Original Article
Middle East Journal of Cancer; July 2022; 13(3): 515-522

Validity of Multi-Slice Computed Tomography in Evaluation of Mediastinal Mass Lesions

Tuan Tran Anh*,, PhD, Huy Huynh Quang***♦, PhD, Hieu Bui Khac****, MD**

**Radiology Center, Bach Mai Hospital, Hanoi City, Vietnam*
***Radiology Department, Ha Noi Medical University, Hanoi City, Vietnam*
****Radiology Department, Pham Ngoc Thach University of Medicine, Ho Chi Minh City, Vietnam*
*****Radiology Department, National Children Hospital, Hanoi, Vietnam*

Please cite this article as: Anh TT, Quang HH, Khac HB. Validity of multi-slice computed tomography in evaluation of mediastinal mass lesions. Middle East J Cancer. 2022;13(3):515-22. doi: 10.30476/mejc.2022.88115.1458.

Abstract

Background: The present study aimed to present computed tomography (CT) scan characteristics of different mediastinal masses in children to correlate CT findings of the mediastinal masses with histopathology; we also sought to differentiate between benign and malignant mediastinal mass lesions based on CT findings.

Method: This prospective cohort study analyzed 60 patients who underwent multi-slice CT scan for characterization of mediastinal mass. Subsequently, imaging findings were verified with pathological diagnosis.

Results: The median age of the patients was 5.3 years. The common symptoms among these patients were cough, dyspnea, chest pain, and fever. There were 24 benign (40%) and 36 (60%) malignant cases. According to their origins, 20 (33.3%) presented as neurogenic tumors, 16 (26.7%) as lymphomas, (15%) as germ cell tumors 9, and the remaining 15 (25%) as tumors: thymic pathologies, lymphangiomas, and bronchogenic cyst. 22 (36.7%) tumors were located in the posterior mediastinum, followed by 21 (35%) in the anterior mediastinum and 11 (18.3%) in the middle mediastinum.

Conclusion: CT scan was found to be able to distinguish specific tissue densities and their ability to display mediastinum in axial plane. Reconstruction in sagital and coronal planes makes it a useful technique for the evaluation of a mediastinal mass.

Keywords: Mediastinal mass lesions, Multi-slice,Tomography, X-ray computed, Histopathology

♦Corresponding Author:
Huy Huynh Quang, PhD
Radiology Department, Pham Ngoc Thach University of Medicine, Ho Chi Minh city, Vietnam
Email: huyhq@pnt.edu.vn

Introduction

Intrathoracic tumors in infants and children, both benign and malignant, are mostly located in the mediastinum. Their clinical presentation is often non-specific in almost 60% of children's mediastinal masses, and they resemble the symptoms of common respiratory diseases. A quarter of those patients are asymptomatic. Although the clinical presentation of the

Received: September 15, 2020; Accepted: March 27, 2022

mediastinal tumors in children is non-specific or asymptomatic, these children have a risk of developing acute airway compression. The mediastinum is like a complex spider web; this is due to the presence of vital structures (heart and great vessels) in the compact space between the two lungs. Mediastinal lesions are challenging to detect on an X-ray since they are of soft tissue densities and surrounded by soft tissue structures. Previous studies have found conventional methods inadequate, and patients frequently had to undergo invasive procedures for diagnosis. Here is where multi-slice computed tomography (MSCT) can provide the answer. It provides information on the anatomical extent of the lesion and the nature of the lesion (fat, fluid, and calcification). MSCT can help to narrow the differential diagnosis or even reach the diagnosis without the need for further invasive procedures.[1,2]

The current study aimed to present computed tomography (CT) scan characteristics of different mediastinal masses in children to correlate CT findings of the mediastinal masses with histopathology. Moreover, we sought to differentiate between benign and malignant mediastinal mass lesions based on CT findings.

