Original Article

DOI: 10.7860/NJLM/2021/48208.2550

Pathology Section

Image Guided Transthoracic Fine Needle Aspiration Cytology of Mediastinal Masses- An Experience from a Tertiary Care Hospital of Eastern India

KALYANI PRAVA GOUDA[1], UPASANA DAS[2], PRAVAT NALINI ROUTRAY[3], BASANTA MANJARI SWAIN[4]

ABSTRACT

Introduction: Image-guided percutaneous transthoracic needle biopsy of mediastinal masses is usually safe and effective technique for obtaining tissue for diagnosis and early decision can be taken for effective management.

Aim: The purpose of this study was to know the efficacy of different investigative methods for diagnosis of mediastinal masses and to analyse various cytomorphological forms.

Materials and Methods: This was a retrospective observational study conducted at Pandit Raghunath Murmu Medical College, Baripada from January 2019 to June 2020. Retrospective review of all Ultrasonography (USG) and Computed Tomography (CT)-guided percutaneous aspirations of the anterior mediastinum mass. Relevant data regarding patient demographics, imaging characteristics of aspirated masses, presence of complications, and subsequent surgical intervention were collected. Cytology and core biopsy pathology results were recorded. The qualitative data were compared using Chi-square test with Yate's correction.

Results: This study included 35 patients (25 male, 10 female). Highest incidence was noticed in anterior mediastinum (n=26, 74.3%) followed by superior (n=4, 11.4%) and posterior mediastinum (n=3, 8.6%). Most of the cases were malignant (n=28; 80%) and Non Hodgkin Lymphoma (NHL) was most common diagnosis (n=10; 28.6%). Radiology yielded the correct diagnosis in 25 out of 35 patients (71.4%). Core biopsy was obtained in six cases and all the cases were diagnosed cytologically with 100% accuracy. There was statistically significant difference between the radiological and cytological diagnosis. The complication rate was minimal (2/35), both were the case of pneumothorax.

Conclusion: Image-guided percutaneous aspiration is a safe diagnostic procedure with high diagnostic accuracy in aspiration cytology than radiology. Highest diagnostic accuracy was seen in non hodgkins lymphoma and it can potentially obviate more invasive procedures.

Keywords: Computed tomography, Non hodgkins lymphoma, Ultrasonographic

INTRODUCTION

Thoracic cavity is a common site of various non neoplastic and neoplastic pathological entities. As thoracic cavity contains a lot of vital structures, clinicians often find it difficult to obtain samples for diagnosis from appropriate site [1]. Among all mediastinal masses, anterior location is the most common one followed by posterior one. Mostly benign lesions and cysts are seen in middle mediastinum [2]. Blind Fine Needle Aspiration (FNA) procedure has many drawbacks like poor localisation, lower diagnostic accuracy and low cellular yield. As thoracic cavity has many complex vascular structures like great vessels and hilar areas, precise localisation and aspiration is very important.

Image-guided percutaneous transthoracic needle biopsy of mediastinal masses is usually safe and effective technique for obtaining tissue for diagnosis and performed with Computed Tomographic (CT) and Ultrasonographic (US) guidance, because these allow visualisation of biopsy needle in target tissue [3].Though many radiological modalities can detect the lesion, but it is often difficult to distinguish benign and malignant ones. Therefore, a confirmed pathological diagnosis is required for patient management. Samples can be obtained by direct mediastinal approaches like parasternal, paravertebral, transsternal, and suprasternal [4,5].

Haaga JR and Alfidi RJ reported first CT guided biopsy in 1976 [6]. CT enables the pathologists to take adequate sample and it helps for easy diagnosis and improved staging. The clinician has increased chance of effective intervention and the diagnosis can help them to manage the lesion without obvious thoracotomy [7]. So, guided aspiration may avoid surgical procedure and help in non invasive management.

There are certain lesions like lymphoma, thymoma in advanced stage and germ cell tumours that require neoadjuvant treatment before surgical resection [8]. Patients presenting in advanced stage of lung carcinoma are also not suitable for surgeries. To avoid invasive surgery, initial diagnosis by image guided FNA can be done and the patient may be treated accordingly [9]. This is a simple, easy and outpatient procedure by which even small biopsies can be taken without much discomfort to the patient [10].

