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ILLUSTRATIVE SURGICAL VIDEO

Microsurgical resection of a cervical dumbbell melanocytic tumor with a large extraforaminal component: surgical video

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Cervical dumbbell tumors with foraminal and extraforaminal extension can introduce technical challenges because of their proximity to critical structures such as the spinal cord, nerve roots, and the vertebral artery. Most cervical dumbbell tumors arise from Schwann cells making up peripheral nerve sheaths but, while uncommon, can be other pathologies. We present the operative video of a 50-year-old male with progressive cervical myelopathy caused by a C4-C5 Asazuma type IIIA dumbbell tumor with intradural, foraminal, and large extraforaminal components. The lesion was resected through a posterior approach consisting of C3-5 laminectomies and a left C4-5 facetectomy with a microsurgical tumor resection. A C3-6 posterior instrumented fusion was also performed. This report highlights technical considerations when resecting tumors of this nature. Gross total resection was achieved, and the final pathology report established the diagnosis of a primary circumscribed central nervous system (CNS) melanocytic tumor. This video illustrates operative nuances relevant to resection of cervical dumbbell lesions with significant extraforaminal extension.

Keywords: cervical dumbbell tumor, primary CNS melanocytic tumor, intradural extramedullary tumor, extraforaminal extension, microsurgical resection, posterior cervical approach, vertebral artery

Introduction

Dumbbell tumors obtain their shape from intradural and extradural components with portions of limited growth due to extension through the neural foramen. Asazuma's classification has been used to describe the extent of such tumors and their spatial relationships with the spinal canal, foramen, and paraspinal structures (1). Most dumbbell tumors arise from Schwann cells in peripheral nerve sheaths but do not always present as Schwannomas. These lesions can often present with progressive myelopathy or radiculopathy due to compression of the spinal cord or local nerve roots, respectively (2). These intimate relationships with critical structures can make surgical resection challenging with many technical nuances in play.

Multiple surgical approaches have been described to reach these cervical dumbbell tumors, including posterior, anterior, anterolateral, and combined approaches. Choosing the optimal approach is heavily dependent on the location of the tumor and its relationship to critical structures such as the spinal cord, nearby nerve roots, neural foramen, and vertebral artery. In select lesions, a posterior-only approach may provide adequate visualization and maneuverability of the lesion to allow for a gross total resection and fixation, if necessary, while avoiding morbidity tied to complex approaches (1–3).

Primary central nervous system (CNS) melanocytic tumors are rare neoplasms derived from leptomeningeal melanocytes and may occasionally mimic more common nerve sheath tumors on preoperative imaging (4). Their presentation as a cervical dumbbell lesion with substantial extraforaminal extension is uncommon (5). In this operative video, we demonstrate the microsurgical resection of a cervical dumbbell melanocytic tumor at C4-5 with intradural, foraminal, and extraforaminal components causing progressive cervical myelopathy.

VIDEO 1 | Microsurgical resection of primary circumscribed CNS melanocytic dumbbell tumor of the left C5 nerve root. https://youtu.be/8FDtBa-MsuI

Clinical presentation

A 50-year-old man presented with progressive cervical myelopathy over the preceding month characterized by bilateral upper extremity weakness and numbness (left greater than right), impaired hand dexterity, gait instability, and recent falls. During the week before presentation, he experienced more rapid neurological deterioration with worsening motor and sensory deficits. Neurological examination demonstrated left greater than right motor weakness, sensory loss involving both hands, gait instability, and signs of cervical myelopathy.

Magnetic resonance imaging (MRI) demonstrated a 2.7 × 0.8 × 1.9 cm bilobed extramedullary lesion centered at the C4-5 level with extension through the left C4-5 neural foramen and minimal extension into the left C3-4 neural foramen. The lesion produced severe spinal cord compression with associated T2 hyperintensity and cord edema. Extraforaminal extension was seen to displace adjacent neurovascular structures. Radiographically, the lesion was most consistent with a nerve sheath tumor showing extension that landed it in a type IIIA Asazuma classification of cervical dumbbell tumor (1).

A comprehensive malignancy workup showed no evidence of another primary lesion or metastatic process. Given the patient's progressive myelopathy with radiographic spinal cord compression, surgery was recommended.

