Original Article

Percutaneous computed tomography-guided aspiration and biopsy of intrathoracic lesions: Results of 265 procedures

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ABSTRACT

Context: Percutaneous computed tomography (CT)-guided needle aspiration and biopsy technique have developed over time as a method for obtaining tissue specimen. Although this is a minimally invasive procedure, complications do occasionally occur. **Aims:** The aim of the study was to evaluate the diagnostic yield and complications of 265 percutaneous CT-guided aspiration and biopsy procedures performed on various intrathoracic lesions. **Settings and Design:** Data of percutaneous CT-guided aspiration and biopsy procedures of intrathoracic lesions performed over a 4 year period were retrospectively analyzed. **Subjects and Methods:** Procedure details, radiological images, and pathological and microbiological reports were retrieved from radiology records and hospital information system. Technical success, diagnostic yield, and complication rates were calculated. **Results:** Total 265 procedures were performed for lung ($n = 179$), mediastinum ($n = 73$), and pleural lesions ($n = 13$). Diagnostic yield for lung, mediastinal, and pleural lesions was 80.7%, 74.2, and 75%, respectively, for core biopsy specimens. Major complication was noted in only one procedure (0.4%). Minor complications were noted in 13.6% procedures which could be managed conservatively. **Conclusions:** Percutaneous CT-guided aspiration and biopsy procedures for intrathoracic lesions are reasonably safe with good diagnostic yield. Complications are infrequent and conservatively managed in most of the cases.

KEY WORDS: Image-guided biopsy, lung, mediastinum, needle biopsy, spiral computed tomography

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INTRODUCTION

Imaging guidance is usually needed for targeting deeply located lesions.[1] Percutaneous computed tomography (CT)-guided needle aspiration and biopsy (PCNAB) technique for intrathoracic lesions has developed over time and is now an established method for obtaining tissue specimen.[2,3] A needle or biopsy gun is introduced percutaneously through a safe anatomical route to sample the lesion. Although it is a minimally invasive procedure, complications do occasionally occur.[4] The aim of this study was to evaluate the diagnostic yield and complications of PCNAB performed for intrathoracic lesions at a Tertiary Care Teaching Hospital over last 4 years.

SUBJECTS AND METHODS

Data of PCNAB procedures on intrathoracic lesions performed from September 2009 to June 2013 were retrospectively evaluated. Procedure details and images were retrieved from the radiology records. Pathological and microbiological reports were obtained from the hospital information system. During this period, 247 patients underwent PCNAB procedure, of which 2 were excluded

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because of incomplete details. Among 245 patients included in the study, 175 were males and 70 females, with sex ratio of 2.5:1. Mean age of patients was 51.9 years with age range of 10–87 years.

All biopsies and aspirations were performed with a 64-slice Multiple detector CT scanner (Brilliance CT, Philips Medical systems, Cleveland, OH, USA). PCNAB procedures were performed on 245 patients, out of which a repeat PCNAB was done in 20 patients on the same lesion at a later date. The repeat procedure was counted as a separate procedure, making a total of 265 PCNAB procedures. A repeat procedure was advised if the first specimen was nondiagnostic or when more tissue materials were needed for histopathology or immunohistochemistry. PCNAB procedure was not repeated in all nondiagnostic cases because either the diagnosis was made from another investigation or patient was advised follow-up, or due to patient's unwillingness.

The patient preparation and basic considerations are similar to that described in earlier studies.[5-8] A short admission was done in all PCNAB procedures of intrathoracic lesions. Six to eight hours fasting was advised to all patients; however, necessary medications such as antihypertensive drugs were given 5–6 h earlier with small amount of water. All procedures were performed under local anesthesia. A written consent was obtained after explaining the procedure, possible complications, and risks versus benefits associated with the procedure.

