DOI: 10.7860/IJARS/2017/31142:2418

Original Article

Radiology Section

# CT Guided Transthoracic FNAC of Intrathoracic Lesions-An Institute Experience

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## ABSTRACT

**Introduction:** In the management of thoracic lesions, especially malignant lesions, specific pathological diagnosis is considered standard, so obtaining the tissue is essential for diagnosis and treatment. There are complex vascular structures in hila and mediastinum and so precise localization is necessary to avoid unnecessary injury to these structures, which can be achieved by doing image guided procedures.

**Aim:** This study was proposed to analyze the role of CT in guiding the FNAC of the thorax and to understand its scope in improving the diagnostic accuracy and therapeutic outcome, decreasing the patient discomfort, cost and surgical morbidity and also in assessing the types of complications arising out of the same.

**Materials and Methods:** This prospective observational study was conducted at Kidwai Memorial Institute of Oncology Bengaluru, India, from 2012 to 2015 for three years. This study consisted of 420 patients who were referred for TTFNAC.

**Results:** The Study consisted of 420 patients in age group of 18-87 years. Total yield of 85% was achieved, complications were seen in 126 patients (20%)in the form of pneumothorax and hemorrhage. Maximal lesions encountered were seen in the lungs, followed by mediastinum. The sensitivity specificity, positive and negative predictive values are 97%, 66%, 94% and 82% for malignant lesions. However, it was lower for benign lesions.

**Conclusion:** CT-guided Transthoracic (TTFNAC) is a good tool for material procurement in benign and malignant lesions. It helps the clinician to initiate appropriate treatment measures like chemotherapy or radiotherapy at an early pace and is associated with low mortality and morbidity. TTFNAC achieves substantial cost savings, as it can obviate more costly and invasive surgical procedures and is minimally invasive. Fewer complications are caused by TTFNAC that can be avoided, if properly planned by avoiding vessels and bullae. However, if they occur they can be easily managed. This procedure can be used as a safe outpatient procedure for material procurement in lung or mediastinal lesions, not accessible for ultrasound guided FNAC, for lesions situated less than 8 cm from chest wall and size greater than 25 mm and it has good patient tolerance.


**Keywords:** Lung FNAC, FNAC of mediastinal lesions

## INTRODUCTION

Intrathoracic mass is a common problem encountered by the clinicians worldwide but it is difficult to diagnose correctly [1]. In oncology, pathological diagnosis is of paramount importance and is always standard for diagnosis, treatment and staging of the disease [2].

FNAC is a method of taking cytology sample by means of a fine needle attached to a syringe [1]. In 1983, for detection of infections and malignancies, the technique of diagnostic lung puncture was first introduced by Leyden and Menbriel in 1986.This method was first used by Menetrier in diagnosing lung carcinomas [3].

A Computed Tomography (CT)-guided TT FNAC is a technique where lung, mediastinal or pleural tissue cells are obtained using a CT-scan to guide FNAC [4].

Presence of complex vascular structures in the mediastinal and hilar areas demand the precise localisation and route for needle aspiration cytology. Haaga and Alfidi reported the first CT-guided biopsy in 1976 [3,4]. Availability of an onsite cytopathologist or a cytopathology technician can confirm the adequacy of the harvested specimen; hence it decreases false negative results or inconclusive results [5].

CT guided FNAC helps in good anatomical display, easier diagnosis, improved staging, increased chance of effective intervention and to formulate early and effective management of the lesion with avoidance of thoracotomy [6].

Complications from image guided needle cytology are infrequent and generally minor, particularly when 22-gauge needles are used. Pneumothorax is the principal complication of CT-guided

chest FNAC, may be decreased by minimizing the amount of aerated lung traversed [7,8]. It almost always is self-limited. Whenever possible, vessels, bronchi, and bullae should be avoided to minimize hemoptysis. The needle-track seeding is a rare occurrence with incidence of about 0.01% [7].

## MATERIALS AND METHODS

This prospective hospital based observational study was conducted at the Department of Radiodiagnosis of Kidwai Memorial Institute of Oncology, between the period of November 2012 to March 2015. This study consisted of 420 patients who were referred for TTFNAC.

Informed consent was obtained from all the patients or their relative after explaining them the procedure proposed and the possible complications that may arise from the same, in a language understood by them.

Sample size was calculated as 420 and the power of the study was 80% as calculated by the statistician based on prevalence of disease and number of cases referred. Success of each procedure was established at final report.

