Massive growth of a meningioma into the brachial plexus and thoracic cavity after intraspinal and supraclavicular resection

Case report and review of the literature

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Most extracranial and -spinal meningiomas (extra-axial meningiomas) occur secondarily, either by direct extension or by metastasis. Less commonly, they occur as ectopic primary meningiomas. Altogether, extraxial meningiomas comprise only approximately 2% of all meningiomas.5 Meningiomas rarely involve the brachial plexus; only two documented cases of primary brachial plexus meningioma have been reported.4 Furthermore, there has been only one case in which an intraspinal meningioma was shown to invade the brachial plexus.11 The occurrence of thoracic cavity meningiomas has been discussed, but it is often not clear in such reports if these tumors are primary or if they have infiltrated from central nervous system or PNS structures. We report the case of a 36-year-old man who was initially treated for a thoracic spinal meningioma that infiltrated the brachial plexus. After resection, progressive and massive growth with infiltration of the brachial plexus and pleural cavity occurred over a 5-year period despite radio- and chemotherapy. The case report is followed by a review of the literature of this rare entity.

Key Words • brachial plexus • thoracic cavity • meningioma • tumor recurrence

Case Report

History. The patient presented at 34 years of age with bilateral lower-extremity weakness. Upper-extremity function and pulmonary function were unremarkable. Spinal MR imaging demonstrated a heterogeneously enhancing T1–3 extramedullary lesion, eccentric to the left, with dumbbell-like extension out of the neural foramina at T-1 and T-2. At this time, the tumor was noted to encase the left subclavian artery and brachial plexus and to extend locally into the apex of the left lung. At an outside institution a T1–3 decompressive laminectomy was performed with extensive tumor resection within and immediately adjacent to the spinal canal (Fig. 1). Postoperatively, the patient noted shortness of breath and left upper-extremity weakness, including weakness in the hand and loss of sensation in the thumb.

Postoperative evaluation was notable for a marked left pleural effusion and significant residual left thoracic tumor in the apex of the lung, brachial plexus, and encasing the subclavian artery. The patient underwent thoracectomy. Several weeks later the mass was excised via a combined thoracotomy and supraclavicular approach, the left clavicle was removed, and the left subclavian artery, left brachial plexus, and T-1 and T-2 neural foramina were explored.

Abbreviations used in this paper: CT = computerized tomography; MR = magnetic resonance; PNS = peripheral nervous system.
Following the second operation, a surgical cure, based on intraoperative observations and postoperative radiographs was believed to have been achieved, but the patient underwent radiotherapy because of atypical features demonstrated in the excised specimens. He received a total dose of 4500 rads in 25 fractions to the left brachial plexus and C3–T3 over a 1-month period.

After a symptom-free interval of several months, the patient noted progressive dyspnea, and follow-up radiological evaluation demonstrated recurrent disease in the left thorax. Of note, it appeared that there was no tumor in the spinal canal or associated with the proximal nerve roots at the site at which the original operation was performed. All disease appeared to be extraaxial. The patient initially refused additional surgery and instead underwent chemotherapy with high-dose ifosfamide with mesna followed by maintenance on interferon alpha therapy. There was little response, and the patient subsequently completed an eight-session course of fractionated stereotactic radiosurgery of 4000 cGy. The tumor continued to enlarge, and the patient was referred to our institution (Fig. 2).

His medical history was otherwise unremarkable. There was no family history of cancer or neurogenetic diseases, and his parents and sibling were in good health.

Examination. On examination at our institution he had developed severe pulmonary disease with dyspnea at rest, requiring supplemental oxygen for low-level oxygen saturation (approximately 80%) as a result of the thoracic mass. Neurologically, there was no evidence of cognitive dysfunction, and cranial nerve function was intact, except for a left Horner syndrome. He had diminished reflexes with 3/5 function of his left upper extremity with left-sided sensory loss in a C6–T2 distribution.