Most of the procedures were done using a coaxial technique.[9] A quick core biopsy needle set (Cook, Bloomington, Indiana, USA) was used [Figure 1]. Length of the biopsy set (9, 15, and 20 cm) was chosen depending on lesion depth. Mostly, an 18-gauge biopsy set (coaxial needle 16-gauge) was used; however, a 20-gauge set (coaxial needle 19-gauge) was used if chances of complications were more. For aspiration, either spinal or

Figure 1: Quick core biopsy needle sets. Top, 15 cm 20-gauge cutting cannula needle with 20 mm specimen notch and 11.5 cm 19-gauge coaxial needle. Bottom, 11 cm 16-gauge coaxial needle and 15 cm 18-gauge cutting cannula needle with 20 mm specimen notch

Chiba needles of varying gauge and length were employed depending on the lesion depth and nature of the sample. In general, 2–3 core specimens were obtained by slight tilt of the outer needle so as to sample different areas. If core biopsy and aspiration (for microbiological analysis) were done using same outer guiding needle, core biopsy was performed first and aspiration later. The tissue cores were placed in a formalin vial while aspirates were inoculated into the culture medium and slides were made.

Lesions were targeted using the technique described previously.[5-8] Procedure was defined technically successful if the needle reached the intended location and specimen was obtained (irrespective of pathological/microbiology results). Technical failure was defined as either inability to target the lesion or inability to obtain specimen despite targeting, or procedure abandoned due to development of complication. For the determination of diagnostic yield, a positive result from any one specimen (core biopsy, fine needle aspiration cytology [FNAC], or microbiology) was considered diagnostic. Inconclusive results and inadequate specimens were considered nondiagnostic.

Diagnostic yield was analyzed for core biopsy with or without microbiology specimens, as fine needle aspiration cytology was performed in very few cases. Diagnostic yield was calculated by dividing the number of procedures that resulted in a diagnosis divided by the total number of core biopsy procedures. A complication was considered as minor if it was managed conservatively. If a complication required active management such as intubation, chest tube insertion, or blood transfusion, it was classified as major. Calculation of technical result, diagnostic yield, and complication was done according to number of procedures (repeat procedure on the same patient was counted as two procedures).

RESULTS

Lung lesions were the most common target followed by mediastinal and pleural lesions [Table 1]. Of 265 procedures, core biopsy alone was the most commonly performed
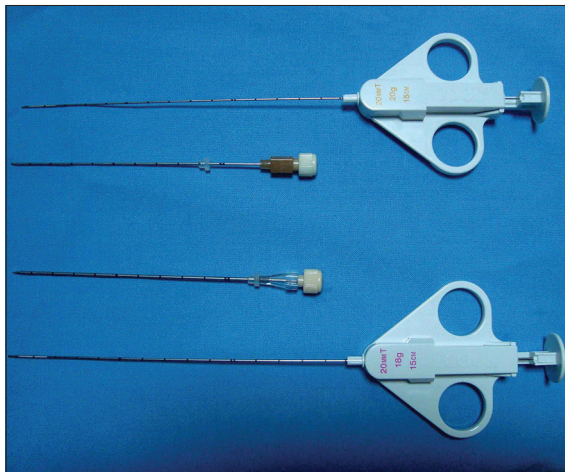
Table 1: Site and type of specimens obtained in 265 percutaneous computed tomography-guided needle aspiration and biopsy procedures

Site	Type of specimen	Number
Lung (*n*=179)	Core biopsy	156
	Core biopsy + microbiology specimen	15
	FNAC	3
	FNAC + microbiology specimen	5
Mediastinum (*n*=73)	Core biopsy	69
	Core biopsy + microbiology specimen	1
	FNAC	2
	FNAC + microbiology specimen	1
Pleura (*n*=13)	Core biopsy	12
	FNAC + microbiology specimen	1

Microbiology specimen included staining for AFB and/or fungal elements and culture for bacterial, tubercular and fungal organisms depending on clinical suspicion. BACTEC culture method was usually used. FNAC: Fine needle aspiration cytology, AFB: Acid fast *bacilli*

procedure. FNAC, microbiological examinations, or combined procedures were done less frequently [Table 2].

Technical success was achieved in 98.8% of procedures (262/265). Technical failure was observed in 1.1% procedures ($n = 3$). This included one case of 9 mm size subpleural lung nodule where pneumothorax developed white targeting the lesion and specimen could not be obtained. In another, 11 mm subpleural nodule alveolar hemorrhage and mild hemoptysis developed after placing the needle and procedure was abandoned [Figure 2]. In one case of lower lobe lung consolidation, the procedure was abandoned due to the development of mild pneumothorax and poor general condition of the patient. Mean diameter of lesions was as following: Lung 51.2 mm (range 9–159 mm), mediastinum 64.0 mm (range 18–166 mm), and pleura 51.8 (range 12–116 mm).

