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Minimally invasive endoscopic approach to the cervicothoracic junction for vertebral metastases: report of two cases

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Abstract The anterior cervicothoracic junction is difficult to expose and many techniques have previously been described. Most of them require an extensile exposure, which can lead to significant morbidity. The aim of this study is to present a less invasive approach, allowing the same exposure on the spine as a larger one. The approach begins with the same incision as the Smith-Robinson technique: a blunt dissection of the posterior face of the manubrium is performed with the finger. An endoscope is inserted through 10-mm trocars, one above the manubrium and the second through the second rib space. The upper mediastinal space is exposed; the dissection is performed on the left side, between the esophagus and trachea medially, between the innominate vein and brachio-cephalic artery distally, and between the left common carotid and internal jugular vein laterally. The recurrent nerve

must be protected. Two patients with spine metastases underwent this new approach. A strut graft was fixed anteriorly after decompression of the spinal cord. Levels T1–T3 can be well exposed through this approach, allowing complete vertebral body removal at level T1 or T2. After body removal, the posterior longitudinal ligament is well exposed, allowing complete release of the spinal cord. The use of the endoscope is the key to providing a good view of the spine without an extensile exposure. This new approach is technically feasible. The exposure is sufficient for vertebral body resection and reconstruction by strut graft. The procedure is less aggressive and painful than sternotomy.

Keywords Endoscopic surgery · Thoracic spine · Metastatic disease · Cervicothoracic junction

Introduction

The anterior cervicothoracic junction is difficult to expose, and many techniques have been described [1, 2]. Most of the previously described techniques are extensile and require osteotomy of the clavicle [19] or sternotomy [1, 20]. A thoracic lateral approach requires elevation of the scapula [7] with extensile muscle dissection and rib resection, leading to significant morbidity. A cervical approach [15] does not allow good spinal cord decompression at the levels T1, T2 or T3, because it is not possible to see the pos-

terior vertebral ligament, and osteosynthesis is not easy due to the obliquity of the access. We used a new video-assisted technique in two patients, which made it possible to minimize the approach and optimize visualization.

Materials and methods

Two patients with metastases of malignant tumors of T1 and T2 underwent anterior spine surgery using a new less invasive anterior surgical approach. All patients underwent pre-operative magnetic resonance imaging (MRI). Neurologic function was graded according to the classification of Frankel [5].

Fig. 1 Skin incision of the video-assisted T1–T3 approach: *a* and *b* indicate the clavicles

The instruments used for this procedure are common orthopedic instruments and specific ones used for thoracoscopic surgery. A variety of scissors, graspers, retractors, rongeurs, curettes and dissectors are adapted for thoracic endoscopic surgery (Medtronic, Memphis, USA). The trocars are single-use trocars, and are radio-lucent to allow X-ray amplifier control. These trocars are 10-mm trocars and the endoscope is a 10-mm scope with 0° or 30° angulation.

The anterior video-assisted approach to the upper thoracic spine from T1 to T3 was performed with the patient supine, a rolled towel placed between the scapulas, and the neck slightly hyperextended. All areas were well padded, and the head was completely covered by drapes in order to have complete access to the manubrium. Spinal cord potentials were intra-operatively monitored. The C-arm was prepared in order to check the exact level during the procedure. A 6- to 8-cm incision was made on the midline, beginning 3 cm above the manubrium and finishing at the middle part of the manubrium (Fig. 1). The subcutaneous tissue and the platysma muscle were incised, the upper border of the manubrium was marked and the space between the second and third rib was dissected (Fig. 2). A blunt dissection of the posterior face of the manubrium was performed with the finger, paying attention to the internal mammary artery, which could be injured. The upper mediastinal space was exposed, as described by Robinson and Smith

Fig. 2 Anatomical dissection of the minimal exposure proposed in this video-assisted technique [*a* manubrium, *b* sterno-cleido-mastoid (SCM) muscle, *c* second intercostal space]