Materials and Methods

Study design

A total of 60 patients participated in this prospective cohort study at Vietnam National Children Hospital for two years, from June 2017 to July 2019, after the approval of the NHP Ethics Committee (reference number: 062017/NHP). All the patients signed the informed consent. All the relevant clinical information and details of laboratory investigation were recorded. All the patients with clinical suspicion of mediastinal mass lesion or an X-ray suggestion of a mediastinal mass underwent MSCT evaluation and correlation with pathological findings was investigated in all the cases.

The inclusion criteria were: 1) patients of both sexes of any age group clinically suspected to have a mediastinal mass lesion; 2) suggestion of a mediastinal widening or a mass on a chest radiograph; 3) availability of histopathological examination report.

The exclusion criteria were: 1) history of hypersensitivity to intravenous contrast agents; 2) post-surgical patients; 3) lesion of vascular origin/cardiac masses.

Procedure

We conducted this research using the Siemen 128-slice CT system with a collimation of 1.5 mm and a reconstruction interval of 0.6 mm, 80 - 100 kv, and 110 - 150 mAs. The matrix size was kept at 512. A plain tomogram was taken as a guide to study. Unenhanced and contrast-enhanced (using non-ionic contrast material) scans were performed sequentially. For contrast enhancement, 1 - 2 ml/kg of non-ionic iodine contrast was initially utilized (Xenetic). Sedatives or anesthetics were considered if the patient could not cooperate during the scan time.

Multi-planar reconstruction and three-dimensional volume-rendering images were created. We evaluated the scans at a multiple window setting (mediastinal window - 50 levels × 350 widths, lung window - 600 level × 1600 width, and bone window - 1000 level × 3000 width).

MSCT characteristics of mediastinal mass were analyzed, such as compartmentalization based on the Benjamine Felson classification system, attenuation pattern, enhancement pattern, presence of necrosis, calcification, invasion, lymph node involvement, presence of metastasis, and other lung collapse-associated findings. Pleural/pericardial effusion was based on MSCT findings.

An available clinical profile provisional diagnosis was assigned, which was correlated with histopathological diagnosis.

Statistical analysis

Continuous variables were summarized as mean and standard deviation, while nominal variables were shown as percentage. The chi-square test and the Fisher Exact test were used for comparing the percentages. *P* values less than 0.05 were considered to be significant. We employed SPSS version 20 software for all the statistical calculations.

Table 1. Histopathological diagnosis of the tumors

Histopathology	Number (n)	Percentage (%)
Neurogenic tumors		
Neuroblastoma	11	18.3
Ganglioneuroblastoma	4	6.7
Ganglioneuroma	4	6.7
Malignant nerve sheet tumor	1	1.7
Germ cell tumors		
Mature teratoma	6	10
Immature teratoma	2	3.3
Yolk sac tumor	1	1.7
Lymphomas		
Non-Hodgkin lymphoma	9	15
Hodgkin lymphoma	7	11.7
Thymus hyperplasia	3	5
Lymphangioma	4	6.7
Bronchogenic cyst	3	5
Others	5	8.5
Total	60	100

Results

Out of the 60 cases in this study, 36 (60%) were male and 24 (40%) were female. The most common age group to present with the mediastinal mass was between 2 and 5 (31.7%). The oldest patient was 15 years old, while the youngest one was 2 days old. In our study, cough was the most prevalent clinical symptom (45%), followed by dyspnea (35%), fever (21%), chest pain (15%), and asymptomatic (10%).

Posterior mediastinal masses formed the majority of the total masses with 36.7% (n = 22), followed by posterior mediastinum with 35% (n = 21), and middle mediastinum with 18.3% (n = 161), as shown in figure 1.

We observed masses in multiple compartments of mediastinum in six cases (10%). Out of these six cases, five involved both anterior and middle mediastinum; one case involved all the compartments (anterior/middle/posterior) of mediastinum. The masses commonly found in multiple compartments were lymphoma.