Complications in this procedure are very infrequent and minor. Though pneumothorax is the principle complication that occurs in guided transthoracic procedure, usually it is self-limited and it can be reduced by minimising the traversing of aerated lung [11]. Again, the seedling of tumour cells in the needle track is rare with incidence of about 0.01% [12].

The objective of the study was to know the efficacy of different investigation methods for diagnosis of mediastinal masses. Before doing surgery, the nature of the lesions can be known by minimally invasive technique. Though CT scan and other imaging modalities are the first investigation of choice, cellular or tissue identification of the lesion is essential for final diagnosis and management.

MATERIALS AND METHODS

This was a retrospective observational study conducted at a tertiary care hospital, Pandit Raghunath Murmu Medical College

and Hospital, Baripada. Data were collected from January 2019 to June 2020 for a period of 1.5 years. The study was conducted in July 2020. All the cases clinically suspicious of anterior mediastinal mass were referred to the Department of Radiodiagnosis for FNA under USG and CT guidance. Total 35 cases were included in the study. Biopsy was taken wherever possible. Informed consent was obtained from all the study subjects.

Inclusion Criteria

- Undiagnosed lung or mediastinal lesions with cough, fever, haemoptysis, previous history of any malignancy.
- Chest roentgenogram showing any lung mass.
- Incidental lung or mediastinal mass in asymptomatic patients.

Exclusion Criteria

- Suspected vascular lesion.
- Patients with high International Normalised Ratio (INR) value.
- Suspected hydatid disease.
- Chronic Obstructive Pulmonary Disease (COPD) with bullae.
- Severe pulmonary hypertension.

As this is a retrospective data based study, so no ethical clearance was obtained. Patient's clinical as well as radiological data were collected from medical records and it was analysed. All cases were reviewed both radiologically and cytologically.

Procedure

A systematic case history, clinical diagnosis, chest radiograph diagnosis, USG and CT scan findings, Fine Needle Aspiration Cytology (FNAC) diagnosis, complications and final diagnosis were maintained in the register. Patients were followed-up till October 2020.

The mass to be aspirated was localised by ultrasound and CT scanning. The aspiration was carried out by trained Pathologist. The site of puncture was marked on the skin. Area was cleaned with antiseptic lotion. The lumber puncture needle of 20 gauge was inserted under image guidance into the lesion by rotating movement. The needle tip was visualised as a white spot or small linear echogenicity. After the confirmation that needle tip is inside the lesion, aspiration was done. In case of larger lesions, periphery of the masses which seemed to be less necrotic, were sampled.

The aspirated material was expelled onto a glass slide, smeared and fixed in 95% ethyl alcohol. Then the smears were stained with papanicolaou's or may-grunwald-giemsa stain and examined in the Cytology Department. At the completion of the aspiration procedure, all the patients underwent expiratory chest radiography to detect pneumothorax. They were monitored for 1-2 hours. In case of specimen inadequacy repeat FNAC was done.

The slides were evaluated based on cytomorphology and background as follows:

- The pattern of arrangement was seen for clusters, singles, nuclear moulding, rosette, acinar and syncytial.
- Nuclear morphology to analyse nuclear membrane, chromatin, nucleoli.
- Cytoplasm for its amount.
- Background for necrotic, inflammatory, clear, mucinous, tigroid and lymphoglandular body.

Reporting was done as unsatisfactory or satisfactory for evaluation as inflammatory, benign and malignant. An 18-20 G cutting needle was used for biopsy. With the help of CT scan, the dimension of the lesion, distance from the skin and the exact site were observed. Skin was disinfected with povidone iodine and injected with 1% lidocaine for local anaesthesia. The needle was inserted during the expiratory apnoea phase of the patient. After inserting the needle, correct position was confirmed by imaging technique. Then the sample was taken from the appropriate site of the lesion, avoiding necrotic and vascular areas. The collected specimen was submitted in the histopathology laboratory in 10% formalin solution for further processing and staining with H&E. Repeat CT scan was done to check for any complication. Patient was kept under observation for 12 hours and then discharged.