[15] and Fieldings and Stillwell [4], to reach the lower part of the cervical spine. Superficial and deep cervical fascia were divided, the sternohyoid, sternothyroid and omohyoid muscles were cut, and the inferior thyroid artery and vein were ligated. The esophagus and the trachea were then retracted medially together with the recurrent laryngeal nerve (Fig. 3), and the left common carotid sheath and left jugular vein were gently pushed laterally. It was possible to identify the left innominate vein distally (left brachiocephalic trunk). A small, self-retaining retractor was positioned to create a larger retrosternal space. Three thoracoscopic trocars with a diameter of 10 mm were inserted, one laterally through the sterno-cleido-mastoid, just above the manubrium, a second in the left second rib space and the third one in the right second rib space. They were used to insert an endoscope and suction. Each trocar could be used for the endoscope, the instruments or the suction. In this way, the operating field was well lit and the spine could be reached from C7 to T3 (Fig. 4). The dissection was performed in the midline, using a bipolar coagulator, small scissors and blunt dissectors. The assistant and the scrub nurse could watch the video monitor, the surgeon had a direct view or could work watching the video. The exposure of the spine necessitated coagulation of some small collateral vessels, but if the dissection was performed in the midline, there was no need for ligation of intercostal arteries and

Fig. 3 Anatomical landmarks after section of omohyoid muscle to open the view in the retrosternal space (*a* esophagus, *b* spine, *c* left common carotid)

no danger of neurologic disturbances [11]. Visualization of vertebral body structures was aided by the constancy of distal insertions of the longus colli muscles into the lateral aspects of the T1, T2 and T3 vertebral bodies. By changing the entry portal of the endoscope and suction, there was a large view of the spine. A complete corpectomy of T1, T2 or T3 could be performed with visualization of the posterior longitudinal ligament. Reconstruction of vertebral body was performed using strut graft and titanium plate. Drainage was used routinely. The drainage was inserted at the same place as the trocar, in the second rib space.

We have operated on two patients using this less invasive approach.

Patient 1

A 59-year-old woman with uterus cancer had a large T2 metastasis with spinal cord compression and neurologic deficits stage B according to Frankel. After removal of T2, a strut allograft was inserted and an anterior plate fixed from T1 to T3, using an angulated screwdriver.

Patient 2

A 58-year-old patient with prostatic cancer had a large T1 metastasis with spinal cord compression and neurologic deficits stage C according to Frankel. After removal of T1, a strut allograft was inserted and an anterior plate fixed from C7 to T2 (Fig. 5).

Results

The operating time for the two patients was 2 h 15 min and 3 h, and the blood loss was 300 and 400 cc respectively. There was no pleural or lung injury, no delay in transit restoration, and no heart trouble. Patient 2 had a regressive incomplete palsy of the recurrent laryngeal nerve. Spinal cord compression was correlated with levels of vertebral body involvement. Follow-up was 29 and 47 weeks respectively. Neurologic functions in patient 1 improved from class B to class C, and patient 2 improved from C to class E.

Radiological results were satisfactory. The patients underwent a computed tomographic (CT) scan control. The decompression of the spinal cord was satisfactory, as shown in Fig. 5.

Pain was significantly reduced, but patient 1 still needed narcotics after surgery for other metastases. The patients underwent radiotherapy after the surgery. They were independent after surgery, with patient 2 driving his car 6 weeks after surgery.

Discussion

Difficulties with exposure of the cervicothoracic junction, especially in patients with previously irradiated malignant metastatic tumors to the cervicothoracic region are well known [8]. Sundaresan et al. [19] have popularized an anterior approach. We propose a technique that is less invasive than the previously described approach. Thoracoscopy, as described by D Rosenthal et al. [16, 17] and Regan et al. [14] allows corpectomy at levels below T3. Dickman et al. [3] described the technique between T4 and T12. Simple surgery, like sympathectomy for hyperhydrosis [10], is proposed at level T2, but T1 or T2 corpectomy is impossible.

