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RESEARCH ARTICLE

An Analysis of the Pattern of Findings on the Mediastinum in the Computerised Tomography Chest in Kenya

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Abstract

The purpose of this paper is to assess the pattern of findings in the Mediastinum in Computersied Tomography chest based on a study of major hospitals in Kenya. CT Scan chest was performed in patients suspected to have pathologies in the chest mediastinum. This was a one year prospective study done in four major radiological centres in Nairobi, namely Kenyatta National Hospital (KNH), the Nairobi Hospital, Medical Imaging and Therapeutic Centre (MITC) and the Aga Khan Hospital, Nairobi. It was carried out on diverse dates from May 1st 1999 to April 30th 2000. There were a total of 101 patients studied out of 376 done CT chest in these four centres. Out of these, 28 were from KNH, Nairobi Hospital 27, MITC 40, and Aga Khan 6 patients. The overall male: female ratio was 2.48:1 with an age range of 2 months to 80 years. Most patients were over 60 years (35.64%) and the commonest clinical presentation was chest pain (21.19%). The major finding was lymph node enlargement. In all patients, a chest radiograph had been done and the commonest finding was a widened mediastinum (34.11%). Majority of the patients referred for CT Scan (23.76%), the clinicians did not give a specific clinical diagnosis. CT scan was able to delineate these masses and give a near exact diagnosis in the majority of these cases. CT scan showed most of the masses in the middle mediastinum (51.49%) and these were mainly lymph node enlargement. Most of the mediastinal masses (53.47%) were benign. The study recommends that CT Scan chest should be done routinely in suspected chest mediastinal pathologies. The study contributes important knowledge to studies of the pathologies in the Mediastinum.

Introduction

Computer Tomography (CT) is medical equipment that produces thin slice of X-Rays from a rotating source through a subject. A receptor picks the remnant X-Rays at the opposite end and their intensity is transmitted to a computer for image reconstruction analysis. CT can be done from head to toe for various pathologic masses affecting these areas. Specific CT findings are confirmed by tissue biopsy for histology. Masses are confirmed because they displace structures of normal anatomy.

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The advent of CT in the Mid 1970s, made it possible for the human body to be studied tomographically in the axial (or transverse) plane with a high spatial resolution and a contrast resolution far superior to that of conventional radiographic techniques. There are several excellent imaging modalities available for studying mediastinal masses such as chest radiographs, conventional tomograhy, Computed tomography, Magnetic Resonance

Chest X-ray both posteroanterior CPA) and lateral X-rays are often the examinations carried out on patients initially and their interpretationis often

difficult. The lateral chest film is mainlyused for localization of lesions seen on the P A film. CT scan enables the mediastinum to be examined and confirm the diagnosis or explain those aspects on a standard chest X-ray, which were difficult to analyse. Mediastinal analysis with other imaging studies is inexact, and CT may be most effective as a road map for more definitive pre- operative assessment. MRI currently offers no advantages over CT in imaging of the Mediastinum but can be helpful in evaluation of parts of the chest not well demonstrated on axial images.

CT is superior to plain radiography in the diagnosis of thymoma, neurogenic tumors and benign cysts. It provides an accurate pre-operative assessment by better demonstration of the full extent of abnormalities, the relationship with adjacent normal structures and is useful in surgical planning, monitoring of therapeutic and detecting recurrence of mediastinal masses.

Imaging Modalities

Chest Radiographs

Posteroanterior and lateral chest radiographs ate the first Imaging Modalities used when a mediastinal mass is suspected. Deformation of Mediastinal contours and lines or displacement of normal structures must be present to identify a mass.

Typical location can help in identification in lymph nodes on the basis of age, gender and clinical findings. For many years lateral chest X-ray had been used for localising the Mediastinal masses (Fraser *et al.*, 1991; Heitzman, 1988).

Conventional Tomography

According to Muhm (1985), conventional tomography is a quick and relatively inexpensive way of determining an abnormality seen earlier on conventional chest radiograph. The examination frequently leads to the diagnosis of the cause of the abnormality for appropriate management. If the diagnosis cannot be made, other examination such as CT and MRI can be suggested for further work up (Buckley *et al.*, 1998). This imaging modality is however becoming obsolete, and would not be found in modern imaging centres.

