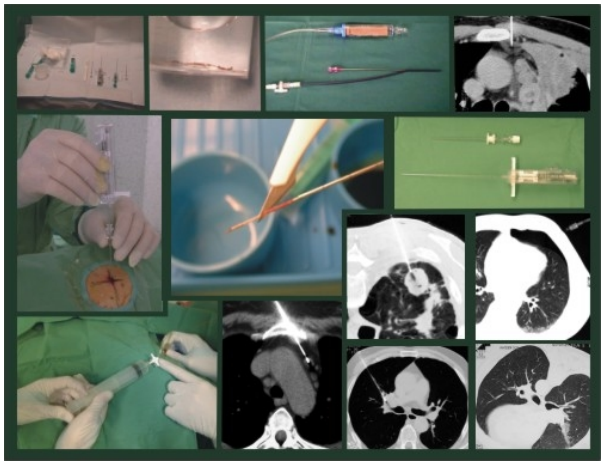
Complications of percutaneous chest biopsy: how to avoid and manage them

(RSNA 2000)



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A special note of gratitude goes to Stephen Ferron, Petra Gangi and Nathalie Chalus for checking the presentation.

1) introduction

Percutaneous needle biopsy of the chest is part of the every day job of thoracic and general radiologists. The radiologist should know how to prevent, and/or reduce complications and know how to deal with them. We reviewed 600 consecutive thoracic biopsies performed during the last four and a half years. First, the contraindications of chest biopsy are pointed out. Then, different techniques for reducing complications are described, particularly in high-risk patients. The management of complications will be discussed including the description of the materials required.

Fig1 : Lung biopsy under CT-guidance. Patient on prone position.

Fig 2 : a 20-gauge coaxial semi automatic cutting needle (Allegiance) is used.

Fig 3 : The procedure is performed with a multidetector CT scanner. The monitor is placed in front of the physician.

2) Material

- Nasal oxygen
- Sterile drapes, tampons
- 22-gauge needle for local anesthesia, scalpel

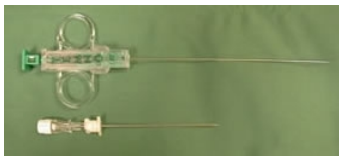


Fig 6 : semi automatic 19-20 gauge coaxial biopsy gun

Fig 7 : Coaxial full automatic cutting gun

Biopsy needle :

- The most frequently used needle are: the semi automatic 19-20 gauge coaxial biopsy gun (Allegiance ®, Temno®, Bard®),
- and coaxial full automatic cutting gun (Allegiance ®, Temno®, Bard®) particularly adapted for hard lesion with calcification or fibrosis (i.e. hamartoma.

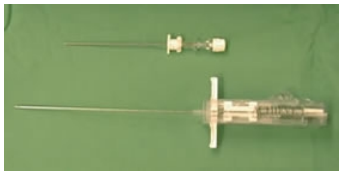


Fig 8 : full automatic 19-20 gauge coaxial biopsy gun

Fig 9 : for all percutaneous lung biopsy a pneumothorax drainage set should be ready for use (pneumothorax set, Cook)

3) Indications

The biopsy should be limited to cases in which the results potentially modify the therapy or surgical approach. The procedure should be technically feasible and the patient should be informed and consenting.

- Nodule or mass of lung, mediastinum, hilum (negative bronchoscopy), or pleura
- Malignancy associated with a parenchymal, hilar, or mediastinal adenopathy or mass requiring staging.
- Languishing parenchymal consolidation or abscess without isolated infectious organism.

4) Contraindications

- Uncooperative patient, intractable cough
- Bleeding diathesis
- Severe obstructive lung disease with Forced Expiratory Volume < to 900 to 1000 ml
- Pulmonary hypertension
- Vascular lesion
- Positive pressure ventilation
- Controlateral pneumectomy

Fig 4: Suspicion of a bronchioloalveolar carcinoma. CT before IV contrast media injection.

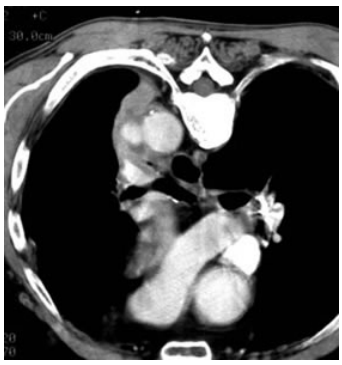


Fig 5 : Saccular aneurysm of descending thoracic aorta. Contraindication of percutaneous biopsy.

5) Complications

Early recognition of complications is essential for avoiding morbidity and mortality.

- Pneumothorax : Pneumothorax occurred in less than 15% (69 patients) of cases and chest tube drainage was necessary in 10% (7 patients) of these cases. The risk increases with lesion depth, small lesions, number of passes through the pleura, and needle size.
- Hemorrhage : Hemorrhage and hemoptysis occurred in 6% of cases (28 patients) with two cases of hemothorax due to biopsy of hypervascularized metastasis of breast and kidney carcinoma. In our series, hemoptysis has always been self-limited and has not required further treatment.
- Rare complications
    - Air embolism is a rare complication. The needle should never be left open to air while in the chest. Deep breathing, straining, and coughing which may facilitate the passage of air into venous system should be avoided. Cavitary air-containing lesions and densely consolidated or fibrotic areas of parenchyma should be avoided if possible. If coughing occurs during the procedure the needle should be removed.
    - Neoplasm seeding rare complication with fine needle technique. Survival time of patients with or without percutaneous biopsies is similar.

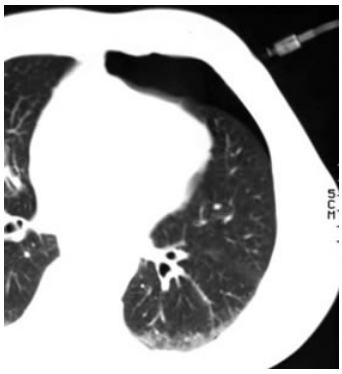


Fig 27 : Symptomatic pneumothorax immediately drained in an emphysematous patient.

Fig 28 : Large pneumothorax without any symptom, aspiration of the collection without drainage.

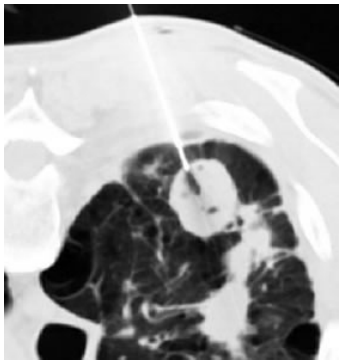


Fig 29 : Percutaneous biopsy of a mass of the superior lobe. The needle pathway should avoid the bullae.

