Percutaneous Localization of Pulmonary Nodules Prior to Thoracoscopic Surgery by CT-guided Hook-wire

SIGRID KASTL[1], THOMAS E. LANGWIELER[1], GERRIT KRUPSKI-BERDIEN[2], ERSEN DEMIR[1] and JAKOB R. IZBICKI[1]

Departments of [1]Surgery and [2]Radiology, University of Hamburg, 20246 Hamburg, Germany

Abstract. *Background: When performing thoracoscopic surgery in patients with small pulmonary nodules, intra-operative localization can be difficult and time-consuming. The percutaneous localization of suspicious intrapulmonary lesions was evaluated pre-operatively to facilitate the resection of the lesion and to avoid thoracotomy. Materials and Methods: Thoracoscopies were performed in 13 patients with intrapulmonary nodules previously localized by CT-scan and flagged percutaneously with a hook-wire. Immediately after the procedure, the patient was transferred to the operating room and thoracoscopic pulmonary wedge resection was performed. Results: All the nodules were properly identified. The time to position the wire was 20-30 min and thoracotomy could be avoided in all patients. The nodules were 0.5 cm - 6 cm in size and situated 1 cm - 4 cm subpleurally. Conclusion: Guide-wire identification of an intrapulmonary nodule is a safe, elegant, time-saving and reliable method. The lack of manual examination of pulmonary parenchyma in thoracoscopy is compensated for by precise pre-operative localization.*

If an intrapulmonary nodule is diagnosed by chest X-ray, CT-scan, magnetic resonance tomography or PET-scan, primary bronchial carcinoma, metastatic disease or benign lesions such as granulomas, hamartomas and infectious diseases such as tuberculosis have to be considered. Primary bronchial carcinomas often show typical CT patterns and, therefore, a thoracotomy with oncological resection and lymph node dissection should be performed. If bronchial carcinoma seems to be unlikely, explorative thoracoscopy and local excision of the lesion are recommended. The disadvantage of the thoracoscopic approach is that palpation of the parenchyma is not possible, which is a severe drawback to lesions not situated subpleurally. To make the identification of an intra-pulmonary lesion easier, flagging it by a hook-wire inserted under CT guidance, leaving it *in situ* and harvesting it with the resected specimen, are proposed. Our experience with this method is reported.

Correspondence to: Jacob R. Izbicki, FACS, Department of Surgery, University of Hamburg, Martinistr. 52, 20246 Hamburg, Germany. Tel: ++49-40-42803-2401, Fax: ++49-40-42803-4995, e-mail: izbicki@uke.uni-hamburg.de

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Materials and Methods

Radiological procedure. A spiral-CT of the perifocal region was performed with 5-mm slice thickness, 8-mm feed and 5-mm reconstruction, with the patient in a supine or prone position depending on the site of the lesion. A metallic grid pattern was laid above the region of interest. A SOMATEX Localization Kit DUO-System® (Somatex, Berlin, Germany) with a 90-mm 19.5-G needle and a diameter of 0.95 mm (Figure 1) was used. The positioning of the needle was subsequently performed in breath-hold and inspiration with 5-mm slice thickness and 5-mm table feed as a single slice without intravenous contrast.

As soon as the direction of the puncture had been determined, local anesthesia was injected, the 19.5-G needle inserted and advanced close to the nodule, but not into it. The hooked wire was then inserted, positioned and anchored within the tumor, and the needle was withdrawn (Figure 2).

Anesthesia and operative procedure. In case of an anteriorly-situated lesion which can be easily resected, the patient was positioned in a 30-degree elevated position. A standard single-lumen endotracheal tube was used and the pulmonary resection was performed under apnea. A double-lumen endotracheal tube was used only in patients with poor pulmonary function or in posteriorly-situated findings. If the hooked wire is positioned from the patient's rear, a lateral position is recommended (Figure 3).

Video-assisted thoracoscopic surgery (VATS). This procedure was performed with a 10-mm 30°-angled video camera (Olympus, Hamburg, Germany); two 10-mm thoracoscopy portals were positioned individually, depending on the tumor localization. Explorative thoracoscopy was performed and the guide-wire was carefully lifted. Nodules can also be resected by a wedge resection with the endostapler (45 mm, ENDO-GIA®; Ethicon, Hamburg, Germany), in which case the specimen is harvested in an Endobag® (Ethicon). At the end of such a procedure, a 24-G chest tube is inserted.

