Original Article

Diagnostic Yield and Complications of CT-guided Peripheral Lung Lesion Biopsy: A Pulmonologist Experience

Sonam Spalgais[1], Dipti Gothi[2], Ram BabuSah[2], Omkar K. Choudhari[2], Umesh Chandra Ojha[2] and Ramesh Singh Pal[2]

Department of Pulmonary Medicine[1], Vallabhbhai Patel Chest Institute, Delhi and Department of Pulmonary Medicine[2], ESI-PGIMSR, New Delhi, India

Abstract

Background. To study the diagnostic yield and complications of computed tomography (CT)-guided peripheral lung lesion biopsy.

Methods. We retrospectively studied the case records of 62 patients with undiagnosed peripheral lung lesions who underwent CT-guided lung biopsy, performed by a pulmonologist at our tertiary care institute during the period January 2015 to June 2017.

Results. Their mean age (range) was 56 (32-82) years; majority 38/62 (61%) were men. Thirty-nine (63%) patients were smokers. The overall yield was (60/62) 96.8%. The diagnosis was malignant in 46 (74.2%) and benign in 14 (22.6%) cases. Only two cases remain undiagnosed. The malignant lesions were small cell carcinoma–5, non-small cell lung carcinoma (NSCLC)–39, non-Hodgkin's lymphoma (NHL) and myofibroblastoma – one each. All NSCLC were in stage IIIB/C or IVA/B. The benign lesions were tuberculosis (TB) and post-TB lesions (n=6each) and anthracosis (n=2). Nine (14.5%) developed pneumothoraces and one required intercostal drainage. The pneumothorax was significantly more common with small size (<3cm) compared with large size lesion (>3cm) (p=0.039).

Conclusions. With the increasing use of mutational analysis and personalised therapy large biopsy is required. With limited availability of interventional radiologist in our country, the art of CT-guided biopsy should be learnt by the pulmonologist, since it is a cost-effective, reliable, first-line diagnostic procedure with comparable yield and complication in hands of pulmonologist.
[Indian J Chest Dis Allied Sci 2019;61:175-179]

Key words: CT-guided biopsy, Peripheral lung mass, Pulmonologist, Malignant.

Introduction

The tissue diagnosis of lung lesion is important for the treatment of both malignant as well as benign lesions. Computed tomography (CT)-guided lung biopsy is a common radiological procedure to confirm the diagnosis of lung lesion. With the recent advances in targeted therapy and personalised treatment, large tissue sample is required for various mutation analysis.[1,2] The pleural based lung lesions can be diagnosed easily with CT- or ultrasound-guided lung biopsy.[3,4] However, peripheral lung lesions are difficult to diagnose as the yield of these lesions with flexible bronchoscopy is relatively low.[5,6] Peripheral lung lesion implies the lesion is not visible through a bronchoscope. Endobronchial radial ultrasound are increasingly being used to diagnose peripheral lung nodules/mass, but this facility is limited to higher centres only, not commonly available and costly as compare to CT-guided biopsy.[4,5,7-9] The tissue obtained by endobronchial radial ultrasound is also limited. Thus, the CT-guided lung biopsy has gained popularity over the last decade in western countries. However, India has lack of trained work-force in this regard. We as pulmonologist initiated the procedure at our centre. This study is a retrospective analysis of lung biopsy performed by the pulmonologist for peripheral lung lesions. We have analysed the yield and complications of the procedure performed by us.

Material and Methods

This study was a retrospective observational study conducted in the Department of Pulmonary Medicine at the ESI-PGIMSR, New Delhi, India after taking an Ethics Committee approval. A retrospective analysis of medical records of the patients with peripheral lung mass/nodules diagnosed on contrast-enhanced computed tomography (CECT) of the chest who underwent computed tomography (CT)-guided tru-cut lung biopsy from January 2015 to June 2017 was done. As per the departmental protocol, patients with mass, nodules and ground-glass opacity on CECT chest with no definite diagnosis underwent CT-guided lung biopsy with "Bard" lung biopsy gun (Figure 1) on an out-patient basis after proper written consent. The biopsy was done without prior fine needle aspiration cytology to prevent two procedures being done on the same patient which can theoratically increase the chances of complications. All these patients had screening blood tests including measurement of prothrombin time (PT), international normalised ratio (INR), and platelet count, prior to biopsy.

