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Technical Notes

CT-Guided Large-Bore Biopsy: Extrapleural Injection of Saline for Safe Transpleural Access to Pulmonary Lesions

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Abstract. A new technique was applied to improve safety for large-bore biopsies of subpleural pulmonary lesions. In 27 patients, normal saline solution (20–40 ml) was injected extrapleurally under CT-guidance in the access route to subpleurally situated lung lesions. Thickness of ventilated lung interposed between the target and the parietal pleura was up to 8 mm (mean: 4.1 mm). The injected fluid resulted in an extrapleural bulge that abutted the lesion to be biopsied. Biopsy with the 14-gauge Trucut needle did not result in pneumothorax in all cases. There were no complications associated with this technique. Extrapleural injection of saline may provide a safe access route to selected pulmonary lesions for CT-guided large-bore transthoracic biopsies.

Key words: Lung—Biopsy—Percutaneous—Technique—Complications—CT-guidance

Pneumothorax is the most frequent complication of thoracic biopsy procedures [1, 2] and may be encountered in up to 60% of cases, averaging 37% in reported CT-guided biopsies [3–8]. Although chest tube drainage is required in only 10–15% of pneumothoraces [1–8], safe methods to prevent pneumothorax would be welcome. The pneumothorax incidence is related to the number of needle insertions and the caliber of the needle when the needle traverses ventilated lung parenchyma on the way to the target [1]. However, when the needle traverses only nonventilated lung adjacent to the pleura, pneumothorax is unlikely. Herein, a simple method is described for prevention of pneumothorax that proved useful for large-bore needle biopsy of subpleural lung lesions greater 1.5 cm and not immediately adjacent to the pleural surface.

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Materials and Methods

Indeterminate pulmonary lesions referred for CT-guided biopsy were candidates for the technique outlined below when they met two conditions: (1) target diameter was to exceed 1.5 cm; and (2) a layer of normal lung up to 8 mm thick was to be interposed between the parietal pleura and the target in the access route. Twenty-seven patients, aged 17–83 years (mean: 63.2 years) with peripheral pulmonary lesions fulfilled these criteria and were biopsied with the technique. There were 19 men and 8 women. Contiguous CT scans (Somatom 2, Somatom Plus, Siemens, Germany) were obtained from the region of the target. Slice thickness was usually 8 mm; only in lesions smaller than 2 cm was the slice thickness reduced to 2–5 mm. Lesion depth and angle of access were then calculated. Depending on location, the target was approached ventrally ($n = 12$), laterally ($n = 8$), or dorsally ($n = 7$) with the patient positioned correspondingly.

The skin and the access to the pleura were carefully anesthetized with 10–20 ml xylocaine 1% using a needle smaller than 1 mm in outer diameter. Advancement of the needle just beneath the pleura was confirmed by CT scan. When the needle tip was shown to be situated 2 mm extrapleurally, 20–40 ml physiologic saline were injected (Fig. 1). This resulted usually in a bulge of the parietal pleura that reached the target. When another CT scan confirmed that the parietal pleura was adjacent to the target, the small-bore needle was withdrawn. Subsequently, a large-bore 14-gauge Trucut needle (Travenol, Deerfield, IL, USA) was advanced to the target using the extrapleural bulge for access. CT scans were performed to demonstrate exactly the extrapleural location and, finally, the location of the needle inside the target lesion.

The above technique with subpleural injection of saline prolonged the duration of the biopsy procedure by 6–14 min. Transmediastinal access routes required more time than other routes. Routine chest radiographs were obtained in expiration 2 and 4 h after biopsy in all patients to exclude or demonstrate pneumothorax. The patient's charts were reviewed for delayed complications and for verification of the biopsy diagnoses.

Results

The technique was applied successfully in 19 subpleural lung lesions and in eight paramediastinal pulmonary lesions. The distance between the proximal margin of the target and the pleural surface in the access route did not exceed 8 mm in any of the cases, and averaged 4.1 mm. All eight paramediasti-