In this study, posterior mediastinal masses comprised 36.7% (n = 22) of the total mediastinal masses, the majority of which were neurogenic-origin tumors. Out of the 20 cases of neurogenic tumors, neuroblastoma constituted 18.3% (n = 14), ganglioneuroblastoma 6.7% (n = 4), and ganglioneuroma 6.7% (n = 4) of the total mediastinal masses. The most common neoplasms in the posterior mediastinum were neuroblastoma, which were presented in 63.6% (14/22).

Anterior mediastinal masses comprised germ cell tumors predominantly. Among these patients, there were six mature teratomas, two immature teratomas, and one yolk sac tumor.

Almost all the masses located in the middle mediastinum or both middle and anterior mediastinum were lymphomas, accounting for 26.7% (n = 16) of the total mediastinal lesions. There were nine non-Hodgkin lymphomas and seven Hodgkin lymphomas in our study.

Table 1 represents the types of the tumors. There were three main groups, namely neurogenic tumors 33.3% (n = 20), lymphomas 26.7% (n = 16), and germ cell tumors 15% (n = 9).

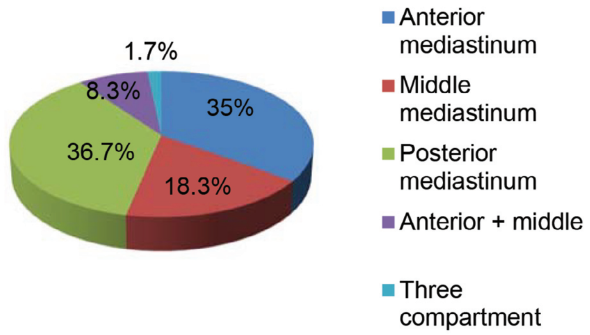

Figure 1. Mediastinal masses were distributed according to compartment division.

Table 2. MSCT features of mediastinal neurogenic origin tumors

MSCT features	Patients' number (n)	Percentage (%)
Calcification	12	60
Necrosis	10	50
Vessel encasement	10	50
Invading the spinal canal	5	25

MSCT: Multi-slice computed tomography

Additionally, herein, there were four thymus hyperplasias, three lymphangiomas, and three bronchogenic cysts.

The median tumor size was 7.8 cm, with the biggest being 16 cm and the smallest being 3.2 cm. The majority of the masses showed heterogeneous attenuation and heterogeneous enhancement (71.7% (n = 43)); homogenous enhancement was only seen in 16.6 % (n = 10) and peripheral rim enhancement in 11.7 % (n = 7).

In our paper, 40% (n = 24) of the mediastinal masses were benign and 60% were malignant. The most prevalent malignancy was lymphoma with 26.7% (n = 16), followed by neuroblastoma with 23.3% (n = 14).

Among the nine germ cell tumors, the solid component was found in 100% of the masses (9/9), and fat tissue and cystic component in 66.7% (6/9); meanwhile, calcification only occurred in 44.4% (4/9) of them.

Table 2 depicts that out of 20 mediastinal neurogenic origin tumors, there were 12 masses with calcification in the tumor (60% (n = 12)); necrosis accounted for 50% (n = 10) these tumors; whereas, five patients had tumors that invaded the spinal canal (25%), and vessel encasement was seen in 50% (n = 10). Table 3 shows 11 (68.8%) cases of lymphoma surrounding large blood vessels in the mediastinum and 56.3% (9/16) cases with the invasion of the surrounding tissues. The diagnostic accuracy of MSCT of the mediastinal tumors for malignant/benign assessment was as high as 88.3% (Table 4).

