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CASE REPORT

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Supraclavicular-median sternotomy approach for a large neurilemmoma invading the thoracic outlet: a case report and review of the literature

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Abstract

Background Large mediastinum tumors invading the thoracic outlet have consistently been a challenge in thoracic surgery. Due to the large size of the tumor and its proximity to many important tissues, appropriate surgical approaches are crucial for a successful surgery.

Case presentations Here, we present a case of a large neurilemmoma that invaded the thoracic outlet that was resected by a supraclavicular-median sternotomy approach. The case was a 58-year-old woman with a large mass in the right chest cavity that had invaded the thoracic outlet. The preoperative biopsy showed a blood clot with a few fibrous connective tissues covered by a single layer of flat epithelium. There was insufficient evidence to diagnose the mass as a tumor, and imaging examinations suggested a diagnosis of solitary pleural fibroma. For good exposure of the cranial and caudal aspects of the large mass, we devised a median sternotomy combined with a supraclavicular approach and safely achieved complete resection. The patient recovered well and experienced no severe complications or functional restrictions of the upper extremity. The postoperative pathology diagnosis was a neurilemmoma.

Conclusions The supraclavicular-median sternotomy approach could be an optional approach for the complete resection of large mediastinal tumors invading the thoracic outlet.

Keywords Supraclavicular-median sternotomy, Neurilemmoma, Thoracic outlet, Surgical approach

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Introduction

Large chest tumors have always been challenging in thoracic surgery, especially when the tumors invade the thoracic outlet. Due to the small operation space and anatomic complexity of the thoracic outlet, complete resection of large chest tumors invading the thoracic outlet is difficult.

Several surgical approaches have been designed for chest tumors invading the thoracic outlet, such as the anterior transcervical-thoracic approach and its corresponding modification proposed by Dartevelle [1, 2], the transmanubrial osteomuscular sparing approach proposed by Grunenwald [3], and the supraclavicular approach or an approach combined with video-assisted thoracoscopic surgery (VATS) proposed by Bandiera and Sakuraba, et al. [4–7]. Each of these approaches has its advantages and disadvantages. However, in some specific cases with large tumors, these surgical approaches may not meet the requirements of the task.

Here, we present a case of a large neurilemmoma invading the thoracic outlet that was resected through a modified approach based on sternotomy combined with a supraclavicular approach.

Case presentations

The case was a 56-year-old woman admitted to a local hospital due to sudden syncope. A routine blood test showed a low Hb of 58 g/L and normal blood glucose, and a subsequent CT scan showed a large mass in the right chest cavity with atelectasis and pleural effusion. The patient was given anti-shock treatment and had a good recovery. After being discharged from the local hospital, she had occasional chest discomfort and did not receive any further treatment over the next 4 years.

After admission to our hospital, Horner's syndrome on the right was detected by physical examination. Then, the patient accepted a needle biopsy, blood tests including AFP and β-HCG, and an enhanced CT scan. The biopsy pathology result did not support a tumor diagnosis because the sample mainly consisted of blood clots and a few fibrous connective tissues covered with a single layer of flat epithelium, and the blood AFP and β-HCG tests were also negative.

Enhanced CT showed a 15.2×12.0 cm round mass (soft tissue density with a large area of low density and calcification) in the right chest cavity with invasion into the thoracic outlet with atelectasis of the upper lobe, and the enhanced scan showed gradual delayed and nonhomogeneous enhancement, with a thick blood vessel-like area in the mass, indicating a diagnosis of solitary pleural fibroma.

