CT Guided Biopsy of Lung lesions – Prevalence of Pneumothorax and Variables affecting it

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ABSTRACT

Introduction: In oncology practice, pathological diagnosis of the disease is considered the standard for diagnosis. Computed Tomography is the optimal and most preferred image-guiding modality for thoracic interventions for biopsy specimen procurement. A well planned and executed CT guided biopsy provides an accurate diagnosis and facilitates institution of definitive treatment. Study aimed to find out prevalence of pneumothorax in Computed Tomography guided biopsy of lung lesions and to find out the factors affecting risk of pneumothorax in Computed Tomography guided biopsy of lung lesions.

Material and methods: This observational study of CT guided lung lesion biopsy was performed from September 2017 to September 2019 at a tertiary hospital. Proper pre-procedure planning and all precautionary measures were taken to reduce development of Pneumothorax.

Results: A total of 50 patients were included in the study which showed prevalence of pneumothorax was found to be more common in males, smokers, older age groups and in patients with underlying emphysema. Risk of pneumothorax was also found to increase with multiple pleural punctures and with increasing procedure time. Smaller sized and deeper seated lesions also had more occurrence of pneumothorax likely due to direct relation with increasing intrapulmonary biopsy tract length. Superficial sub pleural lesions had lesser occurrence of pneumothorax. Decubitus Positioning had least (0%) association with Pneumothorax as compared to supine (25%) and prone (18.1%).

Conclusion: Percutaneous CT guided interventions like core biopsy are relatively simple minimally invasive procedures with good patient acceptance, low morbidity and almost negligible mortality. They provide diagnosis of thoracic lesions quickly and accurately if they are successful in procuring right tissue for histopathological analysis. Knowledge of these factors may augment pre-procedure planning. Referring doctors be aware of these factors and should explain and communicate these risks to the patient and family before the procedure.

Keywords: CT, Biopsy of Lung, Prevalence of Pneumothorax and Variables

INTRODUCTION

CT guided interventional procedures are the most preferred procedures in thoracic lesions. Thoracic interventions like CT guided biopsy are minimally invasive procedures and they can be done quickly on patients without causing significant morbidity when compared to open surgical interventions.[1] Accurate histopathological diagnosis requires accurate specimen procurement procedures, both invasive and noninvasive, like open lung biopsy (OLB), percutaneous transthoracic needle biopsy (TTNB) and fine needle aspiration cytology (FNAC). Percutaneous non-operative procedures in the chest were performed even before the advent of imaging. Leyden performed the first transthoracic needle lung biopsy in 1882 to confirm pulmonary infection.[2] In oncology practice pathological diagnosis of the disease is of paramount importance and is always considered the standard for diagnosis. CT scan is the most popular guiding modality for thoracic interventions. CT offers exquisite anatomical display of the thoracic structures and allows percutaneous access. CT is particularly useful for guiding puncture of mediastinal lesions and intrapulmonary lesions that are difficult to localise and allows determination of an optimal cutaneous entry point. Post procedural complications like pneumothorax and pulmonary haemorrhage if any, are readily recognised on CT scan.[2,3]

Ultrasound, on the other hand, is more cost effective and also free from ionising radiation. The needle is advanced and sample is obtained under real time visualisation. However, ultrasound suffers from limitation of visualisation in some areas such as intrapulmonary or bone lesions as well as deep seated thoracic lesions obscured by overlying lung.[4]

Ability of FNAC and core needle biopsy to provide diagnosis on examination of few cells and tissue samples respectively, have made them one of the most widely used diagnostic procedures in oncology. Both FNAC and core biopsies have their own advantages and disadvantages. FNACs are simple and safer but are more prone to false-negative diagnosis. Availability of an on site cyto-pathologist to confirm the adequacy of the harvested specimen using fast stain techniques is important to decrease false-negative or inconclusive results.[5,6] Core biopsies are less susceptible to false-negative or false positive diagnosis when compared with FNAC. These also provide histological and architectural information, which is important in sub-typing of some

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malignancies. Core biopsy samples are also more suitable for special tests like immunohistochemistry and receptor analysis.[5,6]

Newer developments in core biopsy techniques like automated spring loaded biopsy guns and use of coaxial needle systems allow us to obtain multiple large core samples with a single puncture without significant increase in complications.[6]

