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Diagnostic yield and complications of thoracic ultrasound-guided biopsy performed by pulmonologists

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Abstract

Interventional pulmonology is a growing field in India, and adding thoracic ultrasound (TUS)-guided lung biopsy can be useful for interventional pulmonologists. This study evaluated whether TUS-guided lung biopsy performed by pulmonologists, without the help of radiologists, can accurately diagnose pulmonary disease. A single-center prospective study was conducted with patients with pulmonary lesions requiring transthoracic biopsy. The primary objective was to find out the time taken by an experienced pulmonologist for the procedure without the aid of a radiologist. The secondary objective included the diagnostic yield of TUS-guided lung biopsy performed by a pulmonologist and the complication rate of the procedure. The study included 88 patients aged 18 to 86 years with a mean age of 62.7±12.9 years. The mean time taken for biopsy was 13±2.42 minutes. A total of 68 (77.2%) cases were biopsied in 11-15 minutes. Diagnosis could be established in 88.5% of cases. Pain at the biopsy site was the most common complication seen in 11 (12.5%) cases. Hemoptysis and bleeding at the biopsy site were seen in 7 (7.95%) cases. Pneumothorax was seen in 2 (2.27%) cases. Air embolism, post-procedure intubation, and malfunctioning of the forceps were seen in 1 (1.14%) case. TUS-guided lung biopsy performed by a pulmonologist without the help of a radiologist has a diagnostic yield similar to that performed by radiologists but can take a shorter time. The complications are also similar but can be addressed quickly.

Key words: thoracic ultrasound-guided lung biopsy, lung biopsy, pulmonologist.

Introduction

Over half a century, image-guided percutaneous lung sampling techniques have been used for diagnosing lung lesions. Computed tomography (CT) guided percutaneous transthoracic interventional procedure has been the most common approach [1]. However, conventional CT and CT fluoroscopy use a large amount of ionising radiation and can provide only axial sections of the lung in real time [2,3]. A thoracic ultrasound (TUS) guided sampling of peripheral lung lesions is an equally long-established method [4] and has advantages over CT of being non-ionising, quicker to use, can be performed at the patient's bedside, providing real-time multiplanar monitoring of the procedure, and capable of allowing the operator to compensate for respiratory movement in real-time without the need for breath-hold manoeuvres [5]. Additionally, the use of doppler ultrasound during biopsy identifies blood vessels and helps in avoiding injury to the blood vessels [1]. It has become a widely accepted, effective, safe and minimally invasive technique to obtain tissue specimens from several different intrathoracic lesions.

TUS-guided lung biopsy has traditionally been performed by specialist radiologists. However, they required pulmonologists to manage the possible complications arising out of the procedure. There is a growing body of literature describing the use of TUS-guided lung biopsy by interventional pulmonologists, reflecting the increased access to and skill with ultrasound in this group [6]. TUS-guided lung biopsy performed by pulmonologists may help rapidly diagnose the disease and likely will have similar diagnostic yield and complications as experienced by radiologists. Additionally, the complications can be managed immediately. This study was undertaken as there are no prospective studies on TUS-guided lung biopsy by pulmonologists from India. Interventional Pulmonology is a growing field in India and adding TUS-guided lung biopsy can be a useful tool for interventional pulmonologists.

Materials and Methods

It is a single-centre prospective study conducted in the Department of Pulmonary Medicine in a teaching institute from May 2021 to June 2022. The aims were 1. To find out the time taken by an experienced pulmonologist for the procedure without the aid of a radiologist, 2. To determine the diagnostic yield of TUS-guided lung biopsy by pulmonologist and 3. To find out the complication rate of the procedure done by pulmonologists.

Patients aged 18 years or older, attending our hospital's outpatient or emergency department with peripheral lung lesions (lung mass or non-resolving pneumonia) and consenting to participate were included in the study. Patients were excluded if they were unwilling for the procedure, if the aetiology of the lung lesion was already diagnosed or if the lung lesion was not found to be abutting the pleura. Ethical clearance was taken from our institute.

TUS was done using a conventional ultrasound machine and a low-frequency (2–5 MHz) curvilinear probe. The posterior chest was scanned with the patient in the sitting position using a bedside table as an armrest, whereas the lateral and anterior chest walls were examined with the patient in either the lateral decubitus or supine position. TUS is only useful if a lung lesion abuts the parietal pleura since the ultrasound beam does not pass through the air and, hence, the normally aerated lung. The TUS window was defined as wide if the mass was visible in the TUS over more than one intercostal space. The site for the biopsy was localised. It was cleaned using surgical spirit and povidone-iodine. Subsequently, a surgical drape was applied. Injection lignocaine (2%) was used for local anaesthesia. A biopsy gun [BARD®] (Figure 1) with an 18-gauge cutting needle was used to obtain a trucut biopsy under TUS guidance. Three to four passes were taken depending on the adequacy of the sample. Unlike CT-guided biopsy, trocar was not used during the procedure since the biopsy was taken in real-time. Sterile dressing was applied at the biopsy site. The sample obtained was fixed using 10% formalin and sent for histopathology. Repeat TUS was done to look for post-procedure pneumothorax. A pneumothorax could reliably be diagnosed through the absence of normal lung sliding and lung pulse and the presence of a lung point. The patients were kept under observation to deal with possible complications of post-procedure pneumothorax, hemoptysis, bleeding from the local site and pain at the local site. A post-procedure chest radiograph was taken. The yield was determined as the proportion of conclusive histopathology reports among total biopsies performed.