STATISTICAL ANALYSIS

All statistical analyses were performed in GraphPad Prism 5.0 (GraphPad Software Inc., San Diego, California). The categorical data were presented in percentage. Chi-square test with Yate's correction was performed to compare the diagnostic performance of the studied methods. Accuracy of the tests was evaluated by deriving the sensitivity, specificity and predictive values. A p-value of <0.05 was considered significant.

RESULTS

In this study, total 35 intrathoracic aspirations were done under radiological guidance. The radiological techniques were CT scan (n=23) and USG (n=12) [Table/Fig-1]. Detail analysis of the data and cytomorphological analysis of cytosmears were done. Core Needle Biopsy (CNB) was obtained in six cases.

Location	Number of cases	CT guided cases	USG-guided cases
Anterior mediastinum	26 (74.3%)	17	9
Posterior mediastinum	3 (8.6%)	2	1
Superior mediastinum	4 (11.4%)	2	2
Lungs	2 (5.7%)	2	-
Total	35 (100%)	23	12

[Table/Fig-1]: Distribution of masses in mediastinum.

Majority of the patients were male (n=25, 71.4%) in comparison to female (n=10, 28.6%). The youngest one was 15-year-old girl and the oldest being 95-year-old male. Maximum number of patients (n=16, 45.7%) presented between >40 to 60 years of age followed by 20 to 40 years of age (n=12, 34.3%) [Table/Fig-2].

According to location, anterior mediastinal mass constituted the highest incidence (n=26; 74.3%) followed by superior mediastinal (n=4; 11.4%) and posterior mediastinal (n=3, 8.6%). Two cases (n=2, 5.7%) were from lungs [Table/Fig-1].

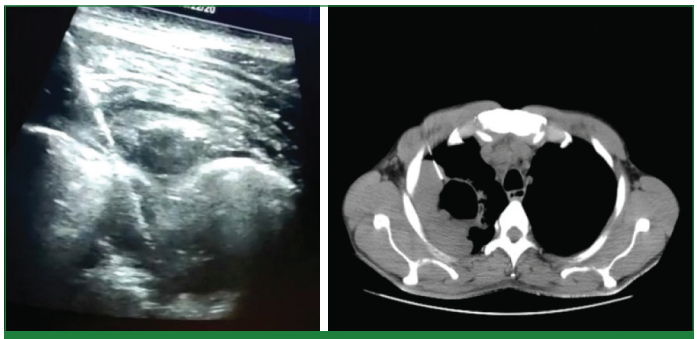
Out of 35 cases, 28 cases (80%) were diagnosed as malignant. A total of four cases were benign thymoma and rest three were inflammatory lesions (two tubercular and one inflammatory). Out of all 28 malignant cases, they were categorised under different diagnosis [Table/Fig-2].

Various types of cytological diagnosis were made in intrathoracic aspirations [Table/Fig-3,4]. Among the cytological types malignant lesions outnumbered the benign lesions. The most common type of malignancy was Non Hodgkin Lymphoma (NHL) (n=10; 28.6%) followed by metastatic adenocarcinomatous deposits in the mediastinal lymph node (n=4; 11.4%). Metastatic poorly differentiated carcinoma and round cell tumors followed by metastatic squamous cell carcinomatous deposits in the mediastinal lymph nodes were the next common lesions. Round cell tumour and germinoma were more common in younger age group. Two liposarcoma cases were observed in 40 to 60 years of age. The most common type of benign tumour was thymoma (n=4; 11.4%). One malignant thymoma was diagnosed in the anterior mediastinum [Table/Fig-2]. Lungs showed one small cell carcinoma from right side upper lobe with mediastinal lymph node involvement, right side pleural effusion and one round cell tumour from left side upper lobe. Inflammatory condition was observed in three cases out of which two were tubercular in nature.