Computed Tomography (CT)

Naidich *et al*. (1991) consider CT the most important tool in the evaluation of Mediastinal mass. It is the next step following chest radiography and is often sufficient in the management of a patient. Characterization on CT is based on specific attenuation of air, fat, water, and calcium. Vascular abnormalities and the degree of vascularization of soft tissue masses are demonstrated by dynamic incremental CT or spiral CT (Armstrong, 1995; Naidich *et al.*, 1991).

Magnetic Resonance Imaging (MRI)

Magnetic Resonance Imaging of the Mediastinum has many advantages. There is an excellent soft tissue contrast with spontaneous tissue-vessel contrast and direct multiplaner capabilities. The MRI technique includes currently ECG- gated spin- echo and T2 - weighted and gadolinium - enhanced Tl - weighted scans in the appropriate axial, sagittal, coronal, or oblique plane. Gradient-echo techniques are useful in exploration of vascular patency. In clinical practice, MRI is done when iodine contrast cannot be used, or after CT if questions remain unanswered (Ikezoe *et al.*, 1992; Link *et al.*, 1993; Webb & Sostman, 1992).

Ultrasound (US)

Transthoracic ultrasound is not currently used in mediastinal mass evaluation, although it does have a potential role in certain situations. The major limitation is an inappropriate window but useful information can be obtained especially in children in masses abutting the chest wall and in vascular abnormalities (Wemeke *et al.*, 1990). Endoesophageal ultrasonography may have a role in assessing masses of the mediastinum particularly to evaluate their relationships with the oesophagus or left atrium.

Transthoracic Needle Biopsies

Percutaneous fine-needle aspiration and more recently, core biopsies with large bore needle guided by CT scanning or US have also been advocated for the diagnostic examination of mediastinal lesions (D'Agostino *et al.*, 1993; Yu *at al.*, 1991). Lf the mass is clearly invasive and looks unresectable, then a biopsy, either guided by imaging or surgical, is indicated, Despite the excellent safety and low complication rate with guided biopsies, the nature of these common tumours found especially in the anterosuperior compartment tends to limit the accuracy of guided biopsies, especially when classification is needed like in non-Hodgkins lymphoma thymomas, or Hodgkins disease.

Anatomy

The mediastinum is a narrow central, vertically orientated space in the chest, bounded on either side by the two lungs and their pleural reflections on their medial aspects. Superiorly it extends from the thoracic inlet, and the diaphragm forms the inferior

border. Anteriorly, it extends from the posterior surface of the sternum to the anterior surface of the vertebrae posteriorly. It is divided into several anatomic compartments. The most accepted form of division recognises a superior and inferior compartment. The inferior compartment is further divided into the anterior, middle and posterior mediastinum (Armstrong *et al.,* 1995). This is the one used in this study. The superior mediastinum lies between the posterior surface of the manubrium sterni anteriorly and the first four thoracic vertebrae posteriorly. Inferiorly, the plane passing through the sternal angle anteriorly and the lower border of the body of the fourth thoracic vertebrae bound it posteriorly. The upper limit is the thoracic inlet and the lateral limits are the mediastinal pleural surfaces. It contains several muscles, the aortic arch, the brachiocephalic vessels, the left common carotid and subclavian vessels, the upper part of the superior vena cava, the left superior intercostal veins, the vagus nerve, the phrenic and left recurrent laryngeal nerves. It also includes the oesophagus, the thoracic duct, the thymus gland, paratracheal, brachiocephalic and some tracheobronchial lymph nodes.

The anterior mediastinum which is part of the inferior compartment lies between the posterior surface of the body of the sternum anteriorly and the anterior pericardial reflection which forms its posterior border. Above, is the superior mediastinum while the diaphragm forms the lower limit. The two pleural sacs form its lateral walls. It contains loose areola tissue, the sterno pericardi alligarnents, lymph nodes and branches of the internal mammary artery.

The middle mediastinum is the broadest subdivision of the inferior mediastinum. It contains the heart, the pericardium, the ascending aorta and the lower part of the superior vena cava. The terminal azygous vein, the tracheal bifurcation, the two bronchi, the pulmonary trunk with its subdivisions into left and right pulmonary arteries, the left and right pulmonary veins, phrenic nerves and some lymph nodes.

