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Original Article

Assessment of Safety and Utility of Image Guided Percutaneous Biopsy in Intrathoracic Lesions

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ABSTRACT

Background: Intrathoracic lesions, encompassing pulmonary, pleural, and mediastinal masses, necessitate histopathological assessment for precise diagnosis. Image-guided percutaneous biopsy has emerged as a technique to attain this. This study evaluates its utility, reasons for inconclusive results, and associated complications.
Methods: 120 patients, who had prior imaging indicating an intrathoracic lesion, were enrolled post-ethical committee clearance and obtaining informed consent. The biopsy was conducted using Siemens 128 slice CT scanner or GE 16 slice CT scanner. Feasibility for image-guided biopsy was determined and procedures were executed. A follow-up evaluation comprised:
a) Histopathology outcomes.
b) Reasons for inconclusive results.
c) Complications, their management, and effect on the patient's clinical outcome.
Results: Conclusive histopathological results were received in 89.1% of cases, aligning with existing literature standards. The findings were significantly valuable for the attending physician. Factors leading to inconclusive results included small lesion size, intraprocedural complications, necrotic core biopsies, and the need for additional samples for IHC examination. Complications, primarily pneumothorax and hemorrhage, were observed in 22% of participants. This rate is consistent with prevailing literature. Most complications were conservatively managed, with only 4.1% requiring further intervention. Monitoring the patients' clinical status revealed symptomatic improvements, affirming the safety and reliability of the biopsy method for intrathoracic lesions.
Conclusion: Image-guided percutaneous biopsy of intrathoracic lesions stands as a safe and dependable technique, offering low complication rates and significant diagnostic insight into pulmonary, pleural, and mediastinal masses.

Key Words: *Pneumothorax; Biopsy; Hemorrhage; Intrathoracic; Patients*

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INTRODUCTION

Intrathoracic lesions may be caused by a wide variety of neoplastic and non-neoplastic pathologies. They can be evaluated by – non-invasive methods like imaging and invasive methods like biopsy. Histopathological examination has been the gold standard for diagnosis of malignancies. Biopsies can be obtained by surgery (either open or video-assisted thoracoscopic surgery), CT guided and Ultrasound guided.

Intrathoracic lesions can be lung lesions, mediastinal lesions and pleural lesions [1].Due to the more invasiveness and increased risk of complications in open surgery and recent advances in radiology, image guided biopsy which is less invasive and has lesser complications is the preferred way of taking biopsy. So depending upon the site of the lesion, the approach of the lesion is decided. Parasternal, paravertebral, oblique, trans-pulmonary are the various approaches to target the lesion. The yield of the procedure is important so that the diagnosis of the lesion can be made histopathologically which will guide the treatment protocol.

Even though percutaneous image guided biopsy of intrathoracic lesion is a relatively commonly performed procedure, yet literature is still lacking in objective evaluation of the diagnostic yield and positive rates of the procedure. Also to determine the complications such as pneumothorax and hemorrhage arising due to the procedure and its impact on patients clinical course.

In this study we intend to assess the overall utility of image guided percutaneous intrathoracic biopsy, identify the factors related to negative or repeat biopsies and assess the rate of complications associated with the procedures, their management and impact on patients clinical course.

AIMS &OBJECTIVES

- To assess the utility of image guided biopsy procedure for intrathoracic lesions in establishing histopathological result of the lesion.
- To identify the factors which result in an inconclusive histopathology report mandating a repeat procedure or open biopsy.
- To assess any complications arising due to biopsy procedure, the clinical significance, management and impact on patients clinical course**.**

MATERIALS AND METHODS

Duration and Ethical Clearance:

The study spanned from March 2021 to September 2022. Ethical approval was secured from the ethical committee of VIMS & RC. All participating patients provided their informed consent.

