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Case Report

A paravertebral approach for CT-guided percutaneous biopsy of presumably inaccessible, posterior and centrally located pulmonary nodules

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ABSTRACT

Introduction: To present 3 cases where a paravertebral approach had to be used for the biopsy of posterior and centrally located pulmonary nodules. **Case presentation:** Three patients underwent percutaneous CT-guided transthoracic biopsy of pulmonary nodules that were initially thought to be inaccessible because of their central, posterior location by a paravertebral approach. The first 2 patients had a history of extra thoracic malignancy and the third patient presented with a bone metastasis and an isolated pulmonary nodule in the right lower lobe, corresponding to potential stage IV lung cancer. Biopsy was feasible in all 3 patients using the paravertebral approach. Pulmonary metastases were confirmed in the first 2 patients, while a TTF-1 positive pulmonary adenocarcinoma was diagnosed in the last patient. No complications occurred. **Conclusion:** A paravertebral approach is feasible for posterior and centrally located pulmonary nodules.

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Introduction

Percutaneous computed tomography (CT)-guided transthoracic biopsy provides pathological assessment of peripheral pulmonary lesions, which are not accessible by fiberoptic bronchoscopy. The procedure is especially useful in patients who are not candidates for surgery, such as those with suspected advanced stage lung cancer or pulmonary metastases from extra thoracic malignancies.

Pneumothorax and intrapulmonary hemorrhage are the 2 main complications of percutaneous CT-guided transthoracic biopsy, respectively reported in 15%-45% [1,2] and 19%-28% of cases [3]. Both are strongly related to the path-length within the lung. The depth of the lesion has been reported to influence the risk of pneumothorax, with an increased risk reported in deeper lesions [4–6]. Similarly, in a large series including 1484 patients, an intrapulmonary needle path >2 cm has been reported to be an independent risk factor of hemoptysis [3].

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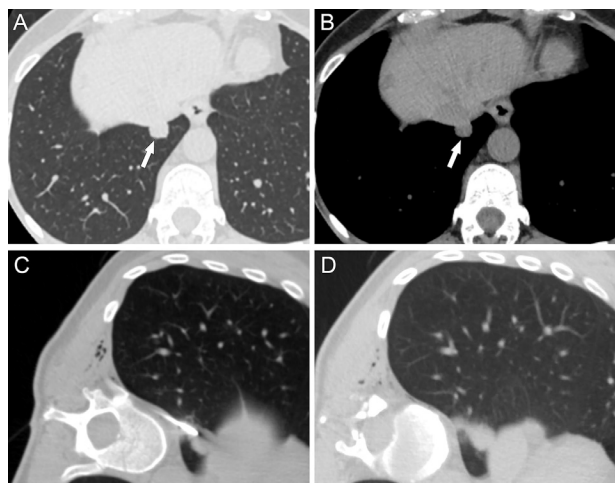


Fig. 1 – Unenhanced CT scan showing pulmonary nodules in both lower lobes. (A) Lung window. The main nodule is located in the right lower lobe (white arrow) in a very central position. (B) On the mediastinal window, the nodule (white arrow) appears in close contact with the retrohepatic segment of the inferior vena cava. (C) With the patient placed in the contralateral decubitus position, access to the nodule is possible along the right paravertebral space and the coaxial needle reaches the lung nodule after crossing a very limited portion of normal aerated lung. (D) There were no complications after coaxial needle withdrawal; a small amount of intra-alveolar hemorrhage is seen along the needle path.

To limit the risk of complications, the shortest needle-path possible that avoids crossing fissures should thus be chosen. We present here 3 cases of seemingly inaccessible pulmonary nodules in a posterior and central location, that were successfully biopsied by a paravertebral approach with hydrodissection and without complications. This retrospective study received institutional review board approval, with waiver for patient consent.

Case presentation

Case 1

A 54-year-old woman was referred for percutaneous biopsy of pulmonary nodules that were identified during initial staging of left breast cancer. There were no liver or bone metastases and no previous CT examinations for comparison were available.

Unenhanced CT scan showed 5 to 7 solid pulmonary nodules in each lung, all measuring <7 mm, except for 1 nodule in the right lower lobe, located directly behind the retrohepatic segment of the inferior vena cava measuring 13 × 9 mm (Fig. 1A and B). The nodule seemed to be inaccessible because of the central location on CT images acquired in the supine position. A right lateral pathway of the coaxial needle

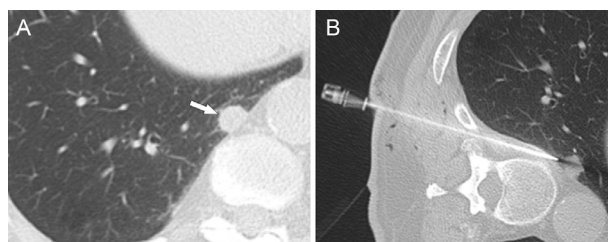


Fig. 2 – Unenhanced CT scan showing a 13-mm right lower lobe pulmonary nodule. (A) The nodule (white arrow) is in a prevertebral, peripheral location. (B) The coaxial needle is inserted between the rib and the transverse process of the vertebra and reaches the target lesion without crossing normal aerated lung.

