Resection of a ventral intramedullary spinal cord ependymoma through an anterior cervical approach: illustrative case

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BACKGROUND Although posterior myelotomy leaves patients with dorsal column deficits, few reports have explored the anterior cervical approach for cervical intramedullary tumors. The authors describe the resection of a cervical intramedullary ependymoma through an anterior approach with a two-level corpectomy and fusion.

OBSERVATIONS A 49-year-old male presented with a C3–5 ventral intramedullary mass with polar cysts. Because of the ventral location of the tumor and the added benefit of avoiding a posterior myelotomy and dorsal column deficits, an anterior C4–5 corpectomy offered a direct route and excellent visualization of the ventrally located tumor. After a C4–5 corpectomy, microsurgical resection, and C3–6 anterior fusion with a fibular allograft filled with autograft, the patient remained neurologically intact. Magnetic resonance imaging (MRI) on postoperative day (POD) 1 confirmed gross-total resection. The patient was extubated on POD 2 and was discharged home on POD 4 with a stable examination. At 9 months, the patient developed mechanical neck pain refractory to conservative treatment and underwent a posterior fusion to address pseudarthrosis. MRI at 15 months showed no evidence of tumor recurrence with the resolution of neck pain.

LESSONS An anterior cervical corpectomy provides a safe corridor to access ventral cervical intramedullary tumors and avoids posterior myelotomy. Although the patient required a three-level fusion, we believe the tradeoff of decreased motion compared to dorsal column deficits is preferred.

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KEYWORDS ependymoma; intramedullary; anterior approach; corpectomy; tumor; ventral resection

Most cervical intramedullary spinal cord tumors are accessed posteriorly, which often requires a midline myelotomy.1 Although hemangioblastomas can sometimes be dissected off the surface of the cord, most lesions necessitate a dorsal myelotomy, which often leaves patients with transient or permanent numbness, paresthesias, and ataxia.2 An anterior approach requires a corpectomy and fusion, whereas a posterior approach requires only a laminectomy or laminoplasty.3–5 Additional limitations of the anterior approach include a narrow and deep working corridor, invasiveness of a corpectomy, and decreased surgeon familiarity.6 Cervical corpectomy for resection of an intramedullary hemangioblastoma and capillary hemangiomas has been described.7–10 To date, however, there are no reports of anterior resection of ventrally located cervical intramedullary ependymoma.

Given the limited evidence supporting the feasibility and safety of anterior resections of cervical intramedullary spinal tumors, we sought to describe the case of an anterior resection of a cervical intramedullary ependymoma through a two-level corpectomy and fusion that achieved gross-total resection and complete neurological recovery.

Illustrative Case

Patient History and Examination

A 49-year-old male presented with 3 months of left upper extremity incoordination, paresthesias, subtle balance difficulties, and intermittent neck pain, without gross arm or leg weakness. Full motor strength was demonstrated in all extremities with no Hoffman’s sign or hyperreflexia. On preoperative magnetic resonance imaging...

ABBREVIATIONS MRI = magnetic resonance imaging; POD = postoperative day.

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(MRI), an intramedullary mixed signal intensity lesion spanned the spinal cord from C3 to C5 (Fig. 1A–D). The lesion contained a cystic component and an area of nodular enhancement in its anterior aspect, suspicious for an intramedullary ependymoma or hemangio-blastoma. Neuroaxis MRI ruled out any metastases. Given the presence of progressive incoordination interfering with the patient’s work and quality of life and the anterior location of the tumor, tumor resection was recommended through an anterior approach.

**Approach Selection**

Risks and benefits of an anterior or a posterior approach were discussed with the patient. For the posterior approach, the more specific risk of permanent dorsal column dysfunction was mentioned. For the anterior approach, the risks of a difficult-to-repair spinal fluid leak, anterior spinal artery injury, loss of cervical motion, and the possible need for posterior instrumentation were mentioned. Due primarily to the ventral tumor location and because the tumor came to the ventral surface of the spinal cord, an anterior approach was favored. Moreover, because of the added benefit of preserving proprioception and the patient’s desire to decrease the risk of posterior column deficits, an anterior corpectomy and ventral tumor resection were chosen. Given the instability induced by a two-level corpectomy, the patient was heavily counseled about the potential need for a posterior fusion.