Discussion

In the current work, 10% of the cases were incidental discoveries. In the 60 subjects, respiratory symptoms were still the most common: 45% of them had a cough, 33.3% had chest pain, 35% dyspnea, and 21.7% fever. This is in line with the study of Pulasani et al.[2] in which out of 50 patients, 44% were examined due to cough, 38% due to dyspnea, 20% because of fever, and 20% because of chest pain. Respiratory symptoms may resemble the symptoms of frequent upper respiratory tract diseases; therefore, on a number of occasions, it is difficult to make an accurate diagnosis of a mediastinal tumor.[3] On account of the smaller size of the thoracic cavity in children compared to that in adults, acute, severe respiratory symptoms due to airway compression

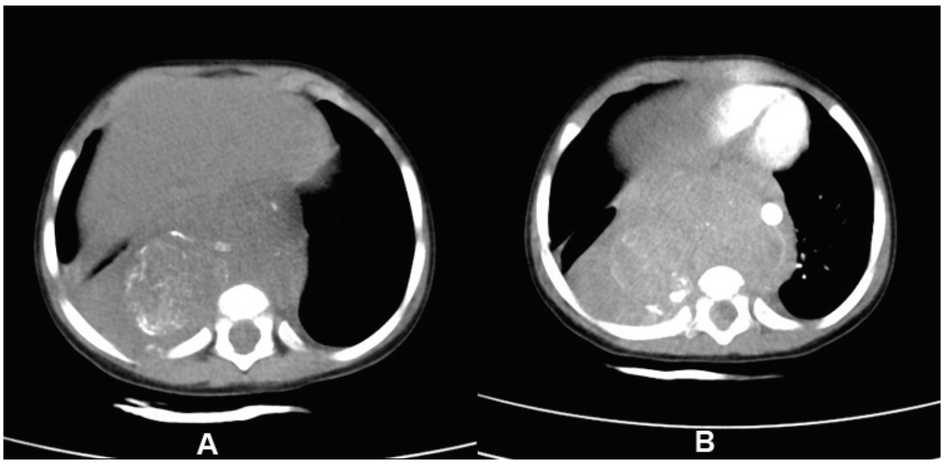

Figure 2. Neuroblastoma in a 16-month-old girl; A: before contrast, calcified inside the mass; B: postcontrast, mass encase aorta.

Table 3. MSCT features of mediastinal lymphoma

MSCT features	Patients' number (n)	Percentage (%)
Necrosis	11	68.8
Haemorrhage	21	2.5
Vessel encasement	11	68.8
Surrounding tissue invasion	9	56.3

MSCT: Multi-slice computed tomography

are more likely to occur. Additionally, most of these masses are located very close to major vessels. Thus, the mediastinal masses are known as a diagnostic challenge for both pediatricians and pediatric radiologists.[4]

The average age of the patients in our study was 5.3 years, with the oldest being 15 years and the youngest being 2 days old. This is similar to the study by Gun et al. who studied more than 120 mediastinal tumors in children and reported an average age of 5.8.[5]

According to previous reports, lymphomas are the most prevalent malignancies, followed by neurogenic tumors. Grosfeld et al., in 1994, reported the largest series of pediatric mediastinal masses with 196 children. Among those patients, lymphomas were the most common tumors with a rate of 42%; neurogenic tumors ranked second, with a frequency of 23.4%.[6] Nonetheless, in our study, the most common mediastinal masses were neurogenic tumors, with a frequency of 33.3%, followed by lymphomas with 26.7% and germ cell tumors with 15%. This result was in accordance with the findings by Gun et al., based on which neurogenic tumors were 38.3%, followed by lymphomas with 18% and germ cell tumors with 7.5%.[5] In this work, neuroblastoma was the most common neurogenic tumor with a frequency of 55% (11/20). Neurogenic tumors are the most prevalent lesions in the posterior mediastinum since it is likely that all of our neurogenic tumors were located in this location. This kind of tumor derives from the sympathetic chains located along the thoracic vertebral bodies. In pediatric patients, the vast majority of these neurogenic tumors are neuroblastomas; the rest are ganglioneuroblastoma or ganglioneuroma.[7]

Mediastinal masses in children could be either benign or malignant.[8] In our series, the majority of mediastinal masses were malignant (60%) and 40% of them were benign. In the study by Grosfeld et al., 72% of the tumors were malignant.[6] This was also the same in the study by Arumugam et al. with 62% of malignant tumors.[9]