would have required crossing 9 cm of normal, aerated lung. Right extrapleural paravertebral access to the nodule was possible with the patient in the left lateral position. A 17-gauge coaxial needle and an 18-gauge automated core-biopsy needle (Bard Monopty Disposable Core Biopsy Instrument, Bard, Tempe, AZ) were used. After superficial local anesthesia with Xylocaine 1%, the 17-gauge coaxial needle was inserted in the right paravertebral region. Repeated injections of saline and xylocaine were used to expand the right posterior paravertebral space and facilitated a posterior extrapleural approach to the nodule, leaving only 7 mm of aerated lung parenchyma to be crossed before reaching the nodule (Fig. 1C). The biopsy was performed with an 18-gauge automated core-biopsy needle. The core-biopsy needle path was set to go no deeper than the nodule, located just before the inferior vena cava. Two adequate core samples were obtained and no complications were identified on the CT image performed after needle withdrawal (Fig. 1D). The patient was asked to stop breathing while the coaxial needle was inserted, at time of the insertion of the cutting needle and when the cutting needle was triggered. The patient was allowed to breathe while the biopsy system was obturated (ie, cutting needle inside the coaxial needle). The chest radiograph showed no delayed pneumothorax and the patient was discharged from hospital. Pathological examination of the biopsy specimens confirmed that the pulmonary nodule corresponded to a breast cancer metastasis. The tumor cells were TTF-1 and P40 negative, while immunohistochemical staining for c-erbB-2 and GATA 3 were both positive.

Case 2

A 72-year-old man with a history of bladder and colon cancer was referred for percutaneous biopsy of pulmonary nodules found on follow-up CT. All nodules were small, with the largest diameter less than 10 mm except for 1 nodule in the right lower lobe. This peripheral nodule was abutting the pleura in a prevertebral location (Fig. 2A) and measured 13 mm in its largest axial transverse diameter. There were no other abnormalities. The nodule was too far from the lateral chest wall to perform a percutaneous biopsy in the supine position.

A lateral approach would have required crossing 11 cm of normal aerated lung.

The patient was placed in the left lateral position, which resulted in possible access to the nodule. After superficial local anesthesia with Xylocaine 1%, a 17-gauge coaxial needle was inserted between the transverse process of the vertebra and the adjacent rib. An injection of saline solution was used to expand the posterior paravertebral space and to facilitate progression of the coaxial needle until the nodule was reached, leaving only 3 mm of aerated lung parenchyma to be crossed (Fig. 2B). Only 1 biopsy pass was needed to reach the nodule. Four core samples were obtained using an 18-gauge automated core-biopsy needle. The patient was asked to stop breathing while the coaxial needle was inserted, at time of the insertion of the cutting needle and when the cutting needle was triggered. The patient was allowed to breathe while the biopsy system was obturated (ie, cutting needle inside the coaxial needle). No immediate or late complications occurred. Pathological analysis of the biopsy samples showed tubular carcinomatous proliferation, confirming a metastatic nodule related to the history of colon cancer. A p.Gly12Ala mutation was found in the KRAS gene after DNA sequencing of the tumor cells.

Case 3

A 72-year-old man with an 18-mm right lower lobe pulmonary nodule and a painful osteolytic lesion of the sacrum was referred to our department for a diagnostic assessment. Stage IV lung cancer was suspected, requiring mutational status of the tumor, thus the pulmonary nodule rather than the bone lesion was targeted for biopsy. Indeed, molecular analysis of bone metastases is difficult because the decalcification process negatively influences the quality of DNA, potentially making mutation detection difficult [7]. The pulmonary nodule was located just behind the upper root of the right inferior pulmonary vein and was considered to be inaccessible in the supine position. The patient was placed in the left lateral position, which gave possible access to the nodule in the right lower lobe through the right paravertebral space. After superficial local anesthesia with Xylocaine 1%, a 17-gauge coaxial

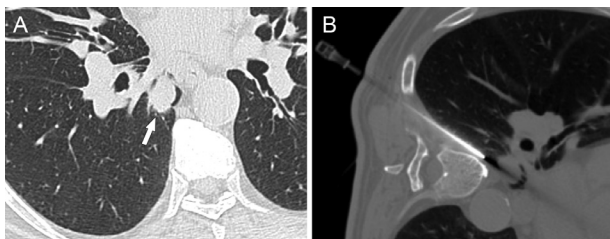


Fig. 3 – Unenhanced CT showing a single pulmonary nodule in the right lower lobe (white arrow). (A) In the supine position, the nodule seems impossible to reach because of its central location in the para-azygos recess, between the vein for the upper segment of the right lower lobe (V6) and the esophagus. (B) With the patient placed in left lateral decubitus position, the lung nodule can be reached through the right paravertebral space.

