An anterior surgical approach to the upper thoracic vertebrae

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Of the various anterior surgical approaches to the spine, exposure of the upper two thoracic vertebrae remains the most challenging. An operative approach to this region is described. The major features include resection of a portion of the clavicle and the manubrium sterni. Following resection of the tumor and involved vertebra, anterior fusion is performed using the clavicle as a strut graft. Immediate stabilization may also be achieved with methyl methacrylate replacement of the vertebral bodies. The operation is well tolerated, and requires minimal postoperative immobilization. The clinical presentation, radiological features, and results of treatment in a series of seven patients operated on during a 2-year period are presented.

KEY WORDS • anterior surgical approach • thoracic spine • vertebral body tumor • bone graft

Over the past 30 years, the value of the anterior approach to the spine in providing greater access to lesions affecting the vertebral body has been amply demonstrated. Most pioneering surgical efforts were directed to the treatment of Pott’s (tuberculous) disease, but similar principles are applicable in the management of primary and metastatic tumors of the spine. Of the various spinal levels, exposure of the upper two thoracic vertebrae remains technically the most challenging.

Limited access to the vertebral bodies is provided by resection of a portion of rib and transverse process (costotransversectomy), an operation first described in 1894 by Ménard. Later, Capener extended this approach by resecting a longer segment of rib to allow anterolateral decompression of the spinal cord. He termed this operation “lateral rhacotomy.” In 1957, Nanson described an oblique approach to the lower cervical and upper thoracic vertebrae via a supraclavicular incision; his operation was designed to provide access to the upper thoracic sympathetic ganglia but also allows limited exposure of the upper thoracic vertebral bodies. In the same year, Cauchox and Biner described a direct approach to the cervicothoracic region through a median sternotomy. Hodgson, et al., used this approach in a small series of 10 cases, and noted an operative mortality of 40%. As a result, they advocated abandoning direct anterior exposures in favor of thoracotomy and resection of the third rib. Most surgical texts reiterate Hodgson’s arguments, citing the morbidity associated with sternal resection and the difficulty in obtaining satisfactory fusion. More recently, Standefer et al. described an operative technique for resection of a benign tumor involving the cervicothoracic junction by median sternotomy and fracture of the medial half of the clavicle.

Although tumors affecting the upper thoracic vertebrae are rare, we believe that a detailed description of an anterior approach to this region should be available to the neurosurgeon faced with this problem. We describe an operative exposure of the upper two thoracic vertebrae and analyze our results with this procedure.

Summary of Cases

Clinical Data

During a 2-year period, seven patients underwent resection of various lesions involving the T1–2 vertebral bodies. The surgical approach described below was used. The clinical features of these patients are summarized in Table 1. Two patients had primary tumors of the spine; one was a primary osteogenic sarcoma, and the other a post-irradiation sarcoma in a patient who had received external radiation therapy 31 years previously for Hodgkin’s disease. Four patients had metastatic cancer from various sites: in two the primary...
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<tr>
<th>Case No.</th>
<th>Age (yrs), Sex</th>
<th>Diagnosis</th>
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<th>Preop Pain</th>
<th>Preop Motor Deficit</th>
<th>Results of Surgery</th>
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<tr>
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<td>osteosarcoma</td>
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<td>2 59, F</td>
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<td>none</td>
<td>improved</td>
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<td>4 58, M</td>
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<td>biopsy</td>
<td>++</td>
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* RT = external radiation therapy; MI = myocardial infarction. Pain: ++ = severe; + = moderate; – = mild.

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focus was in the breast, one tumor was a Ewing’s sarcoma arising in the lower extremity and, in the remaining patient, the primary site was unknown. In this patient (Case 7), the clinical and radiological findings were compatible with malignancy involving the spine. At surgery, a pyogenic paravertebral abscess with osteomyelitis of the vertebra was encountered. Subsequent cultures grew *Staphylococcus aureus*.

Six patients presented with a combination of back and/or radicular pain. Depending on narcotic and steroid requirements, pain was graded as mild, moderate, or severe. Associated signs of brachial plexus involvement were seen in three patients, and a Horner’s syndrome was noted in two. Two patients were paraparetic on admission, but their condition improved on high-dose corticosteroid therapy.

All patients were evaluated by myelography, computerized tomography (CT), and sagittal tomography. Tumor involvement included a single vertebra (T-2) in two patients, two vertebrae (T-1 and T-2) in two, and three vertebrae (C-7, T-1, and T-2) in the remaining three. An acute kyphotic deformity, caused by subluxation of T-1 over T-2, was noted in four patients. A high-grade or complete block was seen in three patients, and varying degrees of epidural encroachment were noted in the remainder (Figs. 1 to 4).

**Surgical Technique**

The operation is performed under general endotracheal anesthesia, with towels placed under the scapula.

![FIG. 1. Computerized tomography scan showing destruction of the T-2 vertebra and associated prevertebral tumor mass (osteosarcoma).](image1)

![FIG. 2. Left: Tomogram showing displacement of T-1 over T-2. Right: Computerized tomography scan showing T-1 overlapping T-2, producing a cap effect.](image2)
to extend the neck slightly. A transverse incision is made approximately 1 cm above the clavicles; this should extend beyond the lateral margin of the sternomastoid process on either side. A T-shaped skin incision is made, with the vertical limb in the midline extending over the body of the sternum (Fig. 5). The platysma is divided in the line of the skin incision, and flaps are raised both superiorly and inferiorly. The external jugular vein and the medial supraclavicular nerve should be divided. The clavicular insertion of the sternomastoid process is dissected free, and reflected upward. Medially, the strap muscles are similarly sectioned and reflected superiorly (Fig. 6 left). The areolar tissue in the suprasternal space is cleared.