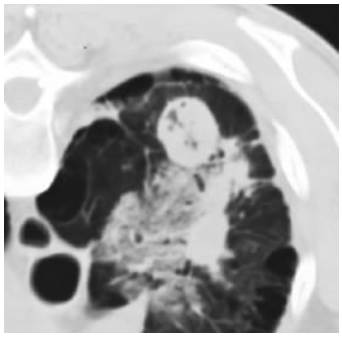


Fig 30 : After percutaneous biopsy. Non pneumothorax but alveolar hemorrhage.

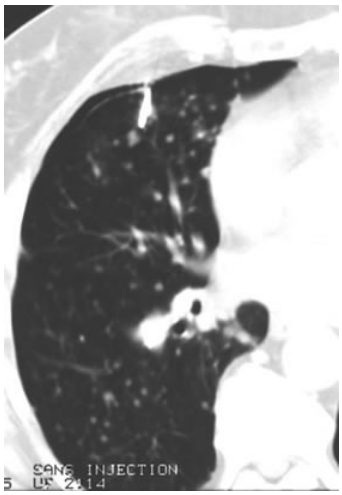


Fig 31 : Percutaneous biopsy of a small metastastic nodule.

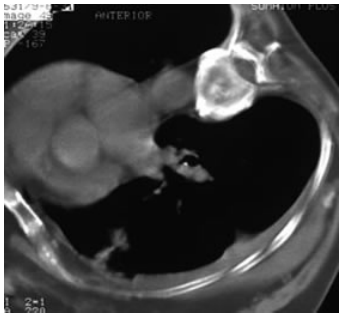


Fig 32 : Follow up. Hemoptysis with hemothorax.

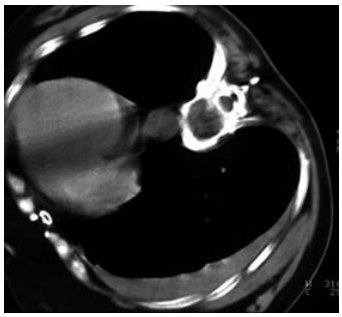


Fig 33 : The patient was hospitalized for two days. Spontaneous resolution of the hemoptysis. The hemothorax was evacuated.

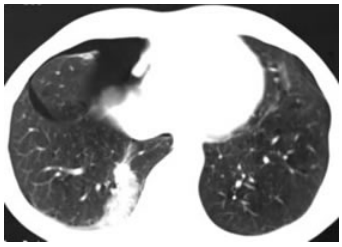


Fig 34 : Asymptomatic pneumothorax and alveolar hemorrhage.

6) Factors that influence complication incidence

- Wise indications : emphysema and small lesions increases the incidence of pneumothorax (Joseph E. Cox and coll.Transthoracic needle Aspiration Biopsy Radiology 1999; 212:165-168) . In these cases especially the Forced Expiratory Volume (FEV) contraindication have to be respected.
    - Severe obstructive lung disease with Forced Expiratory Volume < to 900 to 1000 ml is a contraindication
- Severe obstructive lung disease with FEV < to 900 to 1000 ml is an absolute contraindication
    - Needle Selection: fine coaxial guns. The benefit of finer needle has not be demonstrated beyond 19-gauge
    - We usually use of 19 to 20 gauge coaxial semiautomatic or full automatic guns
- Pathway planning :
    - Extrapleural pathways should be used if possible. Extrapleural pathway is correlated with a very low pneumothorax rates
    - In some cases extrapleural pathways can only be performed after inflation of mediastinal, parietal or paravertebral fat spaces with saline solution. This technique is an effective and elegant way to reduce the risk of pneumothorax
    - shortest pathway
    - pathway should avoid :
        - Aerated lung
        - Peripheral bulla and blebs
        - Fissures
    - The needle is inserted perpendicularly over the lesion avoiding angulation and obliquity as much as possible. (Jane P. Ko and coll. Factors influencing pneumothorax rate Radiology 2001; 218:491-496)
    - Plugging of biopsy tracks with Autologous blood clot has been proposed to prevent pneumothorax (Erich K. Lang and Coll. ABCS to prevent pneumothorax at CT-guided lung biopsy Radiology 2000; 216:93-96)

    - Postprocedure care

        - Immediately after needle removal, the patient is quickly rolled into the puncture-site-down position without any patient effort (passive patient). Although some recent publications (Caroll L. Collins and Coll. Pneumothorax and Dependent versus Nondependent Patient Position

after Needle Biopsy of the lung Radiology 1999; 210:59-64) suggest that the puncture-site-down position may not affect the incidence of pneumothorax

- in case of hemoptysis, the patient should be poisoned in lateral decubitus on the puncture side to avoid diffusion of blood to the controlateral lung

- A control CT is then performed to detect immediate complications. In substantial pneumothorax, immediate aspiration reduces the need of chest tube placement (small plastic intravenous catheter hooked directly to a suction trap; a syringe and three-way stopcock system was used in 8 cases)

- The patient should be left in this position for 2 hours. The patient should avoid activities that may elevate intrathoracic pressure (e.g. coughing, extensive talking, deep breathing). Outpatients are observed in ambulatory care ward with monitoring of the patient's vital signs, oxymetry etc. After 2 hours, the patient can sit up and 4 hours after the procedure, upright expiratory images are obtained

- Early recognition of complications is essential for avoiding morbidity and mortality.

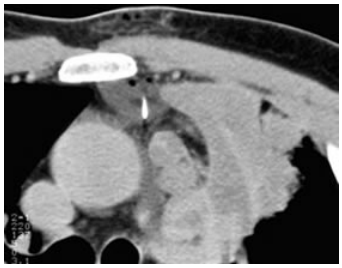


Fig 35 : inflation of mediastinal space with saline solution.

Fig 36 : Systematic oxygen administration.

Fig 37 : puncture-site-down position

How to deal with complications

Early recognition of complications is essential for avoiding morbidity and mortality.