Operative technique

Surgical planning

Preoperative imaging demonstrated a C4-5 dumbbell lesion with intradural, foraminal, and substantial extraforaminal extension causing severe spinal cord compression. Given that the lesion was predominantly posteriorly located with no components anterior to the vertebral artery, a posterior-only approach was selected. Operative goals included gross total resection, spinal cord decompression, vertebral artery preservation, and fusion to maintain the stability of the spine.

Positioning and neuromonitoring

Multimodal neuromonitoring, including somatosensory evoked potentials, motor evoked potentials, electromyography, and direct nerve stimulation, was utilized due to the resection of intradural components with close proximity to the spinal cord as well as tumor involvement with the exiting C5 nerve root. The patient was positioned prone with the head secured in Mayfield fixation. Intraoperative fluoroscopy, neuronavigation, and O-arm imaging were utilized for intraoperative localization of vertebral levels, spinal structures, and the tumor itself.

Exposure and posterior decompression

A posterior midline cervical exposure was performed after localizing the spinous processes of C3 through C6. Following subperiosteal dissection, laminectomies were conducted at C3, C4, and C5 to achieve decompression of the spinal cord and allow for an adequate surgical corridor for the intradural component of the lesion. Given the transforaminal nature of the tumor, a left C4-5 facetectomy was also performed. This established our operative corridor for the bulk of the foraminal and extraforaminal components of the lesion.

Durotomy and intradural tumor resection

Once the thecal sac from C3-C6 as well as the exiting nerve root C5 were sufficiently exposed, a microscope was brought into the field to begin the tumor resection itself. Our operative video begins at this transition and portrays a recording from the microscope itself. A midline durotomy was performed, and the dural edges were retracted laterally using tack-up sutures to avoid blood running down into the surgical field during resection. The arachnoid was opened sharply, and the ipsilateral dentate ligament was sectioned using microscissors. This maneuver improved mobilization and controlled rolling of the spinal cord away from the ventrolateral lesion, allowing visualization of the tumor and reducing injury risk.

The intradural component of the tumor was immediately visualized along the left ventrolateral aspect of the spinal canal, showing significant spinal cord compression and displacement. Attention was first directed toward devascularizing the lesion, followed by internal decompression. This was achieved using bipolar cautery to coagulate the tumor capsule and reduce the size of the tumor. Direct nerve stimulation and electromyographic monitoring were periodically utilized throughout the dissection to identify functional neural tissue and avoid morbidity as much as possible.

Further internal debulking was performed using the Sonopet ultrasonic aspirator. Reducing tumor size allowed for space to further mobilize the tumor away from the spinal cord. This improved visualization of the lateral tumor extension and developed a plane circumferentially between the tumor and surrounding functional structures assisted with the use of direct nerve stimulation. Tissue was obtained

for pathological analysis, and resection of the intradural component was completed.

Foraminal and extradural tumor resection

Attention was then directed toward the foraminal and extraforaminal components of the lesion. The previously completed C4-C5 facetectomy provided access to the extradural components of the tumor as it traversed and extended beyond the neural foramen. Before starting resection, the resected end of the intradural tumor component was followed through the neural foramen to quickly locate the extradural component and reestablish the previous plane of resection. This continuity facilitated easy identification of tissue planes and tumor margins. These findings were confirmed using direct nerve stimulation. A minor incision was made in the lateral dural to facilitate resection of the transforaminal component of the lesion. Using a combination of sharp microsurgical dissection, bipolar cautery, and tissue destruction with the ultrasonic aspirator, the lesion was progressively devascularized and debulked.

Careful consideration of the vertebral artery is necessary, as it is anterior to the lesion and deep to the tumor during resection. Identification and preservation of the vertebral artery is a critical portion of this surgery. Bleeding from the venous plexus surrounding the artery can also be encountered and may indicate closer proximity to the critical structure. Thrombin-soaked patties were utilized throughout the dissection to assist with hemostasis while maintaining planes of tumor resection. Eventually, the vertebral artery was identified deep to the lesion. All subsequent resection proceeded under direct visualization of the vessel, allowing removal of the remaining tumor with clear avoidance of the artery.