Sample Size Estimation:

Based on the study conducted in India by Zafar Neyaz et al., [1] at Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow, a sample size was determined using the given formula. With a 95% confidence interval and a margin of error of 0.05, a total sample size of 120 was rounded off.

Statistical Analysis:

Data collected was inputted into MS Excel, and the Statistical Package for Social Sciences software (version 22) was employed for analysis. Descriptive statistics summarized demographic and clinical data, while qualitative variables were expressed as percentages with a 95% confidence interval.

Inclusion Criteria:

Patients with intra-thoracic lesions referred to the Department of Radio diagnosis, Vydehi Institute of Medical Sciences and Research Centre, Bangalore, were considered eligible if they underwent a CT-guided biopsy and a substantial follow-up.

Exclusion Criteria:

Patients were excluded if they had bleeding disorders or were in an unstable clinical condition.

Evaluation Methodology:

- **Pre-Procedure Assessment:** Patient details were revisited, and prior cross-sectional images were reviewed for the procedure. Laboratory parameters (CBC, PT/INR, Viral serology) were cross-checked. Patients underwent IV access establishment and preparation for the procedure.
- **Approach for Biopsy:** The approach, determined by previous imaging, considered minimal lung parenchyma traversal and avoidance of major vascular structures.
- **Image-Guided Biopsy Procedure:** The biopsies were executed using Siemens 128 slice CT scanner or GE 16 slice CT scanner. The sequence of the procedure involved scannograms, marking, anesthesia, needle insertion, lesion access, sample extraction, and post-sample extraction check scan.
- **Biopsy Equipment:** 18G 20 mm 15 cm or 18 G 20 mm 20 cm T biopsy guns, Quick-Core® Biopsy Needle Set, and Bard Mission™ Disposable Core Biopsy Instrument were used. Ideally, five cores of sample size 1.5 to 2cm were obtained.
- **Post-Procedural Assessment:** Patients were evaluated for immediate and subsequent complications. Predominant complications included pneumothorax, hemorrhage, a combination of both. Procedures and follow-ups for pneumothorax and hemorrhage, depending on severity and symptoms, were detailed.
- **Histopathological Outcome Assessment:** The final histopathological reports were reviewed. The evaluation consisted of determining the clarity of the diagnosis, recognizing reasons for inconclusive reports, and categorizing them accordingly.

Statistical Analysis:

The data, collected throughout the duration of the study, was systematically entered into an MS Excel spreadsheet for initial organization. Further in-depth analysis was executed using the Statistical Package for Social Sciences (SPSS) software, version 22. Descriptive statistics were primarily utilized to delineate and summarize the quantitative variables of both demographic and clinical data. The standard deviation was computed to determine the variation in the data set. Qualitative variables, on the other hand, were succinctly presented as percentages and accompanied by a 95% confidence interval to provide a precise understanding of the study's outcomes and reliability.

OBSERVATIONS & RESULTS

A total of 120 patients who presented with intrathoracic on previous investigations and found suitable for image guided biopsy were included in the study.

Table 1: Distribution of subjects according to age

Age	Frequency	Percent
20 – 34 years	7	5.8%
35 – 49 years	34	28.4%
50 – 64 years	63	52.5%
≥ 65 years	16	13.3%
Total	**120**	**100%**
Mean age: 53.9 ± 11.17 years		

Table 1 shows the age distribution of the subjects where out of 120, 7 were aged 20 - 34 years, 34 between 35- 49 years, 63 between 50- 64 years and 16 were aged ≥ 65 years. The mean age in the present study was 53.9 ± 11.17 years. Majority were aged between 50– 64 years. The average duration of symptoms was of 2 months and ranged from 2 weeks to 1 year.

Table 2: Distribution of subjects according to gender

Gender	Frequency	Percent
Male	86	71.7%
Female	34	28.3%
Total	**120**	**100%**

Table 2 shows the gender distribution of the subjects which consisted of 86 males and 34 females.

