Feasibility and Value of Video-Assisted Thoracoscopic Surgery Wedge Excision of Small Pulmonary Nodules in Patients With Malignancy*

Jim Burdine, MD; Lyle D. Joyce, MD, FCCP; Michael B. Plunkett, MD; Subbarao Inampudi, MD; Mitchell G. Kaye, MD; and Daniel H. Dunn, MD

Purpose: Advances in CT scanning have presented physicians with the challenge of diagnosing small (≤ 10 mm) or deep (> 5 mm) pulmonary nodules (SmPNs) in patients with known malignancies during workup or follow-up. Wedge excision of SmPNs is difficult with video-assisted thoracoscopic surgery (VATS) and often requires the performance of a thoracotomy. The value of the early detection of metastatic disease must be weighed against the morbidity (ie, thoracotomy) that is necessarily involved in obtaining the information. Little is known about the incidence of metastases in this subset of patients. We describe a VATS technique that allows the reliable excisional biopsy of SmPNs and present our findings in this patient population.

Methods: Using CT scan localization, 150 μCi technetium sulfur colloid is injected into the area of the pulmonary nodule. Additional blue dye is injected at the lung surface. During VATS, a sterile gamma probe is used to identify the area of radioactivity and plan placement of staple lines performed by an endostapling instrument. Palpation and the presence of radioactivity in the specimen supported the resection of the correct nodule, and CT scan findings confirmed the procedure. Between March 2000 and January 2001, 17 patients with known malignancies and SmPNs underwent VATS excisional biopsies. Six patients received a new diagnosis of malignancy, and 11 patients were in follow-up of a previously treated malignancy. The malignancies included the following: breast (four patients), head and neck (four patients), pancreas (two patients), lymphoma (two patients), lung (one patient), prostate (one patient), rectal (one patient), seminoma (one patient), and urethral (one patient).

Results: All lesions were successfully resected on the first try. Nodules were removed from 10 segments and all lobes. The mean (±SD) nodule size was 9.2 ± 3.6 mm, and the mean depth was 9.4 ± 5.2 mm. Fourteen of 17 nodules (82.4%) could be neither seen nor felt using standard VATS techniques. Diagnoses included metastatic (four patients), new primary lung cancer (one patient), acid-fast bacillus (one patient), granuloma (seven patients), carcinoid (two patients), and inflammatory pseudotumor (two patients). Among these lesions, 29.4% were malignant, and 35.3% of patients received a diagnosis that altered their therapy. Five of 12 SmPNs (41.7%) < 10 mm in size were malignant. The median length of hospital stay was 2 days. Patients returned to full activity within 1 week.

Conclusion: VATS excision of SmPNs after CT scan localization with radiolabeled technetium is reliable, reproducible, and associated with minimal morbidity. The technique prevented thoracotomies in 82.4% of patients. Despite the small size of these lesions, malignancy was found 29.4% of the time. This technique allows the early diagnosis of SmPNs, with low morbidity, in patients with known malignancies.

Clinical implications: The reliability of this technique, the high incidence of malignancy, and the reduction in morbidity from undergoing excisional biopsy procedures will encourage the clinician to strive for earlier and more aggressive diagnoses of SmPNs. (CHEST 2002; 122:1467–1470)

Key words: CT scan; metastasis; neoplasm; pulmonary coin lesion; radiograph; technetium; video-assisted thoracic surgery

Abbreviations: SmPN = small pulmonary nodule; VATS = video-assisted thoracoscopic surgery
Increased use of spiral CT scanning to work up or follow-up patients with known malignancies means the increased detection of more and smaller lung lesions. Paradoxically, diagnostic modalities such as CT needle biopsy and positron emission tomography scan are often unreliable for detecting nodules ≤ 10 mm. Suzuki et al noted a high conversion from video-assisted thoracoscopic surgery (VATS) to thoracotomy because of a failure to localize small pulmonary nodules (SmPNs) ≤ 10 mm in size or ≥ 5 mm deep. Routine diagnostic thoracotomy for SmPNs entails too much morbidity to be desirable. The performance of serial CT scans means the selection of inappropriate therapy in patients who have received new diagnoses of malignancy or delays in the diagnosis and treatment of patients being observed who experience recurrences of disease.

