Original Article

DOI: 10.7860/IJARS/2018/36473:2439

Radiology Section

Role of Multidetector Computed Tomography in the Evaluation of Mediastinal Mass Lesions

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ABSTRACT

Introduction: The mediastinum consists of important vascular and nonvascular tissues and organs. Partition of the mediastinum into specific compartments aids in differential diagnosis of the masses, assistance in biopsies, and other surgical procedures.

Objective: To evaluate the role of multidetector Computed Tomography (MDCT) in the assessment of mediastinal mass lesions based on International Thymic Malignancy Interest Group (ITMIG) classification.

Materials and Methods: A one year cross-sectional study was conducted on 45 patients with clinical diagnosis of mediastinal mass lesion in the Department of Radiology. On admission, patients were interviewed regarding the demographic data and underwent clinical examination before the CT examination. The compartment localisation was done based on the ITMIG classification system. All the cases were evaluated for compartment localisation and MDCT features of the mediastinal mass along with the involvement of the adjoining structures. The pre- and post-contrast attenuation values, the size, location of the mass, presence of calcification, mass effect on adjoining structures, and infiltration were recorded. The CT-guided biopsy of the mass lesions was performed to conduct histopathological analysis. Data were recorded in a predesigned and pretested proforma. The data were coded and entered in Microsoft excel worksheet.

Results: The majority (32) of the patients in the present study were men with most of them in the age group of 61-70 years, and the mean age was 44.77±21.29 years. The compartment localisation of the mediastinal mass lesions revealed majority of the lesions (21) in the pre-vascular compartment. Upon CT enhancement, heterogenous lesions were observed in many patients (29). CT-guided biopsy (30) was the most frequently performed method. Histopathological analysis revealed thymoma (9) in most of the cases. Malignancy (23) was observed in many of the patients with mediastinal lesions. Lymphoma was the common CT diagnosis in patients with solid component (10), lymphadenopathy (8), and infiltration (7).

Conclusion: MDCT is a useful modality in evaluating the mediastinal lesions, and provides precise information regarding the extent, tissue composition, lesion enhancement pattern, and mediastinal and vascular invasion.

Keywords: International thymic malignancy interest group classification, Mediastinal mass, Multi-detector row computed tomography

INTRODUCTION

Mediastinal masses include a wide variety of tumours that represent 3% of tumours seen within the chest and remain an interesting diagnostic challenge affecting people of all ages [1]. A significant increase in the incidence of malignant mediastinal tumours is reported over the past decades.

The evaluation of mediastinal abnormalities often poses a challenge in the radiographic diagnosis due to its complex anatomical location. The various conditions affecting the mediastinum include tumour, cysts, vascular anomalies, lymph node masses, and mediastinal fibrosis [2]. Multidetector computed tomography (MDCT) is useful in the investigation, characterisation, and demonstration of the extent of a mediastinal mass and its relationship to adjacent structures and organs. MDCT following intravenous contrast medium with multi-planar reforms (MPR) provides an excellent assessment of mediastinal structure, including vessels, and has largely obviated the need to proceed to other investigations [3].

Computed tomography (CT) aided cross-sectional imaging of the mediastinum is the choice of imaging modality of the mediastinal lesions, which determines accurate anatomic details. High resolution MDCT scans aid to precisely localize lesions along with delineation of the adjacent structures.

Diagnostic fine-needle aspiration or core biopsy for both benign and malignant disease processes are safe and highly accurate procedures [4].

Definite compartmental partition of the mediastinum assists in the evaluation, characterisation, and management of mediastinal anomalies. The different classification systems used in the radiological practice are the Fraser and Pare, Felson, Heitzman, Zylak, and Whitten models [5-9]. Several shortcomings among these schemes have resulted in the inability to reliably localize some lesions to a specific mediastinal compartment, due to the inherent limitations in each classification [9,10]. In the existing radiologic practice, the lateral chest radiograph primarily represents non-anatomic divisions of the chest. The chest radiograph appears normal in presence of mediastinal abnormalities [10,11].

