

A STUDY OF YIELD OF CT-GUIDED INTERVENTIONS (CORE NEEDLE BIOPSY AND FINE NEEDLE ASPIRATION CYTOLOGY) IN THORACIC LESIONS AND THE COMPLICATIONS FACED DURING THE INTERVENTIONS

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ABSTRACT

BACKGROUND

The quest for accurate diagnosis of lung pathology has been there all through the history of medicine. The pathologist is the person who makes the final diagnosis, but submission of the lesion to the pathologist involves procedures, both invasive and noninvasive like Open Lung Biopsy (OLB), Percutaneous Transthoracic Needle Biopsy (PTNB) and Fine-Needle Aspiration Cytology (FNAC). Percutaneous nonoperative procedures in the chest were performed even before the advent of imaging. Leyden performed the first transthoracic needle lung biopsy in 1882 to confirm pulmonary infection.

MATERIALS AND METHODS

This is a hospital-based observational study of CT-guided interventional procedures in patients with thoracic lesions diagnosed by imaging methods like chest radiograph, CT or MRI scans. These patients were referred to the Department of Radiodiagnosis for CT-guided thoracic interventions from the Chest Medicine Department and other clinical departments of our hospital (The Oxford Medical College, Hospital and Research Centre). The duration of the study was for a period of 18 months from November 2015 to May 2017.

RESULTS

Yield of CT-guided fine needle aspiration cytology of thoracic lesions in this study was 28.57% with a failure rate of 71.43%.

Yield of CT-guided core needle biopsy of thoracic lesions in this study was 100% with no failure rate.

CONCLUSION

Percutaneous CT-guided interventions like core biopsy and fine needle aspiration cytology are relatively simple minimally-invasive procedures with good patient acceptance, low morbidity and almost negligible mortality.

KEYWORDS

Yield of CT, FNAC, Core Needle Biopsy, Complications.

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BACKGROUND

CT-guided interventional procedures are the most preferred procedures in thoracic lesions. Thoracic interventions like CT-guided fine-needle aspiration cytology and core biopsy are minimally-invasive procedures. They can be done quickly on patients without causing significant morbidity when compared to open surgical interventions.

In oncology practice, pathological diagnosis of the disease is of paramount importance and is always considered the standard for diagnosis. CT scan is the most popular guiding modality for thoracic interventions. CT offers

exquisite anatomical display of the thoracic structures and allows percutaneous access. Intravenous contrast medium injection is mandatory for identification of necrosis, fluid content, normal vascular structures and also contributes to precise delineation of a lesion with regard to the anatomical environment.^{1,2} CT is particularly useful for guiding puncture of mediastinal lesions and intrapulmonary lesions that are difficult to localise. CT allows determination of an optimal cutaneous entry point in such a way as to avoid transgression of a pleural fissure or puncture of large vessels, bronchi, oesophagus and other structures.^{1,2} Post-procedural complications like pneumothorax and pulmonary haemorrhage, if any are readily recognised on CT scan.²

MRI for the evaluation of lung disease is limited by degradation of the images by respiratory motions. Techniques of MRI-guided thoracic interventions need further developments.^{2,3} Ultrasound on the other hand is more cost effective and also free from ionising radiation. The needle is advanced and sample is obtained under real time visualisation. However, ultrasound suffers from limitation of visualisation in some areas such as intrapulmonary or bone

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lesions as well as deep-seated thoracic lesions obscured by overlying lung.^{3,4}

