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Case Report

Primary thoracic intramedullary spinal cord tumor with likely metastases of glial origin to the lumbosacral vertebrae: Illustrative case

Samuel K. Asante[1], Jonathan J. Lee[1], Amanda V. Jenson[1], Lokeshwar S. Bhenderu[1], John D. Patterson[1], Andreana L. Rivera[2], Gavin W. Britz[1]

Departments of [1]Neurosurgery and [2]Pathology, Houston Methodist Hospital, Houston, Texas, United States.

E-mail: *Samuel K. Asante - skasante@houstonmethodist.org; Jonathan J. Lee - jjlee@houstonmethodist.org; Amanda V. Jenson - avjenson@houstonmethodist.org; Lokeshwar S. Bhenderu - lokeshwar.bhenderu@houstonmethodist.org; John D. Patterson - jdpatterson@houstonmethodist.org; Andreana L. Rivera - alrivera@houstonmethodist.org; Gavin W. Britz - gbritz@houstonmethodist.org

***Corresponding author:**
Samuel K. Asante,
Department of Neurosurgery,
Houston Methodist Hospital,
Houston, Texas, United States.

skasante@houstonmethodist.org

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ABSTRACT

Background: Metastasis of systemic neoplasms to the spine is common; however, the metastasis of primary spinal cord tumors to other regions in the body is an infrequent occurrence. A few case reports have described the metastasis of primary spinal cord tumors, and in most cases, patients were younger than 30 years of age.

Case Description: We present an illustrative case of a 47-year-old female with metastatic lesions to the lumbosacral vertebrae years after the initial diagnosis of an intradural, intramedullary spinal cord tumor (IMSCT). Although the surgical biopsy of the IMSCT was nondiagnostic, the patient was not found to have a separate primary neoplastic source, and the specimens of the metastatic lesions from the lumbar vertebral body were of glial origin.

Conclusion: Metastasis from primary IMSCTs is extremely rare. Distant vertebral body and intracranial metastasis are even rarer yet possible. The clinical course is highly aggressive and responds poorly to current standard treatment.

Keywords: Intramedullary, Metastasis, Spinal cord tumor, Vertebral body

INTRODUCTION

Primary spinal cord tumors account for 2–4% of all primary central nervous system tumors, and an estimated 850–1700 new adult cases occur every year in the United States.[2,5] The majority of primary spinal cord tumors are the World Health Organization (WHO) grades 1 or 2, and the classification of the tumor depends on the anatomical location.[2,5,9] The most common location of a primary spinal cord tumor is intradural-extramedullary, which comprises 70–80% of all primary spinal cord tumors followed by intradural-intramedullary spinal cord tumor (IMSCT) tumors that account for 20–30%. Up to 90% of IMSCTs are of glial origin, the most common subtypes in adults being ependymomas followed by astrocytomas.[2,5]

A study of 70 patients with IMSCTs found the median age of presentation to be 41 years.[5] Most IMSCTs occur in the cervical region followed by the thoracic and lumbar regions.[2] The clinical

presentation of patients with IMSCTs depends on tumor location; however, the most common complaint is diffuse or radicular back pain.[2,13,17]

Although metastasis of systemic neoplasms to the spine is a common occurrence,[13,17] the metastasis of primary spinal cord tumors to other regions in the body is an infrequent occurrence, with only a few case reports describing this phenomenon.[1,4,8,10,12,13,16] These limited case reports include the metastasis of IMSCTs to the vertebral bodies,[8,16] intracranial locations,[10,12] and the leptomeninges.[1,4]

We present an illustrative case of a 47-year-old female with metastases to the lumbosacral vertebrae years after the initial diagnosis of a T4/5 IMSCT. We also provide a review of the literature on similar cases.

CASE DESCRIPTION

A 47-year-old female with a medical history of hypothyroidism presented in 2016 with months of pain radiating from the posterior mid-thoracic region to the right scapular area and the anterior portion of the right side of the chest. She also experienced right lower extremity paresthesias without complaints of weakness in her extremities. The patient described her pain as a burning-like quality. Her physical examination was unrevealing with full motor strength in her extremities. The initial workup, including a chest X-ray and mammogram, was negative.