Closure

Following gross total tumor resection, adequate spinal cord decompression and hemostasis were confirmed. The lateral dural incision was repaired with interrupted 4-0 nurolon sutures and reinforced with a muscle graft and dural sealant. The midline durotomy was closed with a running 4-0 nurolon suture. The Valsalva maneuver was utilized and demonstrated no evidence of cerebrospinal fluid leak.

Given the unilateral C4-5 complete facetectomy, a posterior stabilizing fusion was performed. Lateral mass screws were placed from C3 to C6 and connected with rods. The final hardware position was confirmed using intraoperative fluoroscopy. After decortication, an allograft was placed to promote arthrodesis. Lastly, a subfascial drain was placed, and the wound was closed in multilayer fashion.

Surgical nuances and technical pearls

First, a complete unilateral facetectomy was performed prior to the dural incision and tumor resection. Establishing this foraminal corridor early was two-fold. It provided direct access to the foraminal and extraforaminal components, which allowed seamless continuity of tumor planes and thus lesion resection. It also avoided additional bony work while intradural components were exposed, thus heavily reducing risk of intradural injury. In lesions with significant extraforaminal extension, completely conducting the necessary exposure before starting the intradural resection is ideal.

Second, sectioning of the ipsilateral dentate ligament provides mobility of the cervical spinal cord that significantly improves visualization of the tumor margins. It reduces the need for direct spinal cord manipulation during microsurgical dissection, thus decreasing the risk of spinal cord injury due to insufficient exposure. This maneuver is particularly valuable when the location of the lesion is ventrolateral to the cord, as in this case (2).

Third, internal decompression with the Sonopet ultrasonic aspirator was performed before circumferential mobilization of the tumor. Debulking reduced tumor volume, facilitated development of the tumor-cord interface, and improved visualization of critical anatomical structures. Direct nerve stimulation and electromyographic monitoring were used throughout the procedure to assist with identification of functional neural tissue (2).

Fourth, the intradural component was addressed before the foraminal and extraforaminal portions of the lesion. Early decompression of the spinal cord improved visualization of the lateral tumor margin and facilitated identification of the lesion as it traversed the neural foramen. Maintaining continuity between the intradural and extradural portions of the tumor simplified tumor identification during the lateral dissection.

Finally, surgeons should anticipate distortion of normal vascular anatomy in lesions with substantial extraforaminal extension. In the present case, the vertebral artery was displaced by the tumor and became visible during extradural dissection. Constant awareness of its anticipated location was essential during mobilization of the lateral tumor component. Similarly, repair of the lateral foraminal dural defect using interrupted sutures, muscle graft, and dural sealant was considered critical for minimizing the risk of postoperative cerebrospinal fluid leakage.

Postoperative outcome and pathological findings

There were no intraoperative or postoperative complications. The patient had improvement in upper extremity strength with no new neurological deficits. Postoperative MRI demonstrated gross total resection. The spinal cord was adequately decompressed, and the left vertebral artery showed decreased displacement after resection of the lesion. Persistent cord signal change on T2 MRI was noted.

Histopathological analysis demonstrated a melanotic spindle cell neoplasm of the peripheral nerve root and ganglion. Given the unusual findings, the specimen underwent external consultation at Mayo Clinic and separate DNA methylation profiling at the National Institutes of Health. The tumor showed melanocytic differentiation with SOX10, HMB45, and MART-1 positivity and a low proliferative index. The lesion was classified as a primary CNS circumscribed melanocytic tumor, a rare finding for a cervical dumbbell lesion that radiographically mimicked a nerve root schwannoma (4, 5).

Conclusion

Large cervical dumbbell tumors with transforaminal and extraforaminal extension require thorough surgical planning and technical considerations to assist in achieving safe resection while preserving critical neural and vascular structures. This surgical video and report describe a posterior-only approach to access both intradural and extradural tumor components through a single operative corridor. The key technical considerations highlighted in this report facilitated gross total resection of the tumor and effective decompression of the spinal cord. The accompanying operative video illustrates these surgical nuances and may serve as a guide for the management of similar cervical dumbbell lesions.

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Conflict of interest

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