[Received: May 24, 2018; accepted after revision: March 19, 2019]

Correspondence and reprint requests: Dr Dipti Gothi, Professor, Department of Pulmonary Medicine, ESI-PGIMSR, New Delhi, Delhi, India; E-mail: diptigothi@gmail.com

Figure 1. Photograph showing (A) "Bard" tru-cut lung biopsy gun and (B) lung biopsy core needle guard and stylet.

CT-guided biopsy commenced with determining the location and depth of the lesion, and the most appropriate site of the puncture. The site of the puncture was decided based on feasibility of site of the biopsy which is closest to the chest wall. It was marked with the help of multiple paper pins or needles attached to adhesive on the patient's chest (Figure 2A,B,C,D). The location and depth of the mass lesion were measured between the two most appropriately located pin-heads on CT (Figure 3 A, B). The position of the patient and depth of location were decided by the pulmonologist with the help of a radiology technician. The site was prepared and local anaesthesia was given with 2% lignocaine injection. A nick was taken with a surgical blade and the site was punctured with core needle and its stylet (Figure 1A, B). The position of core needle and stylet was checked on CT (Figure 4 A, B). The stylet was removed and the 'Bard' lung biopsy gun is inserted. It is then fired into the lesion. Once the tissue was obtained, the stylet was put in place to prevent air embolism. Two to three lung biopsies were taken with gun and sent for histopathological examination. The site of biopsy was tightly closed after antiseptic dressing. All the above-mentioned steps of lung biopsy procedures were performed by a pulmonologist with a minimum three years of experience in pulmonary medicine and a minimum of five observations of same procedure. CT was done with the help of an experienced radiology technician. Help from radiologist was taken in selected cases with no definite mass lesion. A repeat CT was done at the end of the procedure to look for the pneumothorax. We did all the above procedures as per the radiologically guided lung biopsy procedure guidelines of the British Thoracic Society (BTS) 2003.[10]

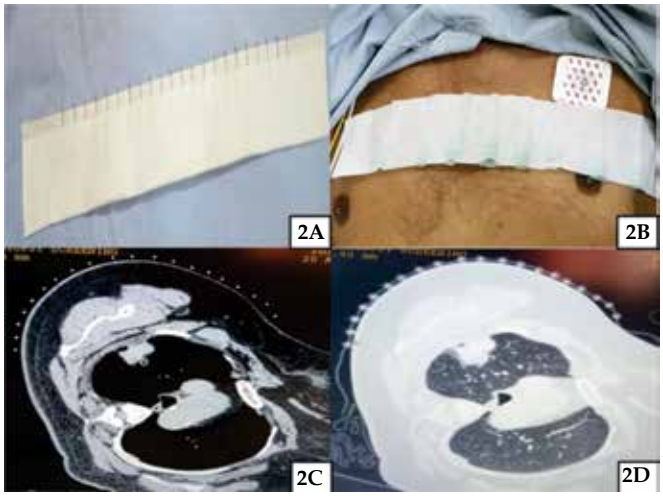

Figure 2. Photograph showing (A) multiple paper pins attached to adhesive for marking the site of biopsy, (B) multiple needles attached to the adhesive on the patient's chest before computed tomography and (C, D) computed tomography of chest (mediastinal and lung window) showing multiple paper pins or needles attached to the adhesive on the patient's chest with lung mass.

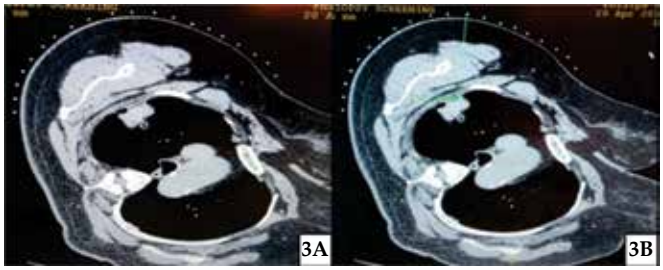

Figure 3. Computed tomography of the chest showing location of the mass for biopsy with the help of paper pins and (B) measurement of length and depth for biopsy needle between two most appropriate paper pins head.