Ability of TTFNAC and core needle biopsy to provide diagnosis on examination of few cells and tissue samples, respectively, have made them one of the most widely used diagnostic procedures in oncology. Both FNAC and core biopsies have their own advantages and disadvantages. FNACs are simple and safer, but are more prone to false-negative diagnosis.^{2,3} Availability of an on-site cytopathologist to confirm the adequacy of the harvested specimen using fast stain techniques is important to decrease false-negative or inconclusive results.⁵ Core biopsies are less susceptible to false-negative or false-positive diagnosis when compared with FNACs. These also provide histological and architectural information, which is important in subtyping of some malignancies. Core biopsy samples are also more suitable for special tests like immunohistochemistry and receptor analysis.³ Newer developments in core biopsy techniques like automated spring loaded biopsy guns and use of coaxial needle systems allow us to obtain multiple large core samples with a single puncture without significant increase in complications.^{3,6}

A well planned and executed CT-guided biopsy/FNAC helps to provide an accurate diagnosis and facilitates institution of definitive treatment. CT is the optimum image-guiding modality for thoracic interventions.

Aims and Objectives

To describe and assess the accuracy of CT-guided core needle biopsy and CT-guided fine-needle aspiration cytology for procurement of material (tissue) in the management of benign and malignant lesions of the thorax.

MATERIALS AND METHODS

This is a hospital-based observational study of CT-guided interventional procedures in patients with thoracic lesions diagnosed by imaging methods like chest radiograph, CT or MRI scans. These patients were referred to the Department of Radiodiagnosis for CT-guided thoracic interventions from the Chest Medicine Department and other clinical departments of our hospital (The Oxford Medical College, Hospital and Research Centre). The duration of the study is for a period of 18 months from November 2015 to May 2017.

Inclusion Criteria

Patients with thoracic lesions referred for CT-guided core biopsy, fine-needle aspiration cytology or drainage.

Exclusion Criteria

- Non-cooperative patients incapable of adequate breath-holding.
- Uncorrected coagulation abnormalities.
- Patients at high risk for pneumothorax or haemothorax due to difficult access to the lesions.

The study includes patients with thoracic lesions situated in the lung parenchyma, mediastinum, pleura, bony thoracic cage and soft tissues of the thorax for diagnostic cytology or

biopsy under CT guidance. Subjects were selected by preprocedural imaging diagnosis using chest radiography, computed tomography, magnetic resonance imaging or sonography. Bleeding and clotting parameters in the form of clotting time, bleeding time, prothrombin time and Activated Partial Thromboplastin Time (APTT) were determined in all patients. Subjects with normal bleeding and clotting parameters were included in the study and the rest were excluded. Detailed history of patients was collected including medical history, occupation and personal history.

Informed Consent- Informed consent was taken from the patient or patient's relative after explaining to them about the interventional procedure proposed for the patient and the possible complications that may arise.

Preparation of the Patient- The patients were admitted before the procedure. No fasting was advised. The patient was positioned in the CT gantry and the percutaneous access site was prepared. Immediate preprocedural topogram and CT of the chest were done from the neck base upto the domes of the diaphragm to delineate the thoracic lesion and to locate the percutaneous site of needle puncture. The point was localised with laser lights located in the CT gantry and marked with a permanent skin marker. The local area was cleaned with povidone-iodine and surgical spirit. Using aseptic precautions, 2% lignocaine was utilised for local anaesthesia and one of the following procedures was performed.

CT-Guided Transthoracic Lung and Mediastinal Fine-Needle Aspiration Cytology (TTFNAC)

18 gauge needle with 20 cc syringes were used for FNAC of lung and mediastinal lesions. Continuous negative pressure was applied with to and fro motion of the needle until the needle hub had an aspirate. The needle with the syringe was given to an onsite cytopathologist or cytological technician to make the smears. A maximum of three attempts were made.

CT-Guided Transthoracic Lung and Mediastinal Biopsy

18 to 20 gauge automated biopsy guns were used for lung biopsies. The biopsy needle was introduced under aseptic precautions until it just pierced the lesion. The samples were obtained and sent in 10% formalin solution for histopathological examination. A maximum of three attempts were tried.