Surgical technique

After excluding any contraindications, the patient accepted surgical treatment. For good exposure of the cranial side of the tumor invading the thoracic outlet and the caudal side of the tumor to the level of the inferior pulmonary vein (Fig. 1a), we designed a sternotomy combined with a supraclavicular approach. The patient was placed in the supine position with the neck hyperextended and the head turned away from the involved side. After endotracheal intubation, a median sternal splitting was performed. Subsequently, a transverse incision was made from the upper edge of the right midpoint of the clavicle to the upper edge of the sternum, intersecting with the median sternotomy incision. After separating the subcutaneous tissue, the sternocleidomastoid muscle was transected above the clavicular tendon, exposing the scalenus anterior muscle, scalenus medius muscle, and subclavian arteries and veins. The sternum was then opened, and the incision near the sternoclavicular joint (forming an "inverted L" angle, Fig. 1b) was retracted outward and upward to further expose the thoracic outlet. First, the tumor was dissected from the mediastinal structures, such as the hilum, superior vena cava, right innominate vein, and aortic arch. Next, the cranial side of the tumor adjacent to the subclavian vessels was carefully separated. The caudal side and lateral part of the tumor were then bluntly dissected from the upper lobe and chest wall. Finally, the tumor and the paraspinal portion were separated using blunt dissection and energy instruments.

The postoperative pathology diagnosis was neurilemmoma of 15×10×9 cm, with extensive haemorrhage, degeneration, necrosis, and reactive hyperplastic vessels. (Superior Mediastinal Lymph Node): No tumor identified in the lymph node. Immunohistochemistry: SMA (negative), Desmin (negative), S-100 (positive), SOX10 (positive), Vimentin (positive), CD34 (negative), CK (AE1/AE3) (negative), WT-1 (negative), MC (negative), Ki-67 (+, 3%), STAT6 (negative), ALK (negative), PGP9.5 (positive), GFAP (negative), D2-40 (positive), CK5/6 (negative), Synaptophysin (negative). The patient was discharged 9 days after surgery with good recovery. Three months later, the patient was in good condition, and the preoperative Horner's syndrome was relieved.

During this surgery, a thorough intraoperative evaluation confirmed complete separation of the tumor from the surrounding tissues, allowing for its thorough excision. The postoperative pathology report indicated that all margins were free of tumor cells, and no metastasis was found in the resected lymph nodes. Postoperative imaging showed no signs of residual tumor or recurrence. Regular follow-up monitoring, including imaging examinations, has shown no signs of recurrence to date, confirming that an R0 resection was achieved.