Material adequacy was calculated. CT diagnosis was compared with histopathology in benign and malignant lesions. Heterogenous enhancement of the lesion, presence of necrosis, size greater than 3 cm, surface lobulation, irregular border, spiculation, corona radiata, pleural effusion, chest wall invasion, vascular invasion, calcification, collapse, lymph nodes and necrotic areas within, thick walled cavity (with wall thickness more than 4 mm) were considered sign of malignancy. If equivocal findings were present, it was considered benign lesion.

**Inclusion criteria:**

1. Undiagnosed mediastinal, hilar, pleural or pulmonary mass lesion on CT-scan.

2. Thoracic lesions with normal bronchoscopic findings.

3. Indeterminate lesions or masses to confirm the nature of the lesion.

4. Lesions greater than 20 mm, not abutting vascular structures, lesion present at less than 8 cm depth from chest wall.

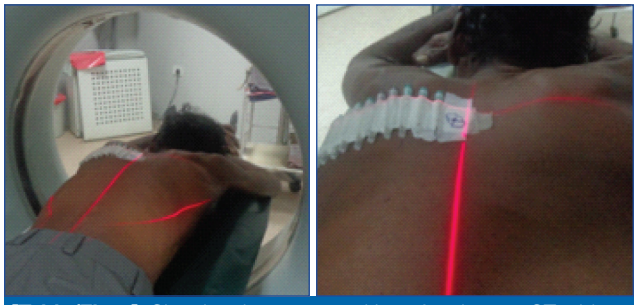
5. Single or multiple nodules when metastases are suspected.

**Exclusion criteria:** Patient with abnormal coagulation profile (prolonged PT/APTT), severe thrombocytopenia (platelet count <50,000), bullous emphysema, pulmonary hypertension, lesion less than 20 mm, abutting vascular structure or hila, lesion situated at a depth more than 9 cms from chest wall were not considered for the study.

Also, the pediatric patients, non co-operative, unconscious patient or severely ill patient, patients with abnormal bleeding parameters and history of bleeding diathesis were not included. Patients with intractable cough were excluded from the study.

**Procedure:** Patient was positioned in the CT gantry based on closer proximity to the lesion either in supine, prone or decubitus based on review films [Table/Fig-1]. Non-contrast CT was obtained from the neck base to the diaphragm domes to delineate the lesions and locate the needle puncture site. This also helped to determine the optimal patient position, needle entry site, and pathway to the lesion with an attempt to avoid major nerves or muscles. Shortest distance to the lesion was identified so as to traverse the least amount of lung parenchyma and to avoid blood vessels or bullae.

Major and the minor fissure were not traversed to avoid seeding or upstaging of the tumour. The appropriate level for FNAC was found and the needle entry site was selected. The distance to the lesion and the angle of entry was planned on the CT monitor at the console.

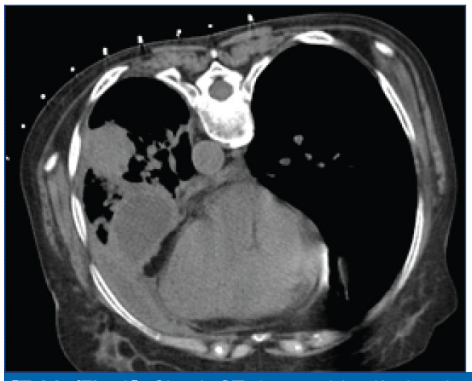
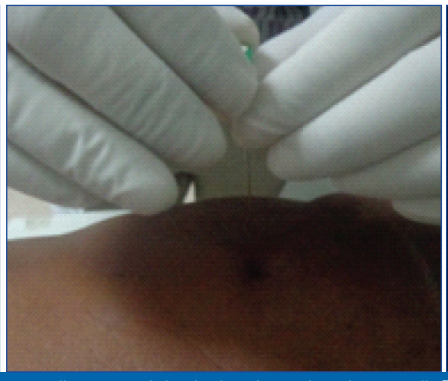
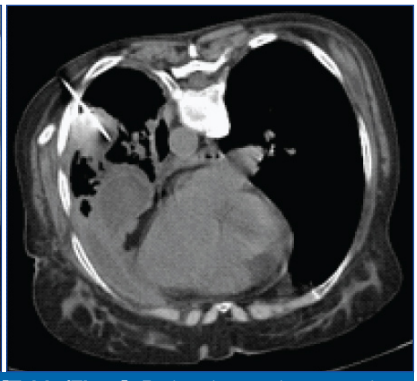


**[Table/Fig-1]:** Showing the prone position of patient on CT table.
**[Table/Fig-2]:** Placement of metallic marker and aligning of the marker to LASER.