Table 3: Distribution of subjects according to location of intrathoracic lesion

Location of Intrathoracic lesion	Frequency	Percent
Anterior Mediastinum	7	5.8%
Chest Wall Lesion	1	0.8%
Lung (Apical)	12	10%
Lung (Paramediastinal)	23	19.2%
Lung (Peripheral)	74	61.7%
Pleural	3	2.5%
Total	**120**	**100%**
Mean size of lesions: 4.2 ± 1.73 cm		

Table 3 shows the distribution of subjects according to location of intrathoracic lesions. Majority of the subjects had peripheral lung lesions (74 subjects) followed by paramediastinal lung lesions (23 subjects) and apical lung lesions (12 subjects). 7 subjects had anterior mediastinal lesions, 3 subjects had pleural lesions and the rest 1 subject had chest wall lesion. The mean size of the lesions was 4.2 ± 1.73 cms.

Table 4: Distribution of subjects according to the approach to the lesion

Approach to the lesion	Frequency	Percent
Posterior	90	75%
Anterior	19	15.8%
Oblique	11	9.2%
Total	**120**	**100%**

Table 4 shows the distribution of subjects according to the approach to the lesion. Posterior approach was followed in 90 subjects. Anterior and oblique approaches were followed in 19 and 11 subjects respectively.

Table 5: Distribution of subjects based on presence of high risk factors

High risk factors	Frequency	Percent
Emphysematous changes	21	17.5%
Underlying pleural effusion	14	11.7%
Intervening critical mediastinal vascular structure	4	3.3%

Without high risk factors	81	67.5%
Total	**120**	**100%**

Table 5 shows the distribution of subjects based on presence of high risk factors. Pre- existing emphysematous changes were present in 21 subjects, underlying pleural effusion in 14 subjects and lesion present adjacent to critical mediastinal vascular structure in 4 subjects.

Raised INR was also considered high risk for the percutaneous image –guided biopsy procedure. In patients with high INR, procedure was performed after the correction of INR. Also in patients on anticoagulants, it was stopped 2 days before and the procedure was planned accordingly.

Table 6: Distribution of subjects according to the complications

Complications	Frequency	Percent
Pneumothorax	18	15%
Pulmonary hemorrhage	7	5.8%
Combined	1	0.8%
None	94	78.3%
Total	**120**	**100%**

Table 6 shows distribution of subjects according to the complications. Majority (78.3%) did not have any complications. Pneumothorax occurred in 18(15%) subjects and pulmonary hemorrhage in 7(5.8%) subjects. Combined pneumothorax and hemorrhage in 1 (0.8%) subject.

Incidence of pneumothorax:

Out of 120 patients who undergone percutaneous intrathoracic biopsy, 19 (15.8%) patients developed pneumothorax, which included mild, moderate and severe.

Table 7: Distribution of subjects according to the pneumothorax

Pneumothorax	Frequency
Mild	14
Moderate	4
Severe	1
Total	**19**

Among these 19 subjects who had pneumothorax, 14(73.7%) subjects were managed conservatively. 5(26.3%) subjects needed intervention for the pneumothorax. Out of 21 cases who had emphysematous changes, it was noticed that 8(38%) of them developed pneumothorax, with increased incidence.

Incidence of significant pneumothorax requiring intervention:

Out of 18 patients who developed pneumothorax, 5 patients required intervention which is 27.7%. There were 4 (21%) cases of moderate pneumothorax and 1(5.3%) case of severe pneumothorax with cardio-mediastinal shift.

Table 8: Incidence of significant pneumothorax requiring intervention

Intervention done for pneumothorax	Frequency
+	5
_	14
Total	**19**

1 patient had moderate pneumothorax during the procedure, so by using 10cm connecting tube and three way, pneumothorax was aspirated. Check scan showed minimal pneumothorax, which subsided conservatively.

1 Patient developed a large post biopsy pneumothorax with progressive increase along with subcutaneous emphysema. Mild surrounding hemorrhage was also positive.