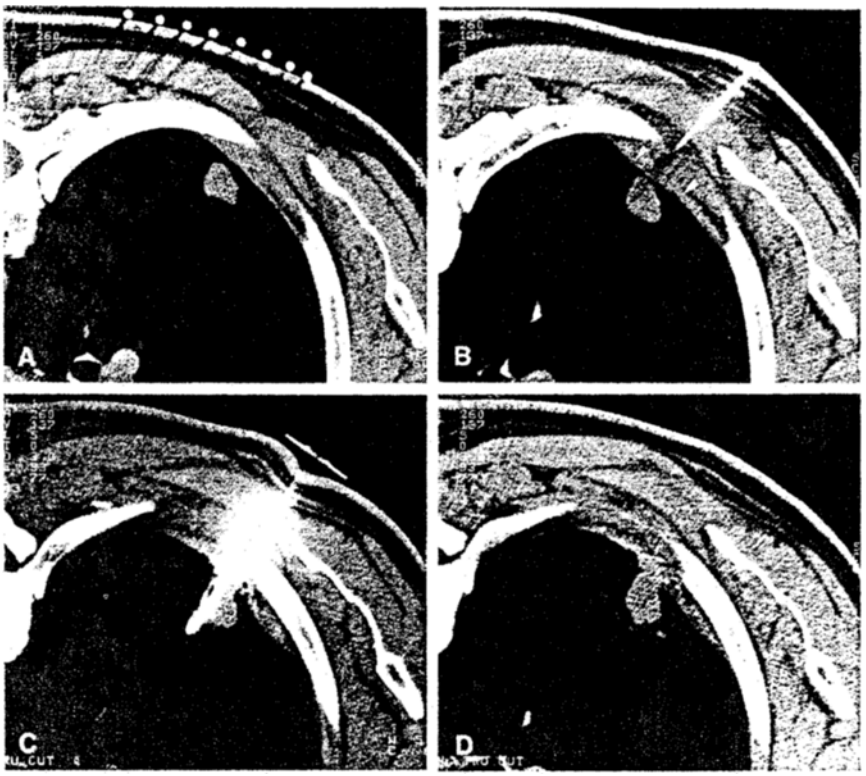

Fig. 1. Extrapleural injection of saline in the thoracic wall for large-bore biopsy of a 1.5-cm-sized peripheral coin lesion of the lung. **A** CT obtained for planning the procedure. Interposition of a 0.4 cm layer of ventilated lung in the access route to the target. Grid taped on the skin. **B** CT after extrapleural saline injection (20 ml). The target is reached by an extrapleural bulge (arrowheads). The tip of injecting needle is outside the plane. **C** Trucut (14-gauge) needle in place traversing the bulge. Histology: squamous cell carcinoma. **D** Postbiopsy scan.

nal pulmonary lesions were approched via a posterior (n = 5) or anterior (n = 3) transmediastinal access (Fig. 2). In all lesions the needle traversed the extrapleural bulge and hit the target. No case developed a pneumothorax as shown by postbiopsy routine chest radiographs. No other complications or adverse effects occurred. Adequate material for histologic examination was obtained from all lesions. Overall diagnostic accuracy reached 100% in 22 malignancies and in five benign lesions.

Discussion

Various methods have been advocated for the prevention of pneumothorax following transthoracic biopsy. Embolization of the needle tract with isobutylcyanoacrylate was used successfully in an experimental setting [9]; however, its value in patients and its safety has not been established. Although embolization of the needle tract with autologous blood clots has been performed in patients [10–13], its usefulness remains controversial. Whereas blood clots reduced the pneumothorax incidence in some studies [10–12], they did not in another study [13]. All these methods were intended for fine-needle techniques. In previous studies, however, no attempt has been made to prevent pneumothorax following large-bore needle biopsies.

Large-bore biopsies have a higher diagnostic yield than fine-needle aspiration biopsy because histologic specimens can be regularly obtained. Histology is superior to cytology in diagnosing and classifying tumors, especially when they are noncarcinomatous in origin. However, the caliber of the needle plays a major role in the development of pneumothorax [1]. In our own experience, pneumothoraces after large-bore puncture required drainage more often than those after fine-needle puncture.

The technique of injecting normal saline solution into the mediastinum has been previously described for biopsy of mediastinal lesions to avoid transpleural passage of the biopsy needle [2, 14]. For this purpose, saline has been injected only into the mediastinum. However, the technique has yet not been used for peripheral pulmonary lesions. We adapted it for such use. The most surprising effect of our technique was that the subpleural lung lesion was not displaced toward the hilum by the extrapleural bulge as we expected. Instead, the portion of the lung peripheral to the target lesion apparently collapsed. Displacement of a target occurred only after the extrapleural bulge had reached it. This effect may be best explained by the fact that the lung constitutes a multichambered system. At least in the early phase, only those chambers which are directly exposed to external pressure collapse. Therefore, we attribute prevention of pneumothorax in our cases to the artificial collapse of interposed lung parenchyma. Small postbiopsy bleeding into the needle tract may have contributed to the pneumo-