Both MR imaging and CT scanning with and without contrast demonstrated a multilobular T2 hyperintense heterogeneously enhancing mass that completely filled the left hemithorax, extended superiorly to encase the left subclavian artery and brachial plexus, and involved the left supraclavicular fossa (Fig. 3). The entire mass was $29 \times 11 \times 15$ cm in the left hemithorax and $5 \times 7 \times 8$ cm in the neck. Medially, the mass extended from C-6 to T-2 and appeared to involve the neural foramen of C-8 as well as the left first and second ribs. It surrounded the left pulmonary vasculature and displaced the trachea and mediastinum to the right with massive compression of the left lung. A head CT demonstrated no intracranial disease other than an incidental small left posterior fossa arachnoid cyst.

Operation. A radical resection was planned to control this markedly progressive symptomatic disease. The patient underwent radical resection of the malignant tumor on the left side of the neck, excision of the first left thoracic rib, left-sided total claviclectomy, left thoracotomy for resection of tumor, and left forequarter amputation. The intraoperative findings were consistent with that of a massive tumor occupying the entire left hemithorax adherent to, and partially invasive into, the chest wall at sites of the prior thoracotomy and chest tubes (Fig. 4). It was also seen to encase the brachial plexus and abut the subclavian vessels, with the superior extent to the C-6 level.
and the left side of the neck. Examination of frozen sections was positive for tumor at the superior and posterior cervical margins.

**Postoperative Course.** His postoperative course was complicated by the development of the acute respiratory distress syndrome. Despite lengthy treatment in the intensive care unit and a trial of nitric oxide therapy, he died 2 months after the operation.

**Pathological Findings.** Histological examination of the tumor specimens showed features characteristic of a meningioma with lobules of polygonal cells, often with nuclear pseudoinclusions (Fig. 5 upper left). The tumor, however, showed infiltration of soft tissues, moderate nuclear atypia, mitotic figures (including atypical ones), and areas of necrosis (Fig. 5 upper right). These combined features were consistent with a diagnosis of atypical meningioma. Immunohistochemical studies showed that the tumor cells were positive for epithelial membrane antigen (Fig. 5 lower left) and negative for S-100 protein, HMB-45, MART-1, and keratin. On electron microscopy, the neoplastic cells had extensive interdigitating cytoplasmic processes that were connected by numerous junctions including desmosomes (Fig. 5 lower right). Abundant cytoplasmic filaments were present, some of which were associated with the desmosomes. These findings confirmed the meningothelial nature of the cells and excluded other tumors, such as a peripheral nerve sheath tumor or malignant melanoma in the differential diagnosis.

**Discussion**

The most common entities in a differential diagnosis for a presumed neoplasm observed on chest x-ray films include primary or metastatic adenocarcinoma, malignant mesothelioma, and melanoma. Rarely, a thoracic cavity meningioma is found by surgeons. Whereas some of these cases were thought to be primary tumors, infiltration from adjacent central nervous system/PNS structures cannot be totally dismissed. Excluding the common carcinomas of the lung or breast, there are fewer than 200 reported tumors involving the brachial plexus. Lusk, et al., reported 56 patients with 57 tumors of the brachial plexus who underwent operation. Forty lesions were nerve sheath tumors, including 26 neurofibromas (nine of which were associated with neurofibromatosis: 1), eight schwannomas, four malignant nerve sheath tumors, one fibrosarcoma, and one (possible) meningioma. Seventeen tumors were not of nerve sheath origin, including both benign (desmoid, myoblastoma, lymphangioma, lipoma, myositis ossificans with lipoma, and branchial cleft cyst) and malignant (breast cancer, lung cancer, melanoma, and malignant thymoma) lesions.