A well planned and executed CT guided biopsy / FNAC helps to provide an accurate diagnosis and facilitates institution of definitive treatment. CT is the optimum image-guiding modality for thoracic interventions.[2,3]

Previously the reported rate of pneumothorax in CT guided lung biopsy varies largely from 22% to 65% depending on the location of lesion, size of lesion, needle size, age of patient, patient history of smoking, number of pleura punctures, patient status, depth of lesion, duration of study, angle of needle etc.[7,8]

Study aimed to find out prevalence of pneumothorax in Computed Tomography guided biopsy of lung lesions and to find out the factors affecting risk of pneumothorax in Computed Tomography guided biopsy of lung lesions.

MATERIAL AND METHODS

This was a hospital based observational study of CT guided interventional procedures in patients with thoracic lesions diagnosed by imaging methods like chest radiograph, CT or MRI scans. These patients were referred to the Department of Radiodiagnosis for CT guided thoracic interventions from the chest medicine department and other clinical departments of our hospital and other hospitals. The institutional review board approved the study, and all patients gave written informed consent. The duration of the study is for a period of 24 months from September 2017 to September 2019.

Percutaneous CT guided transthoracic lung biopsy was done in 50 patients, of which 33 were males and the remaining 17 were females. The age group of the patients in the study ranged from seventeen years to seventy-two years. A consultant radiologist with 15 years of experience in percutaneous CT-guided lung biopsy performed all consecutive biopsies. All biopsies were performed under CT guidance. All patients had pre-biopsy CT scans of the chest available for biopsy planning. All the patients were advised fasting for 6 hours before the procedure. All CT-guided biopsies were performed with an 18-20 gauge lumbar puncture needle and TRU-CUT biopsy needle. The patient lied still in the desired position with suspended or shallow breathing on the CT. Immediate pre-procedural topogram and CT of the chest were done to delineate the thoracic lesion and to plan the percutaneous site of needle puncture. The point was localised with laser lights located in the CT gantry and marked with a permanent skin marker. The local area was cleaned with povidone iodine and surgical spirit. Using aseptic precautions 2% lignocaine was utilised for local anaesthesia and the procedure was performed. The needle was inserted through the skin and advanced to the lesion. Intra-operative CT scans was performed to confirm the position of the lesion and needle. The needle was located to be in an appropriate position within or near the lesion and maximum 3 specimens were taken. Next, the tissue specimen was removed from the notch kept in formalin vial and sent for histopathology to the Department of Pathology, Kalinga Institute of Medical Sciences. Immediately after the procedure, a chest CT scan was performed to evaluate procedural complications, including pneumothorax. Limited CT Study was done only in and around the biopsy tract to reduce the radiation exposure to the patient. Immediate post procedure compression was given for 5 minutes at the site of skin puncture to stop bleeding and a dressing was applied. Patient were reassured and blood pressure, pulse rate and respiratory rates were monitored. In some case of pain, oral analgesics were given. Check CT of thorax was done before the patient was shifted to the wards to identify potential complications like pnemothorax and haemothorax. In case of immediate pneumothorax, the air was aspirated using a 10 ml syringe and LP needle. On the next day, a chest X-ray was done to rule out any delayed pneumothorax. None of the cases included in OUR study developed delayed pneumothorax. None of the cases required ICT drainage tube insertion.

Variables measured at the time of biopsy included the number of pleural punctures, puncture time. Smaller size and deeper seated lesions, intrapulmonary biopsy tract length, positioning of the patient, the lobe in which the nodule was located, needle path traversing a fissure or a bulla, emphysema along the needle track (subjective assessment of emphysema, as defined by the Fleischner Society glossary of terms), distance from the pleura and location of nodule (lung, sub-pleural space, or pleural space).

STATISTICAL ANALYSIS

Statistical analysis was performed for study group, with pneumothorax as the dependent variable and age, sex, lesion, and biopsy measures as independent variables.

RESULTS

This hospital based observational study had 50 patients, of which 41 were males and the remaining 17 were females.

Out of the 50 patients,on whom CT guided lung biopsy was done 9 developed pneumothorax.

