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ANTERIOR MEDIASTINAL MASSES IN CHILDREN:
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Anterior mediastinal masses in children: A radiologic review by ChatGPT

Abstract

Anterior mediastinal masses (AMMs), while rare in children, pose a significant risk due to their potential for life-threatening complications. Positioned within the anterior mediastinum — the space between the sternum and pericardium, filled with connective tissue, lymphatic structures, and the thymus gland — these masses present with a wide range of clinical manifestations. Prompt identification and appropriate management are critical. This review presents an AI chatbot-generated exploration of anterior mediastinal masses in children, specifically using "ChatGPT" (built on the GPT-3.5 architecture by OpenAI). The final text underwent a language edit and plagiarism check via the GPT-4 version.

Introduction

Anterior mediastinal masses (AMMs) in children may stem from various tissues, including lymphatic tissue, thymus gland, germ cells, neurogenic tissue, and vascular structures. The most frequently observed causes of AMMs in this population are lymphoma, germ cell tumors, and thymic tumors. On occasion, benign conditions like thymic hyperplasia, mediastinal teratoma, Morgagni hernia, or vascular anomalies might be the source of these masses (1).

Clinical Presentation

The clinical manifestation of AMMs greatly varies, contingent on the size, location, and characteristics of the mass. Symptoms in patients can include cough, dyspnea, chest pain, or Superior Vena Cava Syndrome (SVCS). SVCS, a condition arising from compression or obstruction of the superior vena cava, can lead to facial swelling, distended neck veins, and respiratory distress. Systemic symptoms such as fever, weight loss, or night sweats may also occur in children with AMMs (2).

Diagnostic Evaluation

A comprehensive history and physical examination, alongside laboratory tests, imaging studies, and a biopsy, form the bedrock of the diagnostic evaluation for AMMs. Laboratory tests, including complete blood counts, liver function tests, and tumor markers, could provide valuable insights into the underlying etiology (3). Imaging studies, such as chest X-ray, computed tomography (CT), and magnetic resonance imaging (MRI), are pivotal for determining the location, size, and extent of the mass (2). Typically, a definitive diagnosis requires histopathological examination, which may be conducted via needle biopsy or surgical excision (4).

Management

The management strategy for AMMs is dictated by the etiology, size, and location of the mass. While small, asymptomatic masses might only require observation, malignant tumors such as lymphoma or germ cell tumors typically necessitate chemotherapy and radiation therapy. In cases of large, symptomatic masses or when a definitive diagnosis is elusive through biopsy, surgical intervention may be necessary (5).

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Prognosis

The prognosis for children diagnosed with AMMs can vary widely, contingent upon the underlying etiology and the disease stage. Benign AMMs have an excellent prognosis, boasting a 5-year survival rate exceeding 90%. Conversely, the prognosis for malignant AMMs, such as lymphoma or malign germ cell tumors, is less favorable and highly dependent on the disease stage at the time of diagnosis (6, 7).

Lymphoma

Mediastinal lymphoma is a subtype of lymphoma that impacts lymph nodes within the mediastinum, the central portion of the thoracic cavity situated between the lungs. Lymphoma represents the third most common malignancy and the most prevalent AMM in pediatric patients (5).

Anterior mediastinal lymphoma can originate from various lymphocyte types, such as B-cells, T-cells, or immature precursor cells. The most frequently seen subtypes of mediastinal non-Hodgkin lymphoma in children include lymphoblastic lymphoma, deriving from T-cells, and primary mediastinal large B-cell lymphoma. Conversely, nodular sclerosis is the predominant subtype of classical Hodgkin lymphoma involving the anterior mediastinum and/or mediastinal lymph nodes (4, 6).

Symptoms associated with anterior mediastinal lymphoma can fluctuate based on the tumor's location and size. Typical symptoms encompass chest pain, coughing, breathing difficulties, swelling of the face and neck (SVCS), and fatigue (6).

