



## Original Research Article

## Yield of ultrasound guided transthoracic needle aspiration in peripheral intrathoracic mass lesions

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## ABSTRACT

**Background:** In thoracic lesions, early diagnosis and sorting out into malignant- benign is important regarding the therapeutic decisions and prognosis. Ultrasound guided Transthoracic needle aspiration (TTNA) and Corebiopsy (CNB) are described to be safe accurate high yielding means of diagnosis. The study aims to determine the yield and safety of TTNA in peripheral intrathoracic mass lesions.

**Materials and Methods:** Study was conducted in government teaching institution in Kerala. Patients with intrathoracic peripheral mass lesions which were visualized by USG were subjected to TTNA, and sent for cytopathology. The patients with inconclusive results were subjected to either USG guided or CT guided CNB. The patients were followed up till a conclusive diagnosis obtained. The results were classified as conclusive /definitive or inconclusive. Diagnostic yield and complication rate calculated.

**Results:** USG guided TTNA had an overall diagnostic yield of 65.5%,with 72.15% yield in malignancy. It had high diagnostic yield in lung carcinoma(82.3%) and was a safe procedure with complication rate of 3% only.

Combined with USG guided CNB, the overall yield became 86.66% with a cumulative yield of 91.13% in malignancy with no increase in complication rate.

**Conclusions:** Ultrasound guided TTNA is a safe procedure with good yield in peripheral lung malignancies.

Ultrasound guided transthoracic needle aspiration and core cut together has a high diagnostic yield in peripheral intrathoracic masses and is accurate in differentiating malignant and benign lesion with a good safety profile.

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## 1. Introduction

The quest for accurate diagnosis by the least invasive technique has started since the history of medicine. Transthoracic needle aspiration lung TTNA yields cytologic specimen and core cutting needles (CNB) provides histologic specimens. Together they are also called PTLB (Percutaneous Transthoracic lung biopsy). The early diagnosis of lesions by cytological or tissue biopsy helps in classification of disease as malignant or

benign and in effective management. Image guidance using fluoroscopy, ultrasound, Computer tomography, and recently electromagnetic navigation helps in better localisation, yield, lesser complication rate during percutaneous transthoracic lung biopsy.<sup>1,2</sup>

Thoracic Ultrasound is used extensively by respiratory and critical care physicians. Peripheral lesions in lungs are well visualised by ultrasound provided they have a line of apposition to parietal pleura. US can also visualise solid lesions arising from the pleura, chest wall and anterior mediastinum and hence ideal in biopsy such

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lesions. It has the advantages of having no radiation, needs only entry level equipment, can be operated by single personnel, adjustments according to respiratory movements, less duration of procedure and cost effectiveness.

The present study was undertaken to determine the diagnostic yield of ultrasound guided transthoracic lung needle aspiration and core biopsy and assess the complications of the procedure.

## 2. Materials and Methods

### 2.1. Inclusion criteria

Patients with radiographic peripheral intrathoracic mass lesions which were visualized using ultrasound, where conventional investigations of sputum, blood and Fiber Optic Bronchoscopy (FOB) were in-conclusive.

### 2.2. Exclusion criteria

Patients with

1. Uncorrectable coagulopathy
2. Poor general condition
3. Bullous changes in the area to be aspirated
4. Suspected vascular lesions
5. Lesions close to vital structures
6. No Co-operation

### 2.3. Period

Study conducted in tertiary care teaching hospital , Government medical college Kottayam,Kerala, the Southern state of India, for a period of eighteen months(one and half years) after obtaining the institutional ethical committee approval

### 2.4. Procedure

Detailed clinical history and examination of included patients done. Routine hemogram, clotting parameters, etc done. A fibre optic bronchoscopy was also done. All patients had two chest radiographs - posteroanterior and lateral views, taken. A CT Thorax was taken whenever possible. Informed consent obtained after a clear and complete explanation.

The site of aspiration was decided based on ultrasound examination by Ultrasound Machine. The most suitable patient position, as well as entry site, direction and depth for the biopsy, were determined.

