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RESEARCH ARTICLE

Role of Chest CT Scan to Predict Malignancy on Mediastinal Mass

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Abstract

Mediastinal mass is becoming a global health problem due to high mortality. The heterogeneous mediastinal components make the symptoms of mediastinal mass diverse. CT scans are still the imaging modality for examining mediastinal mass before surgery or other therapies. In this study, we evaluate whether a CT scan could predict the malignancy of mediastinal mass, which is expected to help establish a pre-surgical or pre-biopsy diagnosis. Sixty-two samples were taken consecutively from mediastinal mass patients who came to Dr. Soetomo General Academic Hospital to undergo a CT scan of the thorax with contrast and histopathology examination (core biopsy or open biopsy), which was carried out in the period from December 2019 to March 2024. The results of the CT scan imaging used in this study variable include mass location, mass shape, mass size, infiltration with surrounding organs, attenuation values before contrast administration, after contrast administration, and additional attenuation before and after contrast administration. The CT scan and histopathology results were compared, and multivariate analysis was performed to obtain predictor factors. The location of the mediastinal mass (anterior, medius, posterior), the solid heterogeny component, cystic, calcification, mass shape, organ infiltration, and contrast enhancement value could significantly predict the mediastinal mass's malignancy. If obtained simultaneously, the organ infiltration and contrast enhancement value >20 HU can indicate whether a mediastinal mass is malignant with a specificity of up to 100%.

Keywords: Chest CT scan, histopathology, mass, mediastinum

Introduction

A mediastinal mass is defined as a mass located in the mediastinum consisting of benign or malignant masses with various histopathologic results.[1,2] It could happen to adults or children. The mediastinum is a cavity in the center of the chest, lying between the sternum and vertebrae, and in this cavity, there are essential structures and organs inside it.[3,4] The International Thymic Malignancy Interest Group (ITMIG) divides mediastinum into three compartments: anterior, medial, and posterior.[5,6] The prevalence of mediastinal mass was 3% of all mass at intrathoracic.[7] The complexity of the mediastinal structure and organs makes mediastinal mass symptoms vary. Signs and symptoms are influenced by the mediastinal mass's location and the mass's origin. The symptom also determines whether there is mass infiltration or not. The signs and symptoms include chest pain, dyspnea, or cough.[1,8]

Anatomical pathology examination is the gold standard for determining the origin of a mediastinal mass. This study includes anatomical pathology examination of surgical results and tissue biopsy. A mediastinal mass biopsy can be performed directly (surgery) or using imaging guidance, either a CT scan or ultrasound. This imaging-guided biopsy aims to assess early disease with an accuracy of 93–96%.[9]

Meanwhile, imaging plays a vital role in diagnosing mediastinal mass. In its journey, mediastinal mass imaging begins with

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radiography as an initial modality, which can only evaluate the presence of a mass with a widening of the mediastinum.[10] Imaging to evaluate mediastinal mass has subsequently developed, with the primary modality currently being a multidetector CT scan of the chest with contrast.[5,11] Multidetector CT scans can explain structurally and functionally mediastinal mass, which is why the ITMIG has made thoracic CT scans the gold standard for imaging mediastinal mass.[5] Through this research, we would see the ability of a chest CT scan to predict the malignancy of the mediastinal mass to help the clinician make further decisions for the patient.

Methods

The research is a retrospective study of 62 samples taken consecutively from mediastinal mass patients who came to Dr. Soetomo Academic General Hospital to undergo a chest CT scan with contrast. The scan was performed using a CT scan of Phillips 128 slices—examination in the supine position. Initial imaging in the pre-contrast phase, then a contrast injection is carried out using a non-ionic contrast agent (350 mmol/ml) at 1.5–2 ml/kgBW using an injector at a speed of 5 ml/second, which then reconstruction is carried out in the form of axial, coronal, and sagittal images. CT scan analysis was carried out using the mediastinal window and lung window. The interpretation was carried out blindly by two thoracic radiology consultants without knowing the results of the histopathological examination of the mass tissue. Histopathology examination was obtained by biopsy (core or open biopsy) and operation, and the result was classified based on the WHO classification of thoracic masses.[12] All the examinations were carried out from December 2019 to March 2024.