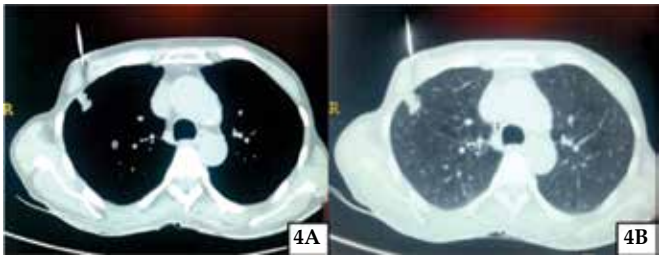

Figure 4 (A, B). Computed tomography (mediastinal and lung window cut) of the chest showing the presence of core needle guard with stylet in the lung mass lesion through chest wall.

We retrospectively reviewed the records of patients, who underwent CT-guided lung biopsy for their clinical presentation, smoking status, chest radiograph, CECT, histopathology of biopsy and complication of the procedure. The aim of this study is to evaluate the yield and complications of CT-guided lung biopsy performed by a pulmonologist.

Statistical Analysis

The data were entered in Microsoft Excel (Microsoft Corp, Redmond, WA) software and analysed. Continuous data are presented as mean and median. The rate of pneumothorax complication with size of the lung lesion was compared using Chi-square test. A p-value <0.05 was considered statistically significant.

Results

We retrospectively studied the records of 62 consecutive patients with peripheral lung lesions who underwent CT-guided biopsy. Their mean age was 56 (range 32-82) years. Majority 38/62 (61%) were males. Thirty-nine (63%) were smokers; majority 38/39 (97%) were *bidi* smokers with a mean smoking index of 660. Common symptoms observed were cough in 46 (74%), breathlessness, chest pain in 40 (64%) and weight loss in 23 (37%). Superior vena cava (SVC) obstruction was present in four (6%) at presentation.

The biopsy specimen for histopathology was sufficient in all 62 biopsy samples. The overall yield of CT-guided peripheral lung lesion biopsy was (60/62) 96.8%. The diagnosis on biopsy was malignant in 46 (74.2%) and benign in 14 (22.6%) cases. Only two cases were left undiagnosed after CT-guided biopsy. Of these two cases, one case was lost to follow-up while in the second case the lung lesion resolved after antibiotics and nephrectomy for renal carcinoma. IHC staining was done in 39/46 (84.8%) biopsy specimens in malignant lesions.

The malignant lesions of lung biopsy were small cell carcinoma (n=5), non-small cell lung carcinoma (NSCLC) (n=39), non-Hodgkin's lymphoma and myofibroblastoma (n=1, each). Immunohistochemistry (IHC) staining was done in 39 biopsy specimens for the confirmation of the diagnosis. The mutation analysis was done as per the requirement among NSCLC from the same sample. A repeat biopsy was not required in any of the malignancy cases for mutation analysis. All the five cases of small-cell lung carcinoma (SCLC) were in extensive stage. Out of 39 patients with NSCLC, 33 (84.6%) presented with pleural effusion or metastasis to liver, bone, contralateral lung and adrenal on CT chest. All NSCLC were in stage IIIB/C or IVA/B as per 8th Edition *Lung Cancer Stage Classification.*[11] The details of malignant lung lesions are given in table 1. Among the benign lesions, the diagnosis were tuberculosis (TB) and post-TB lesions (n=6) and anthracosis (n=2). The overall details of histopathology of biopsy are given in figure 5. Nearly 80% of the histopathological diagnosis concurred with the clinical diagnosis. The clinical and pathological diagnosis correlated more for malignant lesions than benign lesions.

Table 1. Details of malignant lesions

Malignancy	No. (%)
Adenocarcinoma	17 (27.4)
Undifferentiated carcinoma	12 (19.4)
Squamous cell carcinoma	10(16.1)
Small cell carcinoma	5 (8.1)
Non-Hodgkin's lymphoma	1 (1.6)
Myofibroblastoma	1 (1.6)

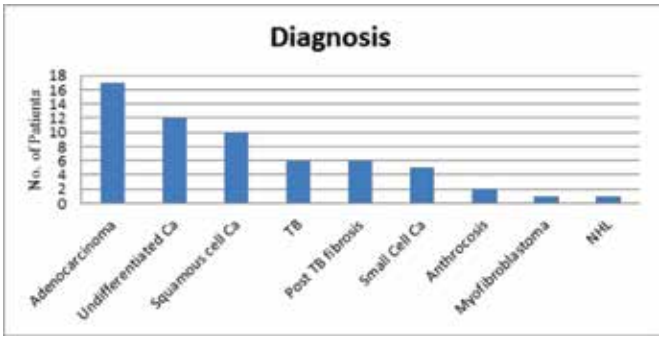

Figure 5. Histopathological diagnosis of lung biopsy in the present study.

