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Case Report

Initial ultrasound evaluation of an anterior mediastinal mass ultimately diagnosed as T-cell acute lymphoblastic leukemia: a report of three cases in children☆,☆☆

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ABSTRACT

Pediatric T-cell acute lymphoblastic leukemia (T-ALL) in the anterior mediastinum has an acute onset and requires early treatment. The diagnostic strategy for anterior mediastinal masses in pediatric patients usually involves imaging evaluation, surgical biopsy, or resection for diagnosis and treatment. Thereafter, appropriate chemotherapy regimen selection is based on the pathological diagnosis. In some cases, general anesthesia is avoided to prevent complications such as airway compression and circulatory collapse. We present 3 cases with T-ALL where ultrasound was used for the first evaluation of the anterior mediastinal mass. A 5-year-old girl had lymph node swelling at the supraclavicular fossa. Ultrasound examination showed a huge anterior mediastinal mass with an abnormal thymus, surrounding the proximal main trachea in the mediastinum. These sonographic findings indicated a possibility for tracheal compression during general anesthesia. A 12-year-old boy had dyspnea. Ultrasound examination showed a massive pericardial effusion and stenosis of the right pulmonary artery. These sonographic findings indicated a risk of circulation collapse. An 8-year-old boy had cervical swelling and dyspnea. Ultrasound examination showed a huge mass on the anterior mediastinum and a huge thrombus in the left atrium. This sonographic finding indicated a risk of thromboembolism. Ultrasonography is useful in pediatric patients with anterior mediastinal masses due to T-ALL. By focusing on the thymus, a diag-

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nosis of T-ALL might be recommended. To avoid catastrophic circulation collapse, tracheal and vascular compression should be evaluated. Direct invasion may also be detectable.

Introduction

Various types of anterior mediastinal masses have been reported in pediatric patients [1–4]. The most frequent etiology is hematologic malignancy. Particularly, T-cell acute lymphoblastic leukemia (T-ALL) is well-known for its acute onset and the need for early treatment [5–7]. Unlike adult patients, mediastinal mass by T-ALL may grow rapidly in pediatric patients and result in severe airway compression, vascular compression, and pleural effusion [6, 8–10].

The diagnostic strategy for anterior mediastinal masses in pediatric patients is usually as follows: (1) imaging evaluation for mediastinal mass; (2) surgical biopsy or resection for diagnosis and treatment; and (3) appropriate chemotherapy regimen selection based on the pathological diagnosis [1–4]. While this diagnostic and treatment strategy is being implemented, various life-threatening complications may occur, such as airway compression during general anesthesia or circulatory collapse due to massive pleural and pericardial effusion, especially in pediatric patients with T-ALL [8, 11, 12]. To avoid such catastrophic complications, steroid therapy may be used before computed tomography or surgical intervention that requires general anesthesia. In this situation, besides chest radiography, ultrasonography was the only imaging modality for anterior mediastinal mass evaluation. However, despite the importance of ultrasonography for the evaluation of anterior mediastinal masses in pediatric patients, to the best of our knowledge, there has been no review focusing on the first ultrasound evaluation of pediatric patients with anterior mediastinal masses caused by T-ALL.

The purpose of this case series is to show three pediatric patients with T-ALL and discuss the sonographic findings relevant for T-ALL diagnosis, the advantages and limitations of ultrasonography in the context of evaluating airway and vascular compression, and the sonographic prediction of additional severe complications, including embolisms and hemorrhage.

Case reports

Case 1: A 5-year-old girl with an anterior mediastinal mass due to T-cell lymphoblastic leukemia

The patient had lymph node swelling at the supraclavicular fossa and was admitted to our hospital. Transverse sonography showed a huge anterior mediastinal mass, and T-cell lymphoblastic leukemia was suspected (Fig. 1A and B). The thymus did not appear normal. The proximal main trachea in the mediastinum was visualized and surrounded the mediastinal mass (Fig. 1A and B). Therefore, computed tomography (CT) without sedation was performed. CT showed compression of the tracheal bifurcation and the right and left main bronchi (Fig. 1C). To avoid catastrophic complications during general anesthesia, corticosteroid therapy was performed before surgical biopsy. The tumor size decreased with corticosteroid therapy (Fig 1D). Biopsy was performed, and T-ALL) was diagnosed.