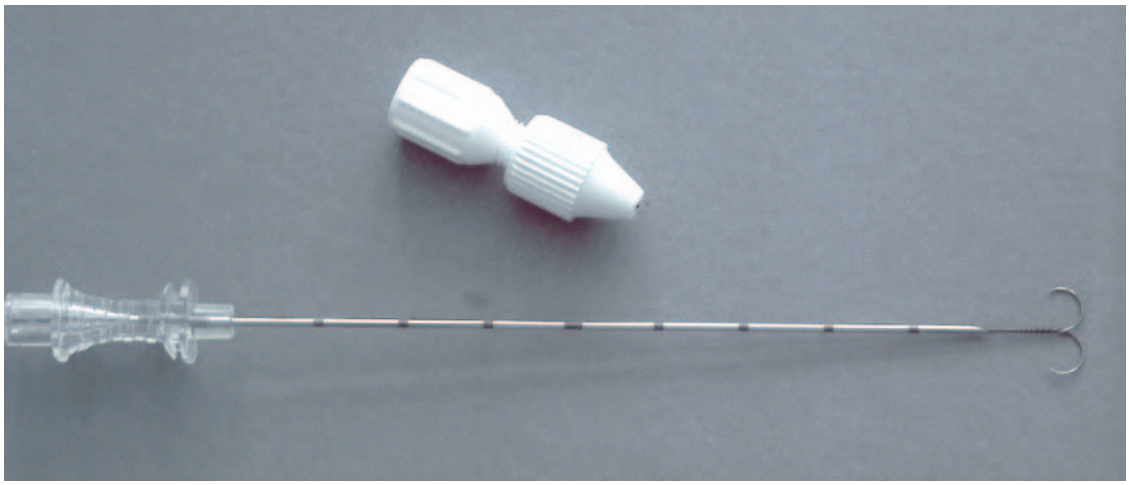

Figure 1. *Equipment: insertion needle and advanced hook-wire.*

Results

In the last 2 years, 140 video-assisted thoracoscopic procedures were performed in our Department on patients with pneumothorax, hyperhidrosis axillaris, suspected mesothelioma and unclear pulmonary parenchymal diseases. Among these were 34 thoracoscopies in patients with pulmonary nodules not suspicious for primary bronchial carcinoma according to CT criteria. In eleven patients with a past medical history of colorectal carcinoma (n=3), soft tissue sarcoma (n=2), malignant melanoma (n=3), malignant schwannoma (n=1), renal carcinoma (n=1) and Hodgkin's disease (n=1), the method described above was used. In two patients, VATS was performed because of an unclear pulmonary nodule without previous malignancy or risk factors for bronchial carcinoma (one later turned out to be a primary bronchial carcinoma, while the other turned out to be a hamartoma).

In 12/13 cases, the resection of the identified nodules was successful, as proved by the radiological follow-up. In one patient, however, technical problems concerning intra-operative mechanical ventilation forced us to stop VATS and perform open thoracotomy for a posteriorly-located lesion.

The mean size of the nodules was 2.8 cm (0.5 cm - 6 cm) and the distance between the lung surface and nodule was 2.6 cm (1 cm - 4 cm).

The mean time from positioning of the wire to VATS was 115 min (60-155 min), and only one attempt was necessary to position the wire. The procedure was uneventful in 9/12 patients, although five mild apical pneumothoraces and two minor hemorrhages were observed.

No partial resection of the wire was observed. To avoid this complication, we recommend that the hook-wire should be inspected before sending the specimen to the pathologist. The data from the 13 patients are provided in Table I.

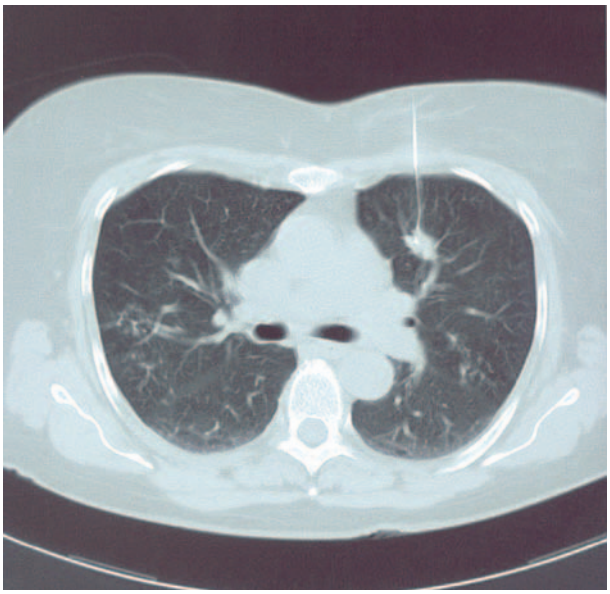

Figure 2. *CT-guided positioning of the hooked wire; CT-scan thorax.*

Discussion

The advantage of VATS is less traumatic access to the thoracic cavity, better visualization of the pleura and the pulmonary surface due to the magnification by the optic system, significantly less post-operative pain (1), a significantly lower complication rate and less restriction