Using the CT-LASER localizing light, which delineated the selected transaxial level on the surface of the patient, a radiopaque marker (needle) was placed on the skin at the entry site [Table/Fig-2]. Ideally, the shortest straight line from skin to the lesion should be chosen, although a longer needle path was selected sometimes to avoid critical structures [Table/Fig-2].

A repeat CT-scan is performed to confirm that the marker location is appropriate for needle entry. Skin entry site is marked with marker pen by using LASER light from the CT gantry and the radiopaque marker is removed [Table/Fig-3].

Percutaneous access site was prepared. Area was disinfected with Povidone Iodine and surgical spirit and draped. 18-22 gauge spinal needle was used and inserted directing the needle tip towards the lesion. FNAC needle was inserted into the subcutaneous tissue. The incremental adjustments in the needle angulation were made and their adequacy was assessed. The needle was advanced to the pre-measured depth. A gritty sensation or increased resistance was felt when a solid lesion was entered [Table/Fig-4].

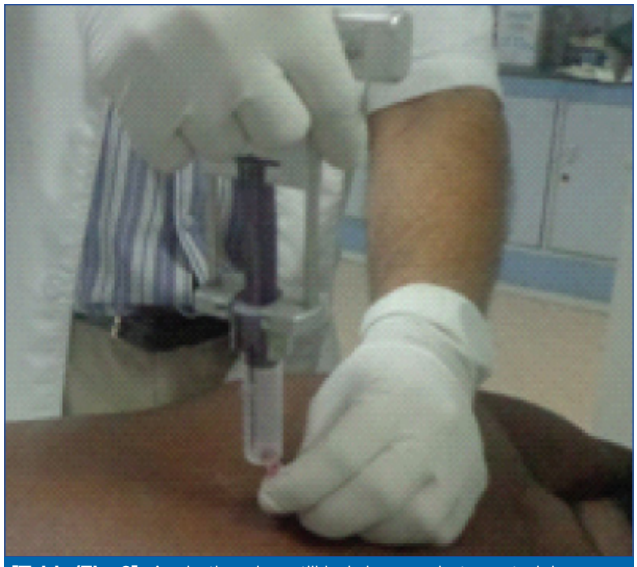




**[Table/Fig-3]:** Check CT done to identify the shortest distance of the lesion from the chest wall. **[Table/Fig-4]:** Patient instructions are given and 18-20 gauge needle is used, directing tip of the needle towards the lesion. **[Table/Fig-5]:** Check CT done to note the tip of needle.

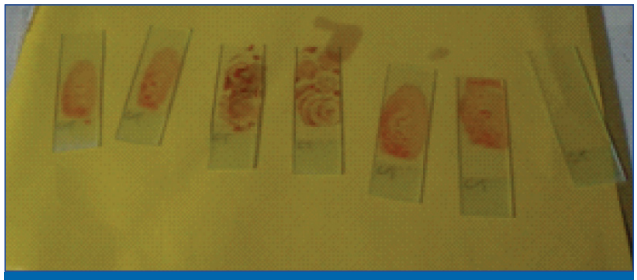
After needle advancement, when the tip of the needle was located in the outer edge of the lesion, repeat slice of the area was taken to check the position of tip [Table/Fig-5]. The key to recognition of the needle tip on CT was identification of an abrupt, squared end, associated with a black shadowing artifact in the adjacent soft tissues. If the needle tip was not within the lesion, it was redirected by manipulating the needle hub by changing the angle, length or both. Once the needle tip was documented to be in the lesion, material was sampled by removing the stylet of the spinal needle and a syringe was attached to the spinal needle.

A 20 cc syringe was used and continuous negative pressure was applied with to and fro motion of the needle until the needle hub has an aspirate [Table/Fig-6]. The needle with the syringe was handed over to the onsite cytopathology technician to make smears which were immediately fixed. A maximum of seven smears is made, if indicated, a specimen was also sent for microbiological evaluation [Table/Fig-7].