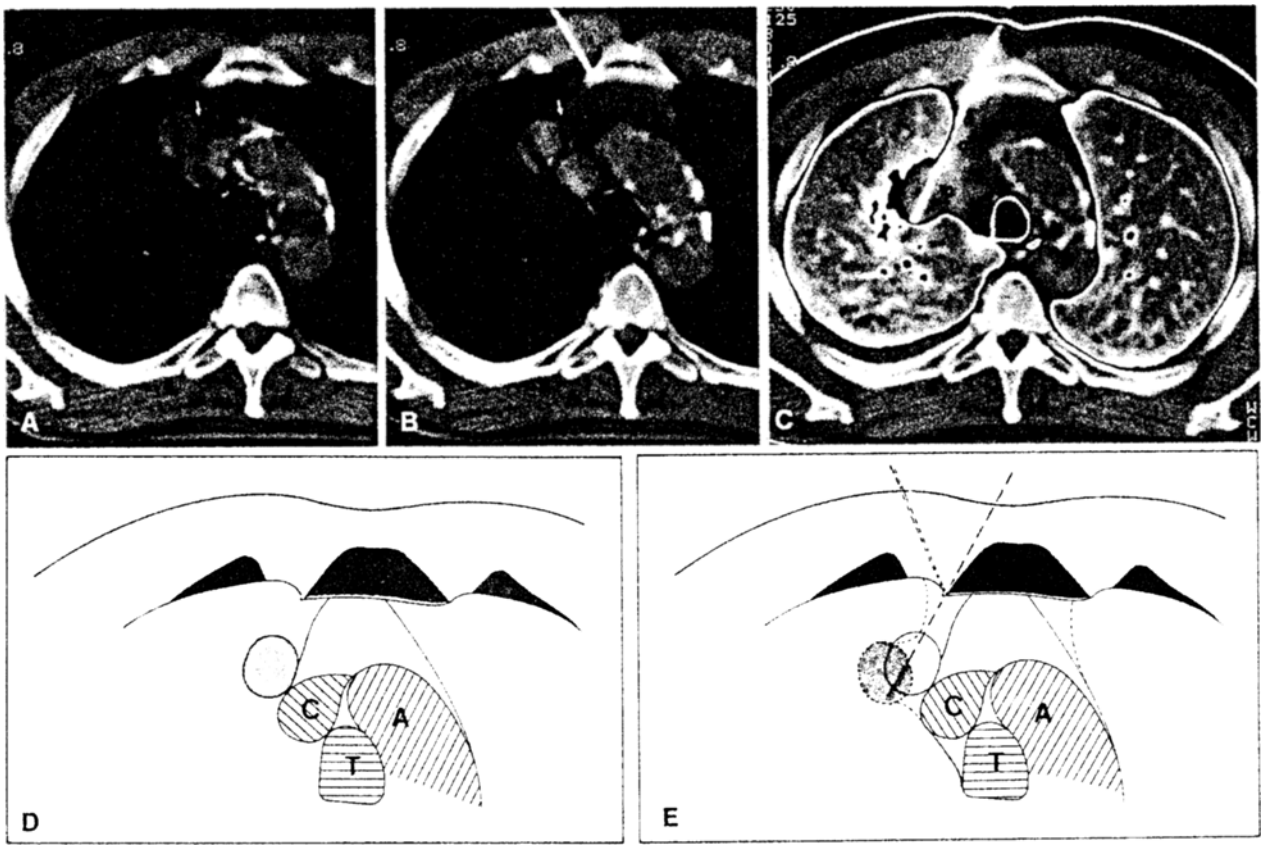

Fig. 2. Extrapleural injection of saline into the anterior mediastinum for safe transpleural large-bore puncture. **A** CT obtained before biopsy procedure reveals an 8 mm layer of ventilated lung in the access route between the target and mediastinal pleura (arrow). **B** After extrapleural injection of 40 ml saline into the anterior mediastinum with a fine needle, the mediastinal pleura abuts the target (arrow). **C** The target is entered with a 14-gauge Trucut needle. Histology: fibrosarcoma. **D** Schematic drawing of the anatomic situs before extrapleural injection of saline. C, superior vena cava; A, aorta; T, trachea. **E** Schematic drawing of the complete procedure. Double dotted line represents needle used for injection of saline; interrupted line is biopsy needle; curved interrupted line is mediastinal borders after injection of saline.

thorax prevention. However, postbiopsy hemorrhage alone does not generally prevent pneumothorax.

Although our technique seems not suitable for lung lesions more than 8 mm distant from the pleura, it enhances safety in a certain number of patients.

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