Diagnosis is commonly reached through a combination of imaging studies like chest X-ray, CT scan, MRI, and positron emission tomography (PET) scan, which aid in differentiating mediastinal lymphoma from other conditions. CT is the preferred imaging modality for the initial evaluation of mediastinal masses. It's crucial to understand that other conditions, such as thymoma, germ cell tumors, and metastatic cancer, can also manifest as mediastinal masses, with imaging findings not necessarily unique to lymphoma. Consequently, a biopsy is essential to validate the diagnosis (4, 8).

On a chest X-ray or CT scan, mediastinal lymphoma may present as a mass or a substantial enlargement within the mediastinum — the area situated between the lungs encompassing the heart, blood vessels, and other organs. The mass may be smooth or irregular, and it might displace other mediastinal structures (7) (Figure 1).

On MRI, mediastinal lymphoma may manifest as a homogeneous or heterogeneous mass, with variable intensities across different sequences. A PET scan identifies metabolic activity within the tumor, assisting in distinguishing between malignant and benign mediastinal masses (8). On diffusion-weighted MRIs, malignant lymphomas display very low ADC values, indicative of the tumor's high cellularity (1).

Here are some radiological features that can assist in differentiating mediastinal lymphoma from other conditions:

1. **Location:** Mediastinal lymphoma typically originates from the thymus or lymph nodes in the anterior mediastinum. The location can be instrumental in distinguishing it from other mediastinal masses, such as neurogenic tumors that predominantly occur in the posterior mediastinum (paravertebral compartment) (4, 6).

2. **Size and Shape:** Mediastinal lymphomas tend to present as large, irregular masses spanning multiple mediastinal compartments. They may also exhibit signs of invasion into adjacent structures, such

as the chest wall or large vessels (1, 8).

3. **Density:** On CT imaging, mediastinal lymphomas typically present as homogenous masses with a soft-tissue density similar to muscle. This can help distinguish them from other conditions that may present with a more heterogeneous appearance, such as thymic cysts or teratomas (3).

4. **Enhancement Pattern:** Mediastinal lymphomas typically exhibit mild enhancement with contrast, which can help differentiate them from other conditions with different enhancement patterns (9).

5. **Lymph Node Involvement:** Mediastinal lymphomas frequently involve multiple lymph nodes in the mediastinum and can cause substantial lymphadenopathy. This can help distinguish them from other conditions that may involve a more focal lymph node involvement (9).

Teratoma

Anterior mediastinal teratomas are a type of tumor that originate from germ cells. These tumors can consist of tissues from all three germ cell layers — endoderm, mesoderm, and ectoderm. Therefore, they may include an array of different tissues, such as bone, cartilage, hair, teeth, and fat (3).

Accounting for up to 18% of pediatric mediastinal masses, germ cell tumors are more commonly observed in children compared to adults (5). They typically occur in adolescents and young adults but can also be found in younger children. These tumors can be either benign or malignant, with the distinction made based on the presence of malignant cells within the tumor. Benign teratomas are most commonly seen, while around 14% of cases involve malignant teratomas (5).

Symptoms of anterior mediastinal teratoma may include coughing, chest pain, shortness of breath, difficulty swallowing, and swelling of the face, neck, or upper chest (3). Diagnosis is typically achieved through imaging studies such as chest X-rays, CT scans, or MRIs (Figure 2).

Characteristics that may suggest a mediastinal teratoma include:

1. **Location:** Teratomas typically originate in the anterior mediastinum (1).

2. **Mixed Density:** Due to the presence of various tissue types, teratomas usually show mixed density on CT scans, which may include fat, calcifications, and fluid-filled spaces (7).

3. **Well-defined Borders:** Teratomas tend to have well-defined borders, which can help differentiate them from malignant tumors that may have irregular or ill-defined borders (2).

4. **Heterogeneous Enhancement:** Teratomas may exhibit heterogeneous enhancement on contrast-enhanced CT or MRI, due to the different tissue types within the tumor (2).

5. **Presence of Teeth or Bone:** The presence of teeth or bone within the tumor is strongly indicative of a teratoma (4).

It's important to remember that radiological findings should always be considered in conjunction with the patient's clinical history and physical examination, and additional diagnostic tests (such as biopsy) may be necessary to confirm a mediastinal teratoma diagnosis (7).