Diagnostic yield for lung, mediastinal, and pleural lesions was 80.7%, 74.2, and 75%, respectively [Table 2]. Complications are shown in Table 3. We encountered a major complication in the form of hemoptysis in only one procedure [Figure 3]. This patient had a right upper lobe nodule and developed massive hemoptysis immediately after biopsy with drop in oxygen saturation, requiring oxygen inhalation and blood transfusion. Postbiopsy CT scan revealed the presence of ground glass opacities suggestive of alveolar hemorrhage surrounding the lesion and other lobes. Minor complications included small pneumothorax (not requiring intercostal drainage) [Figure 4], alveolar hemorrhage with or without mild hemoptysis, hemothorax, pneumorrhachis, and epidural spillage of saline-contrast-local anesthetic mixture [Figure 5]. Among lung procedures, complications were more frequently encountered while targeting lesions

below the carina (23/91, 25.3%) as compared to lesions above the carina (10/88, 11.4%).

The nature of lesions in various organs is shown in Table 4. Primary malignancy was the most common lung lesion with adenocarcinoma as most common type. Granulomatous and infective lesions were the second most common lung lesions. Only two benign lung neoplasms were seen which included a case each of inflammatory myofibroblastic tumor and a case of neurogenic tumor. Mediastinal lesions were located in prevascular ($n = 40$), paratracheal or retrotracheal ($n = 6$), paravertebral ($n = 9$), subcarinal space ($n = 3$), cardiophrenic recess ($n = 1$), middle mediastinum ($n = 3$) and aorto-pulmonary window ($n = 1$). Most of mediastinal lesions were either primary malignancies or extension of lung malignancy into mediastinum. Lymphma and plasmacytoma were the second most common mediastinal lesions. Among diagnosed pleura lesions, one was mesothelioma, two metastatic deposits, two lymphoma, four benign neoplasms, and one bacterial lesion. The benign pleural neoplasms were two solitary fibours tumor, one schwannoma and one benign mesenchynmal tumor.

Total 20 PCNAB procedures were repeated. Site of biopsy, reason for repetition, and results of the repeat procedure are listed in Table 5.

DISCUSSION

Although most of PCNAB procedures were technically successful, in one small subpleural lung nodules specimen could not be obtained and pneumothorax developed during
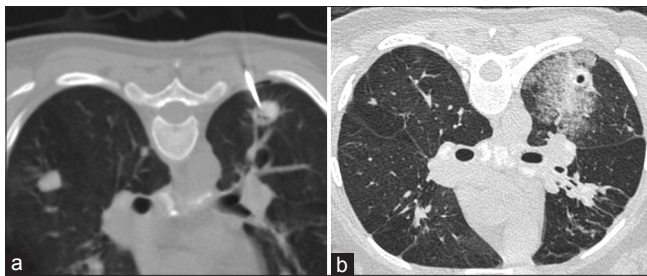

Figure 2: Technical failure during biopsy of small lung nodule. (a) Prone computed tomography image with needle placed inside the nodule. (b) Procedure abandoned due to development of mild hemoptysis and alveolar hemorrhage
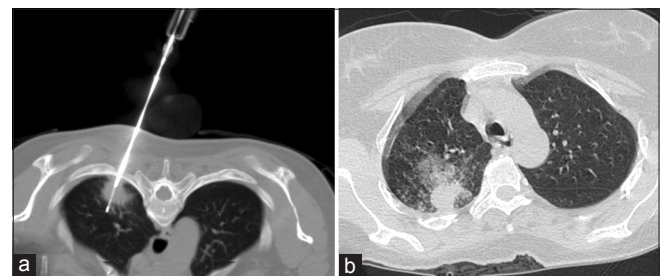

Figure 3: (a) Computed tomography image after placement of biopsy needle in right upper lobe nodule. (b) Immediately after biopsy alveolar hemorrhage is seen around the lesion. Similar alveolar hemorrhage also noted in other areas of lung (not shown) and patient developed major postprocedure hemoptysis

Table 2: Site-wise diagnostic yield in 265 percutaneous computed tomography-guided needle aspiration and biopsy procedures