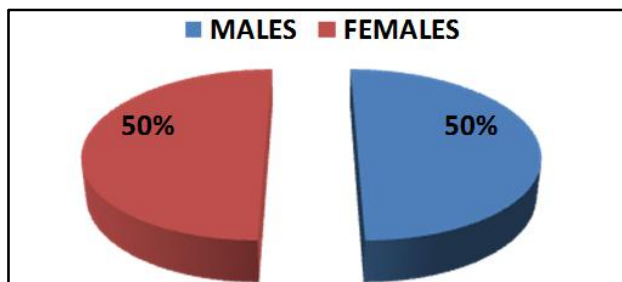
Post-Procedural Care

Immediate post-procedure compression was given for 5 minutes at the site of intervention to stop bleeding and a dressing was applied. The patient was reassured and blood pressure, pulse rate and respiratory rate were monitored. In case of pain, oral analgesics were given. Check CT of the entire thorax was done before the patient was shifted to the wards to identify potential complications like pneumothorax and haemothorax.

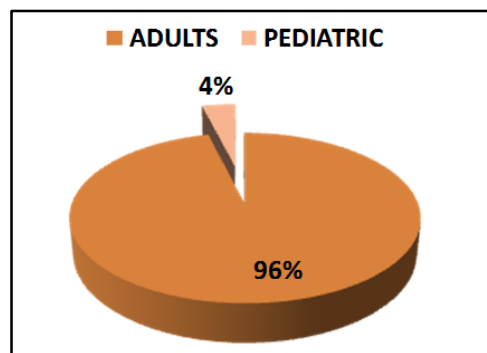
Methods of Statistical Analysis

- Descriptive analysis was adopted to present the study data using percentages and proportions.
- Efficacy of CT-guided thoracic interventions (core needle biopsy and fine-needle aspiration cytology) was undertaken by computing measures like yield and failure rates.

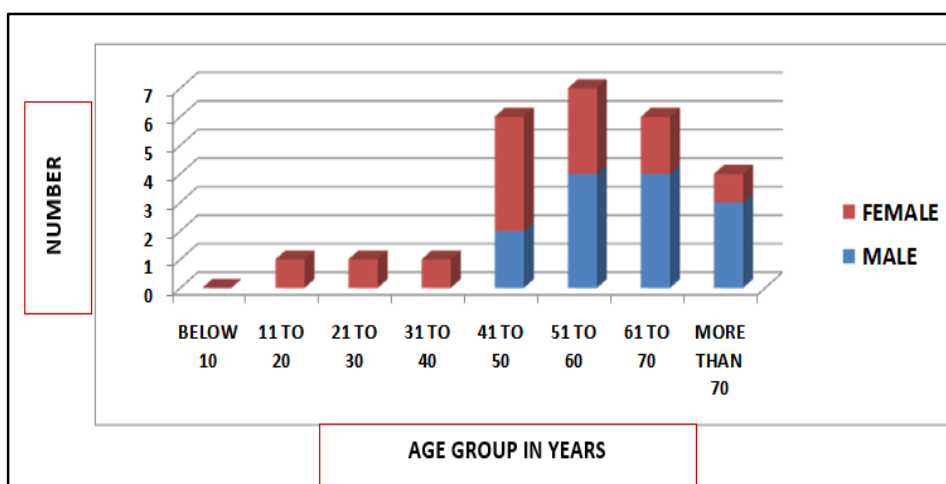
RESULTS



Graph 1. Sex Distribution of Patients



Graph 2. Distribution of Patients into Adult and Paediatric Age Groups



Graph 3. Sex and Age Distribution of Patients

Lesion Site	Number
Lung parenchyma	14
Mediastinum	3
Pleura	2
Thoracic vertebrae	2
Total	21

Table 1. CT-Guided Core Biopsy

Lesion Site	Number
Lung parenchyma	4
Mediastinum	1
Pleura	1
Thoracic vertebrae	1
Total	7

