# Diagnostic Yield of Ultrasound Guided Transthoracic Fine Needle Aspiration Biopsy in the Diagnosis of Intrathoracic Lesions

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## ABSTRACT

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Image guided TTNA of pulmonary lesions are widely applied now a days. Most of the lesions which are located nearer to the chest wall can be well visualized by ultrasonography. Whereas smaller lesions, deeply located ones, mediastinal or juxtra-hilar lesions may not be visualized sonographically. In those cases CT-guidance becomes beneficial. This report is of 22 TTNAs done during a 1 year period. In considering the poor economic ability of the patients USG-guidance was preferred provided the lesion could be well visualized. Ultrasound guided method was successfully performed in all the cases which were selectively chosen based on chest radiograph shadows which were smaller than 7x7 cm size and seemed close to chest wall. Negligible immediate or late complications were noticed. Image guided TTNAB of intra-thoracic lesions can therefore be made with minimum complication, can allow the physician to decide the mode of treatment in a shortest possible time and in most of the cases ultrasound guidance is sufficient enough considering the poor economic status of people seeking healthcare in the public sector health facilities. US-guided needle biopsy provides a precise and safe approach for transthoracic tissue sampling of lesions. The amplitude US angiography further extend the diagnostic potential and safety of this invasive procedure. Vascular information can be obtained and the needle shaft can be visualized clearly while conducting a biopsy. US examination and US-guided needle aspiration biopsy have now become indispensable diagnostic tools for various chest diseases.

**Keywords:** Transthoracic needle aspiration, Ultrasound guided aspiration, Diagnostic yield

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## INTRODUCTION

Image guided transthoracic needle aspiration (TTNA) of lung lesions has been a valuable diagnostic tool since it was first described in 1965.[1] Transthoracic fine needle aspiration cytology (TTNA) is an established and safe technique for diagnosis of thoracic mass lesions. Ultrasound is cheaper, radiation free, and allows real time monitoring. Its limitations are obscurement of lesions by aerated lung, smaller, deep seated and cavitary lesions. Sonography is used for guidance in pulmonary, pleural or mediastinal lesions in contact with the chest wall and CT for those not approachable by sonography.[2-4] Computed tomography (CT) scan depicts clear anatomical details and provides access to any area of the body. It is, however, expensive and the needle is not passed in real time. CT has, among its advantages, clear depiction of anatomical details and access to any area of the body. It, however, is expensive, takes longer to perform and involves radiation exposure.[5-8] Also, the needle is not passed in real time. Ultrasound, on the other hand, is cheaper, radiation free, and allows sample collection under real time monitoring. The limitations of this modality are obscurement of lesions overlaid by aerated lung, smaller, deep seated, and cavitary lesions.

Pneumothorax is a common complication.[6-13] The rate of pneumothoraces reported in the literature varies from 4-5 % that too in a patient with benign lesion. Symptoms usually develop slowly, and the radiologist has plenty of time to calmly place a small-bore chest tube. However, the problem must be considered serious. On occasion, a patient quickly becomes gravely ill. This situation occurs in patients with little pulmonary reserve and severe chronic obstructive pulmonary disease. Of patients with TNB-induced pneumothoraces, only 1 in 5 require chest-tube placement. One technique that has been recently described is the rapid needle-out pa-

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tient-rollover time after transthoracic biopsy reducing the rate of overall pneumothorax and pneumothorax requiring a drainage catheter.

Other complications like hemoptysis (4-5 %) found to subside without intervention. Air embolism is an extremely rare complication in TTNA and no case was reported in our study subjects. Air embolism[6-10,14] occurs when a fistula is created between a pulmonary vein and an airway. Air bubbles into the pulmonary vein, returns to the left atrium, and exits the heart by means of the aorta. The coronary and intracranial arteries may be embolized, with subsequent stroke or myocardial infarction. Recovery is possible if the patient is placed into a hyperbaric chamber to reduce the size of the bubble. An air embolus can potentially be aspirated by using an angiographic micro catheter.

Contraindications to FNAC are unconscious or with real time monitoring by the USG machine are usually seen with uncooperative patients or in those with respiratory failure, hemorrhagic diathesis, intractable coughing or pulmonary hypertension, coagulopathy, liver disease etc and such suspected patients were excluded while selection of patients for procedure.

