SCIENTIFIC PAPER

Anterior approach to the upper thoracic spine (T2-T4): the experience of seven cases

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ABSTRACT

In this report we review the cases of seven patients with pathological lesions involving the anterior aspect of their upper thoracic spines (T2-T4) who were surgically treated. The three men and four women ranged in age from 40 to 77 years, with a mean age of 60.3 years. There were four cases of infection and three cases of tumour metastases. All except one presented with neurological deficits, and all improved after surgery. The surgical approaches were high thoracotomy from the left side (two cases), manubriotomy (two cases), osteotomy of clavicle with partial manubriectomy (two cases), and video-assisted thoracoscopy (one case). Two complications were related to treatment. One patient developed pleural effusion after video-assisted thoracoscopy drainage of T2 prevertebral abscess, and one had hoarseness. Both of them recovered uneventfully. Preoperative planning is important, because the choice of the surgical approach depends on the levels of the lesion, the deformities, the extent of dissection, and the stabilising implants needed.

Key Words: Anterior lesions; Case report; Postoperative complications; Spinal cord compression; Thoracic vertebrae/surgery

Introduction

The anterior aspect of the upper thoracic spine (T2-T4) is a difficult area to approach surgically. The normal kyphosis of the upper thoracic spine indicates a deep surgical field. The thoracic cage, sternum, clavicle, and the major blood vessels in front of the spine impose limitations for an anterior approach. Pathological involvement of the upper thoracic spine usually results in a collapse of the vertebral bodies, and an increase in kyphosis adds further difficulties. Cervicothoracic junction abnormalities are also not uncommon. As many as 15% of the spinal metastases involve the vertebral bodies and pedicles of the cervicothoracic region. Diagnoses are often delayed in patients with upper thoracic spine problems because of the difficulties in ob-

Chinese Abstract

本文評估了七名患上胸椎體腫瘤而須接受前路手術之病者。病者包括三名男性及四名女性，平均年齡為60.3年。四例是感染，三例是腫瘤轉移。除一例外，其餘均有早期徵兆，術後都得到明顯改善。手術入路包括經胸切口（2例）、胸骨柄切開（2例）、經胸骨切開及部份切除胸骨柄（2例）、及經胸腔鏡（1例）。兩例術後出現併發症，包括胸腔積水及嘔吐。病者經術後康復良好。胸椎之手術入路取決於腫瘤的位置及範圍、畸形、及手術須否內固定等因素，因此術前之計劃極其重要。

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Clining good radiological images in this region. Clinicians may overlook the lesion in the absence of neurological deficits caused by cord compression, because complaints by these patients are often non-specific, such as vague thoracic back pain or chest discomfort. This review aims to summarise our surgical experience in a regional hospital during the almost 2.5 years from January 1999 through May 2001, and we examine the pros and cons of different techniques in the approach to this bodily region.

**METHODS & RESULTS**

We reviewed seven patients with lesions involving the upper thoracic spine (T2-T4) that required an anterior surgical approach from January 1999 through May 2001. The patients comprised three men and four women, who ranged in age from 40 to 77 years, with a mean of 60.3 years. There were four cases of infection and three cases of tumour involvement. Of the three tumour cases, one was plasmacytoma of T4, one was tumour metastasis to T2 and T3 from carcinoma of breast, and one was tumour metastasis to T3 from an unknown primary. Among those four cases of infection, three patients were suffering from infective spondylitis. Their cultures were tuberculosis, Staphylococcus aurus, and gram-negative bacilli, respectively. The remaining case of infection occurred in a 57-year-old man who suffered from a T2-T3 prevertebral abscess. The clinical data of these seven patients are summarised in Table 1.

