

Identifying interlobar fissure in a Craig grade 4 fissureless patient by near-infrared thoracoscopy

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Abstract: Traditionally, surgeons can only count on their naked eyes to identify the fissure in patients with incomplete fissures, which often cause surgical approach into the fissural parenchyma and may lead to postoperative prolonged air leak (PAL). We describe a novel technique using near-infrared (NIR) thoracoscopy with indocyanine green (ICG) to identify the fissure accurately and real-time for the first time in a patient with totally fused oblique fissure (Craig grade 4).

Keywords: Lobectomy; incomplete fissure; near-infrared (NIR)

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Introduction

In East Asia, fused fissures are not uncommon. Incomplete fissures often cause surgical approach into the fissural parenchyma, which may lead to postoperative prolonged air leak (PAL) (1). Meanwhile, as the development of the thulium laser, some surgeons performed dissection of incomplete interlobar fissure using thulium (2). Thus, the accurate identification of the interlobar fissure is more demanding. However, there is no appropriate method to identify the interlobar fissure accurately beyond surgeons' naked eyes. We report the use of near-infrared (NIR) thoracoscopy with indocyanine green (ICG) to identify interlobar fissure in a patient undergoing video-assisted thoracoscopic surgery (VATS) lobectomy with totally fused fissure (grade 4 according to Craig's classification) (3). To our knowledge, this is the first report of such surgical techniques.

Case presentation

A 39-year-old female was admitted to our department with a chief complaint of expectoration for 3 years and exacerbation for 1 month. She was diagnosed with bronchiectasis of left lower lobe by high-resolution

computed tomography. After routine radiology and laboratory tests to rule out surgery contraindications, VATS left lower lobectomy was scheduled.

After general anesthesia, routine VATS procedures were performed. After single lung ventilation, thoracoscopic explorations revealed that the oblique fissure of the left lung was totally fused and hard to identify (*Figure 1A*). The inferior pulmonary ligament was exposed and dissected up to the inferior pulmonary vein using an electric hook. The inferior pulmonary vein was cut by a stapler after careful dissection.

ICG is a tricarboyanine fluorescent dye and has been approved by the Chinese Food and Drug Administration. The D-light P[®] NIR thoracoscopy (KARL STORZ GmbH & Co, Germany), was used for intraoperative conventional imaging and real-time fluorescence imaging. It has three modes, including a "white light mode" for white imaging, a normal NIR mode ("standard mode") and an enhanced NIR mode ("spectra A mode"). All surgical procedures were performed with fast switching between "white light mode" and "spectra A mode" by depressing a foot pedal. The use of NIR with ICG was approved by the Institutional Review Board of Peking University People's Hospital (IRB No. 2015PHB157-01) and registered at ClinicalTrials.gov (ID:

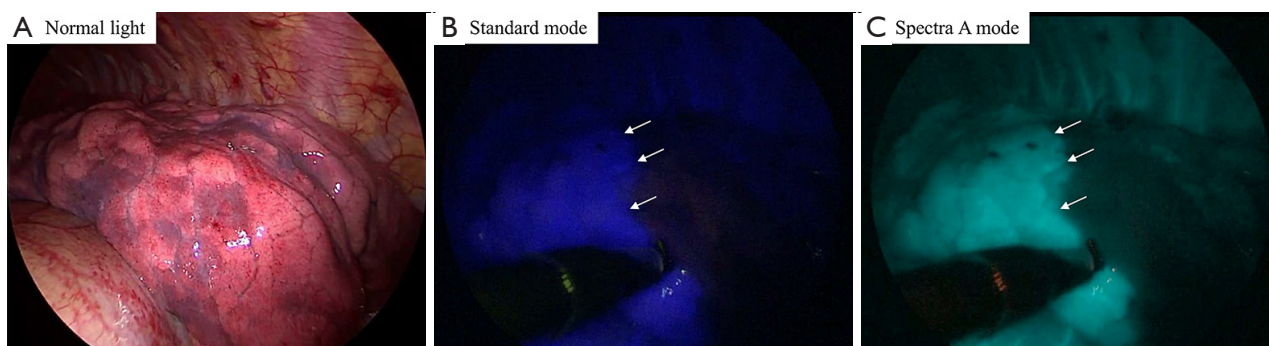


Figure 1 The fused fissure was accurately identified by NIR thoracoscopy. (A) The fused fissure under normal light; (B) after ICG was injected, the oblique fissure was accurately identified under “standard mode”, and (C) “spectra A mode”. ICG, indocyanine green; NIR, near-infrared.