**Operation**

With the patient under general anesthesia, he was positioned supine with Gardner-Wells tongs without weight, and somatosensory and motor evoked potential monitoring was set up, including D-wave monitoring. The otolaryngology team performed a wide left-sided neck exposure of the C3–6 vertebral bodies to loosen all tissue planes for the long retraction time needed. C3–4 and C5–6 discectomies were performed under the microscope, followed by total corpectomy of the C4–5 vertebral bodies. Intraoperative ultrasound confirmed the location of the tumor. Fibular allograft preparation was completed prior to dural opening to allow for fast graft placement and plating in the event of the loss of evoked potentials during the tumor resection.

Under microscopic guidance, a small midline durotomy was made with an 11 blade and a nerve hook. The dura was then retracted with tack-up sutures to the longus colli muscles. The ventral tumor margin was visible on the surface of the spinal cord. The tumor was colored slightly red and grayish and was clearly distinct from the spinal cord. An electrode strip was placed caudal to the tumor in the subdural space to monitor D-waves. A bipolar device was used to dissect and coagulate the surface of the tumor. The tumor was removed in a piecemeal fashion with meticulous microdissection, taking care to minimize any traction or manipulation of the spinal cord. An intraoperative frozen specimen confirmed glial tumor. After debulking the internal tumor, borders with the normal spinal cord were inspected and any residual tumor was carefully dissected off the resection cavity. Once the tumor was removed in a piecemeal fashion, the area was copiously irrigated, and meticulous hemostasis was ensured. The dura was closed using nylon sutures, and DuraSeal® and DuraGen® were applied. Next, the prepared fibular allograft filled with autograft was placed into the corpectomy defect, and 16- to 18-mm screws were used to secure the C3–6 plate. The wound was irrigated with vancomycin, and a Jackson-Pratt (JP) drain was inserted. The estimated blood loss was 100 mL. A step-by-step demonstration of the operation is described in Video 1.

**Postoperative Course**

The patient remained intubated because of airway edema and was taken to the intensive care unit with a stable neurological exam. MRI showed complete resection of the tumor, and radiographs confirmed...
the C4–5 corpectomy and C3–6 anterior fusion with a fibular allograft (Fig. 2A–D). After extubation on postoperative day (POD) 2, no neurological deficits were encountered. The patient resumed a normal diet on POD 2, the JP drain was removed on POD 3, and the patient was discharged home on POD 4.

Histopathology demonstrated a glial neoplasm composed of tumor cells with ovoid nuclei, stippled chromatin, and eosinophilic cytoplasm. Tumor cells were arranged in perivascular pseudorosettes with no significant mitotic activity or necrosis, consistent with an ependymoma.

For 6 months, the patient reported minimal to no neck pain but later began to experience increasing mechanical neck pain at 9 months. A computed tomography scan was obtained, which revealed the absence of intra- and extragraft bridging bone and potential pseudarthrosis. Because the increased neck pain interfered with the patient’s daily activity, a posterior C3–6 fusion was performed, with an uneventful postoperative course. Subsequent MRI performed at 15 months showed no recurrence (Fig. 3A–D).

Patient Informed Consent
The necessary patient informed consent was obtained in this study.

Discussion
Observations
Although anterior resections of ventrally located cervical intramedullary tumors have been previously reported in the literature,7–10 this report describes, to our knowledge, the first case of a cervical intramedullary ependymoma resected through an anterior approach with corpectomy and fusion.

Anterior Approach for Intramedullary Lesions
The anterior cervical approach has been described for the resection of cervical ventral intramedullary hemangioblastomas, cavernous malformations, and capillary hemangiomas, all with complete resection and without postoperative neurodeficits.7–9,13 In five cases of an anterior cervical approach for intramedullary lesions, pathology included hemangioblastoma, capillary hemangioma, and cavernous hemangiomas, and all cases underwent complete resection with no postoperative neurological deficits.7–9,13 Furthermore, Pluta et al.5 compared anterior versus posterior cervical resection of intramedullary ventral spinal hemangioblastomas. The preservation of neurological function was seen in all patients who had undergone an anterior approach (n = 3), whereas among the posterior group, four of five patients had motor weakness and three of five had proprioceptive sensory loss. An impressive report of a hemangioblastoma resected through an anterior cervical approach was described by McCormick et al.8,15 where a C5–6 corpectomy was performed with fibular allograft to fill the corpectomy defect, similar to the current case. No neurological deficits were encountered, and 6-week postoperative MRI showed no evidence of residual tumor. The findings of these studies underscore the safety of the anterior approach to avoid dorsal column deficits.

