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Transcervical Access for Ultrasound-Guided Biopsy—A Safe Technique to Sample Apical Lung Lesions

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Abstract

Eight patients with apical lobe lung lesions referred for image-guided biopsy where the lesion was abutting the mediastinal or apical pleura, and was visible in ultrasound using a suprasternal–supraclavicular route were consented and subjected to successful ultrasound-guided transcervical biopsy using different routes based on lesion characteristics and location of vital vascular structures—either through the thyroid gland, by the side of the gland lateral to the common carotid artery, or between the thyroid gland and common carotid artery after hydrodissection. Transthyroid access was used in 50% of cases. There were no immediate or long-term complications in any patient over a mean follow-up period of 28.5 months. Sample adequacy was 100%.

Keywords
- transcervical
- transthyroid
- lung apex
- core biopsy

Introduction

Biopsy for histological diagnosis of lung lesions is necessary for treatment planning and is commonly less invasively performed either using a transbronchial route or image-guided percutaneous route. Different imaging modalities have been used which include fluoroscopy, computed tomography (CT), and ultrasound. Ultrasound is useful for guidance only when there is no aerated lung between the chest wall and the lesion.[1] Lesions in the medial aspect of the lung apex are tricky to target using an anterior route because of surrounding structures including ribs, clavicle, subclavian vessels, and internal mammary vessels, and most often *z*-axis tilting of the needle is needed.[2] CT-guided axillary and posterior intercostal access can be used to target these lesions.[2,3] Ultrasound-guided biopsy is safer, quicker, and less expensive; and as per guidelines, ultrasound should be used for guidance whenever possible.[1] We describe an ultrasound-guided biopsy technique for sampling of medial apical lung lesions using a transcervical route which can be performed safely and quickly.

Techniques

All these biopsies were done after providing detailed explanation of procedure and possible complications to the patient, and a written consent. Ultrasound of the lung apex using suprasternal/supraclavicular route was performed on 8 patients (7 male and 1 female) with CT scan-proven apical lobe lung lesions abutting the mediastinal or apical pleura during their visit to the hospital for preassessment. The lesions were visible in ultrasound and ultrasound-guided transcervical biopsy was planned instead of a CT-guided biopsy. Preprocedure evaluation included review of patients'

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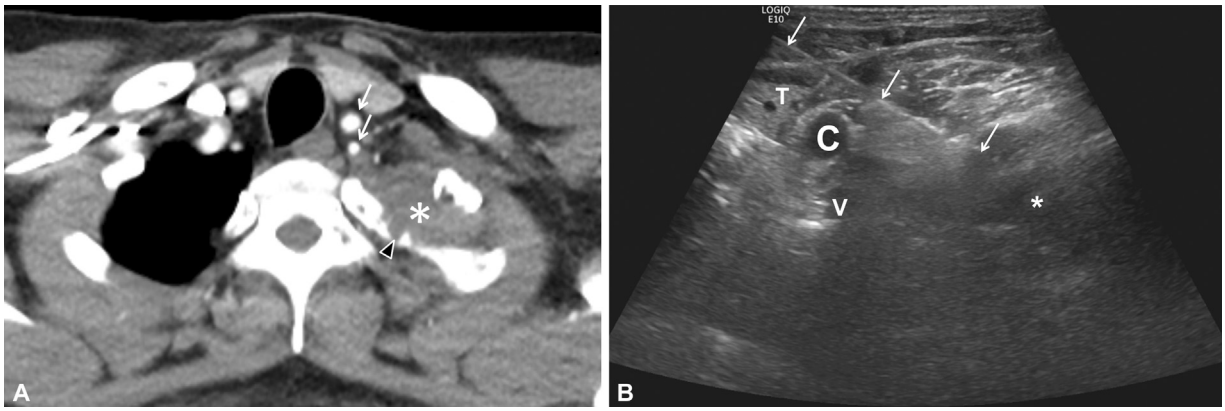

Fig. 1 (**A**) Axial contrast enhanced computed tomography (CT) scan of the chest showing a lesion in the left lung apex (*) causing rib erosions (arrowhead), above the level of the subclavian artery (not visible in this section). The left common carotid and vertebral arteries (white arrows) are shown. (**B**) Intraprocedural ultrasound image showing the coaxial biopsy introducer needle placed with its path anterolateral to the thyroid gland (T), common carotid (C), and vertebral (V) arteries, with its tip in the lesion (*).

medical history for bleeding disorders, and laboratory evaluations including hematocrit, prothrombin time, and activated partial thromboplastin time. Anticoagulants and antiplatelet drugs were stopped in accordance to the local safety standards for invasive procedures. All these biopsies were performed by an interventional radiologist with more than 10 years of experience in imaging and interventions of the neck and chest.

