Conventional Radiological Findings of an Anterior Mediastinal Mass at Ngoerah Hospital

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Abstract: *The most common anterior masses, often referred to by the acronym 4T, consist of thymoma, teratoma, thyroid tissue, and lymphoma (terrible lymphoma). These masses present unique challenges due to their proximity to critical thoracic structures. Although advances in imaging aid in characterization, an accurate diagnosis often requires a multimodal approach integrating radiological, histological, and molecular techniques. The anterior mediastinum, located in front of the heart and bounded by the sternum, undergoes significant changes from childhood to adulthood. In children, the mediastinum houses the large thymus, a vital immune organ; in adults, the mediastinum transitions into a smaller space as thymic function diminishes and the gland atrophies. This evolution leaves an area vulnerable to tumor formation. This case report discusses three distinct cases of anterior mediastinal masses. From the cases presented, it is evident that chest radiography plays a crucial role in establishing the initial diagnosis of patients with mediastinal abnormalities, specifically anterior mediastinal masses. However, in the previously discussed cases, only a single-projection chest X-ray—the posterolateral (PA) view—was performed. As explained in the available literature, in patients suspected of having mediastinal abnormalities, chest X-rays should be performed using two projections: posteroanterior and lateral.*

Keywords: *Mediastinal mass, chest X-ray, CT scan, Thymoma, Teratoma, Thyroid tissue, Lymphoma*

Abstrak: Massa mediastinum anterior yang paling sering ditemukan, yang sering dikenal dengan akronim 4T, terdiri atas timoma (thymoma), teratoma, jaringan tiroid, dan limfoma (terrible lymphoma). Massa-massa ini memberikan tantangan tersendiri karena lokasinya yang berdekatan dengan struktur toraks vital. Meskipun kemajuan teknologi pencitraan membantu dalam karakterisasi lesi, diagnosis yang akurat sering kali memerlukan pendekatan multimodal yang mengintegrasikan teknik radiologis, histologis, dan molekuler. Mediastinum anterior yang terletak di depan jantung dan dibatasi oleh sternum mengalami perubahan yang signifikan dari masa kanak-kanak hingga dewasa. Pada anak-anak, mediastinum berisi timus yang berukuran besar dan berperan penting dalam sistem imun. Pada orang dewasa, ruang mediastinum menjadi lebih kecil seiring menurunnya fungsi timus dan terjadinya atrofi kelenjar tersebut. Perubahan ini meninggalkan area yang rentan terhadap pembentukan tumor. Laporan kasus ini membahas tiga kasus berbeda massa mediastinum anterior. Dari kasus-kasus yang dipaparkan, terlihat bahwa radiografi toraks memiliki peran penting dalam menegakkan diagnosis awal pada pasien dengan kelainan mediastinum, khususnya massa mediastinum anterior. Namun, pada kasus-kasus yang dibahas sebelumnya, pemeriksaan hanya dilakukan dengan satu proyeksi foto toraks, yaitu proyeksi posteroanterior (PA). Berdasarkan literatur yang tersedia, pada pasien yang dicurigai mengalami kelainan mediastinum, pemeriksaan foto toraks sebaiknya dilakukan dengan dua proyeksi, yaitu posteroanterior dan lateral.

Kata Kunci: Massa mediastinum, foto toraks, CT scan, timoma, teratoma, jaringan tiroid, limfoma.