All the cases were divided into different groups like carcinoma, sarcoma and non carcinoma cytologically. Carcinoma group composed of metastatic squamous, metastatic adenocarcinoma

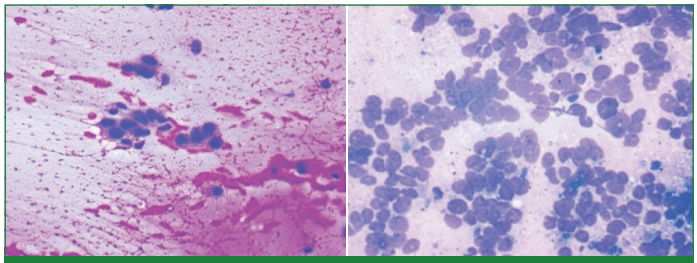
Lesion	No. of cases	<20	20-40	>40-60	>60	Male	Female
Poorly differentiated carcinoma	3 (8.5%)			2	1	2	1
Metastatic adenocarcinoma	4 (11.4%)			3	1	3	1
Metastatic squamous cell carcinoma	2 (5.7%)		1	1		2	
Small cell carcinoma	2 (5.7%)			2		2	
Non hodgkin lymphoma	10 (28.6%)		6	3	1	8	2
Liposarcoma	2 (5.7%)			2			2
Germ cell tumour	1 (2.8%)		1			1	
Round cell tumour	3 (8.5%)		3			2	1
Thymoma	4 (11.4%)		1	2	1	4	
Malignant thymoma	1 (2.8%)			1		1	
Tubercular Lesion	2 (5.7%)	2					2
Inflammatory Lesion	1 (2.8%)	1					1
Total	35 (100%)	3 (8.6%)	12 (34.3%)	16 (45.7%)	4 (11.4%)	25 (71.4%)	10 (28.6%)

[Table/Fig-2]: Distribution of different mediastinal masses in different age groups and gender.

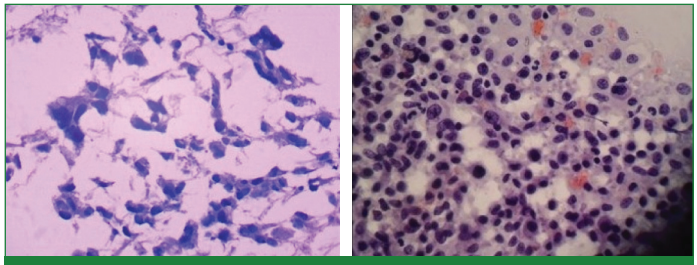


[Table/Fig-3]: USG guided aspiration of mediastinal mass by intercostal approach; **[Table/Fig-4]:** Percutaneous CT guided lung biopsy, right upper lobe. (Images from left to right).

[Table/Fig-5], poorly differentiated carcinomatous deposit in the mediastinal nodes and small cell lung carcinoma [Table/Fig-6]. Liposarcoma was diagnosed due to the presence of atypical adipocytes and lipoblasts over a fatty background [Table/Fig-7]. In non carcinomatous group, tumours include NHL, thymoma, malignant thymoma and germ cell tumour. Cytosmear of NHL showed dispersed monotonous population of cells with coarse granular chromatin and lymphoid globules in background [Table/Fig-8]. In case of thymic neoplasm, cohesive tissue fragments of oval to spindle epithelial cells admixed with lymphoid cells were seen. Germinoma showed large cells present in dispersed manner with prominent nucleoli over a tigroid background.



[Table/Fig-5]: Presence of mucin secreting adenocarcinoma cells (May Grunwald-Giemsa (MGG) stain X400); **[Table/Fig-6]:** Small cell carcinoma (MGG stain X400) (Images from left to right)



[Table/Fig-7]: Smear shows liposarcoma (MGG X400); **[Table/Fig-8]:** Presence of atypical lymphoid cells (MGG X400). (Images from left to right)

Out of 35 cases, radiological diagnosis was similar with cytological diagnosis in 25 cases (71.4%). Discordance in radiological diagnosis was seen in 10 (28.6%) cases. Four cases of round cell tumours were not correctly identified, whereas three cases of carcinoma and two thymomas were incorrectly diagnosed radiologically. One liposarcoma case was also incorrectly diagnosed. Radiological diagnosis was 100% matched with cytology in lymphoma cases. The sensitivity was 58.33, specificity was one, positive predictive value was 1.00(100%) and negative predictive value was 0.2857 (28%). Diagnostic performance of cytology was promising comparing the radiological methods with a significant difference of p-value of 0.0021 and OR 29.24 [Table/Fig-9].

