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REVIEW ARTICLE

Pathologies of the Mediastinum: A Review of Current Concepts and Surgical Management Supported by a Single-Institution Experience.

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ABSTRACT

Introduction: Mediastinal pathologies comprise a heterogeneous group of congenital, neoplastic, infectious, inflammatory, traumatic, and iatrogenic conditions affecting one of the most anatomically complex regions of the thorax. Due to the proximity of vital structures, including the heart, great vessels, trachea, and esophagus, their diagnosis and management remain particularly challenging. Recent advances in computed tomography, magnetic resonance imaging, positron emission tomography, histopathological classification systems, minimally invasive biopsy techniques, and thoracoscopic surgery have significantly improved the management and prognosis of mediastinal diseases.

This review summarizes contemporary concepts regarding mediastinal pathology, emphasizing anatomical classification, imaging characteristics, histopathological diagnosis, and surgical management. Major disease entities include thymic epithelial tumors, mediastinal neurogenic tumors, mesenchymal lesions, and rare mediastinal conditions. The review integrates recent international literature and current guidelines together with a single-center surgical experience reported in an institutional series, including thymoma associated with myasthenia gravis, thymic carcinoma, neurogenic tumors, mesenchymal tumors, hydatid disease, vascular trauma, and rare postoperative complications.

Conclusion: Mediastinal diseases encompass a broad and heterogeneous spectrum of pathological entities requiring individualized diagnostic and therapeutic strategies. Advances in imaging, histopathology, minimally invasive biopsy techniques, and thoracic surgery have significantly improved patient outcomes

Keywords: Mediastinum; thymoma; thymic carcinoma; neurogenic tumors; thoracic surgery; VATS;

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INTRODUCTION

The mediastinum represents the central compartment of the thoracic cavity and contains numerous vital structures including the heart, thymus, great vessels, trachea, esophagus, thoracic duct, vagus and phrenic nerves, lymphatic tissue, and sympathetic chain. Due to the diversity and complexity of the anatomical structures located within this confined region, mediastinal pathology encompasses a broad spectrum of diseases ranging from benign cystic lesions to highly aggressive malignancies. (1)

Clinical presentation of mediastinal lesions is variable and may present with symptoms related to compression or invasion of adjacent structures, including chest pain, dyspnea, dysphagia, cough, superior vena cava syndrome, or neurological manifestations. However, a substantial portion of the abovementioned lesions are incidentally detected on imaging studies performed for unrelated conditions. The widespread use of computed tomography (CT) and magnetic resonance imaging (MRI) has contributed significantly to earlier diagnosis and more precise anatomical characterization of mediastinal abnormalities. (1,2)

The management of mediastinal diseases has evolved considerably over the past two decades. Advances in minimally invasive thoracic surgery, particularly video-assisted thoracoscopic surgery (VATS), uniportal VATS, robotic-assisted thoracic surgery (RATS), endobronchial ultrasound-guided biopsy (EBUS-TBNA), and molecular pathology have transformed both diagnostic and therapeutic strategies. (3,4)

This review aims to provide a comprehensive overview of mediastinal pathologies with particular focus on surgical management, integrating both recent international evidence and institutional experience from published studies. (5-14)

Anatomical Classification of the Mediastinum

The mediastinum is traditionally divided into three compartments: the anterior, middle and posterior mediastinum. More recently, the International Thymic Malignancy Interest Group (ITMIG) proposed a CT-based classification system to improve radiological correlation and standardize diagnostic and reporting criteria. (15)

The anterior mediastinum contains the thymus, lymphatic tissue, and fatty tissue and represents the most common site for thymic epithelial tumors, germ cell tumors, and lymphomas. (1-3)

The middle mediastinum includes the heart, pericardium, trachea, main bronchi, and mediastinal lymph nodes, whereas the posterior mediastinum predominantly contains neurogenic structures and the esophagus. (2) Anatomical localization remains fundamental for establishing differential diagnosis and treatment planning. (1,15)

