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Spinal metastases are the most common spinal neoplasm and are seen in as many as 70% of patients with cancer.1,4 The extradural compartment remains the preferred location for spinal metastases, and intradural metastases, especially intramedullary, are distinctly uncommon.12,13,15,21,23,27 Cerebrospinal fluid dissemination of metastases from posterior fossa tumors accounts for a significant number of intradural spinal metastases mostly manifesting as leptomeningeal carcinomatosis, and has significant therapeutic and prognostic implication, particularly in children.6,7,9 Similarly, tumor dissemination has been reported following CSF diversion procedures, from the CNS to extraneural sites and vice versa.2,11 Patients with a spinal metastasis at one site can also develop recurrent metachronous extradural metastases after initial surgery and adjuvant therapy.2,26 Unintended durotomy during surgery for extradural spinal metastatic tumors has been reported in up to 8% of cases in various series.2,10,17,25 However, intradural tumor recurrence secondary to local dissemination from an extradural tumor following a durotomy has not been described in the literature. We describe 2 cases of local intradural tumor recurrence following unintended durotomy during a primary surgery for purely extradural spinal metastases and we discuss possible etiology and clinical significance.

Intradural tumor recurrence after resection of extradural metastasis: a rare but potential complication of intraoperative durotomy

Report of 2 cases

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In spinal metastases are the most common of spinal neoplasms and occur predominantly in an extradural location. Their appearance in an intradural location is uncommon and is associated with a poor prognosis. Cerebrospinal fluid dissemination accounts for a significant number of intradural spinal metastases mostly manifesting as leptomeningeal carcinomatosis or drop metastases from intracranial tumors. The occurrence of local tumor dissemination intradurally following surgery for an extradural spinal metastasis has not been reported previously. The authors describe 2 cases in which local intradural and intramedullary tumor recurrences occurred following resection of extradural metastases that were complicated by unintended durotomy. To heighten clinical awareness of this unusual form of local tumor recurrence, the authors discuss the possible etiology and clinical consequences of this entity.

Case Reports

Case 1

A 57-year-old man with a significant medical history of colorectal carcinoma presented with back and left-sided chest pain of 5 weeks’ duration. Neurological examination was unremarkable, with no evidence of any motor or sensory deficits or long-tract signs. Workup revealed a metastatic neoplasm involving the lateral aspect of the T-9 vertebral body and paravertebral region, which was initially treated with chemotherapy consisting of FOLFOX (FOLinic acid [leucovorin], 5 Fluorouracil, and OXaliplatin) and stereotactic body radiotherapy of 24 Gy in 3 fractions. Despite this, he developed worsening pain, and repeat MRI showed tumor progression in the T-8 and T-9 vertebral bodies and an associated epidural component on the left side causing cord compression (Fig. 1). Given the failure of chemotherapy and radiation treatment, surgery was indicated to prevent neurological decline and to aid in local disease control. The patient underwent a posterolateral decompressive procedure involving T-7–9 laminectomies and left-sided medial facetectomies with left sided T-7, T-8, and T-9 neurectomies for control of his severe and intractable intercostal pain. An intraoperative durotomy measuring approximately 2 mm in size occurred while dissecting the tumor, which was adherent to one of the nerve root sleeves. This small defect was immediately repaired primarily with 4-0 nonabsorbable suture, and a watertight

Abbreviation used in this paper: EBRT = external-beam radiotherapy.
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Fig. 1. Case 1. Preoperative sagittal T1-weighted (A), T2-weighted (B), and postcontrast axial (C) MR images of the spine showing the presence of a T1 hypointense enhancing lesion involving the left side T-8 and T-9 vertebral bodies, pedicles, and articular processes with associated enhancing epidural soft tissue on the left lateral aspect of thecal sac extending from the mid T-7 through mid T-10 levels, and extending into the left T7–8, T8–9, and T9–10 neural foramina.

closure was confirmed with an intraoperative Valsalva maneuver. A subtotal tumor resection was performed, and adequate decompression of the spinal dura and nerve roots was achieved. Pathology confirmed the tumor as a metastatic adenocarcinoma, a signet ring type consistent with a colorectal primary lesion. The patient’s postoperative course was uneventful, with resolution of the left-sided intercostal pain and no evidence of a CSF leak or subcutaneous pseudomeningocele. He then completed his full course of chemotherapy. He was not considered a candidate for further palliative external-beam radiotherapy (EBRT). Two months after the surgery, he presented again to the emergency department with recurrence of pain and new left lower-extremity weakness. Examination revealed the presence of Grade 4/5 strength in left knee extension and ankle dorsiflexion with brisk reflexes. Repeat MRI demonstrated postoperative changes with abnormal signal and heterogeneous enhancement involving the T7–10 vertebral bodies, interval enlargement of the paraspinal mass, and new intrathecal dural-based and pial-based enhancing nodules consistent with subarachnoid tumor spread (Fig. 2). Imaging also revealed numerous new pulmonary metastases. Magnetic resonance imaging of rest of the neural axis revealed no other distant intradural metastases. In view of the significant spread of the disease, local intradural/intradural recurrence with likely CSF dissemination, and the development of pulmonary metastases, surgery was not considered an option. Alternatives to surgery—intrathecal chemotherapy and/or palliative radiation treatment—were discussed with the patient, but given his very poor prognosis, he elected to be discharged to hospice care at home.