Descriptive data evaluate the characteristics of mediastinal mass based on its histopathology type. The characteristics presented include mass location, mass shape, mass size, infiltration with surrounding organs, attenuation values before and after contrast administration, and additional attenuation before and after contrast administration.

For the comparative study, we assessed the CT scan characteristics of the mass compared with its malignancy, which was divided into benign or malignant masses. The analytical research used chi-square. The multivariate analysis was performed to obtain predictor factors for the characteristics, which are significant results. This study was approved by the Health Research Ethics Committee of Dr. Soetomo Academic General Hospital, ethics number 1612/LOE/301.4.2/III/2024.

Results

The study describes the characteristics of 62 patients who are suspicious of mediastinal mass. Based on gender, the male sample numbered more than females (2:1), with a total of 39 (63%) males and 23 (37%) females. Mass samples in the malignant category amounted to 52 (84%), and samples in the benign category amounted to 10 (16%) of all samples. The number of male samples in the malignant category was 34 (65%), and 18 (35%) women from the total patients in the malignant category. Meanwhile, the number of male samples in the benign category was 5 (50%), and 5 (50%) females from the total samples in the benign category. The age category ranges from 1 year to 73 years, with the dominant age being 20–to 29 years (n=14).

For histopathology type, there are 11 types of malignant mass and five types of benign mass (Table 1).

Table 1 Histopathology Type

Histopathology Type	n
Malignant mediastinal mass (n=52)	
Thymic carcinoma	10
Thymoma	10
Hodgkin lymphoma	15
Non-Hodgkin lymphoma	2
Yolk sac tumor	2
Seminoma	4
Malignant round cell mass	4
Exstraskeletal Ewing sarcoma	1
Thymic neuroendocrine neoplasm	2
Metastase mucinous carcinoma	1
Liposarcoma	1
Benign mediastinal mass (n=10)	
Thymic follicular hyperplasia	3
Mature teratoma	2
Thymic cyst	2
Lymphadenitis granulomatous	1
Ganglioneuroma	2

From CT scan examination, we obtain several characteristics of mediastinal mass, including location, component, shape, and organ infiltration of mediastinal mass (Table 2).

The mediastinal mass is located in the anteromedial compartment (n=29) and is the only malignant mass in this compartment. Its irregular shape makes up the majority of malignant mediastinal mass (n=34). Most infiltration was found at the malignant mass, with the most significant being vascular and lung infiltration. Figure 1 shows Hodgkin lymphoma as a malignant mass located at the anteromedial, with organ infiltration and an irregular shape.

Ratio data were obtained from the mediastinal mass's size and attenuation value (Table 3). Both benign and malignant masses have no significant difference measure. An increase in attenuation has an important value that can predict the malignancy with significant results (p=0.002). Figure 2 illustrates a malignant mass with histopathology-type thymic carcinoma, which shows an increasing attenuation value of more than 20 HU. Figure 3 shows that one of the benign masses with histopathologic teratoma (n=2) has minimal contrast enhancement (2 HU).

An analytical study was done with a chi-square test. From the variables that have been observed, multiple variables are significantly different between benign and malignant. The location of a mediastinal mass, heterogenous solid component, cystic component, the element's shape, and increase of attenuation after contrast administration have significant differences between benign and malignant masses (Tables 2 and 3).

Multivariate analysis revealed that organ infiltration and an increase in attenuation (>20

Table 2 Characteristics of Benign and Malignant Mediastinal Mass

Characteristics	Malignant n=52	Benign n=10	p
Location			
Anterior	12	5	0.04
Medius	2	1	
Posterior	0	0	
Anteromedius	29	2	
Medioposterior	2	2	
Anteromedioposterior	7	0	
Component			
Solid homogenic	18	6	0.089
Solid heterogenic	34	1	0.001
Cystic	0	3	0.004
Necrotic	16	0	0.053
Calcification	5	5	0.011
Fat	1	2	0.079
Shape			
Round/ovoid	9	8	0.000
Irregular	34	2	
Multilobulated/conglomerated	9	0	
Organ infiltration			
Vascular	10	0	0.010
Lung	8	1	
Chest wall	1	0	
Vascular + lung	12	0	
Vascular + chest wall	5	0	
Lung + chest wall	1	0	
Vascular + lung + chest wall	2	0	
No infiltration	13	9	