The medial half of the clavicle and the manubrium sterni are stripped subperiosteally. The medial one-third of the clavicle is resected with a Gigli saw, and the clavicle is disconnected from the sternum after curettage of the sternoclavicular joint. A rectangular block of sternum is removed. A high-speed drill is then used to thin the bone peripherally and the final cut is made with scissors. Running obliquely underneath the manubrium sterni is the subclavian vein and the thymus. The subclavian vein is carefully dissected free, but the thymus may be removed for additional exposure. The avascular tissue plane between the carotid sheath laterally, and the trachea and esophagus medially, is developed to enter the prevertebral space. The recurrent laryngeal nerve lies across the operative field and must be protected (Fig. 6 right). Once the prevertebral space is reached, an incision is made in the midline with cautery, and the prevertebral fascia is stripped from either side. Resection of the vertebral bodies and discs is accomplished both with curettes and rongeurs. Occasionally this may require the use of a high-speed drill.

Resection is continued down to the posterior longitudinal ligament and dura. Magnifying loupes are helpful during this stage of the procedure.

Fusion is performed next, using the clavicle as a strut graft. The clavicle is stripped of all soft tissue and ligamentous attachments, and fashioned to fit the defect. Strips of cancellous bone obtained from the sternum are placed alongside it. Alternatively, a simple methyl methacrylate stabilization procedure may be performed by inserting Steinmann pins into the healthy vertebrae above and below the lesion, and allowing the acrylic to polymerize in situ. The wound is then closed in routine fashion with two small suction drains. A Philadelphia-type collar with a thoracic extension is used for postoperative immobilization. 

Operative Results

The results of treatment in this series were measured using three parameters: 1) pain relief; 2) improvement in motor function; and 3) relief of myelographic block. Using these criteria, all patients were considered improved by surgery. Pain relief was documented in all six patients with prior pain by a reduction in their narcotic requirements on a 24-hour basis. The two patients who were paraparetic prior to operation improved immediately following corticosteroid therapy, and regained nearly normal and normal strength, respectively. Following surgery, both enjoyed normal strength, and steroid therapy was discontinued. All patients left the hospital ambulatory, and no patient sustained a neurological deficit as a result of the operation. Repeat myelography demonstrated resolution of the complete block in three patients.

There were two postoperative complications. One patient (Case 2), who had a previous history of coronary
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heart disease, developed a postoperative myocardial infarction; she recovered uneventfully. In another patient, a Steinmann pin used to maintain fixation became dislodged 4 months later, with resulting perforation of the esophagus. Only conservative measures were required to correct this complication. Late recurrence of tumor at adjacent sites occurred in both patients with osteogenic sarcoma, requiring additional surgery.

**Discussion**

This small series demonstrates the technical feasibility of a direct surgical approach to the upper thoracic vertebrae by partial resection of the manubrium and clavicle, and shows the low morbidity rate associated with the technique. The postoperative course in all patients was relatively benign and similar to that in patients undergoing surgery for disc excision by the methods of Cloward or Robinson and Smith. We believe that the two major indications for this procedure are: 1) when the tumor is confined to the vertebral body or extends strictly in the anteroposterior plane; and 2) when a pathological fracture-dislocation results in direct posterior displacement of bone fragments (see Fig. 2). Although such kyphotic deformities may also be treated by posterior fusion following decompressive laminectomy, the experience of Winter, et al., in patients with congenital kyphosis suggests that anterior fusions are more likely to resist compressive forces, while posterior fusions performed over a kyphos attenuate over time.

Several anatomical factors affect the exposure, and may increase the technical difficulties of surgery. The shape of the thoracic aperture, the height of the manubrium, and the degree of cervicothoracic kyphosis all vary considerably. Although either side may be used for the operative exposure, Johnson and Southwick suggest that it be carried out from the left. They believe that the recurrent laryngeal nerve has a more constant course on the left side, but may branch from the vagus.
at varying levels on the right. We usually choose to resect the clavicle on the symptomatic side, if the patient has radicular pain, to allow better decompression of the involved nerve roots and plexus. Resection of the clavicle also allows vascular control of the innominate and subclavian arteries; this may be important in controlling direct arterial feeders in patients with vascular primary tumors of the spine.12

The upper thoracic spine, although thought to be an unusual site for primary and metastatic tumors, accounted for 10% of spinal metastases in our own surgical series.14 The most common cause of spinal cord compression at this level is direct extension of paraspinal tumors such as breast carcinoma or superior sulcus (Pancoast) tumors.13 Many such patients often have associated signs of brachial plexus involvement, and radiological studies usually demonstrate extensive destruction of the chest wall.3,10 In these patients, sufficient decompression cannot be achieved with the approach described here; instead, a thoracotomy with resection of the third rib may be required.

The relative stability of the upper thoracic spine allows bone fusion to be accomplished without the need for prolonged postoperative external mobilization. The use of a halo brace may be required if more than two contiguous vertebrae are resected. In two of our patients, additional posterior stabilization with Luque rods* was performed at 3 and 14 months, respectively, following this procedure. We anticipate that such additional posterior stabilization may be required in all patients who are expected to be long-term survivors. Although our experience is small, the low morbidity associated with this procedure should encourage others to consider this approach.

References

* Luque rods manufactured by Zimmer, Warsaw, Indiana.

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