They were subjected to fine needle aspiration with a 22 guage 3.5 inches long lumbar puncture needle after the administration of 2% lidocaine local anaesthesia.USG guidance was performed by free-hand technique. The number of punctures depended on specimen quality, quantity and patient tolerance and ranged from one to six. The aspirate is made into smear and fixed in 95% ethanol

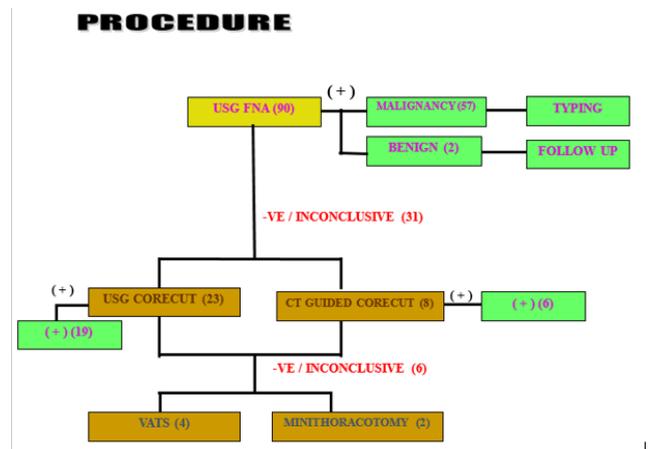
and sent for cytologic examination, AFB staining and gram staining.

The cytology results obtained were classified as

1. Definite for malignancy
2. Suspicious of malignancy
3. Scanty Aspirate/Blood only
4. No evidence of malignancy but no definite benign diagnosis
5. Definite benign pathology

Definite result of malignancy or specific benign diagnosis (1&5) was considered a definitive report.

Patients with a negative result or nonspecific diagnosis were subjected to a core cut biopsy using a maxcore TM core biopsy needle either ultrasound guided or CT guided depending on chest wall apposition, emphysematous changes, and ultrasound window access as decided by the physician. There was no onsite assessment of lesion pathology. All specimens were fixed in 10% buffered formalin. When tuberculosis pleurisy was suspected, one of the specimens was placed in a sterile saline and sent for afb staining and culture. The patients were observed immediately post procedure with ultrasound for pneumothorax and thereafter four hours clinically for any post procedural complications and chest x-ray done if any complications suspected. For patients with negative core-cut results on USG or CT, VATS or Thoracotomy done and followed up till final diagnosis obtained.



## 3. Data analysis

For malignant lesions true positives were taken as those with definite evidence of malignancy on cytologic examination.

Positive result of benign nature was confirmed if

1. The cytologic result was confirmed subsequently by histopathology or
2. If the lesions responded to corresponding management on follow up.

Only patients with definite final diagnosis is included in the analysis

Sensitivity is calculated as  $TP/(TP+FN) \times 100$ .

The diagnostic yield, defined as the number of true positives (definitive results both benign and malignant) divided by total number of patients, as well as the complication rate [pneumothorax (PTX), bleeding] was calculated.

### 3.1. Statistical analysis

Descriptive Statistical Analysis was used.

### 3.2. Observations

A total of 94 patients subjected to USG guided TTNA, four patients were excluded from final analysis since final diagnosis could not be obtained. (2 were lost for follow-up after initial TTNA, one died during the evaluation, one patient refused consent after the inconclusive TTNA).

## 4. Results

Among the 90 patients included in final analysis, the mean age was 58.2 years and 86% were males. 76% were above the age of 50 years. 68% of the study population were current smokers. Eight (9%) were ex-smokers and Three (3%) were passive smokers. Chest Pain (80%) and Cough (76%) were the major symptoms.

Radiologically, 60% of the lesions were on the right side. Maximum number of lesions were situated in the right upper zone (33%). The size of lesions varied between 3.6cm to 9.4cm with a mean of 5.9 cm and 40% of lesions were between 5-7 cm sizes with a high yield.