Case 2

A 68-year-old man, with a history of stage IIB non–small cell lung adenocarcinoma treated with lobectomy and subsequently 4 cycles of concurrent chemotherapy (pemetrexed and cisplatin) and 50 Gy in 25 fractions of intensity-modulated radiotherapy, presented with complaints of parascapular pain. Neurological examination was unremarkable, with no evidence of myelopathy. Magnetic resonance imaging showed an expansile, enhancing mass involving the T-3 vertebral body, extending into the right pedicle and encroaching upon the spinal canal on the right, with effacement of the CSF space around the spinal cord (Fig. 3). Given the disease progression despite chemotherapy and radiotherapy, resection was considered to obtain local control of the disease. The surgery involved a T-3 lateral extracavitary corpectomy and T1–5 posterior segmental instrumentation and fusion. During surgery, a 2- to 3-mm nerve root sleeve durotomy occurred, which was immediately recognized and repaired primarily using 4-0 nonabsorbable suture in a watertight fashion. A subtotal piecemeal resection was performed given that the goal of surgery was palliative, with the main objective being neural element decompression and stabilization of the spinal column. Histopathological examination confirmed the tumor to be metastatic adenocarcinoma consistent with a lung primary lesion. The patient’s course was uneventful until 3 months postoperatively when he presented with left lower-extremity weakness and inability to ambulate for a week. Neurological examination revealed weakness of the left lower extremity, with Grade 2–3/5 strength of all muscle groups and no long-tract signs. Magnetic resonance imaging revealed extensive spinal cord signal change from the midcervical to midthoracic region, along with enhancing intramedullary nodules at T3–5 specifically involving the left hemicord (Fig. 4). Positron emission tomography/computed tomography showed increased uptake in the right paraspinal region and within the spinal canal as well as in a subcarinal node. No other distant intradural metastases were seen on MRI of the neural axis. Despite the presence of intramedullary tumor recurrence, CSF cytological results of a lumbar puncture were negative for malignancy. Surgery was not considered an option because of extensive recurrence of the disease both locally and systemically. Repeat radiotherapy for local control was performed, recognizing the increased risk of radiation myelitis due to prior radiation. The patient remained nonambulatory but had slight improvement in strength and decreased pain.
Discussion

Recent advancements in treatment options for patients with cancer have not only led to prolonged survival but also to more frequent presentations of osseous metastatic disease requiring definitive management. Spinal metastases, in particular, are very common in patients with metastatic cancer, and interventions to treat these lesions have the potential to significantly improve an individual’s quality of life. While the overall prognosis of patients with metastatic spinal tumors remains poor, advances in spinal instrumentation and stereotactic radiotherapy techniques have allowed higher rates of local tumor control, with lessened pain severity and improved neurological function. Nevertheless, the goal of surgery remains palliative because patients’ median survival following development of spinal metastases is typically 3–12 months, and tumor histology is one of the most significant factors predicting survival and determining treatment strategies.
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Intradural spinal metastases are rare but important variants of cancer dissemination. Various mechanisms have been implicated in the development of intradural metastases and include the following: 1) hematogenous dissemination through arterial pathways or retrograde spread along the Batson venous plexus; 2) direct invasion of a tumor adjacent to the spinal dura; and 3) tumor cell migration along CSF pathways and is often coexistent with brain metastases,\(^6,7,9,21\) with an increased risk reported after piecemeal resection of posterior fossa metastases.\(^20\) Similarly tumor seeding via the CSF during surgery has been implicated in the recurrence of primary intradural tumors such as ependymomas at sites distant from the original tumor location.\(^28\) Once intradural spread of a tumor is identified on imaging, diagnosis is typically based on a patient's clinical history or on the findings of direct biopsy because CSF cytology is unreliable (up to 30% of patients with CSF tumor dissemination have negative cytology results). Unintended durotomies during spinal surgeries are not uncommon and are associated with various factors such as primary versus revision surgery, type of surgery, and underlying spinal pathology.\(^9,19,23,22,26,27\) The incidence of unintended durotomy during surgery for spinal metastases has been reported to range from 3% to 8% in various studies.\(^2,10,17,25\) In our experience involving 275 cases of surgery for extradural spinal metastases (unpublished data), an intra-operative unintended durotomy occurred in 20 patients (including the 2 cases reported here), reflecting an overall rate of 7%. In most cases, the intraoperative durotomy can be repaired primarily with no untoward consequences. Wound-related complications like CSF–cutaneous fistula and infection remain the most concerning complications following unintended durotomy in spine surgeries.\(^2,10,17\) Although the occurrence of a durotomy during resection of extradural metastatic tumors is not uncommon,\(^2,10,17,25\) no reports exist of intradural tumor recurrence or dissemination following a durotomy as encountered in the present report.

