Evaluation of Mediastinal Mass Lesions Using Multi-detector Row Computed Tomography and Correlation with Histopathological Diagnosis

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Abstract

Background: Multi-detector row computed tomography (MDCT) is a promising three-dimensional imaging tool allowing substantial anatomical volumes to be routinely covered with isotropic sub-millimeter spatial resolution. MDCT scans precisely localize lesions and biopsy needles diagnostic fine-needle aspiration for both benign and malignant disease processes has become a quite safe and highly accurate procedure.

Aims and Objectives: To correlate MDCT findings of the mediastinal mass lesions with histopathology. To differentiate between benign and malignant mediastinal mass lesions based on MDCT findings. To evaluate MDCT characteristics of mediastinal mass lesions.

Materials and Methods: This study was performed on 50 cases in the age group [6-76] years with clinical or radiological suspicion of mediastinal lesions referred from Departments of Medicine, Surgery and Pediatrics between September 2011 and October 2013 to the Department of radio-diagnosis, Vydehi Institute of Medical Sciences & Research Centre, Bangalore for MDCT evaluation.

Results: The study included 36 cases of benign lesions and 14 malignant lesions. Cases of mediastinal lesions were found between age groups 6 and 76 years. All 50 cases were verified histopathologically. Diagnostic accuracy of 92% and 84% was seen for benign and malignant lesions, respectively.

Conclusion: With the high rate of diagnostic accuracy, MDCT plays a significant role in the assessment of various mediastinal pathology. The maximum number of cases occurred in 4th-6th decade. Anterior mediastinum was the most common compartment to be involved (52%) followed by posterior mediastinum (30%). MDCT definitely has a major role to play in the evaluation of a mediastinal mass regarding diagnosis, distribution pattern and mass effect on adjacent structures.

Key words: Benign, Malignant, Mediastinum, Multi-detector row computed tomography

INTRODUCTION

Computed tomography (CT) is a new method of forming images from X-rays. It was developed and introduced into clinical use by the British physicist Godfrey Hounsfield in 1972. It had a tremendous impact in the field of diagnostic radiology. The introduction of multi-detector row CT (MDCT) into clinical practice in 1998 constituted a fundamental evolutionary step in the development and ongoing refinement of CT imaging techniques. This promising three-dimensional (3D) imaging tool allows substantial anatomical volumes to be routinely covered with isotropic sub-millimeter spatial resolution.¹ The ability of high-resolution MDCT scans to precisely localize lesions and biopsy needles, along with the delineation of adjacent structures, diagnostic fine-needle aspiration for both benign and malignant disease processes has become a quite safe and highly accurate procedure.²

The mediastinum is an extremely complex and interesting area of the body. The multitude of diseases affecting the
mediastinum vary considerably, ranging from tumors (benign to extremely malignant) cysts, vascular anomalies, lymph node (LN) masses, mediastinitis, mediastinal fibrosis, and pneumo-mediastinum. Hence, every possible effort has to be made to arrive at a specific diagnosis at the earliest. Although conventional radiographs can now show recognizable abnormalities in many patients with mediastinal abnormalities, radiographs are limited in their sensitivity and ability to delineate the extent of mediastinal abnormalities and the relationship of masses to specific mediastinal structure. With the CT these problems are overcome because of its excellent density resolution and tomographic format helping the clinicians and radiologists in identifying the precise location, extent, and characterization of these masses. Cross-sectional imaging of the mediastinum by CT demonstrates precise anatomic details and is the imaging modality of choice for most the mediastinal lesions. This study was done to evaluate the primary mediastinal mass lesions on MDCT by correlating the MDCT findings with histopathology, differentiating between benign or malignant mass lesions and to characterize the mediastinal lesions by MDCT.

