Accuracy and safety of CT guided transthoracic needle biopsy

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Summary:

Background: Image guided transthoracic needle biopsy (TTNB) has great diagnostic value for the definitive characterization of lung lesions and is an established primary procedure to diagnose pulmonary nodules. It is traditionally performed as an outpatient procedure. It is safe, accurate, sensitive, and can obviate surgical procedure.

Objective: to assess the accuracy and safety of CT-guided TTNB in Baghdad Teaching Hospital

Patients & Methods: From December 2009 to September 2011, we conducted a prospective study of 43 consecutive outpatient and inpatient lung biopsies. An informed consent was obtained from the patients. No sedation is required. All biopsies were performed using CT guidance without CT fluoroscopy and were performed under local anesthesia using a 16 gauge core biopsy needle with internal automated gun.

A posteroanterior inspiratory CXR was obtained 30 minutes after biopsy.

All complications were recorded. If there was no pneumothorax, the patient was discharged. If there was a small asymptomatic pneumothorax, serial radiographs has been performed, patients also were discharged if no change in size was noted.

Results: A total of 43 patients underwent CT guided TTNB of peripheral lung lesions (mean age 60 years) and a male to female ratio of 28:15. The operation was successful in 40 out of 43 patients. The sample was adequate in 39 out of 43 patients. Complications were recorded in 4 patients (the most common complication was pneumothorax). No patient needed chest tube insertion.

Conclusion: CT guided TTNB is safe and an accurate procedure and can be performed as an out-patient procedure under local anesthesia.

Keywords: *CT guidance, lung biopsy,TTNB, pneumothorax.*

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Introduction:

Transthoracic needle biopsy using image guidance with CT has great diagnostic value for the definitive characterization of lung lesions. Percutaneous fine-needle biopsy with imaging guidance is an established primary procedure to diagnose pulmonary nodules. Haaga and Alfidi reported computed tomography CT-guided biopsy in 1976, and numerous reports since has shown TNAB procedure to be both effective and accurate (1). It is traditionally performed as an outpatient procedure. It is safe, accurate, sensitive, and can obviate surgical procedure with limited morbidity and extremely rare mortality (2, 3). The diagnostic accuracy has been reported as greater than 80% for benign disease and greater than 90% for malignant disease (4-7). Fine needles (20–22 gauges) are adequate in most cases, however, the smaller the lesion, the lower the diagnostic accuracy of needle biopsy (8-11). Successful performance of transthoracic needle biopsy of pulmonary lesions under CT guidance requires both accurate placement of the needle tip within the nodule and withdrawal of an adequate sample from the lesion. The potential pitfalls in transthoracic needle biopsy include technical factors related to the patient (uncooperative patient), CT scanning or the biopsy needle; factors related to the size, location or internal characteristics of the nodule or to an abnormality within the adjacent parenchyma (12).The complications that may occur during transthoracic needle biopsy include pneumothorax or parenchymal hemorrhage and hemoptysis (13).

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Patients and methods:

From December 2009 to September 2011, we conducted a prospective study of 43 consecutive outpatient and inpatient lung biopsies in the Department of Radiology in Baghdad Teaching Hospital. Patients selected are those with lung lesions of unknown etiology that is possibly being malignant. Demographic information collected included patient age and sex, smoking history. Patients excluded from this procedure include those who are on anticoagulation therapy, very ill patients, poor lung functions on spirometry, severe bullous emphysema, non compliant, those with persistent cough and suspicion of hydatid cyst or pulmonary arterio-venous malformation. Standard clinical exam was performed with vital signs and pulse oximetry measurement. Spirometry arranged for those with COPD or significant dyspnea. All of these patients had non-conclusive sputum examination. Fibrooptic bronchoscopy were performed when feasible. An informed consent was obtained from the patients and the procedure was explained to the patient and his/her relatives. The procedures were performed by three doctors (specialist radiologist, pulmonologist

