REVIEW ARTICLE

FLUORO-CT GUIDED BIOPSY OF LUNG NODULES: A STEP BY STEP REVISION

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Abstract

Introduction: *Transthoracic biopsies under fluoro-computer tomography (CT) guidance play an important role on the diagnosis and management of lung nodules, permitting histological examination and differentiation between benign and malignant lesions[1]. Furthermore, with recent advances in target therapy, it is increasingly necessary to obtain tumor tissue for the analysis of molecular fingerprints allowing personalized treatment[1].*

Although many studies report low complication rates for this procedure, they are not negligible, urging the need for a structured and reproducible guide to reduce technique-related complications[1,2].

INTRODUCTION

Transthoracic biopsies under fluoro-computer tomography (CT) guidance play an important role on the diagnosis and management of lung nodules, permitting histological examination and differentiation between benign and malignant lesions[1]. Furthermore, with recent advances in target therapy, it is increasingly necessary to obtain tumor tissue for the analysis of molecular fingerprints allowing personalized treatment[1].

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METHOD

In this article, key concepts and techniques regarding CT-guided biopsies of lung lesions are shared and discussed, including the potential complications of this procedure, using our center's expertise and illustrative cases.

DISCUSSION

The indications and methods for lung biopsy have changed over the years with increased access to CT and more therapeutic options, becoming, nowadays, a rather frequent practice[2,3]. All invasive procedures have a morbidity and mortality rate associated that should be considered when deciding when to subject a patient to them[3]. For this reason, a multidisciplinary meeting will ensure the most appropriate approach to lung biopsy and should include at least a respiratory physician and a radiologist with an interest in chest disease[3].

Percutaneous transthoracic lung biopsy should be considered in the following cases[3]:

· New or enlarging solitary lung nodule or mass that is unlikely to be accessible by bronchoscopy;

· Multiple nodules in a patient with unknown malignancy or who has had a prolonged remission or more than one primary malignancy;

· Persistent focal infiltrates, either single or multiple, for which no diagnosis has been made by sputum or blood culture, serology, or bronchoscopy.

In order to obtain multiple large specimens for diagnosis and molecular analysis, coaxial core biopsy is preferred compared to aspiration cytology[3].

Preprocedural laboratory check and informed consent

Coagulation factors, such as platelet count, prothrombin time and activated partial thromboplastin times, should be checked before the procedure. Any anticoagulants or platelet inhibitors should be withheld[4].

Being an invasive procedure and due to the potential of severe complications, an informed consent should always be obtained[3].

Basic concepts

Respiratory motion – the inferior lung lobes are more affected by respiratory motion. The needle is inserted at the end of the expiratory stage and the patient is asked not to breathe in nor out for a few seconds while the specimen is obtained[2,5].

Cardiac motion - The lingula is the lung segment most affected by cardiac motion, and the myocardium or epicardial coronary arteries must be avoided while carrying out lung biopsies in this location[1,6]

Chest Wall Vessels - All vessels greater than 5 mm should be avoided to reduce hemorrhage[5]. Moreover, inserting the coaxial needle on the superior border of the rib rather than the inferior border, prevents puncture of intercostal arteries[1].

Fissures – Traversing lung fissures rises the probability of pneumothorax, therefore this should be avoided or, if necessary, the patient should be informed of the increased risk of this complication [5,6].

Shock wave injury – After the biopsy needle fires, the shock wave distal to its tip may cause damage to areas lateral to the needle causing mild hemorrhage. Major vessels should be kept away from the danger zones at the tip and lateral to the needle[1].

Technique

1 - Patient positioning - A chest-CT is carried out to localize the pulmonary lesion and the patient is positioned in the most adequate decubitus for the procedure. The best approach for needle insertion is chosen [1,4].

2 - Local Anesthesia - The distance between the skin and pleura should be measured. The needle tip should never advance through the pleura or a pneumothorax can develop. 10-15ml lidocaine 2% is the local anesthesia used at our center [1,4].

3 - Insertion of the coaxial 17G needle – this should be made with a rapid thrust to the subpleural region to limit laceration to the pleura, and under fluoroscopy guidance to diminish the risk of pneumothorax [1,4] (Fig.1a and b)

4 - A fully automated or semi-automated 18G biopsy needle is inserted through the coaxial needle to obtain tissue (Fig.1c).

5 - The number of fragments obtained is variable, depending on the quality of the fragments initially taken, and on the development of complications. Direct inspection can confirm if the specimen is adequate [1,4].

