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Morphological spectrum of mediastinal lesions with special emphasis on evaluation of needle biopsy: An experience from a tertiary care hospital

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***Background & objectives*: Mediastinal lesions are uncommon and are infrequently encountered in routine clinical practice. Hence, there is a need for more elaborate studies of mediastinal lesions to make the pathologists and clinicians aware of the large spectrum of these lesions. The present study describes the histomorphological spectrum of various mediastinal lesions in a tertiary care hospital in India, along with the discussion of some unusual and interesting cases. Considering the limited diagnostic material obtained in guided biopsies, the adequacy of such tissue for providing a definite opinion was also evaluated.**

***Methods*: This was a retrospective study performed on 125 mediastinal masses diagnosed on surgically resected specimens as well as needle biopsies over a period of two years (January 2012-December 2013). A few cases had inadequate diagnostic material, making a total of 116 cases which were further evaluated.**

***Results*: A total of 116 patients of mediastinal lesions were included in the study. Most of the lesions were in 21-30 yr age group, with male:female ratio of 1.7:1. Anterior mediastinal compartment was most commonly involved. Majority of the cases (62.1%) were of neoplastic nature, with benign tumours (34.5%) being more common than malignant ones (27.6%). Thymoma followed by lymphoma constituted the most common mediastinal tumours. One-third of the total cases were diagnosed on needle biopsy samples. All cases where needle biopsy was followed by resection specimen showed concordant diagnosis. The percentage adequacy of biopsy was 91.7 per cent and the diagnostic accuracy was 100 per cent.**

***Interpretation & conclusions*: This study provides the histomorphological spectrum and biological diversity of the mediastinal lesions. It also emphasizes that biopsy is sufficiently adequate, with the help of a comprehensive immunohistochemistry panel, for providing a definite diagnosis in majority of cases.**

Key words Lymphoma- mediastinum - morphological spectrum - needle biopsy - sarcoma - thymoma

Mediastinum is an extrapleural space located between the pleural cavities extending sagittally from the thoracic inlet to the diaphragm and anteroposteriorly from the sternum to spine. Compartmentalization of this topographic site into anterior, middle and posterior compartments is useful in understanding the diversity

of pathologic processes that characterize this space. Primary mediastinal tumours are uncommon[1]. While clinical judgement in combination with radiographic imaging can often narrow the diagnostic possibilities, a definitive pathological diagnosis is required before initiating therapy, especially in cases where surgical resectability is questionable. These lesions are not frequently encountered in routine practice. However, advent of new techniques has made it easier to obtain tissue material from this site. It is therefore, important for a pathologist to be familiar with the wide variety of lesions in the mediastinum. The present study describes the histomorphological spectrum of various mediastinal lesions in a tertiary care hospital in north India.

Material & Methods

This was a retrospective, hospital-based study performed on all mediastinal masses over a period of two years (January 2012-December 2013) in Sir Ganga Ram Hospital, New Delhi, India. The data were retrieved from the archives of pathology department. A total of 125 cases were retrieved in this period. All cases diagnosed on surgically resected specimens as well as needle biopsies were included in the study. Non-surgical [ultrasonography (USG) or computed tomography-guided trucut biopsy] and surgical approaches (excisional and incisional biopsy) were used for achieving tissue diagnosis. Excisional biopsy was used for lesions, which were non-invasive and appeared to be completely resectable on imaging. These lesions were directly excised by various surgical approaches such as video-assisted thoracoscopic surgery, robotic-assisted thoracoscopic surgery or open surgery. For suspected malignant lesions or lesions with questionable resectability on imaging, a non-surgical image-guided trucut biopsy was employed first. In case a definitive diagnosis was not achieved, an incisional biopsy was undertaken through mediastinoscopy or video-assisted thoracic surgery or open surgery.

Lesions arising from the pleura, pericardium and chest wall structures such as ribs and vertebrae were not included. Hence, of a total of 125 cases, six cases (angiosarcoma of the pericardium, giant cell tumour of vertebra, chondrosarcoma of rib, leiomyosarcoma of pleura, solitary fibrous tumour of pleura and malignant mesothelioma) were excluded. In two cases, sample was inadequate for opinion while one case showed extensive (post-chemotherapy) necrosis without any viable cell. Therefore, the remaining 116 cases were included and further evaluated.