Based on the compartment division, we found that 35% of the tumors were located in the anterior mediastinum, 36.7% in the posterior mediastinum, 18.3% in the middle mediastinum, and 8.3% in both the anterior and middle mediastinum. This was quite similar to the study by Gun et al., in which the ratio was 30.8% in the anterior mediastinum, 44.2% in the posterior mediastinum, and 25% in the middle mediastinum.[5]

Among the tumors in the anterior mediastinum, lymphoma accounted for the largest number, followed by germ cell tumors. Lymphomas were located not only in the anterior mediastinum, but also in the middle mediastinum or in some cases, large lymphoma could be found in both anterior and middle mediastinums.[10]

In general, Hodgkin disease has been reported to range from 33 to 56% of the pediatric mediastinal lymphomas.[11] Tansel et al. reported 60% of that in their series.[12] The study by Gun et al. showed that Hodgkin lymphomas had a frequency of 73% (16/22) in their mediastinal

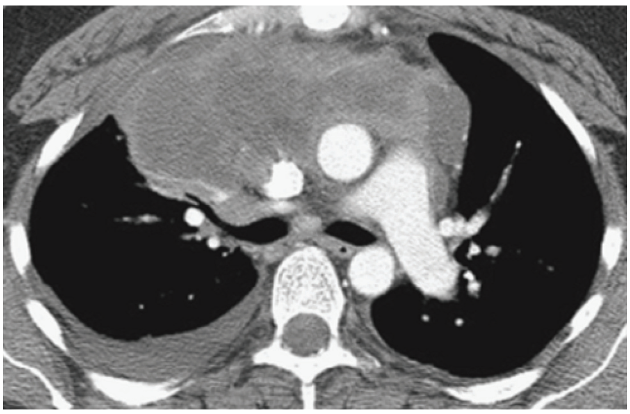

Figure 3. This figure shows the non-Hodgkin lymphoma in an eight-year-old child.

Table 4. Diagnostic accuracy of MSCT of the mediastinal tumors for malignant/benign assessment

MSCT diagnosis	Histopathology		
	Benign	**Malignant**	**Total**
Benign	20	3	23
Malignant	4	33	37
Total	24	36	60
Sensitivity = 83.3%,		Specificity = 91.7%	
PPV = 86.9 %		NPV = 89.2%	
	Accuracy = 88.3 %		

PPV: Positive predictive value; NPV: Negative predictive value; MSCT: Multi-slice computed tomography

lymphomas.[5] Our patients with Hodgkin lymphomas had a rate of 43.8% (7/16) in our mediastinal lymphomas; the remaining were non-Hodgkin lymphomas.

Plain chest radiography is the frequently used screening tool for detecting mediastinal masses. It is often the first mean of detecting a mediastinal tumor. It has several limitations compared with CT since it is difficult to shape a three-dimensional space. In addition, it is difficult to define the origin of the mass and the density of the mass. Another factor that cannot be assessed on plain chest x-ray film is the tumor's boundary with its surrounding structures. Such things can be solved via CT, which provides better contrast resolution depicting the exact size, shape, number, and contour of mediastinal masses; accordingly, it has a higher sensitivity for detecting the lesion. CT can be conducive to staging the mediastinal neoplasms and diagnosing whether the tumor is benign or malignant. Our study revealed a sensitivity of 83.3%, specificity of 91.7%, positive predictive value (PPV) of 86.9, negative predictive value (NPV) of 89.2%, and accuracy of 88.3 %. This can be compared with the results of Pandey et al., with a sensitivity of 83.3%, specificity of 91.7%, PPV of 86.9, NPV of 89.2% and accuracy of 88.3%.[1]

The size of lymph nodes suggests whether it is benign or malignant. Moreover, necrosis in lymph nodes indicates that the disease is aggressive and has a high degree of malignancy.[13]

There were 20 neurogenic tumors in our research; out of these tumors, there were 11 neuroblastomas, four neuroblastomas, four mature neuroblastomas, and one malignant nerve sheet tumor. All of these tumors were located in the posterior mediastinum, with 60% having calcification and 50% having necrosis; 25% of the tumors invaded the spinal canal. These features were highly significant in the diagnosis of a neurogenic tumor from other mediastinal tumors, especially neuroblastoma, which had a high rate of vessel encasement and invaded the spinal canal.[14]

Figure 2 illustrates the mass with calcification inside before the contrast image (A), and the mass encased the aorta in postcontrast image (B).