Case 2: A 12-year-old boy with an anterior mediastinal mass due to T-cell lymphoblastic leukemia

The patient had dyspnea and was admitted to our hospital. Ultrasound showed a massive pericardial effusion (Fig. 2A). Cardiac tamponade was diagnosed. In addition, transverse sonography showed stenosis of the right pulmonary artery and right coronary artery, which were surrounded by the tumor (Fig. 2B and C). Pericardial drainage was performed, and T-ALL was diagnosed. CT showed stenosis of the pulmonary artery (Fig. 2C). Despite decreasing the pericardial effusion, sudden shortness of breath and rapid heartbeat were still present. These symptoms were associated with pulmonary arterial stenosis. Chemotherapy for T-ALL was performed, the tumor size decreased, and symptoms disappeared.

Case 3: An 8-year-old boy with an anterior mediastinal mass due to T-cell lymphoblastic leukemia

The patient had been admitted to our hospital for cervical swelling and dyspnea. Ultrasound showed a huge mass on the anterior mediastinum and a huge thrombus in the left atrium (Fig. 3A and B). CT also showed the thrombus in the left atrium (Fig. 3C). To avoid catastrophic complications due to general anesthesia, corticosteroid therapy was performed before surgical biopsy. The tumor size did not decrease; therefore, chemotherapy was performed before surgical biopsy. Ten days after chemotherapy was initiated, convulsions occurred, and multiple brain infarctions were detected using diffusion-weighted magnetic resonance imaging (Fig. 3D). The tumor size had decreased, surgical biopsy was performed under general anesthesia, and T-ALL was diagnosed.

Discussion

Sonographic approach to diagnosing T-ALL-associated anterior mediastinal mass

The thymus is located in the anterior mediastinum. Therefore, the thymus is usually visualized via the parasternal or suprasternal notch approach using a linear transducer (9-15 MHz) or convex transducer (2-9 MHz). The suprasternal notch is recessed; therefore, a convex probe may be useful to evaluate the anterior mediastinum [13–19]. T-ALL is a neoplasm