Various hypotheses can be suggested to explain the development of this complication, including local intradural seeding of tumor cells into the CSF through the durotomy defect despite adequate intraoperative primary repair. Although the possibility of tumor spread due to direct tumor invasion cannot be ruled out, in our cases there was no evidence of any dural breach by the tumor at the index surgery. The discontinuity between the intradural intramedullary tumor seen postoperatively and the location of the extradural tumor preoperatively may also argue against tumor spread secondary to direct invasion. Although a causal relationship between durotomy and intradural tumor spread cannot be proven here, a correlation does seem to exist. Considering that 2 (10%) of our 20 patients with intraoperative durotomy during surgery for spinal metastasis developed intradural tumor spread and none of the 255 patients without durotomies developed this problem, the presence of unintended durotomy was statistically significantly associated with intradural tumor spread (p = 0.005). Though many potential confounders exist, this statistic supports our hypothesis of rare but possible intradural seeding that occurs due to unintended durotomies. As a consequence, attempts to repair the durotomy in such cases as soon as possible may be useful to minimize the risk of this complication, since prompt durotomy closure would theoretically reduce the burden of tumor cells introduced into the intradural compartment. Even with an apparent “watertight” durotomy repair, however, there may still be microscopic CSF egress and, conversely, tumor cell ingress through the repaired durotomy. Having seeded the intradural space, the potential for local growth remains in the absence of adjuvant treatments including systemic chemotherapy and/or local radiotherapy. Once the tumor recurs intradurally, the consequences can be severe as the treatment options are very limited, and the overall prognosis of intramedullary metastases in general, including less functional recovery following surgery and shorter overall survival, is much worse than that of extradural metastatic lesions.\(^19\)

Various reasons have been cited for worse outcomes in patients with intradural metastasis such as an inability to resect the lesion aggressively and/or the limitations in radiation delivery to the tumor due to its location within either the spinal canal or in the spinal cord. Both the patients described here presented with neurological deficits and significant local recurrence in the intradural and intramedullary compartments following brief periods of clinical improvement after initial surgical resection of the extradural metastasis and decompression of the neural el-
ments. Although unintended durotomy is not rare during surgery for spinal metastases, most patients will undergo postoperative adjuvant therapy, which typically includes EBRT. Since both of the patients described here had already undergone prior chemotherapy and radiotherapy, the options for postoperative adjuvant local control were limited. Presumably, even if a significant number of unintended durotomies during these types of surgeries are accompanied by microscopic intradural tumor seeding, adjuvant EBRT and/or chemotherapy should suffice to prevent tumor progression in the region. This fact simply reinforces the clinical practice paradigm of generally treating patients harboring symptomatic spinal metastases with surgery followed by radiation therapy, rather than vice versa. One could argue that patients in whom systemic and radiation treatments have failed and who then require surgery for spinal metastases may have more aggressive forms of malignancies and may, therefore, be at higher risk for intradural metastases regardless of durotomy. Regardless, our experience suggests that patients with particular clinical circumstances such as those presented here may warrant a lower threshold for proceeding with adjuvant radiation treatment if feasible to avoid intradural progression and subsequent neurological deterioration. We routinely perform MRI at 6 weeks postresection in our patients with metastatic spinal tumor, which is of value in diagnosing local recurrence in general and would be most useful in the specific subtype of patients described in the present report.

Conclusions

It has been demonstrated that surgical intervention produces significant improvements in pain and quality of life for patients with symptomatic spinal metastasis. Minimizing both complications and local tumor recurrence is critical to the successful surgical management of these complicated patients. Raising awareness of unusual or rare complications is essential in their prevention and management. The cases presented here suggest that patients with unintended durotomies during surgery for extradural tumor resection should be monitored for intradural tumor recurrence by early imaging surveillance and that durotomies during metastatic tumor surgery may potentially have unique complications compared with durotomies during surgery to treat degenerative spinal disorders.

Disclosure

Dr. O’Toole reports being a consultant for Globus Medical, Pioneer Surgical, and Nexxt Spine.

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References


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