Success of each procedure was established at final cytology report and final diagnosis was made. Immediate post procedure, compression was given at the site of intervention to stop bleeding and a dressing is applied. A repeat CT was done in the area of interest, to rule out pneumothorax [Table/Fig-8].



**[Table/Fig-6]:** Aspiration done till hub has aspirate material.



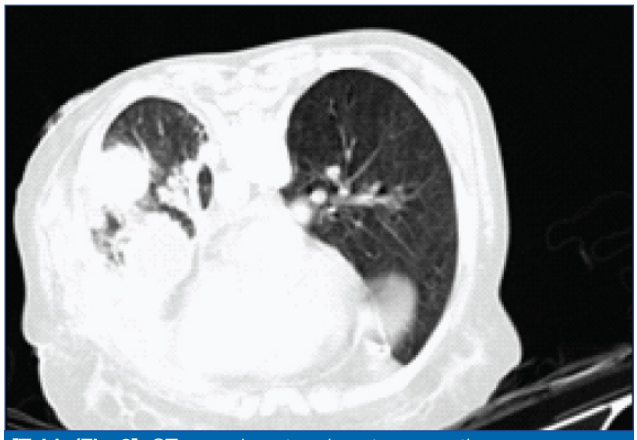
**[Table/Fig-7]:** Smears prepared by the cytopathologist.

In case of pneumothorax, patient was observed for four hours.

**Ethics:** This study was approved by scientific and ethical committee at Kidwai Memorial Institute of Oncology, Bengaluru, India.

## STATISTICAL ANALYSIS

Descriptive analysis was adopted to study data using percentages. Efficacy of CT guided FNAC was computed using yield and failure rates. Validation of CT guided TTFNAC



**[Table/Fig-8]:** CT-scan done to rule out pneumothorax.

in diagnosing benign and malignant lesions were computed by calculating sensitivity, specificity, positive and negative predictive value. Complications were divided in terms of pneumothorax, hemoptysis, death or hemorrhage and percentages were calculated.

## RESULTS

Image guided thoracic interventions are routinely performed of which those done under CT guidance are widely used now a days. For the current study, 420 patients underwent CT guided TT FNAC. In the present study, patients were in the age group of 18-87 years of age; the most common age group encountered was 50 to 60 years followed by patients in the age group below 50 years. Youngest patient encountered was 18 year and oldest was 87 year. This study included 285 males (67.8%) and 135 females (32.1%).

In the current study, the most common site of the thoracic lesions seen was intrapulmonary 360 (85.7%), followed by mediastinal masses 51 (12.1%) and remaining were pleural lesions 9 (2.1%) [Table/Fig-9]. The lesions varied in size from 15 mm to 106 mm, however the lesions less than 25 mm yielded no material. In intrapulmonary lesions, the most common sub-site involved was left upper lobe followed by right lower lobe. Other lesions were mediastinal and pleural, in the mediastinum the most common sub-site was anterior mediastinum. All the 420 patients underwent CT guided TTFNAC procedure, material was procured in 402 patients, i.e., on CT table cellular material could be aspirated from 402 patients and these were handed over to a cytopathologist, present at the procedure room to prepare the smears. In the rest of the 18 cases no material could be aspirated on repeated efforts. Material procured by CT guided TTFNAC was handed over to cytopathologist who prepared an average of 5 smears for each case, these slides were fixed and stained adequately by using Papanicolaou, Giemsa or Hematoxylin and Eosin in case of cell block specimens. In a fewer cases cell block

| Region | Number of Lesions | Percentage (%) |
|---|---|---|
| Mediastinum | 51 | 12.1 |
| Pleura | 9 | 2.1 |
| Lungs | 360 | 85.7 |
| Total | 420 | 100 |

**[Table/Fig-9]:** Anatomical division of intrathoracic lesions.

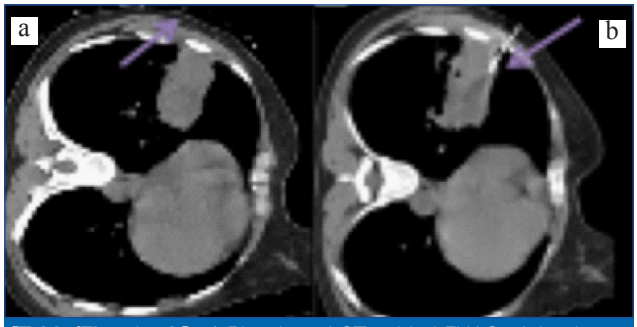
study was attempted to further characterise the lesion, in case of suspected infective etiology the aspirate was subjected to microbiological examination.

