

Lung segmentectomy assisted by highly selective independent segmental ventilation

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Case report

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Abstract

Background: The identification of targeted intersegmental plane and resection with adequate surgical margin is one of the crucial steps in anatomical pulmonary segmentectomy, and improvements are still needed.

Case presentation: Three cases of intersegmental plane identification using highly selective independent segmental ventilation during segmentectomy are reported. All cases required the cooperation with anaesthesiologist who is able to perform segmental ventilation and double confirmation of branch of segmental bronchus by surgeon. The surgical procedure provides a direct visualization of spare segment inflation and saving time in deflation by the conventional residual segment inflation method.

Conclusions: Highly selective independent segmental ventilation can be considered a suitable option for the pulmonary intersegmental plane identification, which could be universally used for lung segmentectomy.

Background

Precise intersegmental plane identification is a crucial step in anatomical segmentectomy, which is a surgical procedure aiming at curation of small and early lung cancer and sparing of lung function. Traditional approaches include high-frequency ventilation [1], indocyanine green injection [2] and infrared thoracoscopy [3], these techniques are demanding for time of lung collapse, pharmaceutical materials and special camera. Therefore, a more simpler and efficiency way of intersegmental plane identification is required.

With the advance of anaesthesiologic technique, lung ventilation reaches a segmental level. With specialized instruments and proper intubation technique, direct inflation of target lung segment is possible. We report on three successful cases of intersegmental plane identification assisted by using highly selective independent segmental ventilation during segmentectomy. Here, we described our highly selective independent segmental ventilation method for intersegmental plane identification.

Case Presentation

This ventilation technique was approved by the Institutional Review Board and the Ethics Committee of Nanfang Hospital, Southern Medical University.

Three patients, 52, 78, and 60 years old, respectively, were admitted because of small nodule with less than 3 cm was found in computed tomography between April 2018 and May 2018. All patients met the indication of pulmonary segmentectomy. The VATS procedures included: the lateral basal and posterior basal segments of right lower lung (S9 + 10), the apical, posterior and anterior segments of left upper lobe (S1 + 2 + 3), and the apical and posterior segment of left upper lobe (S1 + 2). All segmentectomies were done by single-direction thoracoscopic segmentectomy [4–6].

For ventilation, all the patients were excluded from tracheal and bronchial variation preoperatively. The highly selective independent segmental ventilation approach started at the time of intubation during general anaesthesia, marking a preset site. Two experienced anaesthesiologists performed the identification and visualization of the target segment. Following the management of segmental artery and vein, intersegmental plane identification is required. At the moment, the 5F Arndt pediatric endobronchial blocker (Cook Medical, Bloomington, USA) entered the preset site guiding by fiberoptic bronchoscopy (FOB) and inserted into the orifice of segmental bronchi of independent-ventilated pulmonary segment (Fig. 1 a-b). After reconfirmation by the light of FOB in VATS dark vision (Fig. 1c) and the endo-stapler was clamped at the targeted segmental bronchi, 100% oxygen flowed at 3-5L/min was ventilated by anaesthesiologist (Fig. 1d-f). The independent pulmonary segments were subsequently inflated without ventilation of remaining pulmonary lobe. After the triple confirmation and marking of intersegmental plane, the endo-stapler (Endo GIA™ 60 mm Articulating Medium/Thick Reload with Tri-Staple Technology Purple Cartridge, COVIDIEN Medical, USA) is then introduced and divided the segmental bronchi and the segmental border. The lymph node dissection was then performed.

Discussion And Conclusions

We successfully performed 3 segmentectomies with highly selective independent segmental ventilation. There is no ventilation associated complication after surgery, patients were discharged with uneventful recovery course. The technique of quick and accurate identification of the plane of the lung segment is of particularly importance in segmental resection. The conventional method of is inflation and deflation technique. The shortcoming of this method is the identification of the target bronchus highly depends on the subjective judgment of the surgeon and the waiting time for deflation is long. Other identification techniques for intersegmental plane were described in previous study. The technique of ultrafine fiber bronchoscopy with high-frequency bronchial ventilation (40 Hz, 2 kg / cm²) at target segment was purposed by Okada [7]. Misaki et.al. visualized intersegmental junction under infrared thoracoscopy when intravenously injection of indocyanine green (ICG; 3.0 mg / kg) is done after ligation of the target segmental artery. Oh et.al. reported a method of injection of ICG (25 mg dissolved in 50 mL of saline) at the distal peripheral bronchus after the target segment bronchus was controlled [2]. The disadvantages of this method are the use of specific special equipment or drugs.

Highly selective lung segment ventilation is an anesthesia-surgical technique that combines the proficiency of bronchoscope, ventilator and thoracoscopy under the close cooperation between the surgeon and the anaesthesiologist. The trinity of segmental bronchus identification by bronchoscope, bronchoscope light source under dark vision of VATS, and inflation of remaining segment not affecting other pulmonary lobe ensures the safety of precise resection of target lung segment. Compared with traditional ventilation, our highly selective independent segmental ventilation does not ventilate the remaining pulmonary lobe, avoiding waiting time for lung collapse and not blocking the surgical field. When compared with traditional bronchoscope-guided high-frequency ventilation, our endobronchial blocker was inserted into the orifice of remaining segmental bronchus, which can effectively prevent

potential damage to the endobronchial blocker, and the bronchoscope. The equipment in this technique is conventional consumables, no special video equipment or dye is required. Therefore, this technology can accurately and quickly locate the stereoborder of target lung segment, which is expected to shorten the operation time of the lung segment resection and improve efficiency of intersegmental plane identification.