The patient had progressive breathlessness, mild desaturation and tachycardia.Signs of tension pneumothorax were positive with cardio-mediastinal shift towards left side.8F pigtail was placed. Post pigtail there was significant reduction in the pneumothorax and a chest x-ray after 1 day showed the resolution of pneumothorax.

Incidence of pulmonary hemorrhage:

Out of 120 patients who undergone percutaneous intrathoracic biopsy, 8 (6.6 %) patients developed pulmonary hemorrhage, which included mild, moderate and severe.

Table 9: Distribution of subjects according to the pulmonary hemorrhage

Pulmonary hemorrhage	Frequency
Mild	7
Moderate	1
Severe	-
Total	**8**

Among the 8 subjects who had pulmonary hemorrhage, 7 subjects had asymptomatic hemorrhage with ground glass opacities. So only clinical follow-up was done. There was no need of intervention in those cases. 1 subject had moderate hemoptysis during the procedure, due to which only 3 cores were obtained.

Total hemoptysis estimated was approximately 100-200ml (moderate). Patient was encouraged to cough and expectorate the blood. Injection pause (tranexamic acid) was started, tablet ethamsylate was also given. Hemoptysis settled on conservative measures.

There was no case with massive hemoptysis which needed bronchoscopic/endovascular intervention.

Incidence of significant hemorrhage requiring intervention:

Out of 8 cases who had pulmonary hemorrhage, only 1 patient had frank hemoptysis who was managed conservatively. There was no incidence of pulmonary hemorrhage requiring immediate intervention through endovascular/bronchoscopic approach.

Table 10: Distribution of subjects according to number of cores obtained

Number of cores obtained	Frequency	Percent
3	3	2.5%
4	84	70%
5	12	10%
6	21	17.5%
Total	**120**	**100%**

Table 10 shows distribution of subjects according to number of cores obtained. 3 cores were obtained in 6subjects, 4, 5 and 6 cores were obtained in 84, 12 and 21 subjects respectively.

Among the 6 subjects, only 3 cores were obtained. In 1 subject there was intraprocedural pneumothorax, one more subject had hemoptysis during the procedure. 2 subjects were inco-operative due to pain, so only 3 cores were taken. In other 2 cases only 3 cores were obtained because of small size of the lesion.

Table 11: Distribution of subjects based on conclusive and inconclusive biopsy reports

Biopsy Report	Frequency	Percent
Conclusive	107	89.1%
Inconclusive	13	10.9 %
Total	**120**	**100%**

Clear, concise and conclusive reports were obtained in 109 subjects which is 90.8 %. In 13 subjects (10.9%) the histopathological reports were inconclusive.

Table 12: Distribution of subjects according to factors responsible for inconclusive report

Factors responsible for inconclusive report	Frequency
Inadequate Material	7
Additional material for IHC	3
Large necrotic core	3
Total	13

The factors for the inconclusive biopsy report were introspected. Among those 7(5.8%) cases which had inadequate material is due to small size of the lesion, patient compliance. In 3 cases the lesions were large with necrotic areas within. The histopathology report showed necrotic cells, mandating the repeat biopsy.

A patient had intraprocedural moderate hemoptysis. So only 3 cores were obtained, 2 being fragmented cores. The patient was managed conservatively with injection tranexamic acid and tablet ethamsylate. The histopathology report of the patient was inconclusive due to inadequate sample material.

3 cases needed additional sample material of IHC examination, for further characterization of the lesion.