Anterior Mediastinal Tumors

Thymoma

Thymoma is the most common primary neoplasm of the anterior mediastinum in adults. It arises from thymic epithelial cells and demonstrates a broad spectrum of biological behavior ranging from indolent encapsulated lesions to invasive tumors. (1-3) A strong association exists between thymoma and autoimmune disorders, particularly myasthenia gravis. Approximately 30–50% of patients with thymoma develop myasthenia gravis, while thymoma is identified in approximately 10–15% of patients diagnosed with myasthenia gravis. (1,14)

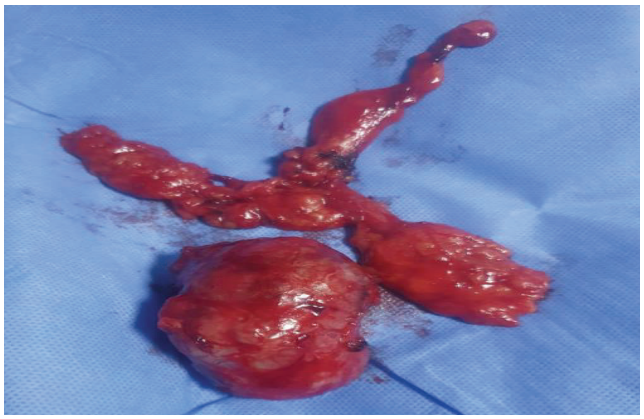


Figure 1. Surgically removed thymoma

In a 10-year single-center experience, a significant association was demonstrated (1-14) between thymoma and myasthenia gravis, emphasizing the importance of multidisciplinary management and long-term follow-up in these patients. Surgical thymectomy remains the cornerstone of treatment and may provide both oncological control and neurological improvement. (3)

According to the WHO classification, thymomas are subdivided into several histological subtypes (A, AB, B1, B2, and B3), each associated with different prognostic implications (1). Current staging systems such as the *Masaoka-Koga classification* and the TNM-based ITMIG system remain essential for treatment planning and prognostic evaluation. (15) Complete surgical resection remains the most important prognostic factor in thymoma management. (3,15)

Thymic Carcinoma

Thymic carcinoma represents a rare but highly aggressive malignant epithelial tumor of the thymus characterized by invasive growth, early metastasis, and poor prognosis compared to thymoma (1,3).

Patients commonly present with locally advanced disease due to nonspecific symptoms and delayed diagnosis. Histologically, squamous cell carcinoma is the most common subtype (1).

In a five-year institutional experience, surgery was reported (10) as a key component of multimodal treatment whenever complete or near-complete resection is achievable. Current modern management typically involves a combination of surgical resection, chemotherapy, and radiotherapy (3). Contemporary NCCN and ESMO guidelines emphasize the need for multidisciplinary evaluation in all cases (3).

Lymphoma and Germ Cell Tumors

Lymphomas are among the most common anterior mediastinal malignancies, particularly in younger patients. Primary mediastinal B-cell lymphoma and Hodgkin lymphoma frequently involve the anterior mediastinum. (1) Mediastinal germ cell tumors include seminomas, non-seminomatous tumors, and teratomas. (1)

Accurate histopathological diagnosis is mandatory before treatment initiation because management differs substantially from other mediastinal tumors. (1,3)

Middle Mediastinal Lesions

Middle mediastinal lesions include bronchogenic cysts, pericardial cysts, lymphadenopathy, and tracheobronchial lesions. Bronchogenic cysts are congenital foregut malformations often detected incidentally but may become symptomatic due to infection or compression. Mediastinal lymphadenopathy may result from malignant, infectious, or inflammatory conditions, including sarcoidosis, tuberculosis, and fungal disease. (1) Endobronchial ultrasound-guided transbronchial needle aspiration, also known as EBUS-TBNA has become an essential minimally invasive diagnostic tool, significantly reducing the need for surgical mediastinoscopy. (4)