Due to the lack of a classification scheme for the division of mediastinal compartments of the cross-sectional images, the International Thymic Malignancy Interest Group (ITMIG) introduced the modified JART (Japanese Association for Research on the Thymus). In this method, new definitions of the mediastinal compartments are used in cross-sectional imaging. ITMIG mediastinal classification system based on the cross-sectional imaging aids to accurately localise and characterise mediastinal lesions [12,13]. The division of the mediastinum is done as pre-vascular, visceral, and paravertebral compartments based on MDCT. There are a few studies worldwide, and no studies in India that have been conducted in this perspective, therefore the present study was conducted to analyse the MDCT characteristics in the evaluation of mediastinal masses in paediatric and adult patients, based on the modified ITMIG JART classification [12,13].

MATERIALS AND METHODS

Sampling and study design

A one year cross-sectional study was conducted on 45 patients in the Department of Radiology. Patients of all age groups with a clinical diagnosis of mediastinal mass lesion and those with a chest radiograph with a suspicious mediastinal abnormality were included in the study. Patients with trauma and allergic reactions to contrast media were excluded from the study.

Since the disease is found to be less frequent, that is, 0.77% [12], hence, based on universal sampling method, all the cases with clinical suspicion of mediastinal mass lesions or those with a chest radiograph with a suspicious mediastinal abnormality fulfilling selection criteria who were referred and diagnosed with mediastinal masses were selected.

Procedure and data collection

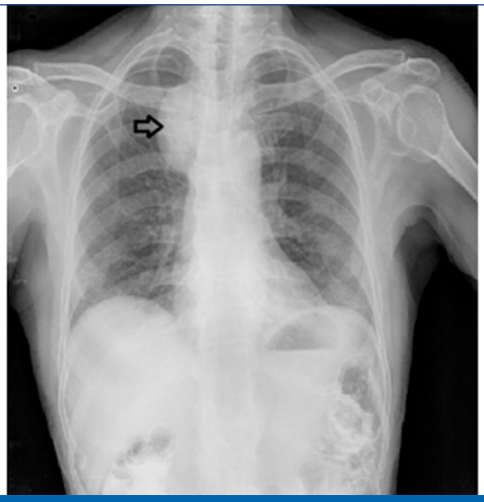
Before commencement of the study, ethical clearance was obtained from the Institutional Ethical Committee. After explaining the purpose of the study, written consent was obtained from the patients before data collection.

Pre-procedure

On admission, patients underwent detailed clinical history before the CT examination. Based on the inclusion criteria, the patients were selected and interviewed regarding the demographic data, and clinical examination was performed. All the cases were evaluated for compartment localisation and MDCT features of the mediastinal mass along with the involvement of the adjoining structures. All the patients underwent pre-procedure CT and antero-posterior and lateral view chest x-ray. The renal parameters were assessed, and patients were asked to fast for at least 4 hours before the contrast study. In cases of deranged renal parameters, patients were advised to hydrate to prevent any contrast related reactions. The patients were positioned in the CT gantry in the supine position.