When the samples had a high cellularity, they were defined as adequate. This constituted to about 85% cases. Samples were considered inadequate when cellularity was poor or absent and when there was necrosis or bloodstained material as no definitive diagnosis could be given in these cases. These cases were considered as procedure failure and these patients were subjected to repeat examinations. However, in the lesion smaller than 25 mm, the yield was very poor.

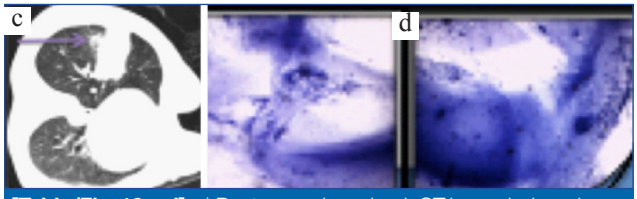
A total of 66 benign lesions and 267 malignant lesions were diagnosed based on final cytological diagnosis. In the intrapulmonary lesions, 66 lung lesions were considered benign, out of which 30 patients showed granulomatous cells, 24 patients showed inflammatory cells, nine cases had hydatid cyst [Table/Fig-10] and three patients had abscess. In the patients with granulomatous cells, microbiological evaluation of the aspirated material was done [Table/Fig-11a-d]. In the malignant intrapulmonary lesions, the most common were primary (75%) followed by secondary (25%). Amongst the malignant lesions, the most common subtype encountered was non small cell type (61.2%), followed by small cell type (23.5%), poorly differentiated carcinomas (10.11%) and 3 round cell morphology cells (3%) cases, which was confirmed as lymphoma on cell block. Amongst the non small cell carcinomas, adenocarcinoma was more common subtype, followed by squamous type [Table/Fig-12].

The radio cytological concordance for the malignant lesions was good, as sensitivity, specificity; positive and negative predictive values for malignant lesions were 97.2%, 66.66%, 94.5% and 82.0% respectively.

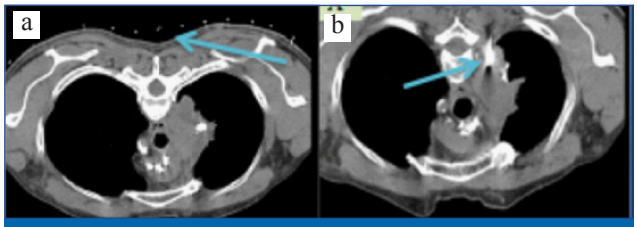
The radio cytological concordance for the benign lesions was lower, fewer lesions attributed as benign on CT were confirmed, and sensitivity, specificity, positive and negative predictive values for benign lesions were 66.6%, 97.2%, 80% and 94.7%.



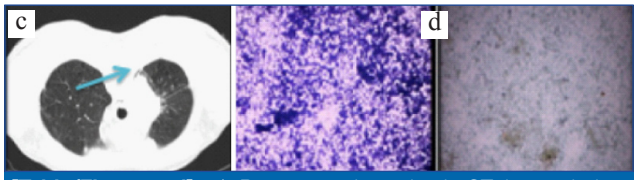

**[Table/Fig-10 a,b]:** a) Planning of CT guided FNAC of the thorax axial sections, plain CT of heterogeneous mass lesion with broad base abutting chest wall in lateral decubitus position; b) Mass lesion with needle in the lesion.



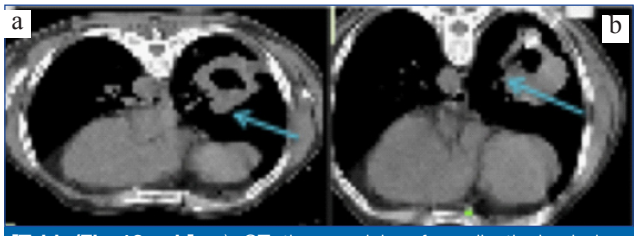

**[Table/Fig-10 c,d]:** c) Post procedure check CT lung window shows no complications; d) Cytology slide showing laminated membranes confirmed diagnosis of Hydatid cyst.