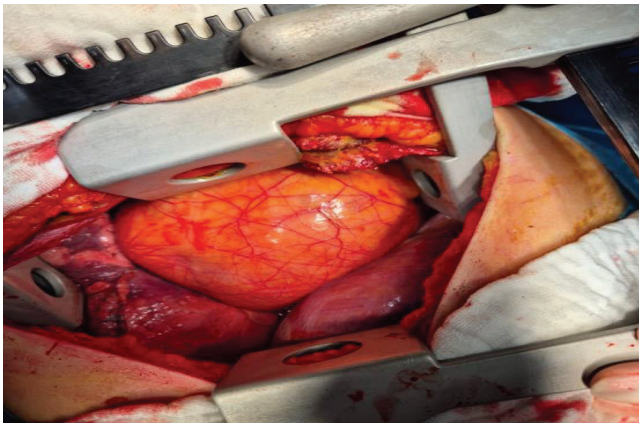


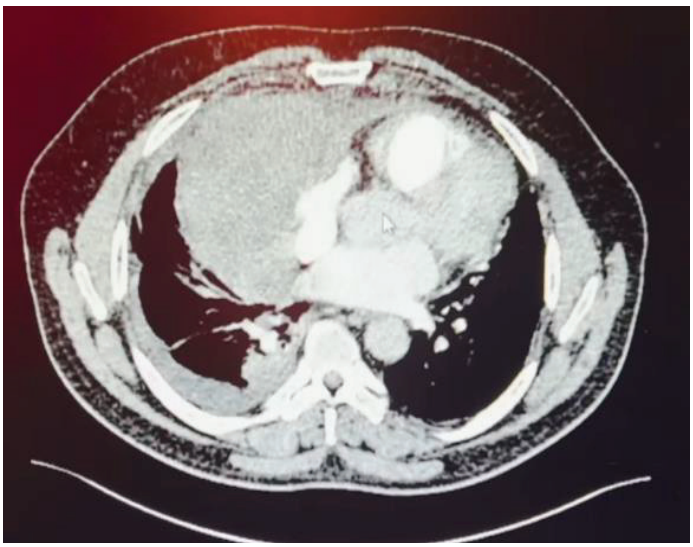
Figure 4. Intraoperative view of a teratoma excision.

Posterior Mediastinal Neurogenic Tumors

Neurogenic tumors represent the most common posterior mediastinal masses in adults accounting for approximately 20% of all mediastinal neoplasms. They arise from peripheral nerve sheath, autonomic ganglia, or paraganglionic tissue. (2)

The most frequent histological types include schwannoma, neurofibroma, and ganglioneuroma. Although most are benign and slow-growing, malignant peripheral nerve sheath tumors may occur (2), A single-institution series reported mediastinal neurogenic tumors, emphasizing the importance of histopathological evaluation and complete surgical resection. (11)

Additionally, a rare giant dumbbell ganglioneuroma involving the posterior mediastinum and spinal canal was described in the same institutional experience, highlighting the complexity of surgical planning and multidisciplinary cooperation between thoracic and neurosurgical teams. (13)



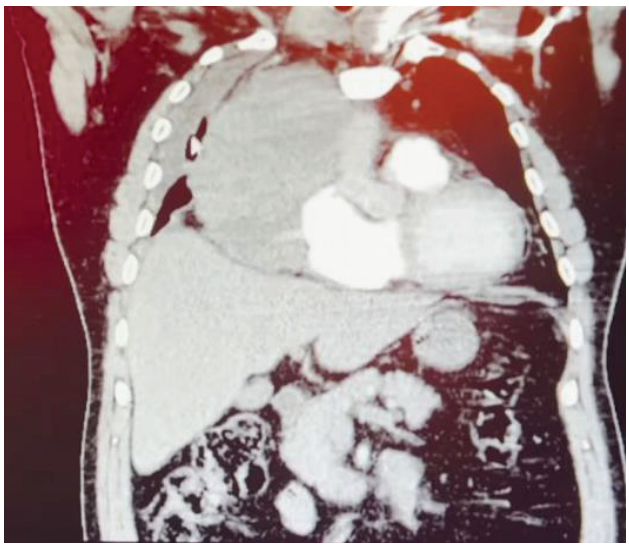


Figure 2 & 3. CT scan of an IV grade seminoma in a 47 y.o. patient that underwent a surgical procedure of full tumor resection in thoracotomy.