Lipoma-Thymolipoma:

Both lipomas and thymolipomas are typically benign AMMs that contain adipose tissue. However, there are distinct differences between the two. Mediastinal lipomas are usually asymptomatic, encapsulated tumors, composed of mature fat cells and are often

found in the anterior mediastinum adjacent to the diaphragm (3). Conversely, thymolipomas originate from the thymus gland and consist of a mix of mature adipose tissue and thymic tissue, including epithelial cells, lymphocytes, and other cellular components of the thymus gland. Thymolipomas may carry more clinical significance due to their association with the thymus gland. They can cause symptoms like chest pain, coughing, difficulty breathing, and SVCS if they grow large enough to compress adjacent structures. In some instances, thymolipomas may also be associated with other conditions like myasthenia gravis or autoimmune disorders (3).

Radiological imaging techniques such as chest X-rays, CT scans, and MRIs are commonly used to differentiate these mediastinal fatty masses from others (Figure 3).

Characteristics that can aid in radiologically distinguishing a mediastinal lipoma from other masses include:

1. Location: Lipomas are typically found in the anterior mediastinum, while other types of mediastinal masses can occur in various locations within the mediastinum (3).

2. Density: On a CT scan, a mediastinal lipoma appears as a well-circumscribed, low-density mass with a Hounsfield unit (HU) value of -50 to -120, which is indicative of fat (3). Other mediastinal masses may exhibit higher densities and/or irregular borders. Thymolipomas present as masses primarily composed of fatty tissue, accompanied by soft-tissue nodules and septa (4).

3. Signal Intensity: On an MRI, a mediastinal lipoma will exhibit high signal intensity on T1-weighted images and suppressed signal intensity on fat-suppressed T2-weighted images, which is consistent with its fat composition. Conversely, other mediastinal masses may exhibit different signal intensities (3).

4. Smooth Borders: A mediastinal lipoma typically presents with smooth, well-defined borders, while other types of masses may display irregular or ill-defined borders (3).

5. Lack of Enhancement: Mediastinal lipomas usually do not enhance with contrast on CT or MRI scans, whereas other types of masses may show enhancement (3).

It's essential to note that while radiological imaging can provide helpful information to distinguish a mediastinal lipoma from other masses, a definitive diagnosis is usually achieved through a biopsy or surgical resection (7).

Thymic Cyst

Thymic cysts are uncommon, benign cystic masses originating from the thymus gland. They can be either congenital or acquired and may not be noticeable until later stages of life. Congenital types are typically unilocular, arising from remnants of the thymopharyngeal duct. Conversely, acquired types, which are more prevalent than congenital ones, are often observed as multilocular during imaging. Acquired thymic cysts tend to develop in response to certain conditions or events, including inflammatory processes, radiotherapy for Hodgkin's disease, or association with other diseases such as HIV or Sjögren Syndrome (1) (Figure 4).

Morgagni Hernia

Morgagni hernia, alternatively known as an anterior diaphragmatic hernia, is a rare form of congenital diaphragmatic hernia (CDH). It occurs due to a defect or weakness in the anterior portion of the diaphragm, allowing abdominal organs such as the omentum or intestines to herniate or protrude into the thoracic cavity (10). In radiologic imaging, herniation of omental fat tissue can

mimic a lipoma in the cardiophrenic space (2).

Morgagni hernia is a congenital anomaly present at birth. The precise cause of this hernia type is not fully understood, but it is believed to stem from incomplete development or fusion of the diaphragm during fetal development. Morgagni hernias typically occur in the anterior (front) portion of the diaphragm, near the midline, and are most common on the right side of the chest. However, they can also occur on the left side or bilaterally (both sides) (9).

Morgagni hernia is relatively rare, constituting about 2% to 4% of all congenital diaphragmatic hernias. Many Morgagni hernias are asymptomatic and may be accidentally discovered during imaging studies conducted for unrelated reasons. However, when symptoms do manifest, they can include respiratory issues (such as difficulty breathing, particularly during exertion), gastrointestinal symptoms (like abdominal pain, bloating, or vomiting), or nonspecific chest discomfort (3, 10).