Informed and written consent was obtained, and in addition to the usual complications, the possibility of tumor seeding in the track as an extremely rare occurrence was explained. All biopsies were performed with the patient in supine position, with a pillow under their shoulders for optimal neck extension and the head turned to the side opposite to the side of the lung lesion. Ultrasound was performed with the probe placed obliquely in the ipsilateral suprasternal–supraclavicular region and the probe was tilted caudally till the apical lung lesion could be clearly seen. B mode and Doppler assessments were made to locate the thyroid gland, common carotid, vertebral and subclavian arteries, and the internal jugular vein. Optimal needle trajectory was chosen either to the side of the thyroid gland, or through the thyroid gland. Efforts were made to avoid the thyroid gland whenever possible by either using a direct trajectory to the lesion when available, or through a track between the thyroid gland and common carotid artery created by hydrodissection (injection of saline between thyroid and carotid artery). When these were not feasible, and there was a clear track to the tumor through the thyroid gland, a transthyroid route was chosen.

Local anesthetic was infiltrated in the skin and the subcutaneous tissue. A 17G 6.8-cm coaxial introducer needle (BioPince, ArgonMedical, United States) was placed in the chosen pathway into the lesion under continuous vision using an in-plane technique and samples were obtained using an 18G 10-cm needle (BioPince, ArgonMedical) with a manually selected 2.2 cm needle throw. In patients where a transthyroid access was used, a 19G 10-cm coaxial introducer needle and a 20G 15-cm biopsy needle combination (Temno, MeritMedical, United States) was used which had a 2-cm needle throw. A minimum of 3 cores were obtained when an 18G biopsy needle was used and a minimum of 8 cores when a 20G needle was used. Transcervical access anterior to the carotid artery and thyroid gland was possible in two patients where the lesion was in the apical most part of the apical segment reaching above the level of the subclavian artery (►**Fig. 1**). Transcervical route with hydrodissection to create a pathway between the carotid artery and thyroid gland was used in two patients (►**Fig. 2**), and transthyroid route was used in four patients (►**Fig. 3**). After obtaining adequate samples, bleeding was observed through the coaxial needle in two patients and the biopsy track in the lung was embolized with thick gelfoam (Spongostan Standard, Johnson & Johnson Medical N.V., Belgium) slurry injected through the coaxial introducer needle before its removal. Postprocedure ultrasound was performed immediately and 5 minutes after biopsy and the patients were monitored for signs of hemorrhage in the neck. None of the patients showed any sonographic signs of bleeding/thyroid edema postbiopsy. Routine postbiopsy care was followed which included bed rest and observation in the recovery room for 4 hours. Even though normal lung was not transgressed in the procedure, a postbiopsy chest radiograph was obtained before discharge to look for complications like pneumothorax and hemothorax. There were no complications in any of the patients and the patients were discharged from the hospital after the period of observation. The patients were contacted over phone the day after the procedure. None of the patients developed any new onset postbiopsy pain, bleeding in the neck, hemoptysis, pneumothorax, or hemothorax.

All biopsies were adequate for histological diagnosis and immunohistochemistry. All the biopsies were proven to be malignant.

Periodic imaging that the patients were put on for their malignancy were reviewed, and there were no long-term complications; in particular, there was no track seeding over