Thoracoscopic resection is increasingly preferred for appropriately selected lesions due to reduced postoperative morbidity and shorter hospitalization. (2,4)

Mesenchymal Tumors of the Mediastinum

Mesenchymal tumors of the mediastinum are rare and include lipoma, liposarcoma, fibrosarcoma, leiomyoma, and hemangioma. (1,12) Diagnosis of these tumors often presents as challenging due to nonspecific imaging characteristics and overlap with other mediastinal lesions.

A retrospective single-institution series, (12) emphasized the critical role of surgery in both diagnosis and treatment of mediastinal mesenchymal tumors. Complete surgical excision remains the preferred therapeutic strategy whenever feasible. (4,12)

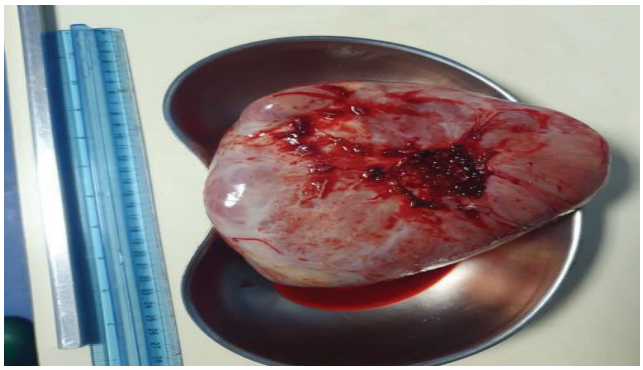


Figure 5. Resected mesenchymal tumor of the mediastinum

Rare and Complex Mediastinal Conditions

Intrapericardial Gossypiboma

Gossypiboma refers to retained surgical textile material following surgery. Although rare, it may remain clinically silent for years. Another case report, (5) described an intrapericardial gossypiboma identified 14 years after coronary artery bypass grafting. (Fig. 6 & 7)

Intrapericardial Hydatidosis.

Hydatid disease involving the mediastinum and pericardium is extremely rare but remains clinically important in endemic regions. A single-center case report (6) described a challenging rare case of intrapericardial hydatidosis, highlighting diagnostic difficulty and the necessity of surgical treatment to prevent life-threatening complications. (Fig. 8)

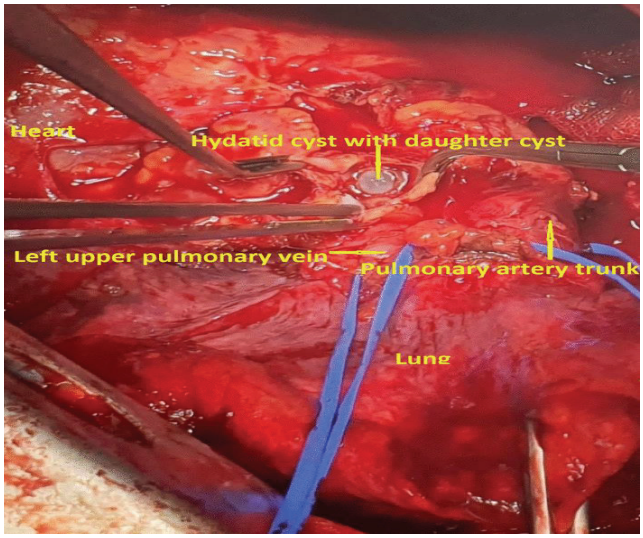


Figure 8. Intrapericardial hydatid cyst and daughter cysts within it, next to the left atrium and left upper

