A Retrospective Evaluation of the Use of Video-Capable Double-Lumen Endotracheal Tubes in Thoracic Surgery

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Objective: The objective of this study was to evaluate whether the use of a video double-lumen tube reduced the need for fiberoptic bronchoscopy for (1) verification of initial tube placement and for (2) reclassification of correct placement after repositioning for thoracotomy.

Design: A single-center retrospective study.

Setting: Thoracic surgery in a medical university hospital.

Participants & Interventions: After institutional review board approval, 29 patients who underwent thoracic surgical procedures using video double-lumen tubes were included in the final retrospective analysis.

Measurements and Main Results: For 27 (93.2%) patients, the use of fiberoptic bronchoscopy was not needed either for initial placement or for verification of correct video double-lumen tube placement upon final positioning of the patient. However, for two patients, fiberoptic bronchoscopy was needed: for (1) one patient with severe left mainstem bronchus distortion as a result of a large left upper lobe tumor, and (2) a second patient with secretions that were difficult to clear.

Conclusion: This study demonstrates that the video double-lumen tube requires significantly less (6.8%) fiberoptic use for both initial placement and verification of final position, in stark contrast to standard practice in which bronchoscopy is always used to verify final positioning of the double-lumen tube. As opposed to intermittent bronchoscopy, the continuous visualization offered by an embedded camera may confer an added measure of safety.

KEY WORDS: double-lumen tubes, thoracic surgery, thoracic anesthesia, video-double-lumen endobronchial tube, fiberoptics, fiberoptic bronchoscopy, one-lung ventilation

METHODS

After approval by the Institutional Review Board, charts were reviewed retrospectively for patients who underwent thoracic procedures with VDLT between January and July 2013. A total of 30 such patients were identified. Inclusion criteria were patients 18 years or older, thoracic surgery, and VDLT usage. Exclusion criteria were lung isolation via non-double-lumen tube method (ie, bronchial blocker) or use of a conventional DLT. Additionally, 1 patient was excluded for whom the VDLT was used via the tracheal stoma. Demographics and other data points, such as American Society of Anesthesiologists (ASA) physical status, Mallampati airway score, laryngoscopic airway grade, type of laryngoscope used, surgical procedure undergone, and FOB used or not, were collected from 29 patients. Data are presented as median (25th-75th) or proportions. Data were analyzed using GraphPad Prism software (GraphPad Prism Software Inc., La Jolla, CA).

RESULTS

Subjects included 18 males and 11 females with a median age of 61 years. Demographics, technique of airway management, and type of surgery are summarized in Table 1. In all 29 patients, lung isolation was achieved successfully via the VDLT, allowing the thoracic surgical procedure to proceed as planned. It was further noted that for 27 (93.2%) patients, the use of FOB was not needed either for initial placement or for verification of correct VDLT placement upon final positioning.

LUNG ISOLATION AND ONE-LUNG ventilation are almost always required for thoracic surgery. Although institutional and practitioner preferences dictate the specifics of how this is achieved, the most commonly used methods for lung isolation and one-lung ventilation include placement of a double-lumen endobronchial tube (DLT) or the use of a standard endotracheal tube with a bronchial blocker. Over the past few decades, the use of the DLT has gained increasing popularity as a result of the advantages and disadvantages of the DLT versus the bronchial blocker.1-3 Regardless of the technique chosen, fiberoptic bronchoscopy (FOB) is the standard of care for DLT and bronchial blocker placement and maintenance.

Specifically, after endotracheal placement of a DLT, FOB is used in 1 of 2 ways: Either the FOB is placed in the bronchial lumen of the DLT and used to guide proper-sided endobronchial insertion or, alternatively, the DLT is inserted blindly and then the FOB is inserted in the tracheal lumen and used to verify the correct side and depth of endobronchial tube placement. Additionally, after lateral repositioning or for evaluation of loss of lung isolation, the FOB is used to confirm and, if necessary, reacquire and maintain proper endobronchial tube placement. Unfortunately, many anesthesiologists lack the training and familiarity of tracheobronchial anatomy for adequate application of these techniques, leading to a high incidence (38%) of malposition.4

A technologic advance in video camera and light source miniaturization may offer a novel solution to this problem. The Vivasight™ (ET View Ltd, Misgav, Israel) DLT is a video double-lumen tube (VDLT) that has an embedded camera and light source between the tracheal and bronchial cuffs, enabling continuous airway visualization on a portable external proprietary monitor that is connected via a mini-USB adapter (Fig 1).

The purpose of this study was to review the authors’ experience using this VDLT and to evaluate whether the VDLT reduced or completely obviated the need for FOB for (1) verification of initial placement and (2) reconfirmation of correct placement after repositioning for thoracotomy.

