Transuncodiscal approach to dumbbell tumors of the cervical spinal canal

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A combined anterior and lateral approach to the anterior cervical spinal canal with fusion was performed on five patients with cervical dumbbell-shaped tumors. The procedure consists of anterior discectomy and ipsilateral uncetomy, and removal of the posterolateral corners and posterior transverse ridges of the upper and lower vertebral bodies at the level of the tumor. In the case of a large tumor in the spinal canal, additional removal of a limited segment from the lateral part of the vertebral body was performed. The bone defect was filled with a T-shaped iliac bone graft. Two vertebral bodies were fused in each case. The highest level of the operation was C-2 and the lowest was T-1. The authors believe that any cervical dumbbell-shaped tumor below the C-2 level can be removed via an anterolateral approach as long as no more than three levels of the spine are involved.

KEY WORDS • dumbbell tumor • cervical discectomy • uncetomy • foraminotomy • cervical spine • spinal tumor

It is generally accepted that, in dealing with a cervical dumbbell-shaped tumor, a posterior approach is carried out first, and then the remaining tumor is removed by an anterior approach. However, we have achieved total removal of these tumors at a one-stage operative procedure by a transuncodiscal approach, with excellent results in five patients. The purpose of the present study is to describe the surgical technique used.

Summary of Cases

Clinical Material

Table 1 summarizes the clinical data in this series of cases. Three of the five patients were male. The patients ranged in age from 25 to 60 years, with an average age of 44 years. Four of the tumors were neurinomas, one of which was associated with von Recklinghausen's disease (Case 5). The fifth tumor was a meningioma. Two neurinomas were seen at the C2-3 level; the remaining four were found in the lower cervical spine. The most extensive intradural tumor involved three levels of the spine (Case 1).

Operative Technique

Exposure of the Prevertebral Space. A description of the exposure of the prevertebral space and anterolateral structure of the cervical spine between the C-2 and C-3 vertebrae follows. The patient is placed in the supine position with the neck rotated to the opposite side and extended maximally at the craniovertebral junction. A transverse skin incision is made one finger-
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### TABLE 1

Summary of clinical data in five patients with dumbbell tumors of the cervical spinal canal

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs)</th>
<th>Sex</th>
<th>Pathology</th>
<th>Preoperative Neurological Findings</th>
<th>Operative Findings</th>
<th>Operative Results</th>
<th>Follow-Up Period (yrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>60, M</td>
<td>meningioma</td>
<td>complete paralysis of lt upper &amp; both lower limbs</td>
<td>large 1 x 1 x 6-cm intradural extramedullary tumor between C-6 &amp; T-1 vertebral bodies extending largely (6 x 8 cm) into lt paravertebral area through an enlarged lt intervertebral foramen at C7-T1</td>
<td>5 paralysis of lt hand, slight weakness of both lower limbs; able to walk without cane</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>55, M</td>
<td>neurinoma</td>
<td>weakness of rt hand &amp; hypalgesia below C-3</td>
<td>1 x 1 x 1-cm intradural mass between C-2 &amp; C-3 vertebral bodies: 3 x 3 x 3-cm epidural intraforaminal mass at lt C2-3</td>
<td>2.5 no neurological deficit</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>43, M</td>
<td>neurinoma</td>
<td>weakness of rt upper &amp; lt lower extremities, hypalgesia of the right leg</td>
<td>cystic tumor: 2 x 2 x 2-cm intraforaminal epidural mass at rt C6-7; 2 x 1 x 1-cm intradural mass between C-6 &amp; C-7 vertebral bodies</td>
<td>1.5 mild hypalgesia in lt C-7 dermatome</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>55, F</td>
<td>neurinoma</td>
<td>weakness &amp; hypalgesia of rt upper extremity</td>
<td>5 x 5 x 5-cm extraspinal mass; 3 x 3 x 3-cm intraforaminal mass at rt C2-3; 0.5 x 0.5-cm intradural mass</td>
<td>1.3 slight paresis of rt 11th nerve</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>25, F</td>
<td>neurinoma (von Recklinghausen's disease)</td>
<td>weakness of rt upper extremity &amp; hypalgesia of rt C-5 &amp; C-6 dermatomes</td>
<td>4 x 4 x 5-cm extraspinal mass; 3 x 3 x 3-cm intraforaminal epidural mass at rt C5-6</td>
<td>1 slight weakness of rt deltoid muscle</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