Results

The study included 88 patients aged 18 to 86 years with a mean age of 62.7 ± 12.9 years. Seventy-eight (88.6%) patients were 50 years or more and 10 (11.4%) patients were <50 years old. Sixty-seven (76.1%) patients were male while 21 (23.9%) were female. Sixty-one (69.3%) patients were smokers while 27 (30.7%) patients were non-smokers. The baseline characteristics of the patients undergoing lung biopsy have been summarised in Table 1.

The mean time taken for biopsy was 13 ± 2.42 minutes. Sixty-eight (77.2%) cases were biopsied in 11-15 minutes. Only 8 (9.1%) cases required 16-20 min for biopsy. 12 (13.5%) biopsies were done in less than 10 minutes. TUS window without intervening parenchyma was seen in all the patients. TUS window was wide in 83 (94.3%) patients while it was limited to one intercostal space in 5 (5.7%) patients. The diagnostic yield in our study was 90.4% with the wide window while it was only 40% if the window was not wide. The p-value was found to be significant ($p<0.05$). The mean depth of lung lesion from the skin was 2.10 ± 0.58 cm while the mean diameter of the lesion was 4.95 ± 1.92 cm (Table 2). The diagnostic yield was 63.3% for lesions with a diameter of upto 3 cm, 95% each for lung lesions 3-6 cm and 6-9

cm. The biopsy sample obtained through TUS-guided lung biopsy was adequate in 86 (97.8%) cases while it was inadequate in 1 (1.1%) case. No tissue could be obtained in 1 (1.1%) case. The procedure was diagnostic in 77 (88.5%) cases while it was inconclusive in 10 (11.5%) cases. One case had a malfunctioning biopsy gun and hence was excluded from the analysis of diagnostic yield. Diagnosis could be established in 88.5% of cases. Malignancy was the most common diagnosis found in 72 (81.8%) cases while 4 (4.5%) cases had tuberculosis and 1 (1.1 %) patient had organizing pneumonia (Table 3). Among the 11 undiagnosed patients, the diagnosis was established by other means, namely CT-guided biopsy in 5 patients, bronchoscopy in 2 patients, thoracoscopy in 1 patient and on clinic-radiological grounds in the remaining 2 patients. Of the total 88, 78 (88.6%) had malignant lesions and 10 (11.4%) had benign lesions. Diagnosis could be established by TUS-guided lung biopsy in 72/78 (92.3%) cases with malignant lesions and only in 5 /10 (50%) cases with benign lesions.

Pain at the biopsy site was the most common complication seen in 11 (12.5%) cases. Hemoptysis and bleeding at the biopsy site were seen in 7 (7.95 %) cases each. Pneumothorax was seen in 2 (2.27%) cases. It was diagnosed using TUS and was confirmed by a chest radiograph. Both cases required the insertion of an inter-costal drainage tube. The lung expanded within 48 hours and the inter-costal drainage tube was removed. One of the patients who had developed pneumothorax on TUS-guided lung biopsy developed it on CT-guided biopsy as well. However, the patient had symptomatic and radiological resolution during follow-up. Air embolism was diagnosed in 1 (1.14%) patient. It was promptly recognised because of the presence of neurological deficit, respiratory distress and the temporal relationship between the onset of these symptoms and the performance of an invasive procedure. He was placed in the Trendelenburg position and supplemented with 100% oxygen. He responded to the given treatment and other possible causes were ruled out with required investigations. One of the patients was intubated post-procedure but the cause of intubation was not TUS-guided biopsy perse but the pre-existing severe illness which would have otherwise required mechanical ventilation. This patient had bilateral pneumonia likely due to an anaerobic infection. However, he subsequently succumbed to his illness. Unfortunately, in one of the patients, the biopsy needle malfunctioned during the procedure and sufficient passes could not be obtained. The diagnosis was, however, established using bronchoscopy (Table 4).