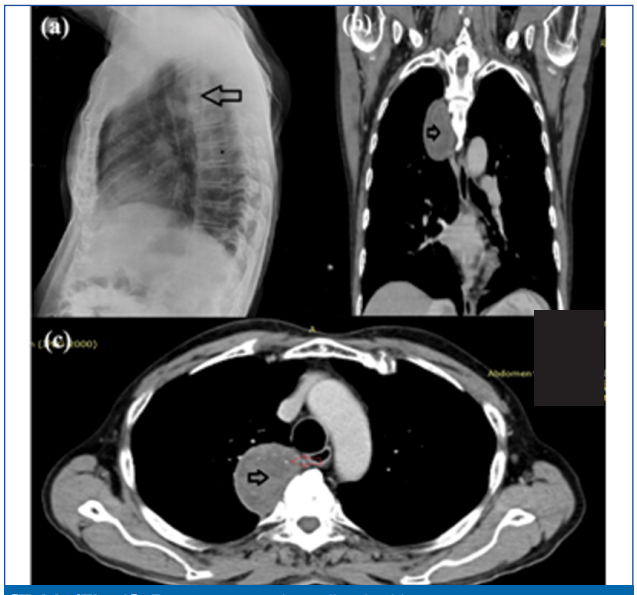
Intra-procedure

CT images were obtained with 64 slice MDCT (Somatom sensation, Siemens), with 5 mm collimation; 0.6 mm reconstruction interval, gantry rotation speed of 0.6 s, pitch of 1.375:1, 120 Kv, and 350 mA were constant features for all cases. Antero-posterior topogram of the thorax were initially performed with the breath held [Table/Fig-1]. An axial section of 3 mm thickness was from the level of thoracic inlet to the level of supra-renal, which was further reconstructed to 1.5 mm. In all cases, plain scan was followed by contrast scan. Initially, 80-100 ml of Iohexol injection or a dose of 300 mg of iodine/kg body weight (in paediatrics) was administered and axial sections were taken from the level of thoracic inlet to the level of supra-renal. The pre- and post-contrast attenuation values,



[Table/Fig-1]: Chest PA view
Arrow in the above image shows homogenous density ovoid lesion in the right paravertebral region. The lesion shows sharp margin above the clavicle with lung surface that indicates posterior mediastinal mass.

the size, location of the mass, presence of calcification, mass effect on adjoining structures, and infiltration were recorded [Table/Fig-2].



[Table/Fig-2]: Reconstructed mediastinal images
(a) sagittal: arrow shows lesion in the posterior mediastinum, (b) coronal: shows homogenously enhancing oval shaped lesion (arrow) in the right paravertebral region with enhancing septations, and (c) axial planes: shows homogenously enhancing oval shaped lesion (black arrow) with foci calcification (red arrow).

ITMIG JART Classification

The three-compartment cross-sectional imaging model of the mediastinal compartments including prevascular, visceral, and paravertebral regions was employed to identify and characterize the lesions [9].

The CT-guided biopsy of the mass lesions was performed to conduct the histopathological analysis. The patient was positioned in the CT gantry and percutaneous access site were prepared. Immediate pre-procedural topogram and CT of the chest were done from the neck base up to the domes of the diaphragm to delineate the mediastinal lesion and to locate the percutaneous site of needle puncture. Patients were positioned in the supine, prone, or lateral decubitus position depending on the lesion location and the biopsy approach. For CT-guided procedures, preliminary 3 or 5 mm thick contiguous axial sections are obtained to confirm the location of the target lesion and to determine the optimal entry site of the needle.

STATISTICAL ANALYSIS

Data were recorded in a predesigned and pretested proforma. The data were coded and entered in Microsoft excel worksheet. The categorical data were expressed as rates, ratios, and percentages. The continuous data were expressed as mean ± standard deviation.

RESULTS

The majority (32) of the patients in the present study were men with majority of them in the age group of 61–70 years, and the mean age was 44.77±21.29 years. Most of the patients (44) presented with symptoms for mediastinal mass lesions, wherein, dyspnoea (26) followed by chest pain (25) were the most common symptoms. Solid component (36) was commonly observed in the CT. Biopsy was performed in majority (36) of the patients, in which CT-guided biopsy (30) was the most frequently preformed method. Malignancy (23) was observed in many of the patients with mediastinal lesions. Thymoma (7) and lymphoma (9) were the most common lesions noted in patients with benign and malignant lesions, respectively [Table/Fig-3].

The compartment localisation of the mediastinal mass lesions revealed majority of the lesions (21) in the pre-vascular compartment. Upon CT enhancement, heterogenous lesions were observed in many patients (29) [Table/Fig-4].

Variable		N (%)
Gender	Male	32 (71.11)
	Female	13 (28.89)
Mean age (years)		44.77±21.29
Symptoms	Asymptomatic	1 (22.22)
	Symptomatic	44 (97.78)
Clinical Symptoms	Dyspnoea	26 (57.78)
	Chest pain	25 (55.56)
	Cough	21 (46.67)
	Weight loss	17 (37.78)
	Fever	14 (31.11)
	Haemoptysis	7 (15.56)
	Dysphagia	7 (15.56)
Type of lesion	Benign	18 (40)
	Malignant	23 (51.11)
	Aneurysm	4 (8.89)
Biopsy	CT guided	30 (66.67)
	Endoscopy guided	6 (13.33)
	Not performed	9 (20)

[Table/Fig-3]: Demographic and clinical characteristics of patients with mediastinal mass lesions.