Table 2. CT-Guided Fine-Needle Aspiration Cytology

Yield of CT-Guided Fine-Needle Aspiration Cytology of Thoracic Lesions-

Total number of FNACs performed for thoracic lesions were 7, of which 5 of them were unsuccessful in terms of inadequate sample for cytological analysis. Most of these

samples were haemorrhagic. Out of 5 patients in whom FNAC failed to obtain adequate tissue for cytological analysis, 2 patients had also undergone biopsy under CT guidance by which adequate tissue sample was obtained for histopathological analysis, which were reported as Aspergilloma and fibrosis.

$$\begin{aligned} \text{Yield of CT guided FNAC} &= \frac{\text{Total no. of FNAC's performed} - \text{No. of FNAC's failed}}{\text{Total no. of FNAC's performed}} \\ &= \frac{7 - 5}{7} * 100 \\ &= 28.57\% \end{aligned}$$

Hence, yield of CT-guided fine-needle aspiration cytology of thoracic lesions in this study was 28.57% with a failure rate of 71.43%.

Yield of CT-Guided Core Needle Biopsy of Thoracic Lesions-

Total number of core biopsies performed for thoracic lesions were 21, of which, all were successful in procuring adequate samples for histopathological analysis.

Yield of CT guided core biopsy = $\frac{\text{Total no. of biopsies performed} - \text{No. of biopsies failed}}{\text{Total no. of biopsies performed}}$ = $\frac{21-0}{21} * 100$ = 100%

Hence, yield of CT-guided core needle biopsy of thoracic lesions in this study was 100% with no failure rate.

Complications of Procedures

26 patients with thoracic lesions underwent 28 CT-guided interventional procedures. There were no intra or post-procedural complications in the 27 procedures performed. Only one patient had a small pneumothorax post biopsy, which was delineated on the post biopsy check CT scan and it measured 1 mm in maximum dimension.

This patient was a 58-year-old female who had bilateral pulmonary opacities on chest CT. The patient was subjected for CT-guided FNAC from the right upper lobe pulmonary opacity. However, FNAC failed in procuring adequate sample as only haemorrhagic smears were obtained by which no

definite cytological opinion was possible. Hence, a repeat CT-guided core biopsy was performed from the right upper lobe, which was successful in procuring adequate tissue sample for histopathological analysis and the lesion was reported as fibrosis. The patient was haemodynamically stable post procedure, but the post biopsy check CT scan revealed a small pneumothorax measuring 1 mm. The patient was kept under observation with constant monitoring of blood pressure and pulse rate, which was recorded every 10 mins. The patient was haemodynamically stable in the observation period and the pneumothorax resolved spontaneously. This was confirmed with a CT scan performed after 30 minutes. The patient was then discharged.

Rate of complications for CT guided interventions in thoracic lesions = $\frac{\text{No. of complications}}{\text{Total no. of procedures}} * 100$ = $\frac{1}{28} * 100$ = 3.6%
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Figures-

Figure 1 - Male patient aged 47 years who had a mass in the lower lobe of left lung and underwent CT-guided biopsy of the mass.



Poorly-Differentiated Carcinoma of Left Lung

Figure 2 - Axial CT images (A and B) in lung windows with the patient in left lateral decubitus position showing post biopsy small pneumothorax (arrows). This was the one and only post procedural complication of CT-guided biopsy that occurred in the patient who had a right upper lobe lung mass.