needle was inserted with an 18-gauge automated core-biopsy needle (Bard Monopty Disposable Core Biopsy Instrument, Bard, Tempe, AZ) to biopsy the pulmonary nodule (Fig. 3A). The automated length of the core-biopsy needle-path was set not to exceed 12 mm, corresponding to the length of the nodule along the needle path. Only 1 pass with the coaxial needle was needed to reach the nodule passing only 8 mm of aerated lung parenchyma. Two biopsy samples were taken. The patient was asked to stop breathing while the coaxial needle was inserted, at time of the insertion of the cutting needle and when the cutting needle was triggered. The patient was allowed to breathe while the biopsy system was obturated (ie, cutting needle inside the coaxial needle). No complications were seen on the CT image obtained after the co-axial needle withdrawal (Fig. 3B). A TTF-1 positive wild-type lung adenocarcinoma was found on pathological examination of the biopsy samples. Percutaneous biopsy of the bone lesion was also performed and confirmed the metastatic stage of the lung adenocarcinoma.

Discussion

We report 3 cases in which a biopsy of small, posterior and centrally located pulmonary nodules was successfully performed by an extrapleural, right paravertebral approach, although they first seemed inaccessible on CT performed in the supine position. Access through the right paravertebral space seemed possible after positioning the patients in a contralateral position. This route provided a short needle-path through aerated lung parenchyma, which is essential to limit the risk of hemoptysis and pneumothorax [8].

The length of the automated needle trajectory had to be precisely set not to exceed the dimension of the target nodule along the needle path, since there were major vessels just behind the targeted nodule in 2 out of 3 cases.

With the coaxial core biopsy system used in this study, the default penetration depth of the cutting needle was 22 mm. This was nearly twice the size of the nodules, which ranged from 10 to 13 mm in all 3 cases along the pathway of the cutting needle. To avoid complications, the penetration depth had to be precisely adjusted before biopsy. To achieve this, we did not insert all of the cutting needle into the coaxial needle, and adjusted the degree of insertion to the desired penetration.

A paravertebral approach with or without hydrodissection has been used for CT-guided percutaneous biopsy of various lesions [9–11]. The injection of saline solution into the paravertebral space creates a wider pathway for the needle and helps prevent puncturing the pleura.

Tyng et al suggested that this was the best approach for adrenal gland biopsy [9]. There was sufficient material in all 13 biopsies in their study for pathological analysis and no complications.

Another report proposed the paravertebral approach for CT-guided fine needle biopsy of subcarinal lymph nodes. Injection of saline to widen the mediastinum was not necessary using a thin, 25-gauge needle. In a series of 141 patients, there were only 5 cases of small hematoma (3.5%) and no pneumothorax [10]. With an onsite cytopathologist, the sensitivity and specificity of the technique was 97 and 100%, respectively.

The extrapleural approach was also used in a series of 20 patients to biopsy other mediastinal lesions, with a success rate of 90% [11] and one case of intercostal neuritis. Although we did not find any other reports of this uncommon complication, this risk should be taken into account, as well as that of injuring the intercostal veins or arteries. Ideally, the course of the intercostal vessels should be carefully analyzed on a contrast-enhanced acquisition before inserting the needle and during its progression. If possible, the point of insertion should avoid the inferior aspect of the ribs. The course of the posterior intercostal arteries has been evaluated in several reports using multidetector CT [12,13]. Helm et al. reported that 17% of arteries are shielded by the superior rib at a distance of 3 cm lateral from the spine, compared to 97% at 6 cm [13]. Choi et al also concluded that the risk of vessel injury is much higher when the needle is inserted within 4 cm from the midline and recommended performing intercostal procedures at least 7 cm lateral to the midline to limit injury to the posterior intercostal arteries [12]. This is not possible with a paravertebral approach. Moreover, trajectory of the needle path from outside to inside is oblique towards the midline. Although there were no complications during the 3 unenhanced CT-guided procedures in our study, the use of contrast enhancement to locate the intercostal vessels is probably safer. Widening the paravertebral space with an injection of saline solution also probably reduces the risk of injuring the intercostal nerves and vessels. Progression with a smooth needle tip is also a possible option.

However, the paravertebral space itself may also need to be biopsied, for example in patients with diskitis-osteomyelitis to isolate and culture the causal pathogenic organism. No complications were reported in a 10-year retrospective review of this procedure [14]. Paravertebral block is also extensively used by thoracic anesthetists to manage acute pain following thoracotomy. The main complications are systemic manifestations such hypotension, arrhythmia, nausea and vomiting, but no local complications related to intercostal nerve or vessel injuries [15].

In conclusion, the use of an extrapleural paravertebral approach for posterior and centrally located pulmonary nodules limits the amount of normal lung parenchyma to be crossed. The patient is positioned on the contralateral side, an injection of saline is used to widen the paravertebral space, and ideally the course of the intercostal artery should be located by contrast-enhanced CT.

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