The posterior mediastinum is bound anteriorly by the trachea in the upper part and the posterior pericardial reflection in the lower. The vertebral bodies form the posterior limits and inferiorly it extends upto the diaphragm. It contains the descending aorta, the azygous veins, the vagus and splanchnic nerves, the oesophagus, thoracic duct and some lymph nodes.

The mediastinum, being a rich and central area for lymphatic drainage, is often a common site of spread of lesions originating elsewhere', for example, direct spread of bronchogenic carcinoma and metastases of carcinoma of the lung or the intra- abdominal organs.

The above anatomical compartmentalization is used in this study. However, other workers like Felson, introduced a radiological compartmentalization of the mediastinum into anterior, middle and posterior!". In this form of division, there is no superior mediastinum. Knowledge of the common lesions and their anatomical location is therefore important to the radiologist in evaluation of the mediastinum and subsequent management.

Limitations of the Study

One limitation of the study was that not masses were confirmed histologically. Moreover, CT Scan chest is expensive and some patients could not afford the study. Nevertheless, the study and its findings as discussed in this paper highlights some of major patterns of findings that CT scan chest has revealed in Kenya's major hospitals, which could be of great use to future understanding of the nature of mediastinal pathologies in the region, and how to curb them.

Material and Methods

This was a prospective study and all retrievable information on CT chest in the period of study was included. Patients send for the examination during the period of study were included. In the study the compartmentalization of the mediastinum into superior and inferior was used. The inferior is further divided into anterior, middle and posterior compartments. The age, sex, and previous chest X-ray findings were recorded as well as the Imaging centre, where it was done. Signs, symptoms and clinical diagnosis were recorded on a Data collection form. CT scans done were from various types of scanners available in Nairobi. These are: Phillips Tomoscan CX1 Q installed in 1991 at KNH and Siemens Somatom AR at the Nairobi Hospital, both of which are third generation units. Then, Siemens Somatom ARSP (with spiral component) at MITC and General Electric Sytex Synergy (with spiral component) at the Aga Khan Hospital, both of them being fourth generation units. The technique used was standardized on all patients, except where intravenous contrast was used.

All patients were scanned in the supine position after being immobilized with the aid of restraining devices. Patients were also instructed when to hold up the breath so as minimize motional artifact. A computer scannogram image was produced by the

scanner and the scan plans were chosen perpendicular to the mid saggital plane. The scans were performed from the thoracic inlet up to the diaphragm (around lumbar vertebrae 2). Contiguous scans of 10mm thickness and occasionally 5mm or 2mm thickness, were done. Intravenous contrast and oral contrast were occasionally given depending on the pre-contrast findings. However, there is no benefit in their routine use due to low attenuating characteristics of the lungs surrounding the mediastinum and high attenuating characteristics of the sternum anteriorly and vertebral bodies posteriorly. Due to the fast blood flow in mediastinal vessels, and the peristalsis in the oesophagus, giving contrast is usually not useful. Contrast agents are also associated with definite risks and in addition they are expensive. Both mediastinal and lung windows were used to evaluate the images. In a few cases reconstruction was also done for further assessment.

Result and Discussion

The chest radiograph had been taken for all the 101 patients and the findings are presented in the tables below.

Table 1: Findings of the Chest Radiograph

Chest Radiograph Findings	No.	0/0
Widened mediastinum	44	34.11
Radio Opaque Mediastinal mass	37	28.68
Shift of Mediastinal Structures	23	17.83
Non-specific findings	9	6.98
Carcinoma of oesophagus	6	4.65
Barium swallow done also		
Left hilum prominent	2	1.55
Segmental pneumonia	2	1.55
Apical opacity	1	0.775
Pulmonary infiltration with hilar congestion	1	0.775
Aortic Calcification	1	0.775
Pulmonary fibrosis	1	0.775
CVP line	1	0.775
Pericardial effusion	1	0.775
Total	**129**	**100.00**

In the chest radiograph, there was usually more than one finding in one patient, for example a widened mediastinum together with a shift of the mediastinal structures. This explains why in Table 1, there are more findings than the total number of patients. In general, the chest radiograph findings were non-specific as compared with CT scan findings. However, chest radiographs confirmed hilar mass, aortic calcification position of CVP line among others.

