and anesthesia preparation times, which include the intubation process (Table 2). The most common form of malposition was deeply migration into the bronchus (*n* = 11, 12.4%). Other forms of malposition are presented in Table 3 and illustrated in Fig. 3.

Intraoperative findings

The incidence of DLT malposition was significantly lower in the VL group (13.3%) compared to the DL group (31.8%) with a p-value of 0.037. The overall complication rate, including mucosal bleeding, tracheobronchial laceration, airway obstruction, hypoxia, and bronchospasm,

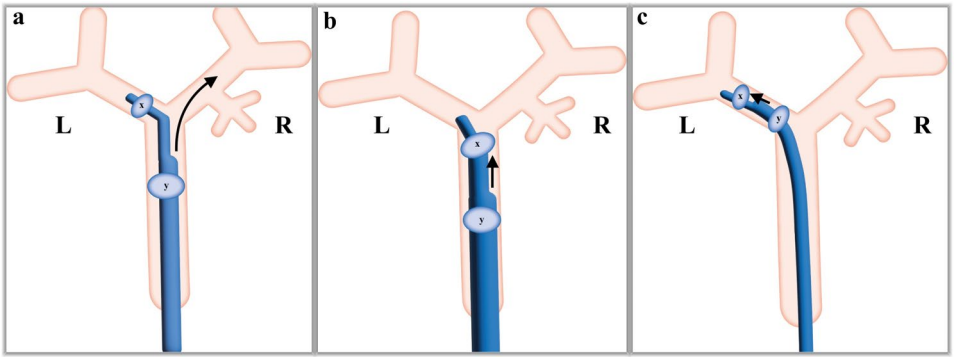

Fig. 3 In these images, which include illustrations of the airway and double-lumen endotracheal tube, (**a**) shows the correct position of the DLT. In (**b**), the DLT is shown to remain proximally due to the use of a tube that is larger than required. As shown in (**c**), when a smaller-than-required tube is used, the DLT can be erroneously advanced proximally. In such a case, ventilation of the right lung becomes impossible

was lower in the VL group (4.4%) compared to the DL group (11.4%) with a p-value of 0.024. There were no cases of tube change in the VL group, whereas 4 (9.1%) cases in the DL group required tube change, though this was not statistically significant ($p=0.056$). The mean time from anesthesia induction to the first incision was significantly shorter in the VL group (25.2±6.1 min) compared to the DL group (28.3±6.5 min) with a p-value of 0.02.

Postoperative clinical findings

The postoperative findings showed no significant differences between the two groups in terms of sore throat, dysphagia, lip trauma, dental trauma, or oropharyngeal mucosal trauma.

The detailed patient characteristics, intraoperative variables, postoperative clinical findings, and malposition types are presented in Tables 1 and 2 and 3, respectively.

Discussion

In this study, we investigated the potential benefits of utilizing video laryngoscopy over traditional direct laryngoscopy in the placement of double-lumen endotracheal tubes during thoracic surgery procedures requiring lung isolation.

VL is a good alternative to DL for tracheal intubation, and its successful use in difficult airway management has been highlighted in various studies [7, 8]. Our findings, including low malposition and complication rates and shorter anesthesia induction-first incision time in the VL group, support the notion that video laryngoscopy offers distinct advantages in the context of endotracheal intubation for thoracic surgeries. However, the data in similar studies in the literature are contradictory. In the majority of similar studies in the literature, parameters such as "first attempt success rate," "intubation time," "malposition rate," "oral, mucosal, and dental injury rates," and "postoperative voice changes" have been emphasized [9–14].

In their randomized controlled study with 70 patients, Russel et al. [9] found a longer intubation time and more frequent voice changes in the VL group. In this study involving 30 anesthetists, it was noted that VL was found to be more difficult than DL in terms of tube delivery and advancement into the trachea, and it was emphasized that the learning curve might have an impact on this situation. In another study, Zani et al. [15] emphasized the impact of anesthetist experience on the selection of an appropriate DLT size. The two anesthetists included in our study had five years of experience with thoracic surgery cases where VL was frequently used. Similarly, in the study by Hsu et al. [10], which included two experienced anesthetists, found a shorter intubation time and less postoperative sore throat in the VL group. However, they found no significant difference between the first intubation attempt success rates.

Contrary, Risse et al. [11] found a longer duration of successful intubation and lower rate of correct DLT position in the VL group. As seen, the results in similar studies in the literature are conflicting. This situation was attributed to the hyperangulated nature of the videolaryngoscope and the difficulty in passing the double-lumen endotracheal tube through the vocal cords. It can be said that the presence of four different blades in the C-MAC videolaryngoscopy set we used in our study may have contributed to the absence of intubation difficulties related to hyperangulation, as emphasized in other studies.

Selecting the most appropriate DLT size for the patient is one of the most important factors influencing DLT malposition and complications [16, 17]. We believe that the magnified and clear visualization of the vocal cords is crucial in selecting the correct DLT size. VL allows for earlier detection of potential size mismatches by providing a clearer view of the vocal cords and the distal end of the DLT during intubation. In our study, DLT size was initially selected based on patient height, but VL's enhanced visualization allowed for the identification of

potential mismatches, prompting adjustments to a larger size when necessary and we attribute the lower rates of DLT malposition and complications in the VL group to this factor. In our study, the most frequently identified type of malposition was deep migration into the bronchus. We believe that selecting a smaller-than-ideal DLT can contribute to deep or contralateral bronchial migration due to a looser fit. In support of this, optimal intubation was achieved in two patients in the DL group by switching to a larger DLT.

Our study has several limitations that should be considered. Firstly, this was a retrospective single-center study, which may limit the generalizability of the findings to other institutions or broader populations. The sample size was relatively small, with only 89 patients, which may affect the statistical power and the ability to detect smaller differences between the groups. Finally, while our study demonstrated a lower incidence of malposition and complications with VL, it did not assess long-term outcomes or patient satisfaction, which are important factors in evaluating the overall effectiveness of intubation techniques.

In conclusion, our study adds to the growing body of evidence supporting the superiority of VL in various clinical settings. While further research is warranted to corroborate our findings and explore the long-term implications, our results suggest that the adoption of VL in thoracic surgery procedures involving double-lumen endotracheal intubation may enhance patient safety and outcomes by reducing the incidence of malpositioned tubes. As such, we advocate for the integration of VL into clinical practice as a standard approach for endotracheal intubation in these contexts.

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Author contributions
S.K. and G.B. planned the study process and organized the methodology. S.K., I.T. and H.T. analyzed and interpreted the patient data who underwent double lumen tube intubation. G.B. and I.T. performed the statistical analyses and reviewed the manuscript. All authors read and approved the final manuscript.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
This observational study was approved by the (Ethical Committee of Kafkas University Medical Faculty Ethical Review Board) Institutional Review Board of our center (80576354-050-99/437).

Consent for publication
Informed consent was obtained from the patients included in the study.

Competing interests
The authors declare no competing interests.

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