

Lung: How To Do It

Identification of the Segmental Bronchus Using Indocyanine Green During Thoracoscopic Segmentectomy



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Pulmonary segmentectomy is an established surgical procedure for early-stage lung cancer and metastatic tumors. However, performing complex segmentectomies is challenging owing to the deep intraparenchymal localization of hilar structures and anatomic variations. Moreover, particular attention should be paid to avoid intraoperative bronchial misidentification. The surgeon can consider enhancing the precision of segmentectomy by marking the segmental bronchus preoperatively. Herein, we report a simple technique that employs indocyanine green to identify the segmental bronchus during pulmonary segmentectomy.

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Pulmonary segmentectomy is an established surgical procedure for early-stage lung cancer and metastatic tumors.^{1,2} Despite technologic advances in 3-dimensional computed tomography (3DCT), performing complex segmentectomies is challenging owing to the deep intraparenchymal localization of hilar structures and anatomic variations. Moreover, intraoperative misidentification of the segmental bronchus should be avoided. Herein, we report a simple technique using indocyanine green (ICG) to identify the segmental bronchus during pulmonary segmentectomy.

(Figure 1). The tip of the bronchoscope was positioned at the entrance of the target bronchus, and ICG was administered through a channel. The segmental bronchus was identified by ICG fluorescence during thoracoscopic operation (Figure 2). Subsequently, segmentectomy was performed by a vein-first method.³ The intersegmental planes were also identified by ICG fluorescence. The Video shows how we performed a standard segmentectomy (thoracoscopic right S2 segmentectomy) with segmental bronchial marking.

TECHNIQUE

Bronchial marking was performed with the patient in the right or left lateral decubitus position under general anesthesia, with single-lung ventilation using a double-lumen endotracheal tube. We performed bronchoscopy and identified the target segmental bronchus. ICG (0.25 mg/1 mL) and air (20 mL) were sprayed in the target bronchus