We can also find systemic nodal in other areas; they involve cervical, axillary, para-aortic, mesenteric, and inguinal groups. Figure 3 demonstrates a non-Hodgkin lymphoma located in the anterior mediastinum with necrosis inside and pleural effusion in the right side.

Germ cell tumors arise from collections of primitive germ cells arrested in the anterior mediastinum on their migration to the gonads during embryologic development.[15] Most of them

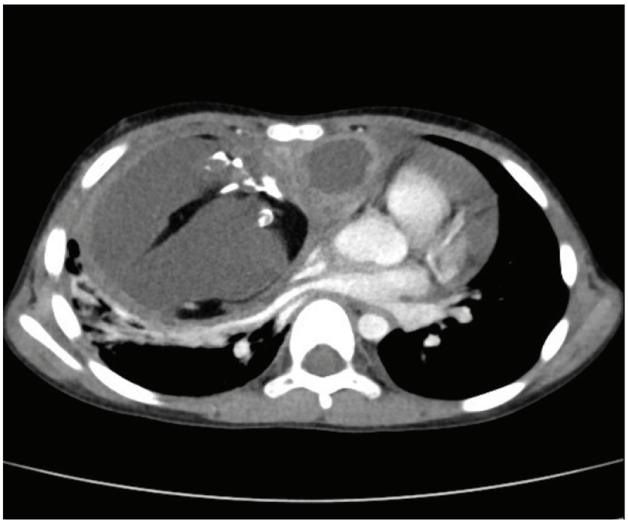

Figure 4. This figure shows the anterior mature teratoma in a nine-year-old boy.

are asymptomatic; however, once they become larger, affected patients may present with respiratory distress due to airway compromise. There are two main types of teratoma, namely immature malignant teratoma and mature benign teratoma. The hallmarks of both immature and mature teratoma are fat, fluid, and calcified components on CT. The presence of fat, fluid, and calcified components within an anterior mediastinal mass in a pediatric patient can contribute to differentiation of a teratoma from other types of mediastinal masses.[16] Another valuable diagnostic feature is the presence of solid tissue within the lesion, a feature more commonly seen in immature malignant teratomas than in mature benign tumors. Mature benign teratomas tend to displace rather than invasive adjacent structures (the latter appearance being more suggestive of malignant immature tumors). Mature benign teratomas have an excellent prognosis following complete excision. Conversely, immature malignant teratomas must be treated with multiple modalities, including chemotherapy and radiation, in addition to surgery. Figure 4 shows a mature teratoma in a nine-year-old boy in the anterior mediastinum. There were cystic components, calcified components, and fat components inside the mass.

Conclusion

The ability of MSCT to distinguish specific tissue densities and to display mediastinum in axial plane and three-dimensional reconstruction makes it a useful technique for evaluating a widened mediastinum detected on conventional radiography. It is more appropriate to base the differential diagnosis of a mediastinal mass on direct observation of the tissue or structure from which the mass arises (lymph nodes, veins, arteries, thymus, thyroid and esophagus). Thorough investigation of the radiologic characteristics of each mass and the anatomic compartment of origin can help radiologists to construct and refine an appropriate differential diagnosis of the mass. It is also instrumental for clinical management. We concluded that CT definitely plays a significant role in the evaluation of a mediastinal mass regarding the organ of origin, distribution pattern and extent of the lesion, its density, and the mass effect upon adjacent structures.

Conflict of Interest

None declared.