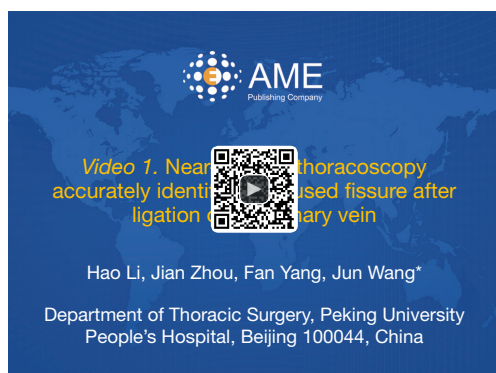


Figure 2 Near-infrared thoracoscopy accurately identified the fused fissure after ligation of pulmonary vein (4).

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NCT02611245). Written informed consent was signed by the patient before surgery.

In order to identify the oblique fissure, 0.4 mg/kg ICG was injected rapidly through the peripheral venous catheter. The D-light P[®] NIR thoracoscopy, was used to detect NIR fluorescent signal. The left upper lobe was fluorescent about eight seconds after ICG injection, while the lower lobe remained dark under “standard mode” (Figure 1B) and “spectra A mode” (Figures 1C,2). The interlobar border lasted visible for at least 80 seconds. Under “spectra A mode”, the fissure was marked on the visceral pleura with an electrocautery. After the lower lobe bronchus and pulmonary artery were dissected and cut off by staples, the oblique fissure was divided by staples following the cautery markings.

The patient had no allergic symptoms, liver damage or other discomfort after surgery. The postoperative period was uneventful without air leaking. The chest tube was

removed on the third postoperative day. Then the patient was discharged the next day with no readmission.

Discussion

Incomplete fissure or fissureless cases are frequently encountered during VATS lobectomy. Various techniques were developed to solve the problem (5). For all the techniques, it is crucial to identify the interlobar fissure when dissecting incomplete fissure especially in patients with totally fused fissure. Meanwhile, with the application of Thulium laser in lobectomy surgeries, the need for accurate identification of interlobar fissure is more demanding. Traditionally, surgeons can only count on their naked eyes to identify the fissure. In this article, a novel technique using ICG and NIR thoracoscopy to identify interlobar fissure was introduced for the first time.

ICG binds rapidly to serum protein once injected into blood vessels, and is distributed throughout the body with blood flow. In order to get the fluorescence imaging, we illuminate the tissue of interest with light at the excitation wavelength (about 750 to 800 nm) while observing it at longer emission wavelengths (over 800 nm) (6).

The initial application of ICG is to evaluate liver function and cardiac output. However, its utilization in thoracic surgery is still preliminary for the detection system is developed into clinical size only recently. Some reports have applied NIR thoracoscopy with ICG to identify the intersegmental lines in VATS segmentectomy (7).

In this case, the upper lobe was fluorescent after the intravenous injection of ICG, while the lower lobe remained dark because no blood entered the lower lobe obviously after the inferior pulmonary vein was cut off. It is well known that the pulmonary circulation system is a low-

pressure system compared with the systemic circulation. The venous blood would remain in the left lower lobar tissue after the inferior pulmonary vein was blocked, which could consequently increase the intravascular pressure in the left lower lobar tissue to a level higher than the pulmonary artery pressure. Thus, the pulmonary arterial blood may not be able to enter the left lower lobe for a short time after the inferior pulmonary vein is blocked. Traditional theory is that blood will still go into the lobe due to the arteries' high pressure. Our practice showed firstly the opposite. We did not notice obvious lung congestion of the left lower lobe, maybe because the observation time only last a few minutes. This novel approach suggests that thoracic surgeons could close the pulmonary veins prior to ligating the pulmonary arteries without worrying lung congestion at least for a short time, which meets the operative principle of malignant tumors. However, the lung congestion maybe unavoidable according to time course after the ligation of pulmonary veins, which would occupy the chest space and increase the difficulty of VATS lobectomy.

This novel technique had its unique advantages. Previous reports using NIR thoracoscopy to identify the intersegmental lines were mainly ICG injection after ligation of pulmonary segmental arteries (7). However, pulmonary arteries were much more difficult to dissect than pulmonary veins in patients with incomplete fissure. The method used in our case only needed to ligate the pulmonary vein and inject ICG through the peripheral venous catheter. This technique may effectively facilitate the intraoperative identification of interlobar fissures, shorten surgical time for VATS lobectomy, and reduce the risk for lobectomy-associated PAL. Future studies are required to further validate the technique.

Conclusions

In summary, we reported a novel and convenient technique to identify interlobar fissure and facilitate fissure dissection in patients with fissureless fissure using NIR thoracoscopy with ICG after ligation of pulmonary vein for the first time. However, a larger clinical study is needed to validate this new method in the future.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

Informed Consent: Written informed consent was obtained from the patient for publication of this manuscript and any accompanying images.

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