Initial imaging

A magnetic resonance imaging (MRI) of the thoracic spine without contrast revealed a spinal cord tumor extending from the superior endplate of T4 to the inferior endplate of T5. There was a considerable enlargement of the spinal cord; the spinal cord with the tumor measured approximately 11 mm in the anterior-posterior dimension and 15 mm in the coronal plane. The imaging findings were concerning for a primary spinal cord neoplasm, such as an ependymoma or astrocytoma [Figure 1a]. The MRI did not show any evidence of edema or syrinx formation. A gadolinium-enhanced MRI of the thoracic spine better delineated an IMSCT partially enhancing lesion centered at T4–5 [Figure 1b]. Additional MRIs of the complete neuroaxis were negative for additional lesions.

Initial surgical procedure

The patient was taken to the operating room for tissue diagnosis 1 month after the presentation in 2016. The neurosurgical team performed a T3–6 bilateral laminectomy. Neural monitoring, including motor-evoked potentials (MEPs) and somatosensory-evoked potentials (SSEPs), was used during the case. After the thoracic laminectomies, the tumor could be seen through the dura. The IMSCT caused the spinal cord to look severely swollen. After the dural opening, the tumor was noted to be localized to the left side of the spinal cord, more lateral than had been anticipated based on previous imaging. A paramedian myelotomy was performed in a surgical plane between the tumor and the spinal cord, and several tumor biopsy specimens were taken.

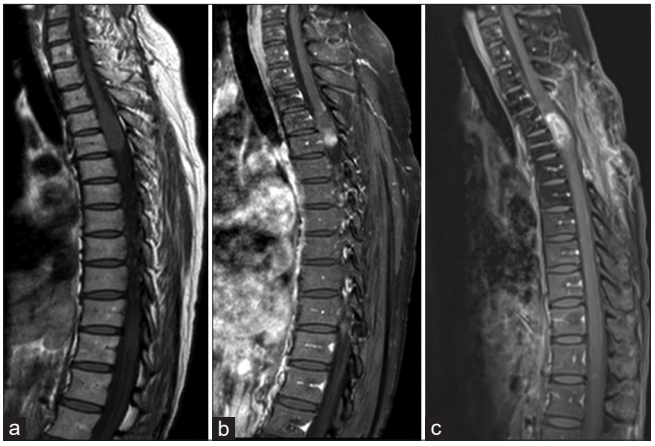

Figure 1: (a and b) Preoperative images – T1 pre- and postcontrast of thoracic spine and (c) one year postoperative – T1 postcontrast of thoracic spine.

The neuropathology team concluded that the specimen could only be termed "abnormal tissue," with no other absolute findings for a specific pathology. After the biopsy specimens had been taken, there was a temporary, intermittent decrease in amplitude in the left tibial MEP and a temporary decrease in SSEP signals on the patient's left side. Due to this decrease in neural monitoring signals, the surgical team decided not to take additional specimens and concluded the operation. The final pathology of the surgical specimens was non-diagnostic. There was evidence of Rosenthal fibers; however, BRAF mutation was absent. After a careful review of the case at the Texas Medical Center multi-institutional Neuropathology consensus conference by multiple-board certified neuropathologists, it was decided not to send the tumor biopsy to another institution.

Postoperative course and treatment

Despite the nondiagnostic final pathology from the thoracic spinal cord lesion, the patient received radiation therapy (a total dose of 54 Gray in 27 fractions) and chemotherapy consisting of four doses of bevacizumab and six cycles of temozolomide at 150 mg/m^2 for 5 days every month. Her motor examination continued to remain stable after surgery. In postoperative year 1, a gadolinium-enhanced MRI of the thoracic spine showed possible pseudo-progression [Figure 1c]. The patient and the treatment team decided to continue the patient on her chemotherapy regimen. An

18-month postoperative MRI showed slight enlargement of an intratumoral cyst, which was likely a treatment effect of the radiation therapy [Figure 2a].

At 20 months post-surgery, the patient complained of new lower extremity paresthesias in a contrasting distribution from her initial presentation. Another gadolinium-enhanced MRI of the thoracic spine showed a large, enhancing nodule superior to the cystic portion of the tumor [Figure 2b]. At this point, the patient restarted her bevacizumab regimen and was given six additional cycles of temozolomide treatment. Another biopsy was discussed; however, it was decided that another operation would be risky given the loss in neural monitoring signals and lack of positive pathology results from the last operation. The patient was followed clinically and radiographically with serial imaging.

A 2-year postoperative MRI showed a reduction in the size of the cystic component of the tumor; however, a 3-year postoperative MRI showed progression of the thoracic tumor superiorly with extension to the C7-T1 level [Figure 2c]. A gadolinium-enhanced MRI of the neuroaxis showed cervical extension of the disease up to the level of the clinoid [Figure 3a] and multiple enhancing lesions in the lumbosacral spine concerning metastases [Figure 3b].