The differential diagnosis of a mediastinal mass on CT is usually based on several findings, including its location, identification of the structure from which it is arising, whether it is single, multifocal or diffuse, its size and shape, its attenuation, the presence of calcification and its character and amounts, and its opacification following contrast administration. In this study, all the cases were subjected to MDCT evaluation for better characterization, extent, probable tissue of origin, and effect on adjoining structures. Plain and contrast studies were performed. The present study comprised of 50 patients.

**MATERIALS AND METHODS**

All patients referred to Department of Radio-Diagnosis, VIMS & RC between September 2011 and October 2013 with clinical suspicion of mediastinal space occupying lesions or who had a chest radiograph with a suspicious mediastinal abnormality were included in the study. Thorough clinical history and clinical examination was done before CT examination. All the cases taken up for the CT were evaluated for the distribution, MDCT features of the mediastinal mass and also the involvement of adjoining structures. Vascular lesions arising from aorta and cardia, traumatic causes and various types of hernias were excluded from the study.

CT images were obtained with general electrical medical systems 16 slice MDCT machine 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 a constant feature for all cases. Routine anteroposterior to program of the thorax was initially taken in all patients in the supine position with the breath held. An axial section of 10 mm thickness was taken from the level of thoracic inlet to the level of suprarenals. In all cases, plain scan was followed by contrast scan. For contrast enhancement initially 80-100 ml of injection of iohexol or in a dose of 300 mg of iodine/kg body weight (in children) was given and axial sections were taken from thoracic inlet to the level of suprarenals.

Sagittal and coronal reconstructions were made wherever necessary. The magnification mode was commonly employed, and the scans were reviewed on a direct display console at multiple window settings (i.e., mediastinal window at 320/40; lung window 1400/-600; bone window of 2400/200) to examine the wide variation of tissue density and also to look for osseous involvement. The pre and post contrast attenuation values, the size, location of the mass, presence of calcification, mass effect on adjoining structures and others.

**RESULTS**

In the study, out of 50 cases, 30 cases (60%) were males and 20 cases (40%) were females. Of 2 cases, 14 cases (28%) were children. Among them 8 were males (i.e., 57.2%) and 6 were females (i.e., 48.2%). The most common age group to present with the mediastinal mass was between 46 and 60 years (Table 1).

In present study of 50 cases, Cough was the most common clinical symptom constituting 44% followed by dyspnea 38%, fever 20% and chest pain 20%. In the study, out of 50 cases, 3 cases had no symptoms pertaining to the chest and CT showed the incidental involvement of the mediastinum (Graph 1).

In the study the anterior mediastinal masses formed the majority with 52% (n = 26) of the total masses (Graph 2). Among the anterior mediastinal masses 52% (n = 26), thymic masses formed the majority constituting 26.9% (n = 7), followed by metastatic LN 19.2% (n = 5) (Table 2). Middle mediastinal masses comprised of 18% (n = 9) of the total mediastinal masses. Among them the metastatic LN involvement formed the majority, i.e., 44.5% (n = 4) followed by tuberculosis (TB) LN enlargement constituting 22.2% (n = 2) (Table 3). Posterior mediastinal masses comprised 30% (n = 15) of the total mediastinal masses, the majority were contributed to neural tumors constituting 40% (n = 6) followed by paravertebral abscess constituting 20% (n = 3) (Table 4).
Among the thymic masses, thymoma constituted 42.8% \((n = 3)\) and is seen predominantly in age group of 46-60 years and males outnumbered females in the ratio of 2:1. Thymic hyperplasia comprised 28.6% \((n = 2)\) and was seen in the age group of 0-15 years. In the study of 6 cases of neurogenic tumors, neurofibroma constituted 50% \((n = 3)\), ganglionuroblastoma 16.6% \((n = 1)\), schwannoma 16.6% \((n = 1)\) and paragangioma 16.6% \((n = 1)\).

In the study, lymph nodal masses constituted 40% \((n = 20)\) of the total mediastinal masses. Among these the metastatic LN involvement is the predominant constitutes 39.1% \((n = 9)\) followed by TB LN enlargement 34.8% \((n = 8)\).

