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How-to-do-it

Percutaneous localisation of pulmonary nodules prior to video-assisted thoracoscopic surgery using methylene blue and TC-99

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Abstract

The widespread use of computed tomography (CT) scans for evaluating patients has resulted in the detection of many small solitary pulmonary nodules of uncertain significance. Workup of these nodules can be expensive and emotionally draining, especially in patients who have an established diagnosis of malignancy. Since the early 1990s, video-assisted thoracoscopic surgery (VATS) has become a procedure of choice in the workup and therapy of small lung lesions. Many different techniques have been described that would assist surgeons in localising small non-descript lesions in the lung during VATS. Most commonly, a single agent or mechanical device has been used for tumour localisation. We have modified the existing pre-VATS localisation techniques, evolving from one single agent with single spot injection to a dual-agent approach. In this approach, each agent is injected at two different locations. This technique provides us with a more precise 'linear projection' to the lesion of interest rather than the vague 'field localisation' provided by a single agent with a single spot injection. This modified dual agent's preoperative localisation is logical, practical and easy to be adopted into the clinical setting for surgeons who choose to use the VATS technique in addressing these lung nodules.

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1. Introduction

The widespread use of computed tomography (CT) scans has resulted in the detection of many small pulmonary nodules of uncertain significance [1,2]. Workup of these nodules can be expensive and emotionally draining, especially in patients with an established history of malignancy. To determine if these masses represent recurrence, additional imaging studies are often used, such as a positron emission tomography (PET) scan, ¹¹¹In-OctreoScan or ¹²³I-MIBG scans. Even with scans, tumour marker measurements, or more invasive methods such as a CT-guided fine-needle aspiration (FNA), the nature of these lesions may remain unclear.

The method for working up these lesions remains controversial and needs to be individualised. Since 1990, video-assisted thoracoscopic surgery (VATS) has become the choice in the workup of these small lung lesions. VATS can be diagnostic and therapeutic, and it can prevent the potential sampling error inherent with an FNA. Because of the small size and often sub-pleural position of these nodules,

preoperative or intra-operative tumour localisation is essential for the success of VATS.

Preoperative localisation techniques include using microvascular embolisation coils with and without a suture attached [1], hook wire insertion [2–5], injection of dye, radiographic contrast media, radioactive peptide [4] and other nucleotides [6]. Each technique has its merits and its drawbacks; some are associated with serious complications while others are time consuming. These limitations mandate the development of novel approaches for preoperative localisation. We developed a new technique using a combination of blue-dye and ^{99m}Tc sulphur colloid. We applied this technique in three patients and found that it provided a quick, safe and effective VATS.

2. Technique

Preoperative injections were conducted under CT guidance using methylene blue and ^{99m}Tc rather than either agent alone. We injected the ^{99m}Tc in two spots, one in the subcutaneous fat directly in line with the target and the second inside or just past the lesion. Methylene blue injections were also deposited at two locations along a tract

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directly in line with the lesion, one along and/or between ribs on the parietal pleura and the other directly onto or just inside the lesion. The patient was then transferred to the operation room (OR) for VATS. We routinely used the gamma probe *ex vivo* to confirm the successful removal of the targeted lesion(s). The probe can be used to assist in the detection and localisation of the lesion(s) *in vivo* as needed. Intra-operative palpation and frozen section can be adjuvant to establish/confirm the diagnosis and assure the complete resection of lesion(s).

3. Case report

The patient is a 69-year-old black woman who underwent a colon resection for a stage III colon cancer in January 2006. Subsequently, she developed two metachronous liver metastases; both were successfully resected. Unfortunately, on a recent follow-up visit, a solitary pulmonary nodule in her left chest and a moderate elevation of carcinoembryonic antigen (CEA) level were noted. With multiple distant recurrences in a relatively short interval, the natural history of her disease dictated the least invasive approach to address the lung lesion. She underwent preoperative tumour localisation and then an uneventful VATS. The total operative time was only 22 min due to the accuracy of the preoperative localisation. She was discharged on postoperative day 2. The final pathology confirmed the diagnosis of metastatic cancer with clear margin. Her CEA returned to normal and, at her 6-month follow-up visit, she had no evidence of recurrent disease.

4. Discussion

Various pre-VATS localisation techniques have been reported. The most common mechanical device enabled localisation method is a CT-guided insertion of a hook wire. This technique has been associated with the development of haemo-pneumothorax. The wires can be dislodged with motions and even lead to a massive air embolism [7]. The most often used tattooing agent, namely methylene blue, can diffuse quickly to the uninvolved pleural surface and make localisation difficult. Furthermore, almost all reported techniques use a single agent deployed at one location within the lung, which helps the surgeon localise the area of potential target, but falls short of determining the exact location of the nodule.

Our dual-agent injection technique provides several distinct advantages over reported single-agent techniques. By injecting both the parietal and visceral pleurae, it makes it easier for surgeons to visualise the tattoo over the lesion of interest. The diffusion of blue-dye on the parietal pleura is slower and less extensive due the confinement of ribs. Should the visceral pleural tattoo develop a wide diffusion zone due to delay in conducting VATS, the location of the original tattooing can still be easily identified with a sample manoeuvre. By inflating and deflating the lung, the mirror images of the kissing tattoos on both pleurae can easily be appreciated, further assuring the surgeon of the exact location of the lesion. Furthermore, the ^{99m}Tc subcutaneous injection can precisely point to the exact location of original parietal pleural marking before diffusion occurred. Finally, should any doubt remain, the gamma probe can be brought into the chest through the direct 'linear projecting' tract created by both agents to locate the lesion *in vivo*.

In summary, this modified dual-agent preoperative localisation is logical, practical and can easily be adopted into practice. It provides excellent 'linear projection' localisation and thus makes VATS quick, safe and efficient.

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