## MATERIALS AND METHODS

The study was conducted on 22 patients who presented with a shadow in the chest x-ray with strong suspicion of malignancy. All cases were in patients of Chest & Respiratory Medicine, General Hospital, Alappuzha, Kerala, India a secondary referral healthcare centre in public sector. All patients were male and the study was done between June 2014 and April 2015.

Complete clinical history, examination and details of relevant investigations were obtained including CBC, ECG, BT, CT, and Prothrombin time and sputum cytology. Selection of patients were done based on chest radiograph shadows which were smaller than 7x7 cm size and seemed close to chest wall, at the same time having no definite localizing clinical signs to locate a site for transthoracic needle aspiration.

The patient was evaluated for the suitable imaging technique for guided TTNA with initial evaluation for sonography guided TTNA. Only those cases in which sonographic guidance was not possible were taken up for CT guided FNAC.

Written information was given to all patients before the procedure and informed consent was obtained in a written form from all patients and /or the attending persons.

At first an ultra sonographic assessment was done. Examinations were performed using an ultrasonic unit (SIGMA 1 AC, L&T Medical) with 3.5-MHz linear array scanner. The patient was positioned prone or supine depending on the skin entry site chosen. Shallow breath taking instructions were given to patient. A lumbar puncture needle (spinocane) of 23 gauge spinal needle (0.65 mm x 8 cm) with a central stillet (disposable type) was used for each patient. The skin entry site was sterilized with standardized antiseptic solution and under sterile precautions 5ml of 2% lignocaine was infiltrated into the skin, subcutaneous tissues and muscles up to parietal pleura. After having an appropriate measuring of the depth of lesion from the skin needle was inserted according to the inclination of the US probe and inner still et removed after reaching the appropriate depth. Open end of the needle is closed with a gloved finger and a 10ml disposable dry syringe was attached. By applying negative pressure technique, moving the needle to and fro a few times and then after releasing the piston the needle is being withdrawn. After drawing about 5-6ml of air into the syringe the needle is attached and the material aspirated is ejected on to clean sterile glass slides. The whole procedure did not take more than a minute to avoid excessive hemorrhage. The smears were made as quickly as possible to avoid coagulation of blood which hampers the smearing pattern. Smears (nearly 2-5 smears per patient) are made immediately and are fixed in absolute alcohol. Labeled samples were sent to pathology department for cytological examination.

After the procedure patient was advised bed rest with biopsies side dependent, further complications doubted were cleared with X-ray chest taken. Inconclusive results were managed with a second attempt at the same site and definite diagnosis obtained in CT guided biopsy.

## OBSERVATIONS

All the 22 cases included were male smokers. Observations obtained for my study are described here.

**Table 1. Age distribution of patient**

| Age (years) | No. of patients | Percentage |
|---|---|---|
| <30 | 1 | 4.5 |
| 31-40 | 0 | 0 |
| 41-50 | 4 | 18.2 |
| 51-60 | 8 | 36.3 |
| 61-70 | 9 | 41.0 |
| | 22 | 100.0 |

Analysis of findings was done by descriptive statistical method.

Maximum number of patients were in 61-70 years age group **(table 1).**

**Table 2. Age distribution and COPD symptoms**

| Age (years) | No. of patients with COPD symptoms | |
|---|---|---|
| <30 | 0 | 0 |
| 31-40 | 0 | 0 |
| 41-50 | 4 | 18.2 |
| 51-60 | 7 | 31.8 |
| 61-70 | 9 | 41.0 |
| Patient with no COPD symptoms | 2 | 9.0 |
| | 22 | 100.0 |

Patients with COPD symptoms are increasing with age **(table 2).**

**Table 3. Radiological distribution of shadows**

| Zone | No. | Percentage |
|---|---|---|
| Right Mid zone | 11 | 50.0 |
| Right Lower zone | 3 | 13.6 |
| Left Mid zone | 8 | 36.4 |
| Left Lower zone | 0 | 0 |
| | 22 | 100.0 |

One case was perihilar in distribution. Maximum number of patients were with lesion on right midzone, next came left midzone which has got high risk of complication if unguided biopsy is done (vascular puncture) **(table 3).**

**Table 4. Presenting complaints**

| Major symptoms | No. | Percentage |
|---|---|---|
| Chest pain | 13 | 59.0 |
| Hemoptysis | 9 | 40.9 |
| Non specific | 3 | 13.6 |