and resident doctor). No sedation required. All biopsies were performed using CT guidance without CT fluoroscopy. Other data included size and location of the lung lesion, number of pleural punctures, and presence or absence of emphysema on the chest radiograph or CT scan. All biopsies were performed under CT guide by using Aquillion 4 scanner (Toshiba Medical Systems, Tokyo, Japan) with 5 or 10 mm collimated sections imaging focused on the mass or nodule (based on localization on topography). Selected images were obtained in the area of interest with 5–10-mm-thick contiguous transverse computed tomographic sections, depending on the size of the lesion. The lesions were localized by means of CT and correlating its location to the nearest intercostal space and measuring the distance from the midline and from the skin to the center of the lesion. Sometimes a lead marker has been used for localization. The patient was instructed to stop breathing after expiration during needle introduction. Intravenous canulla put in place and after skin sterilization a 10-20 mL of 1% lidocaine solution was administered throughout biopsy tract for local anesthesia. Biopsies were performed with the patient either supine or prone position depending on the proximity of the lesion to the chest wall. In some patients, initial punctures were made using a spinal needle to ensure a safe passage of the final automated biopsy gun of 16 gauge needle. CT scan performed immediately after needle introduction to insure the position of the needle within the lesion (Figure-1). The needle track is selected so that suspected area of necrosis, cavity or fluid content of the mass is avoided during needle insertion. After biopsy, all patients were placed in the decubitus position, with the side of the body on which biopsy had been performed facing down. We did not routinely monitor oxygen saturation after biopsy. A posteroanterior inspiratory CXR was obtained with the patient in an erect position 30 minutes after biopsy. CT images were sometimes obtained to help verify the appearance of the lung and to check for immediate pneumothorax. We did not routinely monitor oxygen saturation after biopsy. All complications were recorded, including whether pneumothorax was present or absent, and whether patients had hemoptysis or pleuritic chest pain that was unrelated to pneumothorax If there was no pneumothorax, the patient was discharged. If there was a small asymptomatic pneumothorax , the patient is monitored for another 30 minutes , and a posteroanterior inspiratory CXR was obtained , If there had been no change in the size of the pneumothorax, patients also were discharged.

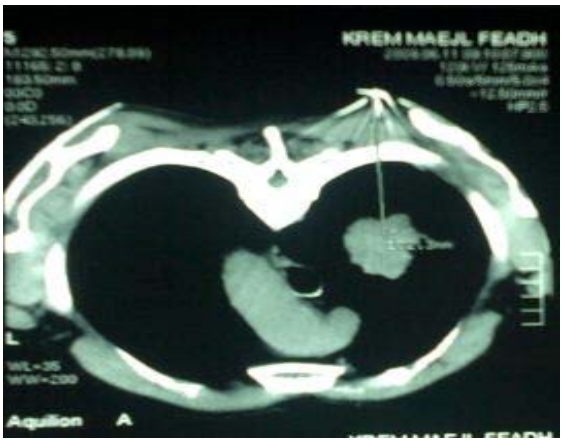

Figure-1: CT chest of patient with lung mass, showing the biopsy needle successfully inserted into the mass.

Results:

Fourty-three patients, aged 9-80 years (28 males and 15 females) with mean age of 60 years underwent CT-guided TTNB. The most frequent age group for whom CT-guided lung biopsies were undertaken are 60-69 years (37.2%) followed by age group 50-59 years (30.2%). The least percent was belong to those below 40 years as well as those older than 80 years (4.7% for both). Males are significantly more than female (65.1% and 34%, P value 0.047) as subjects exposed to this procedure. It was significant to find that majority of the patients were out-patients (83.7%) compared to the in-patient group (7%). New lung mass detected on radiology forming the vast majority (83.7%) of patients subjected to CT-guided TTNB, while lung nodules were the indication for this procedure in 7% of cases (Table-1). New mass with infiltrate, new mass with cavity, new mass and nodules and lung infiltrate forming only 2.3% of total cases. In our study one of three patients with nodule less than 3 cm in size was found to be malignant. Fiberoptic bronchoscopy procedures were arranged before TTNB for 31 patients (72.1%), all of bronchoscopies were non-diagnostic and in the remaining patients it was refused by the patients or contraindicated. Lung biopsy under CT-guide succeeded significantly in 93% and failed in 3% of cases (P value <0.05) (Table-2). Successful procedure means that tissue sample must be obtained directly from the lung lesion and this was confirmed after histopathology results and the lesion identified clearly. Also it was significant to find that one session of biopsy procedure was only needed for successful outcome in 90.7% of patients (P <0.05). While second session was needed in the remaining minority i.e. 9.3%. Second session performed for those whose biopsy samples were adequate in size but no definitive diagnosis obtained from histopathology examination We found that 90.7% - significant P value of <0.05 - of samples biopsied by true-cut needle were adequate for histopathology preparation procedure. The sample adequacy statement is always mentioned by pathologist in the histopathology report. In more