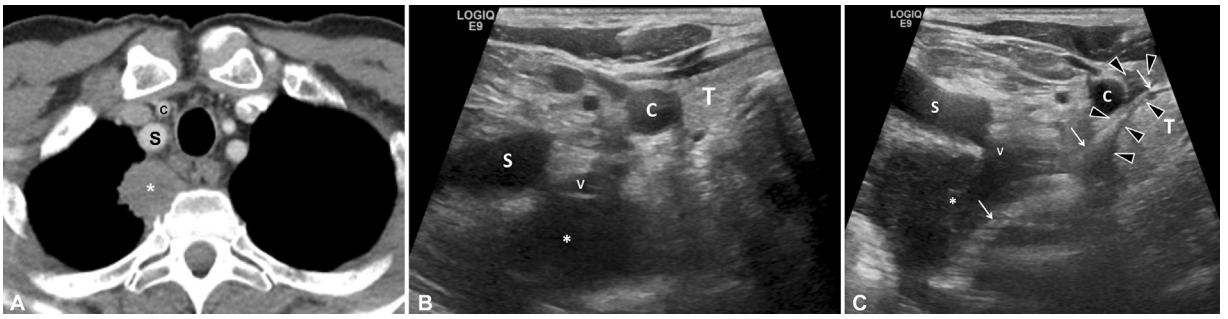

Fig. 2 (**A**) Axial contrast enhanced computed tomography (CT) scan of the chest showing a lesion in the medial aspect of the right lung apex (*) posterior to the right carotid (C) and subclavian (S) arteries. (**B**) Preprocedural ultrasound image of a patient with a right lung apical lesion showing the thyroid gland (T), common carotid (C), vertebral (V), and subclavian (S) arteries, and the apical lesion (*). (**C**) Intraprocedural ultrasound image in the same patient showing the biopsy needle (white arrows) placed through a hydrodissected path (black arrowheads) created by injecting saline between the common carotid artery (C) and the thyroid gland (T), with its tip in the lesion (*). Subclavian artery (S) and vertebral artery (V) are shown.

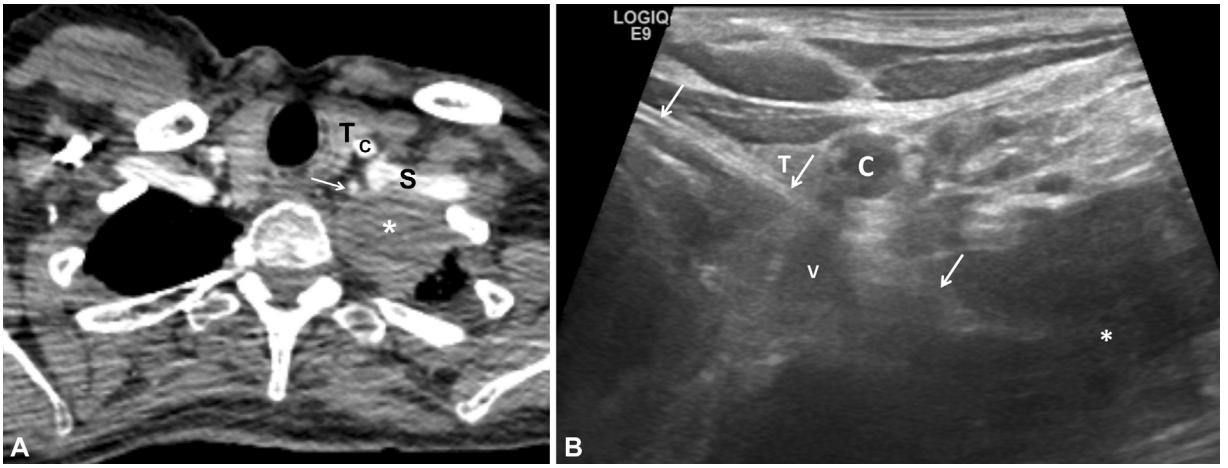

Fig. 3 (**A**) Axial contrast-enhanced computed tomography (CT) scan of the chest showing a lesion in the medial aspect of the left lung apex (*) posterior to the right carotid (C), subclavian (S), and vertebral (arrow) arteries and the thyroid gland (T). (**B**) Intraprocedural ultrasound image during biopsy of a left apical lung lesion showing the coaxial biopsy introducer needle placed into the lesion (*) through the thyroid gland (T) between the common carotid (C) and vertebral (V) arteries.

a mean follow-up period of 28.5 months. ►**Table 1** shows a summary of cases, techniques used, and diagnosis.

