

Successful Right Middle Lobe Resection after Left Pneumonectomy with Selective Lobar Blockade Assisted by Preoperative Coronal Multiplanar Reformation Images on 64 Slice Multidetector Computed Tomography

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Abstract

Selective isolation of a pulmonary lobe is indispensable in patients who have undergone pneumonectomy and require surgery of the remaining lung. The use of a bronchial blocker is associated with the following problems: 1) placement can require considerable time; 2) suction is often necessary to expedite lung collapse; and 3) the position of the blocker sometimes must be corrected intraoperatively with the use of fiberoptic bronchoscopy. To solve these problems, it is useful for physicians to simulate the positioning of blockers on preoperative coronal multiplanar reformation images obtained by 64-slice multidetector computed tomography (MDCT) and to be familiar with airway devices for lung isolation. We describe the use of selective lobar blockade with an endobronchial blocker assisted by preoperative coronal multiplanar reformation images on 64-MDCT in a patient who had undergone a left pneumonectomy.

Case Report

LA 67-year-old man with a body weight of 66 kg was admitted to receive resection of a pulmonary mass in the right middle lobe via an open thoracotomy. He had smoked 20 cigarettes per day for more than 40 years, but stopped smoking in 2005, when he underwent a left pneumonectomy for adenocarcinoma.

On preoperative pulmonary function tests, the vital capacity was 1.92 L (59.6% predicted), and the forced expiratory volume in 1 sec (FEV₁) was 84.9%. Preoperative arterial blood gas analysis showed a pH of 7.39, a carbon dioxide pressure (Pco₂) of 39.9 mmHg, and an oxygen pressure (Po₂) of 89.5 mmHg at an inspired oxygen fraction of 0.21. He could climb four flights of stairs at his own pace without stopping.

Preoperative 64 slice multidetector computed tomography (MDCT) was performed with a 64-detector CT scanner (LightSpeed VCT; GE Healthcare, Milwaukee, WI, USA) with mapping at a 0.6-mm collimation setting to generate 0.625-mm slices reconstructed every 0.5 mm. A coronal multiplanar reformation image was obtained from the CT volume data, allowing the bronchial system to be continuously displayed from the tracheal bifurcation to the cavitary mass in the right middle lobe on a single slice image. We used this image to obtain information to facilitate blocker positioning. The angle of the right bronchus intermedius relative to the right main stem was 153 degrees. The length of the right middle lobe bronchus was 59 mm.

Before induction, a radial artery catheter was inserted, and arterial blood gas analysis at an inspired oxygen fraction of 1.0 revealed a pH of 7.44, a Pco₂ of 39 mmHg, and a Po₂ of 341 mmHg. Then, an epidural catheter was inserted at the level of the T7-T8 interspace for open thoracotomy. After the induction of anesthesia with propofol and rocuronium and the initiation of anesthesia with sevoflurane in oxygen, the patient's trachea was easily intubated using a standard endotracheal tube (ET, Rüschi, Teleflex Medical Sdn.Bhd, Perak, Malaysia) with an internal diameter of 9.0 mm.

A 9-French (3.0 mm) Fuji Uniblocker, (Fuji Systems Corporation, Tokyo, Japan) was placed through a Swivel connector (Fuji Systems

Corporation) before insertion into the ET, lubricated with jelly to facilitate passage. Then, it was advanced and positioned in the orifice of the right middle bronchus, and the balloon was inflated with 4 mL of air while monitoring the procedure with a 2.8-mm outer diameter fibroscope (Karl Storz, Tokyo, Japan).

Middle-lobar blocking was fiberoptically confirmed with the patient in the supine position. Pressure control ventilation with a fraction of inspired oxygen (FiO₂) of 1.0 at a rate of 12 breaths per minute and a pressure of 20 cm H₂O produced a tidal volume of 400 to 450 mL, maintaining the oxygen saturation level at 99% to 100%.