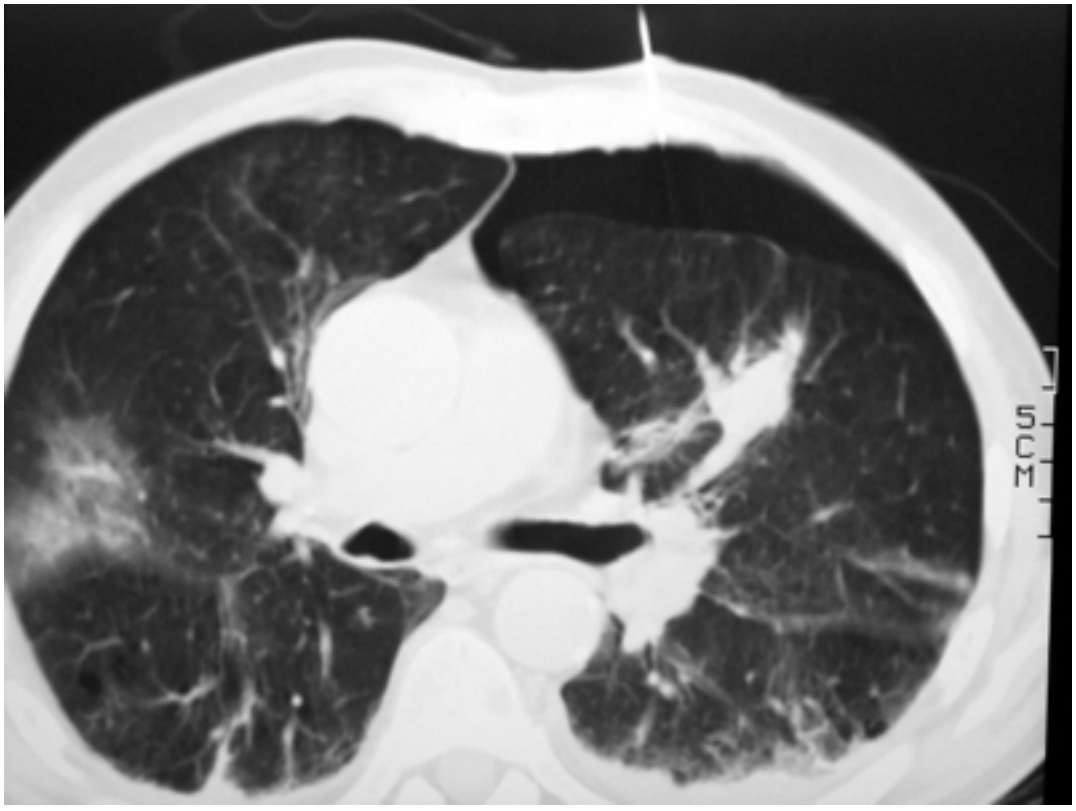
Pneumothorax

- A small asymptomatic pneumothorax (majority of cases) is managed conservatively with supplemental nasal oxygen and the puncture-site-down position should be maintained. If the pneumothorax remains stable on 2 upright expiratory images (+ 3 and + 5 hours after procedure), the patient can leave the hospital with instructions to come back immediately if any respiratory disorders appear.

- In substantial pneumothorax, immediate aspiration reduces the need of chest tube placement (small plastic intravenous catheter hooked directly to a suction trap; a syringe and three-way stopcock system was used in 8 cases).

- If the pneumothorax is large or symptomatic, immediate placement of drainage catheter is required. In these cases a small-gauge pneumothorax catheter (Cook) can be used for immediate drainage (used in one case).

Fig 38 Cases : The patients, who developed a large pneumothorax during CT-guided transthoracic needle biopsy, underwent percutaneous aspiration of the pneumothorax while on the CT scanner table. Air was aspirated from the pleural space by using an 18-gauge intravenous catheter attached to a three-way stopcock and a 50-mL syringe and oxygen was administered both during and after the procedure. Percutaneous catheter aspiration of a large biopsy-induced pneumothorax is safe and easy to perform and may obviate chest tube placement.



pneumothorax

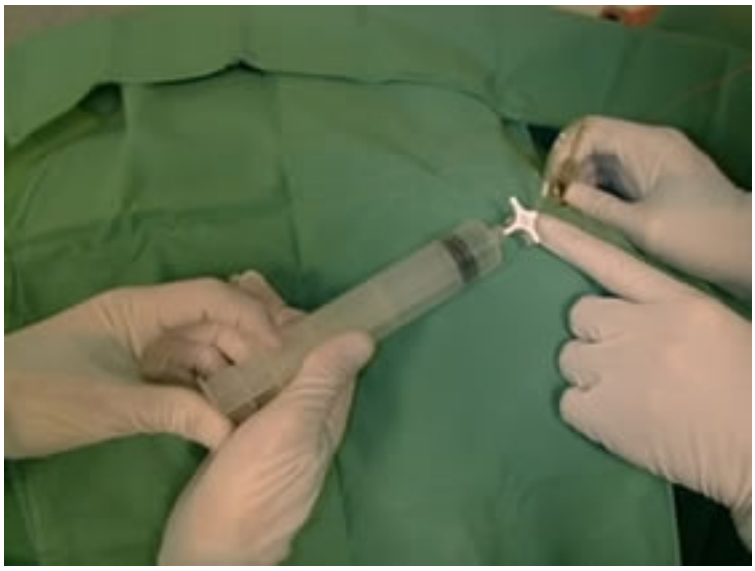
 1

18-gauge intravenous catheter attached to a three-way stopcock and a 50-ml syringe

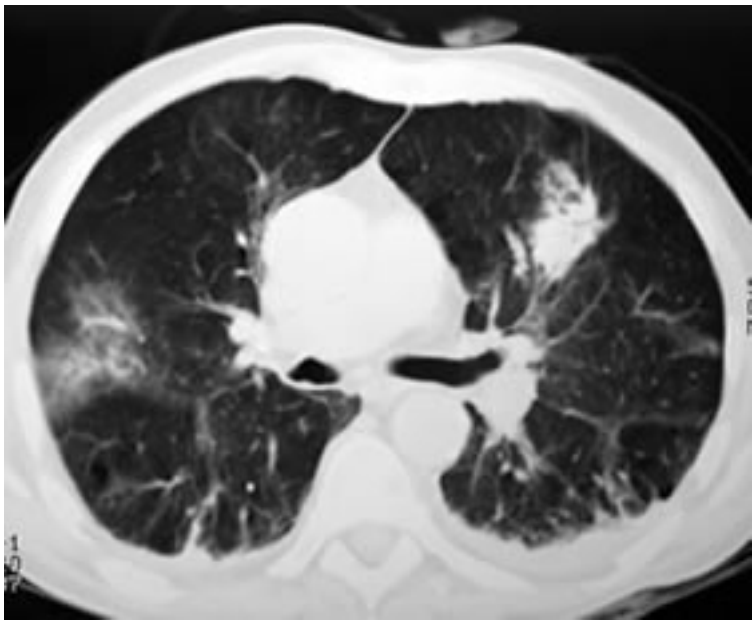
18-gauge intravenous catheter attached to a three-way stopcock and a 50-ml syringe

intravenous catheter puncture

percutaneous aspiration



percutaneous aspiration



percutaneous aspiration CT control

Fig 39 : for all percutaneous lung biopsy a pneumothorax drainage set should be ready for use (pneumothorax set, Cook)

Hemorrhage

- Hemoptysis and hemorrhage are usually self-limiting. The patient should be reassured and positioned biopsy-site down to prevent spillage of blood into the other lung. Nasal oxygen is applied if possible.

