Cervicosternotomy as an anterior approach to the upper thoracic and cervicothoracic spinal junction

Technical note

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Object. The cervicothoracic junction is always a difficult area to approach. When operating on this specific area (for tumor or trauma), the aim is generally to decompress and stabilize the spine. The authors describe an improved median sternotomy method for reaching the anterior aspect of the spine down to T-5.

Methods. Seven patients with a mean age of 40 years (range 17–68 years) were included in this study. The vertebral lesion was due to trauma in 4 cases and tumor in the other 3. A single vertebral body was involved in 2 cases, 2 in 3 cases, and 3 in 2 cases. The vertebra most often involved was T-3 (6 cases), although T-4 was involved in 2 cases, T-5 in 2 cases, and T-1 and T-2 in 1 case each. All patients underwent the same preoperative workup: CT scanning, MR imaging, and CT angiography of the aortic arch.

Results. The median sternotomy made it possible to effectively decompress and stabilize the spinal cord. An anterior screw plate was used in 5 cases. The plate extended from T-2 to T-5 in 3 cases, from T-2 to T-4 in 2 cases, and from C-7 to T-4 in 1 case. The mean duration of surgery was 195 minutes (range 180–240 minutes). No neurological deterioration occurred. The mean hospital stay was 8 days (range 6–15 days). In 2 cases (28.6%), recurrent left nerve palsy was observed postoperatively; the palsy was transient in both of these cases, and full recovery occurred within 3 months. The mean follow-up among this series of patients was 29 months (range 22–38 months).

Conclusions. The median sternotomy provided a good means of reaching the upper thoracic spine (T2–5) and cervicothoracic junction. It enables surgeons to decompress the spinal cord and stabilize the spine.

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KEY WORDS • cervicothoracic junction • spine surgery • spine trauma • spine tumor

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The anterior approach to the upper thoracic spine and cervicothoracic junction is always a difficult problem, although several authors have published recommendations depending on the vertebral levels involved.2,4,6,7,10,11 The main problem of surgery in these areas is how to give the spine sufficient postoperative stability. Guidelines based on a review of the literature have suggested that lesions as caudal as T-3 can be approached by performing a classic anterior cervicotomy, associated with manubriotomy as required.2,4,6,7,10,11 Below T-3, an anterolateral approach via thoracotomy is recommended.

The main difficulty arises when a broad exposure extending from the lower cervical spine down to T-5 is required, for example, when T1–4 are involved. In such cases, some authors have recommended performing an anterior approach with clavicular resection.2,7,11 Another solution is the so-called trap door method, which is a combined cervicothoracic anterolateral approach.5,9 Most authors have stressed the fact that complete splitting of the sternum should be avoided at all costs.2,4,5,7,10

Abbreviation used in this paper: CCA = common carotid artery.

A median sternotomy, which was first described as a spinal approach in 1957 by Cauchonix and Binet,1 has been abandoned because of the high morbidity and mortality rates it entails.

We report our own experience with the anterior spinal approach down to the T-5 level via a cervicosternotomy, leading to successful anterior vertebral body resection and internal fixation.

Methods

The 7 patients in the present study consisted of 5 males and 2 females, who underwent surgery between January 2005 and March 2006. The mean age was 40 years (range 17–68 years). In 4 cases, the patients had sustained a spinal trauma (Fig. 1); in the 3 remaining cases, the vertebral lesion was a metastasis. Three patients were neurologically normal, and 4 had neurological signs due to a lesion. Two in this latter group of patients exhibited Frankel Grade A function, 1 had Frankel Grade B function, and 1 had Frankel Grade C function (Table 1).

In most cases, more than 1 vertebral body was involved; only 2 patients had a lesion involving a single
vertebra. In 3 cases, 2 vertebrae were involved. In the 2 remaining cases, 3 vertebrae were involved. The vertebrae were resected and replaced with either an autologous bone graft harvested from the iliac crest (4 cases) or an adaptable vertebral body prosthesis (Scient’X, Tecorp) filled in with methylmethacrylate cement (3 cases). Two patients underwent a combined approach with a prior posterior fixation with a short-segment osteosynthesis 1 level above and below the injured vertebra. The vertebra most often involved was T-3 (6 cases), although T-4 was involved in 4 cases, T-5 in 2, and T-1 and T-2 in 1 case each. In all but 1 of the 7 patients an anterior fixation plate was attached with screws after vertebral body resection.

The preoperative workup was the same in all patients. Computed tomography scanning of the spine with sagittal, coronal, and axial reconstructions was centered on the lesion. Magnetic resonance imaging of the entire spine and CT angiography of the aortic arch were also performed. The latter modality allowed us to confirm the feasibility of the anterior approach and to determine if the approach should be performed medially or laterally with respect to the left carotid artery (Fig. 2).