Majority (13.6%) of patients presented with chest pain and hemoptysis, which is indicative of the lesion to be peripheral, close to chest wall **(table 4).**

Sl. No. 3 - developed minimal pneumothorax and Sl No.13 developed mild hemoptysis. Overall yield is 91% and complications 9% **(table 5).**

Even though the majority of lesions were in the 6-7 cm group, a good no. (27.3%) were in 3-4cm size group. Unguided biopsy of this latter group would be of very low efficacy in diagnosis **(table 6).**

**Table 5. Result of cases individually**

| Sl. no | Age | Radiological size of lesion (cm) | No, of TTNA sittings | Diagnosis & Comments |
|---|---|---|---|---|
| 1 | 56 | 4x4 | 1 | Adeno Ca |
| 2 | 58 | 4x4.7 | 1 | Adeno Ca |
| 3 | 45 | 3.5x3.5 | 2 | I$^{st}$ Benign cella & alveolar macrophage<br>II$^{nd}$ Benign cell |
| 4 | 55 | 4.5x4.5 | 2 | Both attempts benign cells only. CT two months later, yielded squamous cells Ca |
| 5 | 60 | 4x6 | 1 | Carcinoid |
| 6 | 69 | 4.5x6 | 1 | Squamous cell Ca |
| 7 | 65 | 5x5 | 1 | Squamous cell Ca |
| 8 | 41 | 7x5.5 | 1 | Adeno Ca |
| 9 | 48 | 6x6.5 | 1 | Adeno Ca |
| 10 | 66 | 6x6.5 | 1 | Adeno Ca |
| 11 | 62 | 6x6 | 1 | Adeno Ca |
| 12 | 59 | 5x5 | 2 | Benign cells (both) |
| 13 | 60 | 6x6 | 1 | Squamous cell Ca |
| 14 | 63 | 5x5 | 1 | Adeno Ca |
| 15 | 64 | 4.5x5.5 | 1 | Adeno Ca |
| 16 | 60 | 5.5x6.5 | 1 | Squamous cell Ca |
| 17 | 68 | 3x3 | 1 | Squamous cell Ca |
| 18 | 67 | 4x6 | 1 | Squamous cell Ca PD |
| 19 | 45 | 4.5x3.5 | 1 | Adeno Ca (broncho alveolar) |
| 20 | 60 | 6x6 | 1 | Squamous cell Ca |
| 21 | 24 | 6x6 | 2 | I$^{st}$ Malignant cells<br>II$^{nd}$ Thymoma |
| 22 | 65 | 3x3 | Could not localize with US- CT guided | Squamous cell Ca |

**Table 6. Size distribution of radiological shadow (diameter in cm)**

| Size in cm | No. | Percentage |
|---|---|---|
| 3-4 | 6 | 27.3 |
| 4-5 | 1 | 4.5 |
| 5-6 | 7 | 31.8 |
| 6-7 | 8 | 36.4 |

**Table 7. Cell type obtained by TTNA**

| Type | No. | Percentage |
|---|---|---|
| Adeno | 9 | 41.0 |
| Squamo | 9 | 41.0 |
| Benign | 2 | 9.0 |
| Others(Carcinoid, Thymoma) | 2 | 9.0 |

Of the 22 cases enrolled in the study, US localization was possible in 21 cases and material obtained by

TTNA for opinion. 4 cases required second TTNA to get a definite opinion. Of these 4 cases 3 cases showed benign cells on repeat biopsy, one of these later proved to be malignant on CT guided biopsy (25%). As for remaining one, initial report was that of malignant cells and a repeat biopsy was demanded on which conclusive report of thymoma was obtained **(table 7).**

**Table 8. Diagnostic yield Vs cell type**

| Type | No. | Percentage |
|---|---|---|
| Adeno | 9 | 77.8 |
| Squamo | 9 | 100.0 |
| Benign | 2 | 100.0 |
| Carcinoid | 1 | 100.0 |
| Thymoma | 1 | 100.0 |

Thus for Adenocarcinoma a 100% yield in diagnosis was obtained. Benign lesions even though not confirmed by excision, repeated TTNA showed same result and there was no progression or enlargement of lesion on follow up for six months. For the other 2 malignant lesions diagnosis was reached and was confirmed on discussion with cytopathologist **(table 8)**

### Complications

There were only 2 cases of complications (9%). One case with a minimal pneumothorax (film displayed) which responded to conservative management and was radiologically stable on a follow up of six months period. Second case had a hemoptysis which was mild lasting for only 2 days and the patient presents a history of hemoptysis two months earlier.