Morgagni hernia diagnosis is typically achieved through imaging studies such as chest X-rays, ultrasounds, CT scans, or MRI. These imaging techniques can help visualize the diaphragmatic defect and determine the location and contents of the herniation (3) (Figure 6).

Conclusion:

AMMs are rare but potentially life-threatening conditions in children. The clinical presentation can vary significantly, and early recognition is vital for optimal management. A diagnostic evaluation should include a comprehensive history and physical examination, laboratory tests, imaging studies, and a biopsy. Management of AMMs depends on the underlying etiology, size, and location of the mass. The prognosis for children with AMMs varies widely depending on the underlying etiology and disease stage.

Comments for ChatGPT:

Given that this free version of ChatGPT generates references that do not exist in the medical literature and occasionally provides inaccurate information, we have re-evaluated all data based on genuine references. The use of ChatGPT in academic literature is intriguing. However, commentary on the advantages or disadvantages, benefits, or deficiencies of such chatbots has already been noted in the literature (11, 12). While ChatGPT and similar language models offer potential benefits for medical literature, it is crucial to balance the use of AI capabilities with the necessity for human touch and critical thinking in healthcare. It appears that artificial intelligence still requires human intelligence to make valuable contributions to literature.

Here are some orders used in ChatGPT to write this review:

- Write a medical article about anterior mediastinal masses in children.
- Could you add references into the article?
- How can we radiologically distinguish mediastinal lymphoma/teratoma/lipoma from each other's?
- Can you write a sample of radiology report about mediastinal lymphoma/teratoma/lipoma in a child?
- Please write this sentence with another way; "....."
- You said that: "Mediastinal lipomas are most commonly found in the posterior mediastinum", it is not true, unlike it was reported in a reference as "Mediastinal lipomas typically arise within

the anterior mediastinum, which is not the case in this study, and represent 1.6-2.3% of all primary mediastinal tumors".

ChatGPT replied as below:

I apologize for the mistake in my previous response. You are correct that mediastinal lipomas are more commonly found in the anterior mediastinum rather than the posterior mediastinum. According to the reference you provided, mediastinal lipomas represent 1.6-2.3% of all primary mediastinal tumors and typically arise within the anterior mediastinum.

Thank you for bringing this to my attention, and I apologize for any confusion my previous response may have caused.

It's important to note that while I strive to provide accurate and up-to-date information, I am an AI language model and not a medical professional. Therefore, it's always recommended to consult with a qualified healthcare provider for specific medical advice or concerns.

Figure 1: A case of Hodgkin lymphoma in a 12-year-old boy, presenting with pathological lymph nodes in the anterior mediastinum. The postero-anterior (a) and lateral chest X-rays (b) reveal a substantial opacity in the anterior mediastinum, mediastinal enlargement, and slight tracheal displacement. Opacity in the right lower zone is also notable. Bulky mediastinal masses surrounding the large vessels are evident in axial (c) and coronal (d) contrast-enhanced CT images. Additionally, right pleural effusion and atelectasis are visible.