Note: significance p<0.05

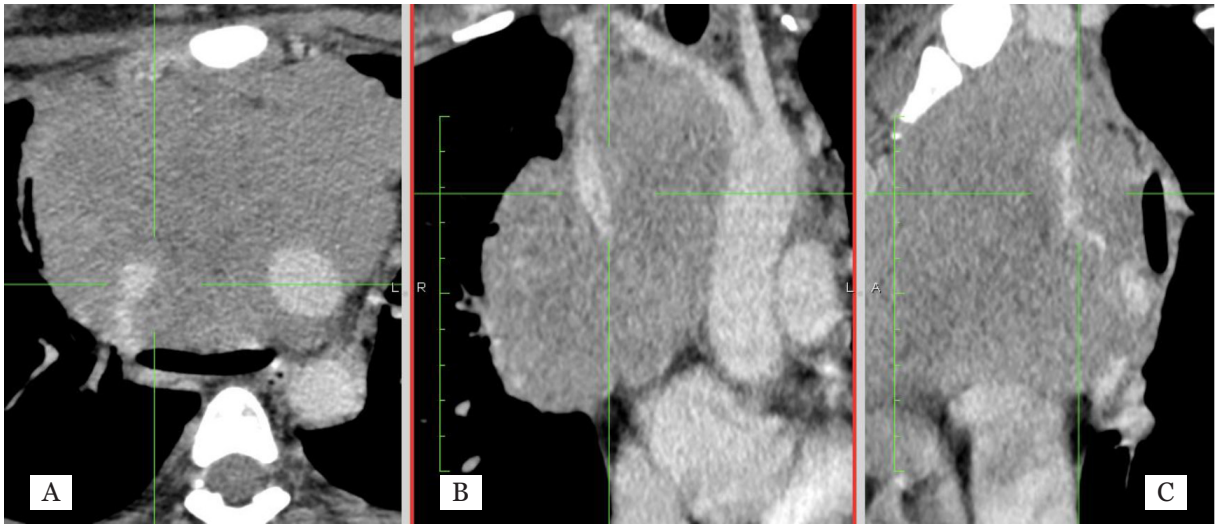

Figure 1 Chest CT Scan of a Patient with Histopathology Result Showing Mediastinal Mass

Note: (A) axial, (B) coronal, and (C) sagittal showing a mass in the anteromedial mediastinum with irregular shape and infiltration of vascular

Table 3 Size and Attenuation of Mediastinal Mass

Variables	Malignant n=52	Benign n=10	p
Size			
Mean	11.412	8.708	0.100
Median	11.35	10.00	
Increase of attenuation			
Mean	28.22	13.75	0.002
Median	26.5	10.5	

Note: significance p<0.05

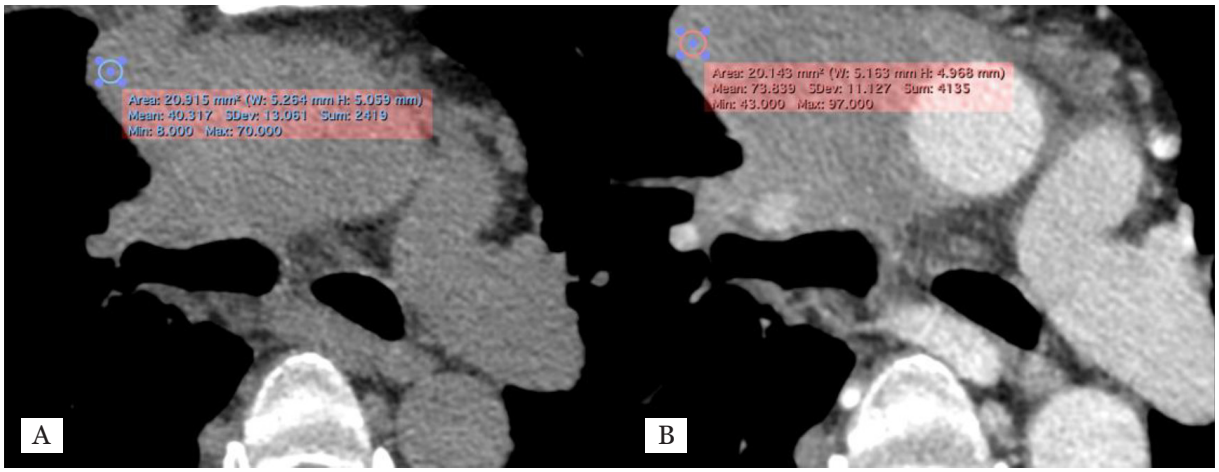

Figure 2 Chest CT Scan with Histopathology Result Thymic Carcinoma Shows Mediastinal Mass