## DISCUSSION

In the past several years, improved imaging capabilities and biopsy techniques have made it possible to obtain tissue diagnosis in most of the lung lesions suspected of neoplasm. The most common cause of non diagnostic TTNA in malignant lesion is failure to adequately sample the area. There has been many reported studies about usefulness of image guidance in his regard having its own merits and demerits.

The present study is an attempt to evaluate the usefulness of ultrasound guided TTNA, its efficacy and safety in the diagnosis of suspected malignancy. There are only very few reported studies in this regard.

It has got advantages of lack of radiation hazard for operator and patient, repeatability, comparatively less expensive and easily accessible in all hospitals even in developing countries.

Cell type diagnosis of peripheral malignancy usually pose difficult problem for the chest physician. Even though sputum cytology is reported to yield 10-25% of cases, in our series all the 22 cases were negative. Although fibro-optic bronchoscope is available in our hospital, as its yield in peripheral small nodules are very limited, we didn't opt for it. Our hospital is not equipped with fluoroscopic guided aspiration. Thus when we sought the most appropriate method in our circumstances the answer was ultrasound guidance.

In 1976 Chandrasekhar et.al stressed the usefulness of ultrasound for guiding percutaneous biopsy of peripheral masses by reporting 4 cases (results obtained for 3 cases). Their equipment had the drawback of using A and B mode with which is difficult to localize and reach the lesions, particularly small masses. The change of position due to respiratory movement and cardiac pulsation was also a problem. They utilized large biopsy needles in their study.[37]

In 1982 Izumi et.al from department of Medicine, Jichi Medical School, Japan reported successful aspiration biopsy in 20 patients with peripheral pulmonary lesions, from which an yield of malignant cells in 16 samples were reported. They also not mentioned the size of lesions and utilized 2.4 MHz scanner and 21 gauge needles in their study.

In 1985 Young M.D et.al (Taiwan) reported 25 cases of ultrasound guided aspiration biopsy of peripheral pulmonary lesions, with a reported efficacy of 84% and a pneumothorax complication of 8%. They used 18-22 gauge needle, which are well known to have more chance of complication than a 23 gauge needle.

In 1992 Yuan et.al of National Taiwan University Hospital, China reported a study including 30 patients with very small pulmonary peripheral lesions with a success rate of 90% and complication of 3.3%.

All these studies were done with real time visualization of needle in the lesion while aspiration was being done.

Present study is peculiar in that the operator sees the lesion ultrasonically prior to the procedure rather than during it. The point for puncture is marked and angulation of the probe (needle) and appropriate depth to centre of the lesion are noticed then. So this method can be utilized in those hospitals where chest and radio diagnosis department are separate as in most hospitals of a developing country.

Most of the patients in the study were in age group 61-70 and were smokers (with high smoking index of

600-800) who had quitted at the onset of symptoms. Majority of the lesions identified radiologically were in the right midzone (50%) with lesion size ranging between 3-7cm in diameter. We could obtain a 100% aspiration in the cases studied, were 3 cases required a second TTNA for a confirmatory result (15%) with first attempt in 19 cases (95%). As Adenocarcinoma is well known for its peripheral location, 9 Adenocarcinoma were diagnosed in the first attempt itself (100%). When squamous cell carcinoma is considered, which is usually a central tumour diagnosis was possible only in 7 cases out of 9. Other 2 were diagnosed in CT guided biopsy. In one of which was not at all possible to locate lesion using US and Ct showed the lesion to be more than 1cm beneath the chest wall. The diagnosis of Carcinoid with US guided TTNA was possible with first attempt and with minimal complications was the outcome of our study.

In thymoma, US characteristics of anterior mediastinal tumour was found during initial US but only second attempt of TTNA after discussion with cytopathologist and sonologist could produce confirmation. Even though the recommendation of use of large needle in suspected lymphoma or thymoma was not followed here we could make a diagnosis using 23 gauge needle itself.

The high success rate achieved in this study may be due to proper selection of patient, large size of lesion with peripheral location, team approach with sinologist and cyto-pathologist and understanding and co-operative patients.