- If the hemoptysis does not stop quickly, a bronchoscopic tamponade of the lobar bronchus is performed. If vascular injury is suspected, embolization or surgery should be considered.

Rare complications

- Air embolism is a rare complication. Treatment consists of administration of 100% oxygen, left lateral decubitus position with the head down, and immediate transfer to a hyperbaric unit.

7) Results

The sensitivity of PNAB in diagnosing malignancy varies greatly from 64% to 97%. In our series, the sensitivity is 91% and the specificity is 99%. However, the ability of PNAB to make a specific diagnoses of all lesions (benign and malignant) is lower. In our series, the sensitivity and specificity decrease respectively to 88.8% and 93.1%. Negative results do not exclude malignancy. False positive results are rare; we reported one diagnose of adenocarcinoma which were found to be tuberculoma after surgery. False negative results have many causes: Size and location of the lesions, pathologic type of lesion (lymphoma, sarcoma, etc.), needle type used, and operator experience.

Date of the procedures :	from 1995 to 2001
Number of cases :	600
age	ranging from 26 to 81 years
sensitivity	91 %
specificity	99 %

8) Cases

Case 1

Fig 67 : To avoid mediatonoscopy, transternal biopsy.

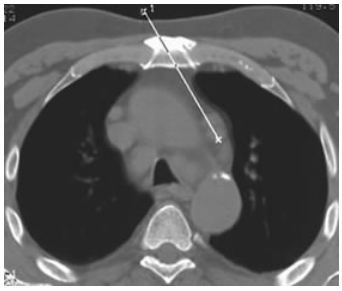


Fig 68 : Pathway

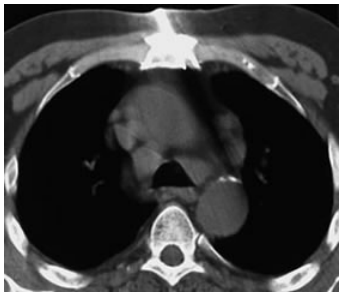


Fig 69 : Bone perforation with a 14-gauge Bonopty needle (Bard)

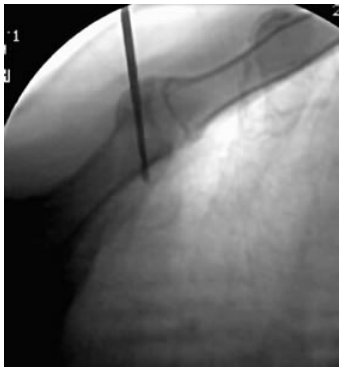


Fig 70 : Fluoroscopic control of sternal perforation

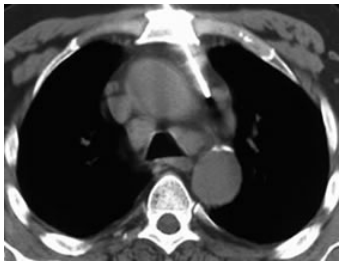


Fig71 : Coaxial biopsy with a semi automatic gun.

Case 2

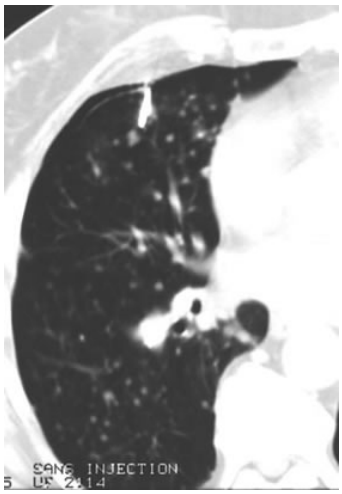


Fig 72 : Percutaneous biopsy of a small metastastic nodule. Hemoptysis with hemothorax.

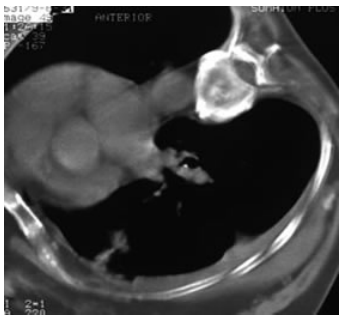


Fig 73 : The patient was hospitalized for two days. Spontaneous resolution of the hemoptysis. The hemothorax was evacuated.

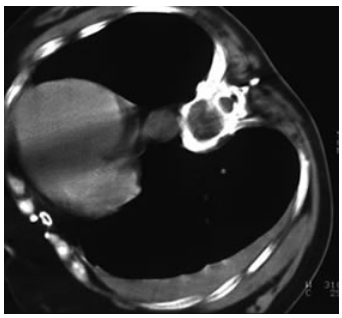


Fig 74 : The patient was hospitalized for two days. Spontaneous resolution of the hemoptysis. The hemothorax was evacuated.

Case 3

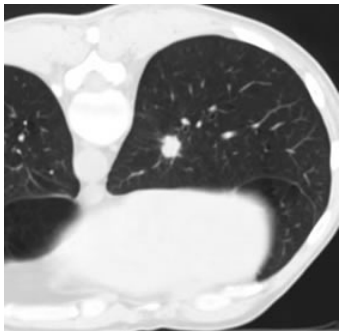


Fig 75 : metastastic nodule

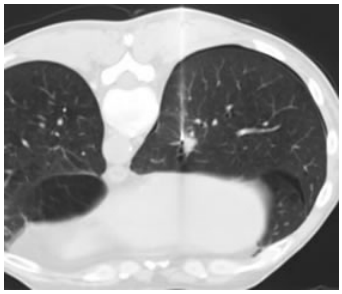


Fig 76 : biopsy

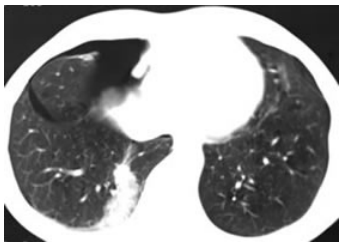


Fig 77 : Asymptomatic pneumothorax. The patient is quickly rolled into the puncture-site-down position. Spontaneous resolution.