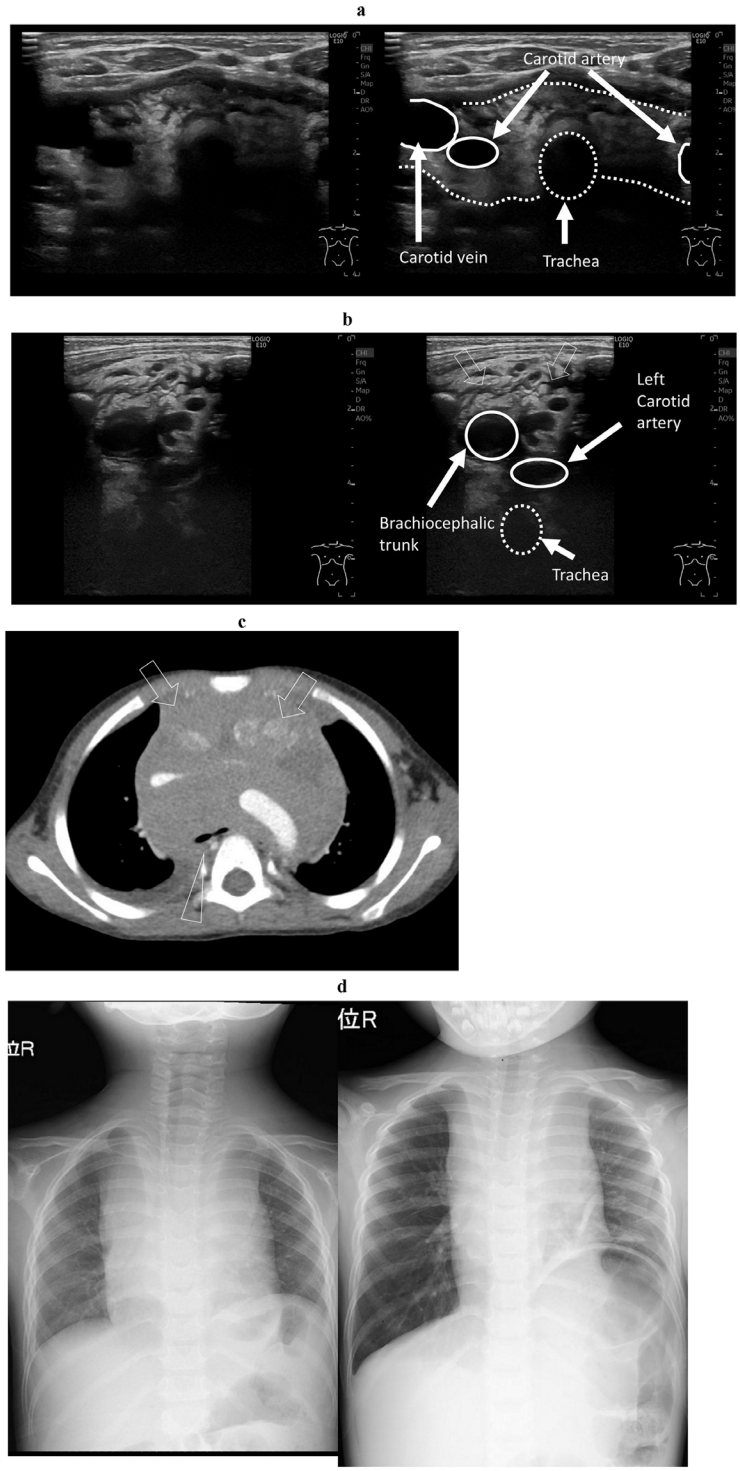

Fig. 1 – A 5-year-old girl with an anterior mediastinal mass due to T-cell lymphoblastic leukemia. (A) The right panel is a schematic presentation of the left panel. Transverse sonogram showing a huge anterior mediastinal mass (dotted line). An abnormal thymus was detected, and T-cell lymphoblastic leukemia was suspected. The proximal main trachea in the mediastinum is visualized (dotted circle). (B) The right panel is a schematic presentation of the left panel. The tracheal bifurcation was difficult to visualize using ultrasonography (dotted circle). The vacant arrows indicate the anterior mediastinal mass. The dotted circle may indicate the main trachea; however, it was difficult to evaluate the lumen. (C) Computed tomography showed compression of the tracheal bifurcation (arrowhead) and the right and left main bronchi. Vacant arrows indicate a large anterior mediastinal mass. (D) Radiographs obtained before (right panel) and 4 days after preoperative corticosteroid therapy (left panel). The tumor size had decreased. A biopsy under general anesthesia was performed, and T-cell lymphoblastic leukemia was diagnosed.