6 - The specimen fragments should have 15mm or 22mm, with preference of 22mm to obtain more tissue, except when there is a need to avoid vessels close to the lesion and, in that case, 15mm fragments are taken [1,4].

7 - Fragments are stored in formalin. Between biopsies the needle must be cleaned to avoid insertion of formalin into the patient [3].

8 - Patients are taken to recovery and post biopsy, erect chest radiograph should be performed at least 1-2 hours after the procedure. Decision should be made at that time regarding further management if a pneumothorax is present[3].

COMPLICATIONS

Pneumothorax and hemorrhage are the most common procedure complications. Other rare complications include hemothorax, air embolism, tumor cell seeding and death [6,7].

Risk factors for pneumothorax include parenchymal emphysema, small lesion, longer skin to lesion distance and lesion located close to fissure. Furthermore, the larger the incision angle and the higher the number of samples taken, the higher the risk [6,7]. After the procedure the patient should be placed in lateral decubitus, lying on the side of the affected lung [1,7].

If the pneumothorax is progressing, manual aspiration should be made, and if the volume aspirated is more the 670cc, insertion of a pigtail catheter with a subaquatic drainage system is recommended [7] (Fig. 2).

Track occlusion is another method used at our center to limit the development of a pneumothorax. It consists of inserting a pleural air leak sealant through the guide needle at the end of the procedure, to occlude the track left by the needle, preventing air from entering, It is usually applied to high risk patients (e.g. emphysema) [6,7] (Fig. 3).

Recently this sealant has gained another utility in tagging the location of lung lesions. Under fluoroscopy guidance, radiologists can insert this product into the skin adjacent to a lesion, enabling surgeons to more easily and precisely localize it [7].

Alveolar hemorrhage is usually auto-limited, and risk factors include emphysema, pulmonary hypertension, small lesion and longer skin to lesion distance (Fig. 4). If hemoptysis occurs (4%) the procedure should be interrupted and the patient placed in lateral decubitus, lying on the side of the affected lung [6].

Hemothorax is another potential complication although significant hemorrhage is rare. Hemorrhage may occur from intercostal or internal mammary arteries or veins

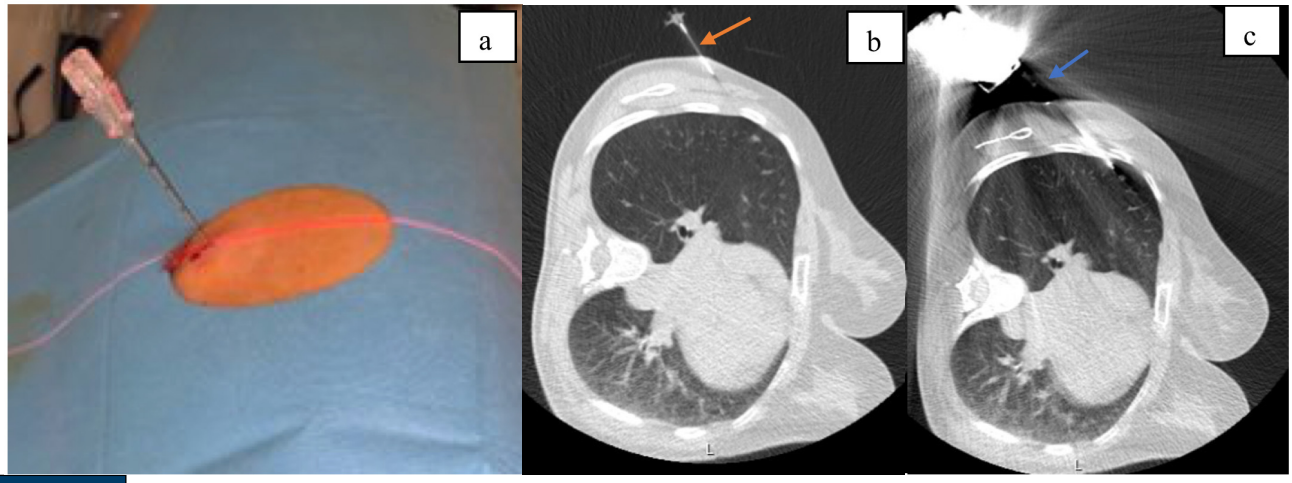

Figure 1 *(a) Image of a superficially inserted coaxial (guide) needle. (b) CT axial scan showing the same coaxial needle (orange arrow). (c) CT axial scan showing the biopsy needle inserted within the coaxial needle (blue arrow).*