Case 4

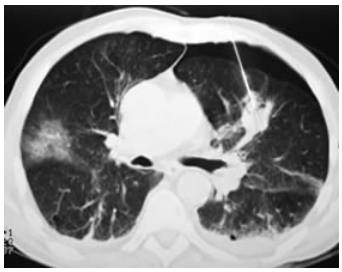


Fig 78 : Lung biopsy. Pneumothorax in an emphysematous patient.

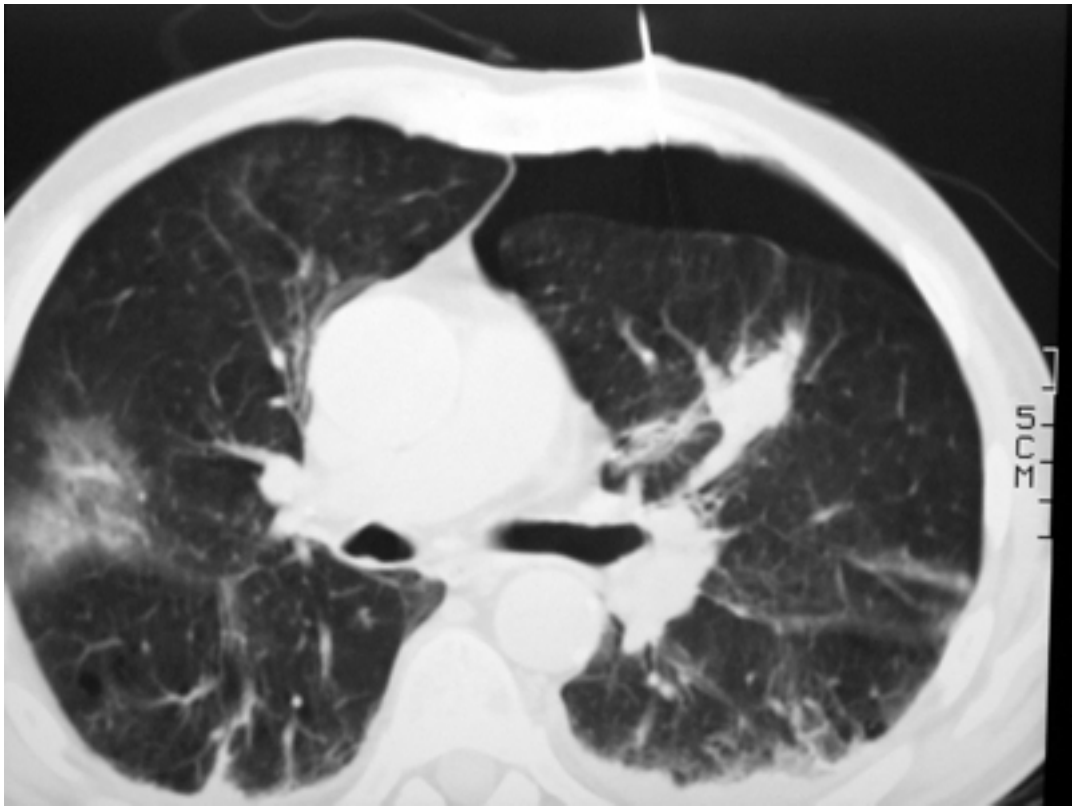


Fig 79 : pneumothorax

Fig 80 : Aspiration materials: 18-gauge intravenous catheter, three-way stopcock and a 50-mL syringe

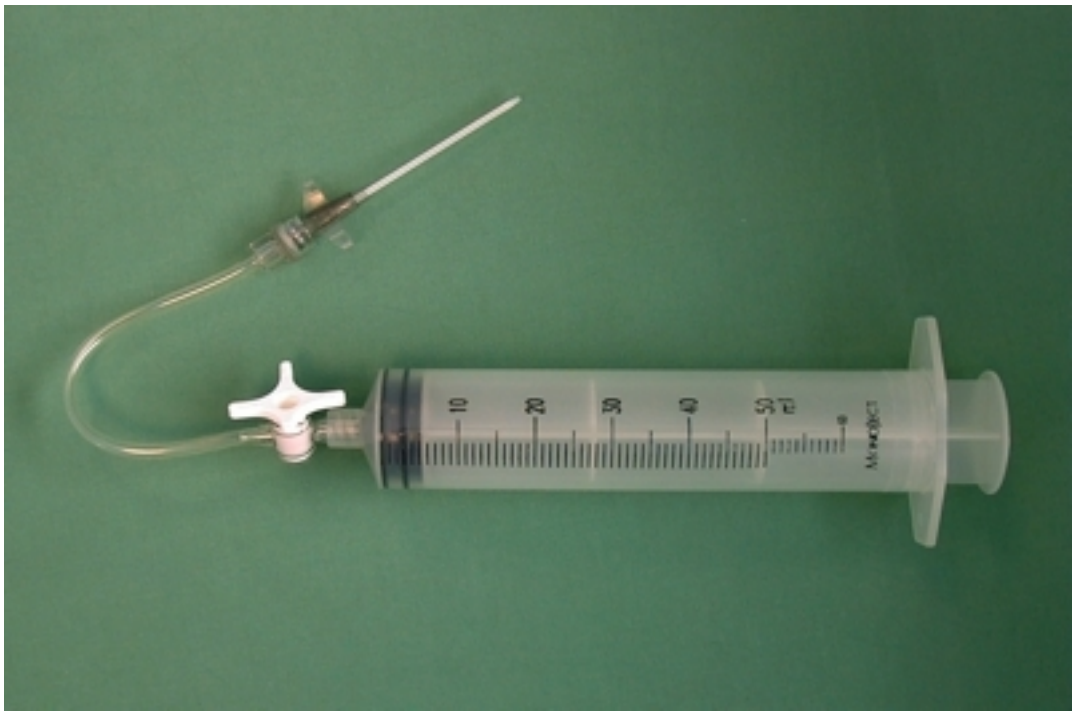


Fig 81 : 18-gauge intravenous catheter attached to a three-way stopcock and a 50-ml syringe