References

1. Pandey S, Jaipal U, Mannan N, Yadav R. Diagnostic accuracy of multidetector computed tomography scan in mediastinal masses assuming histopathological findings as gold standard. *Pol J Radiol.* 2018;83:e234-e242. doi: 10.5114/pjr.2018.76709.
2. Pulasani K, Narayanaswamy I, Ramprakash HV. Evaluation of mediastinal mass lesions using multi-detector row computed tomography and correlation with histopathological diagnosis. *Int J Sci Study.* 2015; 3(6):156-63. doi: 10.17354/ijss/2015/414.
3. Dixit R, Shah NS, Goyal M, Patil CB, Panjabi M, Gupta RC, et al. Diagnostic evaluation of mediastinal lesions: Analysis of 144 cases. *Lung India.* 2017;34(4):341-8. doi: 10.4103/lungindia.lungindia_311_16.
4. Kemu A, Rashid N, Ahmad KK, Ali W. Diagnostic role of computed tomography in evaluation of mediastinal masses. *Ann King Edw Med Univ.* 2011; 17(4):410-5. doi: 10.21649/akemu.v17i4.574
4. Gun F, Erginel B, Unüvar A, Kebudi R, Salman T, Celik A. Mediastinal masses in children: experience with 120 cases. *Pediatr Hematol Oncol.* 2012;29(2): 141-7. doi: 10.3109/08880018.2011.646385.
6. Grosfeld JL, Skinner MA, Rescorla FJ, West KW, Scherer LR 3rd. Mediastinal tumors in children: experience with 196 cases. *Ann Surg Oncol.* 1994;1(2):121-7. doi: 10.1007/BF02303555.
7. Duwe BV, Sterman DH, Musani AI. Tumors of the mediastinum. *Chest.* 2005;128(4):2893-909. doi: 10.1378/chest.128.4.2893.
8. McCarville MB. Malignant pulmonary and mediastinal tumors in children: differential diagnoses. *Cancer Imaging.* 2010;10 Spec no A(1A):S35-41. doi: 10.1102/1470-7330.2010.9015.
9. Arumugam V, Nazir H, Rajasekar KV. Multidetector computed tomography evaluation of mediastinal lesions with histopathological diagnosis. *Open J Respir Dis.* 2015;5:55-62. doi: 10.4236/ojrd.2015.53006.
10. Almeida PT, Heller D. Anterior mediastinal mass. 2020 Aug 14. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2020 Jan. PMID: 31536215.
11. Allen CE, Kelly KM, Bollard CM. Pediatric lymphomas and histiocytic disorders of childhood.

Pediatr Clin North Am. 2015;62(1):139-65. doi: 10.1016/j.pcl.2014.09.010.
12. Tansel T, Onursal E, Dayloglu E, Başaran M, Sungur Z, Qamci E, et al. Childhood mediastinal masses in infants and children. *Turk J Pediatr*. 2006;48(1):8-12.
13. Delacourt C, Mani TM, Bonnerot V, de Blic J, Sayeg N, Lallemand D, et al. Computed tomography with normal chest radiograph in tuberculous infection. *Arch Dis Child.* 1993;69(4):430-2. doi: 10.1136/adc.69.4.430.
14. Okamatsu C, London WB, Naranjo A, Hogarty MD, Gastier-Foster JM, Look AT, et al. Clinicopathological characteristics of ganglioneuroma and ganglioneuroblastoma: a report from the CCG and COG. *Pediatr Blood Cancer.* 2009;53(4):563-9. doi: 10.1002/pbc.22106.
15. Sundararajan S, Carter YM. Mediastinal Nonseminoma. 2020 Jun 25. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2020 Janñ. PMID: 28613751.
16. Juanpere S, Cañete N, Ortuño P, Martínez S, Sanchez G, Bernado L. A diagnostic approach to the mediastinal masses. *Insights Imaging.* 2013;4(1):29-52. doi: 10.1007/s13244-012-0201-0.