All patients except the one with prevertebral abscess presented with neurological deficits. Their other symptoms included upper thoracic back pain and chest and sternal discomfort. The intervals between the onset of symptoms to the establishment of a diagnosis ranged from 1 to 10 months. The surgical approaches used were high thoracotomy from the left side (2 cases), manubriotomy (2), osteotomy of clavicle with partial manubriectomy (2), and video-assisted thoracoscopy (1). Two complications were related to the surgical procedures. One patient (Patient 3) had hoarseness despite the surgeons’ identification and protection of her recurrent laryngeal nerve. She recovered spontaneously 1 month later. Another patient (Patient 4) developed pleural effusion and right lower lobe pneumonia after video-assisted thoracoscopy drainage of prevertebral abscess. He recovered after appropriate treatment. There was no neurological complication and all of them improved from the preoperative neurological deficits. Regarding shoulder function, all except one had good shoulder abduction without pain. The one patient with shoulder weakness and limited abduction (Patient 6) had the operative approach of resection of the medial portion of the left clavicle. Because of this, for a second patient who underwent a similar approach (Patient 2), the clavicle was refixed at the end of the

<table>
<thead>
<tr>
<th>Patient no.</th>
<th>Sex</th>
<th>Age, years</th>
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</tr>
</thead>
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<tr>
<td>1</td>
<td>Female</td>
<td>54</td>
<td>TB T3-T4</td>
<td>Left thoracotomy</td>
<td>ASF T3-T5 (titanium cage)</td>
<td>FU 18 months, no pain</td>
</tr>
<tr>
<td>2</td>
<td>Female</td>
<td>47</td>
<td>Metastasis T2 &amp; T3 (carcinoma, breast)</td>
<td>Osteotomy left clavicle and partial manubriectomy</td>
<td>ASF T1-T4 (titanium cage)</td>
<td>Died 11 months later of metastases</td>
</tr>
<tr>
<td>3</td>
<td>Female</td>
<td>40</td>
<td>Metastasis T3 (unknown primary)</td>
<td>Manubriotomy</td>
<td>ASF T2-T4</td>
<td>FU 5 months, walking well</td>
</tr>
<tr>
<td>4</td>
<td>Male</td>
<td>57</td>
<td>Prevertebral abscess T2</td>
<td>Video-assisted thoracoscopy</td>
<td>Drainage and debridement</td>
<td>FU 18 months, no pain</td>
</tr>
<tr>
<td>5</td>
<td>Male</td>
<td>71</td>
<td>Plasmacytoma T4</td>
<td>Left thoracotomy</td>
<td>ASF T3-T5</td>
<td>Died 1 year later of metastases</td>
</tr>
<tr>
<td>6</td>
<td>Female</td>
<td>76</td>
<td>Infective spondylitis T3</td>
<td>Resection of portion of clavicle and manubrium</td>
<td>ASF T3-T4</td>
<td>Died 4 months later of renal failure</td>
</tr>
<tr>
<td>7</td>
<td>Male</td>
<td>77</td>
<td>Infective spondylitis T3, T4</td>
<td>Manubriotomy</td>
<td>ASF T2-T4</td>
<td>Died 1 month later of colitis</td>
</tr>
</tbody>
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ASF = anterior spinal fusion; FU = follow up
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operation and she had good shoulder function. The clinical details of four patients undergoing different surgical approaches are presented in the case illustrations.

Case Illustrations

Patient 1: 54-year-old woman
This patient presented with epigastric pain and chest discomfort for 10 months. Three weeks before admission, she developed bilateral lower limb weakness and numbness. There was no sphincter disturbance. Upper motor neuron signs in the lower extremities were demonstrated. There was an increase in upper thoracic kyphosis. Plain x-ray (Fig. 1) and magnetic resonance imaging (MRI) of the spine showed destruction of T3 and T4 with localised kyphosis (Fig. 2). In this patient the retropulsed bony fragment compressed the spinal cord. Left thoracotomy approach by resection of the third rib with the patient lying on her side was chosen. Anterior decompression and fusion from T3 to T5 using a titanium cage packed with bone graft from the resected rib was performed (Fig. 3). The pathology came back as tuberculous infection. Postoperatively, her lower limbs' strength returned to normal. There was no more chest and thoracic back pain. The left shoulder abduction was almost full with more than 110° on the latest follow up.