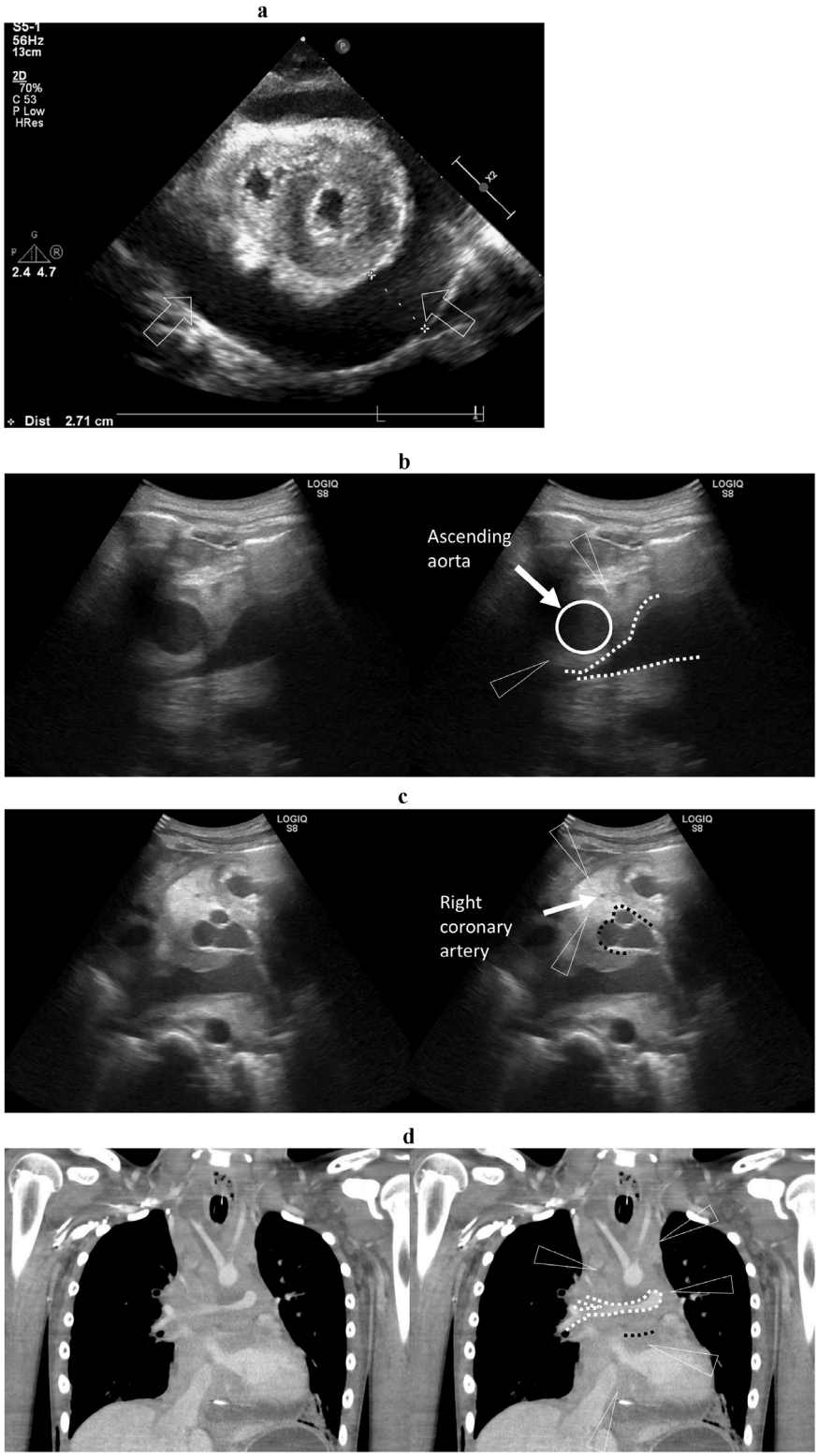

Fig. 2 – A 12-year-old boy with an anterior mediastinal mass due to T-cell lymphoblastic leukemia. (A) Transverse sonogram showing massive pericardial effusion (arrows). Cardiac tamponade was diagnosed. (B) The right panel is a schematic presentation of the left panel. Transverse sonogram showing stenosis of the right pulmonary artery (dotted line). A highly echoic lesion (arrowheads) indicates the mass surrounding the ascending great artery (circle). (C) The right panel is a schematic presentation of the left panel. A highly echoic lesion (arrowheads) can be visualized around the right coronary artery. Dotted line indicates the aortic root. (D) The right panel is a schematic presentation of the left panel. Computed tomography showing the lesion invading the middle mediastinum, and the pulmonary artery (white dotted line), ascending great artery, pulmonary vein, and left coronary artery (black dotted line) surrounded by the lesion (arrowheads).