In the study, majority of the masses, showed heterogeneous enhancement, i.e., 44% \((n = 22)\) followed by homogenous enhancement; 28% \((n = 14)\) non enhancing masses constituted 12 \((n = 6)\) (Graph 3).

In the study, majority were solid masses constituting 54% \((n = 27)\) of the cases followed by solid and cystic masses in 22% \((n = 11)\) of the cases (Graph 4). In the study, 24% \((n = 12)\) of the cases showed calcification in the mediastinum mass (Graph 5). Mass effect was noted in 62% of the cases and was predominantly noted on the airways.

**DISCUSSION**

In present study of 50 cases, 35 of benign and 11 malignant cases correlated with histopathological examination (HPE). With the sensitivity of MDCT for evaluating the benign lesions is 95%, specificity is 91%, with a positive predictive value of 97% and for malignant lesions sensitivity 78%,
specificity is 33% positive predictive value of 84% (Table 5).

The present study did not correlate with HPE in 4 cases (Table 6). In one case, the diagnosis of mediastinal lipomatosis was given on MDCT, but histopathological diagnosis was thymolipoma. Both these entities have similar findings on CT, except that thymolipoma has soft tissue strandings within the fat density lesion suggestive of thymic tissue.8 One case was diagnosed as tubercular LN on MDCT, histopathological diagnosis was metastatic LN. The node showed peripheral rim enhancement with central area of hypodensity (necrosis) (Figure 3). This is the feature seen both in tubercular and metastatic LN and can be difficult to differentiate unless calcification is seen.11,12 Another case, showed LN with homogenous enhancement and no egg shell calcifications on MDCT leading to the erroneous diagnosis of lymphoma rather than sarcoidosis. The absence of calcification can cause confusion between the two entities. One case of retrosternal mass with calcification was diagnosed as thyroid carcinoma on MDCT and histopathological diagnosis was goiter with benign nodular calcification. In the absence of infiltration into the adjacent structures and regional LN, benign entity should have been considered.

In present study, granulomatous lesions constituted 16%, which is greater in comparison to Wychulis et al.6 study (i.e., 6.3%) probably due to the higher prevalence of TB in comparison to the western population. According to Im et al.9 series, right paratracheal LN enlargement was seen in 87% of cases whereas Present study showed 60% involvement. Similarly in Im et al.9 study, 52% of the TB LN enlargement showed central areas of low attenuation with rim enhancement on contrast study. The present study showed 40% involvement. The present study had 3 cases of paravertebral abscess (5.6%) which was associated with vertebral body destruction.

In present study, the thymic tumors formed the majority with 14%, which is similar to studies conducted by Cohen et al.11 In a study by Chen et al.13 on 34 patients with CT diagnosis of thymic mass, thymoma constituted 42% and thymic cyst 2.9%. Whereas present study of 7 patients with thymic mass, thymoma constituted 42% and hemihyperplasia 28 %. According to Naidich et al.,14 Thymoma is most common seen between 50 and 60 years that is comparable to this study in which the 3 patients with thymoma where of age 40, 48 and 48 years, respectively.

Intrathoracic goiters are also common cause of mediastinal enlargement. Thyroid masses account for 11-15% of mediastinal masses.15 In the present study, they represented only 4% of the cases.

**MDCT Characteristics of Mediastinal Masses**

The normal thymus conforms to the shape of the adjacent vessels on CT, whereas a thymic mass does not intend to. Furthermore, a mass gives rise to focal swelling, usually centered away from the midline, whereas the normal gland is approximately symmetrical.