However, the right middle lobe was not well deflated when the patient was in a left lateral decubitus position, and good surgical access was not obtained. We fiberoptically advanced the blocker approximately 1 cm distally, confirmed air tightness, and applied suction for rapid deflation through a suction port. Satisfactory conditions for surgery were thus obtained. Arterial blood gas analysis 15 min after this maneuver showed a pH of 7.33, a Pco₂ of 50 mmHg, and a Po₂ of 430 mmHg. The procedure took 280 min and was uneventful. At the end of the surgical procedure, the blocker balloon was deflated, and the blocker was removed.

The patient awakened without difficulty, the trachea was extubated,

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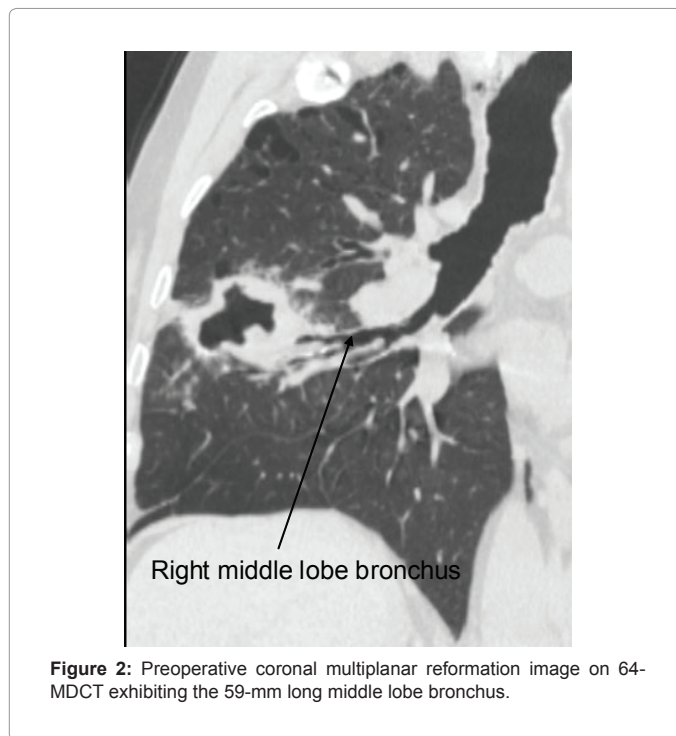
and the procedure was completed uneventfully. Permission for this case was obtained from the patient.

Discussion

Selective lobar blockade is necessary in patients who have undergone pneumonectomy and require thoracic surgery involving the remaining lung. Selected lobes can be collapsed by means of bronchial blockers such as a wire-guided endobronchial blocker [1,2], a single-lumen endotracheal tube with an enclosed bronchial blocker (Univent[®]) [3], or endobronchial intubation with a left-sided, double-lumen endobronchial tube (DLT) on the right side [4]. In some patients, right endobronchial intubation with a single-lumen tube [5] has been attempted to deflate the right upper lobe bifurcation. The procedure of choice depends on the anatomy of the patient's upper airway and bronchial tree, the surgical site, and the physician's level of skill. We decided to perform selective lobar blockade with a Fuji Uniblocker [6] because selective right middle lobe isolation was possible and we were familiar with the airway equipment.

Lung separation technique with a bronchial blocker has several distinct advantages over one-lung ventilation. First, it avoids total lung collapse and only blocks selective lobes, improves oxygenation [7], and avoids difficulties associated with re-collapse of the lung. Second, lung separation technique with a single-lumen endotracheal tube allows the tube to remain in place without the need for tube exchange in patients who require airway management after thoracic surgery. In contrast, the use of a bronchial blocker can require a longer time for placement, more support suction to promote lung collapse [8], and numerous sessions of fiberoptic bronchoscopy to manage dislodgement of the blocker [9], as compared with a DLT.

To simulate the positioning of the blocker, we used preoperative coronal multiplanar reformation images on 64-MDCT and predicted that the positioning of the blocker into the middle lobe bronchus would be relatively easy. To the best of our knowledge, this is the first case report to document selective right middle lobar blockade using coronal multiplanar



reformation images to visualize the distal airways in a patient who had undergone a pneumonectomy. Besides confirming in advance that the patient had normal airways without a distorted tracheobronchial tree or narrow right main bronchus, the right middle lobe bronchus was situated at an obtuse angle of 153 degrees with respect to the right main stem. The blocker was therefore expected to be easily introduced into the middle lobe bronchus. Because the right middle lobe bronchus was a sufficient length (59 mm) relative to the outer dimensions of the spherical inflated cuff (diameter 15 mm, major long axis 21 mm when inflated with 4 ml of air) the risk of dislodgement was considered minimal. Although gravity causes the dynamics of the tracheal carina to shift downward with lateral positioning [10], the bronchus has a more fixed structure anatomically. Therefore, lateral positioning does not markedly change the bronchial distance or angle. Virtual bronchoscopy also might be another way to evaluate the anatomy of the airways.