Diagnostic methods	Positive	Negative	Sensitivity (95% CI)	Specificity (95% CI)	OR (95% CI)
FNAC	35	0	58.33	1	29.24
CT and USG	25	10			

[Table/Fig-9]: Diagnostic accuracy analysis between cytological and radiological investigations.
OR: Odds ratio; CI: Confidence interval; p-value <0.05

Only six cases were submitted for histological diagnosis. Three cases of benign thymoma and three cases of Non Hodgkins Lymphoma were diagnosed by CNB. All the six cases were diagnosed cytologically with 100% accuracy. Complication like pneumothorax developed in 5.71% cases and patients were managed conservatively.

DISCUSSION

In the management of intrathoracic lesions, the decision depends upon clinical features, CT/USG findings and tissue diagnosis. Though radiologically we can predict the tumour type and extension, tissue diagnosis is utmost important to differentiate between benign and malignant lesions. Again, blind FNA procedure is not advisable in the thoracic cavity. So, guided procedures localise the lesion and adequate materials are obtained. Image guided FNAC of intrathoracic lesions is mainly useful for localised lesions of lung rather than diffuse parenchymal lung disease [13]. Now-a-days, although neoadjuvant chemotherapy is a preferred mode of treatment, still it requires pre-diagnosis which can be obtained by guided fine needle cytological procedures and CNB, which provide a better diagnostic yield. Literatures have shown that CT guided FNAC and biopsy had a diagnostic accuracy ranging from 65-97% in lung nodules [14,15]. The goal of this study was to find out better diagnostic accuracy in FNA as compared to radiological investigations and also to analyse different lesions of lungs and mediastinum cytomorphologically.

Chest radiography has limited role in characterising mediastinal lesions and its precise location. Multi detector CT is an important imaging modality for location, morphology, anatomical extent and

pattern of contrast enhancement in mediastinal lesions. Location and tissue characterisation on imaging are critical to narrow down the differential diagnosis of mediastinal masses [16]. Advantages of US guidance include real-time, continuous monitoring of the needle during advancement and sampling, also it can be performed at the bed side of critically ill patients [17].

A practical approach in distinguishing different mediastinal lesions based on CT attenuation value like attenuation of air, fat, soft tissue, water and calcium. Multiplanar reformation images display the detailed anatomical relationship of the tumour with the adjacent structures. Imaging findings, clinical features along with laboratory data not only enable a reasonably narrow differential diagnosis, but also provide a guide to diagnostic interventions.

To avoid pneumothorax risk, USG or CT assistance is preferred for putting the needle in the mediastinal lesion. Transpulmonary approach, which involves transgression of the lung and visceral pleura by the needle is associated with a substantial risk of pneumothorax and generally used for biopsy of lesions that are not accessible with an extrapleural approach [18].

In the present study, the epidemiological data was similar to other studies with an age range of 15-95 years and a male to female ratio 2.5:1. In the study by Knudsen DU et al., age range was from 17-84 years [19]. Out of the lesions diagnosed as malignant, lymphoma (24.1%) was the most common one and metastatic adenocarcinoma was the second most common lesion. In the study, according to Kalhan S et al., adenocarcinoma was the most common and Konjengbam R et al., showed squamous cell carcinoma as the most common lung neoplasm [20,21]. Khouri NF et al., conducted a study and out of 116 cases, 10.3% cases were diagnosed as lymphoma [22]. Yu C et al., found that correct histological diagnosis with USG guided aspiration biopsy alone is lower in thymoma (55%) and lymphoma (30%), but higher in lung cancer (67%) and metastatic cancer (78%) [23].

Present study revealed, 74.3% cases were in the anterior mediastinum. Alder OB et al., and Shrestha M et al., also observed anterior mediastinal predominance [24,25]. Out of the benign tumours, thymoma is the most common presentation (50%) and there was one thymic carcinoma. Two tubercular granulomas were diagnosed correctly by cytology. The patients were followed-up and they responded to antitubercular treatment.