breadth below the inferior margin of the mandible from about two finger-breathds off the midline to the tip of the mastoid process, sparing the marginal mandibular branch of the seventh nerve. An additional incision is made, running along the anterior margin of the sternocleidomastoid muscle from the first incision to the midcervical region (Fig. 1 *left*). The sternocleidomasto-
Exposure of the prevertebral space and anterolateral structure of the lower cervical spine is made in the same manner as in the Smith-Robinson and Cloward methods. When the extraspinal portion of the tumor is very large, as in Case 1 (Fig. 3), a skin incision is made along the posterior margin of the sternocleidomastoid muscle, starting at the midcervical region and running down to the clavicle, and then turned forward to run along the upper margin of the clavicle (Fig. 1 right). The sternocleidomastoid muscle is divided near its clavicular junction, and the common carotid artery and internal jugular vein as well as the vagus nerve are retracted medially. This step gives full exposure of the anterolateral structures of the lower cervical spine, including the large extraspinal portion of the tumor. Intracapsular decompression of the tumor is then carried out. Next, the common carotid artery and internal jugular vein are retracted laterally, and the trachea and esophagus are retracted medially to expose the prevertebral space. The tumor is excised at the external orifice of the intervertebral foramen.

Exposure of Intraspinal Tumors. The longus colli and longus capitis muscles are transversely divided at the level of the tumor. The stumps of these muscles are separated from the vertebral bodies and transverse processes. The bone arches of the foramina transversaria above and below the tumor are removed by an air drill and the vertebral vein and vertebral artery are exposed (Fig. 4A). Under an operative microscope at ×16 magnification, anterior discectomy is accomplished at the level of the tumor and a vertebral spreader is inserted into the emptied disc space to open the space widely and effectively expose the medial surface of the uncinate process. Through the emptied disc space, an ipsilateral uncectomy and then removal of the posterolateral corners of the upper and lower vertebral bodies (anterior foraminotomy) are performed (Fig. 4B and C). The posterior longitudinal ligament is exposed, as the remaining disc tissue, including the anulus fibrosus, is removed.

First, the intraforaminal portion of the tumor is removed in piece-meal fashion. The anteromedial portion of the vertebral artery usually adheres tightly to the tumor with multiple tumor feeders arising from this segment of the vessel. These feeders are coagulated by a bipolar coagulator and then divided. To obtain a better exposure of the intraspinal tumor, the intravertebral foramen is then enlarged by further removal of the upper and lower posterolateral portions of the vertebral bodies and the posterior ridges of the vertebral bodies are also removed with an air drill. The posterior longitudinal ligament is divided along the upper and lower posterior margins of the exposed vertebral bodies. The epidural venous plexus, which are usually well developed on the dorsolateral surface of the intraforaminal and epidural tumor, should be coagulated, divided, and separated from the tumor capsule. Bleeding from the venous plexus can be relatively easily controlled by either insertion of Biobond-soaked Oxycel or by the alternative insertion of fibrinogen-soaked

Fig. 3. Case 1. Left: Left oblique x-ray film of the cervical spine showing a large intervertebral foramen between C-7 and T-1 on the left with marked erosion of the pedicles on the left C-7 and T-1 vertebral bodies (arrows). Center: Left retrograde brachial arteriogram showing medial displacement of the proximal portion of the left vertebral artery and downward displacement of the left subclavian artery (arrows) with marked stretching of the left thyrocervical trunk and its tributaries. Right: Ascending myelogram showing an almost complete block at the T-1 level with a lobulated tumor shadow between C-6 and T-1 (arrows).
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**Fig. 4.** Case 2. A: The sternocleidomastoid muscle is divided at its insertion. The longus colli and longus capitus muscles are transversely divided at the level of the tumor and their stumps are separated from the vertebral bodies and transverse processes. The bone arches of the foramina transversaria above and below the tumor are removed by an air drill and the vertebral vein and the vertebral artery are exposed. XI = 11th cranial nerve; M = mastoid process; C1 = left transverse process of the first cervical spine. B: *Broken lines* indicate the limits of the uncectomy, the opening of the foramina transversaria, and the removal of the posterolateral corners and transverse ridges of the C-3 vertebral body. C: A schematic view of the transuncodiscal approach. *Broken lines* indicate the limits of the ipsilateral uncectomy, the removal of the posterolateral corner and transverse ridge, and the unroofing of the foramen transversarium of the C-3 vertebra. D: The left vertebral artery is retracted forward. The intervertebral foramen is enlarged by maximal widening of the intervertebral space and removal of the intraforaminal tumor. Through this space the dural canal is opened, and a small intradural tumor is delivered epidurally.