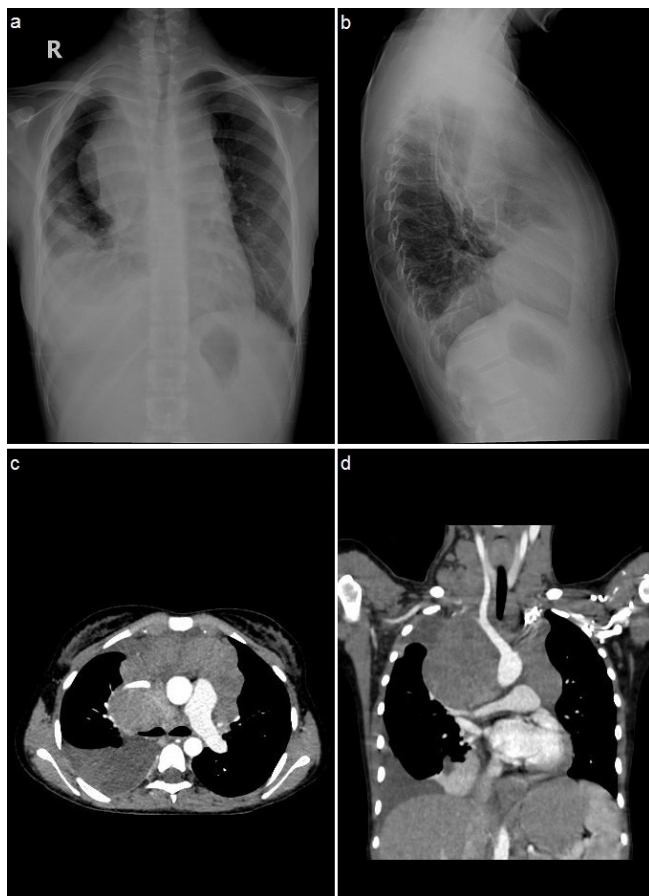


Figure 2: Chest X-rays of a 2-year-old girl display a sizeable, well-defined opacity that blurs the heart borders and extends to the left hemithorax, as seen in postero-anterior (a) and lateral (b) views. The densities of fat, calcification, and fluid are assessed by ROI on the axial (c) contrast-enhanced CT. The histological examination confirmed a teratoma after the surgical operation.

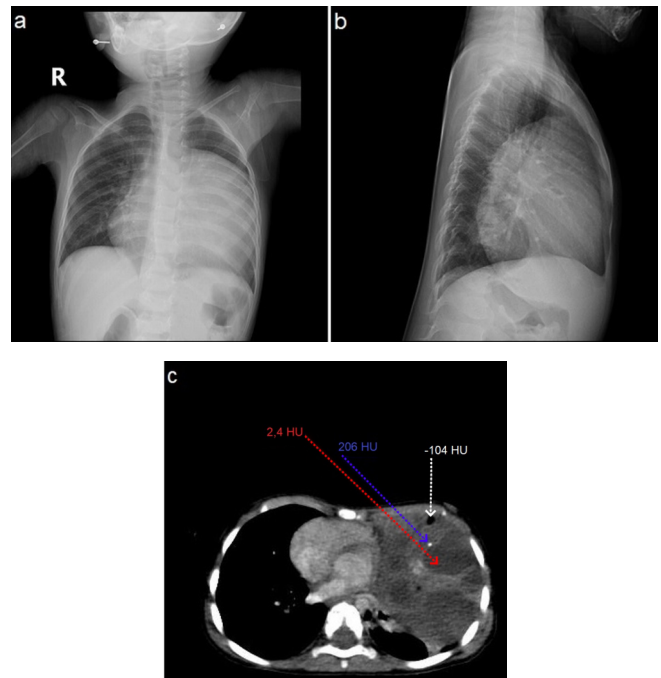
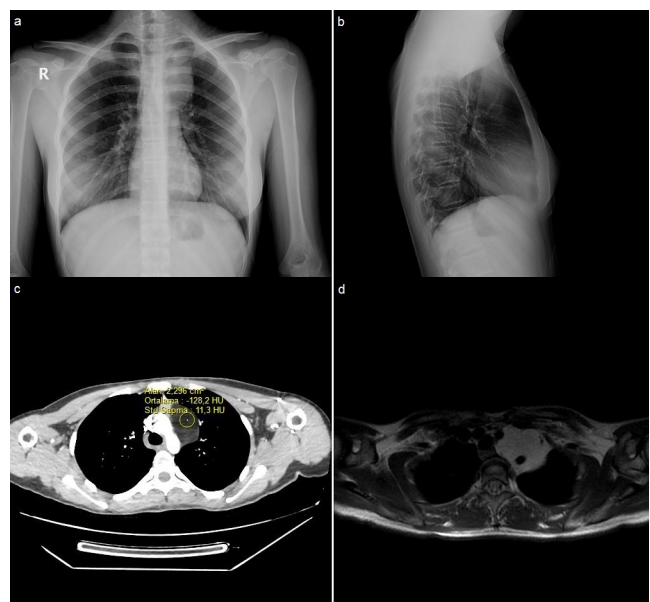


Figure 3: A case of mediastinal lipoma in a 16-year-old girl. Postero-anterior (a) and lateral (b) chest X-rays highlight an oval opacity adjacent to the trachea and aortic knob. The ROI value on the axial (c) contrast-enhanced CT aligns with adipose tissue. The lesion on the axial (d) T1W image is hyperintense due to its fat content.