Several authors have demonstrated that US can be as effective as CT for guidance of thoracic biopsy of peripheral thoracic lesions.[24-26] CT guidance was necessary only in cases of deeper or smaller nodules, or where the nodules were located near the heart and great vessels. Most of the lesions small or large were seen abutting to the chest wall and were well visualized by USG. Hence an USG guided method was sufficient in most of the cases. US has a number of advantages over CT including bedside approach, lower cost, and no radiation exposure which led to our preference to perform US-guided biopsy of peripheral lesions with real time monitoring. Real time monitoring itself helped avoid puncturing the aerated lung and the fact that many of the lesions were located peripherally also may have contributed to the lower rate of pneumothorax among our patients.

## CONCLUSIONS

Image guided TTNA remains an important modality in the diagnosis of thoracic diseases, particularly malignancies. It is to conclude of that, US guided TTNA of pulmonary nodules allow an early diagnosis which provides improved opportunity for the cure or expeditious treatment. TTNA using a 23 gauge needle is a highly specific and sensitive technique with a good diagnostic accuracy and can be used safely as an outdoor procedure.

Most of the cases came to the doctor with symptomatic chest diseases in which a pulmonary nodule is seen by chest X-ray, a diagnosis can be achieved by a more cost effective US guidance method. Ultrasound-guided TTNA is a quick cheap ionizing radiation-free procedure and may be a valid option in the diagnosis of peripheral lesions. Real-time US visualization allows accurate needle placement, shorter procedure time, and performance in debilitated and less cooperative patients. Only in few cases computed tomography allows the performance of TTNA in situations in which ultrasound do not correctly visualize the lesion or the needle tract.

Regarding safety, US guidance were extremely safe with the two most common complications reported being, pneumothorax a large proportion of which can be managed conservatively with observation rather than tube thoracostomy, as well as hemorrhage. Serious complications including hemoptysis, air embolism, or cardiopulmonary arrest have been reported, but are extremely rare. There is a higher reported pneumothorax rate using CT guided imaging as compared to US guidance. This is likely secondary to the fact that US guided biopsies are only performed on nodules and masses that are directly abutting the pleura. US guided TTNA also appears to have an equivalent safety profile compared to CT guided TTNA.

### CT- fluoroscopically – guided TTNA

CT-fluoroscopic guidance is reported to be a reliable and effective method, and it is becoming a popular technique as scanners with this capability become widely available. For TTNA of large pulmonary masses and for mediastinal or hilar lesions, CT-fluoroscopy can substantially reduce procedure time. Although small pulmonary nodules can be readily targeted with CT-fluoroscopy, it is still difficult to verify that the needle remains within the moving nodule as it is aspirated.

The problem is due to the need to move the patient in and out of the imaging plane, which requires 1 hand, while simultaneously aspirating with and controlling the biopsy needle, which often requires 2 hands. In this situation, manual core biopsy (eg, with a Temno core gun; Bauer Medical International, Santo Domingo, Dominica Republic) can be definitive because the coring device can be demonstrated in position through the lesion before it is fired.

A potential disadvantage of CT-fluoroscopy is exposure of the patient and operator to high doses to radiation. To minimize operator exposure, an approach that incorporates caudal-to-cranial or cranial-to-caudal angulation is best. The ribs make selecting such an approach in the thorax is made difficult.

Machines capable of CT-fluoroscopy are often the best and fastest scanners in the developing health scenario.. It may be difficult to justify interrupting the throughput of patients for diagnostic scans to perform a procedure that is often just as easily performed by using a less expensive piece of equipment. As CT-fluoroscopy capable machines became ubiquitous, they replaced fluoroscopy as the method of choice

Precision of US and CT scan is comparable for guidance in TTNA from thoracic mass lesions. US can, therefore, be used as first line modality in far flung areas where CT scan is not available and when cost constraints are present. Limitations of US include lesions in contact with chest wall with no aerated lung in between. The advantages of US include real time monitoring and low cost. Biopsy of a chest wall or a pleural-based lesion is often simply and rapidly performed under US guidance, which avoids exposing the patient and operator to ionizing radiation. If the lesion is in the chest wall, it is often readily depicted on sonograms. Pleural-based lesions are depicted even more readily than chest-wall lesions because acoustic reflection of the lung flanks the mass.

## END NOTE

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