Relevant clinical information that included age and sex of the patients and compartment location of the lesions was recorded for all cases. Detailed information including signs, symptoms and other ancillary findings that were of clinical or conceptual interest such as radiological data and per-operative findings was recorded from the patients' files in selected cases. Haematoxylin and eosin stained slides along with immunohistochemistry (IHC), wherever available, were studied. Special emphasis was awarded to a few cases of particular interest, which were either common differentials in mediastinal lesions or posed a diagnostic challenge to the pathologist.

The study protocol was approved by the Ethics Committee of Sir Ganga Ram Hospital, New Delhi.

Statistical analysis: Descriptive statistics was analyzed with SPSS version 17.0 software (SPSS South Asia, Bengaluru, India). Continuous variables were presented as mean ± standard deviation. Categorical variables were expressed as frequencies and percentages and were analyzed using Chi-square analysis.

Results

A total of 116 patients of mediastinal lesions were included in the study. Age of the patients ranged from three months to 75 yr, with a mean age of 41.14 ±18.98 yr and median age of 40 yr. Most of the lesions (26/116, 22.4%) were seen in 21-30 yr age group (Fig. 1). The patients were divided into paediatric (<15 yr), adult (15-60 yr) and geriatric (>60 yr) age groups with respect to broad type of lesions, *i.e.* benign, malignant and non-neoplastic (Fig. 2). Nine (7.8%) patients were in paediatric, 83 (71.6%) in adult and 24 (20.7%) in geriatric age group. Seventy three (62.9%) were males and 43 (37.1%) were females, with male:female ratio of 1.7:1.

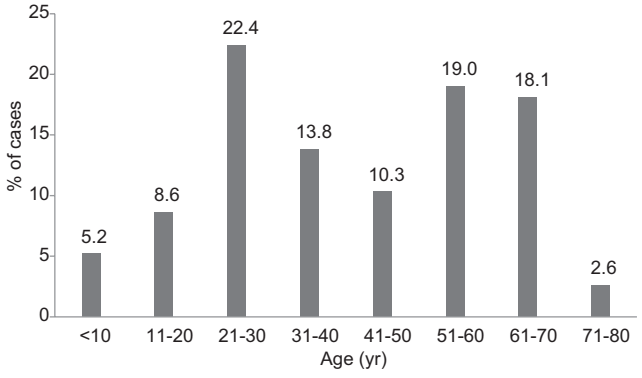

Fig. 1. Age distribution of primary mediastinal lesion.

Most of the mediastinal lesions were primary in origin, except two cases of metastatic carcinoma and a single case of systemic lymphoma having generalized lymphadenopathy with secondary mediastinal involvement. Seventy two (62.1%) cases were of neoplastic nature while 44 (37.9%) were non-neoplastic. Of the total 116 cases, benign tumours were found in 40 (34.5%) patients, while 32 (27.6%) had malignancy. The frequency of malignancy was significantly higher in male population (38.4%) as compared to females (9.3%) (P=0.001).

Compartment localization of the lesions was available in 97 (83.6%) cases (Table I). Most of the lesions were in anterior mediastinum (68/97, 70.1%), followed by 19 (19.6%) in posterior, six (6.2%) in superior and four (4.1%) in middle compartment. In the remaining 19, where information regarding the compartment was not available, they belonged to lymphoma (6), thymoma (2), sarcoma (2), benign neural tumour (2), mediastinal cysts (2), other thymic lesions (1), germ cell tumour (GCT) (1), metastasis (1) and miscellaneous (2) category. Of the total 32 malignant cases, compartment information was available in 22 cases. As most of the cases were present in the anterior compartment, accordingly maximum number of malignant tumours (15/22) was also found in the same compartment.

Of the total 116 lesions, 33 (28.45%) were diagnosed on guided biopsy and 77 (66.38%) on excised specimens. A total of 36 guided biopsies were received, three of which had inadequate material. Hence, the percentage adequacy of biopsy (procurement rate) was 91.7 per cent. Thirty three biopsies were evaluated and final diagnosis was achieved in all the cases, making a diagnostic accuracy of 100 per cent. In one non-Hodgkin's lymphoma (NHL) case, further subtyping and categorization was not possible on needle biopsy. Therefore, lymph node excision biopsy was sought for and the final diagnosis of NHL, null cell type was given. In six (5.17%) cases, biopsy was followed by surgical excision specimen, and in all cases, biopsy diagnosis was confirmed on histopathological specimen (Table II).