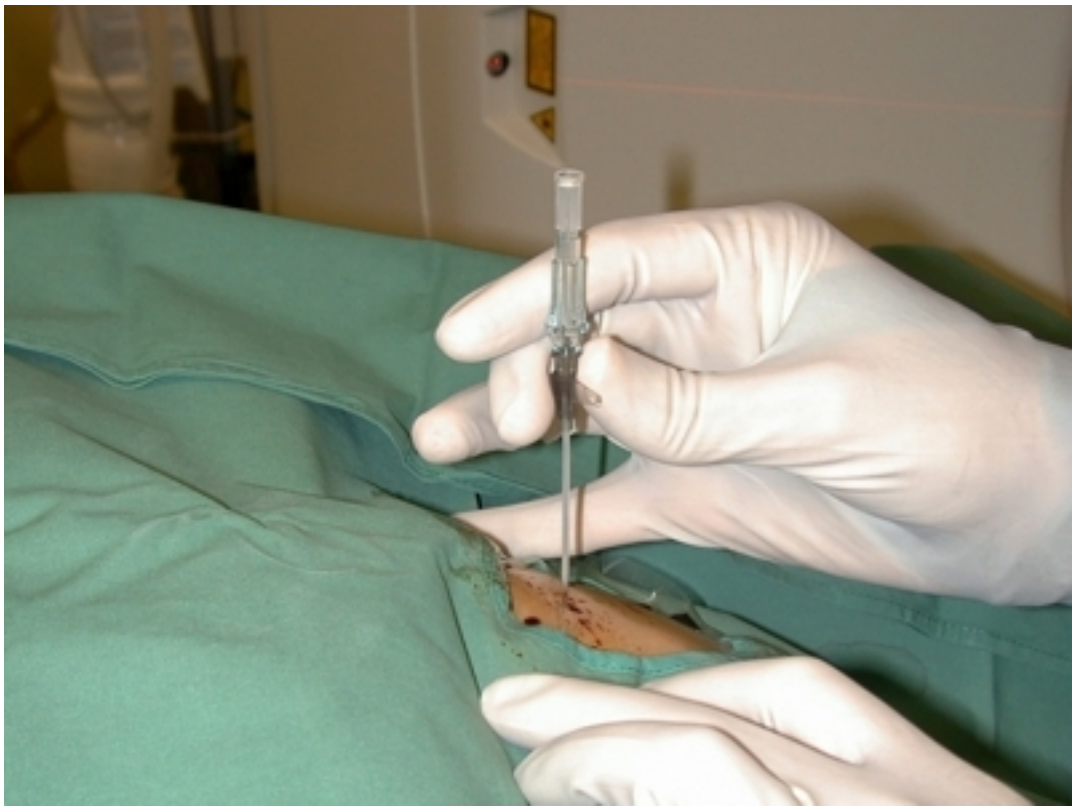
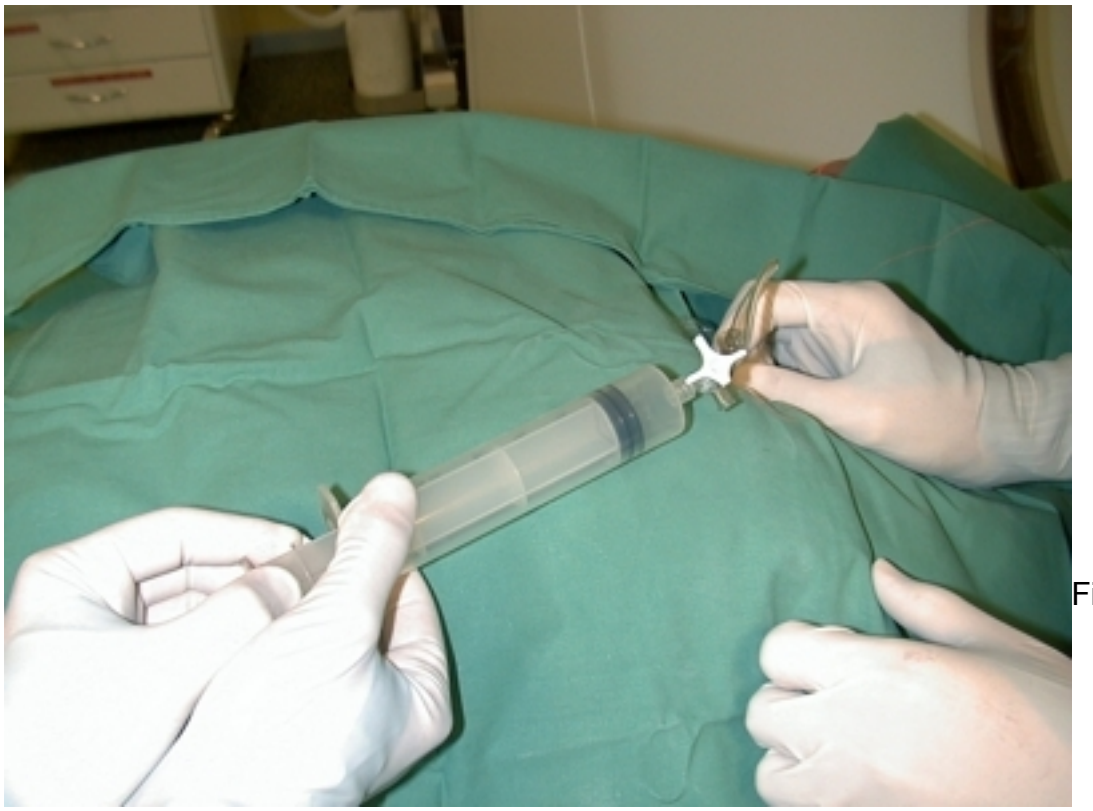