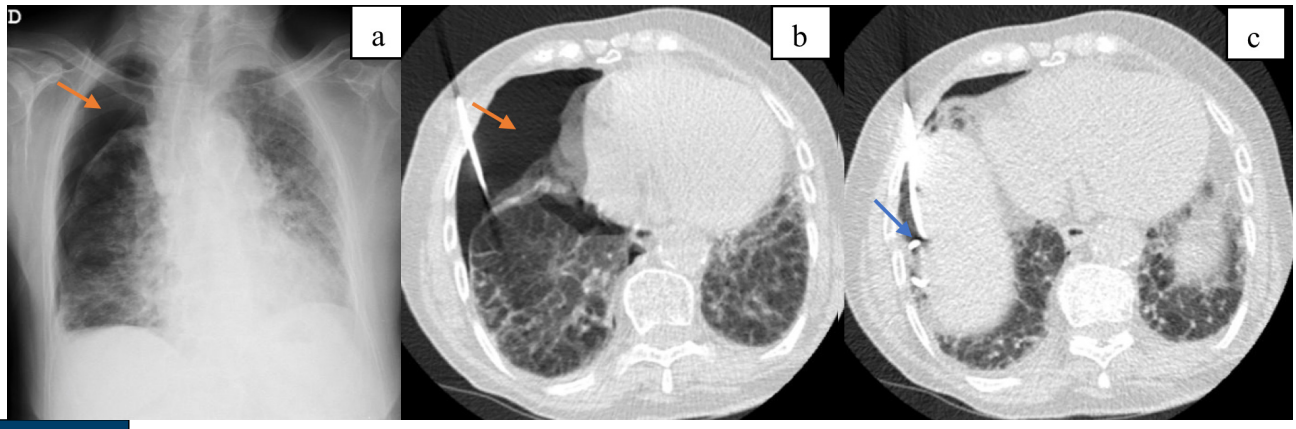

Figure 2 *PA Chest X-ray (a) and axial lung CT (b) showing a pneumothorax that developed during lung biopsy (orange arrows). (c) Axial lung CT scan showing the same patient after insertion of a pigtail catheter to drain the pneumothorax (blue arrow).*

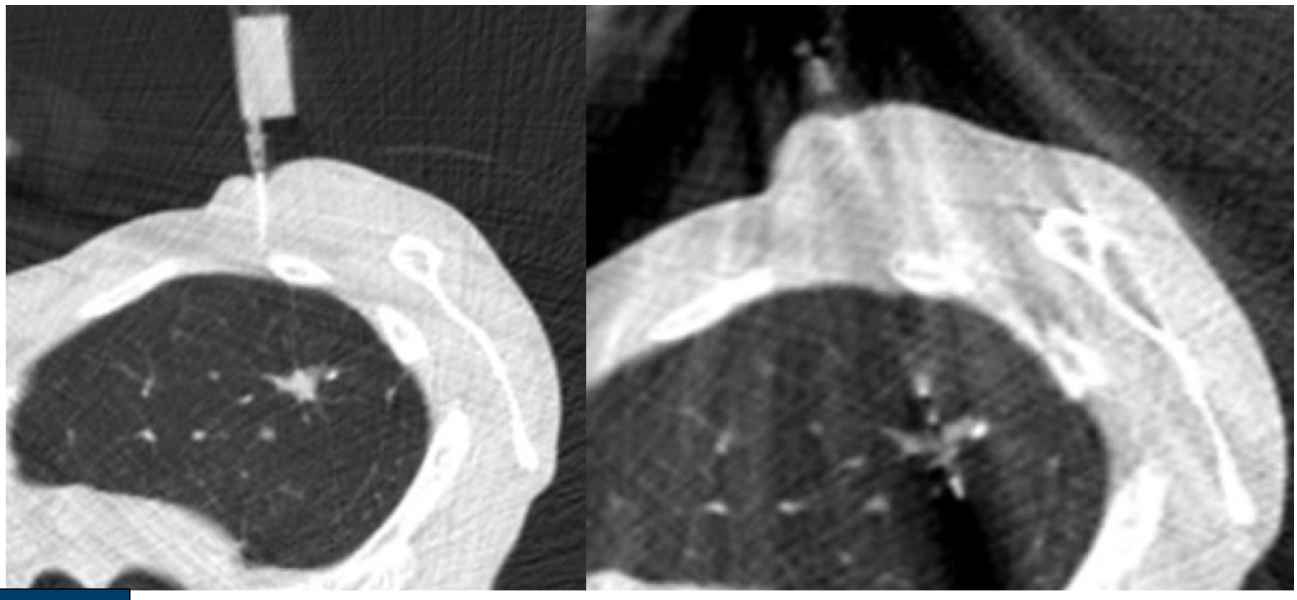

Figure 3 *Axial CT lung scans showing the insertion of a pleural air leak sealant using the guide needle, to prevent pneumothorax*