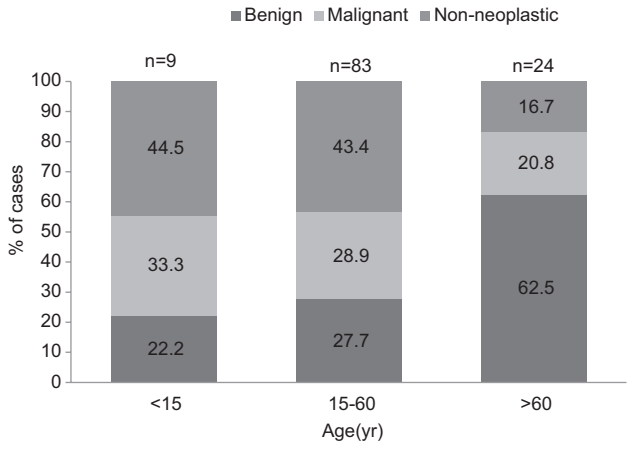

Fig. 2. Relation between age groups and type of mediastinal lesions.

Mediastinal lesions displayed a wide histomorphological spectrum. Thymic epithelial lesions constituted a total of 53 (45.7%) cases, of whom 25 were of thymoma and three were of thymic carcinoma. Atrophic or involuting thymus, thymic follicular hyperplasia, thymic cyst and a single case of thymic haemangioma formed the remaining 25 cases. Most of the thymic lesions were present in anterior compartment (except one case each of thymoma and thymic carcinoma, which had recurrence in posterior compartment). Moreover, of all the lesions present in anterior compartment, thymic epithelial lesions constituted 70.6 per cent (48/97). All the thymic lesions were seen exclusively in adults and elderly, except for a single case of thymic hyperplasia in a child of nine years of age. The most common thymoma was of type B2. There was one case of thymic haemangioma in a 62 yr old woman who presented to thoracic surgery for evaluation of chest pain and weakness for the last two months. Radiology showed anterior mediastinal mass suggestive of thymoma. Thoracoscopic radical thymectomy was done. Resected mass was well encapsulated and measured 7 cm in maximum diameter and weighed 60 g. Cut surface was dark tan, spongy and congested (Fig. 3A). Histology showed numerous, closely packed blood-filled cavernous channels. These were lined by uniform looking endothelial cells (Fig. 3B). Thymic tissue was identified at the periphery embedded in the fat attached to the mass.

Lymphomas were the second most common tumour (11.2%) after thymoma. NHL was seen in

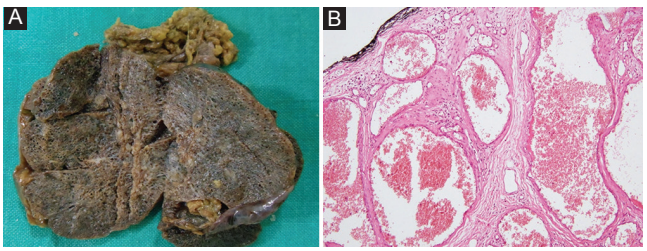

Fig. 3. (A) Thymic haemangioma; Gross: well-encapsulated mass having dark tan and spongy cut surface. **(B)** Section shows numerous, closely packed congested cavernous channels lined by uniform looking endothelial cells (H & E, ×200).

Table I. Distribution of lesions in the compartments

Diagnosis	Number of cases within each compartment				Total
	Anterior	Middle	Posterior	Superior	
Thymic epithelial lesions*	48	0	2	0	50
Lymphoma**	7	0	0	0	7
Sarcoma	2	1	3	0	6
GCT	3	0	0	0	3
Benign neural	0	1	5	0	6
Cysts	0	1	5	0	6
Others***	8	1	4	6	19
Total count	68	4	19	6	97

*23 cases of thymoma, 3 thymic carcinoma and 24 other lesions (atrophic or involuting thymus, thymic follicular hyperplasia, thymic cyst); **2 cases of NHL, 5 HL; ***9 cases of granulomatous lymphadenitis, 1 metastasis, 9 miscellaneous. NHL, non-Hodgkin's lymphoma; HL, Hodgkin's lymphoma; GCT, germ cell tumour