**Thymic cyst**

Congenital are typically unilocular, contains clear fluid of water density with a thin wall usually <6 cm in diameter. Acquired are usually multilocular, wall of variable thickness
and range in size from 3 to 17 cm in diameter, sometimes septations and calcification of the cyst wall may be seen.16

**Thymoma**

On CT, thymomas appear as homogenous soft tissue density masses, which are usually sharply demarcated and oval, round or lobulated in shape, project to one side of the mediastinum, and do not conform to the normal shape of the thymus (Figure 1). Rarely, cystic with discrete nodular components, except in patients with cystic masses, thymomas usually enhance homogenously and not uncommonly may contain calcium. Pleural implants may be present which are often unilateral and usually unassociated with pleural effusion. Large tumors have areas of hemorrhage, necrosis or cyst formation.

**Thymolipoma**

CT shows a fatty mass with varying amounts of intermixed soft tissue representing thymic tissue. Sometimes it is predominantly fatty so that it is impossible to distinguish a thymolipoma from a mediastinal lipomatosis.18

**Germ cell tumors**

Germ cell tumors include benign and malignant teratoma, seminomas, embryonal carcinoma, endodermal sinus (yolk sac) tumor, choriocarcinoma, and mixed types.

**Teratoma**

MDCT often shows combination of fluid filled cysts, fat, soft tissue and areas of calcification (Figure 5). Calcification seen in 20-80% of cases, being focal, rim like, or rarely representing teeth or bone. A fat fluid level is particularly diagnostic. Cystic teratoma characteristically has a thick wall, soft tissue septations and in homogenous areas approaching fatty attenuation values, within a predominantly near water density mass; differentiates from other benign cysts.5

**Seminoma**

Typically, primary mediastinal seminomas are large, smooth or lobulated, homogenous soft tissue masses, although small areas of low-attenuation may be seen. Obliteration of fat planes is common and pleural or pericardial effusion may be present.
Non-seminomatous germ cell tumors: On MDCT, these tumors usually show heterogeneous opacity, including ill-defined areas of low attenuation secondary to necrosis and hemorrhage or cystic areas. They often appear infiltrative, with obliteration of fat planes and may be spiculated calcification may be seen.

**Thyroid masses**
The MDCT appearance of a mediastinal goiter is variable, but the goiter can confidently diagnosed when continuity of the mass with the thyroid is visible. MDCT is at greatest value in defining the morphologic extent. Marked irregularity of the gland contour, loss of distinct mediastinal fascial planes and/or presence of cervical or mediastinal adenopathy should signal potential malignancy.19

**Parathyroid adenoma**
When visible on CT, they usually appear homogenous in density. In anterior mediastinum, they may be indistinguishable from small thymic remnants, small thymomas or small LN and are usually found in the expected location of the thymus. CT correctly identifies parathyroid adenoma preoperatively in 81% of patients.20

**Primary mediastinal lymphoma (PML)**
An anterior mediastinal mass often associated with enlarged nodes in the middle and posterior mediastinum, PML often affects extrathoracic sites at time of diagnosis particularly abdomen, head and neck.

On CT Hodgkin’s lymphoma is characterized by the presence of a discrete anterior and superior mediastinal mass with surface lobulation. Surface lobulation of main mass is due to involvement of multiple nodes and coalescence. Masses typically exhibit homogenous soft tissue attenuation, while large tumors may exhibit heterogeneity with complex low attenuation representing necrosis, hemorrhage, and cystic degeneration. It commonly involves cervical, mediastinal, hilar, and paraaortic nodes.21
Non-Hodgkin’s lymphoma comprises of mediastinal large B-cell lymphoma and lymphoblastic lymphoma and is more common in children than Hodgkin’s lymphoma. Large cell lymphomas are typically confined to the mediastinum and contiguous nodal areas initially without showing extrathoracic disease at presentation. It may present with hematogenous spread to kidney, liver, ovary, adrenal gland, GI tract, and central nervous system during disease progression or at recurrence. CT demonstrates mediastinal mass without surface lobulation, often associated with vascular involvement and pleural or pericardial effusion. Lymphoblastic lymphoma is characterized by mass without surface lobulation involving vascular structures often associated with pleural and pericardial effusion, systemic nodal involvement including cervical, axillary, para aortic, mesenteric and inguinal groups and by hepatomegaly and splenomegaly.