than half of cases (58.1%) for whom the procedures were done, one attempt was enough for successful tissue sampling. In about one third (34.9%) of patients two attempts trials were needed for proper localization of the needle into the lung lesions. Three and four attempts were needed in minority of cases (4.7% and 2.3% respectively) (Table-3). The most frequent cause of the lung lesions for which biopsies were done are malignant (31 patient, 80.5%) (Table-4, Figure-3). Squamous cell carcinoma was the final diagnosis in 20 patients (50%) and it also forms the most common type of lung carcinoma in this study(64%). Four patients (10%) found to have adenocarcinoma, three patients (7.5%) with alveolar cell carcinoma (a special entity from adenocarcinoma), two patients (5%) with large cell carcinoma and other two (5%) delineated as non-small cell carcinoma as no characterization of subtypes could be confirmed. Lesions other than malignancies forming 22.5% (9 patients). Chronic inflammation was detected in 2 (10%), normal lung histopathology in three patients (7.5%), and non-specific results from two cases (5%).Nonspecific results were caused by hypocellular samples, lack of specifically identifiable benign or malignant cells, or by specimens that were indistinguishable from normal lung tissue . No results came from 3 patients due to loss of patient contact. Despite a relatively small sample size, these data indicates that squamous cell lung cancer still forms the commonest type of lung cancer in our patients. Two patients developed small pneumothorax after the biopsy procedure with no major symptoms and no one need chest tube drainage, (Table-5, Figure-2). One patient developed prolonged pain and another one fainting attack. No complication(s) recorded for the rest of the patients.

Table-1: Radiologic characteristics of lung lesions

Characteristics	Frequency	Percent	X^2	P value
New Mass	36	83.7		
Nodule	3	7.0		
New Mass and Infiltration	1	2.3	139.651	0.000
New Mass and cavity	1	2.3		
Mass and Nodule	1	2.3		
Infiltration	1	2.3		
Total	43	100.0		

Table-2: Frequency and percentage of successful CT-guided lung biopsy operation

Successful Operation	Frequency	Percent	X^2	P value
Successful	40	93.0		
Not Successful	3	7.0	31.837	0.000
Total	43	100.0		

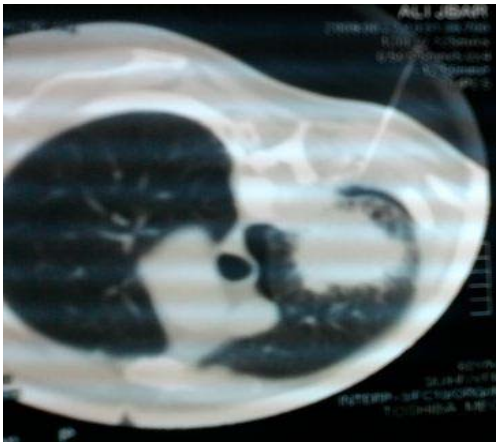

Figure-2: CT chest showing development of small pneumothorax after needle introduction.

Table-3: Number of transthoracic needle passes per one session of biopsy procedure

Number of Needle Passes	Frequency	Percent	X2	P value
1	25	58.1		
2	15	34.9		
3	2	4.7	36.535	0.000
4	1	2.3		
Total	43	100.0		

Table 4: Histopathologic diagnosis

Histopathologic Diagnosis	Frequency	Percent	X^2	P value
Squamous Cell Carcinoma	20	50.0		
Adenocarcinoma	4	10.0		
Alveolar Cell Carcinoma	3	7.5		
Large Cell Carcinoma	2	5.0	52.400	0.0000
Chronic Inflammation	4	10.0		
Normal	3	7.5		
Non-specific	2	5.0		
NSCLC	2	5.0		
Total	40	100.0		

Table-5: complications of transthoracic lung biopsy

Complications	Frequency	Percent	X^2	P value
Pneumothorax	2	4.7		
Prolonged Pain	1	2.3	99.047	0.000
Fainting	1	2.3		
No complications	39	90.7		
Total	43	100.0		

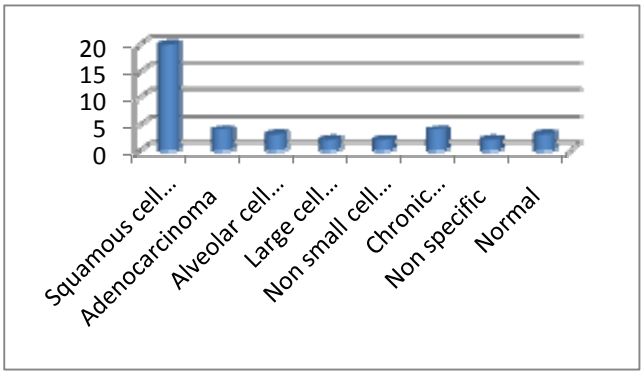

Figure-3: Histopathological results of ling biopsy

Statistical Analysis:

SPSS version 18 used for data input and analysis. Discrete variables presented as number (frequency) and percent and continuous variables presented as mean ± standard deviation (SD). Chi square test for goodness of fit used to test the significance of observed distribution. P value is asymptotic. Findings with P value less than 0.05 were considered significant.