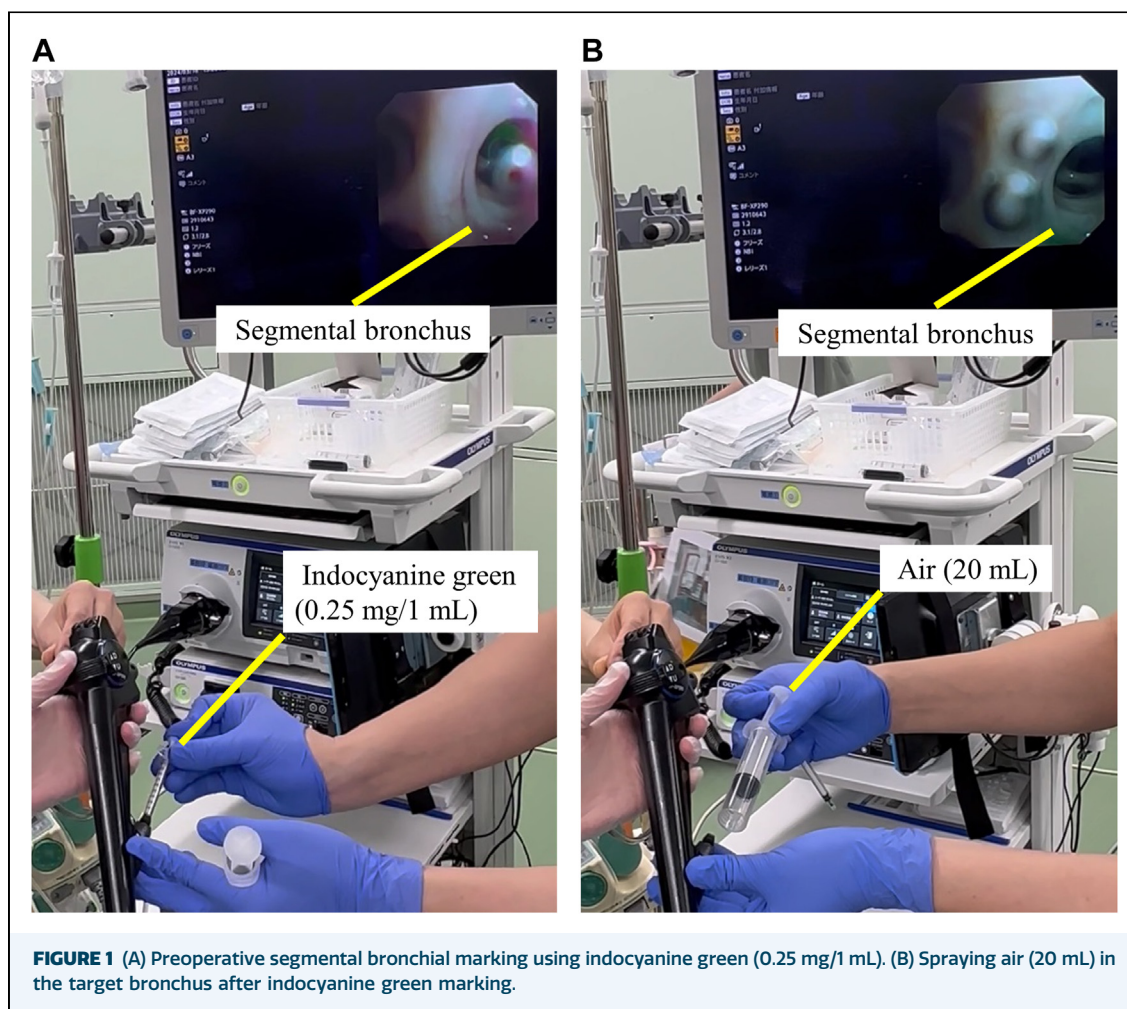
COMMENT

A novel technique for performing a segmentectomy after bronchial marking is presented. There were no bronchial marking errors in any case, and all patients completed the segmentectomy as planned. In this method, the time required for marking is minimal. Furthermore, this bronchial marking method did not interfere with the ICG fluorescence method for intersegmental identification.

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Although this is a simple method of spraying ICG on the target segmental bronchus, the ICG may flow to other bronchi if the injection volume is too large or because of the effects of preoperative positional changes. Therefore, a small amount of ICG should be injected into the target segmental bronchus after positional change and spread with air.

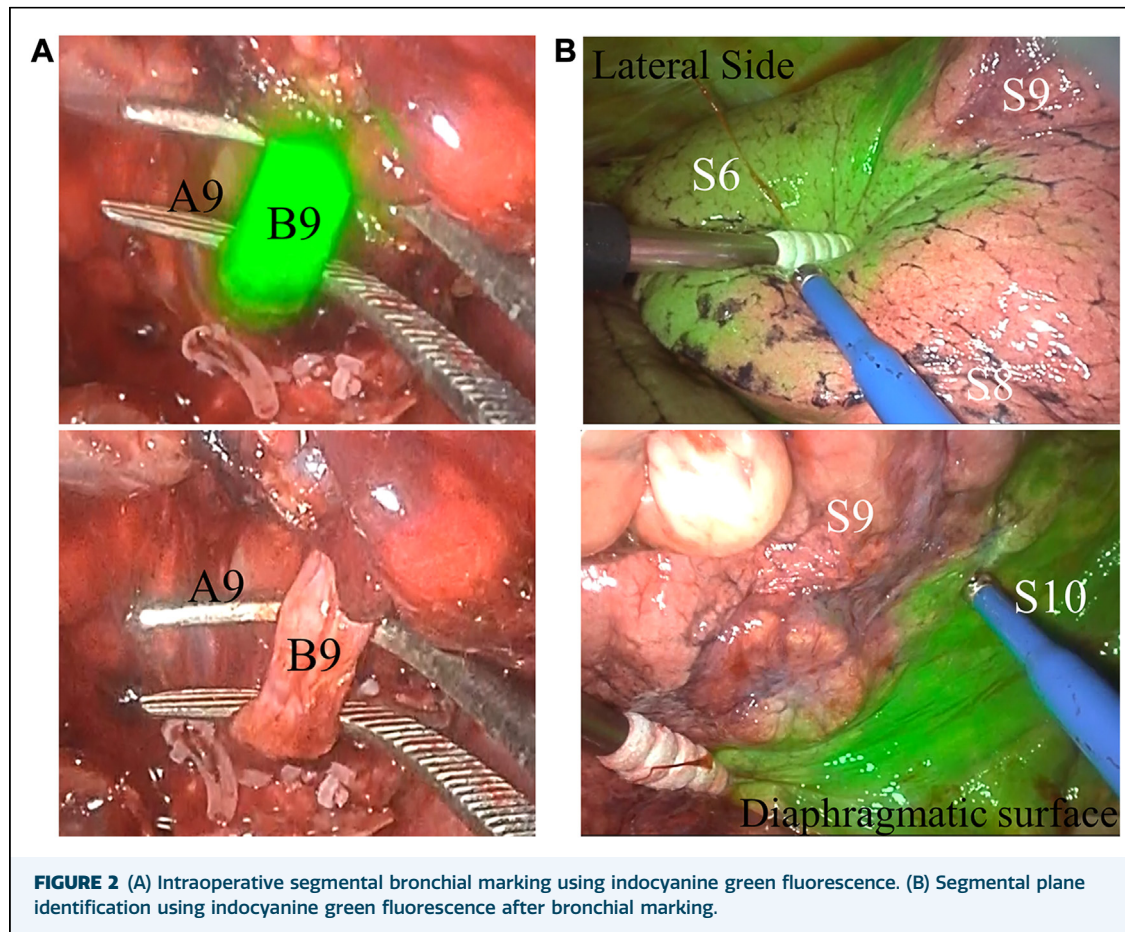
With the advancement of 3DCT, segmentectomy has become more prevalent and refined.^{2,3} Endobronchial marking for tumor localization^{4,5} is useful for wedge resection and securing sufficient margins. In contrast, we present the use of bronchial marking by ICG through a topical bronchoscopic technique.