### 4.1. Diagnostic Yield of USG TTNA

USG FNA yielded a definite result in 59 of the 90 patients (65.55%). 57 were malignant lesions and 2 were benign. The overall yield was 65.55%. (Table 1)

The 31 patients who had an in-conclusive result were subjected to core-cut biopsy. 23 of them had USG biopsy while 8 underwent CT guided biopsy. Of the 23 subjected to USG guided core-cut biopsy, 19 had a definitive result (82.6% yield). Eight subjected to CT core biopsy (75% yield) (Table 1)

Of the six patients who still remained un-diagnosed four underwent Video Assisted Thoracoscopy (VATS) and Two underwent Thoracotomy. Both procedures gave 100% results.

Together, USG TTNA and USG Core-cut gave 86.66% (78 out of 90) definite results (Table 2).

### 4.2. Diagnostic yield in malignancy

79 patients out of 90 had a final diagnosis of malignancy. 57 malignancies detected by USG guided TTNA (72.15 %)

and 15 by USG core-biopsy (Table 3).

USG guided TTNA and core-cut had a cumulative yield of 91.13% (73/79) among total malignancy diagnosed.

### 4.2.1. Typing in malignancy

Among the 79 malignant diagnosis obtained, 68 were primary lung carcinoma and 11 were other malignancies including metastases.

Among the 68 lung carcinomas identified by all procedures, TTNA could type 82.35% (56/68). A cervical tumor metastases was also identified by TTNA. So 57 epithelial tumors out of 69 could be typed by TTNA alone. The remaining 10 malignancies required histopathological diagnosis by core-cut or VATS or Open Lung Biopsy. (Table 4)

### 4.3. Yield in Benign Lesions

11 benign peripheral lesions identified by all procedures together. This consisted of three pulmonary TB granuloma, one Wegner's granulomatosis, two bacterial abscess, two actinomycosis, two semi-invasive aspergillosis and one sarcoidosis.

One tuberculous granuloma identified by TTNA which was also TTNA smear AFB positive. A bacterial abscess which later responded to antibiotics also yielded in TTNA. Nine out of Eleven benign lesions were identified by histopathological diagnosis by ultrasound guided or ct guided core-cut or VATS.

### 4.4. Complications

Only minor complications not requiring major interventions occurred during guided TTNA and Core-cut biopsy procedures.

Of the 90 subjected to USG guided TTNA, Three out of Ninety had complications (3%), One person had syncope, treated supportively and two had minor pneumothoraces which responded to supportive management.

Mild hemoptysis observed in one patient (4.34%) subjected to USG guided core-cut biopsy and one patient had pneumothorax in CT guided biopsy too (12.5%), which was treated by aspiration and supportive management.

### 4.5. Sensitivity of USG guided TTNA and core-cut in malignancy and Benign Lesions

Sensitivity for malignancy was 72.15 % for TTNA and 9.1% for benign lesions together USG guided TTNA and corecut had sensitivity of 91.13% for malignancy and 54.5% for benign lesions. (Table 5)

## 5. Conclusions

Ultrasound guided TTNA is a safe procedure with good yield in peripheral lung malignancies.

**Table 1:** Diagnostic Yield of USG TTNA, CNB

Procedure	No of Patients	Malignancy	Benign	Total +ve Res	Yield (%)	Inconclusive result
USG TTNA	90	57	2	59	65.55	31
USG Corecut	23	15	4	19	82.60	4
CT Guided Corecut	8	5	1	6	75	2

**Table 2:** Diagnostic yield of usg guided & USG core-cut

Guidance	Total	Malignancy	Benign	Definite Result	Cumulative Yield
USG guided	90	57	2	59	78 (86.66%)
Usg core	23	15	4	19	

Together, USG FNA and Corecut gave 86.66% (78 out of 90) definite results.

