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Original Article

Bronchial Blocker Versus Left Double-Lumen Endotracheal Tube for One-Lung Ventilation in Right Video-Assisted Thoracoscopic Surgery

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Objective: The aim of this study was to compare the quality of lung deflation of a left-sided double-lumen endotracheal tube (DLT) with a bronchial blocker (BB) for one-lung ventilation in video-assisted thoracic surgery (VATS).
Design: A prospective, randomized, clinical study.
Setting: A university-affiliated teaching hospital.
Participants: Forty-five adult patients undergoing esophageal tumor surgery using VATS with right lung deflation.
Interventions: Patients were assigned by a computer-generated randomization sequence to either the left-sided DLT or BB group. The correct positioning of the airway device was confirmed using fiberoptic bronchoscopy.
Measurements and Main Results: The variables assessed included: (1) time required to correctly place the devices and to achieve lung collapse; (2) the number of times the device malpositioned; (3) the quality of lung deflation as rated by the surgeon; (4) blood pressure and heart rate at baseline (T_1), immediately before (T_2) and after (T_3) and 1 minute (T_4) after intubation; (5) the number of patients with hypoxemia ($SpO_2 < 90\%$) during the one-lung ventilation (OLV) period; and (6) postoperative hoarseness of voice, sore throat, or pulmonary infection. Of the 45 patients approached for the study, 21 patients in the DLT group and 19 patients in the BB group were analyzed. The time required to place the device in the correct position was similar between the 2 groups. The time to achieve right lung collapse in the BB group was significantly longer (mean difference: 3.232, 95% confidence interval [CI]: 1.993-4.471; $p = 0.003$). The quality of lung collapse, OLV duration, number of patients with device malposition, and hypoxemia in both groups were similar. There were more patients suffering hoarseness (odds ratio [OR]: 4.85, 95% CI: 1.08-21.76; $p = 0.034$) or sore throat (OR: 4.29, 95% CI: 1.14-16.18; $p = 0.030$) in the DLT group, while no patients developed postoperative lung infection in either group. Compared to T_1, systolic blood pressure (sBP), diastolic BP (dBP), and heart rate (HR) at T_2 in both groups were higher ($p < 0.05$) in the DLT group. Then, compared to T_2, sBP and dBP at T_3 and T_4 and HR at T_3 in the DLT group were higher ($p < 0.05$).
Conclusions: The results of this study showed that BB is an effective alternative for left one-lung ventilation in right VATS, but requires a longer time to achieve complete lung collapse. Moreover, the use of BB caused less hemodynamic perturbation and can reduce postoperative hoarseness and sore throat.

Keywords: one-lung ventilation; thoracic surgery; bronchial blockers; double-lumen tubes; complications

VIDEO-ASSISTED THORACOSCOPIC SURGERY (VATS), a technique increasingly used in thoracic surgery, requires one-lung ventilation (OLV) with a well-collapsed

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lung to improve visibility of the surgical field. Unlike thoracotomy in which the surgeon can compensate for suboptimal lung collapse by directly retracting the lung, such luxury cannot be afforded by the VATs technique in which access to the pleural cavity is limited. Insertion of a double-lumen endotracheal tubes (DLT) is a well-established technique to achieve OLV and is widely considered the gold standard.[1,2] Its large lumen facilitates the suctioning of blood or secretions from the bronchi, and the switch from two-lung ventilation to OLV easily and reliably can be achieved. However, malpositioning of the tube can occur, and the insertion of the DLT can cause complications such as tracheobronchial rupture, traumatic laryngitis, or arytenoid dislocation.[1–4] Moreover, it is sometimes not possible to use a DLT, such as for patients whose tracheas are difficult to intubate or in small adults and children. The DLT also may induce a more pronounced cardiovascular response to intubation compared with the use of regular endotracheal tubes.[5] The bronchial blocker (BB) is inserted inside a standard single-lumen tube previously placed into the trachea. One advantage of this blocker compared to the DLT is that the BB avoids the need for a tube exchange when postoperative mechanical ventilation is needed. Therefore, the BB is considered as a reliable alternative to achieve the OLV.

