Fluoroscopy-guided barium marking for localizing small pulmonary lesions before video-assisted thoracic surgery

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Summary Purpose: To evaluate the effectiveness of fluoroscopy-guided barium marking for localization of small peripheral pulmonary lesions before video-assisted thoracic surgery (VATS) resection.

Material & methods: Twenty-one patients with peripheral pulmonary lesions 15 mm or less in diameter who were scheduled to undergo VATS resection were studied. A catheter was inserted bronchoscopically into the target segment and guided to a presumed lesion. The tip of the catheter was confirmed fluoroscopically to be at the exact spot determined beforehand. A 50% (weight/volume) barium sulfate suspension was instilled into the bronchus through the catheter, and the site of barium marking was ascertained by CT scanning.

Results: The average instilled volume of barium was 0.42 ± 0.07 ml. On CT scans, barium spots were superimposed on the target lesions in 19 of the 21 patients and were only 6–7 mm from the lesions in the other 2. Barium was well preserved in all patients at the time of VATS resection. A mild cough persisted for about 1 week in one patient, but the other patients had no specific complications.

Conclusion: Fluoroscopy-guided barium marking is a safe, convenient, and reliable method for localization of small pulmonary lesions before VATS resection.

Introduction

As we enter the era of CT screening for lung cancer, small pulmonary lesions not seen on chest
radiographs will most likely be detected with increasing frequency.\(^1\)–\(^3\) Such lesions are difficult to diagnose by conventional techniques such as transbronchial or percutaneous biopsy. Recently, video-assisted thoracic surgery (VATS) resection has been used to treat small pulmonary lesions.\(^4\)–\(^6\) Accurate resection by VATS requires techniques that can pinpoint the location of lesions. Several such techniques including lipiodol injection,\(^7\) wire-hook localization,\(^8\)–\(^12\) pleural marking by dye,\(^13\)–\(^16\) and coil marking,\(^17\) have been developed. All reported methods use CT scanning for guidance, and many are done percutaneously. Procedures performed under CT guidance are cumbersome and require a CT room; percutaneous approaches may cause such complications as pneumothorax, bleeding, and embolism.\(^18\),\(^19\)

This study examined the reliability, safety, and convenience of fluoroscopy-guided barium marking via a transbronchial approach for the localization of small pulmonary nodules not seen on the pleural surface.

### Material and methods

To be eligible, patients had to have peripheral pulmonary lesions 15 mm or less in diameter that were scheduled to undergo wedge resection by VATS and were difficult to identify thoracoscopically. All patients gave informed consent.

This prospective study consecutively enrolled 21 patients from January 2000 through December 2003. There were 11 men and 10 women aged 38–77 years. None of the lesions studied could be detected on chest X-ray films, even retrospectively. The average diameter of the lesions was 10.7 ± 0.7 mm, and the average distance from the pleural surface was 9.4 ± 1.1 mm. Eight lesions were located in the right upper lobe, 2 in the right middle lobe, 6 in the right lower lobe, 4 in the left upper lobe, and 1 in the left lower lobe (Table 1).

The optimal site for the catheter tip was decided on chest radiographs, using CT scans for reference (Fig. 1). Under bronchoscopic guidance, a catheter was inserted into the target segment and guided to a presumed lesion. The catheter tip was checked frontally and laterally by fluoroscopic examination to confirm that it was located on the exact spot designated beforehand. A 50% (weight/volume) barium sulfate suspension was instilled into the bronchus through the catheter, and the site of barium marking was ascertained by CT scanning (Fig. 2).

### Results

The average instilled volume of barium was 0.42 ± 0.07 ml. On CT scans, barium spots were superimposed on the target lesions in 19 of the 21 patients and were 6–7 mm from the lesions in the other 2. The average time from marking to VATS resection was 13.1 ± 3.6 days (range 1–71 days). Barium was well preserved in all patients when VATS resection was performed. A mild cough persisted for about 1 week in one patient, but the other patients had no specific complications (Table 2).