To our knowledge, this is the first case series of pulmonary segmentectomy assisted by highly selective independent segmental ventilation. Because of the simplicity of this technique, we purposed that the universal use could be feasible for resection of pulmonary segments and the efficacy of this method should be estimated in a larger clinical trial.

List Of Abbreviations

FOB: fiberoptic bronchoscopy

ICG: indocyanine green

VATS: video-assisted thoracoscopic surgery

Declarations

Ethics approval and consent to participate

This ventilation technique was approved by the Institutional Review Board and the Ethics Committee of Nanfang Hospital, Southern Medical University. Written informed consent was obtained from the patients for publication of this technical procedure.

Consent for publication

Consent for publication was obtained from presented patients.

Availability of data and materials

All images supporting the technique of this article is included within the article. We could provide surgical videos with patients' consent.

Competing interests

We declare no competing interests.

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Authors' contributions

KC C and XS S suggested the method and drafted the manuscript. KC C, XS S, XG L, D L, Z N, H W performed the surgeries. J Y and JY C performed the anaesthesia procedures. XS S, JX Z and Z N contributed to editing and revising the manuscript. All authors read and approved the final manuscript.

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Refer to the Funding section.

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Figures

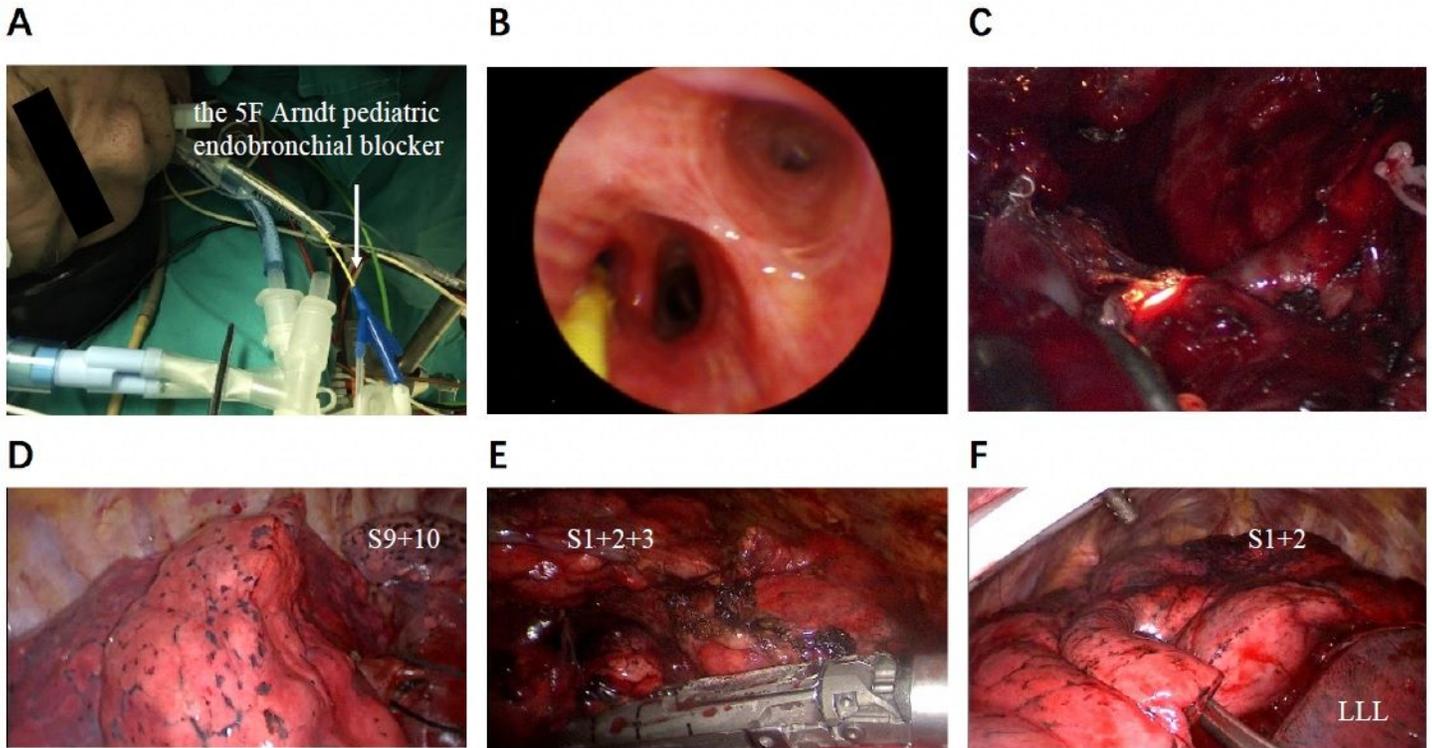


Figure 1

The illustration of lung segmentectomy assisted by using highly selective independent segmental ventilation. (a) The insertion of endobronchial blocker during general anesthesia. (b) Two experienced anesthesiologists performed the identification and visualization of the target segment. (c) the light of fiberoptic bronchoscopy at orifice of remaining pulmonary segment was visualized under VATS dark vision. The intersegmental plane was appeared slowly enough to easily visualize and to manipulate the stapler across targeted segmental border in case 1 (d), case 2 with sever pleural adhesions (e) and case 3 (f). The remaining segment was inflated but the remaining lobe was kept deflated.

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