In 1 case (metastasis of a thyroid carcinoma), the lesion was embolized preoperatively to minimize hemorrhage.

Surgical Technique

Patient Positioning. General anesthesia was induced with orotracheal intubation, and a nasogastric tube was routinely placed. The patient was placed supine. A longitudinal roll was situated along the spine between the scapulas. Both arms were placed at the side, with the shoulders stretched caudally. The head was gently rotated toward the right. Blood pressure was monitored via direct puncture of the left radial artery, and this localization allowed simultaneous control of the compression of the left subclavian artery during the procedure. Central venous accesses were located on the right upper limb and the lower limbs in case the left brachiocephalic vein had to be sacrificed.

Exposition of the Spine. The first step in the surgical approach was performing a left cervicotomy anterior to the sternocleidomastoid muscle. The size of the upward incision depended on which cervical vertebra was targeted. The second step involved extending the incision down to the xiphoid process. The interjugular anastomotic vein and inferior thyroid vein were ligated and sectioned. The third step required extending the incision over the midline, and the sternum was split using a sternotome after dissecting the upper anterior mediastinum. A Guilmet self-retaining retractor was inserted. The underlying sternothyroid and sternothyroid muscles were divided near the sternum, taking care to leave the insertion point of the sternocleidomastoid muscle intact. The pleurae were carefully retracted laterally. The thymus was split along its midline, and the inferior thymic vein was divided between ligatures near its origin. The left brachiocephalic vein was identified, mobilized, and encircled with a silastic loop but never sacrificed. The aortic arch and the origin of the brachiocephalic artery were identified by retracting the left brachiocephalic vein superiorly. Most of the time (5 cases), we proceeded medially to the left CCA to reach the spine; in the other 2 cases, the spine was reached between the left CCA and the left subclavian artery. This step was previously determined and depended on the conformation of the aortic arch and the arteries.
involved (CCA and left subclavian artery; Fig. 3). We then proceeded laterally to the left primitive carotid artery to preserve the recurrent nerve while advancing toward the cervical spine. The esophagus and trachea were retracted to the right by using malleable retractors. According to the patient’s anatomy and the lesion level (especially for T-5), it was sometimes necessary to deal with the aortic arch to ensure a stable anterior osteosynthesis. In such cases, careful mobilization of the aortic arch inferiorly was performed using a soft malleable retractor.

Once the spine was fully exposed, a intraoperative radioscopic checkup was performed using a C-arm (anteroposterior view).

Vertebral Resection and Reconstruction. The anterior vertebral body resection was then performed, and a surgical microscope was used while the spinal cord was being decompressed and the posterior vertebral ligament was opened. In 3 cases the vertebra was reconstructed with a prosthetic device filled with cement; in 4 cases an iliac crest autograft was inserted in the intervertebral space. In 6 cases, an anterior fixation plate was screwed 1 level above and below the resection area. At the end of the procedure, the wound was closed up with a simple drain placed over the closed sternum using conventional cable wires.

Results

In all the patients included in this series, the median sternotomy made it possible to successfully decompress the spinal cord and stabilize the spine. An anterior fixation plate was attached with screws after performing the vertebral body resection in all but 1 patient. The plate extended from T-2 to T-5 in 3 cases, from T-2 to T-4 in 2 cases, and from C-7 to T-4 in 1 case. The patient who left without a fixation plate was suffering from nonunion after a T4–5 fracture. Posterior fixation was performed first, and the involved vertebral bodies were subsequently removed through the cervicosternotomy and replaced with an autologous bone graft harvested from the iliac crest, which was placed between the body of T-3 and the body of T-6 without any complementary means of fixation. A classic lateral thoracotomy would have been contraindicated in this patient, who had emphysema combined with a restrictive syndrome due to paraplegia. Any selective ventilation, which is normally performed systematically during thoracotomy, would have been contraindicated in this patient.

Patients with normal preoperative neurological findings remained free of any neurological impairment. The patient whose preoperative function was rated Frankel Grade C experienced improvement to Frankel Grade D at 5 days postoperatively and remained unchanged at the last follow-up.

The patient with a T3–4 fracture leading to dislocation of the spine and whose preoperative function was rated Frankel Grade B had improvement to Frankel Grade C by the time he left the hospital and at the final follow-up. The last 2 patients with preoperative Frankel Grade A function remained unchanged postoperatively and at the final follow-up.

The mean duration of surgery was 195 minutes (range 180–240 minutes). Patients were able to stand up after removal of the mediastinal tube 3 days postoperatively. Any postoperative pain was managed by a patient-controlled analgesia system during the first 3 days, and then orally. At the end of the hospital stay, none of the patients needed Grade III analgesics, with an average visual analog score of 3/10. The mean hospital stay was 8 days (range 6–15 days).