Note: (A) axial without contrast and (B) axial with contrast showing contrast enhancement values more than 20 HU (33 HU)

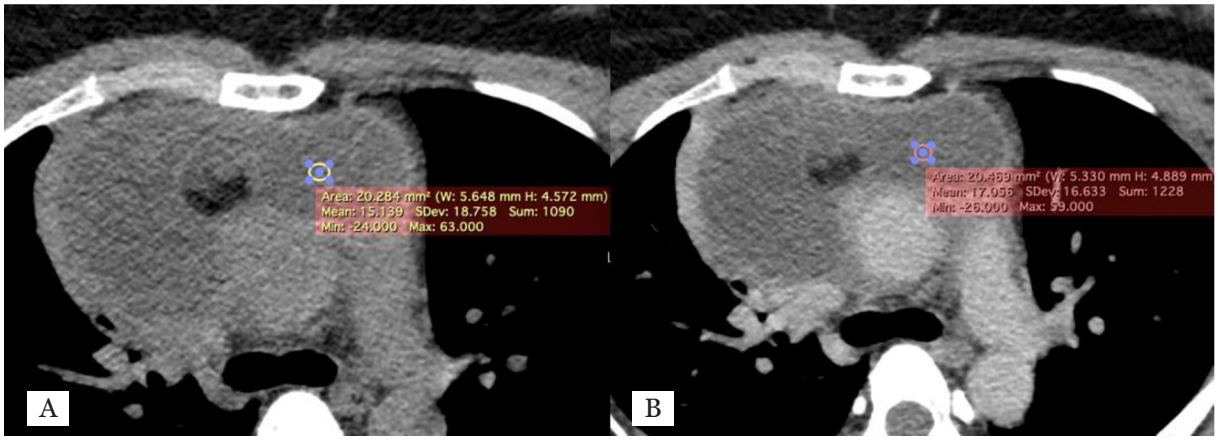

Figure 3 Chest CT Scan with Histopathology Result Mature Teratoma (Benign Type Mass)
Note: (A) axial without contrast and (B) axial with contrast showing contrast minimal contrast enhancement (2 HU)

HU) significantly influence the prediction of the malignancy of mediastinal mass, with diagnostic accuracy present in Table 4.

Discussion

In this study, the gender prevalence we obtained reveals that males 39 (63%) have more cases than females 23 (37%). This result is similar to the research done by Pandey et al.,[13] where the research sample included 60 patients, 37 male and 23 female. A similar result in research conducted by Amin[14] was that from 45 samples, 31 (68.9%) were male, and 14 (31.1%) were female.

The malignant mediastinal mass has a big proportion compared with the benign mass, with 52 (84%) malignant mass and 10 (16%) benign mass. This research is contrary to research conducted by Kaur et al.,[15] where it was found that there were more benign lesions than malignant ones. This research's most histopathological type of mediastinal mass was Hodgkin lymphoma (n=15). However, in the sample distribution range in this study, the age distribution was mainly between 20 and 29 years, which is why the most significant sample was Hodgkin lymphoma. Hodgkin lymphoma occurs in the young age range (20–40 years).[16]

The location statistically has significant differences between malignant and benign (p=0.04). Anteromedius is becoming the most common location of malignant mediastinal mass, with the most histopathology results being Hodgkin lymphoma. This is in accordance with research conducted by Pramesti et al.,[17] which concluded that mediastinal lymphoma is most common in the anteromedial mediastinum.