Definition of abbreviations: Ca=Carcinoma; TB=Tuberculosis; NHL=Non-Hodgkin's lymphoma

On CECT chest, majority of benign lesions 7/12 (58.3%) were less than 3cm in size, only one active tuberculosis case had a lesion of >7cm in size. The majority of malignant lesions 43/45 (95.5%) were >3cm in size, while only 2/45 (4.5%) had lesion of <3cm in size. There were three cases of multiple nodules on CECT chest, of which two lesions were found to be benign and one malignant on biopsy. The size of the lesion in two undiagnosed cases was between 3-7 cm on CECT chest. The details of size of the lung lesions on CECT chest are given in table 2.

Table 2. Details of lung lesion size on contrast-enhanced computed tomography of the chest

Lesion Size	Malignant	Benign	No Diagnosis	Total
Multiple nodules	1	2	0	3
<3cm	2	7	0	9
3-5cm	12	3	1	16
5-7cm	11	1	1	13
>7cm	20	1	0	21

The recorded adverse event of CT-guided peripheral lung lesion biopsy was pneumothorax, seen in 9/62 (14.5%) cases. Three cases were treated with closed aspiration, one case required intercostal drainage (ICD) and five cases of minimal pneumothorax resolved with conservative treatment with oxygen inhalation. It has been observed that pneumothorax was more common with small size (<3cm) of the lung lesion compared to the large size lesion (>3cm) (p=0.039) (Table 3).

Table 3. Occurrence of pneumothorax

	Total	Pneumothorax No. (%)	Significance
<3cm	12	4 (33)	p=0.039
>3cm	50	5 (10)	

Discussion

Computed tomography-guided lung biopsy is widely accepted as a safe, accurate and minimally invasive diagnostic method for the evaluation of lung lesions.[12-14] The diagnostic yield of CT-guided lung biopsy reported in the literature ranges from 64% to 97%.[4-6,9,12,15,16] The diagnostic yield for CT-guided peripheral lung lesion biopsy in our series of patients was as good as the one performed by the radiologist. CT-guided lung biopsy sample yielded large tissue for IHC and mutational analysis. Thus, personalised targeted management was possible.[1,2]

The common complication of CT-guided lung biopsy is pneumothorax. Various studies from different parts of the world reported 9%-57% occurrence of pneumothorax with this procedure, and out of which 3.5%-6% required intercostal tube drainage.[5,14,17-21] Our study showed pneumothorax rate of 14.5% where only one case required intercostal tube drainage. The rate of pneumothorax was more common with small size lesion. This difference in rate

of pneumothorax with the size of the lesion is also reported in various other studies in the literature.[17,22,23]

The various risk factors for the development of pneumothorax during CT-guided biopsy of the lung include: number of pleural punctures per procedure; passing of biopsy needle through emphysema, bulla and fissure of the lung; longer pleural-to-target lesion distance.[24,25] Various methods to minimise pneumothorax with CT-guided biopsy are: use of the coaxial needle technique for the prevention of multiple pleural punctures; to avoid the risky area of pneumothorax, like emphysema, bulla and fissure of lung by double oblique approaches; sealing the needle tract after biopsy with normal saline or desiccated polyethylene glycol hydrogel or autologous blood patch; rapidly rolling over the patient to an ipsilateral decubitus position of biopsy in order to place the puncture side down.[24-29] We used coaxial needle and took the shortest distance to avoid this complication.