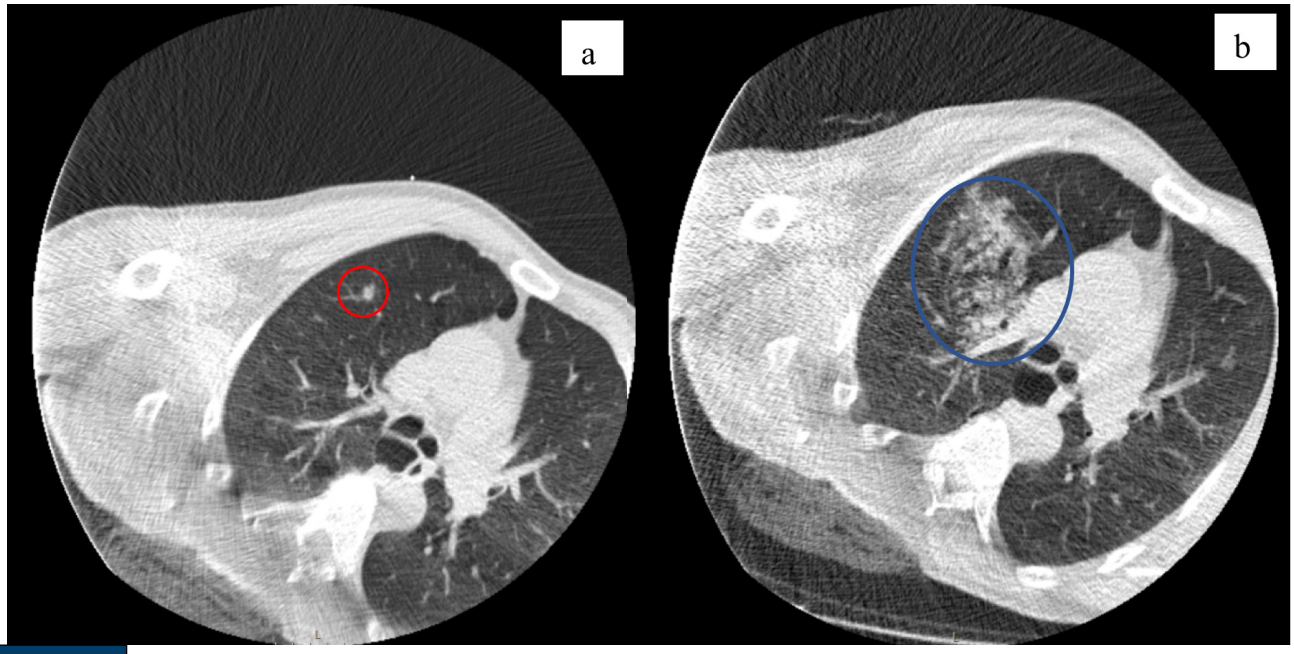

Figure 3 *(a) Axial CT lung scan showing a small lung nodule previous to biopsy (red circle). (b) Axial CT lung scan of the same area after biopsy showing an alveolar hemorrhage (blue circle).*

Pulmonary embolism is a rare but dangerous complication. Risk factors include biopsy of cystic or cavitated lesions, vasculitis and positive pressure ventilation. To prevent this complication, the coaxial needle must be closed every time the biopsy needle is removed, to prevent air from entering. If a pulmonary embolism is suspected, the patient should be placed in Trendelenburg position with an oxygen 100% face mask [1,6].

Tumor cell seeding is extremely rare and there is no established relationship between the needle size, lesion size, lesion location and the risk of seeding[6].

CONCLUSION

In this article, basic concepts, protocols, and techniques used for CT-guided core biopsy of lung lesions are summarized, to enlighten radiologists and non-radiologists about this procedure and its possible complications. Percutaneous lung biopsies are frequently performed with considerable benefits for patient management and can be carried out safely on an outpatient basis.

Radiologist should attempt to obtain diagnostic specimens while reducing preventable complications, and other specialists should be aware of its risks to measure the risk-benefit ratio.

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