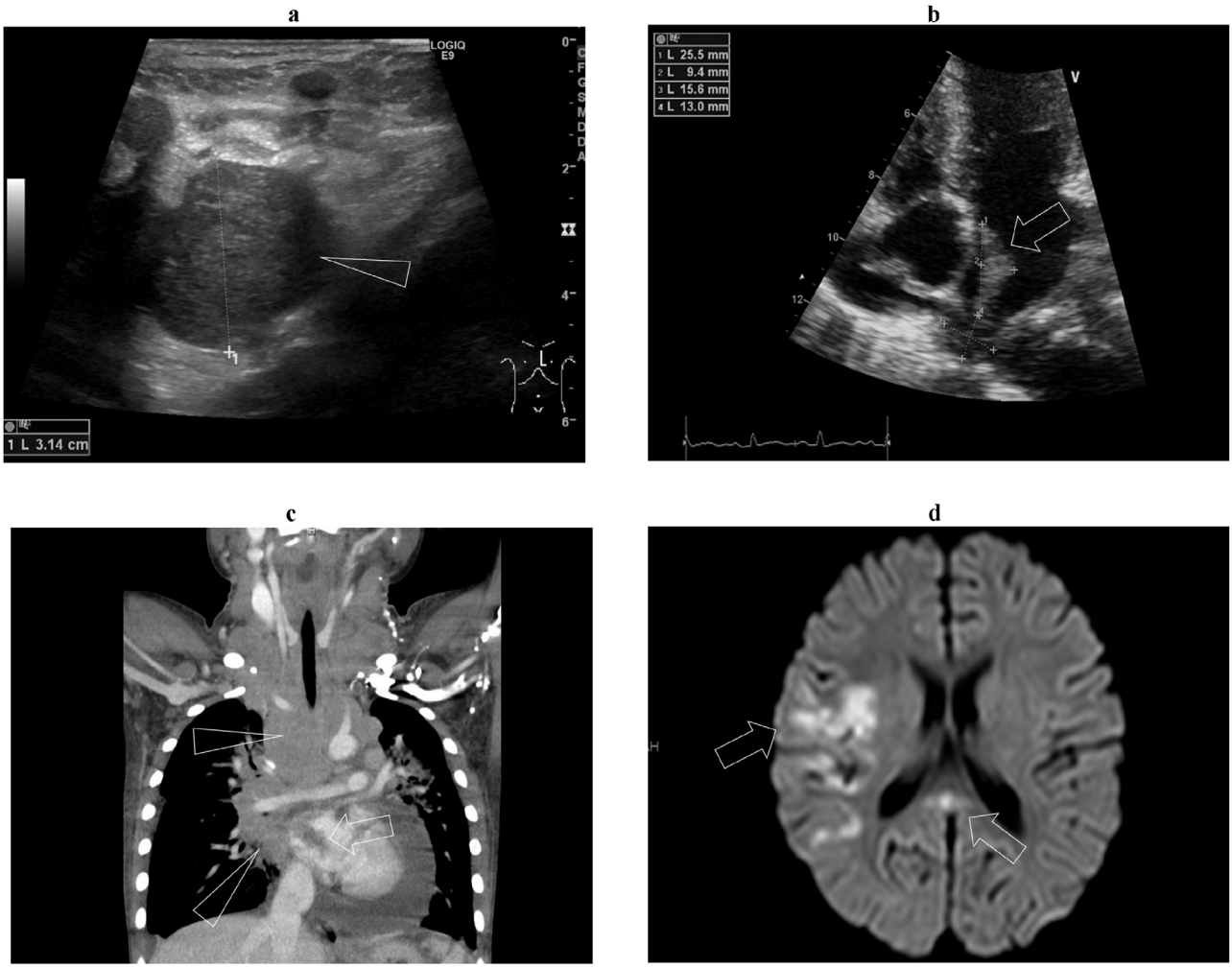

Fig. 3 – An 8-year-old-boy with an anterior mediastinal mass due to T-cell lymphoblastic leukemia. (A) Sagittal sonogram showing a huge mass on the anterior mediastinum (arrowhead). (B) Sonogram showing a huge thrombus (arrow) in the left atrium. (C) Computed tomography showing a thrombus (arrow) in the left atrium. A mediastinal mass was also detected (arrowheads). (D) Ten days after chemotherapy was initiated, convulsions occurred and multiple brain infarctions (arrows) were detected using diffusion-weighted magnetic resonance imaging.

of immature T-lineage cells [1]. Normal T-cells mature in the thymus; therefore, the thymus is usually involved in T-ALL. Hence, the presence or absence of a normal thymus is a useful clue for diagnosing T-ALL, which is suspected if the thymus is involved in the development of an anterior mediastinal mass (Fig. 1A and B). If a normal thymus is detected using ultrasonography, other types of malignancies, including B-cell lymphoma or teratoma, should be considered.

Sonographic evaluation for airway and vascular compression

Evaluation of airway compression by the anterior mediastinal mass is important for subsequent surgical biopsy [2–4, 20–22]. General anesthesia should be avoided in patients with severe airway compression [20]. Ultrasound can be used to evaluate the trachea, but it might be difficult to evaluate around the tracheal bifurcation and the right and left main bronchus because of their location deep in the mediastinum (Fig. 1B). Although the main trachea can visualized via a suprasternal and cervical approach using a linear transducer (9-15 MHz), the tracheal bifurcation and the right and left main bronchus would not be easily visualized using a convex transducer [19, 23]. Therefore, clinical symptoms, radiography, and, if possible, computed tomography are recommended for evaluating this area (Fig. 1C) [4, 24–26]. Vascular compression can also result in catastrophic complications. Pleural and pericardial effusions are usually evaluated using ultrasonography (Fig. 2A) [12]. In addition, evaluation of pulmonary arterial compression is