Biopsy of metastases, pathology analysis, and clinical course

Subsequently, the patient underwent a fluoroscopic-guided biopsy of the L4 vertebral body [Figure 3c]. The pathology [Figures 4a-d] showed foci of glial tissue within the bone and marrow space, confirmed with GFAP immunohistochemical stain. The glial tissue was hypercellular and composed of ovoid cells with mild nuclear pleomorphism. There was also hemosiderin present within the glial tissue, suggestive of chronic bleeding. Additional immunohistochemical stains to better characterize the glial tissue, including IDH1 (R132H) mutation for glial tumor confirmation, ATRX expression loss for definitive astrocytic differentiation, and epithelial membrane antigen (EMA) (perinuclear dot-like staining) for ependymal differentiation, were negative.

The patient underwent palliative radiation of 37.5–45 Gy in 15 fractions to the cervical and lumbar spine. The patient continued to have difficulty ambulating. Her neurologic examination worsened to a motor strength of 2/5 in her lower extremities and to complete loss of her bowel and bladder sensation. After a lengthy discussion, the patient and her family decided to proceed with hospice care.

DISCUSSION

The pathology from the initial surgery of the thoracic IMSCT tumor, although nondiagnostic, had evidence of Rosenthal fibers, which suggested that the tumor was an ependymoma or a pilocytic astrocytoma, among other possibilities. The EMA staining and BRAF mutations, to definitively classify the tumor being either an ependymoma or a pilocytic astrocytoma, were negative. Despite this, the oncology team decided to initiate treatment with radiation and chemotherapy.

In general, the treatment options for IMSCTs include surgical resection, radiation therapy, and chemotherapy. These treatments are often combined, and the exact therapy depends on the tumor's histology, location, and staging.[5,14,17] Ependymomas often carry an excellent prognosis since they have an easily identified plane of dissection, making patients with these lesions excellent candidates for surgical resection.[13,17] Radiation therapy and chemotherapy are

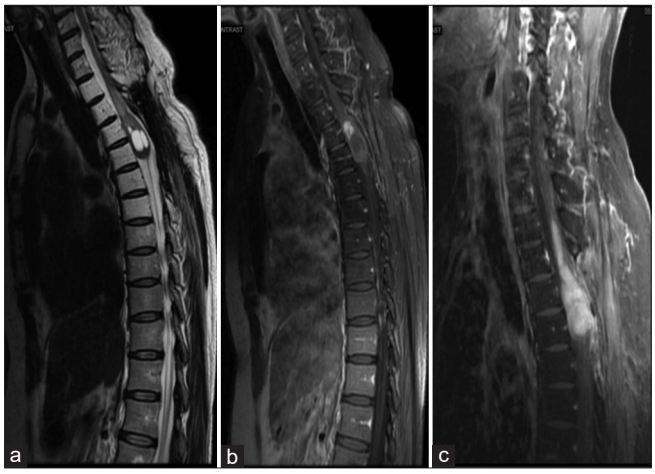

Figure 2: (a) 18 months postoperatively – T2 noncontrast of thoracic spine, (b) 20 months postoperatively – T1 with contrast of thoracic spine, and 3 years postoperatively showing progression (c) 3 years postoperatively – T1 with contrast of cervicothoracic spine.

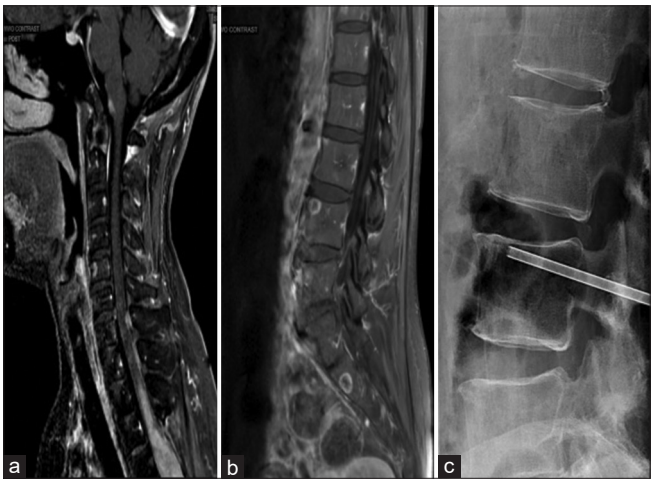

Figure 3: (a) Three years postoperatively – T1 with the contrast of cervical spine, (b) 3 years postoperatively – T1 with the contrast of lumbar spine, and (c) X-ray-guided biopsy of L4 vertebral body.