**Table 3:** Diagnostic yield in malignancy

Total no of malignancy diagnosed	USG guided FNA	USG guided corecut	CT corecut	Vats	Minithoracotomy
79	57	15	5	1	1
Cum Yield	91.13				

**Table 4:** Typing in malignancy

		Total	USG guided TTNA	usg Guided CNB	Others(ct,VATS, OLB)
lung Carcinoma - 68	Sq Cell -16 adeno - 26 adeno sq-1 Small cell - 3 large cell-3 poorly diff-19 Mesothelioma -3 Pulmonary lymphoma - 1	68	56/68 (82%)	9/68	3/68
	Other Maligant Tumours - 11	11	1/11 (9.1%)	7/11	3/11
	Sarcoma-1 Metastasis Ovarian - 1 Cervical -1 Plasmacytoma - 2 Invasive nervesheath Tumour - 1 Thymic carcinoma - 1				

**Table 5:** Sensitivity of ultrasound ttna & core-cut in benign & malignant lesions

	Malignant	Benign
USG TTNA	72.15	9.1
USG TTNA & corecut	91.13	54.5

Ultrasound guided transthoracic needle aspiration and core cut together has a high diagnostic accuracy in differentiating all malignant and benign lesion presenting as peripheral intrathoracic lesions with a good safety profile.

## 6. Discussion

In thoracic lesions, early diagnosis, separation of malignant-benign lesions and early treatment are the main goals to decrease mortality.

Image guided Percutaneous lung biopsy (PTLB) either TTNA or CNB is the preferred method of tissue sampling

for peripheral lesions.<sup>3</sup> According to BTS guidelines USG is recommended wherever possible so as minimize radiation exposure. It requires less infrastructure, personnel and is cost effective too.

However there are not many studies assessing the diagnostic yield and accuracy of USG guided TTNA by following up the lesions till a final conclusive diagnosis obtained. Peripherally located mass lesions were included in the present study. Since a comprehensive review of literature revealed a high specificity in the diagnosis of malignancy, (nearly 100%) a conclusive evidence of malignancy was considered as diagnostic and for all inconclusive cases and

benign cases repeated procedures, invasive procedures or follow up was done to ensure a definitive diagnosis.

Of the 90 patients included in final analysis subjected to TTNA, 86% were males and 76% were above the age of 50 years with 68% current smokers. This is at par with other studies.<sup>4,5</sup> The substantial number of males reflects the male predominance in lung cancer as the study included mass lesions and lung carcinoma is the major diagnosis chest pain (80%) was the major symptom. Chest pain is present in 76% of our patients may be due to the peripheral nature of lesions selected. When it is present in lung cancer it shows an advanced stage of disease.<sup>3</sup>

### 6.1. Diagnostic yield

Interpretation of the TTNA specimens falls into one of the following categories: malignant, specific benign (conclusive), or nonspecific benign, scanty aspirate (inconclusive). In our study USG guided TTNA gave a conclusive diagnosis in 59/94 (diagnostic yield 65.5%) cases, the rest 31/90 were inconclusive.

Percutaneous FNA is considered to have a very low false-positive rate of 0 to 0.2%, which imparts a high level of confidence in a positive biopsy result. However, the false-negative rate of FNA varies, occurring in 6 to 54% of biopsies.

The adequacy of the specimen can be assessed immediately and the number of unsatisfactory samples reduced if a cytopathologist is present during the procedure. Our study did not have on site cytopathological examination which might explain the initial lower results of TTNA.

Diagnostic accuracy is also dependent on the size and site of the lesion, operator experience, needle type, choice of biopsy technique,<sup>3</sup> and sonologic factors like length of apposition to pleura, lack of pleural sliding, pleural adhesion. Our study did not look into the factors causing increased yield.

The inconclusive 31 patients were subjected to core cut biopsy either USG guided or CT guided. USG corecut yielded a diagnosis in 19 out of 23 cases (82.6% accuracy). Together FNA and core cut under USG guidance yielded definite results in 78/90 peripheral mass lesions (cumulative yield 86.66%). This is comparable to similar studies.<sup>3</sup>

Hence combined with USG guided core needle biopsy, the yield of TTNA increased considerably which shows that wherever possible both procedures can be done concurrently which increases the yield. Similar studies validate this.[3]

### 6.2. Diagnostic yield in malignancy and typing

79 patients out of 90 had a final diagnosis of malignancy and TTNA diagnosed 57/79 (72.15%) malignancies. 73/79 of the malignancy diagnosed could be detected by USG guided TTNA and core biopsy together (cumulative yield

of 91.13%).