Patient 2: 47-year-old woman
The patient was diagnosed to have carcinoma of the left breast 5 years earlier. She had a simple mastectomy done in another hospital at that time. She presented with weakness of lower limbs 2 weeks before admission. Plain films showed destruction of the T2 and
T3 vertebrae, whereas MRI showed anterior cord compression caused by pathological fractures of T2 and T3 (Figs. 4 & 5). Anterior decompression and fusion from T2 to T4 that used a titanium cage packed with bone graft from the ilium was performed through the approach of osteotomy of left clavicle, as described by Birch² (Fig. 6). Three days after the operation, the patient was able to sit up, and she could fully abduct her left shoulder. On follow up, she could walk until 11 months later, when she died of carcinomatosis.

**Patient 3: 40-year-old woman**

This patient presented with interscapular back pain and weakness of her lower limbs for 4 weeks before admission. Her motor power was charted as grade 4 over 5. Plain films and MRI showed destruction of the T3 body, and the tumour involvement was causing cord compression at that level (Fig. 7). Bone scans showed multiple hot spots over the right sixth and ninth ribs, C4, C5, T7, L1, and the ilium. Anterior decompression was performed through a manubriotomy approach.¹³ Vertebra T3 was excised and fusion of T2 through T4 was achieved with an iliac bone graft (Fig. 8). Patient 3 could sit out of bed and started walking 3 days after operation (Fig. 9); however, she developed the complication of hoarseness of voice despite identification and protection of the recurrent laryngeal nerve intraoperatively. She regained her voice in 1 month's time. The bone biopsy from T3 was adenocarcinoma with unknown primary. She had received a course of localised radia-
tion therapy. Her last follow-up visit was 5 months after operation when she remained well and was walking independently with no pain in her back.

**Patient 4: 57-year-old man**

This patient had a known history of diabetes mellitus for 8 years that he controlled with drugs. He presented with a 1-month history of upper thoracic back pain. The pain was so severe that he could not sleep. Blood investigation showed increased erythrocyte sedimentation rate of 106. Magnetic resonance imaging revealed a prevertebral abscess that extended from T1 through T3 (Fig. 10). The cardiothoracic surgeons performed video-assisted thoracoscopic debridement and drainage. The approach was from the right side. Postoperatively, Patient 4 developed right lower lobe pneumonia and pleural effusion, which subsided with appropriate treatment. The culture of the abscess did not grow any bacteria, probably because of the antibiotic treatment before the patient was admitted. The bone biopsy showed inflammation suggestive of infection. On follow up 1.5 years later, the patient did not have any thoracic back pain.

**DISCUSSION**

Different surgical approaches to the upper thoracic spine have been described. Using the low cervical incision, one can approach down to the third thoracic vertebra in some patients. Sharan et al., in a study of 106 consecutive midsagittal cervicothoracic MRI, had demonstrated that the mid portion of the T3 vertebra often lies above a horizontal line just over the sternal notch. He advocated the use of a suprasternal incision when the most caudal point of the lesion lies above this line, as determined by the midsagittal MRI. This approach avoids the need of sternotomy, and the incision can easily extend upwards to the neck if necessary. On the other hand, there is a wide variation in the individual anatomy of the cervicothoracic region. Shapes of the thoracic aperture and the degree of cervicothoracic kyphosis vary considerably, and these discrepancies sometimes make the surgical approach to T1 very difficult. To facilitate the exposure of the upper thoracic spine, various types of sternotomy with or without osteotomy of the clavicle have been designed. Full sternotomy as described by Hodgson affords an extensile exposure. The lower half of the sternotomy, however, is complicated by the presence of major blood vessels, and it is usually not neces-
Sundaresan\textsuperscript{24} described a direct approach to the upper thoracic spine by partial resection of the manubrium and clavicle through a sternoclavicular “T” incision. Kurz\textsuperscript{11} modified the approach by using a left-sided “L” incision, because this leaves the constancy of the recurrent laryngeal nerve and the manubrium intact. With this approach, he could reconstruct spinal deformities down to T3 using the clavicular and methacrylate strut graft. While excision of the medial third of the clavicle allows better exposure of the involved nerve roots on the symptomatic side, one would worry about the shoulder function postoperatively. In Patient 2, we preserved the sternocleidomastoid insertion while we osteotomised the clavicle. The clavicle was refixed with a metal plate and the clavicular head was sutured back to the remnant of the manubrium at the end of the operation. The patient demonstrated almost full shoulder abduction after surgery.