Discussion

In our study wherein the TUS-guided lung biopsy was done by the pulmonologist, the mean time taken for lung biopsy was 13 ± 2.4 minutes. The mean time studied and reported by the radiologist was 5.35 minutes [7]. In another study again by a radiologist, the mean of the

procedure time was 31 ± 16 minutes [5]. So, the time taken by us was comparable to the time taken by radiologists. In fact, it was better than some of the studies. To the best of our knowledge, no study has been reported about the time taken when the biopsy was done by a pulmonologist. The procedure was done by the treating physician, so the physician was aware of the lesion and the familiarity with the patient helped in allaying the anxiety too. Thus, the time taken by us was relatively lower.

The TUS-guided biopsy was diagnostic in 77 (88.5%) cases. The diagnostic yield was better for malignant lesions compared to benign lesions in our study ($p<0.05$). The yield was comparable to a recently published literature review and pooled analysis which reported an overall diagnostic accuracy of 88.7% for the technique [8]. Again these studies were done by radiologists. Thus, the TUS-guided transcutaneous lung biopsy performed by the pulmonologist has a similar yield but can be done in a shorter time when compared with the radiologist. The diagnostic yield was higher with a wider window on TUS. Lee M H and colleagues also had similar findings and the diagnostic yield increased with an increasing window on TUS evaluation of lung lesions [5]. Thus, one must try to ensure a wide window for doing a TUS-guided lung biopsy. The diagnostic yield also varies with the diameter of the lesion. Most of the patients had a diameter of lung lesions ranging from 3 cm to 6 cm. The yield among this group with a diameter of 3-6 cm was 95% while in a study by Laursen CB and colleagues, the diagnostic yield was only 80.1% for the same size lesion. The diagnostic yield was 63.6% for lung lesions less than 3cm in diameter which was again marginally better than in the previous studies [9].

Among the 11 undiagnosed patients, the diagnosis was established by other means namely CT-guided biopsy, thoracoscopy and clinico-radiological grounds. Overall, CT-guided biopsy was beneficial, especially in patients with smaller lung window. Bronchoscopy was useful in benign cases. Thus, it is better to use other modalities like CT scans for patients with narrow windows and bronchoscopy for suspected benign lesions.

Our study had certain complications as well. But most of the complications were mild and could easily be managed. Pain at the biopsy site was the most common complication seen in 11 (12.5%) cases. It was mild and managed with analgesics. It was found in only 2% of cases in a study by Laursen C B et al. [9]. The high incidence of pain at the site of biopsy in our study was because even mild pain during the procedure reported by the patient was recorded in real-time by the treating physician who was more familiar with the patient. Hemoptysis and bleeding at the biopsy site were seen in 7 (8 %) cases each. Hemoptysis was mild with streaks of blood. Hemoptysis is recorded in 1.25 to 5% of cases in other studies similar to our study [10,11]. The incidence of pneumothorax in our study was comparable to the study by Laursen C B et al. [7] where 2.5% of patients developed pneumothorax and was lower than the study

by Sconfienza et al. [9] where 5.8% of patients developed pneumothorax. It was even better than the pooled incidence of pneumothorax of 4.4% [1]. The pneumothorax could be swiftly and easily managed by the pulmonologist available at the site of the procedure. Air embolism, a potentially life-threatening complication was seen in one patient. The immediate recognition by pulmonologists, well versed in emergency complications embolism management proved life-saving for the patient. Air embolism is usually due to direct puncture of the pulmonary arterial branch or puncture of an air-filled structure adjoining a blood vessel [12]. Though the precaution was taken while inserting the needle and removal of the stylet, the patient still developed the embolism.

This study was not free of limitations. It was conducted at a single-center and with a relatively small sample size. A multi-center study with randomization and inclusion of radiologist-performed lung biopsy as the control is required to confirm the findings of this study.

Conclusions

TUS-guided lung biopsy performed by a pulmonologist has a diagnostic yield similar to radiologists but can be performed in a shorter time. The complications are also similar but can be addressed quickly. Since ultrasound is available with pulmonologists these days it can be added to the pulmonologist armamentarium of interventional pulmonology.

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Table 1. Baseline characteristics of patients presenting with lung lesions.

	n=88
Age (years) mean + SD	62.7±12.9
Sex	
Male	67 (76.1%)
Female	21 (23.9%)
Current or former smoker	61 (69.3%)
Never smoker	27 (30.7%)

Table 2. TUS characteristics of lung lesions.

	n=88
Wide window on TUS	83 (94.3%)
Depth of lung lesion (cm) (Mean ± SD)	2.10 ± 0.58
Diameter of the lung lesion (cm) (Mean ± SD)	4.95 ± 1.92

Table 3. Diagnosis established by TUS-guided lung biopsy.

