Preoperative marking for peripheral pulmonary nodules in thoracoscopic surgery: a new method without piercing the pulmonary parenchyma

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Abstract

Air embolism is a rare complication of computed tomography (CT)-guided preoperative marking of peripheral pulmonary nodules. Here, we describe a new CT-guided marking method, which allows the quick intraoperative identification of peripheral pulmonary nodules and avoids this complication. This method does not require piercing of the pulmonary parenchyma and uses an 18-gauge indwelling catheter and a central venous catheter with a guidewire. Between July 2009 and January 2013, 16 patients underwent this procedure and could be intraoperatively diagnosed without any air embolisms. No postoperative complications were observed in this series. We believe that this simple technique is effective and will not cause severe complications.

Keywords: Air embolism • Computed tomography • Thoracoscopic surgery

INTRODUCTION

Thoracoscopic surgery is currently the method of choice for the resection of peripheral pulmonary nodules. However, if a pulmonary nodule is too small or is not close to the pleural surface, then it is difficult to identify its exact location through a port site; in such cases, preoperative localization is sometimes required in thoracoscopic surgery. The use of percutaneous computed tomography (CT)-guided marking by using hook wires [1, 2] to intraoperatively detect small pulmonary nodules has been reported. However, this procedure requires piercing of the pulmonary parenchyma and may therefore lead to complications. The most common complications are pneumothorax, intrapulmonary haemorrhage and haemoptysis. Air embolism is a rare complication but can be catastrophic [3, 4]. We propose a new marking technique that does not require piercing of the pulmonary parenchyma; this technique involves the use of an 18-gauge indwelling catheter, a central venous catheter and a guidewire.

SURGICAL TECHNIQUE

The indications for the use of the technique were defined as follows: (i) the nodules were peripheral and indeterminate, as well as predicted to be difficult to identify thoracoscopically; (ii) the nodules were ≤20 mm in diameter and were not obviously attached to the visceral pleura and (iii) the maximum distance from the inferior portion of the nodule to the nearest pleural surface was ≤30 mm. We decided upon these criteria because we felt that the deeper nodule located at >30 mm from the pleura should be indicated by segmentectomy to make a diagnosis. Preoperative marking was performed on the day of the thoracoscopic surgery. The patient was placed in a lateral position inside the gantry, and under CT guidance, an 18-gauge indwelling catheter (Surflex, SR-OT1832C; Terumo Corporation, Tokyo, Japan) was inserted into the skin and extended up to the parietal pleura just above the pulmonary nodule. The needle was removed, and the external part of the catheter hub was fixed to the thoracic wall (Fig. 1). Subsequently, the patient entered the operating room on foot. Under general anaesthesia using single-lung ventilation, the patient was placed in a lateral position, and the thoracic cavity was entered through two or three trocar ports. After a guidewire of a central venous catheter kit (Safe Guide, 1912-8WGE; Nippon Covidien Ltd, Tokyo, Japan) was inserted into the skin and extended up to the parietal pleura just above the pulmonary nodule. The needle was removed, and the external part of the catheter hub was fixed to the thoracic wall (Fig. 1). Subsequently, the patient entered the operating room on foot. Under general anaesthesia using single-lung ventilation, the patient was placed in a lateral position, and the thoracic cavity was entered through two or three trocar ports. After a guidewire of a central venous catheter kit (Safe Guide, 1912-8WGE; Nippon Covidien Ltd, Tokyo, Japan) was inserted through the indwelling catheter (Fig. 2A), the indwelling catheter was removed, and then a central venous catheter was threaded over the guidewire into the thoracic cavity (Fig. 2B). The tip of the catheter was pulled out through a trocar port onto the extracorporeal side and equipped with a small round cotton stype (Fig. 2C). The tip of the central venous catheter was then pulled back into the thoracic cavity, and the stype was fixed to the chest wall. After inflation of the lung, pyoktanin blue was injected through the central venous catheter, thereby staining the stype (Fig. 2D). The pigmentation of the visceral pleura overlying the pulmonary nodule was visualised under subsequent deflation of the lung. Because the maximum distance from the inferior portion of the nodule to the pleural surface just beneath the pigmented lesion should be
≤30 mm, the forceps were inserted such that the pigmented lesion would be in the ring (2 or 3 cm in diameter) of the forceps.