Prevalence of pneumothorax in CT guided lung biopsy =

$$\frac{\text{Number of patients with pneumothorax}}{\text{Total number of cases in study}} \times 100$$

$$= \frac{9}{50} \times 100$$

$$= 18\%$$

Of the 33 cases who were males, 8(24.2%) developed pneumothorax. Of the 17 cases who were females, 1 (5.8%) developed pneumothorax. Out of the 50 patients on whom CT guided lung biopsy was done, 3 had underlying emphysematous changes in HRCT thorax. All the cases who had underlying emphysema developed pneumothorax. 12.7% cases who did not have emphysema developed

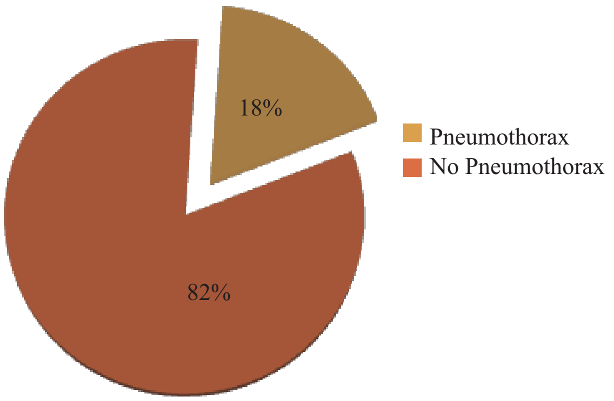

Figure-1: Prevalence of pneumothorax in CT guided lung biopsy

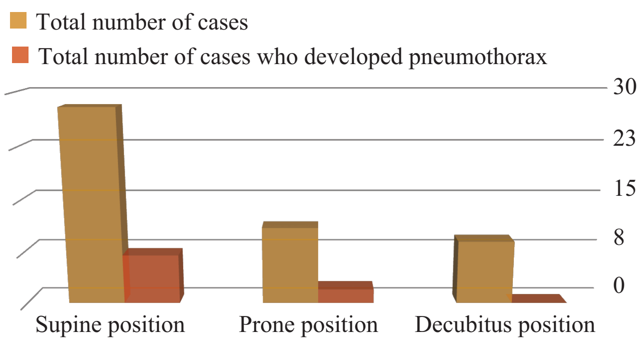

Figure-2: Variation of Pneumothorax with positioning of the patient

pneumothorax

Out of the 50 cases in the study, in 32 cases the procedure was performed in supine position. In 9 cases the procedure was performed in prone position and in 9 cases the procedure was performed in decubitus position.

Out of the 28 cases on whom the procedure was done in supine position, 25% (7 cases) developed pneumothorax. Out of the 11 cases on whom the procedure was done in prone position, 18.1% (2 cases) developed pneumothorax. Out of the 11 cases on whom the procedure was done in decubitus position, no case developed pneumothorax.

In this study which comprised of 50 patients, 13 had smoking history of more than 10 years.

Out of the 13 cases who had history of smoking for > 10 years, 5 cases (38.5%) developed pneumothorax and 4 cases (10.8%) did not develop pneumothorax.

Age group	Pneumothorax Present	Pneumothorax Absent
Below 10	-	-
11 to 20	-	1
21 to 30	-	-
31 to 40	0	4
41 to 50	1	8
51 to 60	1	17
61 to 70	5	9
71 to 80	2	2
81 to 90	-	-

Out of the 9 cases who developed pneumothorax, maximum number belonged to age group of 61 to 70 years (7 cases).

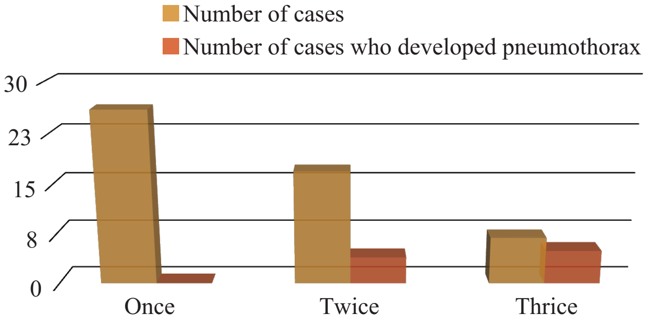

Figure-3: Number of puncture vs. development of pneumothorax

Next came the age group of 71 to 80 years (with 2 cases).