In the pre-vascular compartment, thymoma (9) was the common type of mediastinal lesion, whereas, in the visceral compartment aneurysm of the arch of aorta (4) was the common type of lesion. However, in the paravertebral compartment, oesophageal carcinoma (4) was observed in many cases. Among the lesions metastasised in multiple compartments, lymphoma (3) was common [Table/Fig-5].

Variable		N (%)
Compartmental distribution of lesions	Pre-vascular	21 (46.67)
	Visceral	10 (22.22)
	Paravertebral	8 (17.78)
	Pre-vascular + visceral	3 (6.67)
	Pre-vascular + visceral + paravertebral	2 (4.44)
	Pre-vascular + paravertebral	1 (2.22)
CT findings – Enhancement	Heterogenous	29 (64.44)
	Homogenous	11 (24.44)
	Non-enhancing	5 (11.11)
CT findings	Solid component	36 (80)
	Cystic component	19 (42.22)
	Lymphadenopathy	18 (40)
	Pleural effusion	17 (37.78)
	Infiltration	15 (33.33)
	Calcification	5 (11.11)
	Fat component	2 (4.44)

[Table/Fig-4]: Imaging studies and classification of mediastinal lesions.

Histopathological analysis revealed thymoma (9) in most of the cases [Table/Fig-6]. Foregut duplication cyst (2) and lymphoma (9) were the most common CT diagnoses in non-enhancing and heterogeneous enhancement CT. However, aneurysm of arch of aorta (4) was a frequent CT diagnosis in patients with homogeneous enhancement. Lymphoma was the common CT diagnosis in patients with solid component (10), lymphadenopathy (8), and infiltration (7).

Lesion		N (%)
Pre-vascular lesions	Thymoma	9 (20)
	Lymphoma	6 (13.33)
	Thymic carcinoma	3 (6.67)
	Teratoma	1 (2.22)
	Ectopic parathyroid	1 (2.22)
	Thymic cyst	1 (2.22)
Visceral lesions	Aneurysm of arch of aorta	4 (8.89)
	Carcinoma oesophagus	2 (4.44)
	Foregut duplication cyst	2 (4.44)
	Pseudoaneurysm	1 (2.22)
	Lymphoma	1 (2.22)
Paravertebral lesions	Carcinoma oesophagus	4 (8.89)
	Schwannoma	3 (6.66)
	Neuroenteric cyst	1 (2.22)
Multiple compartment lesions	Lymphoma	3 (6.67)
	Germ cell tumour	2 (4.44)

[Table/Fig-5]: Distribution of lesions according to the compartments.

Histopathological finding	N (%)
Thymoma	9 (20)
Non-Hodgkin's lymphoma	4 (8.89)
Squamous cell carcinoma of oesophagus	4 (8.89)
Hodgkin's lymphoma	3 (6.67)
Adenocarcinoma of oesophagus	2 (4.44)
Adenocarcinoma of lung	2 (4.44)
Schwannoma	2 (4.44)
Mature teratoma	1 (2.22)
Metastases	1 (2.22)
Malignant schwannoma	1 (2.22)
Squamous cell carcinoma of lung	1 (2.22)
Seminoma	1 (2.22)
Small round cell tumour	1 (2.22)
Thymic carcinoma	1 (2.22)
Thymic cyst	1 (2.22)
Ectopic parathyroid adenoma	1 (2.22)
Thyroid carcinoma	1 (2.22)
Biopsy not performed	9 (20)

[Table/Fig-6]: Histopathological diagnosis of patients with mediastinal mass lesions.

DISCUSSION

Although conventional classification of the mediastinal masses may suggest the presence of mediastinal lesions, in most cases determining the precise anatomical details is possible by ITMIG model used in the cross-sectional imaging of the mediastinum in MDCT. Accurate analysis of the vasculature of the mediastinum is important to determine metastasis.