Region	Type of specimen	Total procedures	Diagnostic results	Nondiagnostic results	Technical failure	Diagnostic yield (%)
Lung	Core biopsy with or without microbiology specimen	171	138	31	2	80.7
	FNAC with or without microbiology specimen	8	6	1	1	-
Mediastinum	Core biopsy with or without microbiology specimen	70	52	18	0	74.2
	FNAC with or without microbiology specimen	3	2	1	0	-
Pleura	Core biopsy with or without microbiology specimen	12	9	3	0	75
	FNAC with or without microbiology specimen	1	1	0	0	-

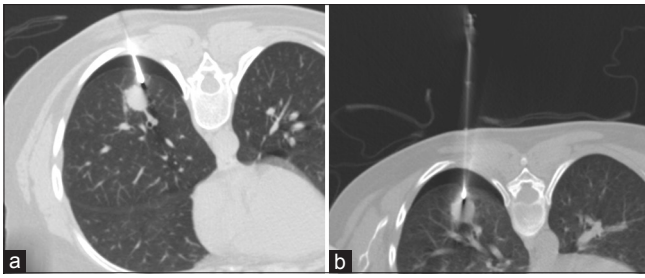Diagnostic yield not calculated for FNAC procedures due to fewer numbers

Figure 4: (a) Initial puncture just missed the lesion with development of pneumothorax. (b) Needle was withdrawn and readvanced toward the lesion after observing that pneumothorax was stable

Table 3: List of complications in 265 procedures

Complications	Number of procedures (%)	Procedure site
Major		
Hemoptysis	1 (0.4)	Lung
Minor	36* (13.6)	
Small pneumothorax	25 (9.4)	Lung (23), mediastinum (2)
Alveolar hemorrhage ± mild hemoptysis	9 (3.4)	Lung (9)
Small hemothorax	1 (0.4)	Lung
Pneumorrhachis	1 (0.4)	Posterior mediastinum
Epidural spillage of saline-contrast-local anesthetic mixture	1 (0.4)	Middle mediastinum

*One patient developed both mild pneumothorax and alveolar hemorrhage

Table 4: Nature of various lesions in 245 patients

Diagnosis	Lung (*n*=170)	Mediastinum (*n*=63)	Pleura (*n*=12)
Primary malignancy	87	21*	1
Metastasis	14	2	2
Lymphoma and plasmacytoma	0	12	2
Benign neoplasm	2	7	4
Tuberculosis	6	3	0
Granulomatous lesion	12	7	0
Fungal infection	5	0	0
Supplement/bacterial infection	3	0	1
Inflammatory lesion	10	0	0
Fibrotic lesions	3	0	0
Nondiagnostic result	25	11	2
Technical failure	3	0	0

*Primary malignancy/extension of lung malignancy

Table 5: Result of repeat procedures

Region of repeat procedure	Number of repeat procedures (*n*=20)	Reason	Result of repeat procedure	
			Diagnostic	ND
Lung	9	ND (7), MTN (2)	6	3
Mediastinum	10	ND (8), MTN (2)	7	3
Pleura	1	ND (1)	1	0

ND: Nondiagnostic, MTN: More tissue needed

targeting. Small subpleural lesions are difficult to biopsy because a short needle length inside the lung remains unstable that can easily dislodge during respiratory motion and may result in tearing of the pleural surface.[10] Another problem with small subpleural lesions is that if the initial puncture misses the lesion, there is no scope for needle

Figure 5: Left paravertebral route was initially chosen for this middle mediastinal mass arising from esophagus. For widening the left paravertebral space, a mixture of nonionic contrast, saline, and local anesthetic was injected. Inadvertently the mixture filled the epidural space (black arrow)

redirection inside lung and repeat puncture is needed. This leaves a tiny rent in pleura at the initial puncture site which can produce pneumothorax. Once pneumothorax develops the lesion moves away from chest wall and it becomes more difficult for the needle to pierce the visceral pleura.[10,11]

In a patient with lower lobe consolidation, mild pneumothorax developed immediately after placing the outer guiding needle which worsened the patient's existing respiratory distress. Greater respiratory movement of lower lobes predisposes the needle movement in and out of lung which results in development of pneumothorax and poor anchorage of the needle.[12] Diagnostic yield for lung procedures was 80.7%. Other workers have shown higher yet comparable values of diagnostic yield for lung lesions ranging from 89.5% to 94.6%.[13,14] Diagnostic yield was low (74.2%) for mediastinal procedures in our series where as in previous series, it is 83.6–96%.[15,16]

Many cases in the present series where fibrocollagenous tissue or few inflammatory cells were seen without granuloma or malignant cells (nonspecific histopathology results) were considered nondiagnostic. However, on basis of imaging, most of them appeared to be infective or inflammatory in nature. In such inconclusive histopathological results, ambiguity over the diagnosis could be cleared only by clinical follow-up. A lesion was considered inflammatory only if the histopathology findings were clearly suggestive.