Introduction

The mediastinum is located between the lungs and houses vital structures, including the thymus, heart, major blood vessels, lymph nodes, nerves, and portions of the esophagus and trachea. Anteriorly, the sternum delimits the mediastinum, while the thoracic vertebrae define its posterior border. Superiorly, the mediastinum extends to the thoracic inlet, whereas the diaphragm forms its inferior border. Laterally, the mediastinum is bounded by the pericardial and mediastinal

pleura, which enclose important thoracic organs and structures. Mediastinal tumors account for 3% of all tumors arising in the thoracic cavity. Comprising the anterior, middle, and posterior compartments, mediastinal masses exhibit a broad histopathological spectrum, with 50% occurring in the anterior compartment (Navas-Blanco, 2021; Duwe et al., 2005)

The mediastinum is a compartment extending along the thoracic cavity between the pleural cavities of the lungs. This compartment extends longitudinally from the thoracic inlet to the superior surface of the diaphragm. Although there are no physical barriers between the compartments other than the pericardium, the mediastinum is typically discussed based on subdivisions. The four-compartment model divides the mediastinum into superior, anterior, middle, and posterior sections (Figure 1). The mediastinum houses many vital structures, including the heart, major blood vessels, the trachea, and essential nerves. The mediastinum also serves as a protected pathway for structures traversing from the neck superiorly and from the abdomen inferiorly. The mediastinum is also clinically significant due to the various physical anomalies and pathologies that can occur in this region (Bardo et al., 2018; Ugalde et al., 2011; Huang et al., 2010; Biondi et al., 2007)

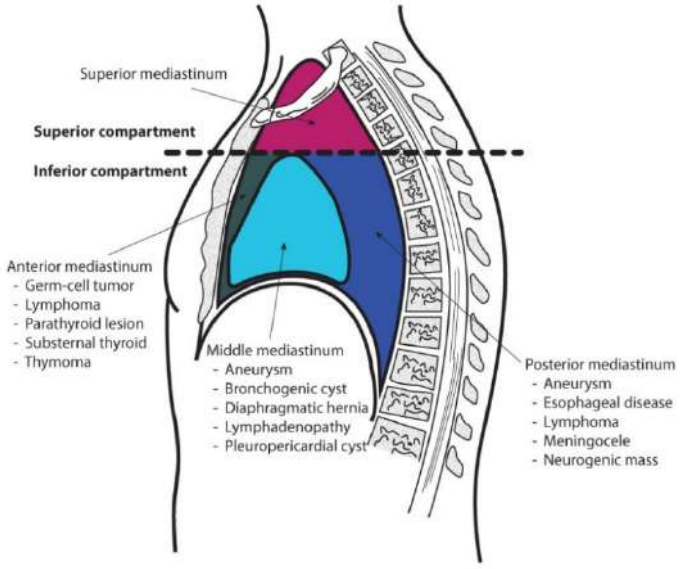

Figure 1. Division of the Mediastinum. The mediastinum can be divided into the following areas: superior mediastinum, anterior mediastinum, middle mediastinum, posterior mediastinum, superior compartment, and inferior compartment.

Each region of the mediastinum can be considered to have a primary function. The superior mediastinum is essentially a passageway that allows structures to pass between the head, neck, and chest (Bardo et al., 2018; Ugalde et al., 2011; Huang et al., 2010). The anterior mediastinum is protective and filled with connective tissue and fat that support the thymus and the vital cardiac structures immediately behind it. The middle mediastinum houses the heart and the roots of the

great vessels. The posterior mediastinum, which can be considered a continuation of the superior mediastinum, also functions as a passageway, providing space for structures to travel between the thoracic and abdominal cavities (Bardo et al., 2018; Ugalde et al., 2011; Huang et al., 2010; Whitten et al., 2007)

The most common anterior mediastinal masses are often referred to as the "4Ts": thymoma, teratoma, thyroid tissue, and lymphoma (*terrible lymphoma*). These masses present unique challenges due to their proximity to critical thoracic structures. Advances in imaging aid in characterization; however, accurate diagnosis often requires a multimodal approach integrating radiological, histological, and molecular techniques. Management considerations include histopathology, patient factors, and tumor biology (Navas-Blanco, 2021)

Thymoma, which accounts for less than 1% of adult malignancies, is the most common anterior mediastinal mass in adults. Benign masses originating from the thymus are rare but include thymolipoma, characterized by an adipose composition, and thymic cysts. Thymic cysts may be congenital, representing remnants of the thymopharyngeal duct, or acquired as manifestations of inflammatory neoplasms such as Hodgkin lymphoma. Conversely, thymic masses may occasionally manifest as aggressive and invasive neoplasms, such as thymic carcinoma and thymic carcinoid (Juanpere et al., 2013)

