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Commentary: "I can see clearly now!" Indocyanine green virtual-assisted lung mapping (ICG-VAL-MAP) and the future identification of small lung nodules

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CENTRAL MESSAGE

In this study by Tokuno and colleagues, ICG-VAL-MAP was found to offer improved pre- and intraoperative identification of small lung nodules compared with VAL-MAP.

Recent expansions in lung cancer screening eligibility criteria[1] as well as the increasing adoption of lung cancer screening using low-dose computed tomography (CT)[2] have likely resulted in a growing number of early-stage lung cancers being identified. For most patients diagnosed with early-stage non–small cell lung cancer (NSCLC), surgical resection offers the best chance at a cure. However, difficulty identifying small, often nonpalpable, lung nodules during thoracic surgery remains a significant challenge and has been shown to result in increased rates of conversion from thoracoscopic to open operations.[3]

In recent years, several methods have been evaluated as a way to improve the intraoperative identification of lung nodules.[4] These methods use different techniques to mark lung nodules so that surgeons can easily identify them pre- and intraoperatively. Two common methods that have previously been evaluated include techniques incorporating CT-guided percutaneous markings and virtual-assisted lung mapping (VAL-MAP).[5] CT-guided percutaneous markings use CT guidance to place hook wires or microcoils at the site of the nodule preoperatively. This method can be associated with complications such as bleeding, dislodgement of markings, and air embolization.[6] In addition, due to anatomical limitations, CT-guided percutaneous markings cannot be used to mark tumors located in the lung apices.[6] Although VAL-MAP is a bronchoscopic dye-marking technique that is associated with fewer complications, there are several important limitations, including difficulty in identifying the dye on CT images and the surface of the lung during resection.[6]

In this issue of the *Journal*, Tokuno and colleagues[7] aimed to improve upon VAL-MAP by using CT contrast and indocyanine green dye. Tokuno and colleagues evaluated 147 patients undergoing thoracoscopic lung resection for tumors a median of 8 mm in size using indocyanine green (ICG)-VAL-MAP from 2017 to 2020. After marking tumors preoperatively, the authors assessed the visibility of lung tumors on a CT scan and intraoperatively. Visibility was classified as easy, faint, or not identifiable. These results were then compared with the results of a historical control trial of 63 patients who underwent VAL-MAP followed by lung resection. Interestingly, in the present study, surgeons easily identified 100% of ICG-VAL-MAP markings on a CT scan. This was significantly greater than the 77% of VAL-MAP markings easily identified by surgeons on a CT scan in the historical control ($P < .0001$). In addition, during surgery, surgeons reported being able to easily identify 99% of ICG-VAL-MAP markings, compared with only 77% of VAL-MAP markings easily identified in the historical control ($P < .0001$). Of note, in the ICG-VAL-MAP group, the R0 resection rate was 100%. These findings suggest that ICG-VAL-MAP may offer improved

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identification of small lung nodules when compared with VAL-MAP.

This study is a welcome addition to the literature and should advance existing techniques of nodule localization. The study has limitations, as the authors have appropriately acknowledged. Because the study used a historical control of patients who underwent VAL-MAP in a previous trial, there are potential confounders that could not be evaluated. For example, differences in surgeon expertise and technical difficulty of the surgery between patients who underwent ICG-VAL-MAP and VAL-MAP could not be evaluated. In addition, several key outcomes, including the extent of dye spread beyond the tumor site in the lung, length of operation, rate of thoracoscopic to open conversion, and margin distance, were not assessed in this study.

Importantly, the authors should be congratulated for the novelty and innovation of the ICG-VAL-MAP technique assessed in this study. The promising results of ICG-VAL-MAP reported in this study certainly warrant further investigation. Future studies should evaluate the extent of dye spread beyond the tumor site in the lung, length of operation, rate of thoracoscopic to open conversion, and margin distance among patients who undergo ICG-VAL-MAP. In addition, future studies should prioritize identifying groups of surgeons (eg, less experienced vs more experienced, general surgeons performing thoracic surgery vs thoracic surgeons) who would benefit most from using this technology.

With an increasing number of patients diagnosed with early-stage NSCLC, the need for tools to aid in the identification of small lung nodules is likely increasing. The present study demonstrates the promising results of ICG-VAL-MAP as a novel method to easily and accurately identify small lung nodules. Although further research is needed to confirm the accuracy of ICG-VAL-MAP as well as identify groups of surgeons who would benefit most from the technology, the findings of the present study suggest that ICG-VAL-MAP may greatly improve the intraoperative identification of lung nodules, potentially leading to improved intraoperative and oncologic outcomes for patients diagnosed with early-stage NSCLC.

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