Although we used a similar basic PCNAB technique, some of the improvisations done by other workers have been discussed in this section. In many series, an on-site cytopathologist was available for FNAC procedures.[10,13] CT-fluoroscopy technique enables real-time visualization of the needle and lesion, which is very helpful for smaller lesions.[17] Fusion positron emission tomography-CT

images of many patients were available in the series by Kulkarni *et al.*, which help in targeting the metabolically active portion of the lesion.[15] In many series, the biopsies were done by an experienced and dedicated operators while in our setup, some of the cases were done by a less experienced resident. Apart from these, the most important reason for the high diagnostic yield in other series was the availability of follow-up and a nonspecific benign pathology result was considered diagnostic if the lesion had a benign course. While in our series, many of such results were taken as nondiagnostic due to the lack of follow-up.

The majority of the complications were encountered in lung procedures. Pneumothorax occurred in 13.9% (25/179) of lung procedures in our series; however, all of them were mild and none required chest tube placement. Pneumothorax has been reported in 20–34.8% of lung biopsies and 3–5.3% cases required chest tube drainage.[13,14] We always roll patients to a puncture site-down position if aerated lung is punctured; this could be the reason that we did not encounter any large pneumothorax in our study. Other workers have also shown that although the patient position after biopsy does not impact the occurrence of pneumothorax, retaining the patient with the puncture site-down reduces the proportion of patients with postbiopsy pneumothorax large enough to necessitate chest tube placement.[18] Alveolar hemorrhage with or without mild hemoptysis was seen in 5.0% and major hemoptysis in 0.5% of lung procedures in our series. Alveolar hemorrhage is common in lung biopsies and has been reported in 3–16% cases; however, it is usually self-limiting and seldom leads to massive hemoptysis.[13,14] Complications were more common when PCNAB was done for lung lesion located below the level of carina. The greater mobility of lower portion of the lungs with respiration results in a higher rate of needle-induced lung injury and usually requires multiple puncture and needle redirection.

Only minor complications were seen in 5.4% of mediastinal procedures similar to previous studies.[15,16] However, we noticed two unusual complications during mediastinal biopsies. Pneumorrhachis (presence of air within spinal canal) was seen during biopsy of a posterior mediastinal mass.[5,19] In another case, mixture of nonionic contrast, local anesthetic, and saline was injected in left paravertebral space to create a safe window for a posterior mediastinal mass. However, instead of filling the paravertebral space, the mixture went into the epidural space. Both patients showed no neurological symptoms. Biopsy was complete from same route in first case; however, in second case, biopsy was done from right paravertebral approach after 1 h of observation. Both above mentioned complications were likely due to transgression of nerve root sleeves that are difficult to visualize on CT scan.

Our study had many important limitations. As this was a retrospective study, it was limited to patients who had already been selected to undergo the PCNAB procedure.

We do not have any record for patients who were refused PCNAB due to high risk of complications. In addition, because of multiple radiologists, the choice of biopsy technique and type of specimen obtained were driven by the radiologist's choice which in turn would influence the diagnostic yield and complication rates. Also, since the follow-up on all cases was not available, the diagnostic accuracy of procedures could not be ascertained. Despite these limitations, the study covers PCNAB procedures performed on a wide spectrum of lesions from different intrathoracic locations. It highlights PCNAB as a reliable yet less invasive and safe means to obtain pathological and microbiological results from a variety of target lesions.

CONCLUSIONS

With proper technique and precautions, PCNAB procedures for intrathoracic lesions are reasonably safe with good diagnostic yield. Diagnostic yield of core biopsy for lung, mediastinal, and pleural lesions was 80.7%, 74.2, and 75%, respectively. Complications were infrequent except for lung procedures and most of complications were minor which were managed conservatively. In lung procedures, complications were higher when sampling site was below carina.

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Conflicts of interest
There are no conflicts of interest.

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