Table 13: Distribution of subjects according to Histopathology of the intrathoracic lesions

Histopathology	Frequency	Percentage
Lung		
Adenocarcinoma	31	25.8%
Mucinous adeno carcinoma	3	2.5%
Squamous cell carcinoma	24	20%
Poorly differentiated carcinoma	13	10.8%
Adenosquamous carcinoma	5	4.2%
Small cell carcinoma	7	5.8%
Granulomatous inflammation	14	11.7%
Caeseating granulomatous inflammation	2	1.7%
Large cell lymphoma	1	0.8%
Mediastinum		
Thymoma	2	1.7%
Pleomorphic sarcoma	1	0.8%
Neuroendocrine tumour	1	0.8%
Myxofibrosarcoma/Inflammatory myofibroblatsictumour	1	0.8%
Pleura and chest wall		
Malignant small round cell tumour (askins)	2	1.7%
Mesothelioma	2	1.7 %
Metastasis to lungs		
Carcinoma Tongue	2	1.7%
Carcinoma hard palate	1	0.8%
Carcinoma rectum	1	0.8%
Carcinoma esophagus	1	0.8%
Spindle cell neoplasm from osteosarcoma	2	1.7%
Metastatic deposit from renal cell carcinoma	1	0.8%
Metastatic deposit from ductal carcinoma breast	1	0.8%
Metastatic deposit from leiomyosarcoma of abdominal wall	1	0.8%

Table 13 shows distribution of subjects according to histopathology of the intrathoracic lesions. Majority of the intrathoracic lesions were adenocarcinoma (31 subjects) followed by squamous cell carcinoma (24 subjects) and granulomatous inflammation (14 subjects).

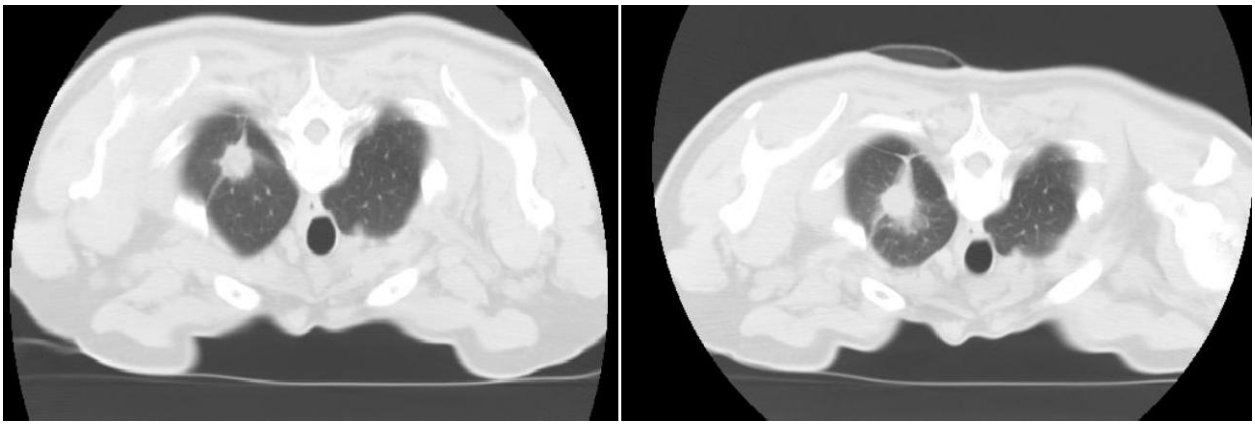
ILLUSTRATIVECASES

CASE 1: Patient presented with chest pain on the left side since 2 months. No history of breathlessness/fever.

CT Findings:

There is a well- defined soft tissue attenuating lesion with irregular margins noted in the apico-posterior segment of left upper lobe, measuring 18 x 17 x 16 mm (FIG 1A). Adjacent fibrotic changes noted.

FIG1A: FIG1B:



Post biopsy:

Adequate 4 cores were obtained from the lesion in the left upper lobe.

Post biopsy check scan revealed minimal ground glass opacities around the soft tissue attenuating lesion in the left upper lobe suggesting minimal pulmonary hemorrhage which was not seen in the pre-biopsy axial CT scan. No evidence of pneumothorax noted.