Traumatic Mediastinal and Vascular Lesions

Thoracic trauma involving mediastinal vascular structures represents one of the most challenging emergencies in

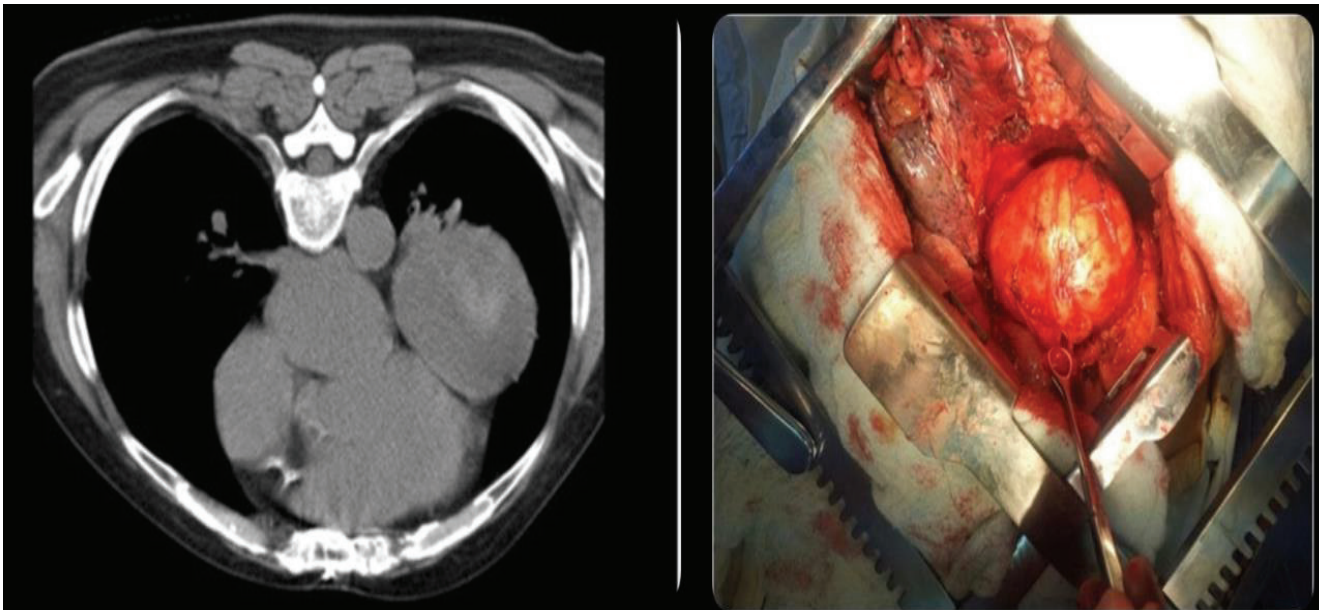


Figure 6 & 7. View of the mediastinal gossypiboma shown in CT scan and also intraoperative.

thoracic surgery. (7,8)

A case report (8) described a successful extraction of a bullet floating within the pulmonary artery after gunshot trauma, demonstrating the importance of rapid diagnosis and surgical intervention. (7) Another report described successful treatment of tracheo-innominate artery fistula by primary surgical repair, preventing catastrophic hemorrhage.

Diagnostic Approach

Accurate diagnosis requires integration of clinical assessment, imaging, and histopathology. (1-4)

Imaging

- Chest radiography: initial, limited specificity
- CT scan: gold standard for evaluation and staging. (1,15)
- MRI: superior for soft tissue and neurogenic/vascular lesions. (2)
- PET-CT: essential for staging and treatment response in malignancy. (3)

Histopathological Diagnosis

Tissue sampling and further diagnosis may be obtained via EBUS-TBNA, mediastinoscopy, VATS biopsy, or CT-guided biopsy (4). Minimally invasive techniques have significantly improved diagnostic accuracy and reduced morbidity.