Germ cell tumors (GCTs) are characterized by primitive germ cells that failed to migrate completely during embryonic development. Although they usually originate from the gonads, these tumors account for 15% of anterior mediastinal masses.2 Among GCTs, benign teratomas are the most common, consisting of tissue from at least two germ layers. Teratomas may contain ectodermal tissue, such as hair and teeth, and tissue derived from the mesoderm (bone) and endoderm (intestinal epithelium). If a teratoma contains fetal or neuroendocrine tissue, it is classified as immature and malignant and has a poor prognosis.10 Seminomas and nonseminomatous GCTs (NSGCTs) are rare malignant GCTs that often present as large, thick masses.

Primary mediastinal lymphoma accounts for approximately 10% of all mediastinal lymphomas.10 Hodgkin lymphoma (HL) constitutes 50% to 70% of primary mediastinal lymphomas and is classified into several subtypes, including nodular sclerosis (the most common), lymphocyte-rich, lymphocyte-deficient, and mixed-cell. Non-Hodgkin lymphoma (NHL) constitutes 15% to 25% of primary mediastinal lymphomas, with the dominant types being primary mediastinal large B-cell non-Hodgkin lymphoma (PMBCL) and lymphoblastic non-Hodgkin lymphoma (LB-NHL), the most common of which is T-lymphoblastic lymphoma (TLL) (Juanpere et al., 2013; Aggarwal et al., 2017)

Enlargement of the thyroid gland, or goiter, can sometimes present as an anterior mediastinal mass. Substernal goiter, which accounts for a significant proportion of cases, is characterized by at least 50% of its volume being located below the thoracic inlet. Typically, mediastinal goiter arises from the extension of the lower cervical thyroid lobe into the thoracic inlet. In rarer cases, mediastinal goiter may result from residual embryonic tissue (Chen et al., 2013). Ectopic thyroid tissue, defined as the presence of thyroid tissue at a distance ranging from the second to the fourth tracheal cartilage, resulting from embryonic developmental abnormalities or migration of the gland into the anterior mediastinum, accounts for 1% of all mediastinal masses (Chen et al., 2013; El Haj et al., 2021)

Radiological examinations play a crucial role in diagnosing anterior mediastinal masses by providing detailed anatomical information, assessing the extent of the mass, and guiding further management decisions. Several radiological modalities are commonly used or associated with the evaluation of these masses (Juanpere et al., 2013):

Chest X-ray (CXR): This is often the initial imaging study performed and can reveal the presence of a mediastinal mass, its location, size, and associated pulmonary abnormalities. Although CXR provides a general overview, it does not offer detailed mass characterization and may require further imaging for a definitive diagnosis.

Computed tomography (CT) scan: This imaging modality is the gold standard for evaluating anterior mediastinal masses due to its high spatial resolution and ability to depict soft tissue structures. Computed tomography (CT) scanning can provide detailed information about the size, location, morphology, density, and relationship of the mass to adjacent structures such as the heart, major blood vessels, and lungs

Magnetic Resonance Imaging (MRI): Magnetic resonance imaging (MRI) is useful for evaluating mediastinal masses in cases where CT findings are unclear or when soft tissue characterization is particularly important. MRI provides excellent soft tissue contrast resolution and can help distinguish various types of tissue within the mass, such as fat, fluid, and solid components. One example is distinguishing thymic hyperplasia from thymic malignancy.

Positron Emission Tomography (PET) Scan: Positron emission tomography (PET) imaging, often performed in conjunction with CT (PET-CT), is highly useful for assessing the metabolic activity of mediastinal masses and detecting distant metastases. PET-CT scans can help distinguish between benign and malignant lesions, guide biopsies or surgical planning, and monitor treatment response in patients with mediastinal malignancies. This is a valuable modality for staging lymphoma, as it is more accurate in detecting intranodal and extranodal disease than CT.