important for managing the concerned patients (Fig. 2B) [5, 8]. Symptoms of this complication might be similar to those of pulmonary embolism; therefore, knowledge of this complication is important, and the pulmonary artery should also be evaluated using ultrasonography. Depending on the patient's body size, the pulmonary artery can be visualized using an appropriate transducer, including linear transducers (9-15 MHz) for cases with small body size or arteries that are not located

in a deep position, convex transducers (2-9 MHz) for cases with large body size or arteries located in a deep position, or sector transducers [27–29]

Sonographic prediction of additional severe complications including embolisms and hemorrhage

In addition to airway and vascular compression, direct invasion of organs such as the tracheal or vascular lumen can result in a distant embolism or massive hemorrhage due to perforation. T-ALL is well-known to be an aggressive malignancy, and direct invasion of the vascular and tracheal lumen can occur. The incidence of these complications is low, however, they can result in severe and catastrophic complications [30]. Invasion into the vascular lumen may be detectable using ultrasonography (Fig. 3B). Thrombi within the atrium or ventricle is usually detected using a sector transducer [31, 32].

Conclusion

Ultrasonography is a useful modality in pediatric patients with anterior mediastinal masses due to T-ALL. By focusing on the thymus, a diagnosis of T-ALL might be recommended. To avoid catastrophic circulation collapse, tracheal and vascular compression should be evaluated. In addition, direct invasion, which can result in severe complications, may also be detectable.

Ethical statements

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1964 and later versions. This retrospective study was approved by the ethics committee of our institution. In addition, we obtained consent from the patients and parents to publish these case reports.

Patient consent statement

Authors have obtained the consents from patients and parents to publish these case reports.

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