Case Report
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# Intra-operative detection of a small lung nodule using methylene blue-is it time to revisit this technique?

## Abstract

**Background:** Small lung nodules are difficult to localize on pre-operative imaging. Methylene blue has been previously reported as a safe and cost effective method for localization. Our case report describes this method to localize a small lesion prior to surgical resection.

**Case report**: A 42 year old woman with an incidentally discovered 4mm right upper lung nodule was injected with methylene blue using CT guidance under local anesthesia. The lung nodule was visualized intra-operatively and resected by video-assisted thorascopic surgery. Final pathology demonstrated an atypical adenomatous hyperplasia.

**Discussion:** Previous studies demonstrated that methylene blue can safely localize lung nodules. This study was described the successful use of this technique for a small lung nodule.

**Conclusions**: Methylene blue contrast injection using CT guidance localizes small lung nodules with a minimum size of 4mm prior to resection. Future larger studies are needed to delineate this procedure for small lung nodules.

**Keywords:** lung nodule, methylene blue, localization, thoracic surgery, pulmonary

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**Abbreviations:** VATS, video assisted thorascopic surgery; EBUS, endobronchial ultrasound; CT, computed tomography

## Background

Small lung nodules are difficult to localize on pre-operative imaging. With the increasing use of CT scans, there has been a consequential increase in the incidental discovery of pulmonary nodules.[1] Approximately 40% of these nodules are malignant, thus necessitating their removal for appropriate diagnosis and staging.[2,3] When video assisted thorascopic surgery (VATS) was first introduced over 20 years ago, the conversion rate to open thoracotomy due to an inability to localize. Consequently, numerous techniques have been proposed to help detect pulmonary nodules prior to surgery. Methylene blue has been previously reported as a safe and cost effective method to detect pulmonary lesions intra-operatively prior to VATS.[1,3–7] This technique is highly effective for small pulmonary nodules that are deep in the parenchyma in the lung, which would be difficult to identify intra-operatively. Time from labeling to surgery is recommended within 3 hours.[1] Minor complications commonly associated with this method include pneumothorax, pleuritic pain, and coughing.[1] While other techniques including navigational bronchoscopy and radial endobronchial ultrasound (EBUS) have been reported, these procedures remain expensive and not readily available in most hospitals.[8–10] In addition, the patient must be placed under anesthesia, which can predispose to an increased risk of complications. Given the increasing number of lung nodules, it is important to be aware of methods available to localize these lesions intra-operatively. Previous experience with methylene blue staining of pulmonary lesions has reported successful localization for lesions as small as 4mm. This case report describes this method to localize a small lesion measuring 4 mm prior to surgical resection.

## Case report

A 42 year old woman with past medical history of hepatocellular carcinoma was found to have an incidental right upper lobe lesion on CT scan during a work up for a liver transplant (Figure 1). CT of the chest scan revealed a 4mm nodule (Figure 1). The remainder of her work up was not significant for any additional findings. Several hours prior to her planned surgical resection, the patient's lung nodule was injected with methylene blue under CT guidance. The procedure was performed under local anesthesia. A 22 gauge Chiba needle was advanced percutaneously in the mid axillary line into the right upper lobe. A CT scan was then performed to confirm position of the needle revealing a small pneumothorax and the tip of the needle approximately 1 cm anterior and a half centimeter superior to the nodule. A solution containing a mixture of 0.7mL of Isosulfan blue and 0.3 mL non ionic contrast (Visipaque 320) was drawn into a 1 mL syringe. The inner stylet of the Chiba needle was removed and the syringe was attached to the hub. Approximately 0.6 mL of the solution was injected while gradually retracting the needle. A post-procedural CT scan revealed ionic contrast adjacent to the nodule with extension to the pleural surface (Figure 2). The patient was immediately transferred from the CT suite to the operating room. She was taken to the operating room for a video-assisted thorascopic surgery (VATS). Intra-operatively, the right upper lung nodule was clearly stained with the methylene blue making its identification easy during surgery (Figure 3A). The area of concern was resected with an endostapler and sent for permanent pathology (Figure 3B). The patient was admitted overnight and was

discharged home the next day without any issues. At her three month follow up visit, she continues to progress well without any issues. Final pathology of the nodule demonstrated an atypical adenomatous hyperplasia.