Solid heterogeny component (p=0.001), cystic component (p=0.04), and calcification (p=0.01) are significantly different between malignant and benign mediastinal mass. Solid heterogeny components are primarily found in malignant mediastinal masses. In malignant mass, the component is the growth of mass cells and the surrounding stromal tissue, which is involved in the surrounding malignant mass.[18] Cystic components are found chiefly in benign mediastinal masses. Another research that

Table 4 Diagnostic Accuracy of Chest CT Scan

Characteristics	Sensitivity %	Specificity %	PPV %	NPV %	Accuracy %
Organ infiltration	76.47	90.9	97.5	45.45	79
Increase the value of attenuation	94.1	72.7	94.1	72.7	90.3
Combination	70.5	100	100	42.3	75.8

supports this research's results is by Szolkowska et al.,[19] where of 179 mediastinal masses with a cystic component in them, 151 were benign masses, and 28 were malignant masses. Mediastinal masses with a cystic component are masses with a round, well-defined shape filled with fluid and lined by epithelium. The majority of cystic masses are congenital benign masses. Some malignant masses, such as thymoma, Hodgkin's lymphoma, germ cell mass, mediastinal carcinoma, lymph node metastases, or nerve mass, can undergo cystic degeneration (especially after radiation or chemotherapy).[20] Calcification gives significant results in this research. The results of this study are contrary to research conducted by Pandey et al.,[13] which stated that calcification was not significant in predicting whether a mediastinal mass was benign or malignant. Some literature notes that calcification cannot prove a mediastinal mass is malignant or benign. Calcification in anterior mediastinal mass can be found in several mass entities, including mass originating from the thyroid and thymus.

The mediastinal mass shape is significantly different between malignant and benign (p=0.000), with the malignant mass dominated by an irregular shape and the benign mass dominating the bay round/ovoid shape. Different growth patterns between benign and malignant masses influence different morphological features in imaging. Benign masses have slow growth characteristics, so they are still round or ovoid. In malignant mass, cellular changes occur, such as acceleration of the cell cycle, gene changes, increased cell mobility, changes in cell walls, and the release of lysis factors. The lysis of the cell walls causes the mass to have ill-defined borders and develop an irregular appearance at the edges.[21]

Almost all the mediastinal mass that made infiltration is the malignant mediastinal mass (p=0.010), with the majority making infiltration vascular. It is explained in the literature that malignant masses can secrete substances that can degrade cell membranes. The degradation of cell membranes causes loss of adhesion between cells, which allows the mass to interact between mass cells and the mass matrix, ultimately infiltrating surrounding organs by the mass.[22] This study's results showed concordance with previous research that the presence of organ invasion provides significant value in predicting mass malignancy.[13]

An increase in attenuation value also results in a significant difference between malignant and benign (p=0.002). On malignant mass, the attenuation is higher than the benign. The author found that attenuation significantly differed between malignant and benign with the cut-off value >20 HU. The authors have not seen previous research that evaluated this value before. Mass angiogenesis theory explains this result. Cancer development requires oxygen, nutrients, and growth factors. Mass cells, which are growing rapidly, are starting to injure the basement membrane, and hypoxia also happens. Those processes activate endothelial cell migration, and angiogenic factors make the proliferation of endothelial cells. New vascularization is made, blood could flow to the new vascular, and give an amount of nutrition to cancer.[23] The addition of intravenous contrast media increases the density and attenuation of blood vessels. The more neo-angiogenesis occurs, the higher the attenuation after contrast administration in the mass fed by blood vessels.

The multivariate analysis shows that infiltration organ and increase of attenuation value after contrast administration could become tools to predict the malignancy of the mediastinal mass. In the presence of mass infiltration, the increased value of mass attenuation after contrast administration, respectively, has a specificity of 90.9% and 72.7%. If the two findings appear together, the specificity increases to 100%. These results can be used to assist in making clinical decisions. If organ infiltration is found and the contrast attenuation value is >20 HU, then 100% of the mass can be predicted as a malignant mediastinal mass.

Conclusions

Mediastinal mass, which has a variety of symptoms, also has a variety of radiological imaging. It consists of malignant or benign lesions. Location compartment, heterogeny component, cystic component, calcification component, shape, infiltration, and increase of attenuation value have a significant difference between benign and malignant mass. Mass infiltration and an increase in attenuation statistically could predict the malignancy of mediastinal mass. Meanwhile, homogenous components, necrotic components,

fat components, and sizes are not significantly different between malignant and benign masses.

Conflict of Interest

There is no conflict of interest in this study.

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