Role of multislice computed tomography in evaluation of thoracic lymphadenopathy

Adel Rezk[a], Sameh Hafez[a], Alaa Abd Al-Hamid[a], Ahmed Youssef Shaaban Gad[b], Mohamed Khamis[a]

Background Mediastinal masses and lymphadenopathy are often incidentally detected on chest radiograph. Despite diagnostic limitations, the chest radiograph is also important for detecting and localizing mediastinal masses and lymphadenopathy when suspected clinically. Multislice computed tomography (CT) has transformed CT from a transaxial cross-sectional technique to a three-dimensional imaging modality.

Aim The aim of this study was to assess the role of multislice CT in evaluation of thoracic lymphadenopathy (lymph node).

Patients and methods The present study was conducted on 25 patients with thoracic lymphadenopathy on plain chest radiograph or clinically suspected with unremarkable chest radiograph recruited from the main university hospital of Alexandria. All patients were subjected to detailed history taking, full clinical examination, and conventional radiograph and multidetector CT of the chest with intravenous contrast, using four and six multidetector CT scanners, GE Lightspeed and Simens Emotion 6, respectively. The scan parameters used were 120 kVP and less than 240 mA per slice; tube rotation was 0.75 s and slice thickness was 1.25 mm. Fiberoptic bronchoscopy with transbronchial needle aspiration biopsy was performed according to radiological and bronchoscopic landmarks for cytological examination and histological examination.

Results In this study, metastatic lymphadenopathy was encountered in nine patients, pulmonary tuberculosis in four, lymphoma in eight, and sarcoidosis in four. The diagnosis was confirmed by transbronchial needle aspiration biopsy and percutaneous needle aspiration from the peripheral lymph node.

Conclusion Multislice CT of the chest is considered as a simple, safe, and minimally invasive procedure. *Egypt J Broncho* 2014 8:17–22

Egyptian Journal of Bronchology 2014 8:17–22

Keywords: computed tomography, mediastinum, lymphadenopathy

[a]Department of Radiology and [b]Chest Diseases, Faculty of Medicine, Alexandria University, Alexandria, Egypt

Correspondence to Ahmed Youssef Shaaban Gad, MD
Chest Department, Faculty of Medicine, Alexandria University, Egypt
Tei: 01144666619; Fax: 03 5422551
e-mail: youssef662000@yahoo.com

Received 27 August 2013 **Accepted** 3 October 2013

Introduction

Mediastinal masses and lymphadenopathy are often incidentally detected on chest radiograph. Although conventional radiography may detect or suggest the presence of mediastinal lesion, in most cases it is of limited use in determining the exact nature and extent of the lesion [1].

Because of this wide variety of anatomic structures, computed tomography (CT) enables accurate detection of lesions as well as precise demonstration of the relationship of such lesions with adjacent vital structures. The CT appearance of the mass often provides enough information to allow a specific diagnosis to be made [1].

Multidetector CT is usually a second-line investigation after conventional radiograph. Axial imaging avoiding the problem of overlapping tissues with similar density, demonstration of mediastinal spaces with their lymph nodes, and relationship with surrounding structures and blood vessels represent the most important contributions of CT. Indications include characterization of lesion (cystic/solid, density/calcification) on the basis of attenuation values and assessment of the mediastinum in patients with a clinical suspicion of disease but unremarkable standard radiograph [2].

Recently, technologic advances in medical imaging permitted the introduction of tridimensional exploration of the bronchial tree. The images obtained through volumetric CT can be used to reconstruct three-dimensional images. Virtual bronchoscopy allows the navigation in airways and the exact location of endobronchial lesions with respect to extrabronchial structures. Hence, it plays a major role in the assessment of focal airway stenosis and involvement of central airways by bronchial carcinoma [3,4].

Once lymphadenopathy has been identified, it can be assessed with cross-sectional imaging, which can confirm its location and its relationship with surrounding structures as well as identify cystic, vascular, and soft tissue structures. Multislice CT has transformed CT from a transaxial cross-sectional technique to a three-dimensional imaging modality [5].

 DOI: 10.4103/1687-8426.137347

Aim

The aim of this study was to assess the role of multislice CT in evaluation of thoracic lymphadenopathy.