**Sarcoidosis**

In the order of decreasing frequency, paratracheal, aortopulmonary, subcarinal, and prevascular LN are commonly involved. LN shows dense or stippled or egg shell calcification and rarely enhance or appear necrotic (Figure 2).

**TB**

The enlarged LN usually shows central area of low attenuation on MDCT with peripheral enhancement (Figure 4).

**Pleuropericardial cyst**

MDCT shows thin walled unilocular water density (0-20 HU) cystic structure. Wall may calcify. Majority of them arises in the anterior cardiophrenic angle, more so on the right side.

**Bronchogenic cyst**

MDCT typically shows sharply marginated thin walled mediastinal mass of homogenous soft tissue or water attenuation. Rarely, calcification of the cyst wall is present. When dense, bronchogenic cysts may be difficult to distinguish from solid lesions. An important clue can be their lack of enhancement following contrast administration.

**Esophageal duplication cysts**

On MDCT indistinguishable from bronchogenic cyst except for the location.

**Neuroenteric cysts**

MDCT appearance is same as that of other duplication cyst, but the presence of vertebral abnormality points to the diagnosis, vertebral anomalies are present in half of the cases.

**Lymphangiomas**

MDCT usually shows a smooth, lobulated mass, which may mold to or envelop, rather than displace, the adjacent mediastinal structures. They are either unilocular or multilocular with near water density. Calcification is rare. Thin enhancing septations within the mass may be seen.

**Neurogenic tumors**

At CT, many neural tumors have mixed density, including low attenuation region, on non-contrast enhanced CT Schwannoma often demonstrate lower attenuation than skeletal muscle because of their high lipid content, interstitial fluid and areas of cystic degeneration. Neurofibromas are often more homogenous and show higher attenuation than schwannomas because they have fewer of these histologic features. These lesions are heterogeneously enhancing following contrast administration.

Plexiform Neurofibromas are seen in association with neurofibromatosis-1, on CT demonstrates low attenuation infiltrative masses along the mediastinal nerves and sympathetic chain.

**Mediastinal paragangliomas**

Rounded soft tissue masses which are usually extremely vascular and therefore enhance brightly Paravertebral lesions.

**Tuberculous paravertebral lesions**

CT scan is excellent for visualization of endplate destruction, fragmentation of the vertebrae, and paravertebral calcifications. Inflammatory collections and masses are best seen after the contrast administration. Small necrotic foci are recognized by CT scans but are difficult to find in the conventional radiographs. Extension into the
canal of epidural abscesses and bony fragments are well demonstrated on axial CT images. MDCT is also used for guiding percutaneous biopsy and postdrainage follow-up.

**Extramedullary hematopoietic tissue**

Extramedullary hematopoietic tissue typically produces one or smoother, lobular, spherical masses in the paravertebral gutter, usually in the lower thorax, often they are bilateral and symmetrical. Extramedullary hematopoietic tissues are low-density masses due to fat content.

**Esophageal carcinoma**

Narrowing of the esophageal lumen or dilatation caused by obstruction. Thickening of the esophageal wall, either symmetric or asymmetric. Loss of periesophageal fat planes, with or without evidence of invasion of surrounding organs.

**CONCLUSION**

MDCT plays a significant role in the assessment of various mediastinal pathology with an accuracy of 92% on the whole, 97% and 84% for benign and malignant lesions, respectively. MDCT is a promising 3D imaging tool which allows substantial anatomical volumes to be routinely covered with isotopic sub-millimeter spatial resolution highly useful for the investigation of mediastinal masses. MDCT definitely has a major role to play in the evaluation of a mediastinal mass lesions regarding their characterization and differentiating between benign and malignant lesions.

**REFERENCES**


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