In literature it is recorded that in the diagnosis of lung cancer, the sensitivity of TTNA technique is 80- 95%, and the specificity is 95-100%.<sup>3,6-8</sup> Pre-procedural assessment of lesions will help in determining the higher chance of malignancy and highly probable malignant lesions have an increased diagnostic yield.

Considering the high yield in malignancy in this study, assessing pretest probability of malignancy in a peripheral lung mass may help in choice of image guidance and fine versus cutting needles without changing the conclusiveness of results but with lesser complications and economic advantage. More comparative studies with CT can be undertaken in this regard.<sup>9,10</sup>

TTNA alone could type 58.8% (40) of total no of malignancies with precision. Among the 68 lung carcinomas Identified by all procedures, TTNA could type 82.35% (56/68) of tumors. A cervical tumor metastases (squamous cell carcinoma) was also identified by TTNA (57/69) carcinomas. Hence TTNA had a high detection rate for epithelial tumors.

The remaining 10 malignancies consisted of mesothelioma(3), plasmacytoma(2), pulmonary lymphoma (1) malignant nerve sheath tumor (1), thymic carcinoma (1), two metastases (1 sarcoma, ovarian carcinoma). All of these required histopathological diagnosis.

In a study by Diacon et al[3] the high yield (95%) of US-assisted FNAB in 89 cases of lung carcinoma was found to be clinically relevant. The yield of FNAB to CNB was significantly higher in lung carcinoma (95 versus 81%), while in all other malignant tumors and benign diseases CNB gave better results. The choice of FNA or CNB ,according to the study, depends on the suspected diagnosis (carcinoma versus mesothelial tumors), the size, location and mobility of lesion as well as patient related factors like comorbidities and medications.<sup>11</sup> The CNB yields more tissue while FNA is safer in small lesions. In suspected lung carcinomas if safety of patient is a concern, FNA is preferable.

Our study revealed a high typing result for the lung carcinoma with TTNA (82.35%), hence lesions with higher probability of lung carcinomas maybe subjected to TTNA considering the low complication rate without affecting the treatment plan as SCC versus NSCC.

## 7. Benign Lesions

2 benign diagnosis obtained by TTNA, while 9/11 required a histopathological confirmation either core-cut or VATS. So benign lesions required a repeat procedure like core-cut biopsy.

Consistently lower diagnostic accuracy rate for benign lesions (10-30%) compared to malignant lesions, were achieved in all FNA reports.<sup>3,6-8</sup> This may result from the nonspecific lung tissue response to a number of different

benign offending agent. Obtaining a core biopsy specimen increases the rate of a definite benign diagnosis from 52% to 91% because of larger samples. If the lesion is clinically and radiologically in favour of a benign disease, then a decision to obtain larger samples with cutting needles with a follow up programme can be initiated.

Overall sensitivity of TTNA for malignancy was found to be 72.15 % and 9.1% for benign lesions. Together USG guided TTNA and corecut had sensitivity of 91.13% for malignancy and 54.5% for benign lesions. Hakan S et al deduced that image guided TTNA in all thoracic lesions had a yield 70.58%. In malignant lesions FNA had a high sensitivity of 89.55% and specificity of 100%. The negative predictive value was 63%. Benign lesions had a low sensitivity in this study (34%). On extensive literature review, the sensitivity, specificity, and accuracy for FNA of pulmonary lesions is 82 to 99%, 86 to 100%, and 64 to 97%, respectively.<sup>11</sup> Ultrasound assisted TTNA has a high yield in peripheral lung lesions with possible lesser time to diagnosis and economic advantages.<sup>2</sup>

## 8. Complications

3/90 (3%) after TTNA had minor complications. Pneumothorax was the commonest (2/90). Lung USG can detect it with visualizing the Lung point. There is a pooled incidence of PTX of 4.4% in various studies for TTNA.

CNB had a case of hemoptysis (1/23). Hemoptysis is seen in 1–5% of the patients with guided biopsy procedures.<sup>11</sup>

Ultrasound-assisted fine-needle aspiration performed by chest physicians is a safe and accurate diagnostic procedure in patients peripheral lung masses especially with high probability of lung malignancies.

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## 10. Conflict of Interest

The authors declare they have no conflict of interest.

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