Transthoracic needle biopsy to diagnose thoracic mass lesion is usually performed under image guidance. This method is an important alternative to more invasive surgical procedures with high diagnostic yield and less complication rate. This procedure is most frequently performed by a radiologist all over the world.[17] There is lack of published data on image-guided transthoracic lung biopsy performed by a pulmonologist. Diacon *et al*[4] observed less complications in ultrasound-guided lung biopsy procedure when performed by the pulmonologist. In our study all the biopsies were performed by the pulmonologist. The advantage of this procedure is that the patients are more comfortable and less apprehensive as the procedure is performed by the treating pulmonologist. Even if the patient develops pneumothorax, it can be managed safely with close air aspiration or intercostal drainage without delay. The other advantage of this procedure performed by pulmonologist is that the collaborative effort narrows the differential diagnosis. The presence of pulmonologist ensures the proper collection for further analysis of the sample in terms of histopathological or microbiological and other investigation, like immunohistochemistry, mutational analysis. Our study also showed high diagnostic yield with low complication rate.

The limitations of our study include, first, this is a retrospective and single centre study without compared population of radiologists performing the procedure. Secondly, the study population is small.

Conclusions

Computed tomography guided peripheral lung lesion biopsy has a good diagnostic yield for both benign and malignant lesions with large tissue sample for immunohistochemistry and mutation analysis. Pneumothorax is the only major complication frequently seen in small size lesions. With limited availability of interventional radiologist in our country, the art of CT-guided biopsy should be learnt by pulmonologists, since it is a cost-effective, reliable, first-line diagnostic procedure with comparable yield and complication in the hands of a pulmonologist. Multicentre prospective studies with large comparable sample size are required to further evaluate the role of image-(CT or ultrasonography) guided transthoracic needle biopsy by a pulmonologist.

Acknowledgements

The authors thank Dr Supreeti Kholi, Head, Department of Radiology and Mr Sanjeev Kumar Aggarwal, Senior Radiology Technician for their help.

References

1. Tsai C, Tsai WL, Chen MC, Chang GC, Tzeng WS, Chan SW, *et al.* CT-guided core biopsy of lung lesions: a primer. *AJR Am J Roentgenol* 2009;193:228–35.
2. Chen CM, Chang JW, Cheung YC, Lin G, Hsieh JJ, Hsu T, *et al.* Computed tomography-guided core-needle biopsy specimens demonstrate epidermal growth factor receptor mutations in patients with non-small-cell lung cancer. *Acta Radiol* 2008;49:991–4.
3. Kim GR, Hur J, Lee SM, Lee HJ, Hong YJ, Nam JE, *et al.* CT fluoroscopy-guided lung biopsy versus conventional CT-guided lung biopsy: a prospective controlled study to assess radiation doses and diagnostic performance. *Eur Radiol* 2011;21:232–9.
4. Diacon AH, Schuurmans MM, Theron J, Schubert PT, Wright CA, Bolliger CT. Safety and yield of ultrasound-assisted transthoracic biopsy performed by pulmonologists. *Respiration* 2004;71:519–22.
5. Khosla R, McLean AW, Smith JA. Ultrasound-guided versus computed tomography-scan guided biopsy of pleural-based lung lesions. *Lung India* 2016;33:487–92.
6. Herman PG, Hessel SJ. The diagnostic accuracy and complications of closed lung biopsies. *Radiology* 1977;125:11–4.
7. Steinfor DP, Khor YH, Manser RL, Irving LB. Radial probe endobronchial ultrasound for the diagnosis of peripheral lung cancer: systematic review and meta-analysis. *Eur Respir J* 2011;37:902–10.
8. Harter LP, Moss AA, Goldberg HI, Gross BH. CT-guided fine-needle aspirations for diagnosis of benign and malignant disease. *AJR Am J Roentgenol* 1983;140:363–7.
9. Yankelevitz DF, Cham MD, Farooqi AO, Henschke CI. CT-directed diagnosis of peripheral lung lesions suspicious for cancer. *Thorac Surg Clin* 2007;17:143–58.
10. Manhire A, Chairman, Charig M, Clelland C, Gleeson F, Miller R, *et al.* Guidelines for radiologically guided lung biopsy. BTS Guidelines. *Thorax* 2003;58:920–36.
11. Detterbeck FC, Boffa DJ, Kim AW, Tanoue LT. The Eighth Edition Lung Cancer Stage Classification. *Chest* 2017;151:193–203.
12. Loh SE, Wu DD, Venkatesh SK, Ong CK, Liu E, Seto KY, *et al.* CT-guided thoracic biopsy: evaluating diagnostic yield and complications. *Ann Acad Med Singapore* 2013;42:285–90.
13. Afify A, Davila RM. Pulmonary fine needle aspiration biopsy: assessing the negative diagnosis. *Acta Cytol* 1999;43:601–4.
14. Yuan DM, Lu YL, Yao YW, Liu HB, Wang Q, Xiao XW, *et al.* Diagnostic efficiency and complication rate of CT-guided lung biopsy: a single center experience of the procedures conducted over a 10-year period. *Chinese Med J* (English) 2011;124:3227–31.
15. Connor S, Dyer J, Guest P. Image-guided automated needle biopsy of 106 thoracic lesions: a retrospective review of diagnostic accuracy and complication rates. *Eur Radiol* 2000;10:490–94.
16. Neyaz Z, Lal H, Thakral A, Nath A, Rao RN, Verma R.