Table II. Diagnosis and biopsy type of lesions

Diagnosis	Specimen type			Total
	Needle biopsy	Excision biopsy	Needle biopsy followed by excision biopsy	
Thymoma	1	20	4	25
Thymic carcinoma	0	3	0	3
Other thymic	0	25	0	25
NHL	7	0	1	8
HL	5	0	0	5
Sarcoma	3	5	0	8
GCT	1	3	0	4
Benign neural	2	5	1	8
Cysts	0	8	0	8
Granulomatous	9	0	0	9
Miscellaneous	3	8	0	11
Metastatic	2	0	0	2
Total	33	77	6	116

NHL, non-Hodgkin's lymphoma; HL, Hodgkin's lymphoma; GCT, germ cell tumour

eight (6.9%) patients and Hodgkin's lymphoma (HL) in five (4.3%). Overall, the most common age group with lymphomas was between 20 and 30 yr with male:female ratio of 5.5:1. Anterior compartment was most commonly involved. In NHL category, six cases were of primary mediastinal B-cell lymphoma (PMBCL) type with a single case each of NHL-null cell type (paediatric case) and angioimmunoblastic T-cell lymphoma (elderly patient). The latter case was a systemic lymphoma with secondary mediastinal involvement. All the cases of HL belonged to nodular sclerosis (NScHL) type.

Sarcoma was seen in eight (6.9%) male patients. Compartment localization showed a random distribution. The spectrum of sarcoma included three cases of rhabdomyosarcoma (RMS), two malignant peripheral nerve sheath tumours (MPNST), two malignant fibrous histiocytoma (MFH) and one case of synovial sarcoma (SS). Both cases of MFH were seen in elderly, two of the RMS cases were present in paediatric patients while rest all were seen in adults. The challenging case of SS presented in a 58 yr old man who presented with chest pain, cough and dyspnoea. Contrast-enhanced CT of the chest showed

a well-defined, sharply demarcated soft-tissue density lesion along the vascular structures and the right border of heart in the anterior mediastinum. There was gross thickening of the right-sided pleura, with calcification (Fig. 4A). Grossly, the mass was adherent to the lung and measured 12 × 8 cm. Cut surface of the tumour was grey-white and fleshy (Fig. 4B). Microscopy showed the tumour to be composed predominantly of fascicles of monotonous spindle-shaped cells with stray small glandular structures which were highlighted with cytokeratin (CK) (Fig. 4C & D). The possibility of spindle cell thymoma and SS was considered and a panel of IHC markers comprising vimentin, CK, epithelial membrane antigen (EMA), bcl-2 and CD99 was performed. The spindle cells were positive for vimentin, EMA, CD99 and bcl-2 and negative for CK. Hence, spindle cell thymoma was ruled out and final diagnosis of biphasic SS of mediastinum was made.

GCT occurred in four patients and comprised two cases of mature cystic teratoma and one case each of immature teratoma and seminoma. GCT showed preference for young male patients and anterior mediastinal location. An extremely rare case of mature cystic teratoma with islet cell hyperplasia was seen in a 13 yr old boy, being evaluated for chest pain. Radiology showed a heterogeneously enhancing mass in the anterior mediastinum with areas of fat attenuation and calcification, suggesting the possibility of teratoma (Fig. 5A). USG of the abdomen and testes was normal and the serum alpha-fetoprotein and beta-human chorionic gonadotropin levels were within normal limit. Per-operatively, the tumour was seen arising from the left half of thymus. The mass was resected and submitted for histopathological examination. It was well encapsulated and measured 8 × 5 × 4 cm. On cut section, the mass showed solid cystic areas. The tumour was sampled extensively. Microscopy showed the tumour to be composed of mature and differentiated tissue derived from all the three germ layers. In addition, many foci showed pancreatic tissue with reversal of its normal architecture. A large number of variably sized and irregular islands of islets cells, haphazardly admixed with acini were present (Fig. 5B & C). These cells were positive for synaptophysin (Fig. 5D). Thus, a final diagnosis of mature cystic teratoma containing pancreatic tissue with pancreatic (islet) cell hyperplasia was made.