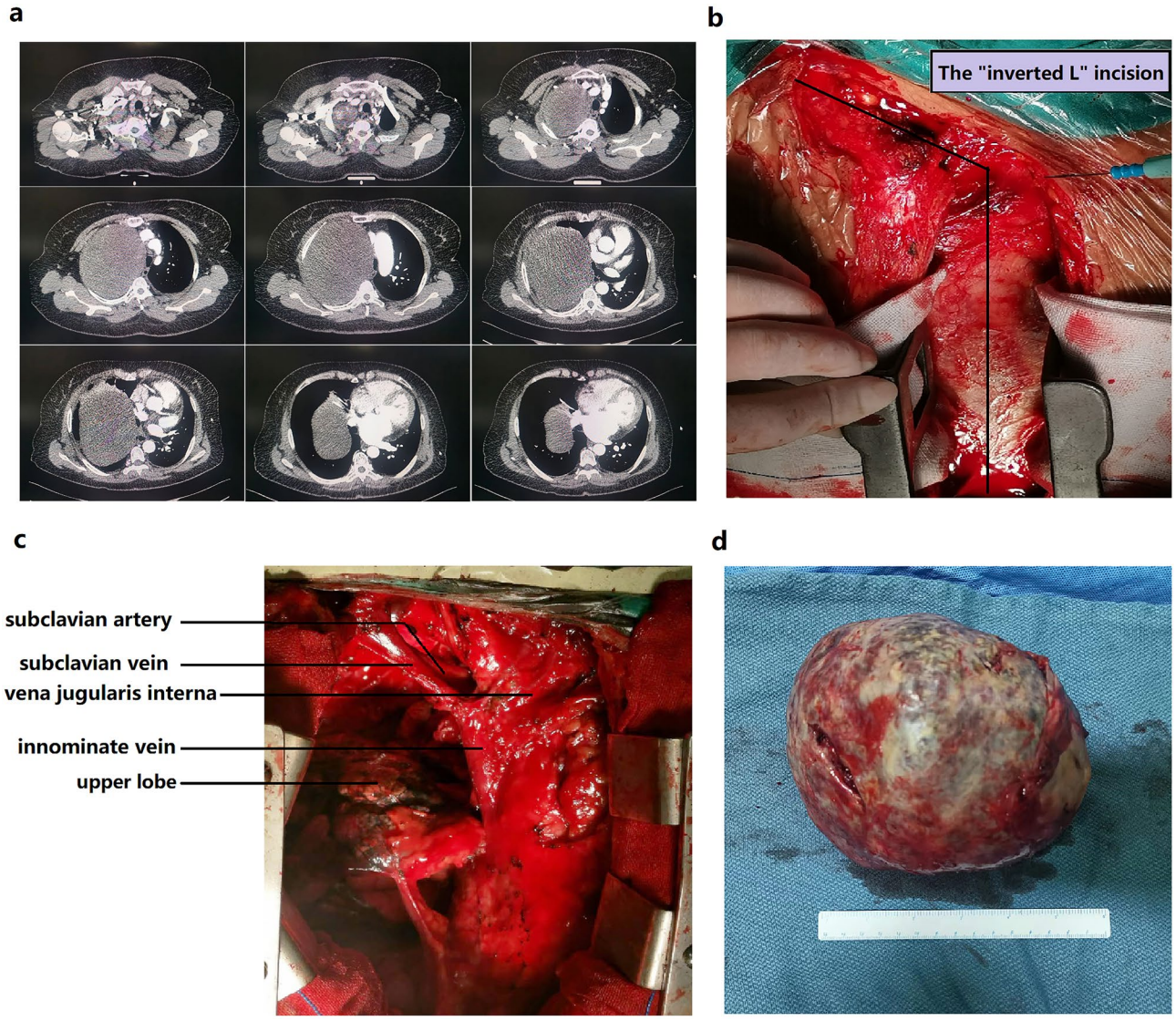

Fig. 1 **a**. CT manifestation of the patient; **b**. the "inverted L" incision (median sternotomy combined with a supraclavicular incision); **c**. exposure of important structures of the thoracic outlet after tumor removal; **d**. Pathological specimen

We conducted regular telephone follow-ups with the patient to monitor postoperative recovery and assess for any signs of tumor recurrence. During these follow-ups, the patient consistently reported no symptoms indicative of recurrence. The patient underwent routine postoperative imaging and clinical examinations at a local medical facility, which, according to the patient's verbal report, indicated no evidence of tumor recurrence. Unfortunately, despite our requests, the patient has been unable to provide us with the official examination reports. Efforts are ongoing to assist the patient in obtaining and submitting these reports. We will continue to monitor the patient closely and aim to include more comprehensive data from future follow-ups in subsequent updates.

Discussion

The origin of thoracic outlet tumors is complex. According to several research reports, neurilemmomas are the most common tumors invading the thoracic outlet, accounting for approximately 50%~60% of cases [8, 9]. Patients with these tumors in their chest are usually asymptomatic but may experience chest discomfort or dull pain when the tumors are very large. Interestingly, in this case, the first symptom was sudden syncope. Considering the low Hb level, CT manifestations, and preoperative pathology results, the syncope is probably the result of internal haemorrhage of the tumor. Although neurilemmoma in the chest can cause necrosis and cystic degeneration, internal haemorrhage is very rare. This patient had Horner's syndrome on the right side, identified during a physical examination after admission to

our hospital, which may be caused by tissue compression by the tumor, and approximately 6%~8% of patients with chest tumors invading the thoracic outlet have been found to have Horner's syndrome [8, 9].

The most common differential diagnosis of large lesions in the chest is solitary fibrous tumors of the pleura (SFTP). These patients are usually asymptomatic, and the diagnosis is hard to differentiate through clinical manifestations. Interestingly, approximately 14% of patients with SFTP could develop syncope due to episodic hypoglycaemia, often as the first symptom [10]. In this case, the first symptom was syncope due to internal haemorrhage rather than hypoglycaemia. The imaging manifestations of neurilemmoma and SFTP are sometimes similar, but enhanced scanning is usually gradually delayed in neurilemmoma, while SFTP usually shows early enhancement and possibly serpentine vessels [11–15]. In this case, the CT scan result was consistent with these features, except for the thick blood vessel-like enhancement indicating blood vessels, which is more often seen in SFTP.Based on the above, our radiologist preferred a diagnosis of SFTP rather than neurilemmoma.