Three of the 12 solid lesions on CT scans were primary lung cancer. Two were adenocarcinomas, and one was a small cell carcinoma. All five lesions appearing as ground-glass opacities (GGOs) were adenocarcinomas. Two out of the three lesions appearing as high-density GGOs were adenocarcinomas (Table 3). Specimens were examined immediately after resection, and 10 patients with primary lung cancer underwent VATS lobectomy with mediastinal lymph node dissection. The patient with small cell carcinoma received chemoradiotherapy.

### Discussion

As we enter the era of spiral CT screening for lung cancer, we will be removing smaller lesions. Small lesions not close to the pleural surface must be accurately localized. Suzuki et al. recommended that small lesions situated more than 5 mm from the pleural surface be marked before VATS resection. In this study, barium marking via a transbronchial approach proved to be a useful method for the localization of small pulmonary nodules not seen on the pleural surface. The method is less cumbersome than procedures performed under CT guidance, and it can be performed percutaneously without requiring a CT room. It is also less likely to cause complications such as pneumothorax, bleeding, and embolism. However, it is important to note that this study was conducted in a single institution with a limited number of patients, and further research is needed to confirm the general applicability of this method.
Marking is needed to localize lesions appearing as GGOs, regardless of size and proximity to the pleural surface.

Several marking techniques done under CT guidance have been described. Percutaneous wire-hook localization is an effective procedure, but the wires used are designed for breast tissue, which is denser than lung tissue. Consequently, the wire is dislodged from the nodule in 4–20% of patients, necessitating a large resection. This procedure carries the risk of pneumothorax and pulmonary hemorrhage, and has caused fatal air embolism. Injection of methylene blue is another commonly used marking procedure. VATS resection must be done within 3 h after marking, because of rapid diffusion of the dye. Close coordination between radiologic and surgical services is therefore required. Another drawback is that some nodules cannot be located during operation because of diffusion of the dye or severe anthracosis of the visceral pleura. Moon et al. successfully located small nodules by injection of lipiodol under CT-guidance in 10 patients. Indigo carmine was used to mark the pleural surface, but usually disappeared within a couple of hours after injection.
Only two reports have specifically documented CT-guided barium marking under bronchoscopic guidance.21,22 Kobayashi described a patient who underwent this procedure with no complications.21 Okamura et al. performed barium marking by CT-guided bronchoscopy for 21 small peripheral lesions approximately 10 mm in diameter. All lesions were successfully marked and identified at the time of VATS resection. No complications were associated with this procedure.22 However, their procedure is complicated because bronchoscopic examination and CT scanning must be done simultaneously.

We performed barium marking under fluoroscopic guidance, not CT scanning, during routine bronchoscopic examinations. To date, many different marking procedures have been devised to localize small pulmonary lesions, but all have required CT guidance. To our knowledge, this is the first report to describe a technique for barium marking under fluoroscopic guidance. Nineteen of the 21 lesions were pinpointed by barium. In the other two, barium spots were only 6–7 mm from the lesions. A key point of our procedure is that the spot to be marked with barium is designated on chest radiographs, using CT scans as reference, before the site is actually marked. Instilled barium into bronchi is maintained very well and does not disappear. The time from barium marking to VATS resection ranged from 1 to 71 days, and barium spots clearly remained in all patients at the time of VATS resection. One patient had a mild cough for 1 week after marking, but no other specific complications were reported.

Two approaches have been used to mark lesions: percutaneous and transbronchial. Although a percutaneous approach was used in most previous studies, this approach has a risk of embolism. We regard the transbronchial approach to be safer, and there were no complications except for the mild cough described above.

We conclude that fluoroscopy-guided barium marking is a reliable, convenient, and minimally invasive method for localizing small peripheral pulmonary lesions before VATS resection.

References