To our knowledge, no studies are available evaluating the role of MDCT in characterisation of mediastinal masses based on new classification system proposed by ITMIG using the three-compartment mediastinal classification system, so far. Hence, we presume that this is the maiden study, which evaluated the role of MDCT in characterisation of mediastinal masses based on the classification. In the present study, pre-vascular compartment was the most common compartment involved. Studies conducted by Dubashi et al.,[14] and Juanpere et al.,[3], concluded that anterior mediastinum is the most common compartment to be involved in mediastinal masses. The most common lesion in the multicompartment was lymphoma (6.67%) followed by germ cell tumour (4.44%). Six cases (13.33%) showed multi-compartment involvement. Out of these, 6.67% of the cases involved both pre-vascular and visceral compartment while pre-vascular + paravertebral compartment was observed in one patient (2.22%).

The present study is in concordance with a study conducted by Arumugam et al., who reported malignant lesions and benign lesions in 62% and 38% of the patients, respectively [4]. In the pre-vascular compartment, thymic lesions were the most common lesions. This was similar to the study conducted by Pulasani et al., who observed, among the thymic lesions, thymoma was the most common (42.8%) lesion detected on CT [15]. Study conducted by Carter et al., also interpreted thymoma as the common lesion among the thymic lesions [9]. In the present study, intrathoracic goitres were common, which was in accordance with a study by Alsaif et al., which showed that retrosternal goitre was observed in 3–12% of mediastinal masses [16]. The other lesions that were included in the pre-vascular compartment were germ cell tumour (2.2 %) and a rare case of ectopic parathyroid adenoma (2.2%). In the present study, the most common paravertebral lesion was oesophageal carcinoma, whereas in the study conducted by Pulasani et al., neural tumours were most common in the posterior mediastinal lesions [15]. According to a study by Nakazono et al., schwannoma is the most common mediastinal neurogenic tumour [17], which is similar to the present study.

In the present study, heterogeneous enhancement was common, similar to a study conducted by Kaur et al., which showed heterogenous enhancement in 58.3% cases. Other findings were also comparable and consistent with the same study, which included solid component and cystic component [18]. Arumugam et al., reported calcification in most of the cases (60%), which was contradictory to our study, however infiltration, mass effect, lymphadenopathy and pleural effusion were comparable with our study [4]. In the present study CT and endoscopy guided biopsy was conducted in many cases, however biopsy was conducted in few patients due to inadequate blood profile or disagreement for biopsy. CT diagnosis in most cases correlated with the histopathological diagnosis. The cases that were interpreted as thymoma and lymphoma were observed to be masses of the lung on histopathological analysis. It could be due to invasive lesions from the lungs can infiltrate into the mediastinum resulting in false interpretation of a mediastinal mass.

The ITMIG JART system of mediastinal compartment classification will aid in advanced and effective localisation of the lesions, appropriate differential diagnosis, and contribute in planning the treatment strategy. While lesions of the mediastinum are unusual, it is difficult to identify with imaging alone due to the inconclusive imaging characteristics. However, combination of clinical and imaging interpretations document in a plausible diagnosis. Therefore, the application of the system presented in this article permits in evaluating and interpreting the lesions via MDCT findings and correlation of indefinite imaging features with specific clinical evidence. This approach will be helpful for the radiologists and the medical faculty to further evaluate and determine the treatment plan.

Overall, imaging plays a vital role in the evaluation of mediastinal masses. The new, three compartments based classification system is an easy model, which helps in identifying mediastinal mass lesions.

LIMITATION

The observations noted in the present study need further validation due the potential limitations of the study, which include single centre study, smaller sample size, fewer numbers of paediatric cases, and male preponderance. Further, age and gender specific multi-centric studies involving large sample might enhance the utility and feasibility of MDCT and the IMTIG mediastinal compartment classification.

CONCLUSION

MDCT is a useful modality in evaluating the mediastinal lesions, and provides precise information regarding the extent, tissue composition, lesion enhancement pattern, and mediastinal, and vascular invasion. Furthermore, the new ITMIG three-compartment based classification system is simple and easy in identifying the mediastinal mass lesions.

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FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Publishing: **Oct 01, 2018**