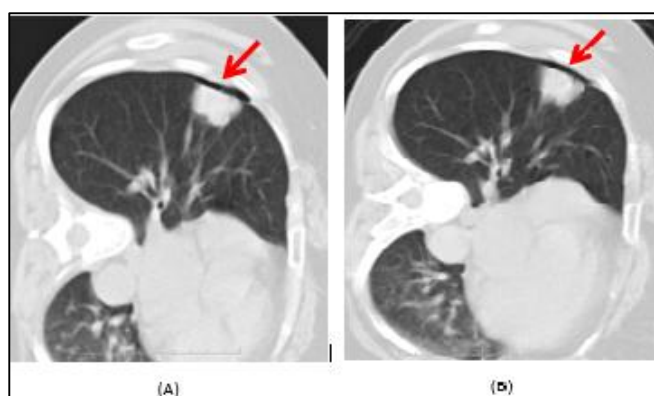
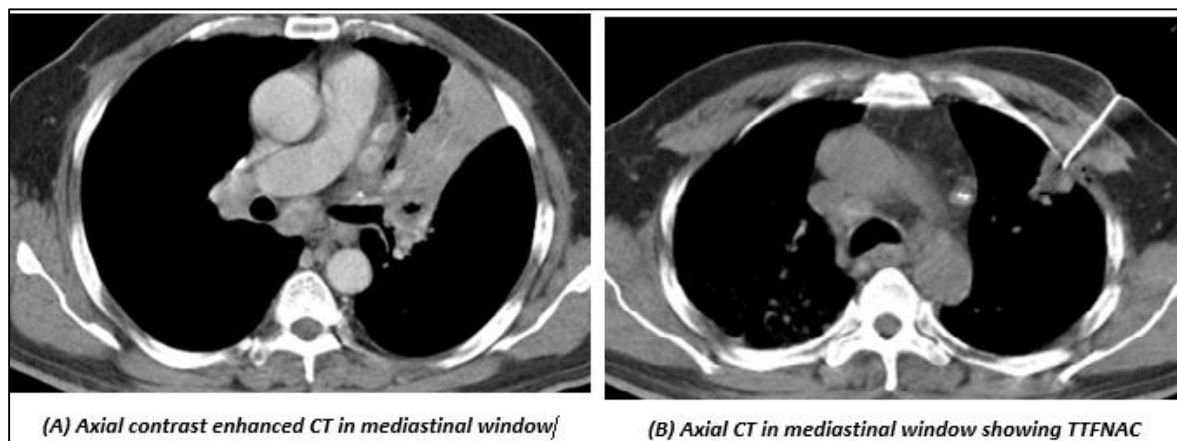


Figure 3 - Male patient aged 55 years who had collapse and consolidation of the upper lobe of left lung for which CT-guided transthoracic FNAC was done, but, however, it failed to obtain adequate tissue for cytological diagnosis.



Collapse and Consolidation of Left Upper Lobe

DISCUSSION

Image-guided thoracic interventions are the result of advancements in cross-sectional imaging. CT is the most commonly used imaging modality for thoracic interventions. These minimally-invasive thoracic interventions like CT-guided transthoracic lung biopsy and transthoracic fine-needle aspiration cytology have become very popular for the diagnosis and management of thoracic lesions and hence more invasive procedures such as thoracoscopy, mediastinoscopy and thoracotomy can be avoided.¹⁻³

This study was designed to determine the efficacy and safety of CT-guided interventional procedures for the diagnosis of benign and malignant lesions of the thorax. In this hospital-based observational study, the total number of patients was 26, of which 13 patients were males and the remaining 13 were females. The age group of the patients ranged from 16 years to 80 years. Maximum number of patients was in the age group of 51 to 60 years with a value of 7 accounting for 27% of the total patients. This was followed by age groups 41 to 50 years and 61 to 70 years, each of which had 6 patients. There were 4 patients aged above 70 years. Age groups of 11 to 20 years, 21 to 30 years and 31 to 40 years had 1 patient each. There was only one paediatric patient who was a female aged 16 years.

The 26 patients underwent imaging investigations like chest radiograph and CT scan for diagnosis of thoracic lesions. Then, CT-guided interventions, which comprised of percutaneous transthoracic core needle biopsy and transthoracic fine needle aspiration cytology were done after the patients gave written consent for the procedure and after through patient preparation was done as described previously. The patients were also explained in their own language, the type of procedure including risks and the complications like pneumothorax and pulmonary haemorrhage, which may arise after the procedure. All patients were subjected for bleeding and clotting parameters in the form of clotting time, bleeding time, prothrombin time and activated partial thromboplastin time. Subjects with normal clotting and bleeding parameters were included in the study and the rest were excluded.