Another case of a GCT was seen in a 22 yr old man who presented with a mediastinal mass. Testes were normal and no other mass was present anywhere in the body. Needle biopsy revealed a poorly differentiated malignant tumour present in cellular groups, with some scattered mature lymphocytes (Fig. 6A). In this case, IHC played a crucial role. The negative

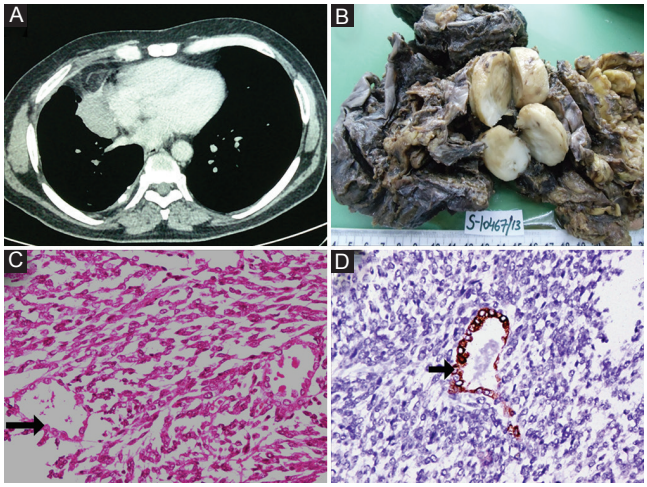

Fig. 4. (A) Synovial sarcoma; contrast-enhanced computed tomography of the chest showing well-defined soft-tissue density lesion along vascular structures and right border of heart in anterior mediastinum, with right pleural thickening and calcification. **(B)** Grossly, the mass was adherent to the lung and was grey-white, fleshy on cut surface. **(C)** Tumour was composed predominantly of fascicles of monotonous spindle-shaped cells with stray small glandular structures (arrow) (H & E, ×200). **(D)** Epithelial elements are highlighted with cytokeratin (arrow) (IHC, ×200).

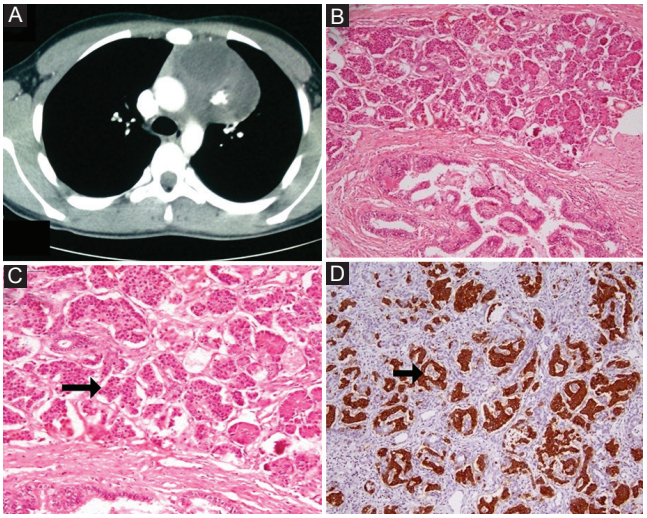

Fig. 5. (A) Mature cystic teratoma with islet cell hyperplasia; contrast-enhanced computed tomography of the chest showing large left para-cardiac mass with solid-cystic component and areas of calcification. **(B)** Section shows mature teratoma with focus of pancreatic tissue (H & E, ×100). **(C)** Marked islet cell hyperplasia (arrow) with few islands of pancreatic acini (H & E, ×200). **(D)** Positive synaptophysin staining of endocrine cells (arrow) (IHC, ×200).

staining of tumour cells for leucocyte common antigen (LCA), synaptophysin and CD5 ruled out lymphoma, neuroendocrine tumour and thymoma, respectively. Cells were strongly and diffusely positive for placental alkaline phosphatase (Fig. 6B) and focally for CK; hence, a diagnosis of mediastinal seminoma was made.

Benign neurogenic tumours (8/116) and mediastinal cysts (8/116) represented 6.9 per cent each of all mediastinal lesions. The most common benign neurogenic tumour was schwannoma in four, followed by neurofibroma in two, ganglioneuroma and paraganglioma in one each, and compartment information was available in six of these cases. All cases were in posterior compartment, except for the single case of paraganglioma which was seen in the middle compartment. The most common cystic lesion was bronchogenic cyst (6/8). Most of the cases (5/8) were seen in posterior mediastinum. One case of epidermoid cyst was present in the middle compartment and site information was not available in the remaining two cases.

Within the three age groups, there was no significant difference among various mediastinal lesions. The most common benign and malignant lesions in paediatric age group were bronchogenic cyst (3/9) and RMS (2/9), respectively. In this age group, three of the nine patients had malignant lesion (33.3%) as compared to adult age group (combining all non-paediatric lesions), in which 29/107 (27.1%) patients had malignancy. Inter-group comparison showed no significant difference in prevalence of malignancy in paediatric versus adults age group.