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![Fig. 3. A series of MR images demonstrating tumor at the T-1 foramen, extending to and involving the brachial plexus.](image)

![Fig. 4. Intraoperative photographs demonstrating the size of the thoracic component of the tumor at the time of resection.](image)
topic primary meningiomas. A rare entity, there are only two documented cases of primary brachial plexus meningioma. In 1989 the authors of one paper reported a 51-year-old woman who presented with a right-sided supraclavicular mass with multiple recurrences over a 13-year period. Examination by electron microscopy, immunohistochemistry, and light microscopy confirmed the diagnosis of meningioma. The only other report of a primary brachial plexus meningioma included a single photomicrograph of a hematoxylin and eosin–stained section in an Armed Forces Institute of Pathology fascicle on PNS tumors and lacked a text reference.

Surprisingly, there is only one paper in which the authors have documented the possible invasion of the brachial plexus by an intraaxial meningioma. A 47-year-old woman presented with a meningioma exiting the spinal canal along the C-7 nerve root. The intraspinal component of the tumor was resected, but CT scanning was suggestive of further tumor involving the brachial plexus. At exploration of the plexus mass, however, only scar tissue was found, without pathological evidence of viable tumor. The authors hypothesized that the scar may have been residual tumor that was subsequently killed after its blood supply had been compromised from the initial operation. In light of these reports, it is interesting to speculate if this patient’s initial tumor consisted of a primary brachial plexus meningioma with extension into the spinal canal or if the initial site of tumor formation was the spinal canal with subsequent infiltration into the brachial plexus and thoracic cavity.

Despite the significant research into the pathophysiology of meningiomas, the general paradigm for therapy of these tumors has not changed significantly over the past decade. The most efficacious treatment for meningiomas is surgery. For incompletely resected or recurrent tumors, radiotherapy can be provided and close follow-up examination is necessary in cases of locally invasive meningiomas, including those with a benign histological appearance. Lastly, when the meningioma cannot be resected and/or previous treatments have failed, immunotherapy may be considered.

Malignant meningiomas constitute 10 to 15% of all meningiomas, and limited information exists regarding adjuvant treatment of these aggressive primary brain tumors. Long-term survival is possible for patients with atypical and malignant meningiomas in whom surgery and postoperative radiotherapy are performed. Improved tumor control and survival may be associated with an increased radiation dose. In one large study in which surgery and radiotherapy were used to treat atypical and malignant meningiomas, the overall survival rates at 5 years and 10 years were 87% and 58%, respectively; in patients with malignant meningiomas the survival rates were 60% and 60%, respectively.

In another study the authors compared the results of surgery alone with a combined strategy of surgery, postoperative radiotherapy, and chemotherapy with cyclophosphamide, Adriamycin, and vincristine in patients with malignant meningioma. A modest improvement in survival was seen in those patients who underwent the combined therapy regimen. Neuroradiologically documented responses included three cases of partial tumor response and...
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11 cases of stable disease (of 14 patients). The median time to tumor progression was 4.6 years (range 2.2–7.1 years) and median patient survival was 5.3 years (range 2.6–7.6 years). The provision of chemotherapy with tamoxifen for nonresectable refractory meningiomas did not seem to offer a significant therapeutic effect.

Various chemotherapeutic agents that have shown some efficacy in individual cases include combinations of Adriamycin and dacarbazine or ifosfamide and mesna. The most effective immunotherapy appears to be administration of interferon alpha, which is relatively nontoxic and easily tolerated. More studies, however, are needed to define better the roles of these and other agents in the management of recurrent, unresectable, or malignant meningiomas.

The present case highlights a rare presentation of a relatively common tumor. It is important to consider the possibility of meningioma in the differential diagnosis of lesions of the chest and peripheral nerves. Their treatment remains primarily surgical, with the addition of radiotherapy and chemotherapy for more aggressive and/or refractory lesions.

Conclusions

To our knowledge, this is the first reported case of active invasion of the brachial plexus by meningioma in which associated pathological analysis has been documented. The diagnosis of meningioma should be considered when a brachial plexus mass is demonstrated, and it should be remembered that the behavior of this lesion can often be more aggressive than its histological appearance might suggest.

References


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