Out of the 26 patients, the most common site of the thoracic lesion was in the lung parenchyma as revealed by imaging accounting for 65.38% with a value of 17. The remaining lesions were distributed as follows- 4 in the mediastinum, 2 in the pleura and 3 in the thoracic vertebrae. The maximum number of patients with thoracic lesions was in the 51 to 60 years age group, which comprised of 7 patients. Thoracic CT revealed 16 lesions as being malignant based on certain imaging signs such as irregular borders, necrosis, bone erosion, chest wall invasion, vascular invasion, bronchial obstruction, etc., which were more common in these malignancies. Malignant lesions usually have irregular borders and areas of necrosis when seen on imaging. Malignant thoracic lesions may also invade the chest wall and adjacent vascular structures. They can invade bronchi and cause airway obstruction.^{7,8} Eight lesions were considered as being benign and the remaining two as indeterminate.

A total of 28 interventional procedures were done in this study, which comprised of 21 core biopsies and 7 TTFNACs. The procedures were done at various sites including lung parenchyma, mediastinum, pleura and thoracic vertebra. Among the interventions, lung biopsy and lung fine-needle aspiration cytology were the most commonly performed procedures. The tissue obtained by CT-guided core biopsy and TTFNAC was sent for histopathological and cytological analysis. All the core biopsies done were adequate in procuring tissue for histopathological analysis. Among the 21 core biopsies, 14 lesions were typed as being malignant, 5 as being benign and the remaining 2 as normal tissues by histopathology. One of the tissues reported as normal was that obtained from T12 vertebra and the other was that obtained from the left lung. Thus, all of the core biopsies were successful in procuring tissue and none had failed.

Out of the 7 TTFNACs performed, only 2 were successful in procuring adequate tissue for cytological analysis and these 2 tissues were reported as being benign by cytology. One of the tissues reported as being benign was obtained from T10 vertebra and the other from upper lobe of right lung, which were revealed to be tuberculosis and lung

abscess respectively by cytology. Thus, 5 of the FNACs failed as they were unsuccessful in procuring adequate tissue for cytological diagnosis contributing for a failure rate of 71.43%. This is also comparable to other studies, which have shown that fine-needle aspiration cytology is associated with a high failure rate.^{1,2}

In this study, the yield of CT-guided TTFNAC was very low as 5 of the 7 FNACs failed in procuring adequate tissue for cytological diagnosis and consequently the yield was only 28.57% with a failure rate of 71.43%. However, CT-guided core biopsy had a yield of 100% without any failures as all the 21 core biopsies were successful in procuring adequate tissue for histopathological analysis. Core needle biopsy is more accurate in obtaining adequate tissue for pathological analysis when compared to fine needle aspirations.^{1-3,5-7} Therefore, to increase the yield of fine needle aspirations for procuring adequate tissue, aspirations should be combined with core needle biopsy.^{9,10}

The rate of post-procedural complications in this study was 3.6% as there was only 1 pneumothorax encountered in all the 28 procedures performed. Based on the review of literature, the rate of pneumothorax after CT-guided thoracic interventions ranges from 8% to 60%.¹¹

CONCLUSION

Percutaneous CT-guided interventions like core needle biopsy and fine-needle aspiration cytology are relatively simple and minimally-invasive procedures with good patient acceptance, low morbidity and almost negligible mortality. CT-guided core needle biopsy is superior to CT-guided FNAC in procuring adequate tissue for histopathological analysis. So, CT-guided core needle biopsy should be performed for the diagnosis of thoracic lesions, especially in malignant lesions where early diagnosis and resection are the best chances for patient survival.

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