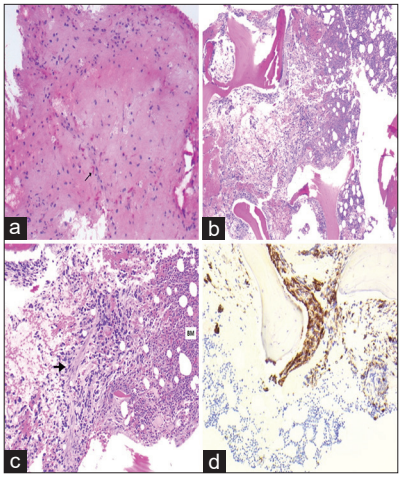

Figure 4: Pathology images after open surgical biopsy and L4 vertebral biopsy. Pathology images (a) initial open surgical biopsy-hematoxylin and eosin (H&E) stain showing the slightly hypercellular glial tissue with scattered Rosenthal fibers labeled with an arrow. L4 vertebral biopsy: (b) H&E stain ×4–L4 vertebral body biopsy showing glial cells embedded in bone marrow, (c) H&E stain ×10–L4 vertebral body biopsy, and (d) glial fibrillary acidic protein (GFAP) stain-L4 vertebral body biopsy with the brown staining confirming glial tissue. The bone marrow is designated by "BM" in the image with the suspected glial tissue marked with the arrowhead.

reserved for partially resected or recurrent ependymomas. On the other hand, astrocytomas tend to be infiltrative and do not have a clear plane of dissection leading to a poorer prognosis.[17] Therefore, astrocytomas are managed with maximal, safe surgical resection followed by radiation therapy if the tumor progresses.[3,13,17]

There are currently no long-term and prospective studies that investigate the treatment of IMSCTs with unknown pathology treating primary IMSCTs with unknown pathology. Thus, this patient's treatment plan was tailored toward treating an aggressive ependymoma or astrocytoma. From the biopsy of the L4 vertebral body, the intermingling of glial cells within the bone marrow suggested the glial tissue had been growing for an extended period [Figures 4b and c]. Finally, given that patient had no other primary lesion and pathology finding from the L4 needle biopsy showing a glial tumor, this suggests that the vertebral body lesions are likely metastasis from the primary IMSCT.

Metastases from primary IMSCTs are extremely rare, and only a few cases have been reported in the literature. In one publication by Handis *et al*., a thoracic intramedullary H3K27M mutant glioma was reported to have seeded at the level of the cauda equina, with intracranial dissemination and extensive vertebral body metastasis.[8] Another publication by Tadele *et al*. reported vertebral body destruction due to metastasis of an intramedullary infiltrative astrocytoma of the spinal cord.[16] In the cases above, spinal bony metastases were both observed at the presentation. Although metastasis to bone from IMSCTs is rare, the spread of high-grade gliomas to the vertebral body is more common with a recent meta-analysis finding 63% of glioblastoma bone dissemination involving the vertebral column.[15] There have been reports of vertebral body metastasis of various other brain tumors including meningiomas,[18] hemangiopericytomas,[11] medulloblastomas,[6] and ependymomas.[6] The exact mechanism of vertebral bone metastasis is unknown. One possible mechanism of metastases from IMSCTs to the vertebrae is the dissemination of cancer cells into the cerebrospinal fluid and subsequently the Batson's plexus.[8] High-grade gliomas can also gain direct access to extra meningeal tissues through dural vessels or spread hematogenously after entering the bloodstream through the breakdown of the blood–brain barrier.[7] Metastasis can also occur iatrogenically due to hematogenous seeding during surgery.[6]

In the aforementioned cases, metastases from IMSCTs were found at the initial presentation and diagnosis of the IMSCT. In our case, evidence of metastasis to the lumbosacral spine was observed 3 years after the patient's initial presentation and after many rounds of chemoradiation.

CONCLUSION

Metastases from primary IMSCTs are rare. Distant vertebral body and intracranial metastasis are even rarer yet possible. Their clinical course is very aggressive and responds poorly to current standard treatment.

Declaration of patient consent

Patient's consent not required as patient's identity is not disclosed or compromised.

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Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The author(s) confirms that there was no use of artificial intelligence (AI)-assisted technology for assisting in the

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