Ultrasonography (US): Although less commonly used to evaluate mediastinal masses, US can be used for initial assessment or as a guide during biopsy procedures, particularly in pediatric patients or when radiation exposure needs to be minimized. US provides real-time visualization of the mass and adjacent structures, assesses vascularization, and facilitates targeted sampling of suspicious lesions.

Fluorodeoxyglucose PET-CT: This imaging modality is sensitive for detecting hypermetabolic activity associated with malignant mediastinal masses and helps assess the metabolic activity of such masses, identify areas with increased glucose metabolism indicative of malignancy, and determine disease staging by detecting distant metastases or lymph node involvement.

Case Report And Discussion

Masses in the anterior mediastinum are generally rare and often pose challenges for clinicians in diagnosing and managing patients. Various causes of masses in the anterior mediastinum include thymoma, lipoma, lymphangioma, carcinoma, and adenoma. The prevalence of anterior mediastinal masses is 50% of all masses found in the mediastinum (Navas-Blanco, 2021; Duwe et al., 2005). In daily practice, radiological imaging plays a crucial role in the evaluation, diagnosis, management, and treatment planning of mediastinal abnormalities. Mediastinal masses are generally discovered incidentally on chest radiographs. Chest radiography is often the first imaging modality to reveal a mediastinal mass. Chest radiographs with two views (PA and lateral) are very helpful in localizing abnormalities within the mediastinal compartments. *The hilum overlay sign* on PA-view chest radiographs helps determine whether opacity in the hilar region is located within the hilum versus anterior or posterior to it. If hilar vessels are visible through the mass, this indicates the mass does not originate from the hilum and is located anteriorly or posteriorly (Ahuja et al., 2023).

A CT scan with intravenous contrast is recommended as a supportive examination for masses in the anterior mediastinum to aid in evaluating size, density characteristics (presence or absence of calcification, hemorrhage, necrosis), as well as the presence of invasion or spread to surrounding organs (Scorsetti et al., 2016). In the first case, a 76-year-old female patient with a mediastinal mass, a PA chest X-ray (Figure 2) revealed a partially ill-defined opacity in the right paracardial region projecting at the level of the right Th8–11 paravertebral spaces, forming an obtuse angle with the mediastinum, with a positive silhouette sign and a suspected anterior mediastinal mass. Subsequently, the patient underwent a chest MSCT scan with axial, sagittal, and coronal reformatted slices, both with and without contrast, revealing a malignant mass in the anterior to mid-mediastinum adhering to the medial aspect of the visceral pleura, extending to the anterior

wall of the right hemithorax, infiltrating the right pectoralis major muscle, and destroying the manubrium and body of the sternum, infiltrating the superior vena cava and causing a total occlusive intraluminal thrombus extending to the right atrium, accompanied by dilation and tortuosity of the collateral veins in the supraclavicular region, axilla, and right hemithorax (Figure 3)

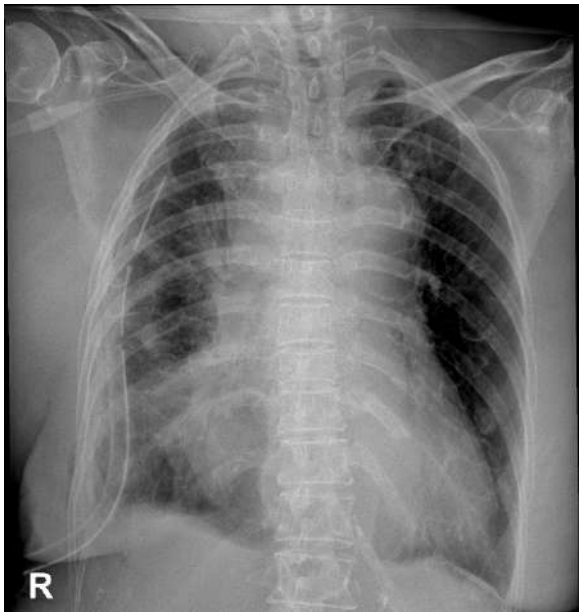

Figure 2. AP chest radiograph findings: A partially ill-defined opacity is visible in the right paracardial region, projecting to the level of the right paravertebral spaces at T8–11 and forming an obtuse angle with the mediastinum; silhouette sign (+)