Reliable, easy-to-use localization of SmPNs would increase VATS success and would obviate the conversion to thoracotomy. The inherent problem with VATS is the reliance on visualization and indirect palpation with instruments or a single digit. Furthermore, the radiologist’s needle and the thoracic surgeon’s thoracoscope often approach the SmPN from different directions, making depth perception unreliable (Fig 1). In addition, the lung is inflated for the radiologist and deflated for the thoracic surgeon. Multiple VATS localization techniques have been suggested. Each is associated with significant problems, limiting their usefulness and widespread application.

We have developed a technique using readily available technology that allows the easy, reliable, reproducible localization of SmPNs for successful diagnostic VATS excisional biopsy. Our experience allows us to assess the value of accurate diagnosis in patients with known malignancies.

Materials and Methods

Between March 2000 and January 2001, we prospectively studied all patients with known malignancies and SmPNs that had been found on routine spiral chest CT scans. Seventeen patients were identified. Six had received a new diagnosis of malignancy, and their lung lesions were identified during a workup for metastatic disease. Eleven patients had new lung lesions noted on CT scans that were obtained as routine follow-ups of previously diagnosed and treated malignancies. The malignancies included the breast (4), head and neck (4), pancreatic (2), lymphoma (2), lung, prostatic, rectal, seminoma, and urethral.

Diagnostic VATS was performed immediately after localization of the lung lesion by CT scanning. Patients were prepared for surgery and then transported to the radiology suite. A chest CT scan confirmed the lesion’s presence. A 22-gauge spinal needle then was guided to the location of the lesion (Fig 2), and 150 µCi unfiltered technetium sulfur colloid was injected at the site of the lesion. The needle then was withdrawn and 0.1 mL Lymphazurin (United States Surgical, Norwalk, CT) blue dye was injected near

*From Minnesota Thoracic Associates, PA (Drs. Burdine and Joyce), Minneapolis, MN; Consulting Radiologists, LTD (Drs. Plunkett and Inampudi), Minneapolis, MN; the Minnesota Lung Center, PA (Dr. Kaye), Minneapolis, MN; and General Surgery (Dr. Dunn), Abbott Northwestern Hospital, Minneapolis, MN.

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Correspondence to: Jim Burdine, MD, 920 E 25th St, No. 440, Minneapolis, MN 55407; e-mail: jburdine@mnthoracic.com
the lung surface. The patient was transported immediately to the operating room. General anesthesia was induced, and a double-lumen endotracheal tube was placed using flexible bronchoscopy. The patient then was positioned for VATS. The operative lung was isolated. After prepping and draping, three working ports were created and the lung was visualized. A sterile gamma probe (Navigator GPS; United States Surgical Corp; Norwalk, CT; and Neoprobe; Neoprobe Corp; Dublin, OH) [Fig 3] was used to identify and isolate the area of the lung with high radioactive counts (Fig 4). An autosuture stapling device (EndoGIA; Autosuture; Norwalk, CT) that was 30 or 45 mm long and used 3.5-mm staples was placed on an area of the lung with low counts and was fired. Multiple firings separated the portion of the lung with high counts from the rest of the lung. The excised wedge of lung was placed in a specimen bag (Endocatch; Autosuture) and was removed from the chest. Palpation, radioactive counts, and CT scans (if needed) of the specimen confirmed the resection of the correct pulmonary nodule. Frozen section histopathologic evaluation identified the nature of the lesion. The $t$ test was used for statistical analysis.

RESULTS

Nodules were removed from 10 different segments involving all lobes. The mean node size was 9.2 $\pm$ 3.7 mm (size range, 6 to 20 mm). The mean depth was 9.4 $\pm$ 5.2 mm (depth range, 1 to 20 mm). The nodule could neither be seen nor palpated using standard VATS techniques in 14 of 17 patients (82.4%). None of the malignant tumors could be seen or palpated using conventional VATS techniques. All lesions were resected on the first attempt. The mean ($\pm$/SD) count of the lesions was 3,333 $\pm$ 2,237. The background count was 46 $\pm$ 55 counts per second. This difference allowed the discrimination of the involved lung and the appropriate placement of endostaple lines. The peak counts decreased over time but still allowed the easy identification of the nodule-bearing lung. For this reason, the time from the CT injection to operating room counting was minimized and averaged 67 $\pm$ 24 min.