Other lesions such as granulomatous lymphadenitis (7.8%) were also seen. All granulomatous lesions showed lack of necrosis and were negative for acid-fast bacilli. Therefore, it was not possible to characterize the granulomas as of tuberculous or sarcoid aetiology. The remaining cases were put in miscellaneous category (9.5%), which included cases of sclerosing mediastinitis, retrosternal adenomatous goitre, undifferentiated giant cell tumour, an infarcted haemangioma and a case of leiomyoma.

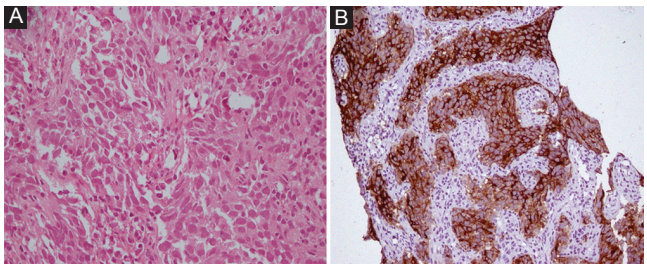

Fig. 6. (A) Seminoma; section shows a poorly differentiated malignant tumour present in cellular groups with some scattered mature lymphocytes (H & E, ×200). **(B)** Tumour cells are positive for placental alkaline phosphatase (IHC, ×200).

Discussion

Primary mediastinal tumours are uncommon and represent about three per cent of tumours within the chest wall[1]. In the present study, all the tumours were primary in origin, except for the two cases that had metastases from a primary lung carcinoma and a case of systemic NHL. Shabb *et al*[2] also reported primary lesions to be more common than metastases. In our study, most of the patients were in the third decade of life with a median age of 40 yr and a male preponderance. The demographic profile of the patients in our study was similar to other studies[3,4]. Most of the lesions were in the anterior compartment similar to other studies[5,6]. In the present study, 62.1 per cent of lesions were neoplastic in nature, of which benign lesions were more common than malignant lesions as has been reported earlier[5,7]. However, some other studies reported 60-70 per cent of mediastinal masses to be malignant[4,6].

Malignant masses were reported to be found in the anterior, middle and posterior mediastinum in approximately 60, 30 and 15 per cent of cases, respectively[8]. The prevalence of malignancy in paediatric population has been reported to be lower than in adults (37 vs. 47%)[9]. However, in our study, the presence of a lesion in any particular compartment was not a predictor of it being malignant. Inter-group comparison showed no significant difference in prevalence of malignancy in paediatric versus adult age group.

Thymus located in anterior mediastinum forms the bulk of mediastinal lesions. The non-neoplastic entities include thymic hyperplasia, cystic change and many others. Thymic cysts are very deceptive as thymomas or carcinomas are known to undergo cystic change[10]. In adults, the most common mediastinal tumour is thymoma[11], followed by lymphoma, although some studies have reported lymphoma as the most common mediastinal tumor[4-6]. Although rare in children, thymomas represent 20 per cent of anterior mediastinal neoplasms in adults[12]. Thymoma was the most common tumour, followed by lymphoma in our study. Higher number of thymoma cases may be attributed to the reason that being a tertiary-care hospital with facility of robotic surgery, a large number of referred cases are received from peripheral centres.

Mediastinal lymphomas arise in either cortical/ medullary lymphocytes of the thymic gland or the mediastinal lymph nodes. Since most of the mediastinal lymphomas are a part of systemic process, primary mediastinal lymphomas are rare[13,14]. Almost any histological type of lymphoma can occur in the mediastinum. The most common lymphomas include NScHL and PMBCL[14].

In the present study, lymphomas were seen in 11.2 per cent of the cases and were present only in the adult patients and involved anterior compartment. PMBCL was most common type of NHL, and all cases of HL were of nodular sclerosis type. PMBCL and HL, both of which are B cell derived lymphoma, are shown to have a biological, clinical and morphological overlap between the two[15]. Sometimes, distinguishing NScHL from PMBCL can be very challenging and help of IHC has to be sought in such cases.