An automatic stapler was used to resect the nodule with the surrounding tissue (see Supplementary Video 1). This technique was appropriate for the small peripheral indeterminate nodules, located at ≤30 mm from the nearest pleural surface, regardless of whether the nodules were easily visible or palpable by a finger through the port site.

RESULTS

Between July 2009 and January 2013, we used this method for 16 patients (13 men and 3 women, with the mean age of 64 years), and written informed consent was obtained. The reason for the limited number of patients was that we adopted the strict indications for the procedure. We applied this technique to all nodules that met the indication. None of these patients had tumour violation during the thoracoscopic wedge resections performed using this technique; intraoperative diagnoses were possible for all these patients. Eight of the 16 patients who had intraoperative diagnoses of primary lung cancer subsequently underwent thoracoscopic lobectomies with mediastinal lymphadenectomies through four trocar ports. The mean diameter of the nodules was 12.4 mm (range, 5–20 mm), and the mean distance from the inferior portion of the nodule to the most proximal pleural surface was 19.9 mm (range, 10–30 mm). No postoperative complications were observed during the mean observation period of 26 months.

DISCUSSION

Avoiding piercing of the pulmonary parenchyma is an effective way of preventing an air embolism after CT-guided marking. Although some surgeons are comfortable operating without making any markings for preoperative localization, others prefer to identify the exact location of small nodules. Nevertheless, severe complications, such as air embolism, tension pneumothorax, tumour seeding and severe pulmonary haemorrhage or haemoptysis could occur because of piercing of the pulmonary parenchyma. In one report [5], severe complications occurred in 74 of 9783 biopsies (0.75%), including 6 cases of air embolism (0.061%). Our new method which does not require piercing of the pulmonary parenchyma, should not, in theory, cause an air embolism.

The dramatic upsurge in the early detection of small lung nodules because of the development of radiographic tools such as high-resolution CT has led to concerns among many surgeons regarding thoracoscopic surgery for these small nodules. Therefore, preoperative localization involving conventional CT-guided marking with a wire, a procedure that requires piercing of the pulmonary parenchyma, is being increasingly used. We believe that our simple method that avoids piercing of the pulmonary parenchyma for preoperative marking of peripheral nodules is a feasible and useful alternative marking method for peripheral pulmonary nodules.

SUPPLEMENTARY MATERIAL

Supplementary material (Video 1) is available at EJCTS online.

Video 1: Under general anaesthesia using single-lung ventilation, the patient is placed in a lateral position and the thoracic cavity is entered through two or three trocar ports. After a guidewire of a central venous catheter kit is inserted through the indwelling catheter, the indwelling catheter is removed and then a central venous catheter is threaded over the guidewire into the thoracic cavity. The tip of the catheter is pulled out through a trocar port onto the extracorporeal side and is equipped with a small round cotton stype. The tip of the central venous catheter is then pulled back into the thoracic cavity, and the stype is fixed to the chest wall. After inflation of the lung, pyoktanin blue is injected through the central venous catheter, thereby staining the stype. The pigmentation of the visceral pleura overlying the pulmonary nodule is visually confirmed under subsequent deflation of the lung. Because the pulmonary nodule should be just below the pigmented lesion, the forceps are inserted such that the pigmented lesion would be in the ring (2 or 3 cm in diameter) of the forceps. An automatic stapler is used to resect the nodule with the surrounding tissue.

Conflict of interest: none declared.
REFERENCES


Figure 2: (A) Under single-lung ventilation, a guidewire of a central venous catheter kit was inserted into the thoracic cavity through the indwelling catheter. (B) The indwelling catheter was removed and a central venous catheter was inserted over the guidewire into the thoracic cavity. (C) The tip of the central venous catheter was pulled onto the extracorporeal side through a trocar port and equipped with a small round cotton stype. (D) The tip of the central venous catheter was then pulled back into the thoracic cavity, and the stype was fixed to the chest wall. After inflation of the lung, the stype was stained with pyoktanin blue.