CASE 2: 55 year old male, chronic smoker presented with cough. Chest x-ray demonstrated central lung mass with speculated margins in the right parahilar location measuring 3 x 2.9 cm (FIG 2 A). Significant emphysematous changes in the lungs.

FIG 2 A: 

Developed a large post biopsy pneumothorax with progressive increase along with subcutaneous emphysema. Mild surrounding hemorrhage was also positive (FIG 2B, C)

The patient had progressive breathlessness, mild desaturation and tachycardia. Signs of tension pneumothorax were positive with cardio-mediastinal shift towards left side .

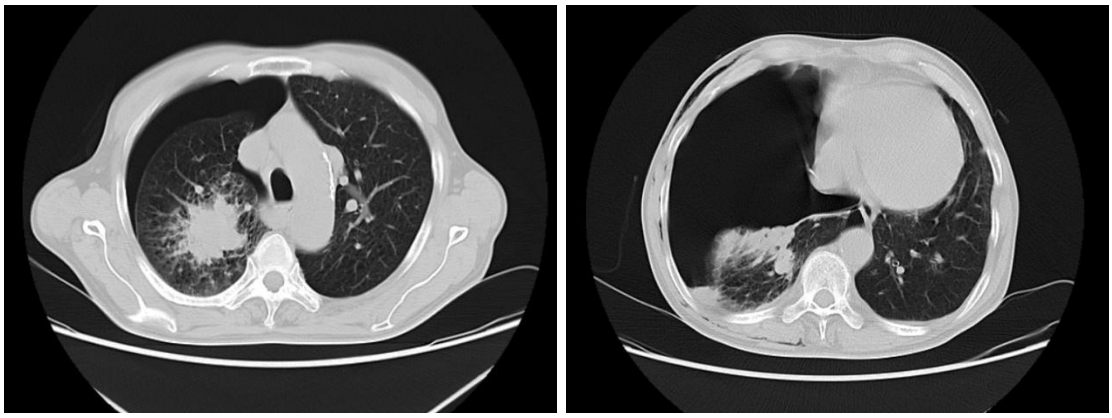


FIG 2 B,C:

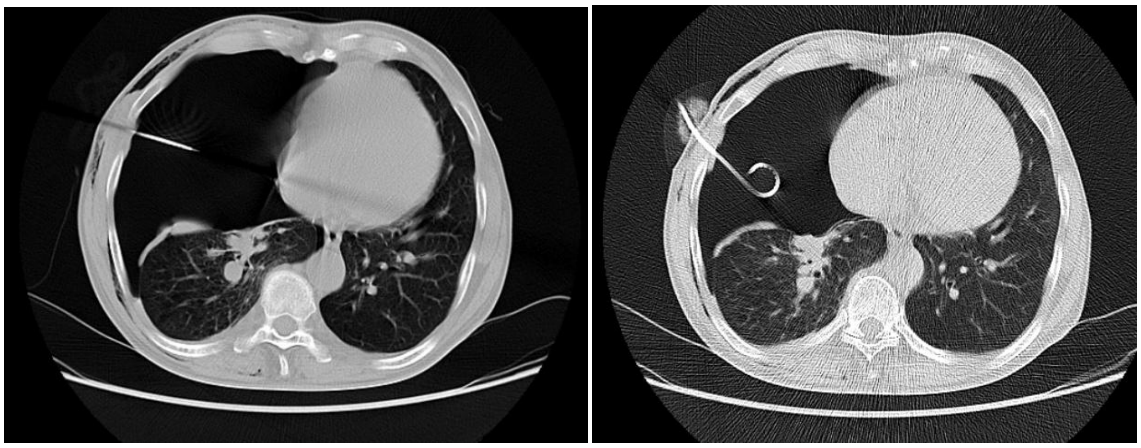


FIG 2 D, E: 8F pigtail insertion was done.