Surgical Management

Open Surgery

Open thoracotomy or median sternotomy remains indicated in invasive tumors, vascular involvement, or complex reconstruction (3,4)

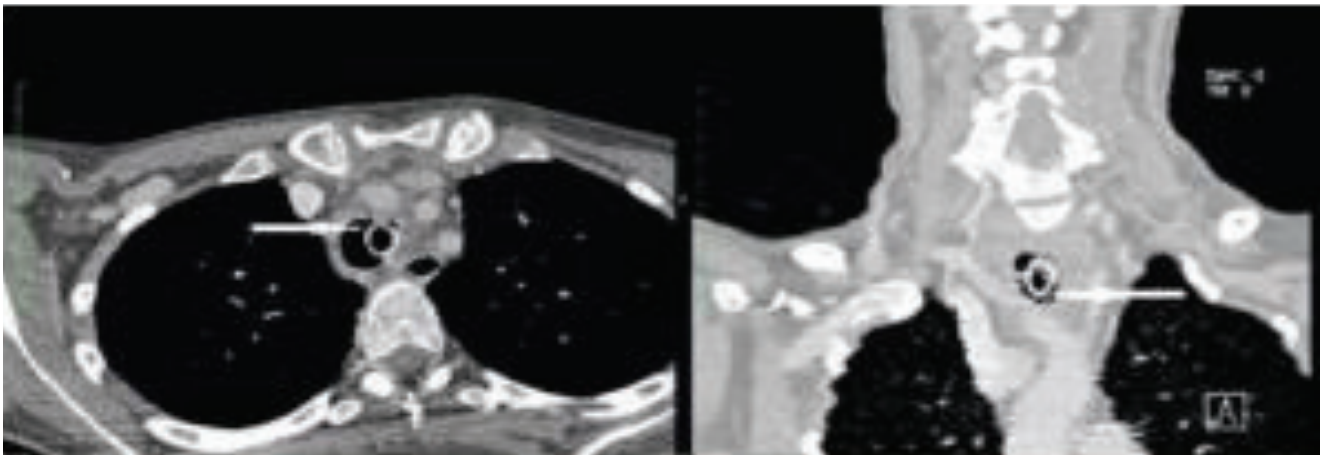


Figure 9. Enhanced CT of thorax and neck indicating close contact between the trachea and the innominate artery (IA) at the level of the tracheostomy cuff, suggesting TIF.