Diagnosis	n=88	Percentage (%)
NSCLC: Squamous Cell Carcinoma	33	37.5
NSCLC: Adenocarcinoma	25	28.4
NSCLC: Adenosquamous	1	1.1
NSCLC: NOS	4	4.5
Small Cell Carcinoma	4	4.5
Mature T-cell lymphoma	1	1.1
Mesenchymal tumour of neural origin	2	2.2
Pleomorphic Carcinoma: NOS	2	2.3
Organising Pneumonia	1	1.1
Necrotising granuloma	4	4.5
Inconclusive	11	12.5

Table 4. Complications during TUS-guided lung biopsy.

Complications	n	Percentage (%)	95% CI
Pneumothorax	2	2.27	0.28 – 7.97
Hemoptysis	7	7.95	3.26 – 15.7
Bleeding at the local site	7	7.95	3.26 – 15.7
Pain at the biopsy site	11	12.5	6.1 – 21.27
Air embolism	1	1.14	0.03 – 6.17
Intubated post procedure	1	1.14	0.03 – 6.17
Malfunctioning of forceps	1	1.14	0.03 – 6.17

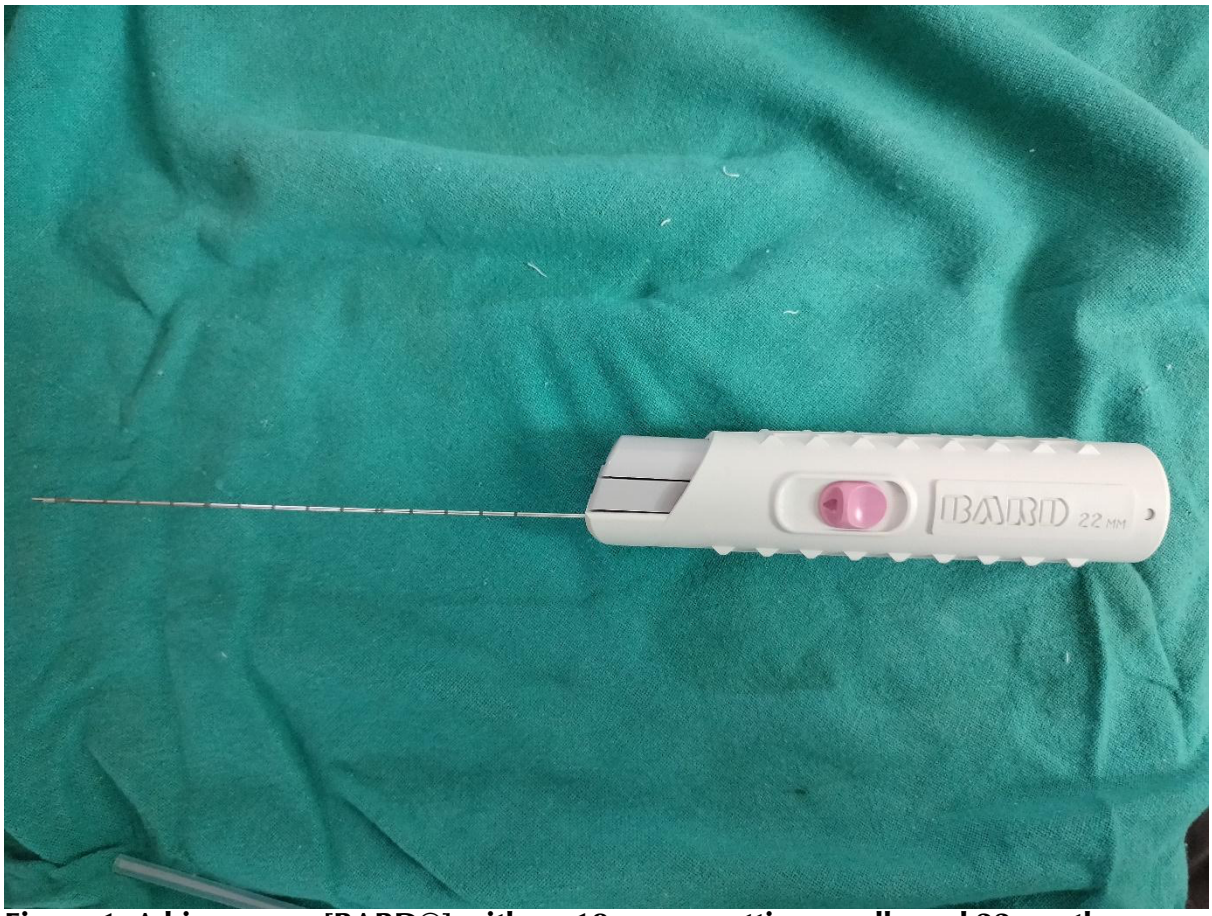

Figure 1. A biopsy gun [BARD®] with an 18-gauge cutting needle and 22mm throw was used to obtain a trucut biopsy under TUS guidance.