Our findings suggest that bronchial marking can be a safely performed surgical procedure. In facilities lacking advanced imaging techniques, such as 3DCT, performing precise anatomic segmentectomy is critical owing to the heightened risk of misidentifying deep bronchi. Furthermore, intraoperative bronchoscopy may be difficult in facilities that do not have a team of anesthesiologists and respiratory physicians or in teaching institutions

that instruct residents. In such cases, pre-marking may eliminate the need for bronchoscopy.

We have applied this method for a simple segmentectomy, such as S6 segmentectomy or left division segmentectomy and lingular segmentectomy. Expert surgeons can perform a segmentectomy without segmental bronchial marking. For such surgeons, the need for this marking technique may be limited to cases of complex or difficult segmentectomy. However, we believe that surgeons unfamiliar with segmentectomy will find the marking technique useful for understanding the course and anatomy of the bronchus.

Our method may be useful for segmentectomy with significant intraoperative lung deployment or complex segmentectomies, such as S9 and S10 segmentectomy or subsegmentectomy. Furthermore, the low ICG dose ensured that the markings remained stable during intraoperative lung deployment and did not compromise the effectiveness of the fluorescence method for confirming the intersegmental plane.



The limitation of this method is that it requires accurate identification of the bronchial anatomy using a bronchoscope. Therefore, if the bronchoscope misidentifies the bronchial anatomy, the effectiveness of the marking would be lost.

Here, we present a novel method for intraoperative segmental bronchus identification using ICG, which may be useful in centers with inadequate 3DCT access and in cases of complex or difficult segmentectomy.

The Video can be viewed in the online version of this article [<https://doi.org/10.1016/j.atssr.2024.08.007>] on <http://www.annalsthoracicsurgery.org>.

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DISCLOSURES

The authors have no conflicts of interest to disclose.

PATIENT CONSENT

Obtained.

REFERENCES

1. Saji H, Okada M, Tsuboi M, et al. Segmentectomy versus lobectomy in small-sized peripheral non-small-cell lung cancer (JCOG0802/WJOG4607L): a multicentre, open-label, phase 3, randomised, controlled, non-inferiority trial. *Lancet*. 2022;399:1607–1617.
2. Takamori S, Oizumi H, Suzuki J, et al. Thoracoscopic anatomical individual basilar segmentectomy. *Eur J Cardiothorac Surg*. 2022;62:eza509.
3. Oizumi H, Sasage T, Takamori S, Suzuki J, Watanabe H, Kato H. Vein-first strategy for thoracoscopic lung segmentectomy under use of three-dimensional reconstruction of computed tomography. *Curr Chall Thorac Surg*. 2024;6:1.
4. Sekine Y, Itoh T, Toyoda T, et al. Precise anatomical sublobar resection using a 3D medical image analyzer and fluorescence-guided surgery with transbronchial instillation of indocyanine green. *Semin Thorac Cardiovasc Surg*. 2019;31:595–602.
5. Sato M, Murayama T, Nakajima J. Techniques of stapler-based navigational thoracoscopic segmentectomy using virtual assisted lung mapping (VAL-MAP). *J Thorac Dis*. 2016;8:S716–S730.