Patients and methods

Patients

A prospective study in the Radiology and Chest Department, Faculty of Medicine, Alexandria University main hospital was conducted, including 25 patients with thoracic lymphadenopathy on plain chest radiograph or clinically suspected with unremarkable chest radiograph. There were 12 male patients and 13 female patients; their age ranged between 6 and 67 years with a mean age of 45 years.

Methods

All patients were subjected to history taking with special emphasis on history of renal impairment as well as on allergy to contrast agents, clinical examination, and laboratory investigations especially urea and creatinine. Radiological evaluation with plain chest radiograph and CT of the chest was performed using four and six multidetector row CT scanners — GE Lightspeed and Simens Emotion 6, respectively — with intravenous contrast media (patients were scanned 20 min after intravenous contrast injection). Histopathological correlation was performed whenever possible.

The medical ethics were considered: the patients should be aware of examination, patient approval should be obtained, and the patient had to get benefit from examination.

Results

The present study included 25 patients with thoracic lymphadenopathy. There were 12 male patients and 13 female patients; their age ranged between 6 and 67 years with a mean age of 45 years. The main complaints of the patients were cough (72%), dyspnea (68%), chest pain (68%), and hemoptysis (36%) (Tables 1–5).

Percutaneous fine needle aspiration from the enlarged axillary and right supraclavicular lymph nodes was conducted in three (12%) patients and was confirmed to be due to Hodgkin lymphoma (HL) in one patient, non-Hodgkin lymphoma (NHL) in the other one, whereas the last one was due to metastasis from ipsilateral managed right cancer breast (Tables 6 and 7).

Discussion

Although conventional radiography may detect or suggest the presence of mediastinal lesions, in most cases it is of limited use in determining the exact nature and extent of a lesion. Because of this wide variety of anatomic structures, CT enables accurate detection of lesions as well as precise demonstration of the relationship of such lesions with adjacent vital structures.

Table 1 Comparison between computed tomography and radiograph detectability of thoracic lymphadenopathy

	Modalities			
	Radiograph		CT	
	Positive	Negative	Positive	Negative
N (%)	15 (60)	10 (40)	25 (100)	0 (0)

CT, computed tomography.

Table 2 Distribution of the lymph nodes regarding the station

Station of LNs	Patients [*n* (%)]
Highest mediastinal	2 (8)
Upper paratracheal	6 (24)
Prevascular and retrotracheal	1 (4)
Lower paratracheal	6 (24)
AP window	4 (16)
Paraaortic	1 (4)
Subcarinal	0 (0)
Paraesophageal	1 (4)
Pulmonary ligament	1 (4)
Hilar	4 (16)
Interlobar	0 (0)
Lobar	0 (0)
Segmental	0 (0)
Subsegmental	1 (4)
Others	
Supraclavicular	1 (4)

Most of the patients have more than one site involved. AN, anteroposterior; LN, lymph node.

Table 3 Distribution of the patients according to the cause of lymphadenopathy

Pathologies	Patients [*n* (%)]
Lymphoma	8 (32)
Tuberculosis	4 (16)
Metastasis	9 (36)
Sarcoidosis	4 (16)
Total	25 (100)

Table 4 Distribution of the patients according to data confirmation

Data confirmed by	Patients [*n* (%)]
Transbronchial biopsy	18 (72)
Percutaneous fine needle aspiration	3 (12)
Clinical and laboratory	4 (16)
Total	25 (100)

Table 5 Distribution of lesions confirmed by transbronchial biopsy

Lesions	Patients [*n* (%)]
Lymphoma	6 (24)
Metastasis	8 (32)
Sarcoidosis	4 (16)
Total	18 (72)

The CT appearance of the mass often provides enough information to allow a specific diagnosis to be made [1].

Recently, technologic advances in medical imaging permitted the introduction of tridimensional exploration of the bronchial tree. The images obtained through volumetric CT can be used to reconstruct three-dimensional images. Virtual bronchoscopy allows the navigation in the airways and the exact location on endobronchial lesions with respect to extrabronchial structures. Hence, it plays a major role in the assessment of focal airway stenosis and involvement of central airways by bronchial carcinoma [3,4].