Table 2: Clinician's probable diagnosis

Diagnosis	No.	% (n = 101)
Retrostemal goitre	11	10.9
Thymic mass	3	3.1
Benign Mediastinal mass	7	6.9
Metastases to the mediastinum	17	16.8
Non specific	24	23.76
Carcinoma of the Oesophagus	9	8.91
Old TB with Lymphadenopathy	5	4.95
Superior mediastinal mass	3	2.97
Hilar Mass	2	1.98
Scoliosis with mediastinal mass	1	0.99
Cystic hygroma	1	0.99
Primary Malignant bone tumour	1	0.99
Mediastinal benign cyst	1	0.99
Extra oesphageal tumour	1	0.99
Paravertebral soft tissue mass	1	0.99
Mass sterno-clavicular joint	1	0.99
Airway obstructive disease	1	0.99
Diabetes mellitus	1	0.99
Lobar pneumonia	1	0.99
Mitral value replacement	1	0.99
Pulmonary hypertension	1	0.99
Hodgkin's lymphoma	1	0.99
Bronchogenic Carcinoma	1	0.99
Respiratory Emphysema	1	0.99
Nodular lympadenopathy	1	0.99
Penetrating thoracic injury	1	0.99
Lung cancer with metastases	1	0.99
Ca PNS with sternal metastases	1	0.99
SVC obstruction	1	0.99
Total	**101**	**100**

Note: Most of the clinical diagnosis was made after a chest radiograph or a Barium swallow.

Superior mediastinal masses were seen in 20.79% and anterior mediastinal masses, in 8.91%. Most masses like thyroid and thymic were arising from the superior mediastinum and extending into anterior mediastnum. Some radiologists classify such masses as anterior mediastinal and those that arise from superior and extend posteriorly as posterior mediastinal. In this study, those masses arising as such are classified as superior mediastinal masses. Most of these superior mediastinal masses, presented as neck masses and majority presented with symptoms of upper airway obstruction. Of the thyroid masses, most of them were goitres (91%) which were benign. Thymic masses were mostly thymomas, which were malignant.

Thyroid masses accounted for 9.90% of all mediastinal masses whereas thymomas formed 4.0% of all masses. The findings of the CT scan are presented in Table 3 below.

Table 3: Findings of the CT Scan in the mediastinum

CT Scan Findings	No.	% (N=101)
Lymph node enlargement or calcification	18	17.82
Carcinoma of oesophagus	11	10.90
Metastases	10	9.90
Thyroid masses	10	9.90
Lymphomas	9	8.91
Aortic aneurysm	5	4.95
Thymomas	4	3.96
Neurogenic tumours	4	3.96
Benign Cysts	2	1.98
Germ Cell Neoplasm	1	0.99
Soft tissue mass (anterior mediastinum)	5	4.95
Prominence of pulmonary artery	2	1.98
Teratoma	1	0.99
Pericardial mass	1	0.99
Right pericardial cyst	1	0.99
Foreign body at left hilum	1	0.99
Mediastinal mass (lobe)	1	0.99
Calcified coronary artery	1	0.99
Subclavian line in tip of atrium	1	0.99
Massive aortic calcification	1	0.99
Endobronchial ca with LN	1	0.99
Superior mediastinal mass	2	1.98
Right atrial myxoma	1	0.99
Gunshot particle at posterior mediastinum	1	0.99
Dilatation of pulmonary truck	1	0.99
Foreign body in oesophagus	1	0.99
Mitral valve prosthesis in position	1	0.99
Pneumopericardium with gas in pericardium	1	0.99
Total	**1**	**100**

In the study, the most common CT finding in the mediastinum examination was lymph node enlargement with or without calcification. This accounted for 17% of the masses. Most significant ones were in the middle mediastinum. Majority of the adenopathy was neoplastic in origin mainly from lymphomas and metastasis from upper gastrointestinal tract, bronchus, breast and PNS. The other causes of adenopathy were inflammation. Tuberculosis accounted for most of this group. In the study, no inhalational adenopathy from diseases like pneumoconiosis was shown. Lymph nodes are usually recognized on chest radiograph, though they were more easily recognized on contrast enhanced CT scan. In the 60 patients who had lymph node enlargement, the majority of lymph nodes were located at the superior mediastinum (prevascular and paratracheal). These observations concur with studies done elsewhere. Filly, Blank and Castellino (1976) have observed that superior mediastinum is the most frequent site of a localized nodal mass in patients with Hodgkins disease particularly those with the nodular sclerosing type (29). Other masses seen in this region included lymphomas (8.9%), bronchogenic cyst 1.0% pericardial cyst 1.0% and atrial myxoma 1.0%. In this study, most masses were located in the middle mediastinum (51.0%) and a majority of

these masses were malignant metastasis. Other workers have found out that 90% of masses in the middle mediastinum are malignant (30). Bronchogenic carcinoma formed 2.97% of all the mediastinal masses.