Out of the 50 cases, in 26 cases pleura was punctured only once. In 17 cases pleura was punctured twice. In 7 cases pleura was punctured thrice and in 8 cases pleura was punctured three times.

Out of the 7 cases in whom pleura was punctured three times, 5 cases (71.4%) developed pneumothorax. Out of the 17 cases in whom pleura was punctured twice, 4 cases (23.5%) developed pneumothorax. No case developed pneumothorax when pleura was punctured once.

Out of the 50 cases, 22 cases were done with total puncture time (total time duration in which needle was inside the pleural cavity) of 10 to 15 mins. None of these cases developed pneumothorax. 15 cases were done with puncture time of 16 to 20 mins out of which 4 cases developed pneumothorax. 8 cases were done with puncture time of 21 to 25 mins out of which 5 developed pneumothorax. 5 cases were done with puncture time of 26 to 30 mins out of which 4 developed pneumothorax.

Out of 50 cases in the study, 7 cases who had maximum dimension of 16 to 25 mm, 42.8% (3 cases) developed pneumothorax. Of the 8 cases who had maximum dimension of 26 to 35 mm, 37.5% (3 cases) developed pneumothorax. Of the 11 cases who had maximum dimension of 36 to 45 mm, 18.1% (2 cases) developed pneumothorax. Of the 11 cases who had maximum dimension of 46 to 55 mm, 9% (1 case) developed pneumothorax. cases with lesion maximum dimension of more than 56 mm, did not develop pneumothorax.

Maximum dimension of lesion	Number of cases	Number of cases who developed pneumothorax
16 to 25mm	7	3
26 to 35mm	8	3
36 to 45mm	11	2
46 to 55mm	11	1
56 to 65 mm	11	0
66 to 75 mm	2	0

Out of the total 50 cases in the study, 14 cases had intrapulmonary biopsy path of > 15 mm out of which 50% cases (7 cases) developed pneumothorax. 36 cases had intrapulmonary biopsy path of < 15 mm of which 5.5% cases (2 cases) developed pneumothorax.

Out of the 50 cases included in the study, 17 cases had lesions which were pleura based, of which 2 (11.7%) developed

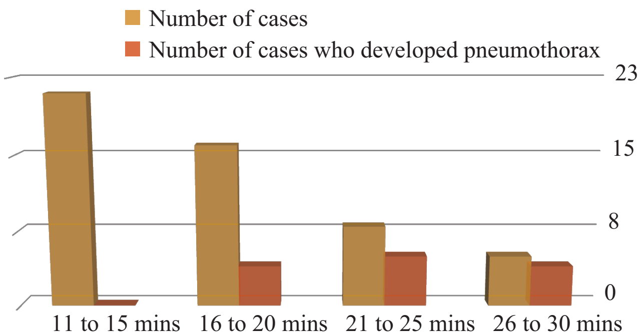

Figure-4: Puncture time vs. development of pneumothorax

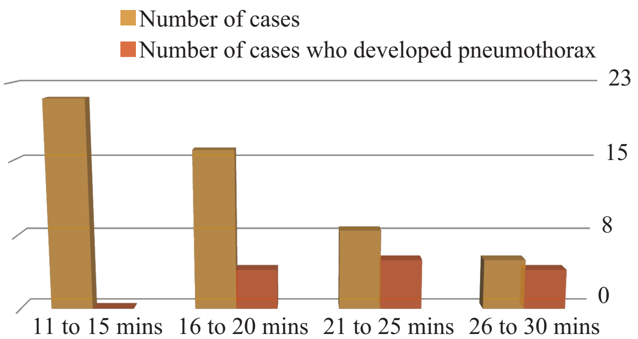

Figure-5: Length of intrapulmonary biopsy tract vs development of pneumothorax

pneumothorax. Rest 33 cases had lesions which were not pleura based of which 7 (21.2%) developed pneumothorax.

Out of the 50 cases included in the study, 26 cases had spiculated margins of which 19.2% (5 cases) developed pneumothorax. Out of the 24 cases with smooth margins, 16.6% (4 cases) developed pneumothorax.

