Navigating the lung for hidden treasure

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Small right upper lobe mixed attenuation lung nodule. The lesion was an adenocarcinoma.

Central Message

Small lung nodules are hard to find and resect at VATS exploration. This technique is one of many that facilitates a complete resection.

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Small incidentally discovered lung nodules that might be cancer are an increasingly frequent dilemma for thoracic surgeons. Ground-glass lesions add an element of complexity because they are often difficult to palpate at the time of video-assisted thoracic surgery (VATS) exploration. The conversion of lung resection from an open thoracotomy to VATS eliminates the possibility of careful 2-finger palpation of the lung to search for small lung nodules. Numerous adjunctive techniques have been described to facilitate resection of these small lung nodules, including the percutaneous placement with computed tomography (CT) guidance of a hook wire, fiducials, coils, dyes, gelatin, intraoperative ultrasound, and radioactive tracers.¹⁻⁵ Most of these techniques also can be performed with navigation-guided bronchoscopy. Even when these small lesions are localized, it is imperative for the thoracic surgeon to design a resection strategy to facilitate a complete resection of the lesion with adequate margins. As the authors suggest, there remains uncertainty about the definition of an adequate margin, but a commonly accepted one is 1 to 2 cm or more than twice the diameter of the lesion. This of course does not take into account the histology of the lesion where, for example, a pure lepidic adenocarcinoma likely needs a lessor margin. The thoughtful thoracic surgeon weighs several factors in formulating an operative plan for a patient with a small lung nodule. The size, solid versus ground glass, depth, and location in the lung lobe all are important factors. Subpleural lesions, even ground-glass ones, can always be located and readily removed without preoperative marking. Port placement is important for small nodules, both for easy palpation of the lesion and for placement of the stapler to resect the lesion without undue torqueing on the port site. Most solid nodules 1 cm or less in depth can be readily found and removed. Ground-glass lesions with higher attenuation also usually can be found within 1 cm of the visceral pleura. Deep lesions (≥ 2 cm) are always problematic. The location within the lobe (not mentioned in this study) is important because lesions close to an acute angle of the lung (ie, the tip of the superior

segment of the lower lobe, the apex of the upper lobe, the acute angle of the diaphragmatic edge of the lower lobe) are easier to find and completely resect. Deep nodules along the broad surface of the lobe are harder to resect with adequate margins. Deep nodules often require an extended segmentectomy to obtain adequate margins as the segmental margins narrow centrally limiting margin width.

With these considerations in mind, Dr Sato and colleagues⁶ report a multicenter trial of virtual-assisted lung mapping of 203 nodules in 153 patients. Ground-glass lesions accounted for 36% of patients. Patients underwent bronchoscopic localization based on a preoperative CT scan (virtual bronchoscopy), which allowed them to target selected peripheral bronchi close to the lesion. A small amount of indigo carmine dye was injected to guide the resection. This could be done on the day of the resection or 1 to 2 days beforehand. Wedge resection was performed in 71% of patients, and segmentectomy was performed in 28% of patients. The mean size of the nodule was 9.6 mm, and the mean depth was 10.4 mm. Successful resection was defined as a resection margin greater than the lesion diameter or greater than 2 cm. The predetermined study goal was achievement of a successful resection in 95% of patients. The lesion was successfully resected in 89% of patients when the lesion depth was less than 2 cm. Multivariable analysis indicated that the depth of the necessary resection margin was the most important factor predicting a successful resection. Poor dye marking was noted in 14% of patients, and the most common reasons

cited were central lesion location, anthracotic lung, and emphysema. Almost all resections were performed with VATS (98%). Surgeons judged 54% of lesions not removable without the aid of virtual-assisted lung mapping.

How might thoracic surgeons incorporate this study in their pursuit of complete resection of small lung nodules? Depending on local resources and expertise, this technique seems worthy of further explorations and refinement. Navigational bronchoscopy is not uniformly practiced and in some institutions lies outside the realm of thoracic surgery and is performed by interventional pulmonologists. Thus partnership with an interventional pulmonologist might be necessary in some institutions. Local expertise and institutional results with other localization modalities will likely continue to shape a thoracic surgeon's localization paradigm. I think this is likely to be a short-lived problem as robotic surgery matures. I envision a smart robot incorporating the preoperative CT in its prescription for a resection

plan that has inputs of port placement and anatomic landmarks of the deflated lung to facilitate a complete resection.

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