Introduction

The cervicothoracic junction is a complex and narrow space involving many key neurovascular structures with close associations. Tumors frequently invade or compress surrounding tissues and organs in this region, resulting in a risk of injury during surgery [1]. There are many surgical approaches to treat tumors of the cervicothoracic junction, but they are associated with high morbidity and mortality [2, 3]. Video-assisted thoracic surgery (VATS) has a shorter hospital stay and fewer complications when compared with traditional open approaches [4]. While VATS can reach many mediastinal masses, the cervicothoracic junction is a watershed area where visualization and exposure become more difficult, and where transcervical resection is the most appropriate [5]. Furthermore, instrumental collision within the narrow space increases the susceptibility of iatrogenic injury [6].

Transoesophageal endoscopic resection has been recently developed to resect mediastinal tumors, even in the cervicothoracic junction [7, 8] but when the tumor is too large, it is difficult to remove the intact tumor from the esophagus. Based on our experiences with transoesophageal endoscopic surgery and transcervical videomediastino-thoracoscopy, we describe a new technology named small incision-assisted submucosal tunnel endoscopic resection (S-STER), which integrates transoesophageal endoscopic resection and tumor removal using a cervical incision.

Case report

Because of difficulty in swallowing for 6 years, a 49-year-old male presented to our department with a superior mediastinum tumor found during a routine check-up at a local hospital using endoscopic ultrasound (EUS). He presented for evaluation of his difficulty in swallowing. He had a history of transthoracic mediastinal tumor resection 7 years prior, with no other personal or family history. Contrast-enhanced chest computed tomography (CT) showed a mass (3.9 × 2.6 cm) in the cervicothoracic junction (Figure 1A). No metastasis to the lymph nodes or other organs was seen on the CT scan. EUS showed it was heteroechoic and well demarcated, ~35.1 × 24.5 mm in diameter, and located in the esophageal extralumen (Figure 1B).

Because a tumor of the cervicothoracic junction is difficult to resect using VATS and the patient had a strong intention for surgery, after the discussion of a multiple disciplinary team, we thought that the tumor could be dissected completely using S-STER.

Description of the technology

The patient was placed under general anesthesia with endotracheal intubation. Prophylactic intravenous antibiotics were introduced 30 min before the procedure. The transoesophageal endoscopic resection was similar to our previous procedure [7]. A transparent cap was attached to the tip of the gastroscope to...
improve operative field exposure and the endoscopy system was a CV-290 (Olympus, Tokyo, Japan). The tumor was resected using a hybrid-knife. A FORCED COAD (Olympus, Tokyo, Japan) electrosurgical unit was used. The total procedure included four steps as follows (Figure 1C–G).

Step 1: A routine STER procedure. Using STER, a submucosal longitudinal tunnel was created between the mucosal and muscle layers towards the tumor site. Full-thickness myotomy was performed above the estimated location of the mediastinal tumor. The tumor was carefully dissected via en bloc resection.

Step 2: Cervical incision. An oblique incision was made along the sternocleidomastoid muscle. The tissue was carefully separated from the lateral side of the internal jugular vein to the deep side until the tumor was located.

Step 3: Tumor extraction. The tumor was ligated using sutures and carefully removed from the cervical incision. Then, the wound was sutured and a drainage tube was added.

Step 4: Mucosal closure. Closure of the mucosal incision was achieved by placement of several metallic clips. Any mucosal injury or perforation was also clipped to avoid mucosal leakage.

Perioperative results
The procedure was successfully completed without any injury of surrounding vital structures. Histopathological examination revealed a Schwannoma. There was no sign of recurrence during a routine follow-up at 4 months.

Discussion
Schwannomas are rarely found in the esophagus and are challenging to diagnose using standard imaging techniques. Confirmation of the diagnosis requires pathological examination with further immunostaining studies after surgical resection. Meanwhile, transoesophageal endoscopic surgery has become a new strategy for treatment and diagnosis.

In this report, we used S-STER to replace traditional VATS. The surgery was accomplished without conversion and the patient was discharged uneventfully, thus demonstrating the safety and feasibility of the procedure.

The patient had a history of transthoracic mediastinal tumor resection resulting in disorder and adhesion of the mediastinal. Moreover, the tumor was in the cervicothoracic junction, making it difficult to use transthoracic resection [9]. Transcervical thoracoscopic resection could reach the tumor and obviate entry into the pleural cavity, but the narrow space limited the mobilities of instruments, and disorder of the mediastinal added to the difficulty [1]. Theoretically, this tumor could be effectively removed by transoesophageal endoscopic resection, but it was too large to be removed intact from the esophagus. According to our experience, S-STER was suitable when the short axis of the tumor was >2.5 cm and the texture was relatively hard.

Compared with transcervical thoracoscopic resection, our procedure had the following advantages. First, pain from the cervical incision was lower than that from a chest incision. Second, the flexible gastroscope facilitated increased freedom of manipulation and elimination of iatrogenic injury caused by equipment collisions. In addition, a transparent cap was attached to the tip of the gastroscope to improve operative field exposure. Compared with transoesophageal endoscopic resection, our procedure had the advantage of resecting large tumors. We resected the tumor using a cervical incision with a gastroscope, which protected the esophagus tunnel and kept the tumor integrated.
There were also some potential risks that should be consid-
ered, such as complications due to damage to the integrity of
the esophagus and the invasion of important mediastinal struc-
tures when emergency surgery was required.

In conclusion, S-STER made the endoscopic from intraluminal
to extraluminal, without the limitation of tumor size and with
protection of the tunnel. Further studies should be conducted to
confirm the safety and effectiveness of this procedure.

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Conflict of Interest
All authors have no financial relationships with any organiza-
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References
1. Wang S, Chen Z, Zhang K et al. Individualized surgical treat-
ment for patients with tumours of the cervicothoracic jun-
ction. Interact Cardiovasc Thorac Surg 2022;34:1024–30.
2. Prezerakos GK, Sayal P, Kourliouros A et al. Paravertebral
tumours of the cervicothoracic junction extending into the
mediastinum: surgical strategies in a no man’s land. Eur Spine J
2018;27:902–12.
3. Okamura A, Watanabe M, Imamura Y et al. Cervicothoracoscopic approach in esophagectomy. Ann Surg Oncol 2018;25:333.
4. Isaacs KE, Belete S, Miller BJ et al. Video-assisted thoracoscopic
surgery for ectopic mediastinal parathyroid adenoma. BJ innov 2019;3:743–9.
5. Zhu XS, Song N, Song NC et al. Comparison of the perioperative
outcomes in antero-superior mediastinal tumor resection per-
formed by transcervical resection and video-assisted thoraco-
scopic surgery. J Thorac Dis 2018;10:6838–45.
6. Shen Y, Zhang Y, He M et al. Advancing gastroscope from
intraluminal to extraluminal dissection: primary experience of
laparo-gastroscopic esophagectomy. Ann Surg 2022;275:
e659–63.
7. Gao P, Li Q, Hu J et al. Transoesophageal endoscopic removal of
a benign mediastinal tumour: a new field for endotherapy? Gut
2020;69:1727–9.
8. Mouroux J, Venissac N, Leo F et al. Usual and unusual locations
of intrathoracic mesothelial cysts: is endoscopic resection al-
ways possible? Eur J Cardiothorac Surg 2003;24:684–8.
9. Hazelrigg SR. What is the best surgical approach to the
superior mediastinum? Semin Thorac Cardiovasc Surg 2018;30:
475.