Differentiating mature and immature teratoma on imaging is difficult. Both the lesions appear as well defined loculated cystic mass with characteristic fat fluid level and calcifications [26]. Presence of foetal tissue or neuroendocrine tissue can differentiate these two lesions and helpful in prognosis. Takahashi K and Al-Janabi NJ suggested, even mature teratoma may present as a nonspecific cyst without fat or calcium content in 15% cases [16]. Another limitation in imaging technique is the presence of calcification of different forms like punctate, coarse or curvilinear which is unable to distinguish benign from malignant lesions [26].

Thymic cyst on CT appears as a well-defined water attenuation lesion may be unilocular or multilocular, but when complicated by haemorrhage or infection, it may resemble a solid mass with higher CT attenuation. Other fluid attenuating lesions include lymphangioma, bronchogenic cyst, and pleuropericardial cyst.

The soft tissue attenuating mediastinal lesions predominantly include thymic neoplasm, thymic hyperplasia, germ cell tumours and lymphadenopathies. Thymic hyperplasia usually appears as symmetric diffuse enlargement of the gland. Asymmetric enlargement raises the possibilities of a thymoma. On CT, presence of convex round thymus with an irregular margin and heterogeneous contrast enhancement with associated necrosis, haemorrhage, cystic changes and calcifications suggest possibilities of malignancy [27].

Primary lymphoma accounts for 20% mediastinal neoplasm in adults and 50% in children and usually in anterior mediastinum. Lymphoma appears as a homogenous soft tissue mass in anterior mediastinum with surface lobulations and mild to moderate contrast enhancement [16]. Fat attenuation lesions predominantly include lipoma, liposarcoma, mediastinal lipomatosis, thymolipoma and teratoma. On CT, lipoma has a homogenous fat attenuation, well-defined margin and with no contrast enhancement whereas liposarcoma has an aggressive imaging appearance with fat, soft tissue density and in homogeneous enhancement patterns [19].

Cytomorphologically, the differential diagnosis of large cells was diffuse large cell lymphoma, germ cell tumours, poorly differentiated carcinoma and B1 and B2 thymomas. They were differentiated based on their cellular arrangement, presence of any epithelial component, nuclear characters, presence of nucleoli and background. Small cell lymphomas were differentiated from small cell carcinoma due to the presence of lymphoglandular bodies, dyscohesive pattern of arrangement, condensed chromatin and absence of nuclear moulding. In case of poorly differentiated metastatic carcinomas, clinical history and serum markers were correlated. Benign lesions were usually haemorrhagic and had low cellularity. Multiple aspirations were done in some cases to rule out any malignancy.

The findings of each case both cytologically and radiologically were compared. The degree of agreement was seen in 71.4% cases by considering the cytological diagnosis as standard. Piplani S et al., study found 89.2% agreement between radiology and cytology [28]. The statistical value was also significant ($p<0.05$) considering higher diagnostic rate in cytology than radiology.

The cytological diagnosis showed 100% diagnostic accuracy histologically in all six cases. According to Nasit JG et al., the FNAC and CNB showed no statistical difference while diagnosing carcinoma from non carcinoma group [29]. So, initially FNAC can be done in suspected malignant cases where further biopsy may not be required for the treatment. In case of inadequate material, CNB can be done. In CNB, needle is introduced at one point of the lesion. If it is cellular, adequate material is obtained. But if the tumour is necrotic at center, representative sample may not be obtained if the cutting needle hits the necrotic area. In contrast, in guided aspiration the needle can be rotated and samples can be taken from multiple areas including edge and center [29]. In the present study as the biopsies were performed in solid tumours, adequate material was obtained in both the procedures. The cytological diagnoses were matched histologically.

Limitation(s)

The patients were reluctant for biopsy procedures once they had been diagnosed with malignancy and preferred to visit higher centers for the treatment. Though histopathology is the gold standard, as a new medical college, CNB was performed only in selected cases.