In 2 cases (28.6%), recurrent left nerve palsy was observed postoperatively. These palsies were transient, and both patients recovered completely within 3 months. No deep or scar infections occurred. At the final follow-up all patients but one were free of pain; the one suffered

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs), Sex</th>
<th>Level of Lesion</th>
<th>Type of Fracture</th>
<th>Level of Anterior Plate Screw Fixation</th>
<th>Type of Vertebral Reconstruction</th>
<th>Posterior Fixation</th>
</tr>
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<tr>
<td>1</td>
<td>58, F</td>
<td>T3</td>
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<td>2</td>
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<td>no</td>
</tr>
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<td>3</td>
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<td>T2–4</td>
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<td>4</td>
<td>27, M</td>
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<td>flexion compression</td>
<td>T2–5</td>
<td>iliac crest autograft</td>
<td>no</td>
</tr>
<tr>
<td>5</td>
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<td>flexion compression</td>
<td>T2–5</td>
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</tr>
<tr>
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<td>7</td>
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<td>no</td>
<td>iliac crest autograft, T3/T6</td>
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</tr>
</tbody>
</table>

* PMMA = polymethylmethacrylate.
Sternotomy at the cervicothoracic junction

From chronic chest pain related to the surgical approach. On the postoperative radiographic evaluation, no cases of pseudarthrosis or hardware failure were noted. A solid fusion in all fracture cases and a stable compound union in all tumor cases were demonstrated in the entire series of patients at the final follow-up (Fig. 4). Regarding the 4 cases treated for trauma, the mean segmental kyphosis (measured on the adjacent vertebrae of the lesion) was 24° on preoperative evaluation, 15° on immediate postoperative CT scanning, and 17° at the final follow-up. The mean follow-up in the study was 29 months (range 22–38 months).

Discussion

The cervicothoracic junction is always a difficult area to approach. Several authors have described possible approaches depending on the area to be reached. It has been pointed out that any lesion cephalad to T-1 can be reached via a supraclavicular classic cervicotomy. Any lesion caudal to T-3 can be reached via an anterolateral thoracotomy. However, problems arise when the area to be reached extends from C-7 to T-1 to T-3, T-4, or T-5.

The posterior approach has been described as a means of dealing with upper thoracic lesions. The main problem with this method is how to reach the vertebral body. It is possible to perform vertebral body resection and reconstruction via a posterior procedure, but doing so requires long operative times and leads to considerable blood loss. Extending this approach to the cervical spine is hardly feasible. The main advantage of the posterior approach is that it makes it possible to perform posterior fixation during the same surgery.

Because of these drawbacks, many authors have preferred anterior approaches. With these approaches, spinal cord decompression, kyphosis reduction, corporeal reconstruction, and fixation can all be performed during the same operative session. Several surgical procedures involve this approach—supraclavicular cervicotomy, cervicotomy associated with manubrial resection, and anterolateral resection—which is also known as the “trap door” approach.

Note, however, that the authors of an exhaustive review of the literature have pointed out that T-4 is very difficult or even impossible to reach, especially when anterior fixation is required.

In these cases, we recommend completely splitting the sternum. This procedure is not new, as it was first described by Cauchoix and Binet back in 1957, but it has been abandoned because of the high morbidity and mortality rates it entails. Multidisciplinary collaboration and the development of improved surgical procedures associated with enhanced postoperative anesthesiological care now make it possible to use the median sternotomy in upper thoracic and cervicothoracic junction surgery, as no detectable complications occurred in the 7 consecutive patients we described here.

This approach requires a preoperative strategy that is...
carefully planned based on CT angiography of the aortic arch. The bone images are superimposed on the vascular images. The best approach (medially or laterally to the left carotid artery) to the spine is then chosen. Completely splitting the sternum makes it possible to identify all the components of the aortic arch. The left brachiocephalic vein is fully dissected. Vertebral body resection can be performed beneath or below that vein without sacrificing it. In addition, complete sternal splitting makes a wide lateral exposure possible. Resection of the vertebral body can be total when required (in the case of tumors), and a vertebral body prosthesis can be used. A T-4 and T-5 vertebral body resection with a fixation including T-5 was successfully performed using this approach.

Patients were satisfied with the aesthetic outcome. There is no bone resection. Since the acromioclavicular and sternoclavicular joints are not stressed or dislocated during the procedure, there is no specific postoperative pain resulting from the overloading of these joints.

Conclusions

This cervicosternotomy may provide a good solution for reaching the upper thoracic spine (T2–5) and the cervicothoracic junction. It makes it possible to decompress and stabilize the spinal cord during the same operation. This operative procedure requires a multidisciplinary team of surgeons including a vascular surgeon and a spinal surgeon.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

References