Nazzaro et al\textsuperscript{18} described the “trap door” exposure of the cervicothoracic junction, which uses an extensive skin incision from the neck down to the sternum and out along the fourth intercostal space, either on the left or right side, to the midaxillary line. Transection of the clavicle is not required and the sternoclavicular joint is preserved. This approach permits bilateral anterior exposure from C4 through T4 vertebrae as well as increased anterolateral access on the side of the approach. Recently, Luk et al\textsuperscript{13} described an approach that uses unilateral or bilateral manubriotomy. The manubrium was osteotomised in either an L-shape or an inverted T-shape, with the transverse limb of the osteotomy exiting at the second intercostal space. A retractor was then placed between the transected manubrium, which thus exposed the upper mediastinum. We employed this approach in two patients (Patients 3 and 7) and found excellent exposure of the anterior aspect of the cervicothoracic junction down to T4. There was minimal pain and the patients could mobilise their shoulders very soon after their operations. According to Luk et al, the bilateral manubriotomy provided an 8-cm interval between the split manubrium that allowed access to both sides of the vertebrae. This gap is usually wide enough for local excision of tumour or infective spondylitis. Exposure of T4 and below, particularly in the presence of kyphosis, is better approached through...
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Resection of the left third rib with a periscapular incision is used for exposure of T1 through T4. This approach was chosen for Patient 1 because the surgical field had to extend down to T5 (fusion from T3 through T5), and the patient presented with kyphosis from the collapse of vertebral bodies. The advantage of this approach is that the orthopaedic surgeons are more familiar with thoracotomy. The disadvantages are the division of periscapular muscles and cephalad retraction of the scapula. Our experience was that Patients 1 and 5 did not experience too much pain postoperatively and their shoulder movements were satisfactory.

Neither the supraclavicular approach nor the high transthoracic approach allow simultaneous access to the lower cervical and upper thoracic vertebrae. Occasionally, one should consider a combined cervical and thoracic approach, for example in rare situations that require exposure from the third cervical vertebra to the thoracic vertebra below T4. Selection of the surgical approach, therefore, depends on the extensiveness of the lesion, the instrumentation needed, and any reconstruction of the cervicothoracic junction.

Lastly, as illustrated by Patient 4, in whom only minimal surgical intervention (ie, drainage and local debridement) was required, the minimally invasive approach of video-assisted thoracoscopy was employed. Video-assisted thoracoscopy presents the spine surgeon with an endoscopic option to approach the anterior aspect of thoracic vertebral column. Its benefits include minimal invasiveness, better visualisation and magnification, and diminished postoperative pain and ventilatory compromise. Recent years have seen the rapid development of video-assisted thoracoscopy for the management of spinal deformities. It is a new technique, but its goals and objectives are the same as those of conventional thoracotomy or other surgical approaches. Yet, with its increasing indications for treating spinal conditions, this technique is likely to be more commonly employed in the future.

CONCLUSION

Patients with different pathological conditions that affected their upper thoracic spines (T2-T4) and which required anterior surgical approaches have been presented. Different approaches were used in each patient. The rationale and limitations of these approaches are discussed. Although not many procedures on the upper thoracic spine require instrumentation other than excision of the lesion and the installation of a bone block or a metal cage loaded with bone graft, situations may arise that require more extensive exposure distal and proximal to the lesion. Consequently, orthopaedic surgeons must be able to master different techniques when treating spinal lesions in this difficult region. Preope-
tive planning is especially important in deciding on the appropriate surgical approach.

REFERENCES


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