Five of seventeen SmPNs (29.4%) were malignant. Diagnoses included metastatic disease in four patients, two of whom had received a new diagnosis of malignancy, and two in patients with a history of treated malignancy 8 months and 2 years prior. One patient with a history of lung cancer that had been resected 5 years prior was found to have a new primary lung cancer. Benign diagnoses included acid-fast bacillus (1), granuloma (7), carcinoid tumor (2), and inflammatory pseudotumor, (2).

The mean size of the malignant tumors was 6.8 $\pm$ 1.3 mm, and the mean depth was 5.8 $\pm$ 2.9 mm. Benign tumors were larger (mean size, 10.3 $\pm$ 3.8 mm) and deeper (mean depth, 11.8 $\pm$ 5.27 mm) [$p < 0.01$]. Five of 12 SmPNs (41.7%) that were $\leq$ 10 mm in size were malignant. Knowledge of the nodules’ diagnosis affected therapy in 6 of 17 patients (35.3%).

Thoracotomy would have been required to recover the nodules in 14 of 17 patients (82.4%) because the lesion could neither be seen nor palpated. All of the malignant tumors were undetectable without use of the gamma probe. Typically, a chest tube was left in the patient overnight. There was one patient who developed a pneumothorax on postoperative day 2 that required the placement of a chest tube for 2 additional days. Otherwise, there were no complications. The median length of stay was 2 days (range, 1 to 10 days). Patients returned to their preoperative level of activity within 1 week.

DISCUSSION

The accurate and timely diagnosis of pulmonary nodules is essential for the proper management of patients with known malignancies. The introduction of spiral CT scanning has resulted in the detection of
increased numbers of pulmonary nodules of decreasing size. The implications of metastatic lung lesions, no matter what size, on treatment selection for patients who have received a diagnosis of a malignancy are enormous. However, the small size of these lesions makes diagnosis difficult. The peripheral location often precludes bronchoscopy. Radiologic techniques including CT scan measurement of nodal enhancement and positron emission tomography scanning have limited accuracy as node size decreases. VATS has replaced thoracotomy as the preferred surgical modality for diagnostic excisional biopsy of indeterminate pulmonary nodules because of decreased morbidity. Yet, the success of VATS excision becomes more limited as the pulmonary nodule size decreases. Suzuki et al demonstrated 46% conversion to thoracotomy for lesions ≤ 10 mm in size and > 5 mm deep.

Many investigators have developed numerous techniques to help in nodule localization for VATS. Methylene blue injected near the lesion improves localization, but it diffuses rapidly and does not allow for accurate depth perception. Wires used for breast localization have been used but are easily dislodged when the lung collapses. Injectable liquids that solidify, such as agar and cyanoacrylate, raise concerns about embolization and local tissue injury, which may alter the histologic appearance of the tumor. Intraoperative ultrasonography requires expensive equipment and training, and may be difficult to use in patients with COPD and air-trapping. Radiopaque markers such as barium or injectable coils also have been tried, but they require intraoperative fluoroscopy and prolonged radiation exposure. The injection of nonfiltered technetium sulfur colloid is easily performed in the radiologic suite. It is commonly used in lymphatic mapping for breast cancer. Any surgical department that performs breast sentinel node mapping already possesses an intraoperative gamma probe. The key to its use in VATS is the placement of the staple line in an area of low counts. Peak counts differ from background by 100 counts. Peak counts differ from background by 100

The results of this study in patients with known malignant disease reinforce the need for timely VATS wedge excision of SmPNs. Metastatic disease was found in a high percentage of patients (23.5%). A metachronous lung tumor and AFM meant that 35.3% of patients received diagnoses that immediately influenced their treatment and prognosis. The other 64.7% of patients, who already were concerned about metastatic or recurrent malignancies, received information that influenced their peace of mind. The use of a radiolabeled marker precluded conversion to thoracotomy because of the failure to localize the nodule in 82.4% of patients. The information was obtained with minimal morbidity and time away from their daily lives.

CONCLUSION

Excisional VATS biopsy after radiolabeled localization of SmPNs is highly reliable, easy to use, and reproducible. VATS excision can be accomplished with low morbidity. The high incidence of malignant diagnoses confirms the value of accurate and timely diagnoses in patients with known malignancies. The fear of thoracotomy and its associated morbidities should not be a limiting factor in the workup of SmPNs. This should encourage clinicians to aggressively seek the earlier diagnosis of SmPNs in this patient population.

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REFERENCES