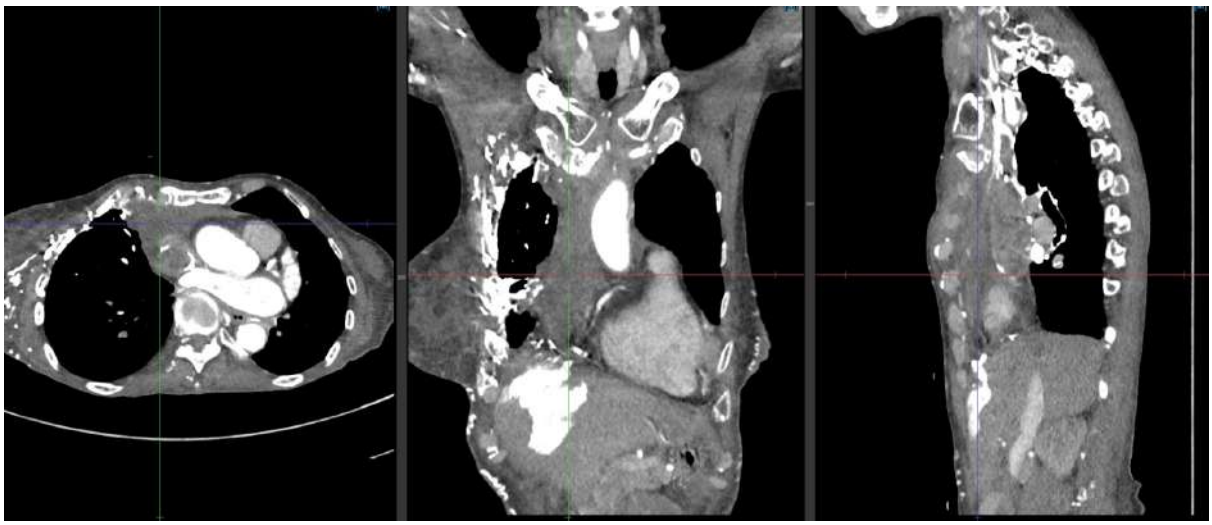

Figure 3. Contrast-enhanced chest CT scan findings: A malignant mass in the anterior to middle mediastinum adhering to the medial aspect of the visceral pleura, extending to the anterior wall of the hemithorax, infiltrating the right pectoralis major muscle, and destroying the manubrium and body of the sternum, infiltrating the superior vena cava and causing a total occlusive intraluminal thrombus extending to the right atrium,

accompanied by dilation and tortuosity of the collateral veins in the supraclavicular, axillary, and right hemithorax regions

In the second case, a 33-year-old woman diagnosed with recurrent Hodgkin lymphoma. A PA chest X-ray (Figure 4) revealed a lobulated-edge opacity forming an obtuse angle with the mediastinum, projected at the level of the right paravertebral spaces from T7 to T10, with a silhouette sign (+), suggesting anterior mediastinal mass. Chest MSCT scan with axial, sagittal, and coronal reformatted slices, with and without contrast: Chest MSCT scan with axial, sagittal, and coronal reformatted slices, with and without contrast (Figure 5) A homogeneous solid mass with calcified components in the right anterior mediastinum extending to the left anterior mediastinum, starting at the level of the paravertebral spaces of T3–T9, encasing the superior and inferior branches of the right and left main bronchi, the superior and inferior branches of the right and left pulmonary arteries, and adhering to the posterior right and left sides of the heart, which also encases the superior and inferior branches of the right and left main bronchi, the superior and inferior branches of the right pulmonary artery, and adheres to the pulmonary trunk and aortic arch, suggesting a lymphoma