Accurate assessment of lymph nodes of the mediastinum is essential in selecting the best treatment and prognosis in patients with non-small-cell lung cancer. As mediastinoscopy is not always performed for staging, CT may be the only procedure used for evaluation of intrathoracic lymph nodes. Nodal metastases in lung cancer staging are classified as N1, N2, or N3 on the basis of the location of the nodes with respect to the primary lung cancer. N1 refers to local spread to intrapulmonary peribronchial and ipsilateral hilar nodes. N2 refers to more distant spread, including ipsilateral mediastinal and midline prevascular, retrotracheal, and subcarinal nodes. N3 is defined as even more distant spread to contralateral mediastinal or hilar nodes or to ipsilateral or contralateral supraclavicular nodes [6].

In our study, stations of lymph nodes were evaluated for detection of nodal metastasis. A lymph node is considered metastatic when the short axis of the node is more than 13 mm in the subcarinal region and more than 10 mm for the remaining regions. Necrotic nodes are considered metastatic regardless of their size [7].

Table 6 Distribution of metastatic lymphadenopathy according to the primary lesion

Lesions	Patients [*n* (%)]
Breast cancer	2 (8)
Esophageal carcinoma	1 (4)
Lung cancer	5 (20)
Pleural mesothelioma	1 (4)
Total	9 (36)

Although CT scanning is clearly an imperfect means of staging the lymph nodes, it remains the best overall anatomic study available for the thorax. A CT scan usually guides the choice of nodes for selective node biopsy by invasive techniques, and thus continues to be an important tool for diagnosing lung cancer. The choice of individual nodes for sampling as well as the choice of the most appropriate invasive technique (including transbronchial, transthoracic, or transesophageal needle aspiration, mediastinoscopy, or more extensive surgery) will typically be directed by the findings of the CT scan [8].

Mediastinoscopy should allow evaluation of nodes in the upper paratracheal, lower paratracheal, right tracheobronchial, left peribronchial, and subcarinal nodal stations. Aortopulmonary window and anterior mediastinal nodes are typically considered accessible to the mediastinoscopy [9].

Fultz *et al.* [10] concluded that, to properly search for metastatic spread, it is important to carefully evaluate the specific nodal stations that drain the thoracic structures from which a primary tumor originates. The mediastinal lymph nodes are generally considered enlarged if the short-axis diameter is greater than or equal to 10 mm, but micrometastasis in the lymph nodes can occur without nodal enlargement. Owing to the limitations of size criteria in predicting nodal status, pathologic confirmation is essential for true staging. CT is useful in helping the surgeon or interventional radiologist to determine the most appropriate approach for nodal sampling.

Lardinosis *et al.* [11] reported that noninvasive radiographic imaging with chest CT and PET scans is routinely performed in patients with suspected metastatic lung cancer. Chest and upper abdomen CT scans may reveal hilar and mediastinal adenopathy and liver or adrenal involvement. Although CT accuracy is 88% (80% sensitive, 100% specific) in the mediastinum, staging is enhanced by PET. Integrated CT/PET scanners appear to have better test characteristics than CT or PET alone.

Silvestri *et al.* [12] stated that a chest radiograph should be obtained in all patients with suspected

Table 7 Comparison of computed tomography features in thoracic lymphadenopathy due to various causes

CT features	Tuberculosis	Sarcoidosis	Lymphoma	Metastasis
Total (*N*)	4	4	8	9
Enhancement				
Rim enhancement	3/4	0/4	1/8	4/9
Mild homogenous	1/4	2/4	3/8	3/9
Hypodense areas	3/4	0/4	1/8	4/9
Calcification (punctuate)	1/4	0/4	1/8	0/9
Loss of facial planes	0/4	0/4	6/8	6/9
Site (most common)	Right paratracheal	Bilateral hilar	Anterior mediastinal	Hilar, paratracheal, subcarinal

CT, computed tomography.

non-small-cell lung cancer as an initial estimate of the extent of disease. This should be followed by a more detailed evaluation by contrast-enhanced CT scanning, which extends through the lungs, liver, and adrenal glands. CT scanning is ideal for tumor node metastasis staging. It can characterize the primary tumor and define its relationship with the chest wall and mediastinal structures; it can identify mediastinal lymph nodes that are enlarged and suspicious for malignant involvement; and it can detect contralateral lung, chest wall, or upper abdominal lesions that are suspicious for metastasis.