Out of the 50 cases included in the study, the 8 cases with puncture depth of 61 to 70 mm, 37.5% (3 cases) developed pneumothorax, Out of the 12 cases with puncture depth of 51 to 60 mm, 25% (3 cases) developed pneumothorax. Out of the 15 cases with puncture depth of 41 to 50 mm, 13.3% (2 cases) developed pneumothorax. Out of the 14 cases with puncture depth of 31 to 40 mm, 7.1% (1 case) developed pneumothorax. The 1 case with puncture depth of 21 to 30 mm did not develop pneumothorax.

Out of 50 cases included in the study, 10 cases had lesion in right upper lobe, 10 cases had lesion in right middle lobe, 10 cases had lesion in right lower lobe, 10 cases had lesion in left upper lobe and 10 cases had lesion in left lower lobe.

Out of the 10 cases with lesion in right upper lobe, 20% (2 cases) developed pneumothorax. Out of the 10 cases with lesion in right middle lobe, 20% (2 cases) developed pneumothorax. Out of the 10 cases with lesion in right lower lobe, 20% (2 cases) developed pneumothorax. Out of the 10 cases with lesion in left upper lobe, 10% (1 case) developed pneumothorax. Out of the 10 cases with lesion in left lower lobe, 20% (2 cases) developed pneumothorax.

DISCUSSION

Image guided thoracic interventions are the result of advancements in cross sectional imaging. Computed Tomography is the most commonly used imaging modality for thoracic interventions.[1] These minimally invasive thoracic interventions like CT guided transthoracic lung biopsy have become very popular for the diagnosis and management of thoracic lesions and hence more invasive procedures such as thoracoscopy, mediastinoscopy and thoracotomy can be avoided.[1-3]

This study was designed to determine the prevalence of pneumothorax in CT guided lung biopsies done in our hospital and also to find out the various factors affecting it. In this hospital based observational study the total number of cases was 50 of which 33 were males and 17 were females.

The pneumothorax rate from previous articles ranged from 15% to 62%.[1,6,7,9-17] The high range may be attributed to the different gauges of passing needles, differences in the size of lesions, the use of different techniques, and differences in experience. There are some consensus on preventing pneumothorax, including the use of a coaxial method to prevent multiple passes through the pleura, prevention of crossing the fissure, prevention of crossing of pre-existing blebs or bullae, proper patient selection, and use of blood patch after removal of the introducer needle.[21] The factors associated with pneumothorax were analysed in the present study, and the results demonstrated that needle path length from the pleura to target, location of the lesion, and emphysematous lung disease were associated with pneumothorax, which is consistent with previous articles.[11,14,19,20] Other factors mentioned in previous articles include smaller nodules[14,19], larger numbers of puncture[11], and lesion location in the lower lungs.[14]

Prevalence of pneumothorax was 18% (9 cases) in our study. In our study pneumothorax rate was significantly less in comparison to other studies because we adopted various innovative techniques. None of the cases included in our study developed delayed pneumothorax. None of the cases included in our study needed CT tube drainage. All the cases were done in TRU-CUT biopsy needle. We avoided transgressing the pleura multiple times. In most of the cases (86% cases) we transgressed the pleura less than two times only. We did not transgress fissures at all. In most of the cases we tried to take the shortest horizontal route possible for reaching the lesion thereby reducing the traversed intrapulmonary biopsy tract length. For the lesions that were peripherally located but were not abutting the pleura, lignocaine was injected in the extra-pleural space thereby displacing the pleura towards the lung parenchyma containing the lesion so that the distance traversed in reduced. We also avoided doing the procedure in supine position and tried to do as many cases as possible in decubitus position. We speculate that in decubitus position, the biopsy tract collapses on its own by itself by gravity thereby reducing the rate of pneumothorax.

CONCLUSION

In Conclusion, Pneumothorax was found to be more common in males, smokers, older age groups and in patients with underlying emphysema. The factors associated with post-biopsy pneumothorax in the present study were longer needle path length between pleura and the lesion, multiple pleural punctures and with increasing procedure time. Smaller sized and deeper seated lesions also had more occurrence of pneumothorax likely due to direct relation with increasing intrapulmonary biopsy tract length. Superficial sub-pleural lesions had lesser occurrence of pneumothorax. Decubitus Positioning had least (0%) association with Pneumothorax as compared to supine (25%) and prone (18.1%). No clear relation could be established between the margins of the lesion and the risk of pneumothorax. No clear relation could also be established between the location of the lesion and risk of pneumothorax.

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