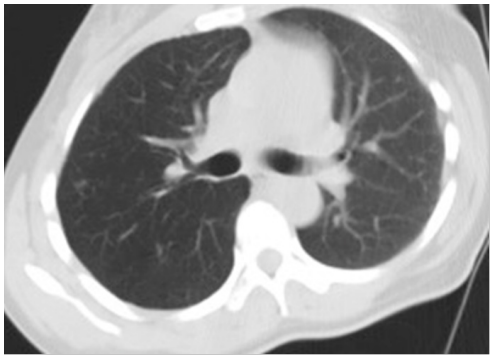
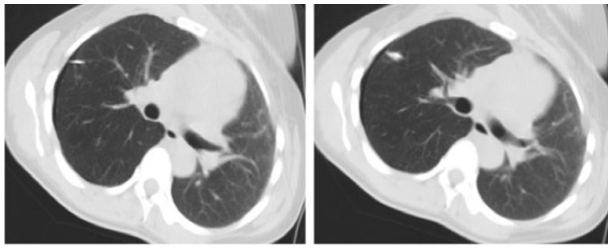
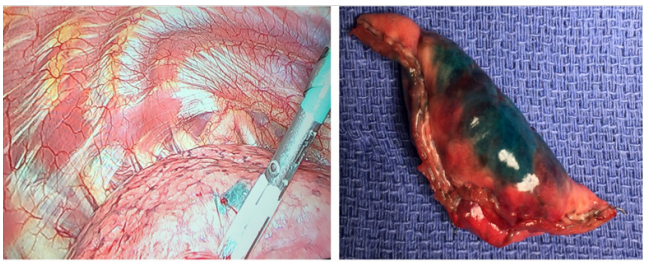


**Figure 1** Pre-operative CT chest/thorax of a 42 year old patient with a right upper lung nodule.



A. B.

**Figure 2** CT chest/thorax of before (A) and after (B) injection with methylene blue to localize a right upper lung nodule.



A. B.

**Figure 3** A. Intra-operative image of video-assisted thoracopic surgery of a 42 year old woman with a right upper lung nodule injected with methylene blue under CT guidance. B. Magnified view of 1.5 cm resected lung tissue containing a 4 mm nodule demonstrating the methylene blue stain.

## Discussion

Small lung nodules are difficult to localize for surgical resection thus making thorascopic resection challenging. Multiple strategies for localization prior to surgery have been proposed to help localize these nodules. Previous studies have demonstrated that methylene blue can be used to localize small lung nodules making their detection easier during operative intervention.[1,3–7] A literature review of these studies is presented in Table 1. Only one additional study described the successful use of this technique for a small lung nodule measuring 4mm. This technique can be a cost-effective, easy method to detect small lung nodules prior to surgery. The procedure can be performed under local anesthesia, which poses minimal risk to the patient. Identification of the nodule prior to surgery avoids putting the patient through a longer procedure under general anesthesia. In addition, this technique circumvents the need to send numerous frozen samples and the wait time for the results to determine if the lesion has been resected. Other techniques for pre-operative identification of lung nodules have been proposed including endobronchial ultrasound and navigational ultrasound.[8–10] However, the increased costs may make widespread application of this particular technique difficult. Additionally, these procedures often require the patient to undergo monitored anesthesia care or general anesthesia, which increases the risk of potential anesthesia complications. In conclusion, methylene blue contrast injection using CT guidance can be used to localize small lung nodules ≤4mm prior to resection. Given rising healthcare costs coupled with the increasing diagnosis of incidental lung nodules, it remains imperative to revisit this safe and effective technique. Results from this study could help to expand this localization technique to small lung nodules. Further studies are needed to further demonstrate the widespread applicability of this technique in a larger population.

**Table 1** Previous studies reporting the use of methylene blue to localize pulmonary nodules

| Study | No. patients | Nodule size (mm) | Complications |
|---|---|---|---|
| Lenglinger et al[4] | 15 | Aug-33 | Pneumothorax (n=5); pleuritic pain (n=1) |
| | 44 | NR | Pneumothorax (n=7); pulmonary hemorrhage (n=5); coughing (n=2) |
| Wicky et al[6] | | | |
| Vandoni et al[1] | 51 | 25 | Pneumothorax (n=13) |
| Stephenson et al[7] | 30 | Apr-18 | Pneumothorax (n=2), pleuritic pain (n=1) |

NR=not reported

## Conclusion

Methylene blue contrast injection using CT guidance localizes small lung nodules with a minimum size of 4mm prior to resection. Future larger studies are needed to delineate this procedure for small lung nodules.

## Acknowledgments

None.

## Conflicts of interest

None of the authors declares conflicts of interest.

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None.

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