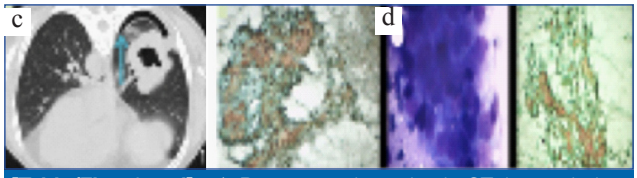

**[Table/Fig-11 a,b]:** a) CT scan thorax plain showing planning of the soft tissue density lesion with calcific spec and calcified mediastinal nodes in prone position; b) Mass lesion with needle tip in the lesion.




**[Table/Fig-11 c,d]:** c) Post procedure check CT lung window shows no complications; d) Cytology slides showing caseation necrosis consistent with tuberculosis.




**[Table/Fig-12 a,b]:** a) CT thorax plain of mediastinal window showing planning of lesion with thick walled cavity in prone position; b) Mass lesion with needle tip in the lesion.




**[Table/Fig-12 c,d]:** c) Post procedure check CT lung window showing pneumothorax; d) Cytology slides showing tumour cells consistent with squamous cell carcinoma.

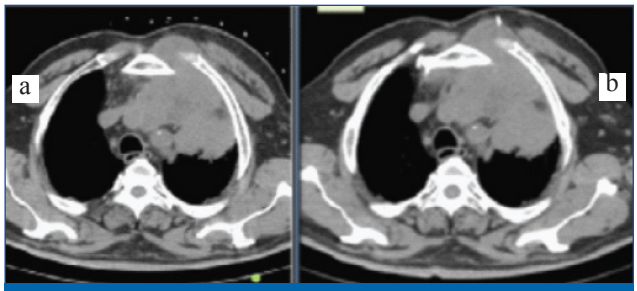
The sensitivity of the CT for the benign lesions is lower than malignant lesions however specificity is higher and hence it is suggested to follow-up the patients for a period of at least three months before subjecting the patient to interventional procedures in particular in smaller nodules less than 25 mm.

## DISCUSSION

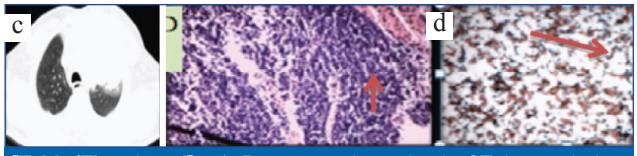
Amongst the mediastinal masses, lymphoma was the most common subtype which showed round cell morphology and was confirmed by immunohistochemistry. Thymoma was seen in 2% cases [Table/Fig-13a-d]. Followed by neurogenic neoplasm, [Table/Fig-14a-d] lymph nodal metastasis was seen in six cases, three case of mature teratoma was seen. The mediastinal lesions showed good radiological and cytological agreement in cases of teratoma, thymoma, lymphoma and neurogenic neoplasm and less in neuroendocrine tumour metastasis.

In the present study, patients were in the age group of 18-87 years, the most common age group encountered was 50 to 60 years followed by patients in the age group below 50 years. Youngest patient encountered was 18 years and oldest was 87 years. Mean age was 52.5 years. Pediatric patients were excluded from the study.

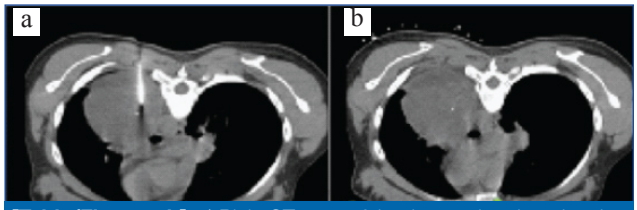
In this study most common lung lesions were encountered in left upper lobe followed by right lower lobe. Least number of lesions



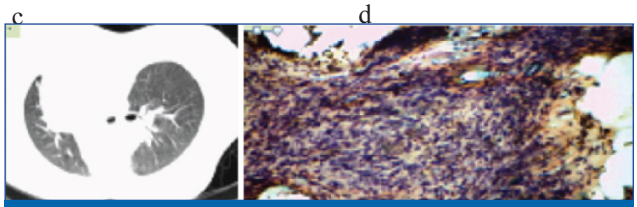

**[Table/Fig-13 a,b]:** a) Axial CT-scan thorax plain study showing planning of the CT guided FNAC of a heterogeneous mass lesion with broad base towards anterior mediastinum with extra thoracic extension; b) Mass lesion with needle tip in the lesion.




**[Table/Fig-13 c,d]:** c) Post-procedure check CT lung window showing no complications; d) Hematoxylin and Eosin and pap smear slides showing thymoma.