While less than 5 minutes are required for initial blocker replacement, the blocker should be advanced 1 cm distally, with the patient in the lateral decubitus position. A previous study [11] recommended that once the optimal position of an Arndt blocker is achieved in the supine position, the cuff should be deflated and the blocker advanced approximately 1 cm to avoid dislodgement. A Fuji Uniblocker is similar to an Arndt blocker because it is a wire-guided independent endobronchial blocker with a soft high-volume cuff made of silicone. To facilitate surgical exposure, assisted suction should be applied to expedite lung collapse. Campos and Kernstine [8] reported that after ventilation of one lung was achieved with either a DLT or bronchial blocker, the surgical exposure was clinically equivalent to that during elective thoracic surgery.

The Fuji Uniblocker with stylet, which allows flexible high torque control and good controllability of the catheter tip, can be easily directed to block a selective lobar bronchus. The stylet can be removed, and a 1.4-mm lumen can be used as a suction port for rapid deflation of lobes or for oxygen insufflation to apply continuous positive airway pressure to

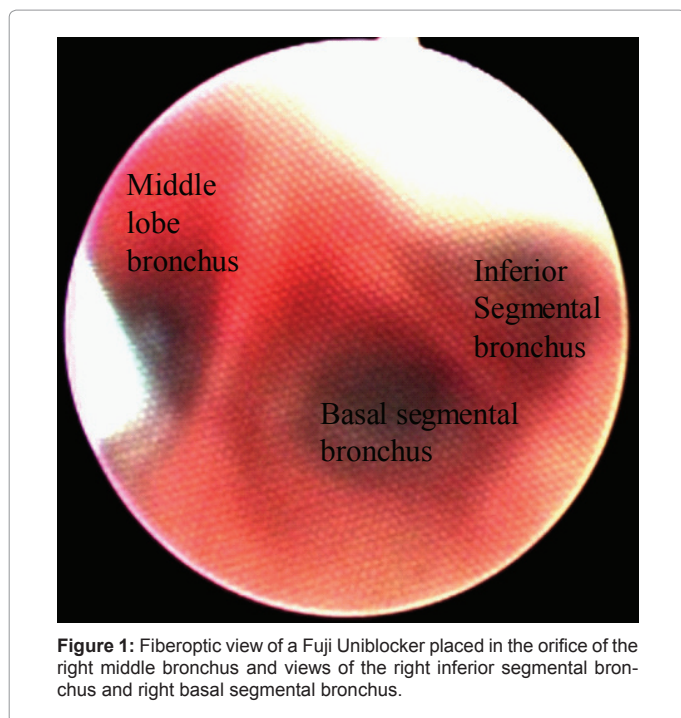


Figure 1: Fiberoptic view of a Fuji Uniblocker placed in the orifice of the right middle bronchus and views of the right inferior segmental bronchus and right basal segmental bronchus.

deflated lobes. The disadvantage of this device is that once the stylet has been pulled out it cannot be reinserted because of blocker shaft damage, thus precluding realignment of the blocker if necessary. In our patient, we pulled out the stylet after sufficient surgical access was confirmed. In addition, the Swivel connector facilitated lung collapse while maintaining sufficient ventilation. The simultaneous use of ventilation with the Swivel connector within 5 minutes of blockade reduced the risk of hypoxia and assured a high margin of safety.

The use of Fuji Uniblocker in combination with a Swivel connector enabled selective occlusion of the right middle lobe in our patient as expected on the basis of coronal multiplanar reformation images. However, a bronchial blocker requires assisted suction and ventilation with a small tidal volume to ensure proper surgical access.

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