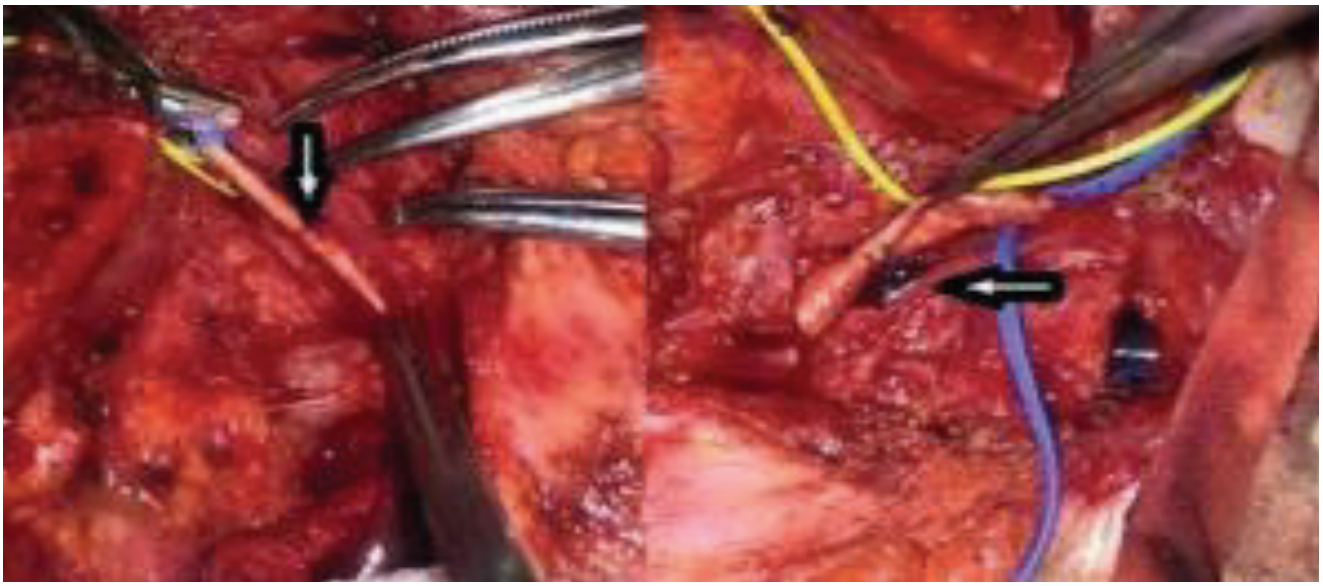


Figure 10. An orotracheal airway was secured whilst removing the tracheostomy cannula. The resulting abundant IA hemorrhage

Minimally Invasive Thoracic Surgery

VATS and uniport VATS have revolutionized mediastinal surgery offering reduced pain, shorter hospitalization, lower complication rates, and faster recovery. Robotic-assisted thoracic surgery is increasingly used for thymectomy and complex mediastinal procedures due to enhanced visualization and precision (4).

A single-center experience supports the growing role of minimally invasive surgery in mediastinal disease management across multiple entities (10-14).

DISCUSSION

Mediastinal pathology remains one of the most complex domains in thoracic surgery because of the anatomical diversity and biological heterogeneity of lesions arising within this region (1,2).

The development of modern imaging modalities has significantly improved diagnostic precision. CT-based compartment classification proposed by ITMIG has standardized radiological interpretation and improved multidisciplinary communication (15). Despite advances in imaging, histopathological diagnosis remains essential due to overlapping radiological features among thymoma, lymphoma, germ cell tumors, neurogenic tumors, and metastatic lesions (1-4).

Minimally invasive approaches have transformed thoracic surgery. VATS and robotic surgery now allow resection of many mediastinal lesions previously requiring sternotomy or thoracotomy.

Current evidence demonstrates comparable oncologic outcomes in selected early-stage thymic tumors with reduced perioperative morbidity (3,4).

Evidence from single-center studies and case series (1-10) contributes to the understanding of mediastinal across multiple domains, including thymic tumors, neurogenic lesions, mesenchymal tumors, rare mediastinal conditions, and traumatic vascular injuries.

These studies reinforce the importance of surgical expertise and multidisciplinary collaboration in mediastinal disease management.

Future perspectives include:

- expanded robotic surgery
- molecular classification of thymic tumors
- artificial intelligence-assisted imaging analysis
- personalized oncologic therapy (1-4).

CONCLUSION

Mediastinal diseases encompass a broad and heterogeneous spectrum of pathological entities requiring individualized diagnostic and therapeutic strategies. Advances in imaging, histopathology, minimally invasive biopsy techniques, and thoracic surgery have significantly improved patient outcomes (1-4). Surgical management remains central in the treatment of both benign and malignant mediastinal lesions. A single-center series of studies demonstrates the essential role of thoracic surgery in the management of common mediastinal tumors and rare complex thoracic conditions (4-14)

Multidisciplinary collaboration and continued evolution of minimally invasive techniques are expected to further improve outcomes in mediastinal pathology (3, 4).

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Abbreviations

CT - Computed Tomography; MRI - Magnetic Resonance Imaging; VATS - Video-Assisted Thoracoscopic Surgery; RATS - Robotic-Assisted Thoracic Surgery; EBUS - Endobronchial Ultrasound-Guided Biopsy; TBNA - Transbronchial Needle Aspiration; ITMIG - International Thymic Malignancy Interest Group; WHO - World Health Organization; TNM - Tumor, Nodes, Metastasis; NCCN - National Comprehensive Cancer Network; ESMO - *European Society for Medical Oncology;*

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