Discussion:

Transthoracic needle biopsy of the lung is a commonly performed and widely used procedure associated with very low morbidity and almost no mortality (7). The most common complication is pneumothorax, which is rarely life threatening; the condition usually manifests within 1 hour after the procedure (8). New lung mass detected on radiology forming the vast majority (83.7%) of patients subjected to CT-guided TTNB, while lung nodules were the indication for this procedure in 7% of cases. Bronchogenic carcinoma may present as a peripheral mass in the lung, mass with cavity, or consolidation. However, many benign disease processes such as infections, granulomatous disease, and cryptogenic organizing pneumonia may also present as a lung mass. Certain features can be depicted clearly with CT, which helps to suggest whether the lesion is benign or malignant (9) In our study one of three patients with nodule less than 3 cm in size found to be malignant, in McWilliams studies, the overall malignancy rate discovered on radiological screen is very low (less than 1 to 2%) in lung nodules less than 5 mm in diameter, with higher rates associated with larger than 5mm lesions (10-12). Fiberoptic bronchoscopy procedures were arranged routinely before TTNB If there is no bronchial lesion, the reported yields from fiberoptic bronchoscopy have consistently been less than those from TTNB (13) The yield from fiberoptic bronchoscopy is even less for smaller lesions; most authors have reported diagnostic accuracies below 50% when the lesion is 2 cm or smaller (14) According to Cortese and McDougall, fiberoptic bronchoscopy is most accurate for lesions measuring 4-6 cm in diameter (15) Proper localization and CT confirmation of needle location inside the lesion with avoidance of necrotic site these entire factors play role in successful TTNB procedure. This result is in line with Eric van Sonnenberg, et a when diagnosis was made in 82.7% of cases (16) The single most important factor appears to be the careful performance of the biopsy, that is, making sure that one or more adequate samples are obtained from the lesion (17). A relatively large needle size (gauge 16) may play an important role in successful outcome in this study. A large (12-gauge) cutting needle used in lung tumor biopsy in Yotaro Izum study (18) For safety, it is logical to use the smallest needle possible that can provide a definitive diagnosis but still There is a place for larger needles in selected patients because larger samples may improve the diagnostic yield for noncarcinomatous malignancy and may increase the chances of obtaining specific diagnosis in patients with benign disease (19) The mean number of passes in our study was 2.5 and ranged from 1 to 4 passes that is comparable to a study done by Tomiyama et at (2000), where the mean number of passes per biopsy procedure was two (range 1 to 3)(20) and also comparable to a study done by Donnie et at (1999), where the mean number of passes per biopsy procedure was two ranging from one to four (3). The adequacy of samples in our study was 90.7%, similar to a study done by VanSonnenberg et al (92%).A definitive diagnosis has been achieved in 87.5% in our series that similar to results of the study mentioned (92%). (21) All of the outpatient cases were discharged from hospital after new CXR and ensuring absence of complications. Early discharge (after 30-minute postbiopsy chest radiography if there was no pneumothorax) after outpatient TTNB of the lung is associated with little morbidity and no mortality. The rate of pneumothorax was 4.9% that is lower than a study done by Carole J. Dennie et al (1999), where the pneumothorax rate was 22.9%. This could be attributed to the large number of patients that was included in that study (506 patients) (3).The needle path length and the number of needle passes were often considered to be related to the pneumothorax rate (22) Pneumothorax occurred in two female patients, age 52 and 50 respectively. In Patricia R. Geraghty et al, The relationship between pneumothorax rate and age as a continuous distribution was not significant (23) The incidence of pneumothorax reported in the literature during the past 30 years is 5%–57%, with a 1.6%–17.0% chest tube insertion rate (24-25) In this study, the rate of chest pain was 2.4% that is similar to a study done by Dennie et al in 1999, rate of pleuritic chest pain is 2.4 % (3).

Conclusion

Transthoracic core needle biopsy of peripherally located lung lesions is both safe and accurate procedure and can be performed by experienced persons as an out-patient procedure under local anesthesia.

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