Discussion

Ultrasound guidance for lung lesion biopsy is well-established and commonly used but is suitable only when the lesion is in contact with the chest wall, with no aerated lung between the skin and the lesion.[1] Ultrasound is preferred over CT guidance by majority of the operators for biopsy of such lesions, and as per guidelines, ultrasound should be used whenever possible since it is safe, quick, provides real-time needle guidance, more cost effective, and does not involve radiation.[1] Lesions in the lung apex are difficult to target using an anterior approach because of intervening structures including ribs, clavicle, subclavian vessels, and internal mammary vessels.[2] CT-guided axillary or posterior intercostal access have been used to sample these lesions.[2,3] The disadvantages of CT guidance including a non-real-time nature and difficult differentiation of blood vessels from soft tissue without intravenous contrast injection contribute to possibility of complications despite a posterior or axillary access, since an overshoot of the biopsy needle either accidental, from inaccurate measurement of the needle throw, or underestimation of needle tip depth due to partial coverage of an *z*-axis obliquely placed needle can still cause injury to major vessels. Also, the risk of intercostal injury is higher with CT-guided posterior access for lesions in the lung apex since it is known that intercostal arteries are exposed in the intercostal space instead of coursing in the subcostal groove posteriorly for more than 6 cm from the spine, especially in the upper intercostal spaces and in the elderly population.[4]

Table 1 Summary of cases

Total number of cases	8
Side of the lesion	Left: 4 Right: 4
Route of biopsy; and average number of cores in parenthesis	Transthyroid: 4 (8.25) Transcervical with hydrodissection: 2 (3.5) Direct transcervical lateral to carotid artery: 2 (3.5)
Histopathology diagnoses; and number of cases in parenthesis	Undifferentiated/anaplastic carcinoma: 1 Poorly differentiated adenocarcinoma: 1 Invasive squamous cell carcinoma: 2 Poorly differentiated nonsmall cell cancer favoring squamous cell carcinoma: 1 Undifferentiated nonsmall cell cancer with no neuroendocrine differentiation: 1 Moderately differentiated adenocarcinoma of bronchioloalveolar type: 1 Malignant sarcomatoid mesothelioma: 1

Anatomically lung apex reaches above the first rib and clavicle into the base of the neck, and can be seen in ultrasound through a suprasternal, supraclavicular, or infraclavicular route.[5] Lesions in the apical most part of the lung can be targeted using an access above the level of the subclavian artery, anterolateral to the carotid and vertebral arteries. Lesions at or below the level of the subclavian artery reaching the mediastinal pleura can be accessed through or by the side of the thyroid gland, the needle trajectory being posteromedial to the common carotid artery. A combination of B mode and Doppler mode facilitates mapping and avoidance of all major neurovascular structures including common carotid artery, subclavian artery, vertebral artery, thyrocervical artery, brachial plexus, and phrenic nerve. A good sonographic anatomical knowledge of the neck is necessary to avoid neurovascular injury. With the availability of coaxial introducer needles, multiple cores of tissue can be obtained after a one time meticulous and careful placement of the needle into the lesion, and the biopsy track can be embolized with gelfoam or fibrillar collagen if bleeding is observed.

The safety of core biopsies of thyroid nodules using 18G biopsy needles is well documented and transthyroid route for accessing the cervical spine has been described in literature.[6] Kattapuram and Rosenthal described in 1987 the first reported case/cases of transthyroid route for cervical spine, but the paper is not clear on the number of patients in whom this route was used, and the size of the biopsy needle used in these patients; no complications were reported.[7] Sutphen and Murakami in 2007 reported a transthyroid approach for radiofrequency ablation of a C5 vertebral body osteoid osteoma without complications.[8] Wiesner et al in 2018 in their paper on CT-guided biopsies of the cervical spine mention that it is often difficult to avoid the thyroid gland when sampling the lower cervical spine,[9] and Husseini et al in 2021 describe an anterolateral approach through the thyroid gland or other anterior cervical structures to access cervical spine infections[10]; in these two publications again, there are no details specific to the transthyroid route. In our experience, transthyroid route was used for four out of eight cases, 20G core biopsy needle through a 19G coaxial introducer needle was used in all four cases, and no immediate or long-term complications were observed throughout the available follow-up period. Considering the smaller size of the biopsy needles used and a single transgression through the thyroid with a coaxial needle, thyroid Doppler to avoid intrathyroidal blood vessels was not undertaken in the cases described. To the extent of our knowledge ultrasound-guided transcervical or transthyroid route for lung apical lesion biopsy has not yet been described in available literature.

Conclusion

In conclusion, ultrasound-guided transcervical access including access through the thyroid gland to sample suitable lung apical lesions is feasible enabling the operator to confidently identify and avoid major neurovascular structures without radiation or intravenous contrast injection, and shows a high diagnostic performance, but should be performed by radiologists with a very good sonographic anatomical knowledge of the neck and its safety profile needs to be further explored by its application in a larger number of patients.

Data Availability Statement
The dataset is included in this manuscript.

Conflict of Interest
None declared.

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