Risks of the Anterior Approach
The anterior approach has several potential pitfalls. It requires a corpectomy and fusion, which both decrease cervical motion and place the patient at risk for pseudarthrosis, as seen in this case report. Among the reports of anterior cervical approaches for tumor resection referenced above, only Nagoshi et al.9 reported successful fusion in two patients with iliac crest autograft. Other studies were limited by short follow-up with no mention of the fusion rate.8,13 Although the anterior approach requires a fusion, and in this case a second surgery, we believed that the loss of motion was far less debilitating than dorsal column dysfunction. In this case, a two-staged procedure may have prevented pseudarthrosis and increased the chances of a successful fusion.14 However, given the high neurological risk of the intramedullary tumor resection, the senior author wanted to limit the general anesthesia time to only what was necessary. A two-stage procedure might have added unnecessary risk with the longer anesthesia time, higher blood loss, and greater risk of infection and wound-related complications associated with the combined anterior and posterior approach.15 Nevertheless, the patient was heavily counseled prior to the operation regarding the risks and benefits of having a two-stage procedure. The patient opted for an anterior-only approach with close monitoring of having a two-stage procedure. The patient opted for an anterior-only approach with close monitoring of pseudarthrosis during the postoperative clinical visits and serial imaging. Although reports of dorsal column mapping can minimize this risk, it is our anecdotal experience, and that of others,8 that dorsal myelotomy

FIG. 2. Postoperative lateral (A) and posteroanterior (B) radiographs showing the C4-5 corpectomy and C3-6 fusion with a fibular allograft. Postoperative MRI showed a complete tumor resection on midsagittal T2-weighted sequence (C) and T1-weighted sequence with contrast (D).

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leaves patients with posterior column dysfunction that is at best transient and often permanent.

Additional limitations and challenges of the anterior approach include a limited, deep, and narrow working channel, which can make the tumor resection more challenging than the posterior approach. The smaller working channel can be mitigated by performing a wide corpectomy, using the intraoperative microscope, and employing long or even single-shaft instruments. Another added risk of the anterior approach is a higher risk of adjacent segment disease following corpectomy, which results from increased stress on the adjacent levels and causes accelerated degeneration. Furthermore, the large durotomy necessary for resection increases the risk of an anterior cervical cerebrospinal fluid fistula. Water-tight dural closure is essential and may require the use of dural substitutes, dural sealants, and/or lumbar drainage. Moreover, the anterior approach poses additional risks to the nearby structures with possible airway edema, dysphagia, dysphonia, and damage to the anterior spinal artery.

Special Considerations for Ependymomas

Overall survival ranges from 85% to 100% at 5 years regardless of recurrence, which occurs in 15% to 33% of cases. Although the follow-up period in the current case report did not extend beyond 15 months, previous studies of ependymomas have shown that local recurrence is unlikely to occur in patients with gross-total resection. In the present case, the anterior surgical approach provided direct access to the ventral intramedullary ependymoma and did not cause any posterior column deficits. Compared to ependymomas, the plane of hemangioblastomas may be more forgiving, as they typically come to the surface and have a distinctive reddish-orange appearance.

Lessons

We describe the resection of a cervical intramedullary ependymoma through an anterior approach with two-level corpectomy and fusion, with gross-total resection and neurological improvement. Careful selection of patients presenting with ventral spinal ependymomas may demonstrate satisfactory neurological outcomes when approached anteriorly, avoiding dorsal column morbidity.

References


Disclosures
Dr. Zuckerman reported being an unaffiliated neurotrauma consultant for the National Football League (NFL).

Author Contributions
Conception and design: Zuckerman, Kelly, Topf. Acquisition of data: Zuckerman, Topf. Analysis and interpretation of data: Chanbour. Drafting the article: Kelly. Critically revising the article: Zuckerman, Chanbour, Kelly, Topf, Dewan. Reviewed submitted version of manuscript: Zuckerman, Chanbour, Kelly, Topf, Dewan. Approved the final version of the manuscript on behalf of all authors: Zuckerman. Study supervision: Zuckerman, Morone.

Supplemental Information
Video

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