**[Table/Fig-14 a,b]:** a) Plain CT-scan of the thorax showing planning of mass lesion in the left paravertebral region with a speck of calcification in prone position; b) Localization of the needle tip in the lesion.




**[Table/Fig-14 c,d]:** c) Post procedure check CT showing no complications; d) Cytology slides showing tumour cells consistent with spindle cell neoplasm. Biopsy was done later and this case was proven as schwanomma.

was seen in right middle and right upper lobes [Table/Fig-15].

Based on assessment of CT features of the available review CT-scans, these lesions were classified as benign, malignant or indeterminate, about 217 CT-scan showed malignancy features, 36 CT scans showed benign features and 96 cases were indeterminate.

Most of the malignant lesion show heterogenous enhancement, necrotic areas and spiculated or thick walled borders [Table/Fig-16].

The rate of post procedure complications was studied in all the cases, by doing an immediate check plain CT. A total of 126 patients developed minor complications, no death was encountered, and no patients needed chest tube insertion. Pneumothorax developed in 20% cases [Table/Fig-12]. All of these lesions were at a depth exceeding 4.5 cm from the chest wall. 39 cases were at an angle of more than 90 degrees from the chest wall, three cases had cavitary lesions [Table/Fig-17].

In the present study about 42 patients developed intrapulmonary hemorrhage, these lesions were at a depth of more than 2.5 cm from the chest wall. Lesion depth has been identified as the most important risk factor. Haemorrhage may occur from intercostal or internal mammary arteries or veins.

| Lobes | Number | Percentage (%) |
|---|---|---|
| Right upper | 48 | 11.3 |
| Right middle | 60 | 14.28 |
| Right lower | 87 | 20.7 |
| Left upper | 105 | 25 |
| Left lower | 60 | 14.28 |
| Total | 360 | 100 |

**[Table/Fig-15]:** Distribution in to lung lobes and sides.

| Imaging Signs of Malignancy | Percentage (%) | Malignancy |
|---|---|---|
| Irregular Border | 37.1 | 156 |
| Spiculation | 40 | 168 |
| Enhancement | 73.5 | 309 |
| Pleural Effusion | 13.5 | 57 |
| Chest wall Invasion | 9.3 | 39 |
| Vascular Invasion | 15 | 63 |
| Calcification | 4.3 | 12 |
| Necrosis | 57.1 | 240 |
| Collapse/Bronchial cut-off | 5.7 | 24 |
| Lymph Nodes | 30.7 | 129 |
| Cavitation | 10 | 52 |
| Total | 100 | 420 |

**[Table/Fig-16]:** Imaging signs of malignancy.

| Complication | Number | Percentage (%) |
|---|---|---|
| Pneumothorax | 84 | 20 |
| Hemoptysis | 0 | 0 |
| Hemorrhage | 42 | 10 |
| Death | 0 | 0 |
| No complications | 126 | 30 |
| Total | 420 | 100 |

**[Table/Fig-17]:** Complication Rate.

In the malignant intrapulmonary lesions, the most common lesions were primary which constituted to about 75% and 25% secondary lesions were seen. Most common lesions encountered in this study were primary lesions.

Comparison with other studies is tabulated in [Table/Fig-18]. this study showed similar diagnostic accuracy and complication rates compared to other studies [5,7,8,10,7,11].

In a study conducted by Adyakinkar et al., total cases were 60, out of which 40 pulmonary lesions were encountered, the diagnostic yield was 88%, with p-value of 0.01, sensitivity was 90% and specificity of 85.7% [12].

In a study conducted by Gosh S et al., Out of 86 cases, 82 cases were pulmonary lesions of which most common encountered lesion was squamous cell carcinoma, there were minimal complications in the form of pain [13].

In a study conducted by Baby J et al., of the 114 cases there were 96 lung lesions, diagnostic yield was seen in 100 cases with diagnostic accuracy of 87.7% and 3% cases developed pneumothorax [14].

In a study conducted by M Sengupta M et al., 74 cases of pulmonary lesions were studied. All malignant lesions showed good yield. Minimal complications were encountered [15]

In a study conducted by Bharadwaj P et al., FNAC showed diagnostic yield of 95.9% and complications in 8.2% [16].

In a study done by Sharma et al CT guided FNAC was done in 81 patients, it yielded positive results in 75 patients [17].