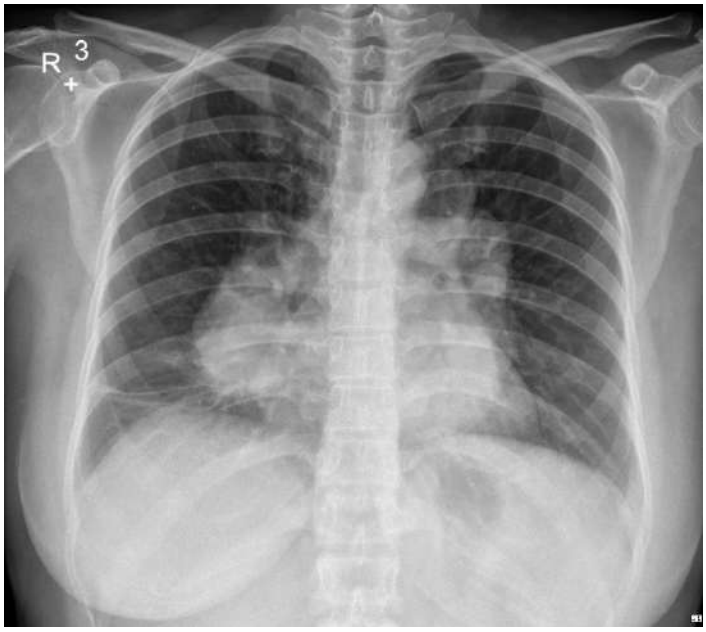

Figure 4. Results of the PA chest X-ray: A lobulated opacity forming an obtuse angle with the mediastinum is visible, projecting at the level of the right paravertebral spaces of T7–T10

Figure 5. Results of Contrast-Enhanced Chest CT Scan: A homogeneous solid mass with calcified components in the right anterior mediastinum extending to the left anterior mediastinum, starting at the level of the Th3-Th9 paravertebral regions, encasing the superior and inferior branches of the right and left main bronchi, the superior and inferior branches of the right and left pulmonary arteries, and adhering to the posterior right and left sides of the heart, which also encases the superior and inferior branches of the right and left main bronchi, the superior and inferior branches of the right pulmonary artery, and adheres to the pulmonary trunk and aortic arch, suggesting a lymphoma

In the third case, a 32-year-old woman diagnosed with GERD, a PA chest X-ray (Figure 6) revealed a soft-tissue opacity with partially ill-defined margins forming an obtuse angle with the mediastinum, projected at the level of T2–T7 vertebrae with a hilum overlay sign, suggesting an anterior mediastinal mass which, on MSCT scan of the thorax with axial, sagittal, and coronal reformatted slices, with and without contrast (Figure 7) revealed a solid mass with necrotic components in the anterior mediastinum at the level of T1–T4, compressing and narrowing the superior vena cava at that level, causing tortuous dilation of the superficial veins of the right and left hemithorax extending to the right and left abdominal walls, and dilation of the inferior vena cava, consistent with the findings of malignant lymphoma.

Figure 6. Results of the PA chest X-ray: A soft-tissue opacity with partially ill-defined edges forming an obtuse angle with the mediastinum, projected at the level of T2–T7 vertebrae, with a hilum overlay sign (+), measuring approximately 11.1 × 5.2 cm

Figure 7. Results of a Contrast-Enhanced Chest CT Scan: A solid mass with necrotic components in the anterior mediastinum at the level of the thoracic vertebrae T1–T4, compressing and narrowing the superior vena cava at that level, causing tortuous dilation of the superficial veins of the right and left hemithorax extending to the right and left abdominal walls, and dilation of the inferior vena cava, consistent with the findings of malignant lymphoma.