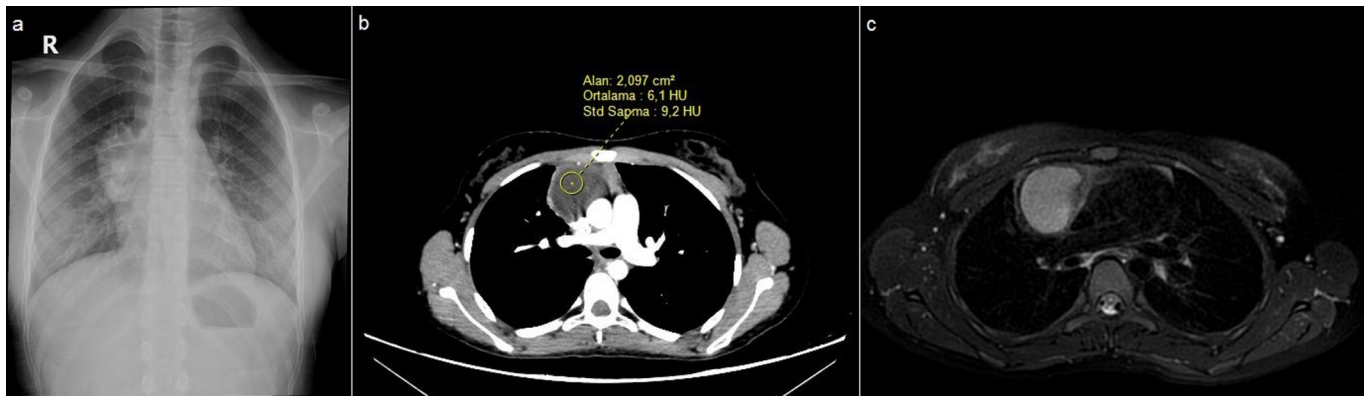
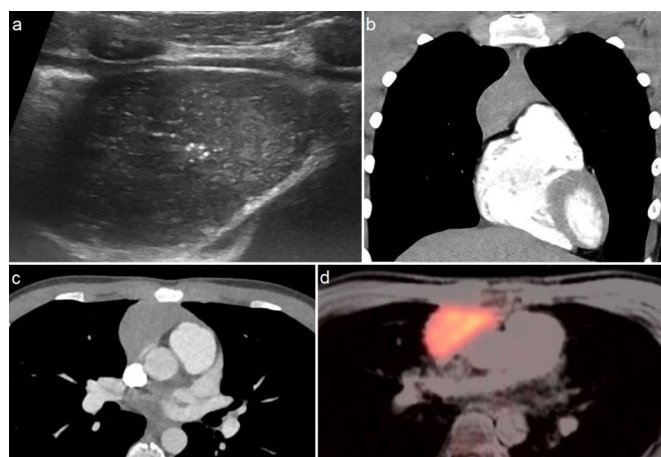


Figure 4: A 15-year-old girl with a thymic cyst. An oval opacity at the right hilar region overlays bronchovascular markings on the postero-anterior (a) chest X-ray. On the axial (b) contrast-enhanced CT, the lesion originating from the thymus exhibits uniform fluid density at ROI measurement and is hyperintense on the axial (c) T2W image passing through the upper mediastinum.



Figure 5: A 3-year-old boy diagnosed with a Morgagni hernia. On the postero-anterior chest X-ray (a), large air-filled round structures with contrast agent levels are visible in the lower mid-chest, projecting through the heart shadow. The lesion, located just behind the sternum on the lateral chest X-ray (b), shows a continuous air column extending into the abdomen, consistent with a herniated transverse colon.



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