Soft-tissue sarcomas occur most commonly in the extremities. Mediastinum as the primary site for these tumours is rare. Mediastinal soft-tissue sarcomas comprise <10 per cent of primary mediastinal tumours[16]. It is often difficult to ascertain the exact site of tumour origin as thymic or the mediastinal soft tissues. Sarcomas represented 6.9 per cent of the mediastinal lesions in our study. The age ranged from three months to 72 yr. The most common sarcoma in our study was RMS. The histopathological spectrum of sarcomas is broad and depending on the morphological pattern; these can be classified as pleomorphic, biphasic and monophasic spindle cell tumours. Important pleomorphic tumours comprise MFH, liposarcoma, leiomyosarcoma and RMS, which can be diagnosed based on the characteristic histomorphological and IHC features. SS, malignant mesothelioma and thymic carcinosarcoma display biphasic pattern and are close differentials in mediastinal tumours[17]. Monophasic spindle cell pattern is seen in monophasic SS, sarcomatoid/spindle cell carcinoma, sarcomatoid malignant mesothelioma, solitary fibrous tumour, MPNST and fibrosarcoma[18,19]. IHC and molecular/ genetic techniques play a pivotal role in supplementing histology for clinching the diagnosis.

Primary mediastinal GCT are uncommon and represent approximately 10-15 per cent of all mediastinal tumours in adults and 19-25 per cent in children[20,21]. In adults, teratoma followed by seminoma is the most common histological type, while in children, teratoma and yolk sac tumour formed the bulk[20]. In general, GCT can be divided into seminomatous germ cell tumours and non-seminomatous germ cell tumours (NSGCTs). NSGCT accounts for 1-3.5 per cent of all the mediastinal tumors[22]. Mixed GCT is much more common than any of the pure histologic forms. A primary gonadal or other extra-gonadal site must be ruled out before making a diagnosis of primary mediastinal GCT. The treatment and prognosis depend on the histological components of the tumour. It is therefore, important for the pathologists to sample the specimen adequately, take representative sections from all the different looking areas, report the percentage of each histological type and thereby guide the clinician to tailor the treatment accordingly. In the present study, GCT accounted for 3.4 per cent of all the mediastinal lesions, most of which were present in anterior mediastinum, as also reported in other studies[23].

Teratoma is the most common mediastinal GCT, typically affecting young adults. Pancreatic tissue occurs frequently in mediastinal teratoma but not in the gonadal counterpart. Pancreatic endocrine tissue is shown to have increased volume density of endocrine cells in teratomatous pancreas, resembling neonatal pancreatic tissue[24].

Malignant tumours such as lymphoma, malignant GCT and sarcoma require a biopsy diagnosis, which is followed by specific chemotherapy. Thymic cyst, thymoma and benign tumours such as neurofibroma and mature teratoma require therapeutic surgical excision. However, when the diagnosis is in doubt or the tumour is at unusual location with resectability issues, preoperative biopsy diagnosis is required[25].

In conclusion mediastinum is a complex anatomic area playing host to a wide range of neoplastic and non-neoplastic lesions. Of all, benign tumours were more common than malignant ones. Thymoma followed by lymphoma was the most common tumour. The frequency of malignancy was significantly higher in male population as compared to females. However, compartment localization or age group (paediatric vs. adults) had no significant association with the presence of malignancy. Our study demonstrated that all cases where biopsy showed adequate viable tissue, it was possible to provide a definite diagnosis with the help of a comprehensive IHC panel.

***Conflicts of Interest*:** None.

References

1. Wongsangiem M, Tangthangtham A. Primary tumors of the mediastinum: 190 cases analysis (1975-1995). *J Med Assoc Thai* 1996; *79* : 689-97.