The posterior mediastinum, sometimes considered as an integral part of the middle mediastinum, can be assimilated by the elasticity of the lungs and pleura. Limited by the posterior contour of the trachea and the anterior vertebral wall, it projects width ways into the paravertebral canals. This area communicates directly upwards to the cervical region and downwards with the subphragmatic area. This is through the orifices, which are the hiatus of the aorta and the hiatus of the oesophagus. This area is difficult to access by conventional x-rays, but it is much more easily investigated by computed tomography. The posterior mediastinum is also easily accessible for needle biopsy. In the study, the main masses encountered were oesophageal lesions and vascular anomalies, especially of the descending aorta.

Table 4: Frequency of Anatomical Location of the Masses

Anatomical Location of Mass	No.	%
Superior mediastinum	21	20.79
Posterior mediastinum	19	18.81
Middle mediastinum	52	51.49
Anterior mediastinum	9	8.91
Total	**101**	**100.0**

Table 5: Location and Frequency of Lymph Node Enlargement

Location of Lymph Node	Frequency	%
Superior mediastinum	15	25.0
Paratracheal (Left and Right)	11	18.33
Tracheobronchial (Left and right)	9	15.0
Subaortic	9	15.0
Pretracheal	7	11.67
Subcarinal	4	6.67
Paraoesophageal	3	5.0
Pretracheal and retrotracheal	1	1.67
Paraaortic	1	1.67
Total	**60**	**100.0**

In other studies, oesphageal masses and abnormalities are not usually discussed with mediastinal masses despite the fact that they belong to the mediastinum. Most of the intra thoracic oesophagus is intimately associated with the thoracic spine and the descending thoracic aorta. In the study, lesions in the middle and distal one third of the oesophagus presented as posterior mediastinal masses. Common presenting symptom was dysphagia. One patient presented with

dyspnoea and aspiration pneumonia as a result of tracheo-oesophageal fistula. Apart from a chest radiograph, some of these patients had a barium swallow done as well. Majority of these patients had a chest radiograph, either showing widening of the mediastinum or displacement of the mediastinal structures, especially the trachea.

In most of these patients who had already been confirmed as having carcinoma of the oesophagus, CT scan was done for accurate staging of the carcinoma. There were a total of 11 patients (10.9%) who had carcinoma of oesophagus. Findings included an intraluminal mass, thickening of the oesophageal wall, loss of adjacent fat planes and evidence of nodal and distant metastasis. In the study, a foreign body was seen in the oesophagus in 1.0%. Other oesophageal benign lesions like hiatal hernia were not observed.

Thoracic Aorta Pathologies

Aortic Aneurysm

Aneurysm is a localised dilatation of the vessel wall and may be classified as true (all three layers intact) or false (disruption of all three layers with containment provided by surrounding connective tissue). In this study, 5.0% of the mediastinal masses were due to aortic aneurysm. Laurent *et al.* (1998) have observed that vascular anomalies represent approximately 10% of mediastinal masses. These must be correctly recognized since failure to identify an aneurysm can lead to dramatic event during an invasive diagnostic procedure. Several entities may cause an aneurysmal dilatation of the thoracic aorta. The dilatations often have a preferential location. The aortic root is widened in patients with Marfan's disease. Cystic Medianecrosis usually involves the ascending aorta.

The descending thoracic aorta or the entire thoracic aorta is frequently involved in atherosclerosis and saccular aneurysms located within the aortic arch are often posttraumatic (31). Out of the 5% aortic aneurysms seen, four-fifths of them were De-barkeys type 1. Only one case of aortic dissection was seen. Aortic dissection may be a life threatening condition, therefore rapid diagnosis is necessary, with close monitoring and often surgical intervention.

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