Fig 82 : insertion of the 18-gauge intravenous catheter



Fig

83 :Percutaneous catheter aspiration with a 50-ml syringe

Fig 84 : percutaneous catheter aspiration with a 50-ml syringe

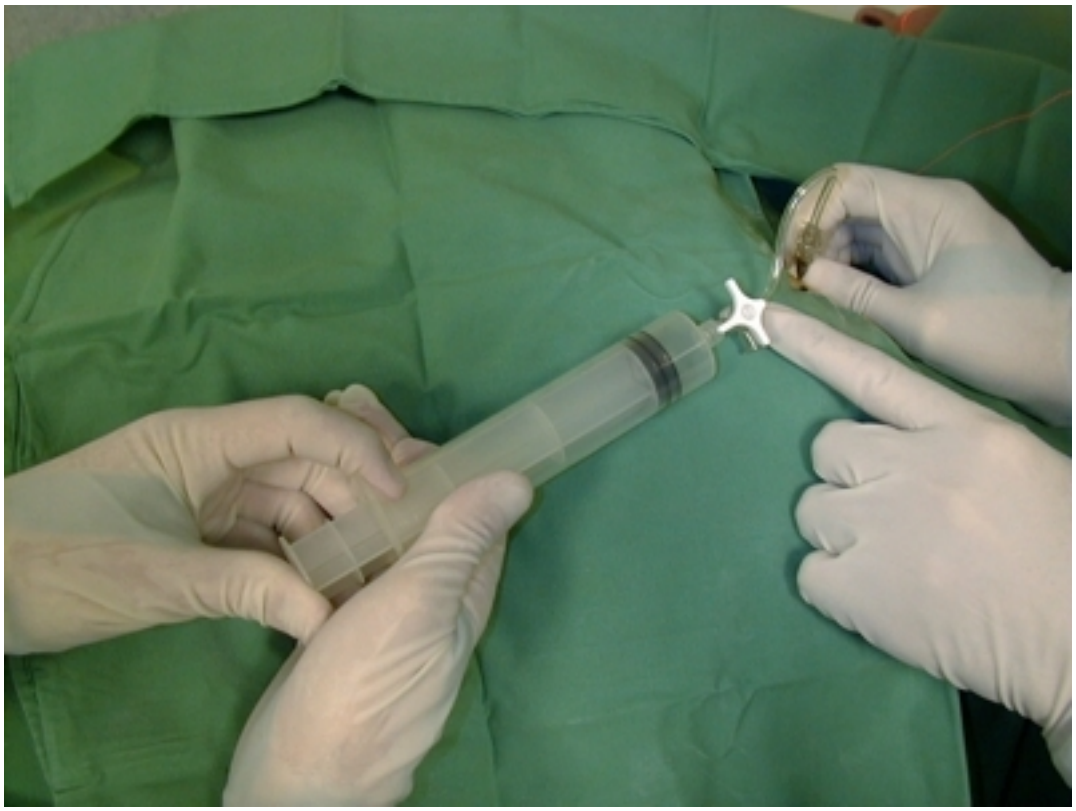


Fig 85 : percutaneous catheter aspiration with a 50-ml syringe

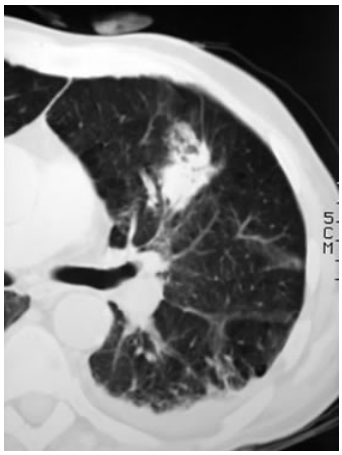


Fig 86 : percutaneous aspiration CT control

Case 5

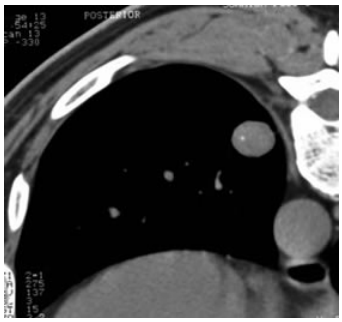


Fig 87 : Small nodule. Percutaneous biopsy with an automatic cutting gun. No complications

Fig 88 : Small nodule. Percutaneous biopsy with an automatic cutting gun. No

complications

Fig 89 : Necrotic mass. Biopsy performed in the periphery of the lesion

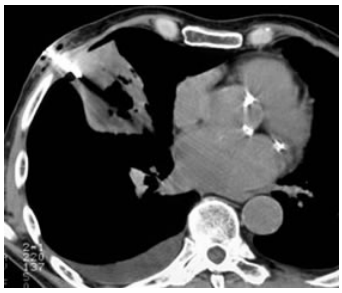


Fig 90 : Necrotic mass. Biopsy performed in the periphery of the lesion

Case 6

Fig 91 : Percutaneous biopsy of a very mobile small nodule with CT and fluoroscopy

Fig 92 : Percutaneous biopsy of a very mobile small nodule with CT and fluoroscopy

Fig 93 : Percutaneous biopsy of a very mobile small nodule with CT and fluoroscopy