CONCLUSION(S)

Radiological image guided FNAC is technically simple, rapid, cost-effective, outpatient procedure and an accurate way to diagnose neoplastic and non neoplastic lesions of mediastinum and lung. NHL and advanced metastatic lung carcinomas do not require surgery. So, it will help the clinician without performing thoracotomy to take rapid management decisions. It also boasts a low rate of complications. Skill and experience are the two most important parameters to achieve satisfactory results in demonstration of benign and malignant lesions.

REFERENCES

[1] Sarjer RN, Rabbi AF, Hossain A, Quddus MA, Chowdhury N, Sarker T, et al. Computed tomography guided transthoracic fine needle aspiration cytology in the diagnosis of sonographically non-approachable intrathoracic masses-A study of 100 cases. J Dhaka Med Coll. 1970;20(1):25-31.
[2] Dalal UR, Dalal AK, Kartik A, Saini V, Anand L. Clinicopathologic profile of Primary Mediastinal masses: Our experience. J Surg Anaesth. 2020;10:35248/2684-1606.
[3] Dixit R, Shah NS, Goyal M, Patil CB, Panjabi M, Gupta RC, et al. Diagnostic evaluation of mediastinal lesions: Analysis of 144 cases. Lung India. 2017;34(4):341-48.

[4] Dasgupta S, Bose D, Bhattacharyya NK, Shah M, Biswas K, Biswas PK. A clinicopathological study of Mediatinal masses operated in a tertiary care hospital in Eastern India in 3 years with special reference to thymoma. Indian J Pathol Microbiol. 2016;59:20-24.
[5] Date H. Diagnostic strategies for mediastinal tumours and cysts. Thorac Surg Clin. 2009;19(1):29-35, vi.
[6] Haaga JR, Alfidi RJ. Precise biopsy localisation by computer tomography. Radiology. 1976;118(3):603-07.
[7] Ghaye B. Dondelinger RF. Imaging Guided thoracic interventions. Eur Resp J. 2001;17(3):507-28.
[8] Korst RJ, Bezjak A, Blackmon S, Choi N, Fidias P, Liu G, et al. Neoadjuvant chemoradiotherapy for locally advanced thymic tumours: A phase II, multi-institutional clinical trial. J Thorac Cardiovasc Surg. 2014;147(1):36-44, 46.e1.
[9] Mukherjee S, Bandyopadhyay G, Bhattacharya A, Ghosh R, Barui G, Karmakar R. Computed tomography-guided fine needle aspiration cytology of solitary pulmonary nodules suspected to be bronchogenic carcinoma: Experience of a general hospital. J Cytol. 2010;27(1):8.
[10] Mondal SK, Nag D, Parikh B, Shah M, Davara K. Computed tomogram guided fine-needle aspiration cytology of lung mass with histological correlation: A study in Eastern India. South Asian J Cancer. 2013;02(01):014-18.
[11] Gupta A, Mrigpuri P. Assessment of clinicoradiological correlation with Ct guided FNAC of different lung lesions: A hospital-based study. International J Contemp Med Res. 2017;4(6):1290-93.
[12] Singh GR, Kumar A, Agrawal R, Kumar B, Singh KK, Sinha AK et al. Diagnostic accuracy of Computed Tomography- guided fine Needle aspiration cytology of thoracic mass lesions- A study of 33 cases. International J Biomed Adv Res. 2017;8(01).
[13] Abraham AE, Suresh PK, Sridevi HB, Sahu KK, Adiga D, Minal J, et al. Image-guided fine needle aspiration cytology of intrathoracic lesions. J Cytol. 2019;36(2):106-10.
[14] Madan M, Bannur H. Evaluation of fine needle aspiration cytology in the diagnosis of lung lesions. Turk Patoloji Derg. 2010;26(1):1.
[15] Desai F, Shah M, Patel S, Shukla SN. Fine needle aspiration cytology of anterior mediastinal masses. Indian J Pathol Microbiol. 2008;51(1):88-90.
[16] Takahashi K, Al-Janabi NJ. Computed tomography and magnetic resonance imaging of mediastinal tumours. J Magn Reson Imaging. 2010;32(6):1325-39.