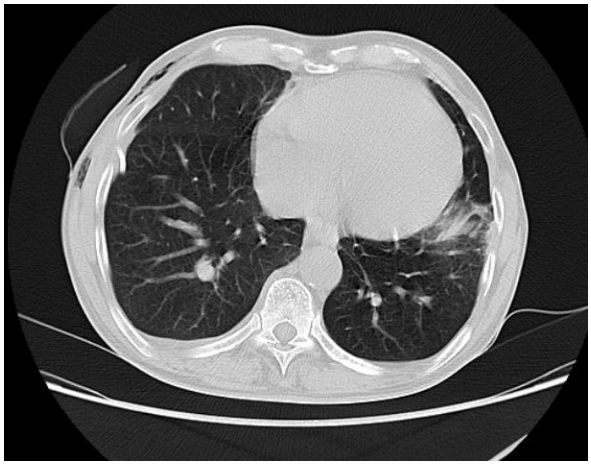


FIG 2 F: Post pigtail complete resolution of the pneumothorax within 1 day, Pig tail catheter noted in situ but pushed laterally against the pleura by the expanded lung .

DISCUSSION

Following a diagnosis of intrathoracic masses usually on cross sectional imaging, the next step involves establishing the diagnosis with histopathology. In the current study, majority (78.3%) did not have any significant complications. Among the subjects (21.7%) who had complications**, t**he predominant complication was pneumothorax which was seen in 15.8 % of subjects**.** Incidence of pneumothorax is within the acceptable limit as compared with the available literature. The study conducted by Zafar Neyaz, et al., [1] also concluded that pneumothorax was the commonest complication which was seen in 23% of subjects. The study by Emily B. Tsai, et

al., [2] showed that pneumothorax was observed in 22.7% of all biopsies performed.

14 subjects (11.6%) were managed conservatively in this study and did not require any intervention. 1 patient had moderate pneumothorax during the procedure, needle aspiration was done to reduce the severity. The needle aspiration reduces the excessive air directly with a syringe through a needle. According to Wang C, et al.,[3] clinically when aspiration is unsuccessful, patients will be managed with chest tube drainage. In their study simple needle aspiration was helpful to reduce the severity when patient had a tension pneumothorax.

In other patients pigtail catheter insertion was effective in the treatment of pneumothorax causing significant improvement of clinical status of the patient. 8F pigtail , done under image guidance in Radiology settings was effective and sufficient in treating these iatrogenic pneumothoraces. This may have definite advantage over placements of large bore ICDs , usually done in ward settings as a blind procedures , where the incidence of misplaced tubes and iatrogenic lung injuries are not uncommon . However we recommend larger prospective studies for this aspect, since the number of procedures requiring pneumothorax pig tailing were quite small in this study and a larger prospective study with randomization comparing the efficacy of ICDs vs small bore pigtails in treating these pneumothorax will be more useful .The study done by charalombos zisis et al., [4] explained about the usage of chest drainage tubes with under water seal to prevent drained air from returning to the pleural space, restore negative pressure in the pleural space to re-expand the lung.

The total incidence of pneumothorax was 15.7%, whereas the incidence among the emphysematous patients was 38 %. Hence in this study we noticed that the pre-existing emphysematous changes were the significant risk factor for the development of the pneumothorax. In the study conducted by Lendeckel D, et al., [5] pulmonary emphysematous changes were found to be an independent predictor of post-interventional pneumothorax. Fish et al., [6] found that the pneumothorax rate was 46% in patients with chest radiographs showing obstructive airway disease compared with 7% in patients with normal findings. In our study 13 subjects out of 21 subjects who had emphysematous changes didn't develop pneumothorax. So in these cases the chances of the pneumothorax were reduced by approaching the lesion through minimal emphysematous areas. However in this study the association of severity of pulmonary emphysema with the severity of pneumothorax was not done.