Percutaneous computed tomography-guided aspiration and biopsy of intrathoracic lesions: results of 265 procedures. *Lung India* 2016;33:620–5.
17. Boskovic T, Stanic J, Pena-Karan S, Zarogoulidis P, Drevelegas K, Katsikogiannis N, *et al*. Pneumothorax after transthoracic needle biopsy of lung lesions under CT guidance. *J Thorac Dis* 2014;6:S99–S107.
18. VanSonnenberg E, Casola G, Ho M, Neff CC, Varney RR, Wittich GR, *et al*. Difficult thoracic lesions: CT-guided biopsy experience in 150 cases. *Radiology* 1988;167:457–61.
19. Li H, Boiselle PM, Shepard JO, Trotman-Dickenson B, McLoud TC. Diagnostic accuracy and safety of CT-guided percutaneous needle aspiration biopsy of the lung: comparison of small and large pulmonary nodules. *AJR Am J Roentgenol* 1996;167:105–9.
20. Anderson JM, Murchison J, Patel D. CT-guided lung biopsy: factors influencing diagnostic yield and complication rate. *Clin Radiol* 2003;58:791–7.
21. Kazerooni EA, Lim FT, Mikhail A, Martinez FJ. Risk of pneumothorax in CT-guided transthoracic needle aspiration biopsy of the lung. *Radiology* 1996;198:371–5.
22. Ohno Y, Hatabu H, Takenaka D, Higashino T, Watanabe H, Ohbayashi C, *et al.* CT-guided transthoracic needle aspiration biopsy of small (< or = 20 mm) solitary pulmonary nodules. *AJR Am J Roentgenol* 2003;180:1665–9.
23. Wallace MJ, Krishnamurthy S, Broemeling LD, Gupta S, Ahrar K, Morello FA Jr, *et al.* CT-guidedpercutaneous fine-needle aspiration biopsy of small (< or = 1-cm) pulmonary lesions. *Radiology* 2002;225:823–8.
24. Vestering MM, Braak SJ. Where are we on (preventing) pneumothorax after (cone-beam) computed tomography-guided lung biopsy? *J Thorac Dis* 2015;7:E341–E343.
25. Kim JI, Park CM, Lee SM, Goo HM. Rapid needle-out patientrollover approach after cone beam CT-guided lung biopsy: effect on pneumothorax rate in 1,191 consecutive patients. *Eur Radiol* 2015;25:1845–53.
26. Li Y, Du Y, Luo TY, Yang HF, Yu JH, Xu XX, *et al*. Usefulness of normal saline for sealing the needle track after CT-guided lung biopsy. *Clin Radiol* 2015;70:1192–7.
27. Zaetta JM, Licht MO, Fisher JS, Avelar RL; Bio-Seal Study Group. A lung biopsy tract plug for reduction of post-biopsy pneumothorax and other complications: results of a prospective, multicenter, randomized, controlled clinical study. *J Vasc Interv Radiol* 2010;21:1235–43.
28. O'Neill AC, McCarthy C, Ridge CA, Mitchell P, Hanrahan E, Butler M, *et al.* Rapid needle-out patient-rollover time after percutaneous CT-guided transthoracic biopsy of lung nodules: effect on pneumothorax rate. *Radiology* 2012;262:314–9.
29. Wagner JM, Hinshaw JL, Lubner MG, Robbins JB, Kim DH, Pickhardt PJ, *et al.* CT-guided lung biopsies: pleural blood patching reduces the rate of chest tube placement for postbiopsy pneumothorax. *AJR Am J Roentgenol* 2011;197:783–8.