Case 7

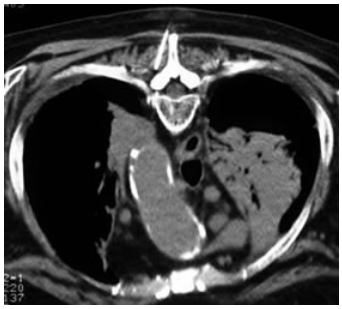


Fig 94 : Paraaortic biopsy under CT guidance

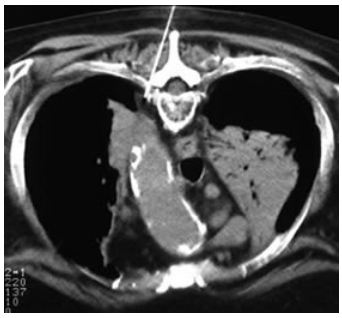


Fig 95 : Paraaortic biopsy under CT guidance

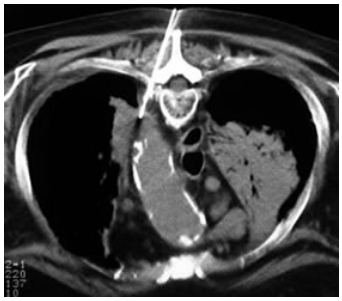


Fig 96 : Paraaortic biopsy under CT guidance

Case 8

Fig 97 : Paramediastinal biopsy. The internal thoracic vessels should be avoided

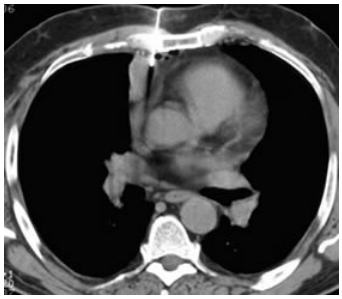


Fig 98 : Paramediastinal biopsy. The internal thoracic vessels should be avoided

Case 9

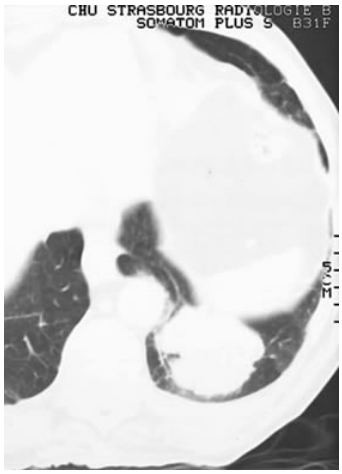


Fig 99 : Percutaneous biopsy performed with a semi automatic gun

Fig 100 : Percutaneous biopsy performed with a semi automatic gun

Case 10

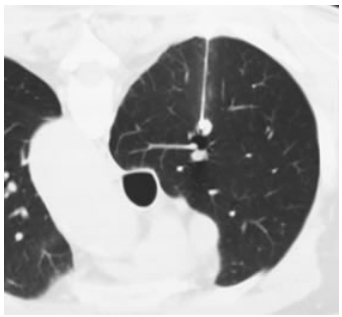


Fig 102 : percutaneous biopsy of a small nodule

Case 11

Fig 103 : mediastinal transpulmonar biopsy

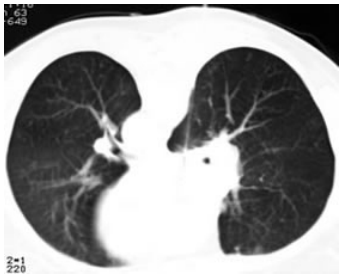


Fig 104 : mediastinal transpulmonar biopsy

Fig 105 : mediastinal transpulmonar biopsy

Fig 106 : mediastinal transpulmonar biopsy. Asymptomatic small pneumothorax

Case 12

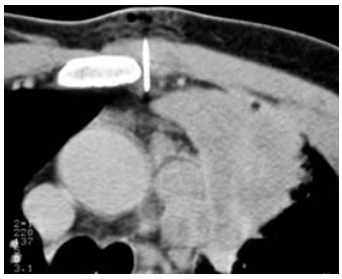


Fig 109 : percutaneous mediastinal lymph nodes biopsy. The needle avoid the internal thoracic vessels. The pathway is enlarged with injection of saline avoiding the lung.

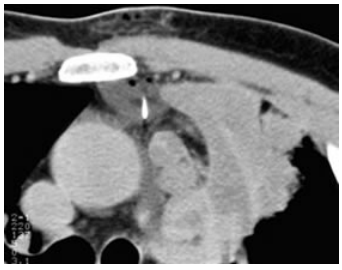


Fig 110 : percutaneous mediastinal lymph nodes biopsy. The needle avoid the internal thoracic vessels. The pathway is enlarged with injection of saline avoiding the lung.

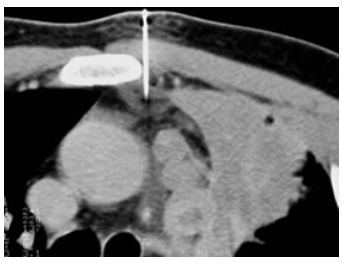


Fig 111 : percutaneous mediastinal lymph nodes biopsy. The needle avoid the internal thoracic vessels. The pathway is enlarged with injection of saline avoiding the lung.

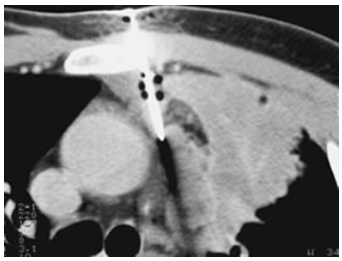


Fig 112 : percutaneous mediastinal lymph nodes biopsy. The needle avoid the internal thoracic vessels. The pathway is enlarged with injection of saline avoiding the lung.

Case 13

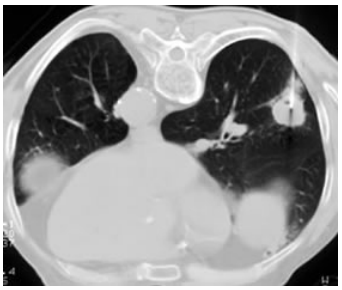


Fig 113 : necrotic lesion, biopsy with a 21-gauge aspiration needle

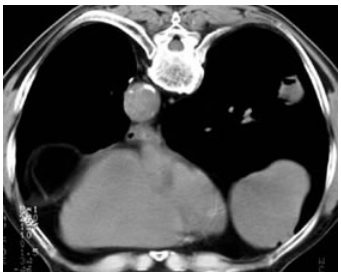


Fig 114 : necrotic lesion, biopsy with a 21-gauge aspiration needle

Case 14

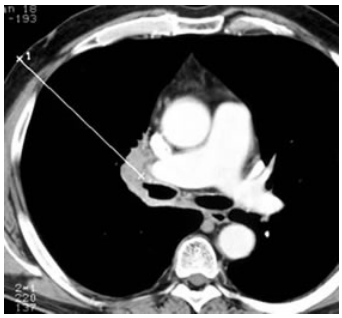


Fig 115 : hilar biopsy with a 21-gauge aspiration needle

Fig 116 : hilar biopsy with a 21-gauge aspiration needle

Fig 117 : hilar biopsy with a 21-gauge aspiration needle. Large pneumothorax with immediate aspiration

Case 15

Fig 120 : transternal biopsy

Fig 121 : transternal biopsy. Pathway

Fig 122 : transternal biopsy. Pathway

Fig 123 : bone perforation with a 14-gauge Bonopty needle (Bard)

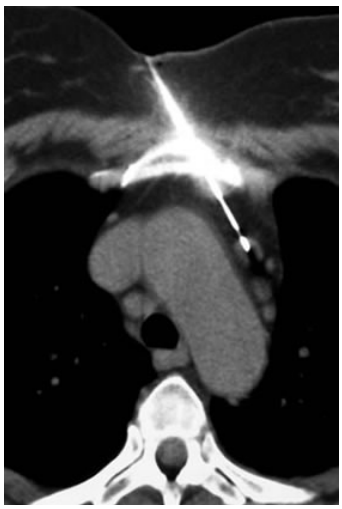


Fig 124 : Coaxial biopsy with a semi automatic gun

Case 16

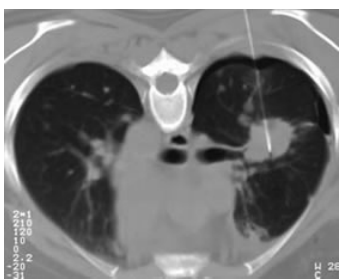


Fig 125 : asymptomatic pneumothorax during biopsy. Plugging of biopsy tracks with autologous blood clot was used to avoid a large pneumothorax.

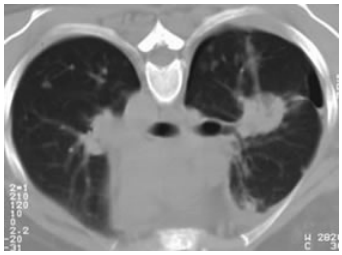


Fig 126 : asymptomatic pneumothorax during biopsy. Plugging of biopsy tracks with autologous blood clot was used to avoid a large pneumothorax.