There was increased incidence seen in the central lesions. In the central lesions, incidence was more due to the longer path traversed by the needle through the lung parenchyma and the traversal of fissure. Similar observation was done in the study done by Boskovic T,et al, [7] where it was concluded increased depth of lesion, increased time of needle across the pleura, and traversal of a fissure were the factors for causing pneumothorax. Carol Wu et al., [8] found that the increased depth of the lesion from the skin or long needle path (> 4 cm) is associated with an increased risk of pneumothorax.

Among the 8 subjects (6.6%) who had pulmonary hemorrhage, 7 subjects had asymptomatic ground glass opacities around the lesion. Similar findings were noted in the study conducted by Tai R et al, [9] where they concluded pulmonary hemorrhage after transthoracic lung biopsy is common but rarely requires intervention, where the incidence of pulmonary hemorrhage was 41% where only 1.8 % of patients had significant hemoptysis.

Among the 120 subjects, clear, concise and conclusive reports were obtained in 89.1 % of subjects. It is an acceptable limit comparing with the available literature. In a study conducted by Milena petranovic et al., [10] the diagnostic yield of CT-guided percutaneous biopsy was 77% (40/52). In 12 patients (23%) results were non-diagnostic. Among these 10.8 % patients the factors for the inconclusive biopsy report was introspected. The predominant cause for inconclusive report was inadequate material seen in 7 subjects (5.8%). Inadequate sample material was due to small size of the lesion, intraprocedural complications and due to distortion of the sample material. It was noticed that in case of small nodules of lung, there was some limited local hemorrhage noted after 2- 3 cores were obtained, somewhat obscuring the target nodule. Subsequently less effective cores were taken and probably leading to the inadequate samples. So in our study there were 3 such cases where only one or two less effective cores were taken. In a study conducted by Liu XL et al.,[11] the diagnostic accuracy was 92 %.

Mentioning about other causes of inconclusive reports, one was crush artefact which occurs due to tissue distortion. Available literature says even the most minimal compression of the tissue can cause crush artefact. Inflammatory and tumor cells are most susceptible for this artefact.

In this study we observed that there were inconclusive reports in lesions with large necrotic cores. It was seen that the precise localization of the needle into the viable portion of the tumour was important to improve the diagnostic yield. But inadvertently in 3 cases (2.5%), the biopsy was taken from necrotic cores , where histopathopatholgy showed necrotic cells, mandating the repeat biopsy. A successful biopsy from these lesions were possible by targeting the non-necrotic solid regions which are usually peripheral.

So it was seen in our study that percutaneous image guided biopsy is safe and reliable method with low complication rates and also helpful in establishing histopathological diagnosis if procedure is done meticulously taking measures to avoid complications.

CONCLUSION

With proper technique and precautions, image guided biopsy procedures for intrathoracic lesions are reasonably safe with good diagnostic yield. Complications were infrequent and most of complications were minor which were managed conservatively. The procedure could allow a definitive histopathological diagnosis to be obtained early, thereby reducing the time to start treatment in patients with malignancies.

Pre procedural diagnostic imaging review were helpful in making and planning correct approach to the lesion thus providing justice to the patient in terms of diagnosis and further treatment planning.

The positive diagnosis rate of percutaneous intrathoracic biopsy under imaging guidance was reported to be good and high. Few factors like large necrotic cores, small nodules, intraprocedural complications, certain lesions required additional samples for the IHC examination resulted in inconclusive histopathology reports. Complications were also infrequent and most of complications were minor which were managed conservatively. However minority of complications did require intervention, especially pneumothorax. None of pulmonary hemorrhage/hemoptysis required intervention in the present study. However significant hemoptysis would be treated with embolization as mentioned in the literature. No such cases were encountered in the present study.

Therefore, an imaging-guided percutaneous biopsy of intrathoracic lesions is a safe and reliable method with low complication rates in pulmonary, pleural and mediastinal masses and also helps in establishing the histopathological diagnosis and further helps the clinician to plan the treatment.

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