Lesoin et al. [9] recommend biclavicular osteotomy and transverse osteotomy of the manubrium. Sundaresan et al. [19] recommend osteotomy at the medial end of the clavicle and manubrium; the clavicle can then be used as a strut graft. This last technique does not avoid damage to the sterno-cleido-mastoid muscle, and carries a risk of pseudarthrosis or instability of the clavicles.

Standerfer et al. [18] use a more classical technique, which involves biclavicular osteotomy combined with sternal splitting. The midline sternal splitting approach is the most extensile procedure, and provides exposure down to T4. It may be combined with a Smith-Robinson approach.

Fig. 4 **A** Anatomical view: positioning of the trocar for endoscope (1) through the second rib space; the other trocar could be on the opposite side (2) or just above the manubrium (3). **B** Peroperative

view showing (1) left SCM muscle, (2) manubrium; the endoscope (3) lights the spine. Another trocar is used for instruments (4)

Fig. 5 **A** Preoperative magnetic resonance image with spinal cord compression at level T2. **B** Postoperative sagittal computed tomographic scan reconstruction

This approach does not interfere with shoulder function. The disadvantages are that the operating field is deep, the sternotomy is always painful, and this increases the risk of pulmonary dysfunction in the postoperative period.

The Smith-Robinson [15] approach, with inferior dissection, affords access from C6 to T2, as also proposed by Fieldings and Stillwell [4]. Geiger et al. [6], using an operating microscope, accessed the spine down to T3, but the authors noted that the posterior aspect of the disc was not visible. We used the same approach to reach C7, and the use of the endoscope allowed us to obtain a very good visualization of T1, T2 and T3, with a complete liberation of the posterior longitudinal ligament. The use of the endoscope was the key point (Fig. 4).

Hodgson et al. [7] recommend the anterior transthoracic approach through the third rib bed for treatment of tuberculous abscesses between C7 and T4. In this approach, the scapula must be freed from its posterior muscular and tendinous attachment, to allow its forward retraction. The operating field is deep and narrow. Micheli and Hood [12] proposed to combine this approach with a right-sided Smith-Robinson approach to gain extensile exposure.

The trap door exposure technique proposed by Nazaro et al. [13] is wide, and recommended for multilevel metastases. This approach provides full bilateral anterior exposure from C4 through at least T4 vertebral levels. In our cases the patient needed only a one-level corpectomy.

The video-assisted approach was quick and safe. The use of the endoscope provided good vision – both directly and on the video monitor. The assistance of a thoracic surgeon is recommended. The dangers to be avoided are esophagus injury, and pleura, lung and vein damage. The left brachio-cephalic trunk (left innominate vein) is not ligated in this approach. If necessary, the ligation and section of this trunk is proposed to reach T4 with an anterior

approach [1]. However, all vascular clamps must be prepared in the operating room. The most frequent complication of this anterior approach is left recurrent laryngeal nerve palsy, as reported by Bauer et al. [1]. Most often regressive and related to the use of a strong retractor, this palsy can be avoided by blunt dissection, protection of the nerve running on the esophagus and blunt retraction with a self-retaining retractor. This danger exists also with the use of video-endoscopy, as one of our cases shows. The anastomosis between the recurrent nerve and the sympathetic chain can be cut, as reported by Bauer et al. [1]. The thoracic duct is the final injury described in the literature [12]. This thoracic duct is most often found between C7 and T1, within a triangle bounded medially by the longus colli muscles and the esophagus, and posteriorly by the first rib. It is not necessary to dissect it; it can be retracted laterally and protected with the left common carotid and internal jugular vein. In case of injury, Louis [11] recommends a ligation.

Complete neurologic decompression was performed, because this approach allows a very good view. The improvement in the neurologic score postoperatively confirms this good decompression. This technique without manubriotomy decreases the morbidity of this less invasive approach. The use of the endoscope allows an extensive view of the spine, which is not possible with a microscope or a light headset.

Conclusion

This new video-assisted technique allowed us to perform wide resection and corpectomy at the levels T1 and T2 with a less invasive approach than those previously described. We report no major complications, but this experience is limited and must be confirmed by further surgery.

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