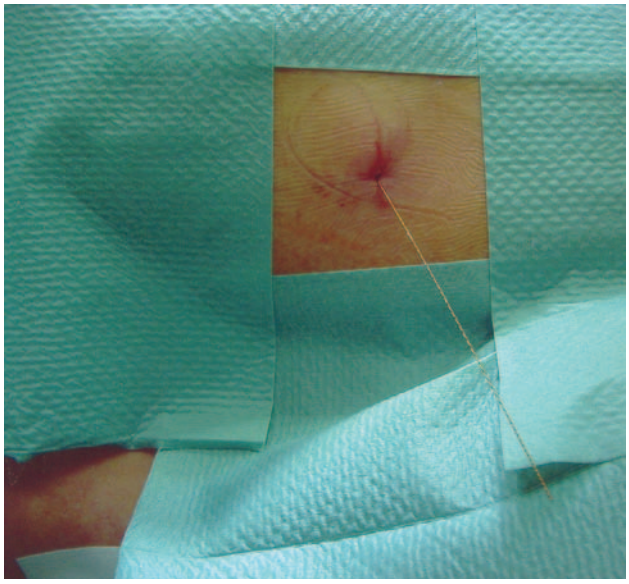

Figure 3. *Clinical picture after insertion of the wire.*

regarding post-operative pulmonary function tests. The patient's mobility is recovered much faster, the post-operative stay significantly shorter and the time to return to work is considerably less than for open surgery (1-3).

In patients with an underlying malignancy, such as colorectal carcinoma, soft tissue sarcoma or malignant melanoma and a newly-diagnosed pulmonary nodule, metastatic disease is likely. VATS should be performed in these cases to verify the indication for chemotherapy and to complete the staging process. In patients with poor pulmonary function, the procedure is excellently tolerated, recovery is rapid, the complication rate low (4) and post-operative pain is significantly less due to a markedly reduced cytokine response (1).

The major disadvantage of VATS is that the surgeon cannot palpate the parenchyma, so that identification of intrapulmonary lesions is difficult.

There have been various techniques described in the literature for the percutaneous localization of pulmonary lesions (5). Some authors reported CT-guided needle localization of small nodules (<1 cm) by injection of methylene blue without leaving the needle *in situ* (6, 7). The disadvantage of this procedure is that the depth of the intraparenchymally-situated lesion cannot be exactly determined during VATS and that vision might be affected by dispersed or leaking dye. Others performed radioisotope marking under CT guidance using a hand-held gamma probe during VATS for localizing small or indistinct pulmonary lesions (8). In our opinion, this method is laborious and inconvenient.

Table I. *Results from the 13 procedures.*

Number of patients	13		
Mean age in years (range)	54.9 (28 - 79)		
Indications: - suspected metastasis after:			
colorectal carcinoma:	n=3 (2 positive, 1 negative)		
soft tissue sarcoma:	n=2		
malignant schwannoma:	n=1		
malignant melanoma:	n=3 (2 positive, 1 negative)		
renal carcinoma:	n=1 (identified as primary bronchial carcinoma)		
- unclear pulmonary nodule:	n=2 (1 bronchial carcinoma, 1 hamartoma)		
- Hodgkin's disease:	n=1		
Localization and size of the nodules:			
right	n=10	left	n=3
segments 2	n=2	segment 1	n=1
3	n=2	segment 10	n=2
4	n=2		
5	n=1		
6	n=2		
0	n=1		
Size of nodule (range)	2.8 cm (0.5-6)		
Distance between lung surface and nodule (range)	2.6 cm (1-4)		
Distance between nodule and wire			
intratumoral	n=8		
0.2 cm -1 cm	n=5		
Time from wire insertion to operation (range)	115 min (60 - 155)		
Number of attempts to position the wire	n=1		
Complication by wire	none		n=9
	minor bleeding		n=2
	dislocation		n=1
Mild apical pneumothorax	n=5		
Duration of operation (range)	mean 60 min (20-115) (n=12)		
Result of histology:	specimen always correctly identified and completely resected		
Post-operative stay (range)	7.3 days (4-14)		
Surgical complications	none		
Post-operative chest tube (range)	5.3 days (2-7)		

Data are given as means + range.

The application of suture-ligated embolization microcoils under CT guidance was recommended by Reinschmidt *et al.* (9). The suture-ligated microcoils are placed within 1.0 cm of the targeted pulmonary nodule, the suture serving as a guide to direct accurate resection of the nodules. However, this system seems to be prone to faults. Other authors reported good results after branding the intrapulmonary lesions with a short hook-wire and suture (10, 11). Some authors combined the percutaneous localization of pulmonary nodules by CT-guided hook-wires with the injection of methylene blue and left the hooked wire *in situ* (12). If the wire is inserted a few centimeters only, this might be especially helpful in the case of a secondary dislocation of the wire.

CT-guided insertion of the wire into the nodule helps to reduce the operative time and the risk of missing small lesions. The problem of dislocation of the guide-wire is low: only 1 /13 wires dislocated when the patient was positioned in the lateral position in the operating room.

PET examination is occasionally recommended in patients with underlying malignancy and a pulmonary nodule. The results, however, are not always satisfactory and sometimes contradictory to the CT findings. We, therefore, recommend the approach described.

In conclusion, the CT-guided localization of an intrapulmonary nodule by a guide-wire is a safe, elegant, time-saving and reliable method. This method is limited by nodules of less than 0.5 cm in size or by central lesions.

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