Oxycel and thrombin-soaked Oxycel into the opened venous plexus. The vertebral artery is gently and slightly retracted back and forth during removal of the intraforaminal and epidural portions of the tumor dorsal to the vertebral artery. Internal decompression of the tumor can be performed with a Cavitron ultrasonic surgical aspirator,* and then the tumor capsule is removed with scissors and forceps. Next the portion of the tumor extending into the subdural space through the dural neck is exposed. The anterolateral part of the dural canal is then opened in longitudinal fashion and the tumor ventral and lateral to the spinal cord is exposed (Fig. 4D). In the case of a large tumor in the spinal canal, an additional lateral vertebrotomy, slightly wider than 5 mm, and a resection of the pedicles must be performed in order to expose the superior and inferior poles of the intraspinal tumor fully and to give enough room for manipulation of the intraspinal tumor. In one patient (Case 1), who had the largest tumor in the spinal canal in this series, the upper pole of the tumor extended up to the two vertebrae above the enlarged intervertebral foramen (Fig. 3). In such a case, the transuncodiscal approach is used at the disc space one level above the intraforaminal tumor, and also a lateral vertebrotomy and resection of the pedicles of the two

* Cavitron ultrasonic surgical aspirator manufactured by Cooper Medical Co., Stanford, Connecticut.
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FIG. 5. Case 1. A: An anterolateral schematic view of the lower cervical spine including the first thoracic spine. The intervertebral space between the C-6 and C-7 vertebral bodies is maximally opened. Broken lines indicate the limits for the uncoforaminotomy, the lateral vertebrotomy, the unroofing of the foramina transversaria, and the removal of the pedicles and posterior transverse ridges. B: A lateral vertebrotomy slightly wider than 5 mm and a resection of the pedicles as well as the posterior transverse ridges of the C-6 and C-7 vertebral bodies are accomplished. The posterior longitudinal ligament is resected and the dura is exposed. The common carotid artery (Ca), internal jugular vein (Jv), and the vagus nerve are retracted medially and the vertebral artery (Va) is slightly retracted laterally and backward. The anterolateral dura between the C5–6 disc space and the T-1 vertebral body is opened in longitudinal fashion and the tumor ventrolateral to the spinal cord is exposed. C: Total removal of the intradural tumor is accomplished.

vertebrae are made (Fig. 5A). An excellent operative field is obtained through the spaces formed by the uncoectomy and anterior foraminotomy, removal of the posterior transverse ridges, and lateral vertebrotomy of the two vertebrae, as well as the removal of the intraforaminal tumor. Further exposure is obtained by the widening of the intervertebral space through a vertebral spreader inserted into the emptied disc space which is maximally opened up to 12 to 14 mm; the posterior longitudinal ligament is divided along the posterior margins of the exposed vertebrae and is removed. Then the common carotid artery and internal jugular vein as well as the vagus nerve are retracted medially, and the vertebral veins and artery are slightly retracted laterally.

FIG. 6. Diagrams showing preparation of the T-shaped iliac bone graft.

FIG. 7. Case 2. Left: Lateral cervical spine x-ray film showing good alignment of the cervical spine and complete fusion between C-2 and C-3. Right: An anteroposterior tomogram of C-2 and C-3 showing complete fusion.
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and backward. The anterolateral wall of the dural canal is opened in longitudinal fashion and the tumor ventral and lateral to the spinal cord is exposed (Fig. 5B). The tumor inside the spinal canal is totally removed (Fig. 5C). The remaining extraspinal tumor is then removed, preserving the surrounding neural structures and the vertebral artery. The dura is closed with continuous sutures of 5-0 monofilament nylon. The remaining dural defect can be closed either by fascia lata if it is large or by a piece of the muscle if it is small. A watertight closure of the dura can be performed by this means. The defect of the bone and intervertebral space is filled with an iliac bone graft which is formed into a T-shape (Fig. 6). The accessory nerve, which has been divided in cases of dumbbell-shaped tumors at C2-3, is anastomosed with 9-0 monofilament nylon interrupted sutures. The divided sternocleidomastoid muscle is reapproximated by interrupted sutures.