Conclusion

From the case presented earlier, it is evident that chest radiography plays a crucial role in establishing the initial diagnosis of patients with mediastinal abnormalities, specifically an anterior mediastinal mass. However, in the previously discussed case , only a single-projection chest X-ray—the posterolateral (PA) view—was performed. As explained in the available literature, in patients suspected of having mediastinal abnormalities, a chest X-ray should ideally be performed using two projections: posteroanterior and lateral. This is important to confirm the presence of a mediastinal abnormality and to determine its location and size—whether it is anterior, medial, or posterior. In the case presented here, a CT scan also confirmed the presence of a mass in the anterior mediastinum. A CT scan can provide detailed information regarding the mass's size, location, morphology, density, and its relationship with adjacent structures such as the heart, major blood vessels, and lungs.

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References

Aggarwal, R., Rao, S., Dhawan, S., Bhalla, S., Kumar, A., & Chopra, P. (2017). Primary mediastinal lymphomas, their morphological features and comparative evaluation. Lung India, 34(1), 19–24.

Ahuja, J., Strange, C. D., Agrawal, R., Erasmus, L. T., & Truong, M. T. (2023). Approach to imaging of mediastinal masses. Diagnostics (Basel), 13(20), 3171. https://doi.org/10.3390/diagnostics13203171

Bardo, D. M. E., Biyyam, D. R., Patel, M. C., Wong, K., van Tassel, D., & Robison, R. K. (2018). Magnetic resonance imaging of the pediatric mediastinum. Pediatric Radiology, 48(9), 1209–1222.

Biondi, A., Rausei, S., Cananzi, F. C., Zoccali, M., D'Ugo, S., & Persiani, R. (2007). Surgical anatomy of the anterior mediastinum. Annali Italiani di Chirurgia, 78(5), 351–353.

Chen, X., Xu, H., Ni, Y., Sun, K., & Li, W. (2013). Complete excision of a giant thyroid goiter in the posterior mediastinum. Journal of Cardiothoracic Surgery, 8, 207.

Duwe, B. V., Sterman, D. H., & Musani, A. I. (2005). Tumors of the mediastinum. Chest, 128(4), 2893–2909.

El Haj, N. I., Hafidi, S., Khoaja, A., Boubia, S., Karkouri, M., & Ridai, M. (2021). Ectopic mediastinal thyroid removed by U-VATS approach: A case report. International Journal of Surgery Case Reports, 78, 284–287.

Huang, Y. X., Jin, L. Z., Lowe, J. A., Wang, X. Y., Xu, H. Z., Teng, Y. J., Zhang, H. Z., & Chi, Y. L. (2010). Three-dimensional reconstruction of the superior mediastinum from the Chinese Visible Human Female. Surgical and Radiologic Anatomy, 32(7), 693–698.

Juanpere, S., Cañete, N., Ortuño, P., Martínez, S., Sanchez, G., & Bernado, L. (2013). A diagnostic approach to mediastinal masses. Insights into Imaging, 4(1), 29–52.

Navas-Blanco, J. R. (2021). Dynamic anterior mediastinal mass compression of the superior vena cava during airway stent deployment. Annals of Cardiac Anaesthesia, 24(3), 399–401.

Scorsetti, M., Leo, F., Trama, A., D'Angelillo, R., Serpico, D., Macerelli, M., et al. (2016). Thymoma and thymic carcinomas. Critical Reviews in Oncology/Hematology, 99, 332–350. https://doi.org/10.1016/j.critrevonc.2016.01.012

Ugalde, P. A., Pereira, S. T., Araujo, C., & Irion, K. L. (2011). Correlative anatomy of the mediastinum. Thoracic Surgery Clinics, 21(2), 251–272.

Whitten, C. R., Khan, S., Munneke, G. J., & Grubnic, S. (2007). A diagnostic approach to mediastinal abnormalities. Radiographics, 27(3), 657–671.