[17] Toloza EM, Harpole L, Detterbeck F, McCrory DC. Invasive staging of non-small cell lung cancer: A review of the current evidence. Chest. 2003;123(1 Suppl):157S-166S.
[18] Molinari F, Bankier AA, Eisenberg RL. Fat-containing lesions in adult thoracic imaging. AJR Am J Roentgenol. 2011;197(5):W795-813.
[19] Knudsen DU, Nielsen SM, Hariri J, Christensen S. Ultrasonographic guided fine needle aspiration biopsy of intrathoracic tumours. Acta Radiol. 1996;37:327-31.
[20] Kalhan S, Sharma P, Sharma S, Dudani S, Ramakrishnan T, Chowdhry A. Evaluation of precision of guidance techniques in image guided fine needle aspiration cytology of thoracic mass lesions. J Cytol. 2012;29(1):06-10.
[21] Konjengbam R, Singh N, Gatphoh S. Computed tomography guided percutaneous transthoracic fine needle aspiration cytology of pulmonary mass lesions: Two years cross sectional study of 61 cases. J Med Soc. 2014;28(2):112.
[22] Khouri NF, Stitik FP, Erozan YS, Gupta PK, Kim WS, Scott WW Jr, et al. Transthoracic needle aspiration biopsy of benign and malignant lung lesions. AJR Am J Roentgenol. 1985;144(2):281-88.
[23] Yu CJ, Yang PC, Chang DB, Wu HD, Lee LN, Lee YC, et al. Evaluation of ultrasonically guided biopsies of mediastinal masses. Chest. 1991;100(2):399-405.
[24] Alder OB, Rosenberger A, Peleg H. Fine Needle Aspiration Biopsy of mediastinal Masses: Experiences. AJR. 1983(140).
[25] Shrestha M, Karki S, Sayami G. Evaluation of intrathoracic lesions by image guided fine needle aspiration cytology. J Pathol Nepal. 2019;9(1):1464-68.
[26] Rosado-de-Christenson ML, Templeton PA, Moran CA. From the archives of the AFIP. Mediastinal germ cell tumours: Radiologic and pathologic correlation. Radiographics. 1992;12(5):1013-30.
[27] Sadohara J, Fujimoto K, Müller NL, Kato S, Takamori S, Ohkuma K, et al. Thymic epithelial tumours: Comparison of CT and MR imaging findings of low-risk thymomas, high-risk thymomas, and thymic carcinomas. Eur J Radiol. 2006;60(1):70-79.
[28] Piplani S, Mannan R, Lalit M, Manjari M, Bhasin TS, Bawa J. Cytologic-radiologic correlation using transthoracic CT-Guided FNA for lung and mediastinal masses: Our experience". Anal Cell Pathol. Amst. 2014;2014:343461.
[29] Nasit JG, Patel M, Parikh B, Shah M, Davara K. Anterior mediastinal masses: A study of 50 cases by fine needle aspiration cytology and core needle biopsy as a diagnostic procedure. South Asian J Cancer. 2013;2(1):07-13.

PARTICULARS OF CONTRIBUTORS:
1. Associate Professor, Department of Pathology, PRM Medical College, Baripada, Odisha, India.
2. Assistant Professor, Department of Pathology, PRM Medical College, Baripada, Odisha, India.
3. Assistant Professor, Department of Radiology, PRM Medical College, Baripada, Odisha, India.
4. Professor, Department of Radiology, PRM Medical College, Mayurbhanj, Odisha, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Upasana Das,
Assistant Professor, Department of Pathology, PRM Medical College, Rangamatia, Baripada, Odisha, India.
E-mail: drupasana80@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Apr 01, 2021
- Manual Googling: Jul 10, 2021
- iThenticate Software: Aug 01, 2021 (16%)

ETYMOLOGY: Author Origin

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? No
- Was informed consent obtained from the subjects involved in the study? No
- For any images presented appropriate consent has been obtained from the subjects. No

Date of Submission: **Jan 02, 2021**
Date of Peer Review: **Feb 15, 2021**
Date of Acceptance: **Jul 20, 2021**
Date of Publishing: **Oct 01, 2021**