Cervical traction with Crutchfield's tongs and a 4-kg weight, which has been applied preoperatively, is decreased to 1 kg and continued postoperatively. Within 2 weeks after the operation a halo vest is applied to the patient and thereafter he becomes ambulatory. Two to 4 months postoperatively the halo vest can be removed.

Postoperative Results

Preoperatively, the patient with a meningioma (Case 1) had paralysis of the left hand and paraplegia; however, function of his lower limbs gradually improved after surgery, and 5 years postoperatively he had mild sphincter disturbance, paralysis of the left hand, and mild weakness of both legs with moderate spastic gait. One of the two patients with a neurinoma at the C2-3 level (Case 2), whose 11th nerve had been amputated and anastomosed, showed excellent neurological improvement including the 11th nerve, at a follow-up examination 2½ years later. The other one (Case 4) showed only a very mild 11th nerve palsy 1 year and 4 months postoperatively. Another patient (Case 3) showed only mild hypalgesia at the left C-7 dermatome 1½ years after the operation. The last patient with von Recklinghausen's disease (Case 5) showed very mild residual weakness of the right upper limb at 1 year postoperatively. These four patients with neurinomas had returned to their original jobs within 6 months after their operations. Postoperative cervical spine x-ray films demonstrated complete bone fusion at the operative sites in all of the patients (Figs. 7 and 8). Postoperative vertebral angiograms demonstrated complete patency of the artery in all of the patients.

Discussion

In the management of spinal tumors, it is generally accepted: 1) that when the paravertebral mass is large, a two-stage operation is indicated: stage one for removal of the intraspinal portion of the tumor and stage two for removal of the extraspinal part; and 2) that a laminectomy is the best procedure to handle even ventral extra-axial spinal cord tumors, such as a meningioma. However, with the anterior approach, considerable portions of several vertebral bodies must be removed and this seems to be an unnecessary procedure. In the case of cervical dumbbell-shaped tumors extending largely outside of the spinal canal through the enlarged intervertebral foramen, such as neurinomas and meningiomas (as in our cases), the anterolateral approach affords the advantage of direct access to the lesion in its entirety. In our combined approach under direct vision, using an operative microscope, we remove the uncinate process and posterolateral corners of the vertebral bodies (anterior foraminotomy) by means of a transdiscal (medial) approach instead of by the lateral approach described by Verbiest. Through the space formed by removal of the tumor from the enlarged intervertebral foramen, by an uncoforaminotomy (un-
cectomy and anterior foraminotomy), and by removal of the posterior transverse ridges of the vertebral bodies, an additional limited lateral vertebrotyomy can be performed. By maximal widening of the intervertebral space up to 12 to 14 mm using a vertebral spreader, a lateral approach to the anterior spinal canal may be safely undertaken and, with only minimal retraction of the vertebral artery, we have been able to expose fully a spinal cord tumor situated in the anterior lateral part of the spinal canal.

The advantages of this approach are as follows: 1) Under microscopic vision, a direct one-stage operation can be safely performed to reach a tumor located in the ventrolateral portion of the spinal cord and, during tumor removal, it is not necessary to retract the spinal cord at all. 2) The removal of vertebral bodies is greatly minimized by a wide opening of the intervertebral space. The disadvantage of this operation is the possibility of injuring the vertebral artery and the phrenic, vagus, accessory, and hypoglossal nerves during removal of the dumbbell-shaped tumor. However, this danger can be avoided if the operation is conducted with detailed preoperative studies, including retrograde brachial arteriograms and computerized tomography scans in addition to routine myelograms, and with the application of microsurgical techniques. This procedure does require division of the accessory nerve for exposure of dumbbell-shaped tumors located at the high cervical level.

References


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