In our study, lymphoma was the diagnosis in eight (32%) patients, HL was encountered in six (24%) patients and predominantly involved the anterior (prevascular) and middle mediastinal lymph nodes, and all demonstrated homogenously enlarged lymph nodes. NHL was encountered in two (8%) patients and involved mainly middle and posterior mediastinal lymph nodes showing central areas of low attenuation following treatment. Lung involvement was encountered only in one patient with NHL.

These findings were in agreement with the results of Toma *et al.* [13] who stated that, at CT, the typical finding in HL is a hypoattenuating, mainly homogenous or nonhomogenous, lobulated mediastinal mass. Hilar lymphadenopathy occurs more frequently in HL than in NHL and is usually bilateral; they added that HL and NHLs constitute 10–15% of all childhood cancers in developed countries and are third in frequency after acute leukemias and brain tumors. In addition, they reported that, in HL, the prevalence of pulmonary involvement in patients of all ages is 5–10% at the time of diagnosis, usually in association with hilar or mediastinal lymphadenopathy, and, in NHLs, lung involvement at the time of diagnosis is observed in less than 5% of patients and may occur without concomitant hilar or mediastinal disease. The presence of pulmonary disease is characteristic of stage IV disease and significantly alters prognosis and therapy. In both HL and NHLs, the most common mechanisms of disease spreading into the lungs are hematogenous and lymphatic dissemination and less frequently direct invasion.

Virginia *et al.* [14] agreed with our results in that superior mediastinal lymphadenopathy is a hallmark of HL. The anterior mediastinal and paratracheal lymph node chains are the most frequently involved. Hilar lymphadenopathy in the absence of mediastinal involvement is unusual. Nodal calcification may develop after radiotherapy. NHL shows a higher frequency of involvement of a single nodal group and a lower frequency of superior mediastinal lymphadenopathy.

Tateishi *et al.* [15] reported that, on CT, HL is characterized by the presence of a discrete anterior mediastinal mass with a lobulated contour. The tumor most commonly demonstrates homogeneous soft tissue attenuation, although large lymph node masses may demonstrate heterogeneity with complex low attenuation representing necrosis, hemorrhage, or cystic degeneration.

In our study, sarcoidosis was encountered in four (16%) patients with typically involved right paratracheal, aortopulmonary, and bilateral hilar lymph nodes; this is associated with lung involvement with perilymphatic infiltration of sarcoidosis predominating in the interlobular septa in one female patient.

Koyama *et al.* [16] in their study stated that sarcoidosis commonly affects young and middle-aged patients, with a slightly higher prevalence in women. The diagnosis of sarcoidosis is commonly established on the basis of clinical and radiologic findings supported by histologic findings. Acute onset with erythema nodosum or asymptomatic bilateral hilar lymphadenopathy usually reflects a self-limiting course with spontaneous resolution, whereas insidious onset especially with lung involvement or multiple extrapulmonary lesions may be followed by progressive fibrosis of the lung and other organs. They also added that lung involvement is seen in ~20% of patients with sarcoidosis and has a strong predilection for the upper lobes. CT can accurately depict this characteristic distribution and typically demonstrates multiple small nodules in a perivascular distribution, along with irregular thickening of bronchovascular bundles and interlobular septa. Other findings include multiple miliary nodules, bronchial wall thickening, and ground-glass attenuation; the latter may reflect the presence of microscopic interstitial granulomas.

As noted by Akira *et al.* [17], the patients with a predominantly ground-glass opacity pattern and consolidation pattern seen on the initial CT scan had a worse prognosis and were susceptible to developing severe respiratory insufficiency.

Prabhakar *et al.* [18] reported that intrathoracic lymphadenopathy is the most commonly encountered radiologic finding in sarcoidosis (85% of cases) and massive lymphadenopathy (lymph nodes>2 cm) seen in 10% of patients. They agreed with the study by Koyama *et al.* [16] and with our findings in that the right paratracheal and bilateral hilar lymphadenopathy are most commonly identified, although left paratracheal and aortopulmonary window nodes are also commonly enlarged. They also added that one of the more common differential considerations in these patients is lymphoma. To further complicate matters, a known association exists between sarcoidosis and lymphoma, described before and called 'sarcoidosis–lymphoma syndrome'.