However, there is little data comparing the use of BB with the DLT in VAT esophageal surgery, especially in the Chinese population, where airway dimensions may differ with patients of other ethnicities.[6] The stiffer nature of the DLT when compared with BB can create technical difficulties during the lymph node dissection for esophageal surgery and thus data comparing different mode of airway management for this type of surgery would be useful. The authors hypothesized that the BB performs clinically better than a DLT for lung isolation causing less injury to the patient undergoing right VATS. The aim of this study was to directly compare the use of a left-sided Robertshaw-type DLT with a BB in a randomized, prospective fashion, evaluating its ease of use, the surgical conditions it provides, as well as postoperative complications.

Methods

This study protocol was approved by the Ethics Committee of the First Affiliated Hospital of Anhui Medical University. Forty-five patients who were scheduled to receive VATS for esophageal tumor surgery between the period of October 2016 and December 2016 were approached for the study. These patients were aged between 46 and 82 years old and of American Society of Anesthesiologists (ASA) physical status 2 to 4. After obtaining written informed consent and prior to induction of anesthesia, patients were assigned to have their airway managed by either a left-sided DLT or a BB according to a computer-generated randomization sequence. Patients with previous or anticipated difficult airway intubation, prior chemotherapy or thoracic radiotherapy, severe chronic obstructive pulmonary disease, pleural and/or interstitial pathology, history of neurologic, psychologic, and respiratory function with $FEV_1 < 50\%$ of predicted value were excluded.

Patients were connected to a monitor to record electrocardiogram, invasive blood pressure, heart rate (HR), and pulse oxygen saturation (SpO2) during the anesthesia. Anesthesia was induced with midazolam (0.05 mg/kg), sufentanil (0.4 μg/kg), etomidate (0.2 mg/kg), and rocuronium (0.6 mg/kg). After the onset of muscle relaxation, the single-lumen endotracheal tube (SLT) or DLT was inserted under video laryngoscopy and was then connected to the ventilation. In the DLT group, the patients were intubated using a left-sided DLT (Mallinckrodt Medical Ltd, Athlone, Ireland) of an adequate size (35-37 Fr for women and 37-39 Fr for men). The DLT was positioned using a flexible bronchoscope at an appropriate depth to allow positioning the tracheal carina between the radiopaque black line of the endobronchial aspect of the DLT and the upper part of the blue bronchial cuff. The BB (Hangzhou Tappa Medical Technology CO., Hangzhou, China) also was positioned through the lumen of the regular endotracheal tube (size 7.5 or 8.0 for men and 7.0 or 7.5 for women) using a flexible bronchoscope such that the cuff was just within the right main bronchus. The balloon of the BB was inflated with 5-to-8 mL of air to obtain total bronchial blockade. An attending anesthesiologist with at least 5 years of experience who was not involved with the study confirmed the correct placement of either the DLT or the BB. After that, the patients were turned into a left lateral decubitus position. The cuff or the balloon was inflated again before starting OLV, and the same anesthesiologist rechecked the position of all device placements again. In the DLT group, the right channel was clamped and opened to air. Then, in the BB group, the lung was deflated prior to inflating the balloon of the blocker by turning the ventilator off and opening the breathing circuit. No further maneuvers were performed to facilitate lung collapse. During OLV, ventilator settings were adjusted to keep peak pressure below 25 cmH_2O and increase respiratory frequency and decrease tidal volume. The ventilation parameters were adjusted to maintain the end-tidal carbon dioxide level to between 35 and 45 mmHg. Anesthesia was maintained with propofol (4-6 mg/kg/h) and remifentanil (15-30 μg/kg/h). Muscle paralysis was maintained with intermittent doses of rocuronium. After the completion of the surgery, all patients were transferred to the postanesthesia care unit (PACU), and received patient-controlled analgesia using 250 mL of sufentanil 3 ug/kg and flurbiprofen axetil 250 mg.

The variables recorded in this study were:

(1) Invasive blood pressure and HR at baseline (T_1), immediately before (T_2) and after intubation (T_3), and 1 min after intubation (T_4);
(2) Time required for correct placement of the device, measured from the start of the laryngoscopy until the end of the bronchoscopic check and the time required to achieve adequate lung deflation;
(3) The number of times of airway device malpositioning, defined as any of the following: intubation of the wrong mainstem bronchus, the herniation of the bronchial cuff or

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