2. Shabb NS, Fahl M, Shabb B, Haswani P, Zaatari G. Fine needle aspiration of the mediastinum. A clinical, radiological, cytological and histologic study of 42 cases. *Diagn Cytopathol* 1998; *19* : 428-36.
3. Davis RD Jr., Oldham HN Jr., Sabiston DC Jr. Primary cysts and neoplasms of the mediastinum: recent changes in clinical presentation, methods of diagnosis, management, and results. *Ann Thorac Surg* 1987; *44* : 229-37.
4. Vaziri M, Pazooki A, Zahedi-Shoolami L. Mediastinal masses: review of 105 cases. *Acta Med Iran* 2009; *47* : 297-300.
5. Adegboye VO, Ogunseyinde AO, Obajimi MO, Ogunbiyi O, Brimmo AI, Adebo OA. Presentation of primary mediastinal masses in Ibadan. *East Afr Med J* 2003; *80* : 484-7.
6. Aroor AR, Prakasha SR, Seshadri S, Teerthanath S, Raghuraj U. A study of clinical characteristics of mediastinal mass. *J Clin Diagn Res* 2014; *8* : 77-80.
7. Shrivastava CP, Devgarha S, Ahlawat V. Mediastinal tumors: a clinicopathological analysis. *Asian Cardiovasc Thorac Ann* 2006; *14* : 102-4.
8. Macchiarini P. Uncommon intrathoracic tumours. In: Souhami RL, Tannok I, Hohenberger P, Horiot JC, editors. *Oxford textbook of oncology*. 2nd ed. Oxford: Oxford University Press; 2002. p. 2165-83.
9. Takeda S, Miyoshi S, Akashi A, Ohta M, Minami M, Okumura M, *et al*. Clinical spectrum of primary mediastinal tumors: a comparison of adult and pediatric populations at a single Japanese institution. *J Surg Oncol* 2003; *83* : 24-30.
10. Moran CA, Suster S, El-Naggar A, Luna MA. Carcinomas arising in multilocular thymic cysts of the neck: a clinicopathological study of three cases. *Histopathology* 2004; *44* : 64-8.
11. Dubashi B, Cyriac S, Tenali SG. Clinicopathological analysis and outcome of primary mediastinal malignancies – A report of 91 cases from a single institute. *Ann Thorac Med* 2009; *4* : 140-2.
12. Nakagawa K, Asamura H, Matsuno Y, Suzuki K, Kondo H, Maeshima A, *et al*. Thymoma: a clinicopathologic study based on the new World Health Organization classification. *J Thorac Cardiovasc Surg* 2003; *126* : 1134-40.
13. Duwe BV, Sterman DH, Musani AI. Tumors of the mediastinum. *Chest* 2005; *128* : 2893-909.
14. Strickler JG, Kurtin PJ. Mediastinal lymphoma. *Semin Diagn Pathol* 1991; *8* : 2-13.
15. García JF, Mollejo M, Fraga M, Forteza J, Muniesa JA, Pérez-Guillermo M, *et al*. Large B-cell lymphoma with Hodgkin's features. *Histopathology* 2005; *47* : 101-10.
16. Paquette M, Truong PT, Hart J, Jones SO, Martens B, Christie JL, *et al*. Primary sarcoma of the mediastinum: a report of 16 cases referred to the British Columbia Cancer Agency. *J Thorac Oncol* 2010; *5* : 898-906.
17. Suster S, Moran CA. Primary synovial sarcomas of the mediastinum: a clinicopathologic, immunohistochemical, and ultrastructural study of 15 cases. *Am J Surg Pathol* 2005; *29* : 569-78.
18. Miettinen M, Limon J, Niezabitowski A, Lasota J. Calretinin and other mesothelioma markers in synovial sarcoma: analysis of antigenic similarities and differences with malignant mesothelioma. *Am J Surg Pathol* 2001; *25* : 610-7.
19. Suster S. Thymic carcinoma: update of current diagnostic criteria and histologic types. *Semin Diagn Pathol* 2005; *22* : 198-212.
20. Wick MR, Perlman EJ, Orazi A, Muller-Hermelink HK, Zettl A, Gobel U, *et al*. Germ cell tumours of the mediastinum. In: Travis WD, Brambilla E, Muller-Hermelink HK, Harris CC, editors. *World Health Organization classification of tumours*. *Pathology and genetics of tumours of the lung, pleura, thymus and heart*. Lyon: IARC Press; 2004. p. 198-220.
21. Takeda S, Miyoshi S, Ohta M, Minami M, Masaoka A, Matsuda H. Primary germ cell tumors in the mediastinum: a 50-year experience at a single Japanese institution. *Cancer* 2003; *97* : 367-76.
22. Macchiarini P, Ostertag H. Uncommon primary mediastinal tumours. *Lancet Oncol* 2004; *5* : 107-18.
23. Strollo DC, Rosado de Christenson ML, Jett JR. Primary mediastinal tumors. Part 1: tumors of the anterior mediastinum. *Chest* 1997; *112* : 511-22.
24. Dunn PJ. Pancreatic endocrine tissue in benign mediastinal teratoma. *J Clin Pathol* 1984; *37* : 1105-9.
25. Larsen SS, Krasnik M, Vilmann P, Jacobsen GK, Pedersen JH, Faurschou P, *et al*. Endoscopic ultrasound guided biopsy of mediastinal lesions has a major impact on patient management. *Thorax* 2002; *57* : 98-103.

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