In our study, tuberculous lymphadenopathy was encountered in four (16%) patients showing the following CT features: presence of calcifications (one patient), rim enhancement (three patients), hypodense areas (three patients), and intact facial planes (four patients). The nodal involvement was almost always multiple with the right paratracheal glands being the most frequently involved.

These findings were consistent with the findings reported in a study by Perez-Solis *et al.* [19]; they stated that, in tuberculous lymphadenopathy, the CT typically depicts enlarged nodes with a low-attenuation center and a contrast-enhanced rim, which correlate with central caseation surrounded by reactive inflammation, whereas lymphomas enhancement pattern is usually homogeneous. The involved nodes occasionally show calcification.

In addition, our results are consistent with the results of Im *et al.* [20] who stated that mediastinal lymph node enlargement was seen on CT scan in nine of 29 (31%) patients who had newly diagnosed disease and in two of 12 (17%) patients who had reactivation. Enlarged lymph nodes in patients with active Tuberculosis (TB) typically show central areas of low attenuation on contrast-enhanced CT scan, with peripheral rim enhancement.

Moon *et al.* [21] assessed the role of CT scan in the diagnosis of tuberculous mediastinal lymphadenitis in 37 patients who had active disease and in 12 patients who had inactive disease. In the 37 patients who had active disease, mediastinal lymph nodes ranged in size from 1.5 to 6.7 cm, and all had central low attenuation and peripheral rim enhancement. Foci of calcification were seen within the lymph nodes in seven (19%) patients. In the 12 patients who had inactive disease, the nodes were usually smaller than nodes in patients who had active disease, and they appeared homogeneous without low-attenuation areas. Calcifications within the nodes were seen in 10 of the 12 (83%) patients who had inactive disease. Low-attenuation areas within the lymph nodes in patients who had active TB corresponded pathologically to areas of caseous necrosis. In all the 25 patients followed up after treatment, enlarged mediastinal nodes decreased in size and low-attenuation areas within the nodes disappeared.

In our study, metastatic lymphadenopathy was the most common cause of lymphadenopathy, whereas lymphoma was the second most common cause followed by tuberculous and sarcoid lymphadenopathy. However, the detection of lymphadenopathy depends mainly on the size of lymph node, which may be normal in early stages of the disease as in micrometastasis. Low-attenuation center of the lymph nodes may be seen in metastasis or tuberculous infection or after treatment of lymphoma. In addition, calcified lymph nodes may be seen in healed granulomatous disease, some metastasis, and in treated lymphoma.

Conclusion

Lymphadenopathy is a common disorder involving the thoracic area, and CT diagnosis of lymphadenopathy depends mainly on the size of lymph nodes. A biopsy confirmation of neoplastic nodal involvement is necessary before a patient is subjected to surgery.

Multi detector computed tomography (MDCT) can provide more data for better characterization of the mediastinal lesion and demonstrating its extent and its relationship with adjacent structures.

In metastatic lymphadenopathy, hilar, paratracheal, and subcarinal lymph nodes groups are the most common sites of involvement, and loss of facial planes, hypodense areas, and rim enhancement are frequent features, whereas calcifications were not observed at all.

Lymphoma is a common cause of lymphadenopathy mainly the HL; no radiological features can differentiate HL from NHL, but superior mediastinal lymphadenopathy is a hallmark of HL and the anterior mediastinal and paratracheal lymph node are the most frequently involved, whereas NHL shows a higher frequency of involvement of a single nodal group and a lower frequency of superior mediastinal lymphadenopathy.

Intrathoracic lymphadenopathy is the commonly encountered radiologic finding in sarcoidosis and typically manifests as bilateral hilar adenopathy with right paratracheal adenopathy, although left paratracheal and aortopulmonary window lymph node are also commonly enlarged with preserved facial planes.

Enlarged lymph node in patients with active TB typically shows central areas of low attenuation on contrast-enhanced CT scan, with peripheral rim enhancement.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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