The clinical significance of this study is that CT guided TTFNAC can be used for material procurement in lung, mediastinal and pleural lesions that is not accessible by ultrasound. Complications can also be avoided to a fair extent and if any can be diagnosed early.

## Recommendations

TTFNAC can be used as an outpatient procedure for procurement of material in intrathoracic lesions as the yield of the procedure is good with lesser complications.

Whenever possible it is suggested to aspirate at least 5-6 ml of aspirate, so that cell block (IHC markers) can be assessed in the same setting as this helps in providing more accurate pathological diagnosis.

| Name of the author | Present study | Singh JP et al., [5] | Gupta A et al., [7] | Singh GR et al., [8] | Emara MM et al., [10] | Mukherjee S et al., [11] |
|---|---|---|---|---|---|---|
| No. of cases | 420 | 34 | 66 | 33 | 66 | 94 |
| Age in years | 18-87 | 35-75 | 9-82 | 10-80 | 9-82 | 40-70 |
| Material Adequacy | 85% | 85.3% | 90% | 90% | 90% | 95% |
| Sensitivity | 97% | 92% | 85.7% | Not available | Not available | 97% |
| Specificity | 66% | 100% | 68.9% | Not available | Not available | 100% |
| PPV | 94.5% | 100% | 66.6% | Not available | Not available | 100% |
| NPV | 82% | 75% | 89.96% | Not available | Not available | 66.66% |
| Complications | | | | | | |
| Pneumothorax | 20% | 11.8% | 20% | 9.8% | 21% | 4.3% |
| Haemorrhage | 10% | 2.8% | - | 8.8% | 10% | - |

**[Table/Fig-18]:** Comparison of the present study results with other study.

It is better to do a plain and contrast CT-scan and correlate it with CT guided TTFNAC as there will be precise lesion localization, improved staging, better identification and characterization of the masses, determine their relationship to major vessels, thereby avoiding inadvertent puncture of vascular structures and vital organs.

It is better for a cytopathologist or technician to be present when CT guided TTFNAC is done so that material procurement can be assessed on the spot.

If the depth of the lesion is greater than 5 cm from the chest wall, it is better to anticipate pneumothorax or complications, by observing the patient for at least 24 hours.

## LIMITATION

Being oncology setup, number of malignant lesions was encountered more than benign lesions.

Pediatric population was excluded from study and hence efficacy in pediatric patients could not be assessed.

As USG, FNAC was done for peripherally accessible lesions in our setup, no cases of mesothelioma, other mediastinal masses, other pleural based and peripheral lung lesions were seen, hence the spectrum of lesions encountered in this study do not represent the true spectrum of intrathoracic lesions.

For lesions lesser than 25 mm in size, no cellular material was aspirated even on repeat efforts.

For the heterogeneous lesions, and necrotic lesions, as no contrast was used during the procedure, it was difficult to localize the most cellular aspect of the lesion, thereby necessitating multiple aspiration attempts.

## CONCLUSION

CT guided TTFNAC is a good tool for material procurement in benign and malignant lesions. It helps the clinician to initiate appropriate treatment measures like chemotherapy or radiotherapy at an early pace and is associated with low mortality and morbidity TTFNAC achieves substantial cost savings, as it can obviate more costly and invasive surgical procedures and is minimally invasive. Complications caused by TTFNAC can be avoided; if properly planned, by avoiding vessels and bullae. This procedure can be used as a safe outpatient procedure for material procurement in lung or mediastinal lesions, not accessible for ultrasound guided FNAC, for lesions situated less than 8 cms from chest wall and size greater than 25 mm and it has good patient tolerance.

## ACKNOWLEDGMENTS

Authors will like to thank Dr. Malathi, Department of Pathology for pathological interpretation, Dr. Ramesh for statistical analysis and Radiology Technicians of Kidwai memorial institute of oncology, Dr. Navin Patil, Dr. Deshpande Pooja Rajeev, Dr. Elroy Furtado, Dr. Anuradha Kapali, Dr. Chinchu, Pream, Dr. Prashanth Sinha, Dr. Sateesh Kumar Atmakuri, Dr. Bangar Ravindra Shivaji, Dr. Nandan Kumar, Dr. Jaipal and Dr. Madhu for the immense help in this study without which this study would be incomplete.

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**FINANCIAL OR OTHER COMPETING INTERESTS:** None.

Date of Publishing: **Jul 01, 2018**