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of patient. However, for 2 patients FOB was used at some point in the procedure. FOB guidance was necessary in 1 patient with severe left mainstem bronchus distortion as a result of a large left upper lobe (LUL) tumor. However, in this patient the FOB was not needed for verification of final placement of VDLT because the embedded camera provided an adequate view for verification. In the second patient in whom the FOB was used, FOB was needed to verify final position upon turning the patient laterally because secretions were difficult to clear. However, in this patient the FOB was not needed for initial placement of VDLT.

**DISCUSSION**

Intubation with a DLT can be more challenging than placing a single-lumen endotracheal tube because of its overall larger size, its larger diameter, and the resultant awkward insertion. Obstacles can arise both in initial insertion of the DLT and in maintenance of final position for lung isolation. Furthermore, malposition and dislodgement are common because of inappropriate sizing (requiring overinflation of cuff), airway factors (edema, tumors), and surgical manipulation. This often necessitates the use of FOB because, as Klein and colleagues have shown, more than 35% of patients require repositioning when blind technique followed by auscultation was reconfirmed with FOB to ascertain correct position. This study demonstrated that the VDLT can be used successfully to achieve and maintain one-lung ventilation and isolation for thoracic procedures. Unlike the use of intermittent FOB visualization, the use of VDLT with its embedded camera and light source allows the anesthesiologist continuous visualization of the tracheal mucosa, the carina, and proximal bronchial airways, thus enabling higher successful insertion and correct placement of the VDLT (Figs 2 and 3). This study also demonstrates that the VDLT requires less FOB use for both initial placement and verification of final position, as compared with the standard, in which FOB is always used to verify final positioning of the DLT.

Moreover, the continuous visualization of the airway has potentially significant consequences for patient safety. For instance, in the present study, in 2 out of 30 of these patients the airway was not readily accessible to the anesthesiologist because the robotic positioning dictated that the head was turned away from the reach of the anesthesiologist. If desaturation were to occur, or if there was an increase in airway pressures, customarily the first step of many clinicians would be to verify correct DLT position. With this device, however, the embedded camera gives the provider a real-time image, allowing the clinician to check position without having to use the FOB, thereby potentially reducing the time in diagnosing the problem and hence instituting proper therapy in a more timely fashion. Similarly, aggressive manipulation of the lung parenchyma can also be noted, allowing the anesthesiologist to proactively prevent malposition by communicating with the surgeon before the manipulation and thus avoiding the potentially harmful consequences of dislodgement. Likewise, VDLT could provide an additional measure of safety in procedures such as pneumonectomies, where it is desired to move the DLT before the surgeon clamps the bronchus, allowing visualization of the stapling that avoids inadvertent stapling of the tube into the bronchial stump or rupturing of the endobronchial cuff of the DLT. Although the FOB remains the gold standard for examination of the tracheobronchial tree, the embedded camera view can be used as an adjunct to teach trainees to recognize and become more familiar with the anatomy via direct visualization. This concept could also be useful for the anesthesiologist who does...
not use DLTs on a regular basis and is more likely to employ the blind advancement technique when placing a DLT. In both of these scenarios, direct visualization could potentially reduce the DLT’s tendency to catch on the trachea’s anterior cartilaginous rings, which may increase the chances of bleeding and further tracheal trauma, as suggested by Knoll and colleagues. Besides, because most nonthoracic anesthesiologists are more familiar with the primary carina vantage point, this view provided by embedded camera can serve as a reference point to facilitate DLT placement. Moreover, the external display enables other providers to assist with external manipulation of the trachea if difficulty is encountered.

Because of the retrospective design, this study did have a number of limitations. As with any retrospective study, it was not possible to control for bias and confounding factors because there was no randomization or blinding. Specifically, at the authors’ institution it is standard practice to always use FOB to confirm final position; hence there was no comparison of the results of FOB use with the VDLT with a control group. All the laryngoscopies were done by trainees under the supervision of thoracic anesthesiologists, and malposition may have been quickly recognized and corrected without the use of FOB because these anesthesiologists are intimately familiar with the anatomy. As with all retrospective studies, the study is dependent on accuracy and availability of data, and certain data points were unavailable. For instance, it is recognized that secretions can obscure the view of the camera lens, and although the built-in irrigation channels can assist in flushing away the debris, the anesthetic records did not indicate if and how many times the VDLT had to be irrigated. Additionally, although the potential lowered incidence of FOB use could result in lowered costs associated with fiberoptic scope setup and maintenance, this study was neither powered adequately nor did the authors have the specific data points to evaluate cost. A design limitation of the VDLT is that if the provider wants to view beyond the primary carina, then one is compelled to use a FOB. Similarly, the FOB allows easier clearing of secretions as opposed to irrigating the fixed camera embedded within the VDLT.

Despite these limitations, the novel design of this VDLT, offering direct visualization of the pertinent airway and tracheobronchial anatomy, is very promising and is a useful concept that warrants further study in larger prospective randomized trial.

REFERENCES