Several surgical approaches have been used for tumors invading the thoracic outlet. Dartevelle's approach fully exposes the subclavian arteries and veins, brachial plexus nerves, and their branches, allowing for the complete resection of Pancoast carcinoma. However, resecting the medial half of the clavicle can impair upper limb function and cause shoulder deformity post-surgery [1, 2]. Grunenwald proposed the transmanubrial osteomuscular sparing approach to overcome limitations of the anterior transcervical-thoracic approach, avoiding impact on the upper limb and shoulder joint seen with the anterior transclavicular-thoracic approach. However, tumors invading the dorsal chest wall or requiring lobectomy still necessitate a posterolateral thoracic incision [3]. Sakuraba's method for neurogenic tumors from the brachial plexus or cervical nerve roots minimizes trauma and ensures complete exposure of the cervical root structure, but requires additional clavicle sectioning for full exposure of the subclavian vessels [5]. For this case, although the CT and clinical manifestations both suggested a high possibility of benign tumors, due to the lack of preoperative pathology diagnosis, we needed an approach that could achieve not only good exposure of this large tumor but also allow for a possible sublobectomy/ lobectomy due to the unknown relationship between the tumor and the upper lobe. Therefore, we chose sternotomy for exposure of the main tumor body and possible sublobectomy/lobectomy. Meanwhile, a combined supraclavicular incision was used for exposure of the cranial side of the tumor invading the thoracic outlet.

To further expose the thoracic outlet, extending the incision supraclavicular to the distal end or severing the subclavian vein may be considered. The tumor did not invade the surrounding tissue, and in this case, it was resected completely without disconnecting the subclavian vein. Even if the vessels were invaded, this approach could provide excellent exposure to the subclavian vessels. During the surgery, we found that the tumor root originated from the spinal side with a rich blood supply, indicating a high probability of it being a neurogenic tumor.

The supraclavicular-median sternotomy approach is an inverted "L" incision formed by the intersection of the median sternotomy and supraclavicular incisions. During the operation, after opening the median sternotomy incision, the portion near the sternoclavicular joint (i.e., the L-shaped angle) can be pulled outward and upward to further expose the thoracic outlet. When exposing the thoracic outlet and the upper pole of the tumor, attention should be given to the following factors: (1) The ipsilateral internal jugular vein, subclavian vein, and innominate vein become thin cords due to the tension of the incision, and should not be mistaken for connective tissue to avoid potential injury. (2) To further expose the thoracic outlet, extending the supraclavicular incision distally or severing the subclavian vein may be considered. Although the tumor was evaluated as benign before the operation, its large size and prolonged compression on the surrounding tissues typically resulted in a close relationship with structures such as the subclavian artery and vein, innominate vein, superior vena cava, and hilum of the lung, despite no obvious invasion. Therefore, a posterolateral incision or a simple median sternotomy approach cannot adequately meet the requirements for the dissection of these structures under direct intraoperative vision. Compared with the other approaches mentioned above, the supraclavicular-median sternotomy approach has the following advantages: (1) The operation does not damage the intercostal muscles and has little effect on respiratory function after the operation; (2) It has great advantages for exposure of the cranial and caudal sides of larger tumors and could also achieve lobectomy if necessary, as there is no need for an additional posterolateral thoracic incision. However, this approach is not suitable for large tumors invading the dorsal part of the chest wall, similar to the other approaches mentioned above.

Conclusion

In conclusion, we designed an improved surgical approach based on median sternotomy for large chest tumors invading the thoracic outlet and confirmed its safety and feasibility through clinical application. However, additional clinical practice is required to confirm its clinical application value.

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Author contributions
Shi and Wu wrote the main manuscript text and prepared the figures, Liu revised the manuscript. All authors reviewed the manuscript.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
This study was approved by the Medical Ethics Committee of Shandong Provincial Hospital affiliated with Shandong First Medical University according to the Guidelines of Chinese Ethics Review Committees(SWYK: No.2019-020) and in this retrospective study, the patient had signed the consent for publication.

Consent for publication
Written consent for publication was obtained from the patients.

Competing interests
The authors declare no competing interests.

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